

**ASIAN DEVELOPMENT BANK**

**TAR: REG 34092**

**TECHNICAL ASSISTANCE**  
(Cofinanced by the Government of Norway  
and the Asian Development Bank)

**FOR**

**REGIONAL INDICATIVE MASTER PLAN ON  
POWER INTERCONNECTION IN THE GREATER  
MEKONG SUBREGION**

**July 2000**

## **ABBREVIATIONS**

ADB	–	Asian Development Bank
EGP	–	Experts Group on Power Interconnection and Trade
EPF	–	Subregional Electric Power Forum
kV	–	kilovolt (1,000 volts)
GMS	–	Greater Mekong Subregion
Lao PDR	–	Lao People's Democratic Republic
NGO	–	nongovernment organization
PRC	–	People's Republic of China
TA	–	technical assistance

## **NOTE**

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

## I. INTRODUCTION

1. In December 1998, the countries of the Greater Mekong Subregion (GMS),<sup>1</sup> all of which are members of the Asian Development Bank (ADB), requested ADB to provide technical assistance (TA) to update a 1996 power transmission study and prepare an indicative master plan for subregional transmission development up to 2020.<sup>2</sup> The detailed terms of reference for the TA were discussed and endorsed at the third meeting of the Experts Group on Power Interconnection and Trade (EGP) in October 1999 and were also endorsed at the ninth GMS ministerial conference in January 2000.

2. The master plan will be based on a work plan<sup>3</sup> adopted by the second EGP and the fifth Subregional Electric Power Forum (EPF) meetings, in December 1998. The plan is expected to help GMS member countries plan and optimize their national power systems with the aim of eventually connecting into a subregional grid system. The TA framework is shown in Appendix 1.

## II. BACKGROUND AND RATIONALE

3. The energy sector in the GMS is characterized by great diversity. The subregion is endowed with substantial energy resources, but their geographic distribution is uneven. The subregion's countries have different types of energy resources and development costs vary greatly. Lao People's Democratic Republic (Lao PDR), Myanmar, Yunnan Province of People's Republic of China (PRC), and to an extent Viet Nam have large untapped hydropower potential exceeding their own demand. Viet Nam and Yunnan Province have significant deposits of coal. There are substantial reserves of natural gas, mainly in offshore fields in Myanmar, Thailand, Viet Nam, and the Joint Development Area between Malaysia and Thailand. Thailand is energy deficient and will increasingly rely on imports, despite considerable indigenous gas and lignite deposits, and some oil reserves.

4. Subregional electricity trade based on interconnected electric power networks will provide significant economic and environmental benefits for individual countries and the entire GMS. It will enable members to reduce national investments in the power reserves maintained to meet peak demand. Other benefits will include (i) a more reliable supply of electricity, including power supply from an interconnected network in case of a power failure; (ii) lower operational costs; (iii) reduced greenhouse gas emissions and other pollutants; and (iv) consumer access to the cheapest and most environmentally sustainable sources of electricity in the subregion, i.e., hydropower and gas.

5. As part of the program for economic cooperation in the GMS initiated by ADB in 1992, a subregional energy sector study, under phase II of the GMS cooperation program,<sup>4</sup> was undertaken to provide the scope of cooperation, required framework, and recommended specific projects or project concepts that would promote subregional cooperation for the

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<sup>1</sup> Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam, and Yunnan Province of People's Republic of China.

<sup>2</sup> The TA first appeared in *ADB Business Opportunities* (Internet edition) in March 2000.

<sup>3</sup> EGP requested (i) ADB financing for preparation of the policy statement and regional indicative master plan on power interconnection; and (ii) World Bank financing for preparation of the regional protocol and study for regulatory and institutional framework.

<sup>4</sup> TA 5535-REG: *Promoting Subregional Cooperation Among Cambodia, People's Republic of China, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam*, for \$4 million, approved on 10 June 1993.

development of the energy sector. Based on the study's recommendations, the EPF was established in April 1995 to (i) promote opportunities for cooperation in the power sector; (ii) facilitate the implementation of priority subregional power projects; and (iii) address technical, economic, financial, and institutional issues relevant to subregional power development. The EGP was created in June 1998 to discuss detailed work programs and recommend its findings to the EPF to (i) promote the development of a subregional transmission network, and (ii) facilitate the expansion of cross-border power trade.

