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Cambodia
Power Sector Strategy

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Energy & Mining Development Unit
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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AFD	Agence Francaise de Development
ASEAN	Association of Southeast Asian Nations
AusAID	Australia Agency for International Development
BOO	Build, Own and Operate
BOOT	Build, Own, Operate and Transfer
BTL	Build, Transfer and Lease
CC	Combined cycle
DO	Diesel oil
EAC	Electricity Authority of Cambodia
EDC	Electricité du Cambodge
EDF	Electricité de France
ENEL	Ente Nazionale de'l Elettricita
HECEC	HECEC Australia Pty. Ltd.
HFO	Heavy fuel oil
IDA	International Development Agency
IEC	International Electromechanical Committee
IFC	International Finance Corporation
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
MBTU	Million British Thermal Units
MEF	Ministry of Economy and Finance
MIGA	Multilateral Investment Guarantee Agency
MIME	Ministry of Industry, Mines and Energy
MOU	Memorandum of Understanding
MSD	Medium speed diesel
NGO	Non-government organization
OCGT	Open cycle gas turbine
OECF	Overseas Economic Cooperation Fund (Japan)
PHRD	Policy and Human Resources Development Fund (Japan)
PPA	Power Purchase Agreement
PSO	Public Service Obligation
RFP	Request for Prequalification
RFP	Request for Proposal
ROW	Right-of-Way
SAR	Staff Appraisal Report
WB	World Bank

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TABLE OF CONTENTS

Annexes

Tables and Figures

PREFACE

This report is based on the findings of a mission that visited Cambodia in February 1999. The team included Enrique Crousillat (team leader), Peter Cordukes (principal financial analyst – sector reform), Surya Sethi (principal investment officer – IFC), P.T Venugopal (utility finances), Fernando Lecaros (power planner/engineer) and Anthony Woods (rural electrification). Additional input was provided by Mac Cosgrove-Davies (rural electrification), James Schmidt (counsel – power legislation), Christine Maurer-Voss and Fabio Tambone (research analysis) and Perry Radford and Carla Sarmiento (report processing). The report benefited from the guidance of Richard Newfarmer (Lead Specialist, EASPR) and comments of the peer reviewers Nadereh Chamlou and Jean-Pierre Charpentier. Valuable comments were received also from Anil Cabraal, Mostafa El-Erian, Jean-Paul Pinard, Raj Soopramanien, Su-Yong Song, Jamil Sopher and Barry Trembath.

The task team is thankful for the cooperation provided by the Government of Cambodia, and in particular for the excellent support of the power policy team established within the Ministry of Industry, Mines and Energy under the lead of H.E. Ith Praing, Secretary of State. The report was discussed with energy sector authorities and staff in May 1999 and revised on the basis of these discussions.

CAMBODIA POWER SECTOR STRATEGY

EXECUTIVE SUMMARY

1. Cambodia's power sector was severely damaged by years of war and neglect. In spite of the Government's efforts, its institutions remain weak and power supply is unreliable, costly, and mostly limited to urban areas. Consequently, only 12 percent of the households have access to electricity: the lowest electrification ratio among East Asian countries. In most cities, deficiencies in the power supply remain due to weak management and poor conditions of generation and distribution facilities. Further, the lack of a transmission system prevents a more efficient use of power supply options resulting in one of the highest electricity costs in the world.

2. After a two-year economic slowdown caused by a long political stalemate and East Asia's financial crisis, political stability is emerging and Cambodia appears to be ready to resume a sustained economic growth. GDP growth for 1999 is expected to reach 4% (as opposed to 1% in 1998) and gradually increase to 6% in 2001 while Cambodia initiates a new era as a member of the ASEAN. Important part of this growth will be associated to industrial expansion stemming from regional trade opportunities and located mostly in the Phnom Penh – Sihanoukville area. Therefore, the next 4 to 5 years will be characterized by an increasing demand for infrastructure in this area. However, while macroeconomic stability and growth are expected to be achieved, progress has yet to be made in addressing fundamental fiscal problems, including a weak domestic revenue mobilization and inefficient public expenditure management. The efficient development of the power sector, open to private participation, will be critical to support Cambodia's goal for sustainable economic growth and social development due to the following reasons: (a) the reliable provision of electricity services at lower costs is an essential condition for the growth of a competitive industry; and (b) power investments for the period 1999-2003 are expected to reach 11% of domestic investment and 2-2.5% of GDP, hence, a power sector successful in attracting direct private investment will minimize the use of public resources thus reducing the pressure on fiscal management problems and releasing public funds for social objectives.

3. Cambodia's power sector is today at a crossroad. After a period of emergency rehabilitation and reconstruction, *the sector is ready to face development objectives aimed at: (a) improving sector efficiency and reducing electricity costs; (b) consolidating the ongoing reform; and (c) addressing the sector's social concerns, particularly the extension of electricity services to rural areas.* It is therefore necessary to formulate and implement a power sector strategy addressing the most salient problems of the sector:

- lack of a legal and regulatory framework, including the lack of transparency and competition in the current process for private sector entry;
- an entrenched public-oriented approach towards the management of public utilities;
- poor technical, commercial and financial performance of the sector;
- weak investment planning;
- lack of resources and strategy to provide electricity services to rural areas; and
- a weak human resource base.

A. Proposed Strategy

4. **Future Development of the Power Sector**. Cambodia's power sector is already considerably unbundled since a large number of small suppliers provide services throughout the country and IPPs are beginning to play a major role in Phnom Penh. It is expected that upon the enactment of the Electricity Act the private sector will increase its role in power generation and provide distribution and commercial

services in most provincial towns. A desirable evolution of the sector structure in moving from the current single buyer model towards a wholesale market[1] could include the following steps/components:

- Electricite du Cambodge (EDC) should be granted a consolidated license for generation, transmission and distribution for a clearly defined period. Further expansion of EDC's role is not recommended, unless EDC's position offers clear technical and economic advantages.
- The current single buyer model is a useful transitional step towards a more competitive market. Conditions for a wholesale market include: (a) the enactment of the Electricity Act and effective functioning of the EAC; (b) physical development of a power system linking the most important load centers; and (c) the presence of a minimum number of competing suppliers (5 or 6). These conditions are not likely to be met before five to six years.
- In the short to medium term (next 3 to 4 years), options to improve sector efficiency include the following, in sequential order: (a) introduce a suitable bidding process for IPPs; (b) improve long term contracts to minimize operation distortions; (c) break the single buyer model allowing new IPPs to sign contracts directly with large consumers—this measure would help to minimize the utility risk and reduce IPP costs; and (d) create a parallel market—competition for bilateral contracts between generators and distributors within a gradual process to move from the single buyer to a fully competitive wholesale market.
- In the short to medium term the sector is likely to get maximum gains by commercializing EDC[2]. The proposed performance based contract with a strategic partner would help improving EDC's performance within a period of two to three years. Once this is achieved and the legal and regulatory framework is in place, EDC could become a good candidate for privatization.
- Given the current single buyer structure, the international nature of future transmission in Cambodia and the decreasing role to be played by EDC as a generator, it expected that EDC would execute the first transmission investments.

5. **Sector Strategy.** The proposed strategy aims to address the development objectives of the Cambodian power sector focusing in short to medium term measures, while keeping in mind the longer term vision presented above. It is designed to improve the efficiency of the power sector taking into account the strengths and weaknesses of the sector. ***Three priority elements of the strategy are: (a) establish the enabling environment for an efficient development and operation of the sector, i.e. a suitable legal and regulatory framework; (b) attract private sector participation in a transparent and competitive manner, as a way to introduce efficiency, mobilize financial resources and reaching a broader human resource base; and (c) commercialize EDC, including a tariff reform to expand its market share, and availing the support of a foreign utility through a performance based contract and eventual strategic partnership. An essential condition for the success of the proposed strategy is the Government's commitment to respect EDC's commercial autonomy and the independence of the regulatory body (EAC).*** The components of the proposed sector strategy are presented in Table 1.

6. It is important to note that the different components are part of a single strategy where all parts are inter-related. A suitable legal and regulatory framework would create fair and efficient conditions for

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[1] A wholesale market implies a fully unbundled structure where generators compete to sell to a large number of consumers, while transmission and distribution companies provide open access and charge for wheeling services. This model requires separating generation from transmission and distribution, firms that are commercially independent, a separate ownership/control of market management and grid operation, and an independent regulatory system. Due to the major and complex tasks involved, the wholesale model should be seen as a long term goal.

[2] Compelling EDC to operate on commercial principles.

a public/private system, provide confidence to private investors, help consolidating EDC's commercialization process, and promote orderly private involvement in rural areas. A financially strong and more commercial EDC would reduce risks to private investors. Finally, making rational public investment decisions would support EDC finances and help private investors to choose viable options.

Table 1: Power Sector Strategy for Cambodia

Development Objectives	Power Sector Strategy	Actions Proposed	Resources Required
Improve power sector efficiency & reduce electricity cost			
• Corporate reform	• Corporatization and commercialization of EDC. *Main requirement: GOC to respect EDC's commercial autonomy*	Short term • Sign performance agreement with GOC. • Performance based contract with foreign utility. Short to medium term • Seek strategic partner. • Implement training program.	 AFD funding ADB/AFD
• Revamping of utilities	• Restore EDC's financial health	Short term • New tariff structure to reflect marginal costs. • Marketing plan (subject to IPP2 commissioning date). • Improve collections – implement action plan signed with GOC. • Implement loss reduction program.	 AFD funding
	• Review power service in provincial towns	Medium term • EAC to assess current arrangements and grant licenses. • Introduce competition.	
• Removing infrastructure constraints	• Define and implement short to medium term expansion	Short term • Remove uncertainty on IPP2. • Negotiations for Vietnam and Thailand interconnections. • Initiate preparation of IPP3 (60-90MW) for 2002. • Fuel conversion in EDC diesel plants. • Hydropower studies (hydrological data, screening, feasibility studies). Medium term • Kirirom hydropower plan; if industrial load builds up along transmission line.	 Experts support Experts support Bilateral donors TA
	• Define financing plan	Seek financing from multilateral and bilateral agencies	World Bank, ADB, OECF

Development Objectives	Power Sector Strategy	Actions Proposed	Resources Required
Addressing Social Sector Concerns	• Rural electrification program.	Short term • Develop rural electrification strategy. Medium term • First rural electrification project.	IDA/bilateral IDA
Establish the enabling environment for an effective development and operation of the power sector	• New legal and regulatory framework. *Main requirement: GOC's commitment to respect independence of EAC* • Policy for IPPs	Short term • Enact Electricity Act. • Establish EAC; - formulate and set regulatory procedures. - training program - set up task force - appoint EAC advisor Short term • Formulate and adopt procedures for competitive bidding. • Transparent and predictable GOC policies. • Experienced and independent advisors.	 IDA IDA IDA IDA

B. Regulatory Framework

7. **Electricity Act.** A draft Electricity Act has been prepared with donors support—including IDA funding—and is expected to be presented to the National Assembly by mid 1999. The draft law provides for the creation of an Electricity Authority of Cambodia (EAC) as an independent regulatory body. The flexibility provided by the draft for the unbundling of the sector, increased private participation and eventual privatization of EDC are considered appropriate. According to the draft law, the Ministry of Industry, Mines and Energy (MIME) will be responsible for coordinating energy policy and planning; it will transfer its regulatory functions to the EAC when it becomes fully operational thus separating two main roles of the state: regulation and policy making. The drafting of the law has been done in a very thorough and professional fashion for which MIME and other government officials can justifiably take credit. *The enactment of the law is an essential step for the Government's sector reform efforts since it would set the conditions required to attract private sector in an orderly and competitive manner. Further, a sector characterized by competing public and private companies will constitute a strong incentive to the effective commercialization of EDC.*

Role of the Regulatory Body

8. Under the proposed law, the EAC's main functions would be to review and approve electricity prices, license power utilities, review their planned investments, finances and performance, and enforce its regulations, rules and standards. It will also prescribe license fees, enforce performance standards, handle consumer complaints, hold hearings and establish a uniform system of accounts. The EAC would comprise a full-time Chairman and two members who will be designated by the Prime Minister and appointed by Royal Decree for three-year terms.

9. The autonomy of the EAC is a key requirement for its effective functioning. The draft law is consistent with this principle since it would establish that: (a) the Chairman and members of the EAC cannot be removed except for criminal activities; (b) EAC decisions cannot be revoked by the executive branch; and (c) EAC will have an important degree of budgetary autonomy. Nevertheless, *experience in other countries has revealed that, even under the protection of the law, regulatory bodies have suffered arbitrary political pressures which undermined their autonomy. It is therefore essential that the GOC makes a firm political commitment to respect the regulator's autonomy.*

10. **Establishing the EAC**. Establishing EAC will be a very large administrative undertaking and needs to commence as soon as possible. MIME should accelerate plans by setting up a task force to address a wide range of tasks required by the draft law. Several of these tasks will be supported by IDA's ongoing project. Work needs to be accelerated by appointment of an EAC advisor and, most important, assigning suitable staff to form the nucleus of EAC. *Until the EAC is operating effectively, transition arrangements will be required. It would take at least 12 months of focused effort for EAC to become operational, setting procedures and training its staff.*

11. **Tariff Setting Procedures**. The draft law establishes the following principles:

- Tariffs should reflect the cost of supply by time of day, season and type of customer;
- Performance-based tariffs may be used if it is in the interests of licensees and consumers;
- Financial returns of licensees could increase if costs are reduced and service quality maintained;
- Lower rates can be set for poor residential and rural consumers;
- Consumers will be protected against monopolistic prices;
- Economic efficiency will be encouraged by using marginal costs to structure tariff rates;
- Account will be taken of supply costs to each class of consumer; subject to any subsidies.

The selection of the price-setting formula (cost plus/rate of return, or price cap) should be made by the EAC on the basis of an assessment of the market structure and the level of information available, as well as the degree of incentives desired.

C. Commercialization and Private Sector Participation

Corporate Reform and Commercialization of EDC

12. Until 1996, EDC operated as a Government department under the direction of MIME. EDC was then converted into a limited liability company by Royal Decree, owned jointly by MIME and the Ministry of Economy and Finance (MEF). The decree gave EDC the non-exclusive right to generate, transmit and distribute electricity throughout Cambodia. EDC has a board of seven directors, three of whom are drawn from the private sector. It currently submits requests for tariff increases to MIME and MEF, but tariff approvals are, in practice obtained from the prime minister. This situation would change upon the establishment of the EAC. *EDC's corporate reform should be seen as a first step towards the GOC's goal to increase efficiency through a strong focus on improving its commercial functions.*

13. Although EDC formally operates as a separate entity, the Government's ownership continuous having an adverse effect on its performance. A complex issue is the Government's inability to separate its role as policy maker, owner and customer of EDC. This problem is manifested in eventual political

interference on EDC's operations and, most important, in the blurring of lines between the finances of EDC and the Government budget which tends to distort EDC's incentives and accountability[3].

14. *In the short to medium term Cambodia is likely to get maximum gains by commercializing EDC.* Progress has been made through the development of a corporate plan. Improvements are being achieved also in the reduction of system losses (down to 20% from 38%). However, much remains to be done to improve EDC's productivity. Evidence from several countries show that the commercialization of public utilities can achieve the bulk of the efficiency gains prior to the ultimate goal: privatization. Commercialization requires state enterprises to be exposed to commercial pricing and market incentives, responsible for its own profits and losses, and independent from the government budget.

15. The possibility of selling shares in EDC is remote due to EDC's serious financial problems and the uncertain regulatory and investment climate in Cambodia. *A better option might be for EDC to seek a strategic partner to help it strengthen its management skills and deal with the private sector interface, i.e. a longer-term involvement by a partner who has a vested interest in the company's financial performance. A first step to achieve this could be to offer a performance based contract to a well managed utility for a two to three year period that could lead to a strategic partnership.* For the short-term, the best strategy for EDC would be to take immediate action to rationalize tariffs and expand its market, improve collections and reduce system losses.

16. **Service in Provincial Cities.** Since 1996, EDC has taken responsibility for power supply in four of twenty-one provincial capitals. It is not clear if it will take over the power service in the remaining towns. In these cases power systems are owned by the Government. There are private operators in most provincial towns working as IPPs or under lease agreements (LO) with MIME. These arrangements relieve public entities from a complex activity; however, they are technically and environmentally unsatisfactory due to a lack of effective regulation. As EDC resources are limited, it is recommended to keep the present arrangements until the new law is enacted, the EAC reviews the existing arrangements and grants licenses on a competitive basis. The GOC might consider also creating distribution franchises by selling parts of its system to local entrepreneurs through open competition.

Private Sector Participation

17. MIME first sought expressions of interest from private power developers in 1994 to help it re-establish adequate power supplies in Phnom Penh and major provincial towns. This approach was adopted due to the extreme shortage of generating capacity and the limited funds at the disposal of the GOC. The GOC did not, however, follow a transparent and competitive process for the selection of projects. This factor, plus the lack of competent and/or independent advisors, and eventual political interference, led inevitably to mistakes that resulted in conditions unfavorable to EDC.

18. With the exception of a first 35MW IPP for Phnom Penh, contracted with a Malaysian consortium, progress in other IPPs[4] has stalled largely due to the worsening investment climate in

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[3] EDC's accounts receivable on December 31, 1998 were 26 billion riels (above 90 days), stemming mostly from public customers. Such position is cause for serious concern; the GOC's practice to offset these accumulated losses against tax remittances and/or 'capital' is not a sustainable solution being necessary to accelerate EDC's commercialization.

[4] Including IPP2: a second 60MW plant in Phnom Penh (Beacon Hill), and smaller plants in Siem Reap, Battambang and Kampong Cham. In addition, EDC has signed a new PPA for a temporary 15MW plant in Phnom Penh to meet power shortages due to the delay of Beacon Hill's project.

Cambodia caused by political instability and the current financial crisis in the region. The passage of the Electricity Act would help to restore confidence of private power investors. However, it should be expected that potential investors will, even after the new law is in place, build the high country and utility risks into their bid prices and seek Government guarantees to offset these risks.

19. To achieve better project conditions, in terms of prices and risk-sharing, the GOC should adopt the following guidelines for selecting and contracting IPPs:

- Adopt competitive bidding procedures. The bidding stage should be based on standard documents prepared for the power purchaser and include drafts of the main agreements, most importantly the Power Purchase Agreement, fuel and transportation agreements, and any Implementation Agreement or license to be awarded.
- Government policies. The international power market is highly competitive, therefore, investors respond best to countries that offer favorable investment policies by removing legal or regulatory barriers, and providing absolute clarity in the procedures to award concessions. Procedures should be made public, making the government's actions fully transparent and predictable.
- Experienced advisors. The power purchaser and the government need to be served by proficient, experienced and independent legal, financial and technical advisors.
- Structuring projects. The general view is that BOO projects yield the best way to maintain involvement of the private sector and encourage competition in the sector.

