

ASIAN DEVELOPMENT BANK

PPA: THA 26347

PROJECT PERFORMANCE AUDIT REPORT

ON THE

**SECOND ERAWAN GAS TRANSMISSION PROJECT
(Loan 1276-THA)**

IN

THAILAND

June 2001

CURRENCY EQUIVALENTS

Currency Unit – Baht (B)

	At Appraisal (31 Oct 1993)	At Project Completion (7 Aug 1997)	At Operations Evaluation (12 Feb 2001)
B1.00	= \$0.03971	= \$0.03163	= \$0.02329
\$1.00	= B25.18	= B31.618	= B42.93

ABBREVIATIONS

ADB	–	Asian Development Bank
DMR	–	Department of Mineral Resources
EGAT	–	Electricity Generating Authority
EIB	–	European Investment Bank
EIRR	–	economic internal rate of return
EXIM	–	Export-Import
FIRR	–	financial internal rate of return
km	–	kilometer
MMCFD	–	million cubic feet per day
OEM	–	Operations Evaluation Mission
OEPP	–	Office of Environmental Policy and Planning
PCR	–	project completion report
PIO	–	project implementation office
PPAR	–	project performance audit report
PTT	–	Petroleum Authority of Thailand
RRP	–	report ad recommendation of the President
SCADA	–	supervisory control and data acquisition
TA	–	technical assistance
TPA	–	third-party access
WB	–	World Bank

NOTES

In this report, "\$" refers to US dollars.

CONTENTS

	Page
BASIC DATA	4
EXECUTIVE SUMMARY	5
MAP	
I. BACKGROUND	8
A. Rationale	8
B. Formulation	8
C. Purpose and Outputs	8
D. Cost, Financing, and Executing Arrangements	9
E. Completion and Self-Evaluation	10
F. OED Evaluation	10
II. PLANNING AND IMPLEMENTATION PERFORMANCE	11
A. Formulation and Design	11
B. Cost and Scheduling	12
C. Consulting Services, Procurement, and Construction	12
D. Organization and Management	13
III. ACHIEVEMENT OF PROJECT PURPOSE	14
A. Operational Performance	14
B. Performance of the Operating Entity	14
C. Sustainability	16
IV. ACHIEVEMENT OF OTHER DEVELOPMENT IMPACTS	17
A. Socioeconomic Impact	17
B. Environmental Impacts	17
C. Impacts on Institution and Policy	18
V. OVERALL ASSESSMENT	20
A. Relevance	20
B. Efficacy	20
C. Efficiency	20
D. Sustainability	20
E. Institutional Development and Other Impacts	21
F. Overall Project Rating	21
G. Assessment of ADB and Borrower Performance	21
VI. ISSUES, LESSONS, AND FOLLOW-UP ACTIONS	22
A. Key Issues for the Future	22
B. Lessons Identified	22
C. Follow-Up Actions	23
APPENDIXES	24

BASIC DATA
Second Erawan Gas Transmission Project (Loan 1276-THA)

KEY PROJECT DATA (\$ million)

	Appraisal	Actual
Total Project Cost	671.0	482.3
Foreign Exchange Cost	566.0	385.5
ADB Loan Amount/Utilization	100.0	70.4
Amount Cancelled		29.6
Amount of Cofinancing		
Export-Import Bank of Japan	100.0	70.4
European Investment Bank	46.0	48.0
World Bank	155.0	111.7
Petroleum Authority of Thailand	270.0	181.8

KEY DATES

	Expected	Actual
Fact-Finding	17 Feb-05 Mar 1993	07 Feb-05 Mar 1993
Appraisal	21 Jun-02 Jul 1993	21 Jun-02 Jul 1993
Loan Negotiations	25-27 Oct 1993	25-27 Oct 1993
Board Approval	02 Dec 1993	02 Dec 1993
Loan Agreement		08 Apr 1994
Loan Effectiveness	07 Jul 1994	11 Aug 1994
First Disbursement		28 Dec 1994
Loan Closing	31 Oct 1997	28 Feb 1997
Project Completion	30 Apr 1997	Apr 1997
Months (Effectiveness to Completion)	34	33

KEY PERFORMANCE INDICATORS (%)

	Appraisal	PCR	PPAR
Economic Internal Rate of Return	23.1	39.4	45.7
Financial Internal Rate of Return	16.6	16.6	15.9

BORROWER

Petroleum Authority of Thailand

GUARANTOR

Kingdom of Thailand

EXECUTING AGENCY

Petroleum Authority of Thailand

MISSION DATA

	No. of Missions	Person-Days
Reconnaissance	1	8
Fact-Finding	1	50
Appraisal	1	48
Review	2	8
Project Completion	1	16
Operations Evaluation ¹	1	20

ADB = Asian Development Bank, PCR = project completion report, PPAR = project performance audit report.

¹ The Mission comprised C.C. Yu, Evaluation Specialist and Mission Leader; B. Palacios, Evaluation Analyst; and Charoon Sompoo, Domestic Consultant.

EXECUTIVE SUMMARY

The Asian Development Bank's (ADB) operational strategy for Thailand in the early 1990s supported upgrading and development of physical infrastructure, with special emphasis on associated policy and institutional reforms, including privatization, and greater private sector participation. The strategy also aimed to promote effective management of the environment and natural resources to conserve their long-term potential and ensure their appropriate use for development activities.

The main objective of the Project was to increase the indigenous natural gas supply capability by expanding the gas transmission system and thus meet the growing energy demand that would otherwise have to be met by imported oil. Additional objectives were to improve environmental and safety standards, increase the efficiency of natural gas use, and strengthen the commercial role and institutional capabilities of the Petroleum Authority of Thailand (PTT) in support of the future development of the hydrocarbon sector. Specific components of the Project included procuring, constructing, and installing offshore and onshore pipelines, onshore compressors, and other ancillary and offsite equipment and facilities including cathodic protection (anticorrosion), and a supervisory control and data acquisition system. The Project also provided for corporate restructuring and institutional strengthening of PTT, the Executing Agency, including overseas training of PTT staff and related studies. The Project was consistent with ADB's operational strategy for Thailand. The Government assigned it high priority, given its emphasis on efficient energy utilization and development of indigenous natural gas resources to enhance energy security.

On 2 December 1993, the Board approved a \$100 million loan for the Project, which was cofinanced by the World Bank (\$155 million), European Investment Bank (\$46 million), and Export-Import Bank of Japan (\$100 million). The total project cost was estimated at \$671 million; additional sources of finance were commercial bank loans, domestic bond issues, and PTT's own financing.

The Operations Evaluation Mission visited Thailand in February 2001 and confirmed that all project components were carried out as originally envisaged, except for PTT's corporate restructuring and institutional strengthening to avoid an overlap with similar past and ongoing efforts. The total project cost amounted to \$482 million, compared with the appraisal estimate of \$671 million. The 28 percent savings resulted from lower-than-expected costs of line pipes, coating, and offshore pipeline construction due to competitive bidding and efficient management. Actual ADB loan disbursement was \$70.4 million, and the balance was cancelled. The loan was closed in February 1997, ahead of the expected closing date of October 1997. The Project started regular operation in April 1997, in line with appraisal schedule.

The Project achieved its key objective by more than doubling the gas transmission capability, from 780 million cubic feet per day (MMCFD) to 1,600 MMCFD. Despite the slower growth in demand for natural gas after the Asian financial crisis, consumption still increases by 7-8 percent per annum. As a result, the Project's offshore and onshore pipelines have reached about 96 percent of their current maximum capacities. The increased transmission capacity has greatly helped Thailand in improving its long-term energy security, particularly for the power industry, as well as securing foreign investments in the upstream exploration and production of natural gas. The Project's two other objectives, i.e., strengthening the commercial role and

institutional capabilities of the PTT, and enhancing environmental and safety standards in the hydrocarbon sector, have been partly achieved.

As a result of the increased gas transmission capacity and the rising international oil prices, which have strengthened the competitiveness of natural gas, PTT has gradually improved its financial performance since 1997 and complied with its loan covenants. However, PTT's performance still shows an imbalance, with its natural gas operations cross-subsidizing its refinery and oil retailing operations. While only 30 percent of PTT's sales come from natural gas operations, they account for 60-100 percent of the company's net profits.

The Project has brought about net positive impacts on the environment and environmental management in the hydrocarbon sector. First, the Project facilitated PTT's collaboration with international consultants, contractors, and suppliers that introduced modern technologies and best practices. This collaboration has helped PTT maintain high environmental (including health and safety) standards. Second, the Project has reduced air emission by substituting fuel oil with natural gas, a cleaner and more efficient fuel. In terms of impacts on institutional strengthening and corporate restructuring, although the proposed studies and training were not implemented as planned, an earlier technical assistance for developing business strategies for PTT to prepare for future deregulation, together with PTT's own initiatives, laid the foundation for the Government's privatization plan for PTT. The initial public offering is scheduled in the fourth quarter of 2001.

The Project did not have any direct social objective. However, in light of the recent oil price hikes in the international market, the Project may have helped reduce inflationary pressure through savings of foreign exchange for oil imports. By helping generate cheaper electricity, the Project has benefited economic recovery in general and the poor in particular.

To summarize, the Project was highly relevant at appraisal. It was not only fully in line with the Government's goal of developing indigenous resources to meet the energy demand, but also consistent with ADB's country operational strategy. The Project appears even more relevant today because, without it, Thailand would have to pay much more in foreign currency for imported fuel oil, given the high world market prices. In terms of efficacy, the Project has achieved its main objective, which was to increase Thailand's capacity for indigenous natural gas transmission and utilization. The recalculated financial and economic internal rates of return of 15.9 percent and 45.7 percent, respectively, demonstrate the high efficiency of the Project. Although the Project experienced a delay due to a poor performance of the onshore pipeline contractor, PTT managed the situation well and the Project was implemented at a cost 28 percent below the appraisal estimate. Since PTT has a proven record of maintaining pipelines and well-trained staff to manage and operate the pipelines, the benefits from the Project are likely to be sustainable. Finally, the Project has brought about positive impacts on institutional strengthening, the environment, and the society. Overall, the Operations Evaluation Mission rates the Project as highly successful.