6. In the GMS, power has been traded on a bilateral basis, mainly through long-term power purchase agreements. There is growing interest in cross-border power trade, spearheaded by regional and international developers who have commenced hydropower development in the Lao PDR to sell power to Thailand. Large hydropower facilities are planned in Yunnan Province, to interconnect with Thailand. Such bilateral trade will bring about some benefits. But the full potential will not be realized unless an advanced degree of grid integration is achieved, i.e., until the power grid is developed and operated in a coordinated manner, including a competitive subregional electricity market.

7. The following electric power projects of a subregional nature are currently ongoing or under consideration: (i) Nam Leuk Hydropower Project<sup>5</sup> in the Lao PDR, scheduled for completion in 2000; (ii) Nam Ngum-Udon Thani 500 kilovolt (kV) line between the Lao PDR and Thailand, for which a feasibility study has been completed; (iii) Nam Ngum 3 Hydropower project in the Lao PDR; (iv) Se Kong-Se San and Nam Theun River Basins Hydropower Development Study in Cambodia, Lao PDR, and Viet Nam, for which the six most feasible sites have been identified; and (v) a proposed power sector study for the Lao PDR.

8. A Mekong integrated transmission system study was started in June 1995 and completed in September 1996, financed by the Government of Japan and conducted by the Mekong River Commission Secretariat. It focused primarily on the lower Mekong Basin countries, i.e., Cambodia, Lao PDR, Thailand, and Viet Nam. However, Myanmar and Yunnan Province in the upper Mekong Basin were included in an overall assessment of the situation and a proposal for an interconnected network in the GMS. A power trade strategy for the GMS was drawn up in January 1998 with World Bank support, paying particular attention to (i) the barriers to power trade; and (ii) the policy, institutional, and commercial framework required to develop and operate a subregional power network efficiently.

9. The financial and economic crisis that hit Southeast Asia in mid-1997 brought with it the need to reassess power sector development plans and expectations in the GMS. Slower growth in the subregion, and a contraction in demand in Thailand,<sup>6</sup> will necessitate adjustments in the GMS electric power program even though the economic recovery is faster than anticipated. Forecasts of demand for electricity will need to be scaled back, requiring a rescheduling of power generation projects and related transmission and distribution systems development programs. Another reason for adjusting the electric power program is the shortage of investment capital, including locally generated funds. The ongoing power sector reform in Thailand will affect the GMS power sector. The availability and greater economic viability of advanced technology for combined cycle gas turbines has led to the extensive use of natural gas for power generation in the subregion, producing minimal greenhouse gases per unit of electricity generated. The study will also examine power generation and transmission plans in the key

<sup>5</sup> Loan 1456-LAO, for \$52 million, approved on 10 September 1996.

<sup>6</sup> The revised long-term power supply and demand forecast in Thailand reflecting the financial crisis is expected to be completed by June 2000.

neighboring countries, such as (i) the proposed power interconnection between the PRC's Guangxi Province and Viet Nam, and (ii) the expected power trade between Malaysia and Thailand, to seek least-cost options for power interconnections among GMS countries.

10. To promote electric power interconnection and trade in the GMS, a policy statement on power trade was adopted at the sixth EPF meeting in October 1999 and endorsed at the ninth GMS Ministerial conference in January 2000. A regional protocol has been under discussion since February 2000 to implement the policy statement and is expected to be ready by 2002.

### **III. THE TECHNICAL ASSISTANCE**

#### **A. Objectives**

11. The main objectives of the TA are to (i) update the subregional transmission master plan proposed as part of the 1996 power transmission study, taking into account the recent economic changes, ongoing power sector reform in Thailand, and increased viability of the use of natural gas in the subregion; and (ii) harmonize transmission planning, design, and operational practices to promote subregional power trade.

#### **B. Scope**

12. The scope of the TA will include (i) assessing electric power demand and reviewing generation and transmission expansion plans in the GMS and neighboring countries, (ii) updating plans for power grid interconnections on the basis of revised demand and supply projections, (iii) formulating an indicative transmission master plan to promote subregional power trade, and (iv) identifying the institutional and regulatory issues that need to be addressed to properly implement the plan. The outline terms of reference for the consulting services that will be required are in Appendix 2.