D. Power Sector Expansion

Electricity Demand

20. Electricity demand in Cambodia is concentrated in Phnom Penh, which accounts for 70% of the country's electricity consumption even though it accounts for only 12% of the population. Consequently, most of the power expansion issues revolve around the evolution of demand in this area. Due to years of neglect, the power system in Phnom Penh was unable to meet demand through conventional grid connections. A large amount of demand was supplied from large and small generators owned by large, medium and small consumers. Since 1995, there has been a gradual normalization of supplies from EDC; however, there remains a substantial capacity of generation sets owned and operated by large industrial and commercial enterprises which prefer to remain as self-generators due of the low reliability and/or high cost of EDC supplies.

21. Power demand in Phnom Penh can be classified in two groups: (a) 'price-taking' customers, comprising users which are unlikely to be self-generators, such as domestic users, businesses and government; and (b) larger users, many of which are not connected to the grid. Demand of price-taking customers is expected to grow at 14% per year during 1999-2002. On the other hand, large users demand is difficult to estimate since it is highly responsive to variations in price levels and reliability. Current price levels (21US¢/kWh for hotels and 17US¢/kWh for industry) will probably inhibit industrial/hotel purchases of electricity from EDC and encourage more off-grid generation. It is estimated that off-grid generation (connected and unconnected to EDC) serves a peak demand of 29-34MW, and a sales potential around 159GWh per year. This group is very large relative to EDC's current industrial and hotel sales. Incorporating them to the grid will require a marketing strategy designed to make EDC's service financially attractive. However, EDC is ill-equipped to initiate such effort: its tariff schedule is inadequate, its generation reserve is small and it lacks an organized marketing team.

Table 2 – Generation Requirements (GWh)

	1998	1999	2000	2001	2002
Scenario I	334	376	444	499	562
Scenario II	334	381	491	583	665

22. **Projections.** Demand projections were made on the basis of two possible scenarios: Scenario I - EDC is to continue with business as usual, with very modest growth in the hotel/industrial market; Scenario II - assumes that EDC can organize an effort to increase its sales and attract new users. Table 2 summarizes the projections under the two scenarios.

Generation and Transmission Expansion Plans

23. Generation and transmission-related decisions are currently overshadowed by short term conditions such as demand uncertainty resulting from the tariff policy and 'uncertainty of supply' in the context of the postponement of IPP2. A demand-supply analysis for Cambodia's expanding system taking into account the above mentioned uncertainties concluded the following:

Medium/Long term options

- *An interconnection with Vietnam appears to be the most competitive solution.*
- A combination of thermal plants is probably the best option for meeting demand through domestic generation.
- Hydro options should be assessed carefully due to the uncertainty related to their early stage of preparation.
- Kirirom hydropower project should be delayed, unless it can be built with grant money.
- Prek Thnot multipurpose hydro should be avoided by the power sector because of its high costs.
- The low loads of - and long distances between - provincial cities do not appear to justify 230kV interconnections, unless local loads exist along the transmission lines.

Short term options: Decision Agenda for 1999-2000

Decisions which do not depend on IPP2:

- Fuel conversion of EDC's medium speed diesel plants will bring immediate savings.
- Hydropower information required: (a) a sound hydrological data base; (b) a screening of hydro plants; and (c) the execution of selected feasibility studies.
- Vietnam interconnection: negotiations should proceed on an urgent basis, together with the required studies[5]. The actual commissioning date can be adjusted according to the IPP2 decision.

Decisions which are contingent on IPP2.

- Case 1: IPP2 proceeds and is commissioned by 2001. Possible demand increases through active marketing may have to slow down during 2001. By 2002 it would be desirable to contract for a new power plant, probably a 60MW plant with staggered units to be put into service following load growth. In this case, the Vietnam interconnection could be commissioned by 2003.

[5] Vietnam would have an energy surplus beginning the year 2001 and both countries are already negotiating conditions for a bi-lateral power trade agreement. It is expected that a MOU will be signed in mid 1999.

- Case 2: IPP2 is not realized. It would be necessary to seek an emergency IPP to be commissioned by 2001. Pursuing higher demand through a marketing plan would definitely not be feasible until 2002. The new IPP would be in the order of 90MW, seeking to complement supplies with imports from Vietnam starting 2003. Demand curtailments would occur in 2001 unless the emergency IPP is commissioned earlier; therefore, the earliest decision on the future of IPP2 is required.

E. EDC Finances

24. EDC's financial performance was unsatisfactory during the last two years, having been affected adversely by the depreciation of the riel.[6] In response to this problem, the GOC approved a tariff revision in January 1999. Although the tariff increase was aimed to improve EDC's financial position and increase revenues, given the new levels (too high for commercial and industrial customers while residential tariffs remained unchanged) there may be a number of unwanted effects as some customers are unlikely to opt for EDC service. A modified cost-based tariff structure designed to reduce cross-subsidies, avoid an uncalled categorization of users and increase EDC's average revenue is recommended. This would consist of:

- A medium voltage tariff with capacity and energy charges; time-of-day tariffs could be an option;
- A medium voltage, interruptible, tariff which mainly reflects energy costs; and
- Two low-voltage tariffs (domestic and general) to reflect different contributions to peak loads, possibly with a fixed cost component.

EDC is seeking to increase its market by attracting new customers. *If EDC is to become financially viable, it should seek a solid customer base increasing its service to high demand customers, easy to monitor and bill, and which impose lower costs on the utility. This will be possible only if a substantial reform of the present tariff structure is implemented.*

Table 3: Likely Financial Position of EDC-1998 to 2003

	Actual	**Actual**	**Approx.**	**Likely**				
	1996	1997	1998	1999	2000	2001	2002	2003
FINANCIAL DATA- Nominal								
Average revenue/riels/kWh	342	353	370	483	519	555	580	608
Total Income- Billion Riels	62.2	80.6	110.5	151.3	211.7	268.5	320.1	381.6
Cost of IPP Power Purchase	1.4	33.1	57.8	88.7	106.0	193.1	224.6	251.1
Distrbn. & Own generation	51.6	41.0	72.1	68.6	86.7	48.1	52.1	60.3
Total taxes- B. Riels	17.1	19.5	17.2	23.0	21.7	22.9	27.5	33.6
Profit/ Loss after taxes	(7.9)	(13.0)	(37.6)	(29.0)	(2.8)	4.4	15.9	36.6
Aprox.Value of Optg. Assets		199.1	333.0	402.3	540.9	575.1	575.1	675.1
Rate of Return on Assets					1%	3%	5%	7%

[6] Three main parameters illustrate EDC's unsatisfactory performance: (i) the loss for 1997 was 8 billion riels (between Sep. 1 and Dec. 31, 1997) and is placed provisionally at 37 billion riels for 1998 on a turnover of 79 billion riels in 1997 and 109 billion riels in 1998; (ii) 'accounts receivable' above 90 days on December 31, 1998 were 26 billion riels equal to 3.2 months of 'sales revenue'; and (iii) 'accounts payables' were at 14 billion riels including 10 billion riels in default for imported fuel and purchases from an IPP for power sold to EDC in 1998.

25. EDC's financial projections for 1999 budget appear overly optimistic since these assume a major improvement in its performance. A more realistic scenario was considered assuming that EDC would be relatively successful in attracting new users (Scenario II, par. 22). Under this scenario EDC's financial performance, judged by the rate of return criterion, would gradually increase as costs are reduced through an expansion of sales and the reduction of energy losses; however, it would not be satisfactory until 2003. Table 3 below summarizes the financial situation. EDC would generate internal cash, after repayment of debts, of the order of US$ 20 million until the end of 2003. When the rate of return on revalued operating assets begins to exceed 6% in due course, EDC may also consider lowering average tariffs in 'real' terms.

26. **Expansion and Investments during 1999-2003**. Considering the demand growth of Scenario II and that EDC will not invest in generation (power will be supplied by IPPs and/or Vietnam), investment requirements for transmission and other infrastructure would be about $80 million current dollars for the period 1999-2003. A tentative financing plan could be as follows: $40 million OECF; $25 million World Bank and/or ADB; and $15 million from EDC's internal cash.

F. Rural Electrification

27. Rural electrification in Cambodia is provided through formal systems, including EDC's limited network as well as the systems serving provincial capitals which are privately operated under contract with MIME. In addition, a large number of small diesel units are providing both captive power for industry as well as informal household electrification. Today, however, these providers cover only about 5% of rural areas. The challenge is to improve existing services and satisfy the large unmet demand for rural electricity services as rapidly as possible. At the same time, the rural electrification program should seek to:

maximize

- economic benefits
- affordability
- private participation and ownership
- financial sustainability of the electrification enterprise

and minimize

- overall costs (i.e. investment, fuel, operation, maintenance, etc)
- environmental impacts
- government fiscal burdens.

28. This will require the GOC to withdraw from its current role as provider of rural electrification services, and instead, adopt a new role in rural electrification as a market enabler and regulator. In so doing, the GOC should seek to establish a commercial environment which encourages private and other non-government provision of rural electricity services. Providers could be involved through a variety of models, including: a small number of relatively large distribution utility franchises, a larger number of smaller licensed operators and, for small stand-alone systems, equipment supply. Over the coming year, the Bank will assist the GOC in developing goals as well as a staged rural electrification strategy incorporating these principles.

Chapter 1: INTRODUCTION

Background

1.1 Cambodia's power sector was severely damaged by years of war and neglect. In spite of the Government's efforts of past years, its institutions remain weak, and power supply is unreliable, costly, and mostly limited to urban areas. Consequently, demand for electricity within the country is severely suppressed. Only 12 percent of the households have access to electricity, the lowest electrification ratio among East Asian countries. Although progress is being made in re-establishing power supply in major cities, deficiencies in the power supply remain due to the poor conditions of both generation and distribution facilities following years of weak management and poor maintenance. Further, the lack of a transmission system prevents a more efficient use of power supply options resulting in one of the highest electricity costs in the world.

1.2 After a two-year economic slowdown caused by a long political stalemate and East Asia's financial crisis, political stability is emerging and Cambodia appears to be ready to resume a sustained economic growth. GDP growth for 1999 is expected to reach 4% (as opposed to 1% in 1998) and gradually increase to 6% in 2001 while Cambodia initiates a new era as a member of the ASEAN. An important part of this growth will be associated to industrial expansion stemming from regional trade opportunities and located mostly in the Phnom Penh – Sihanoukville area. Therefore, the next 4 to 5 years will be characterized by an increasing demand for infrastructure in this area. However, while macroeconomic stability and growth are expected to be achieved, progress has yet to be made in addressing fundamental fiscal problems, including a weak domestic revenue mobilization, and inadequate and inefficient public expenditure management. The efficient development of the power sector, open to private participation, is a critical requirement to support Cambodia's goal to generate sustainable economic growth and social development due to the following reasons: (a) the reliable provision of electricity services at lower costs is an essential condition for the growth of a competitive industry; and (b) power investments for the period 1999-2003 are expected to reach 11% of domestic investment and 2-2.5% of GDP, hence, an efficient power sector successful in attracting direct private investment will minimize the use of public resources thus reducing the pressure on fiscal management problems and releasing public funds for social objectives.

1.3 Developing power infrastructure can alleviate poverty by providing the poor with access to a more efficient and cheaper energy, and it can mitigate environmental degradation by encouraging a shift from traditional to commercial energy and by increasing the supply of cleaner fuels.

1.4 The Government's policy for the rehabilitation and development of the power sector, as stated in late 1994[1], recognized the need to undertake sector reform to strengthen institutions and attract private sector investment. The Government of Cambodia (GOC) has acted on this, with the support of multilateral and bilateral agencies, aiming to: (a) re-establish an adequate supply of electricity in the main urban centers, through direct support of donors and "fast-track" private participation; (b) strengthen sector managerial and implementing capability; and (c) initiate efforts to create the environment required for a sustained and efficient development of the power sector, open to competition and private

[1] Energy policy presented at the Donors Coordination Meeting for the Energy Sector, Phnom Penh, October 1994.

participation. During the last three years, the GOC has been partially successful in meeting its objectives. Power supply in Phnom Penh has improved as donors[2] support in generation and distribution is complemented by private independent power producers (IPP). Following a commercialization plan, EDC was established as a separate entity in March 1996 and EDC's Board of Directors appointed in Aug. 1997. A draft Electricity Act was prepared and early discussions held with the executive branch and the World Bank. The law is expected to establish a regulatory body: the Electricity Authority of Cambodia (EAC).

1.5 Cambodia's power sector is today at a crossroad. After a period of emergency rehabilitation and reconstruction, the sector is ready to face long term development objectives aimed at: (a) securing adequate and reliable power services; (b) the consolidation of the ongoing reform; and (c) addressing social sector concerns, particularly the extension of electricity services to rural areas. To this end, it is necessary to formulate and implement a power sector strategy addressing the most salient problems of the sector and propose a plan to solve them. Government efforts are constrained by: (a) the lack of a legal and regulatory framework, including the lack of transparency and competition in the current process for private sector entry; (b) an entrenched public oriented approach towards the management of public utilities; (c) financial weakness of EDC; (d) weak investment planing; (e) lack of resources and a strategy to provide electricity services to rural areas; and (f) a weak human resource base.

Study Objectives

1.6 The main objective of the present report is to support the Government in developing a strategy for the power sector and establish action plans regarding: (a) investment priorities for generation and transmission; (b) establishing a regulatory framework for the power sector; (c) the commercialization of EDC; (d) defining a policy for private sector participation; and (e) scaling up rural electricity access. An important objective of the proposed study was to seek consensus within the GOC on the above mentioned issues and, subsequently, gain the momentum required to strengthen and reform the power sector.

Audience and Scope

1.7 The present report is the product of a collaborative effort between the Government of Cambodia and the World Bank. It is based on the findings and discussions held by two Bank missions with Government officials, in particular with the policy team of the Ministry of Industry, Mining and Energy (MIME) and EDC management. The report is designed to be a final input for MIME in its effort to formulate a Power Sector Strategy. In this sense, it addresses the main problems of the sector upon which decisions need to be taken or plans be drawn in the very short term. It draws also from the findings and recommendations of previous work supported by the Bank and other donors[3]. In addition to government agencies, the study will be made available to the donors community and private sector developers.

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[2] Including IDA's ongoing US$ 40 million "Phnom Penh Power Rehabilitation Project" that supports urgent investment requirements for distribution and the Government's initial sector reform efforts.

[3] These include the IDA funded "Corporatization of EDC and Regulatory Framework of the Electricity Sector - Phase I" study prepared by Worley in 1997; the "Power Transmission Master Plan and Rural Electrification Strategy", April 1998, report funded by AusAID (Bank executed) prepared by HECEC Australia; ESMAP's project supporting sector reform and energy efficiency; and IDA funded technical assistance in formulating a new power legislation.

Chapter 2: POWER SECTOR EXPANSION

2.1 Future power sector investments in Cambodia are not readily identifiable due to uncertainty in demand and costs of developments such as hydro. Although private sector investment is expected to predominate in certain activities, such as generation, it is still important to identify the type of plant best adapted to the system in order to avoid inefficient contracts. This chapter examines demand and formulates plausible scenarios to be used in structuring a sector expansion strategy, and proceeds to identify the long and short term options for supplying future loads.

Electricity Demand

2.2 Electricity demand in Cambodia is concentrated in Phnom Penh, the main load center which accounts for 70% of the country's electricity consumption even though it accounts for 12% of the population. Consequently, most of the principal power sector strategic issues in the short and medium term revolve around the possible evolution of demand in this region. This section examines the behavior of past demand, future prospects and perspectives for EDC sales in the Phnom Penh grid.

Background

2.3 Due to years of neglect, the power system was unable to supply the demand for electricity from conventional grid connections. A large amount of demand was supplied from large and small generators owned by large, medium and small consumers. Since 1995 there has been a gradual normalization of supplies from EDC and the very small generators (such as gasoline powered sets) are no longer being used, except for few backup units. However, there remains a substantial capacity of generation sets owned and operated by large industrial and commercial enterprises which either use EDC supplies as secondary backup or are not connected to the grid. The reasons for not using EDC supplies are related to reliability and/or cost, including prices as well as connection costs. Under these circumstances the demand for electricity is less dependent on exogenous economic factors but relies more on a dynamic element which responds strongly and rapidly to supplier's policies. Consequently, this assessment proceeds by: (a) reviewing previous demand studies; (b) studying demand in the price-taking subsectors; (c) assessing prospects for demand growth from substitution of private generation; and (d) formulating alternative paths for the evolution of EDC sales. Supporting information for this section is presented in Annex 1, including projections for power demand in provincial towns.

2.4 Past demand projections. Two previous demand studies were reviewed: a 1995 analysis for the Bank's appraisal (SAR) of the ongoing power project[4] and a more recent one by HECEC[5]. The 1995 study was based upon scarce data from previous years; however, its aggregate projections proved to be very accurate, despite large variations between sub-sectors. Observed sales growth rates during 1996, 1997 and 1998 were 76%, 29% and 25%, respectively; these large increases reflect the substitution of small generating sets by grid supplies and grid extensions. The HECEC and SAR projections for 1999 until 2002 forecast a decreasing growth trend (around or below 15%) which reflects the gradual normalization of supplies and an evolution which follows trends in economic growth.

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[4] Phnom Penh Power Rehabilitation Project, effective since December 1995.

[5] "Power Transmission Master Plan & Rural Electrification Strategy", April 1998; study prepared by HECEC Australia Ltd., funded by AusAID and executed by the Bank.

Future Power Demand

2.5 **Future demand: price-taking subsectors.** These comprise users which are unlikely to run their own generators once they are connected to the grid. They include domestic users, businesses, offices, shops, restaurants, hospitals and government. For these subsectors the most recent projection yields growth rates of 13% in 1999, 19% in 2000 and 13% in 2001 and 2002. The spurt in sales in 2000 reflects new connections of existing users which are being reached through the distribution rehabilitation projects financed by the Bank and ADB. It should be noted that in the near future, EDC's statistics may show distortions resulting from the takeover of the wholesalers' operations that may yield erratic statistics for 1999[6]. Subject to this caveat, projections for the price taking subsectors were obtained by applying the HECEC growth rates to EDC's 1998 sales.