Three issues derived from the evaluation may be relevant to ADB's operations. First, ADB needs to decide whether to continue supporting similar energy infrastructure projects. It appears that commercial funding may be available in Thailand for such projects, but continued ADB support for similar projects in other, less developed, developing member countries may be advisable as they bring about significant economic and environmental benefits. Second, the new Government is committed to privatizing key State enterprises including PTT. ADB should continue its policy dialogue in this area and provide assistance as required. Third, natural gas is facing unfair competition from cheaper but "dirtier" fuels such as fuel oil or coal. The Government should strictly enforce its environmental standards by forcing refineries and power

plants to install antipollution equipment, which will enhance the competitiveness of natural gas by making other fuels more expensive.

This Project demonstrates, in a positive manner, that a strong sense of ownership by the Government and the Executing Agency is crucial for project success.

I. BACKGROUND

A. Rationale

1. Thailand's economic growth averaging 7-8 percent per annum was among the fastest in the world during the three decades that ended in the mid-1990s. To sustain that economic growth and reduce the country's dependence on imported oil, the Government adopted a strategy that emphasized efficient energy utilization and gave high priority to the development of indigenous natural gas resources to achieve energy security. The Asian Development Bank (ADB) supported the Government's strategy. ADB's country operational strategy for Thailand in the early 1990s focused on assistance in developing and upgrading physical infrastructure, with special emphasis on associated policy and institutional reforms including privatization and greater private sector participation. The operational strategy also aimed to promote effective management of the environment and natural resources through their conservation and efficient use for development activities.

B. Formulation

2. In early 1990, driven by the increasing demand for energy and additional gas discovery in the Gulf of Thailand, the Petroleum Authority of Thailand (PTT), a State-owned oil and gas company, engaged an American consulting firm to formulate a master plan for natural gas expansion and to prioritize PTT's investment plans. The Project was determined as one of the priority investments needed to increase gas supply capacity. Project preparatory consulting services—preparing basic engineering designs, specifications for materials and equipment, and tender documents; and construction supervision—were performed by an international firm and financed by the World Bank (WB) under a previous agreement. The Project was the last of three pipeline projects financed or partly financed by ADB, which aimed at transporting natural gas produced in the Gulf of Thailand to industrial and utility consumers.¹ In August 1991, the Government requested ADB assistance to finance part of the foreign exchange cost of the Project and PTT submitted data and information on the Project to ADB based on the feasibility report prepared by the consultants. Fact-finding was undertaken between 7 February and 5 March 1993, while appraisal—participated in by representatives from cofinancing agencies including the European Investment Bank (EIB) and Export-Import (EXIM) Bank of Japan—took place between 21 June and 2 July 1993. On 2 December 1993, the Board approved a loan of \$100 million for the Project.

C. Purpose and Outputs

3. The main purpose of the Project was to increase the indigenous natural gas supply capability by expanding the gas transmission system to meet the growing energy demand that would otherwise have had to be met by imported oil. Additional purposes were to improve environmental and safety standards, increase efficiency of natural gas use, and strengthen PTT's commercial role and institutional capabilities in support of the future development of the hydrocarbon sector.

¹ The first two projects were Loan 622-THA: *Natural Gas Transmission Project*, for \$40 million, approved on 22 December 1982; and Loan 1169-THA: *Bongkot Gas Transmission Project*, for \$58 million, approved on 2 July 1992.

4. The major components of the Project at appraisal included (see map)
- (i) an offshore pipeline,² 36 inches in diameter and 425 kilometer (km) long, linking the Erawan Riser Platform with the gas-receiving facilities onshore at Rayong;
 - (ii) an onshore pipeline, 28 inches in diameter and 110 km long, linking the gas separation plants at Rayong with the gas grid at Bangpakong;
 - (iii) onshore gas compression facilities of about 15,000 horsepower;
 - (iv) ancillary and offsite equipment and facilities consisting of cathodic protection; supervisory control and data acquisition (SCADA) and telecommunication systems; gas metering; pressure regulation and pig launcher/receiver; and related equipment for modifying and expanding the existing facilities; and
 - (v) corporate restructuring and institutional strengthening of PTT, including overseas training of PTT staff and other studies.

5. The Project did not provide advisory technical assistance (TA) directly. However, two TAs that accompanied the earlier loan for the Bongkot Gas Transmission Project (footnote 1) were relevant to the objectives of the Project. The first TA³ aimed to assist PTT in developing its business strategies to prepare for future deregulation in the sector and greater competition from the private sector. The second TA⁴ aimed to help the Government establish a set of environmental standards and regulations for the hydrocarbon industry. Because the two TAs were relevant to the formulation and approval of the Project, the Operations Evaluation Mission (OEM) tried to assess the efficacy of both by examining the extent to which they achieved their objectives.

D. Cost, Financing, and Executing Arrangements

6. The total project cost was estimated as \$671 million equivalent at appraisal, including \$566 million in foreign exchange and \$105 million equivalent in local currency. About 70 percent of the foreign exchange cost of the Project was to be financed by ADB, WB, EIB, and EXIM Bank of Japan. ADB's contribution was to be \$100 million, while the other financial agencies were to provide \$301 million. The remaining foreign exchange and all local currency costs were to be financed by PTT's commercial borrowings and internal cash generation. PTT served as the Executing Agency for this Project. The same project implementation office (PIO) established by PTT for the earlier ADB-financed Bongkot Gas Transmission Project implemented the Project. WB financed the project preparatory consulting services under a previous agreement and no ADB loan proceeds were used for this purpose.

² The offshore pipeline was built parallel to an existing pipeline.

³ TA 1726-THA: *Refocusing PTT: Assessment of PTT's Business Strategies and Privatization Program*, for \$450,000, approved on 2 July 1992.

⁴ TA 1727-THA: *Environmental Standards and Regulations for Hydrocarbon Development*, for \$250,000, approved on 2 July 1992.

E. Completion and Self-Evaluation

7. The project completion report (PCR), which was circulated on 27 October 1997, reported that all project components were carried out as originally envisaged, except for PTT's corporate restructuring and institutional strengthening, which were taken care of by other previous and ongoing initiatives.⁵ The PCR reported that the Project was implemented satisfactorily within the original loan closing date and was 28 percent below the original budget. It rated the Project as generally successful.

F. OED Evaluation

8. This project performance audit report (PPAR) will focus on the Project's effectiveness in meeting its objectives. To accomplish this, the PPAR assesses various aspects of project formulation, design, implementation, and sustainability, as well as its socioeconomic, environmental, and institutional impacts. The assessment is based on a review of ADB documents, discussion with ADB staff, and findings of the OEM, which visited Thailand in February 2001. During the visit, the OEM held discussions with PTT officials, key responsible government agencies, private companies, and the PTT's top customer for its natural gas, i.e., the electric power industry. Copies of the draft PPAR were sent to the Government, PTT, and the concerned ADB staff for review; all comments received have been considered in finalizing the report.

⁵ The PCR reported that a team of four international and five domestic financial advisers, who were appointed in July 1997, had started a study to decide whether to structure PTT as an integrated energy company and partly privatize it, or privatize the individual business already in existence.

II. PLANNING AND IMPLEMENTATION PERFORMANCE

A. Formulation and Design

9. The rapid economic expansion that Thailand was able to achieve before the Asian financial crisis imposed increasing strains on the country's energy supply capacities and related infrastructure. To meet the energy challenge, the Government emphasized efficient energy utilization and increased energy security by reducing dependence on imported oil. The discovery of rich natural gas reserves in the Gulf of Thailand made it possible to narrow the gap between the domestic energy demand and supply. By providing the necessary infrastructure, i.e., gas transmission pipelines and auxiliary equipment, the Project was consistent with ADB's country operational strategy in Thailand, which emphasized physical infrastructure and promotion of conservation and efficient use of natural resources. Although the subsequent Asian financial crisis dampened the energy demand and prices, the basic Government strategy of substituting domestic natural gas for imported fuels remains sound and valid. The relevance of the Project was particularly reinforced by the sustained high oil prices in the international market. Without the Project, Thailand would have to pay much more in foreign exchange to meet its energy demand.

10. ADB's country operational strategy also stressed greater private sector participation. A strong justification for the Government to invest in the pipeline transmission capacity was that it would attract or secure more private sector investment in the upstream exploration and production of natural gas. At the time of appraisal, several multinational oil and gas companies had already invested heavily in exploration and the signing of concessionaire agreements partly hinged upon an adequate transmission capacity. The Project would allow the companies to recoup their investments from gas production and would possibly mobilize additional investment in the development of gas reserves.

11. To facilitate long-term deregulation of the hydrocarbon sector and prepare PTT for anticipated greater competition from the private sector, the Project included funds for conducting studies and training related to corporate restructuring and institutional strengthening. The potential environmental improvement due to the substitution of natural gas for imported fuel oil, a much cleaner and more efficient fuel, was recognized but more as a side benefit than as a strong incentive in itself. No additional funds were allocated for environmental purposes mainly because a TA for establishing environmental standards for the hydrocarbon sector had already been provided in conjunction with a previous loan (footnote 4).