#### **C. Cost Estimates and Financing Plan**

13. The total cost of the TA is estimated at \$950,000 equivalent. The Government of Norway will provide a grant of \$742,000 under its Channel Financing Agreement with ADB, while ADB will provide a grant of \$158,000 from the Technical Assistance Special Fund. The participating GMS countries will provide the remaining \$50,000 equivalent in kind. Details of the cost estimates and financing plan for the TA are in Appendix 3. ADB's approval of the TA will not commit ADB to finance any ensuing project.

#### **D. Implementation Arrangements**

14. The Executing Agency for the TA will be ADB. The EGP will act as the steering committee. It consists of two members from each GMS country, and representatives from ADB and the World Bank. The committee will be responsible for providing overall direction and guidance. The representatives of GMS member countries will assist in preparing and collecting data, participate in the committee's meetings, and help organize the meetings as necessary. The committee will meet at least two times during the study period or more often as necessary as part of EGP and EPF meetings. To conduct consultations with nongovernment organizations (NGOs) and stakeholders, an advisory panel will be set up. The panel will consist of three to five representatives from NGOs and stakeholders with interest in the GMS and knowledge of power generation and transmission planning. The panel will (i) discuss the study's objectives with the

consultants engaged to conduct it, (ii) review the consultants' reports, and (iii) attend EGP meetings.

15. The TA will be carried out by a firm of international consultants to be engaged in accordance with ADB's *Guidelines on the Use of Consultants*. The TA will require about 22 person-months of international consulting services. A team of experts will be engaged from a firm, with expertise in power interconnection between states and/or countries, including power system planning and economics, project finance, and assessment of the technical aspects of regulatory and institutional frameworks.

16. The consultants will submit (i) an inception report within 1 month, (ii) an interim report within 7 months, and (iii) a draft final report within 12 months of the commencement of the TA. These reports will be presented at EGP meetings and discussed by representatives of the GMS member countries, ADB, and the World Bank. The indicative master plan is expected to be completed in 15 months starting October 2000.

#### **IV. THE PRESIDENT'S DECISION**

17. The President, acting under the authority delegated by the Board, has approved (i) ADB administering a portion of technical assistance to be financed by the Government of Norway on a grant basis in an amount not exceeding the equivalent of \$742,000, and (ii) the provision of the balance of technical assistance to be financed by ADB on a grant basis in an amount not exceeding the equivalent of \$158,000, both for the purpose of the Regional Indicative Master Plan on Power Interconnection in the Greater Mekong Subregion, and hereby reports such action to the Board.

## TECHNICAL ASSISTANCE FRAMEWORK

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
<b>Goal:</b> Optimal utilization of energy resources in the Greater Mekong Subregion (GMS) through preparation of a regional indicative master plan on power interconnection		Consultants' reports  Discussion of the master plan by the Experts Group on Power Interconnection and Trade (EGP)	Power interconnection to provide reduced investments in reserve capacity, improved supply reliability, lower operating costs, and supply of cheap and environmentally sustainable sources of electricity in the GMS  Active involvement of the GMS countries
<b>Purpose</b>  Prepare a regional transmission master plan taking into account the recent economic changes in the GMS.  Harmonize transmission planning, design, and operational practices to promote subregional power trade.	Preparation of the master plan  Recommendations on planning, design and operational practices, and grid code	Consultants' progress report  Presentation and discussions of the master plan at EGP meeting	Provision of information on each GMS country's technical practices
<b>Outputs</b>  Consolidation and review of existing studies  Assessment of GMS member and neighboring countries' power demand and supply  Review of existing practices and technical coordination	Demand and supply of electricity forecast to 2020  Proposal of technical grid code	Consultants' progress report  EGP review of the progress of the study	Timely provision of demand and supply projections by each GMS member and neighboring countries  Provision of information on each country's technical status

(Reference in text: page 1, para. 2)