2.6 **Future demand: larger users.** Users which usually provide all or part of their supplies, many of which are not connected to EDC's grid, constitute a component of demand which is difficult to estimate and could be highly responsive to variations in price levels and reliability of supply. Customers in this category are mainly hotels and industrial enterprises. According to EDC's 1998 statistics, sales to hotels amounted to 7GWh (down from 9GWh in 1997) and sales to industry amounted to 22GWh (double the 1997 level but low compared to the potential market). The reasons behind these relatively disappointing results can be found in the tariffs applied to these consumers and the reliability of EDC's service. Prices for hotels were 19US¢/kWh and have been adjusted to 800Riels/kWh (21US¢/kWh) in the latest tariff schedule of January 1999. These price levels are not competitive with private generation costs, at least when the customer has the option of running existing generators, with variable costs in the order of 6US¢/kWh. In the case of industry, Riel-based tariffs were below 9US¢/kWh in 1998 and have been adjusted to 17US¢/kWh in 1999. The price level in 1998 was competitive with the cost of private generator sets and could well explain the doubling in sales. However, the current price level will probably inhibit industrial purchases of electricity from EDC and encourage more off-grid generation.

2.7 **Room for growth.** EDC conducted a recent survey of industrial and commercial users and estimated peak demand on the basis of connected capacities (actual and potential). For currently connected customers, EDC estimates that around 16MW are being supplied with the support of backup generation. A closer analysis would indicate a significantly smaller value, probably not over 9MW, which would indicate a potential for increased sales of around 39GWh.

2.8 The unconnected capacity, according to EDC's survey, amounts to 54MVA; unconnected customers usually run with large reserve margins which would lead to an unconnected peak of about 20-25MW, and a sales potential in excess of 120GWh per year. Despite uncertainty as to actual loads, this group of electricity users is very large relative to EDC's current industrial and hotel sales. Incorporating them to the grid will require a marketing strategy where cost-reflective tariffs, reliability and a suitable connection cost policy should combine to make EDC's service financially attractive.

2.9 For most users, grid supplies are in principle an attractive option: generating power is an activity which requires attention and distracts resources from the enterprises' core business. Additionally,

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[6] Although wholesalers were supposed to take care of domestic and small commercial users (where domestic and commercial uses are often indistinguishable), there are reasons to believe that they were also providing service to larger users. Furthermore, taking over these operations has meant an increase in the number of billed domestic users from 20,000 in October 1998 to an estimated 80,000; billing and meter-reading errors can be expected to occur in this process, thereby yielding erratic statistics during 1999.

generating power off grid is inherently expensive: although off grid generation offers the advantage of minimal facilities, no transmission costs and low technical losses, they require usually large reserve margins (often in excess of 100%) to assure continuity of supplies, and the small size of generating sets precludes capturing economies of scale. An electricity company should be able to generate at lower cost and provide similar or better quality of service. However, EDC is ill-equipped to initiate such an effort: its tariff schedule does not reflect the cost structure, its generation reserve is small and it lacks an organized marketing team to negotiate with larger clients. Nevertheless, the effort is worthwhile: these are customers which are easy to bill and control, and constitute the traditional financial backbone of most electrical utilities.

2.10 **Projections.** These considerations led to formulating demand projections based upon two possible scenarios: in one case EDC is assumed to continue with business as usual, with very modest growth in the hotel/industrial market (Scenario I); in the other, it is assumed that EDC can organize an effort to increase its sales to those which are already connected and to attract new users (Scenario II). Both scenarios assume an environment of political stability and continued economic growth in Phnom Penh and surroundings. By 2002 the two scenarios show differences of 100GWh on sales of around 500GWh per year. Growth rates differ by about 2 percentage points overall but by 2002 the industrial/hotel sales of the aggressive scenario could be three times as high as those of "business as usual". The estimation of peak demand under both scenarios yields maximum loads on the order of 110-130MW by 2001. Table 2.1 summarizes the projections under the two scenarios.

Table 2.1 - Demand Projections and Generation Requirements (GWh)

	1998	1999	2000	2001	2002
Sales:					
Scenario I	269	302	357	401	451
Scenario II	269	307	400	477	545
Total generation requirements:					
Scenario I	334	376	444	499	562
Scenario II	334	381	491	583	665
Peak Demand (MW)					
Scenario I	63	77	94	111	130
Scenario II	63	79	104	130	154

Generation and Transmission Expansion Plans

2.11 Generation and transmission-related decisions are currently overshadowed by short term conditions such as demand uncertainty resulting from the tariff policy and uncertainty of supply in the context of the postponement of IPP2[7]. However, the current decision agenda is best analyzed by framing it within a longer term strategic context. This section therefore proceeds by: (a) a discussion of long term strategy; (b) a short term analysis of current issues; and (c) recommendations for addressing decisions on the 1999/2000 agenda.

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[7] IPP2: Second independent power producer planned for Phnom Penh; a 60MW combined cycle power plant sponsored by Beacon Hill & Associates which signed a power purchase agreement with EDC in 1996.

Long term options

2.12 Cambodia's power system is at an early stage of development: the maximum current load in Phnom Penh is in the order of 90-100MW, including off-grid generation. Other load centers in Cambodia have a peak demand below 10MW. The future development of the system can be visualized by the evolution of the power sector in other countries. In general, there is an initial phase of supply which develops around isolated load centers, with medium voltage extensions to serve the immediate vicinity. Progressive load growth then gives way to a situation where interconnection between load centers becomes feasible. The cost of high voltage transmission can then be offset by savings due to economies of scale in new generation and reserve requirements; interconnection also allows lower overall production costs through an optimized dispatch of plants.

2.13 In Cambodia, distances between load centers are quite lengthy, viz. Phnom Penh to: Sihanoukville (220km), Kampong Cham (100km), Battambang (300km), Svay Rieng (120km). With these distances, interconnections probably require 230kV lines, with the possible exception of regional links (e.g. Sihanoukville-Kampot in the South or Bantey Mean Chey-Siem Reap-Battambang in the Northeast) where 115kV lines would be reasonable. Load magnitudes are the other major factor in deciding whether interconnection is desirable. HECEC's load projections for year 2010 show that the greatest load centers after Phnom Penh would be Battambang, Kampong Cham and Bantey Meanchey with 23MW, 21MW and 16MW, respectively. These are not loads that justify 230kV interconnections: a first conclusion is that the possible savings from generation with these loads are unlikely to offset the cost of transmission. These arguments are not enough, however, to discard the development of some initial branches of a national grid; for example, high tension lines to connect power plants located at a distance from the main electricity market can be used to supply local loads as well as significant demand centers along the transmission route. In this case, an interconnection between load centers can be said to piggyback on generation facilities.

2.14 Another special situation may arise when building a transmission line to import energy, in which case a transmission line can be used eventually to supply loads "along the way"; e.g. when interconnecting to Vietnam. A similar rationale for developing high tension lines would apply to taking advantage of lower cost fuel at a given location and transmitting power to the load center; presumably this would justify the Sihanoukville-Phnom Penh interconnection. Taking into account these precedents, the issues to be addressed are:

- Should hydro stations be built, and if so, which and when?
- What type and size of thermal generation -open cycle gas turbines (OCGT), combined cycle (CC) or medium speed diesels (MSD)- should be built and when?
- What are the economics of an interconnection with Vietnam?
- What is the financial risk associated with different developments?

2.15 **Risk premiums.** Before analyzing specific issues it is useful to address some problems specific to Cambodia. At present it is unlikely that either the Government or EDC can finance new power stations directly. As a consequence, new generation will probably be contracted through IPPs. The prices that can be negotiated for power development will vary according to plant types and to the perception of specific investors in regard to financial risk. In general, at least in the medium term, investors are likely to require a substantial risk premium in their rate of return for investing in Cambodia because of a recent history of political turmoil. If institutional conditions continue stable, the risk premium will tend to decrease, but it is likely to remain high in the short and medium term.

2.16 In addition to the political factor, which applies generically to most foreign long term investments in the country, certain types of plant are likely to be loaded with a higher risk premium relative to others. Hydro plants are probably the most affected: due to their non-removable character, they are likely to be discounted at a higher rate than diesel plants or gas turbines for which PPAs can be contracted for shorter periods.

2.17 **Power plant selection.** The annual cost of power plants is a function of capital costs, operating costs and the hours of use. Annex 2 presents a comparison of private generation costs for different plants in Cambodia based on capital costs, including risk premiums, border fuel prices and transportation costs. It is concluded that open cycle gas turbines would be the preferred option for less than 4000 hours of operation, combined cycle would be preferred for 4000 hours and above, and diesel units do not appear to be attractive. Private hydro is never competitive. This simple analysis serves to point out that a combination of thermal plants is probably the best option for supplying the load under a scenario of high discount rates, and high capital and fuel costs. It should be noted, however, that specific technical factors, such as the matching of module sizes to market growth and variations in operating efficiency could change the above mentioned results.

2.18 **Hydro options.** An examination of Annex 2 could give the impression that hydro plants are being unfairly treated. Nevertheless, a cautious approach is justified because of the following reasons: (a) most hydro plants lack the feasibility studies required to confirm their estimated costs; hydro plant characteristics have been derived in most cases from identification-level analyses; and (b) there has been no systematic recording of hydrologic data during the last twenty years to support expectations with respect to hydro plant production, thereby giving rise to a risk factor which would be incorporated into a private sector developer's discount rate. *However, it should be noted that hydro plants could become competitive with the support of public financing. In this respect, it is recommended to seek donors support to undertake the above mentioned preparatory work with view to select the most promising projects.*

2.19 Two exceptional cases call for further discussion: the Kirirom and Prek Thnot plants, where some infrastructure is already available:

- Kirirom (10MW) has an extremely irregular flow: during the wet season it can produce at capacity but during the dry season it only generates around 4MW. The reconstruction cost of the plant was estimated at around 10M$ by HECEC, in addition to a 12.5MUS$ 115kV line; this would yield a cost per kW of $2,000 which would not be competitive with other options. The transmission line would follow Route #4 along which industries are expected to locate. If the line were to be built for supplying these customers, the plant would become competitive. Until such a situation materializes, Kirirom should be delayed, unless it can be built with grant money.
- Prek Thnot (18MW) is part of a larger multiple purpose scheme involving irrigation and flood control, with an estimated cost of 250M$. The electricity component of the project has been valued at 50M$. This yields a cost of 2,800$/kW which is clearly not competitive with other options. Furthermore, the experience of companies elsewhere is that the power component, being the only revenue generating sector, usually ends up by paying for great part of the project. Given the financial weakness of EDC and the public sector in general, a commitment to Prek Thnot is best avoided.

2.20 **Other supply options: the Vietnam interconnection.** Connecting to Vietnam implies a total investment of around $40 million. Assuming a conservative peak load of 50MW it could be highly

competitive compared to other power generation options in Cambodia[8]. To ensure the competitiveness of the interconnection, the purchase price from Vietnam should be kept within the following limits:

- At a price below 5.3¢/kWh for making it competitive with CC plants, and, a fortiori, with diesel and gas turbines;
- At a price below 6.3¢/kWh where it is still competitive with gas turbines for peaking service.

A reasonable negotiation with Vietnam will probably yield prices below these break point values, thereby ensuring the line's viability[9].

Short term options

2.21 The general long term considerations provide a framework for studying near term decisions, which require putting together supply and demand. The demand analysis in the previous section postulated two possible scenarios for peak requirements (Table 2.1). On line, available supply facilities of EDC in 1998 amounted to 66MW. In order to provide a reliable service, a reserve requirement of about 22% should be considered[10]. Applying these figures to peak loads yields the installed capacity requirements of Table 2.2

Table 2.2 - Capacity Requirements (MW)

	1998	1999	2000	2001	2002
Required Installed Capacity:					
Scenario I	77	94	115	135	159
Scenario II	77	96	127	159	188
Required Cumulative Incremental Capacity					
Scenario I	11	28	49	69	93
Scenario II	11	30	61	90	122

2.22 For year 2000, this would require installing around 50MW under Scenario I and 60MW under Scenario II. This will not be possible given time constraints. EDC has contracted for a temporary IPP ("IPPT") which will supply 15MW with diesel units and it intends to run its existing steam units which amount to an additional 15MW. The system is therefore likely to run with insufficient reserve during the year 2000. Beyond 2000, two possibilities appear for 2001:

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8 Presumably the interconnection would be financed with public funds and consequently the annual cost can be calculated without the risk premiums added by foreign developers. Based on a 15% discount rate, 25 year life, plus O&M equivalent to 3% of investment, the annual cost would amount to around 7.4M$. A conservative peak load for the transmission line would be about 50MW, yielding a cost of only 148$ per kW per year, below the capital cost of any of the power generation plants considered beforehand.

9 Vietnam would have an energy surplus beginning the year 2001 and both countries are already negotiating conditions for a bi-lateral power trade agreement. It is expected that a MOU will be signed in mid 1999.

10 Two common criteria for reserve are (a) providing a margin for units on maintenance and (b) providing running reserve to supply the load when losing the largest on-line unit. Currently, the largest units are the 6MW ADB diesel engines. Assuming that two EDC units are on maintenance (e.g. one 6MW engine and one 2.5MW engine), and given that the largest on line units are the 6MW ADB MSDs, total reserve requirements would amount to around 14MW, or 22% of peak load in 1998.

- IPP2 (60MW) comes on line, which would raise supply to 141MW, assuming that IPPT continues to generate and that the steam units are retired; this would cover the requirements for Scenario I but would be insufficient for Scenario II; or
- IPP2 is further delayed and alternative arrangements do not materialize in line, then additional supplies of 54MW (Scenario I) or 78MW (Scenario II) would have to be arranged.

In 2002 the requirements increase, relative to 2001, by 24MW and 29MW for Scenarios I and II, respectively. If IPPT is retired, the required increase would amount to 39MW and 44MW.

2.23 This summary analysis shows that in the case of sustained economic growth and, irrespective of what may happen with IPP2, there is a need to provide additional supplies by 2002 in order to maintain peak demand supplies and to preserve reserve margins. From the long term considerations, the least cost supply option would consist of importing energy from Vietnam if suitable conditions can be negotiated. Otherwise, gas turbines (eventually convertible to combined cycle) would appear to be a good short term solution, particularly for supplying peak requirements.

2.24 **The HECEC generation/transmission plan.** This study proposed the following additions to capacity:

Table 2.3 - HECEC Plan Summary of Generation Additions

Plant	Year	Capacity (MW)	Cumulative Additions (MW)	Total Capacity (MW)
Initial State				66
IPP2	1999	60	60	126
Kirirom	2002	10	70	136
Prek Thnot	2002	18	88	224
IPP3 (S'ville)	2003	90	178	314
IPP4 (S'ville)	2005	90	268	404

The proposed additions to capacity by 2002 (88MW) tally closely with the estimated requirements of Scenario I as shown in Table 2.2 (93MW). A third IPP (IPP3) would supply the extra requirements for 2003 and 2004 before a new plant is needed in 2005. HECEC's plan calls for building a Phnom Penh-Sihanoukville 230kV interconnection to take advantage of lower fuel costs in Sihanoukville. However, as shown in Annex 2, *the savings from siting generation in Sihanoukville do not appear to pay for the interconnection, either as an integral project or as an incremental project to the Vietnam interconnection.*

2.25 **Time constraints.** The short term requirements impose stringent conditions for commissioning times of new units. If IPP2 is not realized and a new 50-80MW IPP contract is required, the available lead time for commissioning a new plant is likely to be insufficient. *Consequently, a very early decision regarding IPP2 will be required if significant shortfalls are to be avoided in the near term.* Despite the time constraints, the actual production of certain types of new plant (e.g. gas turbines and diesel engines) is not necessarily the most significant item on the critical path for new generation: smaller capacity units can be installed in packaged units on a short term basis. *The items which can impose delays are local arrangements regarding land, fuel and cooling water facilities, and, particularly, the bidding process and contracting of a new IPP.*

Decision Agenda for 1999-2000

2.26 **Decisions which do not depend on IPP2:**

- Efficiency improvements: conversion to HFO of the MSD units will bring immediate savings to EDC; these measures are being implemented.
- Hydro plant information: for prospective plants to become competitive it is required to gather additional information including:
  - The organization of a sound hydrological data base in coordination with the Ministry of Natural Resources;
  - A screening of hydro plants to determine which are good candidates for feasibility analyses (the HECEC study provides a good starting point for this activity); and
  - The execution of selected feasibility studies.
- ***Vietnam interconnection: negotiations should proceed on an urgent basis, together with the required studies.*** *The actual commissioning date can be adjusted according to the IPP2 decision.*

2.27 **Decisions which are contingent on IPP2.**

Case 1: IPP2 proceeds and is commissioned by 2001. Under demand scenario I, by 2001 the steam units could be retired and IPPT could be maintained during 2001 to provide the capacity required. However, under scenario II it would not be possible to provide reliable supplies. Therefore, the possible demand increases through active marketing may have to slow down during 2001. *By 2002 it would be desirable to contract for a new power plant of 30-40MW under scenario I and around 60MW under scenario II which would substitute IPPT generation. Interconnection with Vietnam by this date is unlikely to be feasible and therefore measures should be taken to seek a new IPP. The contracted capacity should probably be the higher value (60MW) with staggered units which could be put into service according to load evolution. In this case, the Vietnam interconnection could probably be commissioned by 2003.*

Case 2: IPP2 is not realized. *In this case, it would be necessary to seek an emergency IPP to be commissioned by 2001. Seeking Scenario II sales would definitely not be feasible until 2002. The new IPP would be in the order of 90MW, seeking to supply Scenario I demand and to complement supplies with imports from Vietnam starting 2003. Demand curtailments can be expected in 2001 unless the emergency IPP can be commissioned earlier. Such a tight schedule should proceed within an orderly bidding process in order to meet deadlines.*

Chapter 3: FINANCIAL POSITION AND INVESTMENT REQUIREMENTS

3.1 EDC's financial performance has not been satisfactory during the last two years, having been affected adversely by the depreciation of the riel. Although a recent tariff increase will be beneficial to EDC finances, the new tariff schedule increases cross subsidies and would cause a number of unwanted effects. This chapter examines EDC's financial position and prospects, provides guidelines for a modified tariff structure, identifies investment requirements for the period 1999-2003 and formulates a tentative financing plan.