12. The OEM considers the project design as one of least cost, adequate for PTT's needs at the time of completion, that allows for cost-effective expansion over time as PTT's demand increases. The only significant change made to the design during implementation was an extension (Wang Noi extension) of the onshore pipelines to allow delivery of gas to the Wang Noi power plant being concurrently constructed by the Electricity Generating Authority of Thailand (EGAT). The change involved adding new components including a 100 km 36-inch pipeline through marshy lowlands, a compressor station at Bangpakong, and a sales gas metering station at Wang Noi. The current maximum capacity of the Erawan-Rayong pipeline is 820 million cubic feet per day (MMCFD), compared with the actual flow of 790 MMCFD in 2000 or 96 percent of the current maximum capacity (Appendix 1). However, PTT predicts that the pipeline can safely handle up to 933 MMCFD without additional compression. If additional capacities are needed, one option is to install an offshore intermediary compressor (located halfway between the starting and ending points). The option, which is much cheaper than building a new pipeline, would boost the pressure to increase the capacity by one third to about 1,200 MMCFD.

13. Most project implementation and operation personnel interviewed by the OEM indicated that, if they were given the opportunity to build the same project again, they would still prefer the same design in terms of routing and capacity. However, some held the view that the routing of the pipeline built under the Project parallel to the existing one was not ideal for giving communities in southern Thailand easy access to natural gas. Instead, the line should have been routed closer to the coast. It is the view of the OEM, however, that the alternative routing, while cutting the distance to the said communities significantly, would pose several problems. First, it would incur additional costs as the distance to the offshore platforms would be longer. Second, it would be more environmentally disruptive since the pipeline would be much closer to coastal fishery communities and ecologically sensitive marine environment. Third, population density in southern Thailand is sparse and any future rise in demand could be met through building additional pipelines connecting the main trunk lines, as currently planned (see map).

B. Cost and Scheduling

14. Appendix 2 provides details of cost breakdown by project component and financing source. Table A1.1 indicates that, although there were moderate overruns on some items, such as consulting services, facilities, and project management, the actual project cost amounted to only \$482 million, compared with the appraisal estimate of \$671 million. The actual cost included \$385 million in foreign exchange and \$97 million equivalent in local currency. The 28 percent loan savings were mostly from lower-than-expected costs on line pipes, coating and offshore pipeline construction due to competitive bidding and efficient management by the PIO and the consultants. Actual ADB loan disbursement was \$70.4 million, comprising about \$43.6 million for purchasing line pipes and \$26.8 million for line pipe coating and jacketing; the balance was cancelled. Table A1.2 gives the breakdown of fund provision by source.

15. Appendix 3 shows the detailed project implementation schedule (appraisal and actual), which indicates that the project completion dates were within ADB's appraisal estimates. However, based on PTT's own implementation schedule,⁶ the Project experienced a delay due to unexpected difficulties encountered during implementation.

C. Consulting Services, Procurement, and Construction

16. PTT procured the specified pipes and other equipment, as well as the services of contractors, in accordance with ADB's and other cofinancing agencies' procurement guidelines. The quality of the supplies was reportedly satisfactory. However, while the offshore pipelines were well constructed and within schedule, onshore construction encountered difficulties and experienced a delay. The main difficulties included (i) the contractor's lack of experience in laying pipelines on soft marshy land, (ii) protracted land acquisition, and (iii) flooding. As a result, PTT had to pay additional compensation to the contractor for it to continue the work. In addition, because the original contractor lacked technical capacity, the contract was terminated earlier. The last 50 km of the pipelines had to be rebid, and a different but more experienced contractor was brought in. The final certification for all contractors was issued in April 1997 and the Project started regular operation also in April 1997, 15 months after PTT's own target, but still within ADB's appraisal schedule.

17. Consulting services were procured under an earlier agreement, with WB funding. Interviews with key PIO officials indicated that PTT was highly satisfied with the consulting services performed by an international firm.⁷

⁶ There was a 15-month difference between PTT's own scheduling and ADB's appraisal estimate of the project completion date.

⁷ PTT has engaged the international firm for its ongoing Joint Development Area Project.

D. Organization and Management

18. Generally, PTT has strong capability in organizing and managing natural gas development projects. As project implementation followed closely that of the earlier Bongkot Gas Transmission Project (footnote 1), ADB and PTT were able to take full advantage of the available information and personnel resources already in place. The PIO established earlier continued to implement this Project.

19. PTT's compliance with loan covenants in the areas of project implementation, organization and management, and financial performance was satisfactory. The only loan covenant not complied with was related to the preparation of a detailed training program, with assistance of management consultants, to develop PTT's business and privatization strategies, mainly because it overlapped with similar initiatives PTT had already undertaken. The loan covenant regarding preparing and submitting project benefit monitoring and evaluation reports to ADB experienced a brief delay, but was complied with after ADB issued a reminder.

III. ACHIEVEMENT OF PROJECT PURPOSE

A. Operational Performance

20. All the physical components of the Project were completed as envisaged at appraisal (para. 4), including the offshore and onshore segments of the pipelines, the onshore compression facilities, and the upgrading of the existing SCADA and telecommunication systems; gas metering; pressure regulation and pig launcher/receiver. The facilities built were all in excellent condition at the time of the OEM's visit. Selected project photos are in Appendix 4.

21. The envisaged training and studies on corporate restructuring and institutional strengthening of PTT were not carried out because during project implementation there were already various PTT initiatives to engage international business consultants to conduct such studies and in-house training.

22. The Project clearly achieved its key objective by more than doubling gas supply capability, from 780 MMCFD to 1,600 MMCFD. Despite the slower growth in demand for natural gas after the Asian financial crisis, consumption still increases approximately by 7-8 percent per annum, compared with approximately 15 percent per annum before the crisis. As a result, the Project's offshore and onshore pipelines have reached about 96 percent of their design capacities.⁸ The increased transmission capacity has helped Thailand in improving its long-term energy security, particularly for the power industry, which is the biggest customer of PTT's natural gas. It also helped secure foreign investments in the upstream exploration and production of natural gas. Partly due to the assured and adequate gas transmission capacity, several major multinational gas companies (including UNOCAL, a US-based company and the largest gas producer in Thailand, and TOTAL, a France-based company) operate in the Gulf of Thailand to explore and produce natural gas.

23. The Project's two other objectives, i.e., strengthening the commercial role and institutional capabilities of PTT, and enhancing environmental and safety standards in the hydrocarbon sector, have been partly achieved (paras. 33-41).

B. Performance of the Operating Entity

24. The increased gas transmission capacity and rising international oil prices have strengthened the competitiveness of natural gas. Consequently, PTT has gradually improved its financial performance since 1997. Appendix 5 gives some key financial performance indicators. In 1999,⁹ the latest year for which data is available, roughly B70 billion, or 30 percent, of PTT's total sales revenue of B227 billion came from natural gas. The net profit from natural gas sales was B8.5 billion, compared with the total net profit of B5.6 billion for all PTT for the year. In other words, PTT's non-gas operations, e.g., refineries, gasoline retail, etc., made a net loss in 1999, and natural gas operations cross-subsidized the other segments. This was partly because PTT still enjoys a monopoly in gas transmission while the other segments are almost completely liberalized (para. 39).

25. Appendix 5 also suggests that PTT has been recovering steadily from the financial crisis of 1997. Its net profit margin, which plummeted to the lowest level in 1997 at only 0.9 percent, recovered to 2.5 percent in 1999. Other key financial ratios in 1999—debt/equity ratio (1.9), debt-service coverage ratio (2.1), self-financing capacity (62 percent)—were well within the

⁸ Interviews with various PTT and governmental officials suggest that, if it were not for the financial crisis, the design capacity could have already been reached and another capacity expansion have been needed by now.

⁹ Since 1996, the financial year has been the same as the calendar year.

covenanted levels, i.e., 2.33, 1.3, and 25 percent, respectively, reflecting PTT's strong financial health. The results for 2000, although not yet available, are likely to show a further improvement over 1999.

1. Financial Reevaluation

26. Appendix 6 contains the recalculated financial internal rate of return (FIRR), using updated information obtained from PTT. The new information reflects the depressed natural gas demand and prices after the Asian financial crisis. The exchange rate also affects FIRR. The baht has depreciated by 72 percent since appraisal (1993) and 34 percent since the PCR Mission (1997). A declining local currency means that the portion of the capital cost borrowed in foreign currency becomes more expensive in local currency. The report and recommendation of the President (RRP) and the PCR treated remittance to treasury as part of project cost. In the reevaluation, this has been excluded from the cost items because it represents a portion of PTT's profit claimed by the Government, which is proportionately attributed to the Project. The recalculated FIRR is 15.9 percent, slightly lower than the 16.6 percent in both the RRP and the PCR, but much higher than the weighted average cost of capital estimated at 3.4 percent in real terms. The weighted average cost of capital for the Project was considerably lower than interest rates to be paid if the Project had been financed entirely by commercial sources. Consequently, PTT had gained some advantage over its commercial competitors in the oil industry, by borrowing for the Project from ADB, EIB, EXIM Bank of Japan, and WB.

2. Economic Reevaluation

27. Appendix 7 gives details of economic reevaluation. Unlike in the financial reevaluation, the estimation of the economic benefits and costs of the Project is made for a larger natural gas production-transmission-distribution system, which includes the pipelines built under the Project. The reason is that the economic benefit of the pipelines (increase of gas transmission) would not be accrued without gas production and distribution.