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
<p>Master plan</p> <p>Institutional and regulatory arrangements</p>	<p>Preparation of a master plan</p> <p>Proposal for improvements in institutional and regulatory framework</p> <p>Identification of the roles of the private and public sectors</p>		<p>Provision of information on the existing electric power interconnections</p>
<p><b>Activities</b></p> <p>Collection of various studies</p> <p>Preparation of questionnaire and visiting GMS countries for discussion of demand, supply, and technical practice</p> <p>Preparation of master plan</p>	<p>A list of studies collected</p> <p>Preparation of questionnaire</p> <p>A master plan</p>	<p>Consultants' progress report</p> <p>EGP review of the progress of the study</p>	<p>Timely provision of demand and supply projections by each GMS member and neighboring countries</p> <p>Provision of information on each country's technical status and the existing electric power interconnections</p>
<p><b>Inputs</b></p> <p>International consulting (22 person-months)</p> <p>Consultants' international and local travel</p> <p>Subregional meetings</p> <p>GMS members' counterpart contribution (in kind)</p>		<p>Consultants' progress report and work plans</p> <p>Project account</p>	<p>Timely engagement of international consultants</p> <p>Consultants' familiarity with the GMS power interconnection</p> <p>Active participation of GMS countries in EGP</p>



## **OUTLINE TERMS OF REFERENCE FOR CONSULTING SERVICES**

The terms of reference for the consultants will include, but not necessarily be limited to, the following:

- (i) Consolidation and Review of Existing Studies
  - (a) Review the Mekong Integrated Transmission Study, Nam Ngum 500 kilovolts Transmission Project, Se Kong-Se San & Nam Theun River Basin Study, and other relevant power transmission and generation studies.
  - (b) Collect and compile information on proposed subregional transmission interconnection projects from sources such as the World Bank, Economic and Social Commission for Asia and the Pacific (ESCAP), Asia Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN), the Mekong River Commission, and project developers.
- (ii) Assessment of GMS Member Countries' Demand and Supply
  - (a) Develop a common methodology for electricity demand and supply analysis for the Greater Mekong Subregion (GMS), that would avoid overestimating demand in the subsidized sector.
  - (b) Using this methodology, review and update each member country's electricity demand projections and the overall demand projections in the GMS, after the Asian crisis.
  - (c) Review and update each GMS member and neighboring countries' transmission and generation expansion plans, taking into account the increased viability of natural gas use in power generation, ongoing power sector reform in Thailand, and power needs after the Asian crisis.
  - (d) Assess the status of the ongoing and committed grid interconnection projects in the GMS member countries.
- (iii) Review of Existing Practices and Technical Coordination
  - (a) Assess the technical and operational compatibility of transmission systems in the GMS member countries with respect to design parameters, protection and communications practices, system control and generation dispatch, and grid codes.
  - (b) Recommend changes required to arrive at the optimum common criteria for network design, operation, and control of power transmission facilities required to promote subregional grid interconnections.

(iv) Master Plan

- (a) Assess the technical and economic feasibility of power transmission interconnections among GMS member countries, taking into account the development of public and private sector power generation projects.
- (b) Recommend least-cost grid interconnections required to support plans to expand power generation in the GMS and neighboring countries while ensuring the reliability and quality of supply.
- (c) Prepare project profiles, capital cost estimates, and time schedules for the proposed interconnections up to 2020.
- (d) Assess the availability of domestic financial resources such as insurance companies, domestic bond issues, and special funds, if any, to meet investment needs.
- (e) Assess the availability of international financial resources (bilateral, multilateral, and private sector) to meet investment needs, and develop a financing plan to implement the recommended transmission interconnections.
- (f) Consolidate the above findings into an indicative master plan covering the period 2000-2020.

(v) Institutional and Regulatory Arrangements

- (a) Identify the institutional and regulatory impediments, if any, to the promotion of subregional power trade.
- (b) Determine the improvements necessary in the institutional and regulatory framework to support the power interconnection master plan. Identify the roles of the private and public sectors.
- (c) Determine the human resources and training needed to implement the master plan.

**COST ESTIMATES AND FINANCING PLAN**  
(\$'000)

Item	Total Cost
<b>A. Government of Norway and Asian Development Bank Financing</b>	
1. Consultants	
a. Remuneration and Per Diem	530.0
b. International and Local Travel	85.0
c. Reports and Communications	15.0
2. Subregional Meetings	90.0
3. Advisory Panel	60.0
4. Miscellaneous Administrative and Support Costs	5.0
5. Contingencies	115.0
<b>Subtotal (A)</b>	<b>900.0</b>
<b>B. Greater Mekong Subregion Governments Financing (in kind)</b>	
1. Office Accommodation	15.0
2. Remuneration of Counterpart Staff	25.0
3. Administrative Support and Other Costs	10.0
<b>Subtotal (B)</b>	<b>50.0</b>
<b>Total</b>	<b>950.0</b>

Source: Staff estimates