EDC's Financial Position and Prospects

3.2 **Overview of position in 1997 & 1998**: EDC functions since September 1, 1997 as a wholly state-owned limited liability company with the character of a Society National being vested with a juridical personality. It has a Board of Directors composed of members of the Government and the business community. Although EDC's area of operations is the whole country, the power system is almost wholly confined to Phnom Penh. In order to give EDC a clean start, the balance sheet was reconstituted from September 1, 1997. A reevaluating committee with representatives from MEF, MIME and EDC determined the market values of all assets. Accumulated 'losses' until September 1, 1997 were set off against 'capital'. Long standing 'sales receivables' were placed in an account titled 'provision for doubtful debts' with a view to writing off the doubtful debts in due course against 'capital'. Nevertheless, EDC's financial performance in 1997 and 1998 was not satisfactory [11].

3.3 **Main reasons for EDC's poor financial performance**: Among many reasons that could explain the position, the foremost is that EDC's operational costs are very sensitive to exchange rates. All fuel is imported and all payments to IPPs are in US dollars. Over 75% of EDC's operational costs are incurred in US dollars and the riel has been depreciating steadily over the years. From 2600 to the dollar in September 1995, when the Bank appraised the 'Phnom Penh Power Rehabilitation Project', it is currently 3900, showing a 12% annual average decline over the period. More noticeably, the depreciation was 25% in the second half of 1997. A second factor that appears to have affected financial performance was that EDC, on practical grounds, is buying more and more power from IPPs. In 1996 purchased power was almost zero, but in 1997 it accounted for 43% of total power dispatched, and 54% in 1998. EDC undertakes through the IPPs an additional hard currency commitment increasing its exposure to exchange rate fluctuations. Also, due to a lack of competition in the selection of IPPs, prices are high, particularly for fixed capacity fees. However, it should be noted that higher fuel efficiency is expected in IPP operations, besides greater managerial and technical competence contrasted to inefficiencies that characterize EDC operations. Therefore, total generation costs are likely to be more economic in IPP operations in comparison to own operations of EDC, particularly when a competitive process is established.

3.4 **Tariff Revision**: The Bank had alerted the Government in February 1998 to the deteriorating financial situation of EDC and recommended judicious increases in power tariffs/cost reductions in

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[11] Three financial parameters illustrate EDC's unsatisfactory performance: (i) the loss for 1997 was 8 billion riels (between September 1 and December 31, 1997) and is placed provisionally at 37 billion riels for 1998 on a turnover of 79 billion riels in 1997 and 109 billion riels in 1998; (ii) 'accounts receivable', above 90 days, on December 31, 1998 were 26 billion riels equal to 3.2 months of 'sales revenue'; and (iii) 'accounts payables' were at 14 billion riels including 10 billion riels in default for imported fuel and purchases from an IPP for power sold to EDC in 1998.

operations as feasible. The power tariffs had remained unchanged since 1995. On January 15, 1999 the Government announced significant revisions in the tariffs, as shown in the following table.

Table 3.1: Old and New Tariffs for Power
(US$1=3900 riels/Feb 99)

Old Category	Old Tariff	New Category	New Tariff	Remarks
Domestic	350 riels/ kWh	Residential	350 riels/ kWh	Split into three
		Commercial & Industrial	650 riels/ kWh	Sub-categories under new
		Gov't. Agencies	700 riels/ kWh	Tariff structure
Hotels & Foreigners	19&21UScents/ kWh	Hotels & Foreigners	800 riels/ kWh (=21 UScents)	

The new rates carve out a new category 'commercial and industrial' to bear an 86% increase in the rate applicable to it. Government agencies too face a high increase. 'Hotels and Foreigners' would be billed in riels in place of US.cents and, at the current exchange rate, there is no change in the tariff for foreigners. This tariff is high, but as the riel depreciates, 'Hotels and Foreigners' may get some relief in dollar terms. For residential customers, the tariff has not been changed from the 350 riels/kWh fixed several years back (equal to 13 US.cents/ kWh in 1995 and presently equal to 9 US.cents/ kWh). This category consumes over 60% of the power sold. The cost of service to this category is apparently in excess of the revenue. The implications of not revising the tariff for the residential consumers, at least in not introducing a two or three slab structure, are brought out in par. 3.13.

3.5 Although the tariff increase was implemented to improve EDC's financial position and increase revenues, given the new levels there may be a number of unwanted effects as some customers which supply their own load at present are unlikely to opt for EDC service. This tariff structure has a number of drawbacks:

- It does not reflect the underlying cost structure of EDC, and therefore it may over- or undercharge certain customers;
- Customers who can be supplied economically by EDC may face a price which is not attractive compared to generating their own electricity and the opportunity for increased sales may be lost;
- Customers may reduce their demand during periods when supplies may be available.

3.6 Also, a simplified structure – such as EDC's single kWh charge for all consumers – may be justified when demand is inelastic, but it becomes inadequate when this is not the case, e.g. for hotels and industries in Phnom Penh. Some of the more visible problems with the structure are:

- It does not take account of voltage-level connection;
- It does not provide incentives for peak/off peak load management; and
- It does not allow for special tariffs to large customers, such as interruptible supplies.

3.7 A starting point for tariff reform was provided by a February, 1997 study by Electricité de France (EDF) which suggested improvements to the tariff structure as well as tariff levels to reflect marginal

costs[12]. A summary of this analysis together with an update of certain data is provided in Annex 3. A modified tariff structure designed to avoid an uncalled categorization of users (e.g. hotels vs. industry, foreigners vs. locals) would consist of:

- A medium voltage tariff with a capacity and an energy component; given the differences between peak/off-peak costs; time of day metering could be an option;
- A medium voltage, interruptible, tariff which mainly reflects energy costs; and
- Two low-voltage tariffs (domestic and general) to reflect different contributions to peak loads, possibly with a fixed cost component.

3.8 Regarding tariff levels, there is considerable uncertainty as to certain cost elements, such as medium and low voltage network costs. Based on marginal costs, the energy component of supplying a low voltage customer could be in the order of 8.5-9US¢/kWh, and that of a medium voltage customer could be around 7.5-8US¢ (Annex 3). The network cost component should be added to energy costs. Ideally, this cost could be billed through a capacity charge for large users; for small users, the network cost could add up to another 12US¢/kWh. In any case, the values being charged at present are grossly distorted with respect to costs: high cost consumers are being charged the lowest rate and potentially low cost users are being charged the highest tariff.

3.9 **Tariffs and marketing.** EDC is seeking to increase its market by attracting customers which are not connected at present to its grid. Some of these have running costs associated with their diesel units which are as low as 6US¢/kWh. However, although this value does not take into account either the full operations costs nor the investment cost, the total cost is unlikely to be higher than 14-15US¢/kWh. Considering that connection to the grid is an additional cost, it is unlikely that EDC will have much success in attracting potential users with the present tariff schedule. The rigidity of this schedule and its poor performance when compared to a binomial tariff (i.e. an energy and capacity based tariff) is shown in Annex 3 through an example. If EDC is to become a financially viable entity, it should seek to provide low cost, reliable service to its users. The customer base should be as solid as possible, increasing its service to high demand customers, easy to monitor and bill, and which impose lower costs on the utility. This will be possible only if a substantial reform of the present tariff structure is implemented based on marginal costs providing an economic price signal to users.

3.10 **Financial Projections 1999-2003 made by EDC**: The budget for 1999 has been framed by EDC with the new tariffs in view, also postulating a robust 33% increase in sales volume (compared to 23 % in 1998). Accordingly, EDC would achieve a minor net profit of 1 billion riels in 1999. Its cash flow position would enable it to be current with 'accounts payable' not later than the end of 1999. The extended financial projections for the years 2000-2003 would show an improving financial position with prospects of a rate of return of 7% on operating assets in 2001. This is later than 1999, year in which EDC should be achieving the 6% rate of return according to the Credit Agreement for the ongoing Phnom Penh Power Rehabilitation project. The major assumptions made for EDC projections are (Annex 4 contains more details):

- Besides the first IPP commissioned in 1996, a second IPP (60 MW) will be operational at the end of 2000. An interim IPP for 15 MW will be operational from mid- March 1999 to mid-March 2001.
- Demand matching generation will materialize and consumers will be willing to pay at the new rates.

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[12] Electricité de France, "Étude de la Demande et Étude Tarifaire", February 1997.

- Government will revise tariffs in riels, from time to time, to neutralize inflationary effects.
- EDC costs will decrease gradually from 14.7US¢/kWh in 1998 to 13.4US¢/kWh the year 2000.

3.11 *EDC's projections appear overly optimistic.* Great efforts would be required by EDC and other agencies to achieve such performance. Main issues to solve are: (a) IPP2 has been slipping since 1998; currently, the delayed targeted date for commissioning is November 2000. Due to its slippage, EDC had to contract for interim generation of 15 MW for two years from March 1999 with a developer, who incidentally had the generators available. If IPP2 slips further or is cancelled, EDC must make alternative arrangements for adequate supply in good time; (b) The growth in demand cannot be achieved unless a marketing plan is developed and focussed attention is paid to increase sales to hotels and industrial establishments. The new tariffs for these consumers would, as they stand, encourage self-generation in place instead of buying from EDC. Innovative approaches and flexibility in providing incentives to this market are necessary (see paragraphs 3.4 to 3.7); and (c) tariffs must be revised, from time to time, to neutralize cost increases beyond EDC's control.

3.12 Having viewed the EDC Budget for 1999 and the extended projections for 2000-2003 as too optimistic, the mission analyzed an alternative scenario considering lower sales, although assuming that EDC would be relatively successful in attracting new users (Scenario II, Chapter 2). This "most likely" scenario alone is considered further for financial analysis. It has the following essential features:

(i) Energy sales compare as follows:

	1999	2000	2001	2002	2003
EDC Scenario	354	443	554	676	811
% Increase	33%	25%	25%	22%	20%
Scenario II (GWh)	307	400	477	545	621
% Increase	14%	30%	19%	14%	14%

(ii) It is assumed that a decision with respect to IPP2, either to proceed with that project or to find alternative suppliers, will be made as soon as possible.

(iii) Sales to the different categories of consumers are expected to be as in Table 3.2. Far lower growth in the commercial, hotel and industrial sectors is expected, compared to EDC projections.

(iv) Average tariffs, resulting from the sales mix, would be lower than those projected by EDC; e.g. 12.4US¢/kWh instead of 14.5US¢/kWh for 1999.

In the result, the financial position of EDC, judged by the rate of return criterion, would not become satisfactory until 2003. Table 3.3 below summarizes the financial situation, under this alternative scenario. Fuller details are contained in Annex 5.

Table 3.2: Likely Demand for Power in Phnom Penh

	1998	1999	2000	2001	2002	2003
Residential	164	187	228	257	293	331
Commercial	21	25	29	34	39	44
Govt. Agencies	55	60	68	76	84	93
Hotels & Industrial	29	35	75	110	129	152
Total Sale GWh	**269**	**307**	**400**	**477**	**545**	**621**

3.13 As stated in par. 3.4, the prevalence, in a major proportion, of the subsidized category of residential customers in the customer-mix is the primary reason for the low rates of return. If the average rate for residential customers had only been raised by 14% (to 400 riels/ kWh), the rates of return in the

Table 3.3 above would have been 4% in 2000, 5% in 2001, 7% in 2002 and 11% in 2003. *It is important that this issue of low rates of return and likely non-compliance with ongoing credit covenants (6% return from FY 1999) be addressed by the Government.*

3.14 **Internal Cash Generation**: Under Scenario II, EDC would generate internal cash, after repayment of debts, of the order of US$ 20 million until the end of 2003. EDC may be able to utilize about $15 million of internal cash in its expansion activities in the period until 2003. When the rate of return on revalued operating assets begins to exceed 6% in due course, EDC may also consider lowering tariffs, in 'real' terms, for customer categories where the tariff burden is high.

Table 3.3: Likely Financial Position of EDC-1998 to 2003

	Actual	Actual	Approx.	Likely				
	1996	1997	1998	1999	2000	2001	2002	2003
FINANCIAL DATA- Nominal								
Average revenue/riels/kWh	342	353	370	483	519	555	580	608
Total Income- Billion Riels	62.2	80.6	110.5	151.3	211.7	268.5	320.1	381.6
Cost of IPP Power Purchase	1.4	33.1	57.8	88.7	106.0	193.1	224.6	251.1
Distrbn. & Own generation	51.6	41.0	72.1	68.6	86.7	48.1	52.1	60.3
Total taxes- B. Riels	17.1	19.5	17.2	23.0	21.7	22.9	27.5	33.6
Profit/ Loss after taxes	(7.9)	(13.0)	(37.6)	(29.0)	(2.8)	4.4	15.9	36.6
Aprox.Value of Optg. Assets		199.1	333.0	402.3	540.9	575.1	575.1	675.1
Rate of Return on Assets					1%	3%	5%	7%

Expansion and Investments during 1999-2003

3.15 **Expansion of EDC Operations**: The program under Government review for generation and transmission in the country during 1999-2016 is summarized in Annex 6. During this period generation capacity recommended to be added to the existing 73 MW, is 677 MW or a growth of 9 times in 18 years. Investments are estimated at $964 million (1997 dollars) in power stations and at $363.5 million (1997 dollars) in transmission, together with expansion and establishment of consuming centers.

3.16 Expansion requirements in the near term until 2003 are reviewed in Chapter 2. Keeping in view Scenario II discussed above for Phnom Penh, the capacity additions required to provide a suitable service would be 30MW in 1999, 60MW in 2000 and around 120MW in 2002 (see Table 2.2). Transmission lines and the network have to be constructed in association. For 1999, EDC has rehabilitated temporarily 15 MW of fuel oil fired old steam units and signed a contract for 15MW with an IPP (IPPT) to supply power for two years, both located at Phnom Penh. For 2001-2003, EDC has to choose one of three options, depending on circumstances and economics.

Option A: HECEC proposal. IPP2 (60 MW) as contracted, but delayed in commissioning at Phnom Penh, will operate from end 2000 and through 2001 and beyond. For the additional 30 MW needed in 2002, EDC should install one unit of 3*30 MW gas turbines contemplated as IPP3 at Sihanoukville for the following year (includes transmission line Phnom Penh – Sihanoukville).

Option B: IPP2 plus Vietnam, Sihanoukville delayed. Inter connection to Vietnam appears economically attractive since the price for purchased power is likely to be low and power should be sought to be

purchased from Vietnam as soon as possible. In that case, additional IPP3 units may be delayed until 2005.

Option C: IPP2 cancelled. If IPP2 fails but import of power from Vietnam can be negotiated with supply commencing in 2002, a substitute IPP should be commissioned in 2001 with at least 30 MW, to be raised to 60 MW or more in 2002.

3.17 In all cases, EDC will not invest in generation; power will be supplied by IPPs and/or Vietnam. But since private financing of transmission and related facilities is unlikely to be available, EDC has to seek bi-lateral and multi-lateral institutional financing. The works needed to support one or other of the three options are listed in Table 3.4 below. Besides these investments required to develop Phnom Penh and Southern Cambodia, EDC may import power from Thailand for use in the western region and may lay transmission lines for this purpose.

Table 3.4: Transmission & Other Infrastructure Investments (Million US$) – 1999-2003

	Transmission or other work	Place	1997$	Option(s) involved	
1	GS1-GS3 second circuit	Phnom Penh	0.6	A	B,C
2	Takhmau-Sihanoukville				
	230 kV double circuit line	Tak-Sihan	46.1	A	
3	Takhmau Sub-station	Takhmau	10.5	A	B,C
4	Takeo Sub-station	Takeo	7.0	A	B,C
5	Kampot Sub-station	Kampot	7.5	A	B,C
6	Sihanoukville Sub-station	Sihanoukville	7.1	A	B,C
7	Takhmau to GS-2 115 kV	Tak-Ph.Penh	3.1	A	B,C
8	GS2 to GS3 2nd circuit	Phnom Penh	0.6	A	B,C
9	Second Transformer in GS 3	Phnom Penh	1.1	A	B,C
10	Inter-connection to Vietnam	Thro' Takeo	9.2		B,C
11	Takhmau-Takeo 230 kV line		14.0		B,C
12	Sihanoukville-Kampot line		10.0		B,C
	Total Amount in 1997 Million $			**83.6**	**70.7**

3.18 Construction of the works under Option A would spread over the period 1999-2003 and is estimated to cost $93 million in nominal dollars (=83.6 MM1997$). Under Options B & C, the construction spread over the same period would cost $80 in nominal dollars (=70.7 MM1997$). A tentative financing plan is as follows:

Table 3.5: Financing of EDC Investments 1999-2003 ($MM)

Agency	Amount- Option A	Amount-Options B & C
OECF	40	40
WB and/or ADB	38	25
EDC- Internal Cash	15	15
Total	93	80

3.19 The preparation of the above transmission projects, and associated substations, would be undertaken as part of a second IDA power project for Cambodia. Funding for the required technical assistance is being sought (from Japanese sources – PHRD) and a co-financing operation is envisaged. A dialogue with Vietnam on possibilities of supply of power should also begin as soon as possible.

Chapter 4: COMMERCIALIZATION AND PRIVATE SECTOR PARTICIPATION

Corporatization and Commercialization

4.1 In its effort to address Cambodia's future power needs, the Government is proceeding to commercialize the power sector and seek private participation as a strategy to increase efficiency in the expansion and operation of the sector and mobilize financial resources. This chapter discusses EDC's commercialization process, arrangements for electricity service in provincial cities and provides guidance for a policy on independent power producers.

Corporate Reform of EDC

4.2 Till March 1996, Electricite du Cambodge (EDC) operated as a Government department under the direction of the Minister of Industry, Mines & Energy (MIME), who acted as its Chairman. EDC was then converted into a wholly owned Government limited liability company by Royal Decree. Prior to this change, EDC had been largely responsible for electricity supply principally in Phnom Penh, although billing and collection was carried out by about 150 private individuals who purchased wholesale power from EDC.[13]

4.3 The 1996 Royal Decree gave EDC the non-exclusive right to generate, transmit and distribute electricity throughout Cambodia. Following the decree, EDC's legal status was changed to that of a separate corporate legal entity. Ownership of EDC is held jointly by the Ministers of MIME and Economy and Finance (MEF). EDC has a board of seven directors, three of whom are drawn from the private sector. The board approves annually a corporate plan for the following three years. This plan covers EDC's annual budget, new investment, operations and maintenance plans, and proposes borrowing and tariffs. EDC currently submits requests for tariff increases to the Ministers of MIME and MEF, but tariff approvals are, in practice obtained from the prime minister. This situation will change upon the formal establishment of the Electricity Authority of Cambodia (EAC), an independent body which will assume responsibility for tariff approvals.