28. From society's point of view, the main benefit of the Project is that it allowed replacement of the imported fuel oil, that would have been necessary to meet the same energy demand. Consequently, the CIF (cost, insurance, and freight) price of imported fuel oil is used as a proxy measure for the economic benefit of the Project. The rising fuel oil prices at the Singapore oil exchange, from which Thailand purchases its fuel oil, mean that, without the Project, Thailand would have to spend increasing amounts of foreign currency to import fuel oil. In estimating the economic costs, duties and tax are deducted and nontradable local currency costs are converted to border prices using a 0.90 standard conversion factor. Depletion premium is factored into the economic costs due to the anticipated higher imported fuel oil prices than the production costs of natural gas at the time of depletion.¹⁰

29. Table 1 summarizes the FIRR and the economic internal rate of return (EIRR) estimates at appraisal, and those in the PCR and the PPAR. The reestimated EIRR is 45.7 percent, higher than both the PCR estimate and the appraisal estimate, reflecting the recent trend in oil prices. Generally, the EIRR is much higher than the FIRR in all three sets of estimates. This is typical for an infrastructure project, for which the return to the project proponent could be well below that for society. The Project brings other intangible benefits to society, e.g., those related to environment. These benefits, often difficult to quantify,¹¹ are discussed further in para. 36. Furthermore, the gap between the estimated FIRR and EIRR appears to be increasing with

¹⁰ Depletion premium was not considered in the RRP and the PCR.

¹¹ There are methodologies to do so but given the already high EIRR, the positive conclusion would not be qualitatively affected by the inclusion of the environmental benefits.

each reevaluation, indicating that there may be a growing distortion in the Thai economy in favor of consumption of domestic natural gas at a discounted price compared with the world oil market price. Despite PTT's monopolistic position in gas transmission, the price of natural gas has been relatively low due to a weak demand after the financial crisis. These trends have benefited consumers, power utilities, and industries as energy users.

Table 1: Summary of Financial and Economic Reevaluation
(%)

Item	Appraisal	PCR	PPAR
EIRR	23.1	39.4	45.7
FIRR	16.6	16.6	15.9

EIRR = economic internal rate of return, FIRR = financial internal rate of return, PCR = project completion report, PPAR = project performance audit report.

C. Sustainability

30. Sustainability of the Project depends on continued demand for and adequate supply of natural gas. The demand is likely to continue growing due to long-term economic recovery, expected high international oil prices, and improved enforcement of environmental emission standards. The power sector, for example, currently consumes about 80 percent of PTT's natural gas. Thailand's Power Development Plan emphasizes diversification in its fuel mix as a measure of energy security. Officials interviewed at EGAT stated that its consumption of natural gas by 2016 will increase by more than 300 percent over the 1997 level. On the supply side, the proven and probable natural gas reserves will ensure supply for at least another 20 years (Appendix 8).

31. The Project's sustainability also depends on PTT's capability to operate and maintain the pipelines. Natural gas transmission through pipelines is a core business area for PTT, which has a proven record in maintaining and operating pipelines. The designed life for pipelines is generally about 30 years, which is primarily determined by the life expectancy of the cathodic protection (anticorrosion) system. With proper corrosion inspection and remediation of the corroded pipes, this life expectancy can be achieved. PTT's first pipeline, running parallel to the Project's offshore pipeline, has been in safe operation for 20 years (commissioned in September 1981). The fact that there are now two parallel pipelines makes it possible to shut down one of them for regular maintenance without seriously disrupting the supply of natural gas. As discussed in detail in para. 35, PTT is well versed in maintaining high standards in health and safety in pipeline operations and has invested heavily in monitoring equipment and staff training. Therefore, in all likelihood, the Project will be sustainable and will reach its design life and possibly beyond. It forms one of the main arteries from which the natural gas transmission system in the Gulf of Thailand can be further developed.

IV. ACHIEVEMENT OF OTHER DEVELOPMENT IMPACTS

A. Socioeconomic Impact

32. The Project did not have any direct social objective. In light of the recent oil price hikes at the international market, however, the Project may have helped reduce inflationary pressure through savings of foreign exchange for oil imports. By helping generate cheaper electricity,¹² the Project has benefited economic recovery in general and the poor in particular.

B. Environmental Impacts

33. Improving the hydrocarbon sector's environmental (including health and safety) performance was an objective for the Project. Although no fund was allocated specifically for this purpose under the Project, an advisory TA was provided under an earlier loan (footnote 3). Interviews with officials at the Department of Mineral Resources (DMR), the Executing Agency for the TA, have indicated that Thailand still does not have specific environmental standards for the hydrocarbon sector, which was a key objective of the TA. As of now, there is no consensus on whether such standards are indeed necessary. Thailand has national generic environmental standards that DMR and the Office of Environmental Policy and Planning (OEPP)¹³ use to jointly review the environmental impact assessment reports of hydrocarbon development projects. Furthermore, by engaging international consultants and contractors, the Project promoted the adoption of modern technologies and best practices in the sector, which are generally subject to high environmental and safety standards.

34. The environmental impacts of the Project are complex and cover multiple aspects. First, the construction of the offshore and onshore pipelines was expected to cause some disruption of the local environment, e.g., marine ecology. OEPP indicated that the environmental impact assessment report for the Project was satisfactory. The report recommended rerouting the onshore portion to avoid a wetland conservation area, and PTT complied. PTT monitored the construction activities and submitted its monitoring results to OEPP during the construction period. No major environmental disruption of marine ecology and wetland ecosystems was reported. However, OEPP did not conduct any monitoring itself as it has limited monitoring capabilities and generally relies on self-monitoring by industries.

35. Second, the production and transmission of natural gas also have environmental impacts. Specifically, production of natural gas generates carbon dioxide, which is captured mostly at the gas separation plant. Potential pipe leaks during transmission, which could cause health and safety hazards, are minimized through a sound health and safety management system. Interviews with PTT's Environment, Quality, Safety, and Health Department and site visits revealed that PTT is a highly environment-conscious company. It has exceeded its own targets of ISO 14000 (Environment) and ISO 18000 (Health and Safety) certification and training for its operation units. The Rayong gas separation plant, for example, monitors its ambient environment and emission levels and regularly submits the monitoring results to OEPP. The latest monitoring results, obtained by the OEM, indicate that the plant is in compliance with the national standards for all the parameters monitored. In terms of health and safety measures, the Project's funding was partly used to upgrade the SCADA and telecommunication system, gas metering, pressure regulation, and pig launcher/receiver. The system is being used to monitor

¹² Electricity generated using domestic natural gas currently costs B1.6/kWh, compared with B2.5/kWh when imported fuel oil is used.

¹³ The OEPP officials interviewed were not aware of the ADB-funded TA as DMR was the sole Executing Agency and OEPP was not invited to participate.

any significant change in the transmission system's key parameters—flow, pressure, and temperature—to detect potential anomalies and accidents. Visits to the monitoring site and the control center show that the facility is fully operational (Appendix 4). PTT has remained accident-free until two weeks before the OEM's visit when some construction workers inadvertently dug and damaged a gas distribution line, causing a minor leak. According to the officials interviewed, because the incident occurred with the distribution lines (rather than the trunk transmission pipes built under the Project), the pressure drop caused by the leak was too small to be detected by the SCADA system. No serious damage was reported.

36. Third, use of natural gas as an alternative to imported fuel oil or coal has positive environmental impacts due to the generally higher combustion efficiency and lower emission levels of gas-based power generation. This may have contributed significantly to the marked improvement of the air quality around Bangkok. A visit to a power plant of EGAT, located south of Bangkok, which uses PTT's natural gas, showed that the emissions from the plant's four stacks were virtually invisible (Appendix 4). Natural gas from the Gulf of Thailand is sulfur free, compared with 0.5-1.75 kg per gigajoule sulfur dioxide emissions for different grades of imported fuel oil. Emissions of carbon dioxide—a key global warming agent—from natural gas combustion are about 60 percent of those for coal, and 75 percent of those for fuel oil.

37. Overall, compared with alternative options for meeting energy demand, the Project has brought about positive environmental impacts.

C. Impacts on Institution and Policy

38. The Board approved the Project based on early indication that the TA on PTT's business strategy and privatization program (footnote 2) was being successfully implemented. In addition, project funds were allocated to conduct training and studies related to corporate restructuring and institutional strengthening for PTT. However, the loan proceeds were not utilized because, at the time of project implementation, there were already various PTT initiatives to engage international business consultants to conduct such studies and in-house training, in addition to the earlier ADB TA. While these activities have formed the basis of the Government's present strategy for PTT's restructuring and privatization and the sector's gradual liberalization, pinpointing the incremental impacts of each activity, including the ADB TA, is difficult.

39. Presently, various degrees of deregulation characterize the sector's different segments. Oil refining and retail are almost completely deregulated. Competition between PTT and private oil companies, while improving service quality and efficiency, also drives down the profit margins. This partly explains why most of the net profits for PTT come from natural gas distribution and marketing rather than gasoline retailing. Natural gas production is deregulated, with several major multinational gas companies (including UNOCAL and TOTAL) operating in the Gulf of Thailand, and both competing and collaborating with PTT in supplying natural gas. The distribution of natural gas is also partly deregulated, with PTT Natural Gas Distribution Co. Ltd., a joint venture between PTT, Belgium-based Tractebel S.A., and another local private company, having the license to build its own distribution network. The joint venture is permitted to serve nonutility industrial customers in the Greater Bangkok Area, even though this market segment currently represents only 1 percent of the total natural gas sales in Thailand. The only subsector where PTT still enjoys complete monopoly is pipeline transmission. The large front-end investment required and existing Government's regulations have so far prohibited the private sector from investing in such pipelines. However, the private companies the OEM interviewed (UNOCAL and with the PTT Natural Gas Distribution Co. Ltd.) have expressed possible interest in laying their own transmission pipelines if the subsector is deregulated in the long term.