4.4 Under the draft Electricity Act (discussed in chapter 5), EDC would be issued with a consolidated license to undertake generation, transmission and distribution functions. Both EDC and any other operators would have to obtain a separate license for any new generation facility. It is not recommended to support vertical separation of EDC's generation, transmission and distribution functions since the power system is too small to benefit from competition in each segment. Efforts should concentrate on increasing EDC's efficiency through a strong focus on improving its commercial and business functions. EDC's corporate reform is a first step towards this goal.

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[13] These private individuals—known as 'wholesalers'—were responsible for supplying about half of EDC total sales. Although wholesalers provided a relatively satisfactory service in terms of collections, these arrangements were technically inefficient contributing to high losses. Further, due to a lack of appropriate regulation and enforcement, wholesalers also sold illegally to large consumers and caused considerable non-technical losses borne by EDC. The Government agreed, under IDA's Phnom Penh Power Rehabilitation Project that it would redefine the role of wholesalers or phase them out. EDC has now largely completed the resumption of responsibility from the 'wholesalers' who had been selling directly to about 47,000 retail consumers. This has put pressure on EDC's computerized billing system. Some bills are being prepared manually in the interim but all these new accounts are expected to be computerized shortly.

4.5 Although EDC now officially operates on commercial principles and should be responsible for its own profits and losses, the Government's ownership of EDC continuous having an adverse effect on its performance. *A complex issue is the Government's inability to separate its role as policy maker, owner and customer of EDC. This problem is manifested in eventual political interference on EDC's operations and, most important, in the blurring of lines between the finances of EDC and the Government budget which tends to distort EDC's incentives and accountability*[14]. It is therefore necessary to grant complete autonomy to EDC, accountable to an independent board of directors and subject to the regulation of an autonomous body that provides fairness for all suppliers, both state-owned and private.

Commercialization of EDC

4.6 In the short to medium term Cambodia is likely to get maximum gains by commercializing EDC. The first steps in structuring EDC as a corporation working under an executive board have been taken. Subsequently, progress has been made through: (a) the appointment of external auditors; and (b) the development of corporate plans and objectives which will be monitored through performance measures established under a performance contract. Improvements are being achieved also in the reduction of system losses through ADB and IDA's projects (down to 20% from 38%), which have provided for refurbishment of distribution facilities in Phnom Penh, especially installation/replacement of meters. Collections have also improved except from Government departments and agencies. However, much remains to be done to improve EDC's productivity; improving its financial and budgeting systems and the efficiency of staff, gradually restructuring staff levels to match work requirements and upgrading its financial systems and accounting practices. It is important to note that an efficient EDC operating under commercial principles is also a requirement in attracting private developers, because it would provide the assurance that there is a credible purchasers.

4.7 Now that EDC has a corporate status, the Government should reduce its involvement in EDC's affairs. EDC should be dealt with as a corporation responsible for a commercial service rather than a public obligation. In this respect, it should be treated like any licensee and given full commercial independence notwithstanding the Government's ownership. This appears to be the intent of the new law, which would provide for an explicit separation of the state's functions as policy maker, regulator and owner; an essential condition for a successful commercialization of EDC.

4.8 Evidence from several countries (e.g. Chile) show that regulatory reform and restructuring of the public sector enterprises into commercial enterprises achieved the bulk of the efficiency gains prior to the ultimate, though more gradual, privatization. There is evidence to show that making public enterprises viable commercial entities reduces the pressures to privatize as long as they operate under an independent and transparent regulatory framework. Commercialization requires that state enterprises be exposed to commercial pricing signals and incentives from the financial markets as well as the markets for their products/services. Among other things, commercialization requires:

- Adoption and implementation of internationally recognized accounting practices and standards that promote transparency of costs and ownership claims;

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[14] EDC's accounts receivable on December 31, 1998 were 30 billion riels, stemming mostly from public customers. Such position is cause for serious concern. The Government's practice to offset these accumulated losses against tax remittances and/or 'capital' is not a sustainable solution being necessary to accelerate EDC's commercialization.

- Financial restructuring involving revaluation of fixed assets, debt write-down and/or rationalization, re-capitalizing of enterprise balance sheets to correctly reflect long term debt and equity;
- Expansion of management autonomy, specially in financial and operational decision making;
- Reforming internal organization to decentralize management and developing business processes with adequate checks and balances;
- Redefining enterprise objectives and corporate policy to reflect commercial objectives and targets;
- Separation of core business from non core business that clarifies social welfare responsibilities; and
- Rationalization of tariff levels and structures to ensure that subsidies, if any, are clearly accounted for.

4.9 The Government has expressed interest in privatizing public enterprises, and legislation provides for the Government to divest its shares in EDC if it so wishes. The possibility of the Government being able to sell shares in EDC, at the present time, is remote due to EDC's current serious financial problems and the uncertain regulatory and investment climate in Cambodia. A better option might be for EDC to seek a strategic partner to help it strengthen its management, technical and financial skills and deal with the private sector interface. In the past, this expertise came from technical assistance. Although, this assistance led to improvements, it is not a substitute for a longer-term involvement by a partner who has a vested interest in the company's financial performance. A first step to achieve this could be to offer a management contract to a well managed utility for a two to three year period that could lead to a strategic partnership. A management or performance based contract tailored to EDC's most important needs and with clearly defined performance incentives should be part of the package[15]. Such management assistance would also provide the necessary expertise to develop a competitive and transparent framework for future IPPs, thereby better managing the current process of increasing generation capacity at least cost to the country.

4.10 For the short-term, the best strategy for the Government and EDC to follow would be to take immediate action to rationalize tariffs at a level that makes EDC viable, to improve collections and reduce system losses (in particular losses due to theft). In the medium-term, the Government should cause EDC to meet commercial targets set in a performance contract to enable EDC to become a fully creditworthy enterprise. In the long term, the Government could plan to sell shares of EDC to a strategic investor or to restructure and sell particular assets and functions. This would be difficult, however, and likely to depress asset valuations by potential investors (particularly as to EDC's distribution functions), until a transparent and predictable regulatory mechanism has been put in place.

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[15] The mission was informed that EDC would be the recipient of a grant from the Agence Francaise de Development (AFD) to support EDC's management, particularly its commercial operations and sales development, and provide training during a period of three years. This technical assistance could provide a good opportunity to speed-up the commercialization of EDC through a performance based contract component, i.e. a clearly defined set of performance indicators aimed at introducing strong incentives for a successful implementation of the TA program.

Service in Provincial Cities

4.11 Since 1996, EDC has also taken over responsibility for existing supply in four provincial capitals, Sihanoukville, Kampong Cham, Siem Reap and Takmau. However, it is not clear if it would progressively take over the power service for the remaining provincial towns. Overall, there are 18 provincial centers where EDC has not taken supply responsibility. In these cases power systems are owned by MIME since 1993. These include eight provincial capitals whose systems have been assessed by a technical assistance program of ADB, which may consider funding for their rehabilitation[16].

4.12 There are private operators in many provincial towns working as IPPs and, in some cases, through a lease and operate (LO) agreements with MIME. Although these arrangements relieve public entities from a complex and demanding activity, they are technically inefficient and environmentally unsatisfactory due to a lack of adequate resources and effective regulation. Given the fact that EDC does not appear to have enough resources to extend further its services and the need for MIME to relinquish any utility service obligations, it is recommended to keep the present arrangements until the new law is enacted. Once the law is passed and the regulatory system is firmly in place, the EAC should review the existing arrangements with view to license private operators on the basis of a competitive process. Also, the Government might consider creating some distribution franchises by selling parts of its system to local entrepreneurs through open competition. The arrangements with such franchises and/or licenses should have incentives for an efficient operation, demand side management measures and energy efficiency investments that would lower costs to consumers. In any case, it will be essential for the EAC to issue clear procedures for the selection and licensing of private operators and small IPPs.

Private Sector Participation

Scope for Independent Power Producers

4.13 MIME first sought expressions of interest from private power developers in 1994 to help it re-establish adequate power supplies in Phnom Penh and major provincial towns. EDC adopted this approach due to the extreme shortage of generating capacity and the limited funds at the disposal of the Government for financing power development. The Government did not, however, formulate clear policies or procedures for selection and approval of projects.

4.14 Initially, groups of interested investors signed memoranda of understanding (MOU) with the Government and negotiated directly the contractual arrangements, including the power purchase agreement (PPA), with EDC. EDC had little experience in negotiating these contracts and allowed itself to be advised by the developers and lawyers acting on behalf of, or paid by, the developers. This lack of competent and/or independent legal, financial and technical advisors, plus eventual political interference, has led inevitably to mistakes and resulted in conditions unfavorable to EDC. It has also led to concerns that the transactions were not transparent, nor competitive.

4.15 The first IPP in Phnom Penh, a 35MW diesel station, started commercial operations in 1997; however, this project is not regarded by EDC as a success. This project was arranged with a Malaysian group who were granted a generation license by MIME and have signed an 18-year power purchase

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[16] These are Kampot, Prey Veng, Takeo, Banteay Meanchey, Kampong Speu, Ratanak Kiri, Svay Rieng and Battambang. "Power Rehabilitation II Project", January 1998; report prepared by Fichtner (Germany) and funded by ADB.

agreement with EDC. The installed plant comprised second-hand equipment supplied by ENEL (Italy), but it has had chronic reliability problems. Unfortunately, the agreement does not provide for any penalty if the plant does not meet availability targets. Moreover, under the agreement EDC bears fully the foreign exchange risks. While by itself this provision may be acceptable, at the present time EDC is not permitted to pass on, through tariff adjustments (in Riel terms), any increases in dollar costs arising from this transaction.

4.16 EDC negotiated additional agreements for the following projects:

- In 1996, EDC signed a PPA with Beacon Hill & Associates for a second IPP in Phnom Penh– a 60MW combined-cycle plant to be fueled by naphtha. Although this project would be supported by IFC, it is unclear which are its prospects for reaching financial closure. There is considerable uncertainty on the project's commissioning date, which has been postponed twice (the latest being to November 2000) thus placing considerable pressure on the system's supply-demand balance (par. 2.25).
- Following the negotiation of the first IPPs for Phnom Penh, the Government decided to prequalify developers for IPPs in eight provincial towns and to select developers on the basis of competitive bids. A working group consisting of staff of MIME and EDC was set up to manage the process. Expressions of interest were received for small projects in Battambang and Kampong Cham. Subsequently, competitive bids were also invited for a 2MW plant to be installed in the existing power station to Siem Reap. None of these projects have been financed and it is likely that the MOUs awarded will lapse.

Progress on these projects has stalled largely due to the worsening investment climate in Cambodia caused by the political disturbances of 1997 and the current financial crisis in the region. It is expected that the passage of the Electricity Act would promote private ownership of power facilities and establish competition and, hence, would help to restore confidence of private power investors in Cambodia.

4.17 In the meantime, a two-year power purchase agreement has been contracted with the Khmer Power Utility to meet any prospective power shortage due to the delay in the Beacon Hill project. This involves the provision of a 15MW diesel plant, which is expected to come into service in July, 1999. The Government has provided an exemption from fuel taxes and duties on spare parts as an incentive to the developer. The plan is that these units would later be transferred to provincial towns when they are no longer required in Phnom Penh. Although this project offers the advantage of a short lead time and a great degree of flexibility in adapting to an uncertain market, the transaction was not bid competitively.

Guidelines for Submission and Evaluation of IPPs

4.18 **Improve the Macro Environment and the Legal and Regulatory Framework.** The recent financial crisis in Asia has seriously disrupted the IPP industry in the region and many planned IPP projects have been deferred or canceled. This crisis has adversely affected Cambodia by depreciating the value of its currency, increasing inflation and making more difficult to attract external financing. EDC's financial position has also been adversely affected (see chapter 3). The legal framework in Cambodia is soon likely to improve with the enactment of the Electricity Act. However, potential investors will, even after the new law and regulation is in place, build the consequential higher risks into their bid prices and look for higher returns from their investments, and guarantees from the Government to offset these risks. Nevertheless, the imminent enactment of a new Electricity Law should be seen as a very positive step.

4.19 **Adopt Competitive Bidding Procedures.** Some countries have been able to develop successful projects despite the absence of sound legal and regulatory systems and in the face of an unfavorable

economic background. However, these projects involve greater risks, which need to be shared by the parties, and efforts to mitigate them will likely add to direct and indirect project costs. It is, therefore, very likely that if Cambodia were to improve its legal and regulatory framework investor's interest would increase while overall project costs would decrease reflecting the improved risk profile. Also, more competition could be encouraged leading to lower prices. This has been the global experience; prices being offered for projects under competitive bidding arrangements where political and regulatory risks have been addressed have been falling sharply even in countries such as Bangladesh and Egypt, which were previously considered not to have suitable investment climates for IPPs. This should be the objective of Government policies and power reforms in Cambodia

4.20 Many countries initially have sought to attract investors through direct negotiations frequently on the basis of unsolicited proposals. Often Governments have been eager to sign Memoranda of Understanding (MOU) with these developers for political reasons – e.g. to show that "concrete steps" are taken to address a severe power shortage. Results of these approaches have been mixed, at best. Almost, invariably, they have led to unsuccessful projects characterized by high costs upon the absence of market forces. Thus, most Governments that have sought to encourage private power development through the "MOU process" have found the results to be less than satisfactory and have, following initial failures, adopted competitive bidding procedures. As a result, prices in IPPs in these same countries have fallen sharply. Asian countries that have done so include Philippines, India, Thailand and more recently China, Pakistan, Bangladesh and Sri Lanka.

4.21 There is evidence to show that competitive bidding is best undertaken as a two-stage process; a pre-qualification stage based on a Request for Pre-qualification (RFQ) and a bidding stage based on a Request for Proposals (RFP). During the pre-qualification stage, potential bidders are given the opportunity to express interest and present their qualifications. This is a relatively inexpensive process, which enables the best potential bidders to be identified, i.e. the selection of bidders with demonstrated capacity to meet the project requirements and the conditions outlined in the RFP. Because it is usually very costly to prepare a bid, it is best to prequalify a limited pool of bidders. Also, a larger number will reduce interest in the bidding because it reduces the chances of success.

4.22 The bidding stage should be based on standard documents prepared for the power purchaser and should include drafts of the main agreements for the project, most importantly the Power Purchase Agreement, the primary fuel and transportation agreements, and any Implementation Agreement or license to be awarded. The government and utility's formulation of their "best offers" on these agreements will facilitate the bidding process and generally lead to better prices from bidders. It is very important to fully explain the selection process and to ensure that the key criteria are identified. The price of power should be the factor on which the winning bidder is ultimately identified. Above all, the process should be fair and as open as possible to minimize any opportunity for improper dealing and later political second-guessing.

4.23 **Government Policies.** There is much that Governments can do to attract investors both for generation and distribution. Because the international private power market is extremely competitive, investors respond best to Governments that offer favorable investment policies and make clear how projects will be selected. The first step is for governments to ensure that private power investment is possible by removing any legal or regulatory barriers and having absolute clarity in procedures it will follow for awarding concessions. It is also important for the Government to announce its polices, making clear exactly what is to be offered, what incentives or concessions it will provide - for example, on taxation and import duties. Licensed operators should be subjected to the same duties and taxes so that all are treated equally. The steps and procedures to be followed by all interested parties should be made

public, making Government's actions fully transparent and predictable. It is of vital importance that project awards and concession arrangements be capable of withstanding full public scrutiny.

4.24 Several countries have established an office for handling inquiries and coordinating the approval process in order to make it easier for investors to obtain correct information on these matters. It is highly desirable that the investment selection and approval processes be independent from any form of political intervention. However, the Government should provide support, but only where needed to enable financeable agreements to be concluded. The Government's role is to establish the policies and selection procedures, and provide guarantees and assurances, when necessary.

4.25 **Experienced Advisors.** The power purchaser and the Government need to be served by proficient, experienced legal, financial and technical advisors because contractual arrangements are extremely complex, particularly for limited recourse projects. Investors, developers and lenders will have the best advisors that they can hire and they will do their best to obtain the most advantageous outcome for their clients. For negotiations to be effective, it is thus vital for the power purchaser and the host government to be equally well advised by an independent group of experts.

4.26 **Structuring and Financing the Deals.** There are many possible ways of structuring limited recourse financed projects. These range from Build-Own and Operate (BOO), Build-Own-Operate and Transfer (BOOT) and Build-Transfer and Lease (BTL) and variations of several kinds. It is highly desirable to encourage private investors to retain responsibility for the projects that they finance and build through the BOO structure. The general view is that BOO projects yield the best way to maintain involvement of the private sector and encourage competition in the sector. It is customary to provide for renewal of the BOO concessions and this should provide opportunities - where debt has been repaid - for lower levelized tariffs.

4.27 Policy makers should be aware of the risks that the private sector will and will not absorb in IPP transactions. Generally, the private sector will take the commercial risks including, construction cost overruns and completion delays, and performance risks such as operation and maintenance, thermal efficiency, and fuel supply. The private sector will not typically take political force-majeure risks, foreign exchange risks nor the possibility of the power purchaser not meeting its obligations. Since Cambodia does not have a freely convertible currency and this situation is unlikely to change in the near term, it is almost inevitable that projects will need to be priced with reference to a stable, convertible currency such as the US dollar. This means that the power purchaser, EDC, since it prices most of its sales in local currency, needs to be permitted to pass on the dollar-indexed costs of purchased power to its customers. "Automatic" pass-through provisions should protect EDC from risks stemming from future currency fluctuations as well as variations in fuel costs.

4.28 Finally, it can be helpful for developing countries such as Cambodia, to involve the multi-lateral agencies, including the World Bank and IFC, in private power transactions as lenders, providers of equity and/or guarantors. These institutions can be critical in securing other financing and their involvement can promote transparency and better scrutiny of the project from the government's perspective.

Chapter 5: POWER SECTOR REGULATORY FRAMEWORK

5.1 The Government of Cambodia is committed to establish a suitable legal and regulatory framework required for a sustained and efficient development of the power sector, open to competition and private participation. This chapter describes progress made in this process and provides recommendations for establishing and defining the role of an independent regulatory body.

Electricity Act

5.2 The Government of Cambodia agreed through Royal Decree of March 1996 to enact an electricity law and, subsequently, establish an autonomous regulatory body. To this end, a first draft Electricity Act was prepared using technical assistance provided through bi-lateral aid (Japanese PHRD) and IDA's project. Further inputs were provided by an IDA-funded sector study.[17] The preparation and passing of an electricity law in Cambodia is an unprecedented and difficult task, due to its complexity and the radical changes that would entail. Due to these factors, plus delays caused by the political events of 1997 and the government transition of 1998, the Electricity Act has yet to be enacted. In 1998, a local counsel was engaged to facilitate this process and improve the drafting to the level appropriate for review by the Council of Jurists, as well as preparing an adequate Khmer version of the law. The draft law was discussed with a first IDA sector strategy mission (February 1998) and, subsequently, was reviewed and cleared by the Bank's legal department. The dates for enactment of the law and formation of the regulatory body were amended to February 27 and August 31, 1999, respectively. The draft law was approved by the Council of Ministers in May 1999 and subsequently presented to the National Assembly. Its enactment is expected by mid 1999.

5.3 The draft law provides for the creation of an Energy Authority of Cambodia (EAC), as an independent regulatory body for the power sector. The EAC will establish the principles for supply and pricing of electricity in Cambodia and for regulation of sector activities through licensing of suppliers. The law would provide also for promotion of private ownership of facilities and the establishment of competition where feasible; and for the establishment of the rights and obligations and penalties applicable to producers and consumers. The draft law provides for eventual creation of a national transmission company but also makes provision for the issuance of a consolidated license for EDC to continue to provide generation, transmission and distribution services. The flexibility provided by the draft for the unbundling of the sector operations, increased private participation and eventual privatization of EDC are considered appropriate. Separate from the draft law, a Sub-Decree has been drafted covering the detailed implementation of the law.

5.4 According to the proposed law the Ministry of Industry, Mines and Energy (MIME) will be responsible for coordinating energy policy and planning. MIME will transfer its regulatory functions to the EAC when it becomes fully operational thus separating two main roles of the state: regulation and policy making. MIME will keep responsibility for developing the industry standards of performance on technical, safety and environmental issues, while the EAC will assume regulatory functions on all commercial and financial issues. This will provide greater certainty that adequate electricity prices will be maintained, as well as independent and transparent regulatory processes leading to improved prospects for private investment in the power sector.

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[17] "Corporatization of EDC and Regulatory Structure of the Electricity Sector", April, 1997. Report prepared by Worley International for the Ministry of Economy and Finance, funded by IDA Technical Assistance credit.

5.5 The drafting of the law has been undertaken in a very thorough and professional fashion for which the officials of MIME and other responsible government agencies can justifiably take credit. The enactment of the law is an essential step for the Government's sector reform efforts. The law, and the establishment of a separate regulator, will set the conditions required for attracting private sector in a fair and competitive manner. A suitable legal and regulatory framework would allow private entities to provide a variety of electricity services as licensees, particularly in generation (large and small, including rural electrification), distribution and commercial services. Further, a sector characterized by competing public and privates companies will constitute a strong incentive to the effective commercialization of EDC.

Role of the Regulatory Body

5.6 By Royal Decree of March 1996, the Government of Cambodia agreed to create an independent regulatory authority -- the Electricity Authority of Cambodia (EAC) – once the Electricity Act is enacted. The proposed law would establish the powers and duties of the EAC and define it as a functioning body. Under the current draft law, EAC's main functions would be reviewing and approving electricity prices, licensing power utilities, reviewing their planned investments, finances and performance, and enforcing its regulations, rules and standards. It will also review finances of licensees, prescribe license fees, enforce performance standards, handle consumer complaints, hold public hearings, resolve disputes, and establish a uniform system of accounts based on generally accepted accounting practices.

5.7 It is proposed under the draft law that the EAC should comprise a full-time Chairman and two members who will be designated by the Prime Minister and appointed by Royal Decree for three-year terms. The Chairman will appoint EAC staff in consultation with other members based on the terms and conditions approved by the EAC. The EAC would be funded initially by a Government grant and subsequently from license fees. However, it is envisaged that the Government will approve its annual budget. Decisions of the EAC would be enforceable in the courts but can be appealed in the Supreme Court of Cambodia.

5.8 The autonomy of the EAC is a key requirement to attract private capital and ensure an efficient development and operation of the power sector. The draft law is consistent with this objective since it would establish that: (a) the Chairman and members of the EAC – each on them appointed for three years – cannot be removed except for criminal activities; (b) EAC decisions cannot be revoked by the executive branch; and (c) EAC will have an important degree of budgetary autonomy. Nevertheless, experience in other countries has revealed that, even under the protection of the law, regulatory bodies have suffered arbitrary political pressures which undermined their autonomy. It is therefore essential for the success of the regulatory reform that the Government should make a firm political commitment to respect the regulator's autonomy.

Establishing the Electricity Authority of Cambodia (EAC)

5.9 The development and implementation of the primary law, the sub-decrees and regulations represent a formidable challenge for a country like Cambodia, which has limited previous experience of independent regulation. Before the EAC can become fully effective, it must develop an organization plan, budget and staffing plans, and then engage and train the staff. In addition, it must issue a variety of regulations. The key regulations, identified in the draft sub-decree include the following:

- Application procedures and form/outline of licenses
- Rules regarding capacity acquisition programs
- Tariff setting procedures and approvals process

- Procedures and standards for approving investment programs of licensees
- Prescribing a uniform system of accounts for electric power utilities
- Revocation of licenses

5.10 MIME plans to formally set up the EAC around September 1999 after passage of the Electricity Act. The task of establishing EAC is a very large administrative undertaking and needs to be commenced as soon as possible. It is recommended that MIME should accelerate plans for establishing EAC by setting up a task force. The task force should address a wide range of tasks required by the draft law and sub-decree, including issues of organization, procedures and rules, regulations and conditions, standards and fees. Annex 7 presents a complete list of actions. A comprehensive work program needs to be drawn up by MIME comprising the highest priority tasks. Already, several are being planned to be commenced using funds to be allocated from IDA's ongoing power project. This work now needs to be accelerated by appointment of an EAC advisor and hiring of consultants and, most important, assigning suitable staff who could form the nucleus of EAC's initial staff.

5.11 Under the draft law, salaries of EAC members will be determined by the Government, based on a competitive criterion. The Chairman of the EAC will be authorized to hire EAC staff and pay them competitive salaries. It is envisaged that EAC will have to pay rates better than civil service salary rates, or it will not be able to attract and retain suitable qualified staff. The number and type of staff will need to be determined by the organization and staffing plan, which should include a comprehensive training program.

5.12 Under the proposed law, MIME will relinquish most of its regulatory roles and transfer them to the EAC as soon as the latter is fully operational. It is not easy for the Government to agree to give up important executive roles and to allow decisions previously the prerogative of the Minister to be made by an independent body pursuant to the law. Until the EAC is operating effectively, transition arrangements will be required. It would be reasonable to expect that these steps will take at least 12 months of focused effort for the regulator to become operational setting procedures and fully training EAC's staff. Further, this transition period should be designed avoiding major disruptions in order to minimize any impact on investors confidence.

Licensing Procedures

5.13 The draft law empowers the EAC to issue separate generation, transmission and distribution licenses. Each supplier of electric power services is required to be licensed. The procedures for issuing and the term of licenses will be determined by the EAC. Licensees must satisfy EAC of their competence to operate a utility and must meet certain service obligations and license conditions. Provision has been made for a single National Transmission License, giving an exclusive right to provide transmission service to the entire country. A holder of a National Transmission License will not be permitted to hold any other type license. Special purpose transmission licenses may be issued for construction and operation of transmission facilities. In the case of EDC, the EAC may issue a consolidated license. The license can provide for unbundling of services to encourage efficiency and competition. Retailers, who purchase power from a licensed utility, must also be licensed if it is judged to be in the public interest. Retailers' licenses will have a maximum term of 5 years. A licensee will not be permitted to hold more than one license or have any financial interest in any other licensee unless EAC gives its approval. These conditions reflect a very open approach to the future evolution of the power sector and suggest that – given the Government's commitment through the legal and regulatory reform -- the pace of sector re-structuring would rely heavily on market forces.

5.14 License application procedures need to be prepared by EAC making clear what functions require licenses, the steps to be followed to obtain a license and how much will they cost. Licenses should cover, inter alia, the following: (a) describe the type of service and location of the facilities; (b) a specific period and provisions for renewal; (c) set out conditions to be met, including reliability and performance standards, and the activities permitted; and (d) set forth the requirements for information and reports to be submitted to the regulator. Regulators must be empowered to enforce the conditions in the license if the they are not met, and be able to revoke them if necessary.

Tariff Setting Procedures

5.15 One of the main functions of the EAC will be the approval of electricity prices, unless it is satisfied that they can be established through a competitive market based approach. EAC will establish the procedures for conduct of tariff reviews and, under the draft law, it will take account of the following principles in establishing tariffs:

- Tariffs should reflect the cost of supply by time of day, season and type of service for each class of customer;
- Performance-based tariffs may be used if it is in the interests of licensees and consumers;
- Financial returns of licensees will be allowed to increase if costs are reduced provided quality of service is maintained;
- Lower rates can be set for poor residential and rural consumers;
- Consumers will be protected against monopolistic prices;
- Economic efficiency will be encouraged by using marginal costs to structure tariff rates;
- Account will be taken of costs of supply to each class of consumer; subject to any subsidies provided by the Government.

5.16 Establishing appropriate tariff setting procedures is one of the most important tasks in establishing effective regulation. Private investors, consumers and EDC need to know how prices will be set, keeping in mind that some costs may not be regulated at all. For example, IPP costs are not usually subject to regulation if the PPA price provisions have been set through a *bona fide* competitive process. EDC's power production, transmission and distribution activities should, however, be regulated as long as it remains a vertically integrated company. The process needs to be predictable, transparent and based on rules and procedures that are applied fairly to all parties and consistently over time. Prices need to cover costs and enable the licensed producers (if subject to price regulation) and distributors to make a profit, if they operate efficiently. EDC and private operators must be allowed to make sufficient profits to remain viable and creditworthy. Subsidies where afforded for example for low income consumers, should be fully disclosed and provided only to those who are in need.

5.17 There are several price-setting formula that can be adopted by regulators. These may be based on traditional "cost plus" or "rate of return" methods or on more modern incentive approaches, for example using a "price cap" methodology that would allow increases in profitability provided the company can operate within indexed prices. The rate of return approach has long been used extensively in the USA and many other countries but it does not provide strong incentives to contain costs or increase efficiency. Also, this method requires a reliable process for regular valuation of fixed assets and determination of the cost of capital of the enterprise.

5.18 The price cap approach provides incentives for increasing efficiency and it is usually applied in a way that permits sharing cost reductions with consumers. However, this method may allow excessive tariffs if the initial price is set too high or inaccurate rates if the wrong index is applied. For Cambodia,

as for other countries without established price indices, a proxy index may be to link electricity prices to the US dollar. The selection of the price-setting formula should be made by the EAC on the basis of further studies on the market structure and the level of information available, as well as the degree of incentives desired. In any case, whichever the price formula selected this should allow automatic pass through of power purchase costs, increases in fuel costs and interest rates.

5.19 Before commencing any review process, the regulator needs to become familiar with the costs of the industry. Often, this means preparation of a financial model and having access to detailed financial data such as the cost and current value and condition of key plants and facilities.

Uniform System of Accounts

5.20 The draft law requires the EAC to approve a uniform system of accounts based on generally accepted accounting practices. Regulators need reliable financial data on costs from power suppliers to make decisions in tariff cases, including the setting (and resetting) of initial prices in a price cap regime. This means that cost and financial information needs to be prepared in a consistent manner using reliable and fair accounting procedures and practices. International Accounting Standards would be particularly useful in this respect and should be adopted. Also, licensees' accounts subject to price regulation should be audited in accordance with international auditing standards and certified as to their reliability and compliance with these standards.

Chapter 6: SCALING UP RURAL ELECTRICITY ACCESS

Current State of Rural Electricity Access

6.1 Electrification in Cambodia is at a very early stage, with rural coverage by EDC and licensed wholesalers serving only about 5% of rural businesses and households. Reliability of supply in Cambodia remains problematic except in Phnom Penh and environs and the provincial cities of Sihanoukville and Siem Reap. In these locations the electricity systems including the grids have been rehabilitated. However, both generation and distribution systems in the remaining provincial capitals are in very poor condition. Recently, an ADB-supported Study of 8 of these provincial capitals concluded that the electricity systems in all of them require a complete overhaul to bring them up to an acceptable service standard. There are no public supplies in rural Cambodia which is home to 84% of the population.

6.2 The Cambodia Human Development Report 1999 found that only 13% of the population use publicly provided electricity for lighting with almost all this access limited to urban areas. Currently, electricity networks in rural areas are limited to very small, private sector grids, sometimes under license to MIME. These networks are informal, without adherence to any level of safety or other standards. For the remainder of the population without access to grid service, the only potential electricity supply solutions are stand-alone generators, a very expensive option, and household use of automotive batteries.

6.3 Responsibility for public electricity supplies rests with EDC and the MIME. EDC has the non-exclusive responsibility for generation, transmission, distribution and retail of electricity throughout Cambodia. It presently serves Phnom Penh and a portion of adjoining Kandal province. EDC also operates isolated grid networks for the provincial cities of Sihanoukville, Siem Reap and Kampong Cham. MIME is responsible for policy and planning of the electricity sector and also for management of supplies in the remaining 18 provinces of Cambodia. No rural electrification program has been undertaken either by MIME or EDC.

6.4 In Cambodia it may be appropriate to define rural electrification as electrification of non-urban areas. Given the primarily agricultural character of Cambodian society, this definition encompasses the vast majority of the population and land area, excluding only the cities and towns which are provided with electricity service from EDC or under contractual agreements with MIME. Rural electrification would also include any area not currently electrified, or electrified under arrangements not currently by MIME. In such rural areas, a number of informal suppliers have emerged. They offer limited electricity service to some rural households and communities. Typically, these units are small (30 kW and up) and supply limited electricity for about three to four hours per day to rural households and shops, mainly for lighting. The quality of service is low. Average consumption is reportedly low at 4 to 6 kWh/month. Although the cost of supply is high at about $0.30 to over $1/kWh, monthly expenses are relatively low due to low consumption levels. In addition, many households use small car batteries that are recharged weekly at charging centers and are used to operate small DC lights, radio or TV. The number of households receiving service from the informal sector is unknown.

6.5 Government strategy vis-à-vis rural electrification is described in the draft report, "Cambodia Power Sector Strategy 1999-2016" of January 1999. The report notes that the provision of rural energy is a key factor in the rehabilitation and development of Cambodia. It considers that until grid supply is available, a number of options should be considered including diesel generation, low cost distribution techniques, small hydro, solar and other indigenous resources.

6.6 Cambodia has considerable unexploited renewable energy resources, particularly, hydro. A study completed in 1995 identified a number of sites, based on a desk study and including greenfield as well as rehabilitation projects.[18] These projects range in capacity from 1.3 to 3600 MW with unit installed costs from about $500/kW to $5000/kW. Micro-hydro prospects have not been evaluated, although there are reportedly a large number of potential sites. Solar radiation levels are good ranging from 5 to 5.5 kWh/m^2 permitting a small 30 Wp PV system to meet the 3 to 4 hours of daily service for lighting, radio/TV that some consumers are receiving from informal suppliers today.

6.7 With 80% of Cambodian households located in rural areas and the vast majority without access to modern energy services, the rural electrification challenge is enormous and requires innovative approaches to achieve the Government's development objectives.

Potential Models for Expanding Rural Electrification

6.8 In many countries, the term 'rural electrification' is synonymous with extension of the central electricity grid and provision of 24 hour AC power. However, given Cambodia's current state of electrification, and also the small power requirements of many rural households, the broader definition of 'providing for electricity services' would be more appropriate here. Initially, a typical rural household may require electricity only for 3-5 hours each day for lighting and radio or television. Rural shops may initially have similar demands. While these services can be provided through extension of the central grid, there are alternatives which, in some cases are preferable due to lower cost or other reasons. These include: (a) small, independent grid networks (isolated-grids) powered by diesel, mini-hydro or another generation source; and (b) battery based systems such as solar home systems or battery charging schemes. Also, in the near term, the potential for grid extension from Cambodian supplies is very limited. However, in border areas, especially near Vietnam, there are excellent prospects for cross-border grid extension. These should be the focus of near term grid extension efforts. All of these options – grid extension, isolated-grids, solar systems, and battery charging – should be considered as part of Cambodia's rural electrification program.

6.9 There also are alternative institutional approaches for the supply of electricity which should be considered. These could be owned/operated by private operators, cooperatives, NGOs, or public sector entities. These options, most of which are not mutually exclusive, include:

- **Independent Licensed Operators** – One potential institutional option would be to allow independent ownership of specific assets such as the generator and the distribution system. The widespread use of this approach would probably result in a large number of relatively small operators, which may pose a heavy burden on the newly-formed EAC. However, in some cases this may be the only practical approach for provision of electricity services to a small or remote community. In Indonesia, this approach is used with varying degrees of asset ownership and responsibility: (a) licensee is responsible only for meter reading and bill collection and receives a fee from the utility for providing this service; (b) meter reading and bill collection by licensee plus line maintenance; (c) meter reading, bill collection and ownership and maintenance of distribution assets by licensee plus distribution of electricity purchased in bulk from the utility; and (d) licensee ownership and complete operation of generation and distribution assets in the service area.

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[18] Chrao Phraya Engineering Consortium, *Review and Assessment of Water Resources for Hydropower and Identification of Priority Projects*, 1995.

- **Distribution Utility Franchises** – A small number (perhaps 1 or 2) of distribution utilities could be established which have licensed franchises for specific service territories. The territories could include both urban and rural areas, and need not cover the entire country. In keeping with the proposed electricity law, these would be private companies, subject to regulation by EAC. In exchange for exclusive rights to electrifying some or all of the customers in the territory, franchisees would be required to expand electricity access as agreed with EAC. Franchisees could possibly produce their own power, or purchase bulk power from the transmission utility. Service through isolated-grids could be included in the franchise. The franchise could be established so that solar and battery charging systems, for dispersed customers with low loads would be provided by the franchisee or, alternatively, by private suppliers operating in the franchise area. Non-franchise areas could utilize one of the other institutional approaches
- **Equipment Supply** – This is primarily applicable for solar and battery charging, for which the most practical approach may be to encourage private sector sales of components or systems. Leasing or credit provisions would expand this commercial market, although opportunities for this may not be available in rural Cambodia in the near term.
- **National Utility** – This approach features a single utility to provide electrification to both urban and rural areas nationwide. It derives from the government's desire to control electricity supply through a natural monopoly which is a distribution utility. However, this model has failed in many countries, largely due to two factors: (a) politicization of the electrification process; and (b) lack of incentives and, subsequently, poor financial management . Through its provisions for private sector participation in the power sector, the proposed electricity law has essentially eliminated this approach. It is included here only for completeness.