40. In the short term, however, interviews with the National Energy Policy Office, a Government think tank, indicate that the market-oriented reforms in the sector will focus on two areas: (i) mandatory third-party access (TPA) to PTT pipelines by other gas producers, and (ii) corporatization and partial privatization of PTT through public offering. TPA is in essence different from the existing system where gas producers, e.g., PTT Exploration and Production, and UNOCAL, are obliged to sell gas to PTT through a long-term sales agreement. PTT is the sole entity engaged in gas transmission activities and is largely responsible for marketing the natural gas to end users. Under the new TPA regime, PTT is obliged to provide spare capacity in the pipelines to gas producers for a fee, based on core principles such as the right to access, transparency, and nondiscrimination in terms of standard tariffs and conditions for all users.

41. With respect to corporate restructuring, PTT recently submitted its proposed corporatization structure to the Government through the National Energy Policy Office. Once approved, it could form the basis for the initial public offering planned for the fourth quarter of 2001. As shown in Appendix 9, the proposed structure is centered on a newly formed company PTT Plc., in which PTT, as a Government-owned holding company, will own at least 51 percent. The remaining equity will be offered and traded on the Stock Exchange of Thailand. The publicly listed PTT Plc. will comprise two business units (gas and oil). The holding company PTT will continue to control the remaining business operations, including several refineries that still need restructuring to improve their profitability before further privatization is possible. For purposes of comparison, Appendix 10 shows the current organizational structure of the PTT.

V. OVERALL ASSESSMENT

A. Relevance

42. The Project was highly relevant at appraisal due to the conformity between the Government's goal to substitute indigenous natural gas for imported fuel oil and ADB's country operational strategy, which emphasized supporting infrastructure while promoting efficient use of domestic natural resources. The Project's relevance appears even stronger now in light of the sustained high oil prices in the world market. Without the Project, Thailand would have had to pay much more to import fuel oil. ADB's strategy also stressed the need to encourage private sector participation. The Project met this objective by helping secure and attract private investments in the upstream gas exploration and production. Overall, the Project has been highly relevant.

B. Efficacy

43. The Project has achieved its main objective by doubling the natural gas transmission capacity in the Gulf of Thailand and thereby helping meet the energy demand with domestic natural gas rather than imported fuel oil. Although the Project's corporate restructuring and institutional strengthening component was not implemented as envisaged, the objective of strengthening PTT's commercial role and institutional capabilities in the future development of the hydrocarbon sector has been partly achieved through the earlier ADB TA and PTT's various own initiatives. The assessment of the achievement of the third objective, namely, enhancing environmental and safety standards, is more mixed. On the one hand, the earlier ADB advisory TA on establishing national environmental standards for the hydrocarbon sector did not achieve its objective. On the other hand, through its exposure to international consultants, contractors and suppliers, as well as to various multinational oil and gas companies, through this and other projects, PTT started to adopt modern technologies and best practices. As a result, PTT's overall environmental performance is satisfactory. Overall, the Project has been efficacious.

C. Efficiency

44. With the recalculated FIRR and EIRR at 15.9 percent and 45.7 percent, respectively, the Project has demonstrated high efficiency in achieving its purpose in relation to inputs. ADB worked closely with PTT and coordinated effectively with the cofinancing agencies. PTT, for its part, executed the Project successfully despite the delay caused mainly by the original contractor's lack of experience and technical expertise. This could have been avoided by verifying the contractor's technical expertise and experience before awarding the contract. The consultants who were recruited earlier under WB funding provided optimal design of the Project and critical inputs to the decision of terminating the original contractor to bring implementation back on track. Overall, the delay did not seriously affect the FIRR and EIRR. Consequently, the Project is deemed highly efficient.

D. Sustainability

45. Natural gas is widely regarded as the fuel of choice for many countries worldwide due to the high efficiency, relative environmental cleanness, and price competitiveness of gas-based power generation. The Gulf of Thailand has adequate reserves that should last for at least another 20 years. PTT has a proven record of managing pipelines. In light of these factors, the Project is most likely to be sustainable.

E. Institutional Development and Other Impacts

46. The Project has brought about positive overall impacts on institutional strengthening, environment, and society. It has helped reduce air emissions by promoting fuel substitution. Although the Project addressed no particular social goals, it contributed to the continuing economic recovery and the welfare of the poor by helping generate cheaper electricity and reduce inflationary pressure. Although the direct Project impact on strengthening PTT's capacity as a commercial entity may be limited, PTT has clearly made progress in restructuring, corporatization, and privatization.

F. Overall Project Rating

47. Based on the above five performance evaluation criteria, the Project is rated as highly successful.

G. Assessment of ADB and Borrower Performance

48. The performance of ADB and PTT was satisfactory. As this was their third collaboration on pipeline projects, the two institutions were familiar with each other's operating procedures and collaborated well during project formulation and implementation. PTT closely monitored the contractor's performance and handled the difficulties with the original contractor well. After project completion, PTT continued to monitor project benefits. It submitted the results to ADB and provided strong support to the PCR mission and OEM.

VI. ISSUES, LESSONS, AND FOLLOW-UP ACTIONS

A. Key Issues for the Future

49. Three issues related to the formulation and implementation of the Project are relevant for ADB's operations. First, ADB needs to decide whether it will continue to support similar types of projects in the future. Evidence from this evaluation suggests that pipeline projects as part of energy infrastructure may be, at least partly, financed by commercial banks or from other sources such as corporate bonds. PTT is actively mobilizing such sources for its planned new projects. However, other less developed countries may find it difficult to finance such energy infrastructure projects from commercial sources or by the private sector, as an enabling environment takes time to create. For these developing member countries, ADB's continued support is advisable as pipeline projects bring about significant economic and environmental benefits.

50. The second issue relates to restructuring and privatizing PTT, and deregulating the hydrocarbon sector and the Thai economy as a whole. The Government recently announced a schedule of privatization for the country's main State enterprises, and the initial public offering for PTT is planned for the fourth quarter of 2001. In addition, TPA to the pipelines is the likely next step of liberalizing the hydrocarbon sector. Without these two steps, the Project might be viewed as helping PTT consolidate its monopoly in the gas transmission business. ADB should therefore continue its policy dialogue with the Government regarding economic liberalization and recovery in general and hydrocarbon sector deregulation in particular, and provide assistance as required.

51. The third issue is related to the long-term prospects of natural gas in Thailand, which very much depend on how rigorously the Government enforces its environmental standards, particularly air emission standards. At present natural gas does not compete with imported fuel oil on a level playing field. If the emission standards were more strictly enforced, refineries or power plants would have to install additional desulfurization equipment. This would make fuel oil or electricity more expensive and natural gas even more competitive. However, as pointed out earlier (para. 26), PTT may have gained some advantage over its competitors in the sector through the Project by having had access to borrowings at rates lower than the commercial rates.

B. Lessons Identified

1. For PTT

52. More thorough verification of bidding firms' technical expertise and experience in operating in the particular physical environment is essential. The delay in constructing the onshore pipelines was due largely to the contractor's lack of experience in operating on soft marshy land.

2. For ADB

53. The only unrealized project component was the studies and training related to PTT's corporate restructuring and institutional strengthening because they overlapped with PTT's various ongoing efforts. A thorough examination of past and ongoing efforts before deciding on new initiatives during project formulation is advisable.

54. The Project demonstrates, in a positive manner, that a strong sense of ownership by the government and the executing agency is crucial for the project's success. In this case, both the Government and PTT viewed the Project as a key step to achieve their long-term strategic and business goals.

C. Follow-Up Actions

55. There are no particular, outstanding issues concerning the implementation and operation of the Project.

APPENDIXES

Number	Title	Page	Cited on (page, para.)
1	Actual and Projected Natural Gas Transmitted via Second Erawan Offshore Gas Pipeline	16	4,12
2	Project Cost and Financing	17	4,14
3	Project Schedule	19	4,15
4	Project Photos	20	5,20
5	Financial Performance Indicators	22	6,24
6	Reevaluation of Financial Internal Rate of Return	24	7,26
7	Reevaluation of Economic Internal Rate of Return	27	7,27
8	Thailand's Natural Gas Reserves	31	8,30
9	Proposed Privatization Structure for Petroleum Authority of Thailand	32	11,41
10	Present Corporate Structure of Petroleum Authority of Thailand	33	11,41

**ACTUAL AND PROJECTED NATURAL GAS TRANSMITTED VIA SECOND ERAWAN OFFSHORE GAS PIPELINE
(MMCFD)**

Gas Field	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bongkot	0	0	0	196	345	424	564	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516
Tantawan	0	0	0	0	82	87	64	87	87	87	87	87	87	87	0	0	0	0	0	0	0	0	0	0
Benjamas	0	0	0	0	0	0	29	40	40	40	40	40	40	40	40	0	0	0	0	0	0	0	0	0
Pailin	0	0	0	0	0	0	52	147	147	218	290	290	290	290	290	290	290	290	290	290	290	290	290	290
Total Gas Transmitted	0	0	0	196	427	511	709	790	790	861	933	933	933	933	846	806	806	806	806	806	806	806	806	806

MMCFD = million cubic feet per day.
Source: PTT Business Planning Department.