Strategy

6.10 Today, Cambodian rural electrification is at a crossroad. With the introduction of the new electricity law and a regulator for the power sector, as well as the commercialization of EDC, the path is laid for the expansion of private provision of rural electricity services. Private provision holds the potential of reducing the GOC's fiscal burden for electrification and at the same time, harnessing the capital and entrepeneurship of the private sector. However, the costs of providing such services will be high and many rural customers will have difficulty paying for electrification despite the long-term economic benefit that it will bring. Hence, the private sector will not be interested in participating unless an appropriate regulatory and commercial environment is created and correct incentives are applied. This situation places the Government in a new position: one of market enabler. In this new position, the Government should seek to establish an enabling environment for the rapid, but orderly as well as financially and technically sustainable expansion of rural electrification.

6.11 Over the course of the coming year the World Bank will support the Government in the preparation of a staged rural electrification plan to increase electricity access to rural communities in Cambodia. The strategy should set achievable targets for phased expansion of rural electrification and build upon the five main principles given in the Bank's *Rural Energy and Development* Best Practice Paper: providing for consumer choice, ensuring cost-reflective pricing, overcoming the high first cost barrier, encouraging local participation and implementing good sector policies.[19]

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[19] The World Bank, *Rural Energy and Development: Improving Energy Supplies for Two Billion People*, 1996, pp. 10-11.

6.12 The objective of the strategy should be to expand rural electricity service access to rural populations in a least cost, economically viable and financially sustainable manner using commercial suppliers. The strategy should be designed to achieve the following:

- **Ensure financial sustainability**. Recognizing that rural electrification is often a drain on government resources, ensuring financial sustainability must be of paramount importance. Key aspects of the strategy will be to maximize revenues through tariffs, use subsidies judiciously (e.g., to cover capital expenses but not recurring expenditures), support productive uses to increase affordability and revenues, and adopt efficient subsidy allocation approaches such as competitive bidding for subsidies. Where government resources are needed, a transparent financial mechanism will be considered. For example, the Public Service Obligation (PSO) approach used in some countries may be appropriate. In the PSO approach specified government budgetary resources are transparently allocated for rural electrification.
- **Reduce the unit cost of supply while maintaining appropriate service standards**. Costs will be minimized by using a least cost combination of grid, isolated grid and off grid approaches to electricity supply.[20] Low cost grid reticulation methods will be used to minimize grid extension costs. Least cost generation and supply options including diesel generators, grid extension from provincial load centers, cross-border supplies, small hydropower, solar photovoltaics and use of rechargeable batteries will be considered.
- **Increase affordability**. The strategy will take a three-pronged approached to increasing affordability over and above the cost reduction options mentioned previously: (a) provide financing to help consumers afford the high first cost of obtaining electricity connections or for paying for off-grid services; (b) provide access to financing for electricity suppliers to cover their initial investment costs; and (c) promote revenue generating uses of electricity.
- **Improve economic benefits**. The rural electrification strategy will be closely coordinated with the Government's rural development plans to ensure that electricity will support regional economic development and be available to meet education, health care, household services, communication and other social needs in the region. Particular attention will be made to increasing productive use of electricity as an integral part of increasing rural electricity access.[21]
- **Build upon the strengths of the existing formal and informal suppliers**. The strategy will ensure that existing suppliers will be an integral part of the rural electricity supply plan, possibly using one of the institutional structures discussed previously. With the adoption of the electricity law and regulations, existing informal providers who were allowed to remain would be subject to licensing. The rural electrification strategy would provide for strengthening of their capacities through the provision of financing, adopting policies and incentives necessary to encourage their participation and providing technical and entrepreneurial training.

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[20] Existing EDC standards for power distribution lines and substations are based on IEC standards and are too expensive and over-designed for the low load densities in rural areas in Cambodia.

[21] A Rural business services productive use promotion program instituted in Indonesia under the Bank-financed Rural Electrification projects yielded important benefits to rural businesses. Of the nearly 60,000 rural businesses that were assisted, about 42,000 increased their productivity by switching to electricity use and employment (employee/firm) increased from about 6% to 33% in these firms. A similar program may be beneficial in Cambodia.

- **Establish necessary sector policies**. Retail electricity tariffs should reflect actual cost of service, and should be permitted to vary by service area. The Government role should that of: (a) market enabler -- to create a competitive environment for commercial/cooperative electricity provision; and (b) regulator -- the Electricity Authority of Cambodia as the independent regulator to ensure that access and service is provided fairly, access is expanded appropriately, and appropriate service standards are maintained; and (c) adequate technical and management support to private sector companies and cooperatives. Taxation policy would also need to be reviewed – presently solar photovoltaic systems attract a 39% import duty which makes these products unaffordable to the rural population.[22] For small-scale providers, consideration should be given to using simplified regulatory approaches, which reduce the reporting burden on providers, and allows provincial agencies to handle routine regulatory tasks.
- **Adopt environmentally sound and socially acceptable methods of service**. Consultations with local communities, adoption of best industry practice, use of renewable energy, good resource and waste management practices will be adopted to ensure that the rural electrification programs will meet the requisite environmental and social development standards. Moreover electricity has positive environmental and social impacts as it displaces more polluting and sometimes dangerous kerosene lighting, improves quality of life and enhances access to modern energy services.
- **Retain Flexibility**. Strategy will include a large degree of flexibility, especially in the early stages of institutional development (since the optimal approach will not be known with any certainty at the outset).

6.13 The proposed strategy will serve as the basis for future Bank assistance in scaling up electricity access in rural Cambodia. It will be useful also for the Government in its dialogue with other donors so that a coherent rural electrification program could be designed and implemented.

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[22] In contrast, countries such as Indonesia, China and Sri Lanka, among others have virtually eliminated all import duties on such products, recognizing their value in meeting an important rural service.

Chapter 7: POWER SECTOR STRATEGY

Future Development of the Power Sector

7.1 To assess the options for the future development of the power sector in Cambodia, it is useful to look at the two extreme sector structure models: (a) the vertically integrated public utility responsible for services nationwide; and (b) the fully unbundled wholesale market. EDC was established in 1993 with view to become a nationwide vertically integrated utility. Nevertheless, after five years of operation EDC has not achieved its initial goals and its services are confined to Phnom Penh and three provincial cities. Also, important part of generation is now in private hands. This could be seen as a positive outcome since the single utility model does not offer the efficiency advantages of competition and limits the scope for mobilizing much needed financial resources. Further, the effective development of a national utility is a major task that demands a large and solid human resource base[23]. Given Cambodia's human resources constraints, the single utility model does not appear desirable. On the other hand, a wholesale market is the final stage of development which implies a fully unbundled structure where many generators compete to sell to a large number of consumers, while transmission and distribution companies provide open access and charge a fee for their wheeling services. This model requires separating generation from transmission and distribution, firms that are commercially independent, a separate ownership/control of market management and grid operation, and an independent and transparent regulatory system. Due to its complexity and the major tasks that have to be overcome, the wholesale model should be seen as a long term goal. In the meantime, the evolution of Cambodia's power sector structure should be a function of the system scale and resources available, progress in establishing the legal and regulatory framework and the country's climate for long term investment.

7.2 Cambodia's power sector already has a considerable degree of unbundling since various small suppliers provide services throughout the country and IPPs are beginning to play a major role in Phnom Penh. Further, the draft Electricity Act provides for a broad range of private services through a licensing system. It is therefore expected that the private sector would increase gradually its role in power generation nationwide, and provide distribution and commercial services in most provincial towns. A desirable evolution of the sector structure could include the following steps/components:

- EDC should be granted a consolidated license for generation, transmission and distribution for a clearly defined period. The scope of this license should reflect EDC's current operations. Further expansion of EDC's role is not recommended unless it would offer clear economic and technical advantages. However, due to the small size of EDC's system, it is not recommended either to pursue further vertical separation (par. 4.4).
- Under current conditions, EDC acts as a single buyer which purchases from IPPs and sells to final consumers. The single buyer model should be seen as a useful transitional step towards a more competitive market. Two main barriers of the single buyer model in Cambodia are; (a) generators always face a utility risk since the single buyer/utility acts as an intermediary between generators and final consumers; and (b) there are poor incentives to minimize costs since great part of the costs are passed through to the consumer.

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[23] An important constraint in any effort to improve the power sector's performance is its weak human resource base. This issue was addressed in the UNDP/World Bank report "Human Resource Development Master Plan – Power & Water Utilities, Cambodia", April 1995; prepared by ESBI (Ireland). The report proposed a comprehensive training program focussing on the human resources needs over a period of ten years. This proposal should be reviewed vis-à-vis current progress and strategies and implemented with donors support.

- The introduction of a competitive and transparent bidding process for IPPs during the single buyer stage is essential to reduce costs en ensure better supply conditions (par. 4.19).
- The enactment of the Electricity Act and effective functioning of the regulatory body (EAC) are conditions to be met before moving towards a wholesale market. Other important conditions include the physical development of a power system linking some of the most important load centers and the presence of a minimum number of competing suppliers (5 or 6). However, these conditions are not likely to be met before five to six years.
- In the meantime, options to consider to improve sector efficiency are (beyond the commercialization of EDC, par. 4.6-4.10) the following, in sequential order: (a) improve long term contracts in order to minimize operation distortions, e.g. eliminate all energy take-or-pay provisions thus permitting a merit order dispatch of plants; (b) gradually breaking the single buyer model allowing future IPPs to sign contracts directly with large consumers, and providing open access to EDC's distribution and future transmission system -- this measure would help to minimize the utility risk and, hence, reduce IPP costs; and (c) the creation of a parallel market for a small share of the market. -- once a few generators are in place, competition for bilateral contracts between generators and distributors can be gradually increased within a process to move from the 100% single buyer to a fully competitive wholesale market.
- The ownership of transmission facilities should be independent from generation. Also, an unbiased operator of the grid will be necessary to ensure a competitive environment. Given the current single buyer structure, the expected international nature of transmission in Cambodia and the decreasing role to be played by EDC as a generator, it is expected that EDC will execute the first transmission investments. However, it will be desirable to attract direct private investment in transmission facilities directly associated to generation projects.
- In the short to medium term the sector is likely to get maximum gains by commercializing EDC. It is expected that the proposed performance based contract with a strategic partner (a foreign utility with a vested interest in EDC's financial performance. par. 4.9) would help improving EDC's performance within a period of two to three years. Once this is achieved and the legal and regulatory framework is in place, EDC could become a good candidate for privatization.
- There are private operators in most provincial towns working under IPP or lease agreements (LO) with MIME. Although these arrangements are technically and environmentally unsatisfactory due to a lack of effective regulation it is recommended to keep the present arrangements until the new law is enacted, and the EAC reviews the existing arrangements and grants licenses on a competitive basis. Also, the GOC might consider creating distribution franchises by selling parts of its system to local entrepreneurs through open competition.

Proposed Strategy

7.3 The proposed strategy aims to address the development objectives of the Cambodian power sector focusing in short to medium term measures while keeping in mind the long term vision presented above. Accordingly, a set of actions is proposed to address the country's needs to: (a) improve sector efficiency and reduce electricity costs; (b) consolidate of the ongoing reform; and (c) address the sector's social concerns, particularly the extension of electricity services to rural areas. In particular, these measures aim to:

- Enact the Electricity Act and establish the Electricity Authority of Cambodia (EAC).

- Formulate and adopt competitive procedures for the selection of IPPs.
- Corporatize and commercialize EDC.
- Restore EDC's financial health.
- Review power services in provincial towns and establish a licensing system.
- Remove infrastructure constraints.
- Develop a rural electrification strategy.
- Build an adequate human resource base.

7.4 The proposed strategy is designed taking into account the strengths and weaknesses of the sector. *Three priority elements of the strategy are: (a) establish the enabling environment for an efficient development and operation of the sector, i.e. a suitable legal and regulatory framework; (b) attract private sector participation in a transparent and competitive manner, as way to introduce efficiency, mobilize financial resources and reaching a broader human resource base; and (c) commercialize EDC, including a tariffs reform to expand its market share, and availing the support of a foreign utility through a management contract and eventual strategic partnership. An essential condition for the success of the proposed strategy is the Government's commitment to respect EDC's commercial autonomy and the independence of the EAC.*

7.5 The proposed sector strategy is summarized in Table 1 of the Executive Summary, including a detailed set of recommended actions and a preliminary identification of the resources required. It is important to note that the different components should be seen as part of a single strategy where all parts are inter-related. Making rational public investment decisions would support EDC finances and help private investors to choose viable options. A financially strong and more commercial EDC would reduce risks to private investors. Finally, a suitable legal and regulatory framework would create fair and efficient conditions for a public/private system, provide confidence to private investors, help consolidating EDC's commercialization process, and promote orderly private involvement in rural areas.

Proposed World Bank Assistance for the Power Sector

7.6 The World Bank has been supporting the Cambodian power sector since 1993 through lending for emergency rehabilitation, technical assistance and an active policy dialogue. Future Bank's support in power is considered essential due to the following reasons: (a) the ongoing reform of the power sector – an essential component for a successful development of the sector -- is a long term process requiring sustained support; (b) considerable technical assistance will be required to consolidate the reform, i.e. to complete the legal and regulatory framework and set it functioning and successfully commercialize EDC; (c) the Government will require financial support for its expansion needs, particularly in rural electrification and transmission, areas where most likely the private sector will not be interested to invest; and (d) the ongoing IDA power credit will close by the end of 1999.

7.7 To address the power sector future needs, a Bank assistance program should include both lending and non-lending operations and technical assistance. On the basis of the findings and recommendations of previous sections of this report, and in coordination with other donors' activities, the following assistance is proposed:

Technical assistance. This would include the provision of the following technical assistance:

- Selection and contracting of IPPs; this will include procedures and options for model documents for inviting proposals, and procedures for selecting bids on a competitive basis and contracting;
- Operational procedures for the Electricity Authority of Cambodia; addressing the EAC organization, procedures and rules, regulations and conditions, standards and fees.
- Rural Electrification Strategy; a staged plan to increase access to rural communities building upon five main principles: providing for consumer choice, ensuring cost-reflective pricing, overcoming the high first cost barrier, encouraging local participation and implementing good sector policies.

A proposed second power project for Cambodia will provide the opportunity to include these studies as part of project preparation and/or undertake further technical assistance as required.

Lending services: Second Power Project. The main objectives of the project would be to: (a) support the Government's continued efforts to create an adequate environment for an efficient development and operation of Cambodia's power sector, including direct private participation and overall commercialization of the sector; (b) address the sector's social concerns increasing the access to electricity, particularly in rural areas; and (c) remove infrastructure bottlenecks and, thus, reduce the cost of electricity supply. The project would include the following components:

- Support conventional grid extension and off-grid systems to serve about 20,000 new customers in the south-eastern provinces.
- First stage of a 230kV transmission link from Phnom Penh to southern Cambodia, and associated substations. This transmission system would enable the installation of lower cost IPP generation in the southern coast of the country and/or imports from Vietnam.
- Technical assistance for: (a) the consolidation of power sector regulatory framework, including training for the EAC; (b) strengthening the policy making capability of the MIME; and (c) improving EDC's commercial and financial performance, and providing consulting services for detailed engineering, procurement and construction supervision.

The project will contribute in attracting further private investment in the power sector by means of its support to the consolidation of the power sector reform, and removing a main transmission bottleneck which would allow a lower cost private-based generation in Cambodia's southern coast or imports from Vietnam. Due to the scale of the project (investment of around US$70 million), a co-financing operation is envisaged. Project preparation would start next fiscal year.

Other Donors Support

7.8 The implementation of the proposed power sector strategy will require donors support in the following areas:

- Commercialization of EDC; performance based contract with foreign utility.
- Training program for EDC and MIME.
- Marketing plan for EDC.
- Hydropower studies.
- Rural development strategy (co-financing with IDA).
- Co-financing of transmission investments.

Annex 1: ELECTRICITY DEMAND IN PHNOM PENH

Background

1. Electricity demand estimates are usually associated with sales and, therefore, with actual energy delivered to customers by a utility company. Due to long periods of constrained capacity, the situation in Phnom Penh is different:

(a) Recorded sales by EDC are more representative of supply availability (as opposed to demand), given that customers take practically all the energy that the company has been able to generate;

(b) In order to avoid curtailments, customers have provided for their own supplies which have either supplemented EDC deliveries of electricity (by operating as backup equipment) or have substituted the utility's service entirely by not connecting to the grid and operating in isolation.

2. The objective of this section is to provide a perspective with regard to possible paths for demand evolution based upon recent trends, previous demand projection analyses, and policies regarding tariffs and generation expansion in the near future. Accordingly, it comprises:

(a) A description of EDC's observed demand during 1995-1998;

(b) A review of previous demand projection exercises;

(c) An examination of EDC's market estimations;

(d) An estimation of room for additional growth together with an identification of policies that will influence it; and

(e) Possible paths for demand evolution in the short term under alternative policy scenarios.

EDC's observed demand: 1995-1998

3. Table A1.1 shows the evolution of EDC's sales during 1995-1998. They are broken down according to tariff and consumer categories; two major tariff categories correspond to customers billed in local currency (Riels) and those which are billed in US$. The corresponding growth rates are shown in Table A1.2.

4. Within these two groups, sales categories correspond to domestic users, which are either billed directly by EDC or through wholesalers (which also supply small commercial users), commercial customers (including hotels), several Government-related users (Government, municipality, public lighting, waterworks), and other users (NGOs and embassies).

5. Observed sales behavior is extremely erratic, with growth in excess of 100% for certain categories, particularly during 1995-96. These extremes of growth can be attributed to supply constraints:

- In 1995 the system operated under severe restrictions: practically all generating units (consisting principally of diesel engines) were in poor operating condition and unable to supply peak loads; three-quarters of the installed capacity at the beginning of 1995 had been scrapped by 1998. In April'95 a 5MW JICA-sponsored unit started to provide some relief capacity.