PROJECT COST AND FINANCING

Table A1.1: Cost Breakdown by Project Components
(\$ million)

Item	Appraisal Estimate			Actual			(Overrun)/Underrun		
	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
Land Acquisition	0.00	4.80	4.80	0.00	4.76	4.76	—	0.04	0.04
Materials									
Line Pipe	161.40	0.00	161.40	151.23	0.00	151.23	10.17	—	10.17
Pipeline Coating	75.40	0.00	75.40	53.69	0.00	53.69	21.71	—	21.71
Onshore Pipeline Construction and Commissioning	30.00	10.00	40.00	19.07	19.88	38.94	10.93	(9.88)	1.06
Offshore Pipeline Construction and Commissioning	103.00	24.50	127.50	83.32	4.72	88.04	19.68	19.78	39.46
Consulting Services	15.20	12.90	28.10	16.76	13.49	30.26	(1.56)	(0.59)	(2.16)
Facilities	9.30	5.00	14.30	17.48	10.19	27.66	(8.18)	(5.19)	(13.36)
Alternating Current (AC) Mitigation	1.60	3.00	4.60	0.00	0.00	0.00	1.60	3.00	4.60
Supply and Installation of Compressors	22.00	2.50	24.50	8.09	0.17	8.25	13.91	2.33	16.25
Insurance	2.10	0.30	2.40	0.00	2.40	2.40	2.10	(2.10)	—
PTT Project Management	0.00	4.00	4.00	0.00	5.89	5.89	—	(1.89)	(1.89)
Institutional Strengthening, Corporate Restructuring and Other Studies	3.00	0.30	3.30	0.00	1.16	1.16	3.00	(0.86)	2.14
Taxes and Duties	0.00	22.20	22.20	0.00	9.65	9.65	—	12.55	12.55
Subtotal (Base Cost)	423.00	89.50	512.50	349.63	72.33	421.96	73.37	17.17	90.54
Physical Contingencies	42.30	9.00	51.30	0.00	0.00	0.00	42.30	9.00	51.30
Price Contingencies	27.70	6.50	34.20	0.00	0.00	0.00	27.70	6.50	34.20
Interest and Other Charges During Construction	73.00	0.00	73.00	35.83	18.47	54.30	37.17	(18.47)	18.70
Other Costs including Foreign Exchange Loss	0.00	0.00	0.00	0.00	6.06	6.06	—	(6.06)	(6.06)
Total	566.00	105.00	671.00	385.46	96.86	482.31	180.54	8.14	188.69

Table A1.2: Financing Arrangements
(\$ million)

Source	Appraisal Estimate	Actual
Asian Development Bank	100.0	70.4
Export-Import Bank of Japan	100.0	70.4
European Investment Bank	46.0	48.0
World Bank	155.0	111.7
PTT's Commercial Borrowings/Bonds	100.0	106.2
PTT's Internal Cash Generation	170.0	75.6
Total Project Cost	671.0	482.3

PROJECT SCHEDULE

Activities	Appraisal Estimate	Actual
1. Date of Contract with Consultants	Apr 1993	Apr 1993
2. Completion of Engineering Designs		
Basic Design	Aug 1993	Apr 1993
Detailed Design	Aug 1994	Oct 1994
3. Line Pipe Material Supply		
Date of Award	Sep 1994	Dec 1993
Start of Line Pipe Delivery	Nov 1994	Mar 1994
Completion of Line Pipe Delivery	Feb 1996	Aug 1994
4. Pipeline Coating		
5. Onshore		
Date of Award	Nov 1994	Sep 1994
Completion of Pipeline Coating	Dec 1994	Nov 1994
6. Offshore		
Date of Award	Nov 1994	Sep 1994
Completion of Pipeline Coating	Dec 1994	Feb 1995
7. Construction of Pipeline		
8. Onshore Pipeline		
Date of Award	Dec 1994	Oct 1994
Mechanical Completion	Feb 1996	Aug 1996
9. Offshore Pipeline		
Date of Award	Dec 1994	Sep 1994
Mechanical Completion	Apr 1996	Dec 1995
10. SCADA and Communications Construction		
Date of Award	Feb 1995	Sep 1994
Completion of Installation	Jan 1996	Feb 1997
11. Construction of Compression Stations		
Award of Contract	Mar 1996	Sep 1994
Completion of Installation	Dec 1996	Oct 1996
12. Start of Operation		
Commissioning of Onshore Pipeline	Apr 1996	Sep 1996
Commissioning of Offshore Pipeline	Sep 1996	Apr 1996
Commissioning of Onshore Compressor Station	Dec 1996	Feb 1997
Start of Regular Operations	May 1997	Apr 1997
13. Certification of Completion for All Contractors	Oct 1997	Apr 1997

SCADA = supervisory control and data acquisition.

PROJECT PHOTOS

Photo 1: End of onshore pipelines where gas flow, pressure and temperature are monitored and data are electronically sent to the supervisory control and data acquisition (SCADA) control center.



Photo 2: SCADA control center.



Photo 3: Electricity Generating Authority (EGAT) power plant using natural gas—virtually no air emissions visible.



Photo 4: An industrial customer partially converted to gas. The left chimney still uses fuel oil while the right one uses natural gas (photo courtesy of PTT Natural Gas Distribution Co. Ltd. [PTTNGD]).

FINANCIAL PERFORMANCE INDICATORS

1. Table A5.1 summarizes the Petroleum Authority of Thailand's (PTT) consolidated financial performance over the past five years. Reversals in the country's economic indicators following the financial crisis of 1997 significantly affected PTT's financial performance. Operating profit in 1998 declined by 24 percent following a drop in sales revenue by close to 10 percent. This was mostly in reaction to a weak commercial fuel demand nationwide. Nonetheless, natural gas has consistently been a major contributor to PTT's overall sales revenue, accounting for around 25 percent in 1996 and 1997, and more than 30 percent in 1998 and 1999. Except in 1997 when natural gas operations posted a loss of B550 million, most of PTT's profits have been coming from natural gas.

2. PTT's gross margin improved from a slowdown following the financial crisis. It posted an 11.1 percent gross margin in 1999, up from the previous year's 9.4 percent. Net profit margin narrowed to 2.5 percent in 1999 following what appeared to be a recovery in 1998 when it recorded 5.4 percent. PTT attributes this decline in profitability to increased competition as evidenced by a significant increase in the number of service stations and registered oil traders.

Table A5.1: PTT's Consolidated Financial Performance
(B million, unless otherwise indicated)

Item	1995	1996	1997	1998	1999
Sales Revenue	101,340	163,246	236,258	212,769	227,302
From Natural Gas Products	32,501	40,380	62,938	69,378	70,674
Operating Profit	8,457	8,885	11,756	8,928	13,319
Net Profit from Natural Gas	6,775	8,372	-550	5,776	8,534
Net Profit before Remittance	7,527	7,658	2,210	11,579	5,643
Net Profit after Remittance	4,516	4,238	-1,190	6,349	2,821
Current Assets	30,771	38,607	55,065	49,992	70,873
Net Fixed Assets	39,963	47,915	55,856	60,465	65,232
Total Assets	97,012	116,157	141,338	146,290	176,971
Current Liabilities	17,338	22,847	32,104	31,363	35,899
Long-Term Liabilities	42,136	49,695	75,566	65,919	86,471
Total Equity	35,772	41,810	31,542	46,672	50,121
Performance Indicators					
Gross Margin (%)	13.06	10.61	10.28	9.44	11.09
Net Profit Margin (%)	6.24	4.69	0.94	5.44	2.48
Net Profit/Total Equity (%)	21.04	18.32	7.01	24.81	11.26
Total Equity/Total Assets (%)	36.87	35.99	22.32	31.90	28.32
Current Ratio (times)	1.77	1.69	1.72	1.59	1.97
Financial Covenants					
Debt/Equity Ratio					
Actual	1.21	1.28	2.52	1.56	1.87
Covenant	2.33	2.33	2.33	2.33	2.33
Debt-Service Coverage Ratio (times)					
Actual	3.40	2.68	2.62	2.14	2.14
Covenant	1.3	1.3	1.3	1.3	1.3
Self-Financing Capacity (%)					
Actual	85.57	52.67	51.40	136.58	61.64
Covenant	25.00	25.00	25.00	25.00	25.00

PTT = Petroleum Authority of Thailand.

^a Prior to 1996 PTT's fiscal year was from 1 October to September. Since 1996, the fiscal year coincides with the calendar year.

3. Despite the temporary setback ushered in by the economic slowdown, PTT remains financially sound. Over the last four years, net assets increased 1.4 times while the equity base increased 1.2 times. Performance ratios remain within the covenanted levels. Debt service

coverage, covenanted to be at least 1.3 was 2.1 in 1998 and 1999. Debt equity ratio that was covenanted to be not more than 2.33 remains well below 2. The company's self-financing capacity for 1999 was kept above 60 percent. The audited financial statements were not yet available at the time of the evaluation mission. However, initial estimates show that the performance ratios for the year 2000 continue to be well within the covenanted levels.

REEVALUATION OF FINANCIAL INTERNAL RATE OF RETURN

A. Major Assumptions

1. General

1. The financial reevaluation of the Project was carried out on an incremental basis in terms comparable with those of the report and recommendation of the President (RRP) and the project completion report (PCR). All prices and costs are expressed in first quarter 2001 constant values. All prices and costs are adjusted for inflation, using Thailand's gross domestic product deflator. The exchange rate at the time of the Operations Evaluation Mission (12 February 2001) at \$1 = B42.93 is applied.

2. The economic life of the Project is assumed to be 20 years from 1996 through 2015.

2. Gas Sales Volume and Prices

3. The gas supply sources for the Project include the existing Bongkot fields and the newly developed Benjamas, Pailin, and Tantawan fields that were linked directly to the offshore pipeline. Its transmission capacity at appraisal was 550 million cubic feet per day (MMCFD). The offshore compression facilities increased the present capacity to around 820 MMCFD. The actual (1996-2000) and projected gas transmission via the pipeline is shown in Table A6.1.

Table A6.1: Gas Transmission via the Offshore Pipeline
(MMCFD)

Year	Gas Transmission				Total
	Bongkot	Tantawan	Benjamas	Pailin	
1996	196				196
1997	345	82			427
1998	424	87			511
1999	564	64	29	52	709
2000	516	87	40	147	790
2001	516	87	40	147	790
2002	516	87	40	218	790
2003	516	87	40	290	861
2004	516	87	40	290	933
2005	516	87	40	290	933
2006	516	87	40	290	933
2007	516		40	290	933
2008	516			290	846
2009	516			290	806
2010	516			290	806
2011	516			290	806
2012	516			290	806
2013	516			290	806
2014	516			290	806
2015	516			290	806

MMCFD = million cubic feet per day.

4. The average heating value of the gas from the various fields is assumed to be 1,000 British thermal unit per standard cubic foot on average.

5. The actual purchase cost of gas for the year 2000 is used for the Bongkot field and fields operated by UNOCAL.

6. The actual selling price for the Electricity Generating Authority for the year 2000 is used.

7. The price of the transmission services is the difference between the purchase price and sales price.

3. Capital Cost

8. The actual capital project cost is used. Also included are the project costs of the pipelines linking the Benjamas, Pailin, and Tantawan fields to the parallel pipeline constructed under the Project to allow the transmission of gas from each of these fields to the parallel pipeline.

4. Operating Cost

9. Three percent of the total capital cost is used for the incremental operating costs (the same as used in the RRP and the PCR). The results are given in Table A6.2. The reestimated financial internal rate of return (FIRR) of 15.3 percent is only slightly lower than the appraisal and PCR estimates of 16.6 percent.

Table A6.2: Financial Internal Rate of Return Computation

Year	Gas Flow (MMCFD)	Purchase Price (B/MMBTU)	Sales Price (B/MMBTU)	Cost of Gas (B million)	Sales Revenue (B million)	Capital Cost (B million)	Operating Cost (B million)	Net Cash Flow (B million)
1994						9,348		(9,348)
1995						10,236		(10,236)
1996	196	81	98.16	5,787	7,022	5,312	764	(4,841)
1997	427	79	108.79	12,357	16,955	785	680	3,134
1998	511	82	100.93	15,241	18,826	1,167	690	1,727
1999	709	77	95.60	19,927	24,741	71	807	3,936
2000	790	97	113.08	28,114	32,607		810	3,683
2001	790	105	128.78	30,277	37,134		810	6,047
2002	861	105	128.78	32,998	40,471		810	6,663
2003	933	105	128.78	35,757	43,855		810	7,288
2004	933	105	128.78	35,757	43,855		810	7,288
2005	933	105	128.78	35,757	43,855		810	7,288
2006	933	105	128.78	35,757	43,855		810	7,288
2007	846	105	128.78	32,423	39,766		810	6,533
2008	806	105	128.78	30,890	37,886		810	6,186
2009	806	105	128.78	30,890	37,886		810	6,186
2010	806	105	128.78	30,890	37,886		810	6,186
2011	806	105	128.78	30,890	37,886		810	6,186
2012	806	105	128.78	30,890	37,886		810	6,186
2013	806	105	128.78	30,890	37,886		810	6,186
2014	806	105	128.78	30,890	37,886		810	6,186
2015	806	105	128.78	30,890	37,886		810	6,186
							FIRR	15.89%

B/MMBTU = baht per million British thermal unit, MMCFD = million cubic feet per day.

B. Sensitivity Analysis

10. The reestimated FIRR is sensitive to changes in exchange rate and production volume (Table A6.3). A 10 percent reduction in production volume reduces the FIRR by around 1 percentage point. Keeping the exchange rate at B31.618 to a dollar, the exchange rate at time of PCR, increases the FIRR by 4 percentage points.

Table A6.3 Sensitivity Analysis

Item	FIRR (%)
Project Reevaluation (Base Case)	15.9
Exchange Rate – B31.618 = \$1	19.9
10 Percent Decrease in Production Volume	14.8
With Remittance to Treasury (as in PCR)	11.3

FIRR = financial internal rate of return, PCR = project completion report.

11. The PCR and the RRP treat remittance to treasury as a cost item. The computation of the FIRR for the PPAR excludes this item as it is not considered to be a project cost. It is considered to represent a distribution of overall PTT profits that might be proportionately attributed to the Project. For purposes of comparison, this item is included in the sensitivity analysis. The resulting FIRR is more than 4 percentage points lower than the base case.

12. In all four cases considered, the FIRR is well above the weighted average cost of capital estimated at 6.85 in nominal terms and at 3.40 percent in real terms.

REEVALUATION OF ECONOMIC INTERNAL RATE OF RETURN

A. Major Assumptions

1. General

1. Economic reevaluation¹ of the Project was carried out on an incremental basis in terms comparable with those of the report and recommendation of the President (RRP) and the project completion report (PCR). The analysis assumes a 20-year economic life for the Project, generating benefits from 1996 to 2015. Import duties, taxes, and interest during construction are excluded from the project costs. All costs and benefits are expressed in constant 2001 prices and are in local currency. All prices and costs are adjusted for inflation using Thailand's gross domestic product deflator. Nontradable local currency costs are converted to border parity prices using a 0.90 standard conversion factor. An average exchange rate of B42.93 is applied. The analysis was undertaken using a world price numeraire in foreign currency.

2. The economic benefits and costs of the Project were estimated in a larger natural gas production-transmission-distribution system, which includes the pipelines built under the Project. This is because the economic benefit of the pipelines (increase of gas transmission) would not be accrued without gas production and distribution. Therefore, the benefits, as well as the costs, in Table A7.1 were estimated for the entire system.

2. Economic Costs

3. The economic costs of the Project are inclusive of the following:

- (i) exploration and production costs of hydrocarbon development necessary to develop and maintain gas production at levels of gas transmission assumed in the economic internal rate of return (EIRR) analysis were provided by PTT Exploration and Production Public Company Limited and UNOCAL. They represent those costs necessary to develop and maintain gas production at levels assumed in the EIRR analysis. The following costs were assumed.

Item	\$/Thousand Cubic Feet		
	UNOCAL	Bongkot	Others
Exploration and Production	0.98	0.78	0.88
Operation	0.40	0.63	0.68

Note: UNOCAL operates the Pailin field.

- (ii) Operating and maintenance costs for gas transmission are based on actual costs for 1996-2000 and assumed at 3 percent of project investment cost thereafter, the industry norm and consistent with the approach taken in the RRP and the PCR; and

¹ The methodology applied in the economic evaluation follows that of the Asian Development Bank's *Guidelines for Economic Analysis of Projects*.

- (iii) actual capital cost under the Project and the projected costs for installing the pipelines linking the Benjamas, Pailin, and Tantawan fields are also taken into consideration to allow transport of gas from each field to the pipeline under the Project.

4. Depletion premium² was not taken into account at PCR because of the relatively low cost of crude oil, which was projected to further decline. The price of crude declined further the year following PCR, but rose and peaked in 2000. The project performance audit report takes into account the depletion premium of natural gas with the following assumptions:

- | | | | |
|-------|--|---|----------------|
| (i) | Measures | | |
| | 1 ton of crude oil | = | 6.758 barrels |
| (ii) | Calorific Values | | |
| | Crude oil | = | 39.7 MMBTU/ton |
| | Fuel oil | = | 40.8 MMBTU/ton |
| | Natural gas | = | 1,000 BTU/SCF |
| (iii) | Base Year Price Projections (\$/barrel; CIF) | | |
| | Crude oil | | 26.56 |
| | Fuel oil | | 25.61 |
| (iv) | Assumptions for estimating depletion premium | | |
| | Gas reserve adequacy | : | 20 years |
| | Discount rate | : | 12 percent |
| | Projected crude price | | |
| | at time of field depletion | : | \$15.10/barrel |
| (v) | Depletion Premium (\$/MCF) | | |
| | Base year (2001) | : | 4.68 |
| | Terminal Year (2015) | : | 2.49 |

3. Economic Benefits

5. The economic benefits from gas sales are based on the landed parity value of fuel oil, the lowest valued alternative fuel. Benefits are valued in terms of energy equivalent. The average calorific value for natural gas is assumed to be 1,000 British thermal unit per standard cubic foot. The economic value of natural gas is derived from the actual imported price of fuel oil in Thailand in 2000. Using the Singapore free-on-board posted price, adjusted for international ocean freight, insurance and local transport charges, fuel oil price is estimated at \$17.39 per barrel.

² The inclusion of depletion premium follows ADB's *Guidelines for Economic Analysis of Projects* and is justified on the basis that natural gas is a depletable commodity with a fixed stock. If reserves in the ground were fully exploited and exhausted they become more valuable so that the cost of gas would increase toward the substitute price for alternative fuel energy. Consumption of gas today represents forgone consumption at some future date. Depletion premium refers to the present value of the forgone consumption.

Table A7.1: Economic Internal Rate of Return Computation
(B million, unless otherwise indicated)

Year	Gas	Capital Cost			Operating Cost			Depletion	Total	Total	Net
	Flow (MMCFD)	E&P	Project	Subtotal	E&P	Project	Subtotal	Premium	Costs	Benefits	Benefits
1994			9,140	9,140					9,140		(9,140)
1995			9,350	9,350					9,350		(9,350)
1996	196	2,712	3,704	6,415	1,981	666	2,647	489	9,551	11,210	1,659
1997	427	5,818	404	6,222	4,150	678	4,828	1,192	12,242	21,035	8,793
1998	511	6,345	1,155	7,500	4,538	713	5,250	1,598	14,349	15,433	1,084
1999	709	9,326	67	9,393	6,580	715	7,295	2,484	19,171	34,057	14,886
2000	790	10,575		10,575	8,013	715	8,728	3,100	22,402	58,397	35,995
2001	790	10,575		10,575	8,848	733	9,581	3,472	23,628	57,980	34,352
2002	861	11,405		11,405	9,953	733	10,326	4,238	25,969	52,702	26,733
2003	933	12,511		12,511	10,328	733	11,061	5,143	28,715	53,476	24,761
2004	933	12,511		12,511	10,300	733	11,033	5,760	29,304	50,802	21,497
2005	933	12,511		12,511	10,281	733	11,014	6,451	29,976	48,128	18,151
2006	933	12,511		12,511	10,290	733	11,023	7,225	30,760	45,189	14,430
2007	846	11,311		11,311	10,433	733	11,166	7,338	29,815	38,791	8,975
2008	806	10,760		10,760	10,433	733	11,166	7,830	29,756	34,647	4,891
2009	806	10,760		10,760	10,025	733	10,758	8,769	30,287	32,337	2,049
2010	806	10,760		10,760	10,025	733	10,758	9,822	31,340	31,391	51
2011	806	10,760		10,760	10,025	733	10,758	11,000	32,518	31,391	(1,127)
2012	806	10,760		10,760	10,025	733	10,758	12,320	33,838	31,391	(2,447)
2013	806	10,760		10,760	10,025	733	10,758	13,799	35,317	31,391	(3,926)
2014	806	10,760		10,760	10,025	733	10,758	15,455	36,973	31,391	(5,582)
2015	806	10,760		10,760	10,025	733	10,758	17,309	38,827	31,391	(7,436)

45.68%

E&P = exploration and production, MMCFD = million cubic feet per day.

B. Sensitivity Analysis

6. The reestimated EIRR of 45.7 percent exceeds the appraisal and PCR estimates of 23.1 percent and 35.4 percent, respectively, reflecting the rising trend in crude oil prices. The EIRR is sensitive to changes in exchange rate and in production volume and to the inclusion of a depletion premium (Table A7.2). A 10 percent reduction in production volume reduces the EIRR by around 1.4 percentage points. Keeping the exchange rate at B31.618 to a dollar, the rate at the time of PCR, increases the EIRR by half a percentage point. The stronger currency reduces costs but, at the same time reduces benefits. The assumption of no depletion, a reasonable assumption if a scenario of low crude oil price is to persist over a long period of time, increases the EIRR by 4.5 percentage points.

Table A7.2: Sensitivity Analysis

Item	EIRR (%)
Project Reevaluation (Base Case)	45.7
Exchange Rate – B31.618 = \$1	46.2
10 Percent Decrease in Production Volume	44.3
No Depletion Premium	50.2

EIRR = economic internal rate of return.

THAILAND'S NATURAL GAS RESERVES
(as of 31 December 1999)

Field/Project/Structure	Cumulative Production (BCF)	Proved Reserves (BCF)	Possible Reserves (BCF)	Total Reserves (BCF)	Gas Transmission ^a Capability (MMCFD)	Expected Life ^b of Gas Field (Years)
UNOCAL (Operator)	3,903	2,745	1,252	3,997	500	21.9
Bannpot	113	60	165	225		
Dara	0	0	67	67		
Erawan	1,555	695	35	730		
Funan	390	312	120	432		
Gomin	52	30	176	206		
Jakrawan	144	315	60	375		
Kaphong	82	36	8	44		
Moragot	0	160	220	380		
Pakarang	0	190	22	212		
Pladang	26	54	12	66		
Plamuk	8	43	14	57		
Platong	321	193	15	208		
Satun	1,178	267	86	353		
Surat	26	39	4	42		
Trat	9	301	165	466		
Yala	0	50	84	134		
PTTEP^c (Operator)	831	4,693	4,680	9,373	780	32.9
Bongkot	806	3,156	3,780	6,936		
Arthit	0	80	300	380		
Pailin	25	1,457	600	2,057		
HARRODS	0	82	640	722	820	22.7^d
Busabong	0	40	320	360		
Chang Dang	0	29	232	261		
Chang Phuak	0	4	35	39		
Bua Luang	0	5	29	34		
Boon Darik	0	4	24	28		
CHEVRON (Operator)	99	831	664	1,495		
Benchamas/Pakarong	11	248	190	438		
Maliwan	0	168	250	418		
Tantawan	88	125	24	149		
Jarmjuree	0	290	200	490		
MTJA^e	0	3,061	1,508	4,569		
CPOC	0	829	396	1,225		
CTOC	0	2,232	1,112	3,344		
Total Gulf of Thailand	4,833	11,412	8,744	20,156	2,100	26.3

BCF = billion cubic feet, MMCFD = million cubic feet per day.

Source: Annual Report 1999 Mineral Fuel Division Department of Mineral Resources and PTT Pipeline Operation Report.

^a Kanom Offshore Pipeline = 500 MMCFD, First Erawan Offshore Pipeline = 780 MMCFD; and Second Erawan Offshore Pipeline = 820 MMCFD).

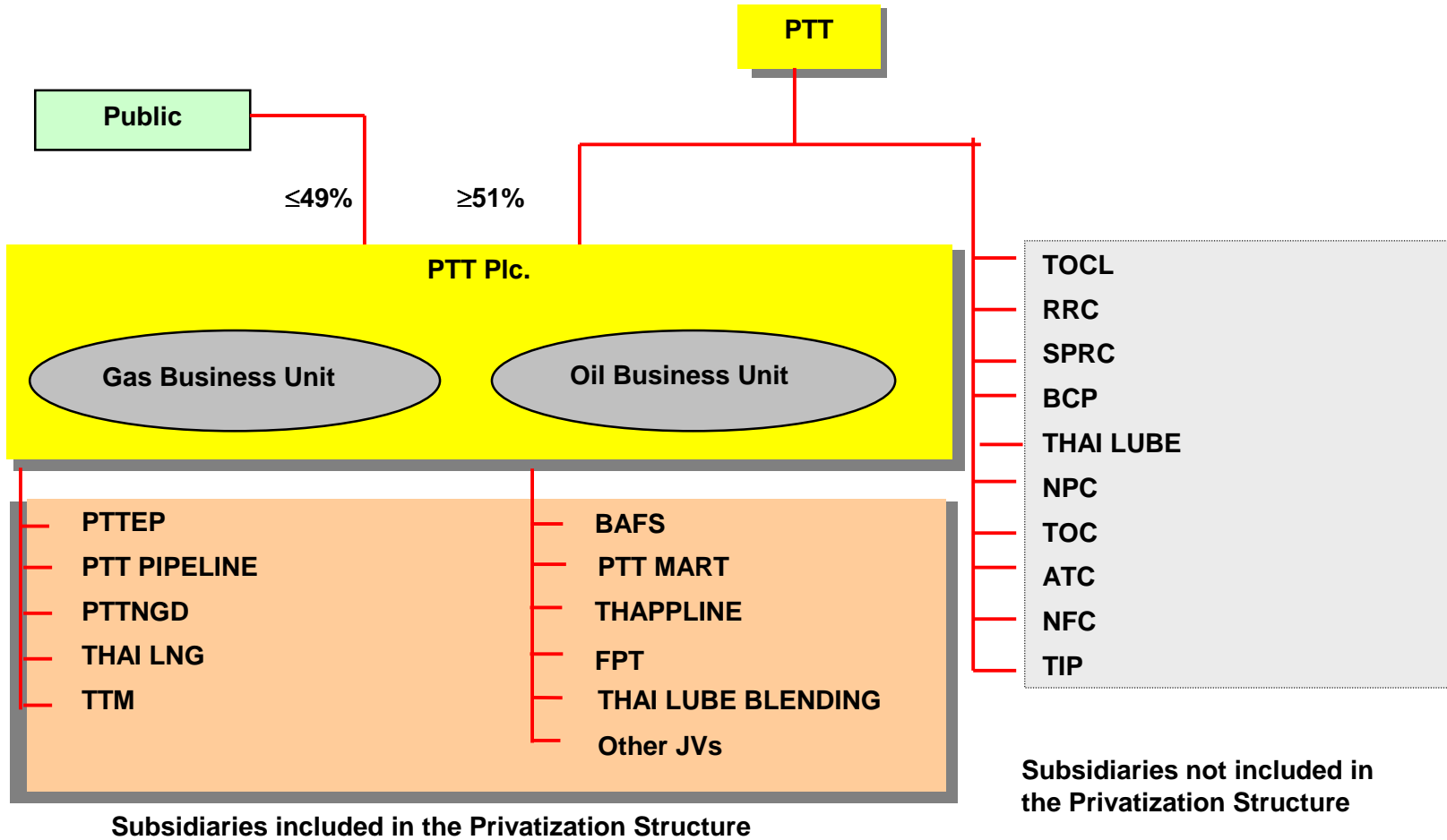
^b Total Reserves x 1000/Gas Transmission Capability/365.

^c PTT Exploration and Production PCL.

^d Including CHEVRON and MTJA.

^e Malaysia-Thailand Joint Development Area.

PROPOSED PRIVATIZATION STRUCTURE FOR PETROLEUM AUTHORITY OF THAILAND



ATC = Aromatics (Thailand) Public Co., Ltd., BAFS = Bangkok Aviation Fuel Services Public Co., Ltd., BCP = Bangchak Petroleum Public Co., FPT = Fuel Pipeline Transportation Co., Ltd., NFC = National Fertilizer Public Co., Ltd., NPC = National Petrochemical Public Co., Ltd., Other JVs = Other Joint Venture Company Limited, PTTEP = PTT Exploration and Production Public Co., Ltd., PTT MART = PTT Mart Co., Ltd., PTTNGD = PTT Natural Gas Distribution Co., Ltd., RRC = Rayong Refinery Co., Ltd., SPRC = Star Petroleum Refining Co., Ltd., THAI LNG = Thai LNG Co., Ltd., THAI LUBE = Thai Lube Base Co., Ltd., THAI LUBE BLENDING = Thai Lube Blending Co., Ltd., THAPPLINE = Thai Petroleum Pipeline Co., Ltd., TIP = Tipaya Insurance Public Co., Ltd., TOC = Thai Olefins Co., Ltd., TOCL = Thai Oil Co., Ltd., TTM = Tran Thai-Malaysia (Thailand) Co., Ltd..