Table A1.1 - EVOLUTION OF EDC SALES (GWh)

	1995	1996	1997	1998
Sales in Riels:				
R-Domestic	3.49	23.5	41.2	54
R-Govt	20.9	29.4	32.1	37.9
R-EDC	0.25	0.5	0.52	0.52
R-Municipal	2.41	3.53	3.5	4.1
R-Commercial	2.77	6.1	8.1	12.6
R-Hotels	0.0082	0.15	0.28	0.42
R-Industry	1.27	4.64	11.4	21.9
R-Wholesalers	46.35	71.5	82	84.5
R-Wholesalers350	0	0	0.87	14.54
R-Water Dept	4.55	8.98	9.3	10.4
R-Public Lighting	0.74	0.73	0.99	2.45
R-Other	1.5	0	0	0
R-Subtotal	84.24	149.03	190.26	243
Sales in US$				
US$-Domestic	1.86	4	8.46	10.9
US$-Commercial	3.88	2.27	2.39	2.62
US$-Hotels	1.46	6.95	8.89	6.35
US$-NGOs	0.401	0.59	0.26	0.17
US$-Embassies	3.43	5.48	6.13	5.76
US$-Other	0.218	0	0	0
US$-Subtotal	11.25	19.29	26.13	25.8
Totals:				
Domestic	5.35	27.5	49.66	64.9
Wholesalers	46.35	71.5	82.87	99.04
Government	20.9	29.4	32.1	37.9
EDC	0.25	0.5	0.52	0.52
Municipality	2.41	3.53	3.5	4.1
Commercial	6.65	8.37	10.49	15.22
Hotels	1.47	7.1	9.17	6.77
Industrial	1.27	4.64	11.4	21.9
Water Department	4.55	8.98	9.3	10.4
Public Lighting	0.74	0.73	0.99	2.45
NGOs	0.40	0.59	0.26	0.17
Embassies	3.43	5.48	6.13	5.76
Other	1.72	0	0	0
Summary (GWh):				
Domestic+Wholesalers	52	99	133	164
Commercial	12	22	26	28
Industrial	1.3	4.6	11	22
Government	28	42	45	55
Total	**95**	**168**	**216**	**269**
Growth Rates (%)		76%	29%	25%

Source: EDC monthly summaries (Dec'95, Dec'96, Dec'97, Dec'98)

Table A1.2 - EDC Sales – Growth Rates by subsector (%)

	1995-96	1996-97	1997-98
Domestic	414	81	31
Wholesalers	54	16	20
Domestic+Wholesalers	91	34	24
Government	41	9	18
EDC	100	4	0
Municipality	46	-1	17
Commercial	26	25	45
Hotels	384	29	-26
Industrial	265	146	92
Water Department	97	4	12
Public Lighting	-1	36	147
NGOs	47	-56	-35
Embassies	60	12	-6
Total	76	29	25
Summary:			
Domestic+Wholesalers	91	34	24
Commercial	80	21	7
Industrial	265	146	92
Government	50	8	19

- In 1996 several new units were put into service: a second 5MW JICA unit, four diesel engines purchased under the Bank's Emergency Rehabilitation Project (4x2.5MW, Aug'96), three 6MW diesel units financed through ADB, and two units (5MW each in Nov'96) under an IPP contract (known as IPP1).
- In 1997 the remaining IPP1 units were commissioned (5x5MW). The additional capacity explains the spurt in sales in 1996 and 1997.
- In 1998 EDC could count on 38MW of own generating capacity (3x6MW ADB-funded diesel, 2x5MW JICA diesels, 4x2.5MW diesels from the Bank Rehabilitation Project) and 35MW from IPP1. Additionally, 3x5MW of steam generating capacity which were rehabilitated around 1993 are still in place but in poor condition; they are not normally operated, but EDC intends to do so as a stopgap measure during 1999/2000 to substitute for IPP2.

The progressive incorporation of dependable generating capacity has helped to reduce the mismatch between supply and load; currently, observed peak demand is on the order of 60MW. It has also stabilized the growth rate of sales which has decreased from 76% in 1996 to 25% in 1998.

Previous load forecasts

6. Two demand projections were examined:
   - The desegregated forecast of expected sales in Phnom Penh prepared by EDC consultants (Worley) and incorporated into the September, 1995 SAR of the Phnom Penh Power Rehabilitation Project; and
   - A more recent forecast, based on an EDC projection which updated the Worley analysis, prepared by HECEC Australia Pty Ltd as part of the Power Transmission Master Plan and Rural Electrification Strategy.

7. **SAR projection.** The methodology used in this projection consists of:

(a) **Residential demand** which is based upon a population model which projects the number of residential units in the city, together with an electrification ratio which yields the number of consumers; average sales are projected, thereby yielding total domestic sales; this value is corrected to take into account non-technical losses, thereby obtaining consumption; the model allows for suppressed demand until 1997 and, together with an estimate of technical losses, produces the generation-level requirements;

(b) **Commercial, manufacturing and government demand** are projected by forecasting the increase in number of consumers and an increase in average sales; a procedure similar to the residential model is then applied to obtain generation-level requirements.

8. The SAR projection is summarized in Table A1.3. Residential load growth drives the forecast demand. A rapid increase in customer numbers was expected to occur in 1996 and 1997, as the system was rehabilitated and suppressed demand was taken up; the rate of increase in customer numbers was expected to fall beyond 1998. Commercial load growth was expected to be rapid over 1996-2001 as suppressed demand was picked up and commercial development accelerated.

9. A comparison of SAR estimates and actual EDC sales for 1995-1998 reveals:

(a) For 1997 and 1998, the projection of total sales turned out to be uncannily accurate: estimated sales of 213GWh and 267GWh against real sales of 216GWh and 273GWh;

(b) Large discrepancies between subsectors, e.g. estimated domestic sales of 225 in 1998 against an expected amount of 168GWh.

Table A1.3- SAR Projections

	1995	1996	1997	1998	1999	2000	2001	2002
Sales:								
Residential	84	120	178	225	273	316	355	386
Commercial	7.9	14.3	19.8	25	31	36	40	43
Manufacturing	2.6	3.9	5.9	7.6	9.7	12.3	15.4	19
Government	8.3	8.7	9	9.4	9.7	10	10.3	10.6
Total GWh	102	147	213	267	323	374	421	459
Growth Rate		43%	45%	26%	21%	16%	12%	9%
Non-technical losses	18	21	28	29	28	32	36	40
Consumption	120	168	241	296	351	406	457	499
Suppressed Demand	121	93	46	10	5	0	0	0
Technical Losses	42	36	32	30	35	40	45	49
Public Lighting	1.51	1.51	1.51	1.51	1.51	1.51	1.51	1.5
Own Consumption	15.8	2.8	4	5	8	11	14	16.7
Total Gen. Req'ts GWh	301	301	324	343	401	459	517	566

10. These results were discussed with EDC management who stated that they were expected, and that their views concerning future sales are centered on the commercial and industrial possibilities for expanding the company's market, rather than the domestic subsector. This opinion appears to be supported by the sales statistics which yielded, for example, more than double the 1998 industrial sales projected in the SAR.

11. **HECEC projection.** As a basis for structuring a Power Transmission Master Plan, power demand estimates were developed based roughly on the following methodology:

(a) **Domestic sales** were based on a population model which yielded the number of consumers; together with an income-based estimation of unit consumption the projection produces the forecast for residential demand (the Worley survey was used for Phnom Penh);

(b) **Other categories** were projected by breaking them down into relatively numerous consumer types (restaurants, hospitals, schools, businesses and offices, shops and services, schools, hotels, small industry and large industry), in addition to other sectors such as government and public lighting;

(c) The methodology projects the number of consumers together with unit consumption based on an econometric model; it also takes into account special extensions of the distribution system (e.g. the Chroy Changva area of restaurants beyond Tonle Sap),

(d) The projection allows for suppressed demand based on a survey of establishments with significant own generation, and corrects the basic estimate accordingly.

12. Given that these estimates are very recent, they exhibit greater consistency vis à vis EDC's reported sales than the SAR projections; the estimates of suppressed demand also allow designing market strategies to increase sales. It is worth noting that, in contrast to the SAR estimates, the domestic projection appears to be low compared to actual sales; however, the problem may lie in the wholesalers' statistics, as they may be supplying a number of businesses which do not fall into the residential category. This problem should be clarified very soon, when EDC, having taken over the wholesaler business, normalizes its billing. Table A1.4 summarizes HECEC's projections and Table 5 shows the estimates of suppressed demand.

Table A1.4: HECEC projections

Summary	1998	1999	2000	2001	2002
# Potential Consumers	168,714	180,257	192,157	204,534	217,398
# Installations Supplied	119,550	149,477	178,702	199,475	219,006
EDC Sales GWh					
Residential	121	138	168	190	216
Hotels	37	45	54	64	74
Restaurants	9	12	13	15	17
Hospitals	7	8	9	10	11
Business, Offices etc.	8	10	12	15	17
Shops & Services	17	20	24	27	31
Small Industry	4	5	6	6	7
Schools	3	3	4	4	4
Large Industrials	26	28	30	32	34
Government	25	27	31	34	38
Public Lighting	1	1	2	2	2
Total	**257**	**296**	**351**	**399**	**452**

13. HECEC's projections for sales yield growth rates on the order of 11%-15% for 1999-2003 (compared to 7-20% in the SAR). Generation requirements follow roughly the same rate, or slightly less assuming a reduction of technical losses.

EDC's market estimations and strategy

14. EDC has made a survey of hotels, guest houses, commercial and industrial customers, whether connected or not to EDC, together with an estimate of their potential capacity. The potential capacity corresponds to their connected transformer capacity or to an estimate of transformer capacity in the case of unconnected customers. The results are summarized in Table A1.6.

Table A1.5 - Summary of Suppressed Demand - HECEC Projection

	1998	1999	2000	2001	2002
Suppressed demand by subsector (GWh):					
Hotels	24	20	18	15	13
Restaurants	3	3	3	2	2
Hospitals	0	0	0	0	0
Business, Offices etc.		6	5	5	4
Shops & Services	7	6	5	5	4
Small Industry	2	2	1	1	1
Schools	0	0	0	0	0
Large Industrials	7	6	5	4	4
Government	0	0	0	0	0
Total	49	43	37	33	28
% of Projected Sales:					
Hotels	64%	46%	33%	24%	18%
Restaurants	33%	25%	19%	15%	11%
Hospitals	0%	0%	0%	0%	0%
Business, Offices etc.		64%	45%	32%	24%
Shops & Services	42%	31%	23%	17%	13%
Small Industry	48%	36%	26%	19%	15%
Schools	0%	0%	0%	0%	0%
Large Industrials	26%	20%	16%	13%	11%
Government	0%	0%	0%	0%	0%
Total	19%	15%	11%	8%	6%

15. Based on these results, EDC has estimated that connected customers have an extra 16MW demand which is being supplied through their own units. This would indicate that there exists a potential for increased sales on the order of 70GWh per year among currently connected customers. EDC's calculations are based on the total potential, together with assumptions relative to actual peak load/potential capacity which are difficult to ascertain. A more conservative estimate, would yield values on the order of 9MW, with an increased sales potential of 39GWh per year which would substitute for existing private generation.

16. On the other hand, the survey yields a very large potential capacity among unconnected customers which amounts to 56MVA. Assuming that 50% of this potential corresponds to actual peak loads, loads not connected to EDC would amount to about 28MW, which could account for sales of around 120GWh per year. Based upon its expectations regarding the potential market, EDC proposes to concentrate its sales effort on the hotel subsector and on the industrial subsector which offer the best prospects for additional sales.

Room for growth.

17. An approximation to future demand has to take into account the uncertainty associated with an immature system in which past sales are not very indicative of future trends, and where there is a large element of controllable demand given the numerous off-grid generators, as well as short term supply constraints. One way to approach the problem consists of projecting sales separately for the "price taking" subsectors and for the large industrial/hotel subsector. Sales in the price-taking subsector, where inertial growth can be expected, respond to extended coverage, new domestic connections as well as population and economic growth stimuli. Sales to the industrial and large commercial subsectors (e.g. hotels) would be projected according to different scenarios which would reflect EDC's marketing approaches.

Table A1.6 - Summary of EDC Survey of Potential Demand in Phnom Penh

Customer Size:	Large			Medium			Small			Total		
	kVA	#Users	kVA /User	kVA	#Users	kVA/ User	kVA	#Users	kVA /User	kVA	#Users	kVA /User
Industrial												
Connected	12,060	17	709	7,500	45	167	8,000	200	40	27,560	262	105
Not Connected	15,300	15	1,020	12,180	65	187	0	0	N.A.	27,480	80	344
Total	27,360	32	855	19,680	110	179	8,000	200	40	55,040	342	161
Hotels/Guest Houses												
Connected	1,000	1	1,000	3,700	9	411	6,480	53	122	11,180	63	177
Not Connected	17,300	9	1,922	8,140	21	388	1,180	9	131	26,620	39	683
Total	18,300	10	1,830	11,840	30	395	7,660	62	124	37,800	102	371
Commercial Users												
Connected							7,590	83	91	7,590	83	91
Not Connected							1,760	11	160	1,760	11	160
Total							9,350	94	99	9,350	94	99
Survey Total												
Connected	13,060	18	726	11,200	54	207	22,070	336	66	46,330	408	114
Not Connected	32,600	24	1,358	20,320	86	236	2,940	20	147	55,860	130	430
Total	45,660	42	1,087	31,520	140	225	25,010	356	70	102,190	538	190
Small Guest Houses/Large Residences (estimated onl												
Connected							7,000	140	50	7,000	140	50

Source: EDC

18. **Inertial growth.** The subsectors where this approach can be applied consist of domestic supplies, small commercial enterprises (restaurants, shops, offices, businesses, hospitals, schools and small industry) and government (including municipal demand, water supply and other official enterprises). The HECEC growth rate projections for these subsectors are summarized in Table A1.7.

Table A1.7: Inertial Growth Rates

	1999	2000	2001	2002
Residential	14%	21%	13%	14%
Commercial	18%	18%	16%	14%
Government	9%	13%	12%	11%

These growth rates can be applied to the 1998 sales figures to obtain the projections shown in Table A1.8.

Table A1.8 - Inertial Growth Sales Projections (GWh)

	1998	1999	2000	2001	2002
Residential	164	187	228	258	293
Commercial	21	25	29	34	39
Government	55	60	68	76	84
Total	240	272	325	367	416
Growth Rate %		13%	19%	13%	13%

The spurt in sales in 2000 reflects the expected new connections resulting from the Bank and ADB distribution rehabilitation projects.

19. **Industrial and hotel sales.** Growth in these categories will be determined by EDC's policies with respect to prices, reliability and sales promotion:

- **Prices** are probably the most critical variable in determining whether these customers will adopt EDC supplies; any effort to increase sales should be complemented by a cost-reflecting tariff policy; at present EDC's tariffs are entirely kWh-based, with no capacity or time of day components, nor voltage-delivery distinctions; this structure is possibly adequate for supplying small consumers with rigid consumption patterns but it is entirely inadequate for stimulating sales to larger clients, such as the hotels and industries which own generating capacity; a clear example of the price effect is the decrease in sales to hotels in 1998, probably resulting from a 20US¢ tariff which makes generation from customer-owned plants attractive;
- **Reliability:** major customers are concerned about service quality (including voltage variations) which EDC should provide in order to attract them;
- **Marketing:** approaching customers and promoting EDC sales are essential to developing the market, including the negotiation of items such as connection costs.

20. EDC has just put in place a new tariff schedule which is not conducive to attracting new customers in these categories, as it does not distinguish between medium and low voltage supplies, nor does it incorporate structural elements such as demand and energy charges. Given the large potential for new sales and the effort required to capture them, two scenarios were postulated in order to illustrate possible ranges of sales to these customers:

- **Scenario I: Business as usual**, with no modifications to the existing tariff schedule and little success in attracting customers; and
- **Scenario II: Aggressive sales** in which EDC actively develops the market for large customers.

21. In Scenario I, sales to industry and hotels can be expected to grow very little, mainly through smaller industries which are not energy intensive. In this scenario, the suppressed demand estimated by HECEC and the potential for connecting off-line customers is not expected to contribute towards new sales. A growth rate of 5% would probably not be pessimistic under these circumstances.

22. Under Scenario II, the sales would seek to penetrate the market identified by EDC in its survey. As indicated beforehand, this market could be as large as 39GWh for currently connected customers and 120GWh for unconnected customers. Given that current sales to this subsector

amount to only 7GWh in the hotel subsector and 22GWh for industry, growth possibilities appear to be limited by physical supply constraints. In reality, however, they are limited by price schedules and service quality considerations. If these can be overcome, a plausible projection could be:

- A base growth rate of 5% as in scenario I; plus
- Increases in sales to connected customers by absorbing the suppressed demand of 40GWh by 2001; plus
- Absorbing 15% blocks of the unconnected market, starting in 2000.

23. The resulting sales projections for the two scenarios are shown in Table A1.9.

Table A1.9 - Hotel and Industrial Sales Projections (GWh)

	1998	1999	2000	2001	2002
Scenario I	**29**	**30**	**32**	**34**	**35**
Scenario II:					
Base Growth	29	30	32	34	35
Additional Sales:					
Connected Customers		5	25	40	40
New Connections			18	36	54
Scenario II Total	**29**	**35**	**75**	**110**	**129**
Scenario II Growth Rate		22%	111%	46%	18%

Overall projections and capacity requirements.

24. Putting together the projections and obtaining generation requirements is performed by (a) correcting for commercial losses to obtain consumption and (b) adding technical losses to obtain generation-level values.

Table A1.10 - Demand Projections and Generation Requirements

	1998	1999	2000	2001	2002
Sales:					
Scenario I	269	302	357	401	451
Scenario II	269	307	400	477	545
Consumption (adjustment for commercial losses):					
Scenario I	288	324	383	430	484
Scenario II	288	329	426	506	578
Technical losses:					
Scenario I	29	32	38	43	48
Scenario II	29	33	43	51	58
Own consumption[1]	17	19	23	26	29
Total generation requirements:					
Scenario I	334	376	444	499	562
Scenario II	334	381	491	583	665
Load Factor[1]	0.61	0.55	0.54	0.51	0.49
Peak MW					
Scenario I	63	77	94	111	130
Scenario II	63	79	104	130	154

[1]HECEC estimation

25. **Supply constraints.** EDC's reliable capacity is at present around 66MW: IPP1 delivers about 28MW, the ADB and JICA plants produce 28MW, and the high speed diesels can produce

another 10MW. It is planning to run the steam units (15MW) and to contract supplies with a temporary IPP of 15MW in 1999, thereby raising the capacity to 98MW. Taking into account maintenance and a 10% running reserve, the system may be able to supply reliably around 80MW, enough for 1999, but probably below what is required in 2000. Therefore an early effort towards sales promotion might not be desirable before a definition with respect to IPP2.

26. **Additional sales promotion measures.** A reduction of commercial losses is an inexpensive and effective way to increase revenues. It requires strengthening management capabilities in the billing and metering areas, and in the short term it may be difficult to implement given that EDC is taking over the wholesalers functions in a process that is taxing the company's resources. However, once the initial problems are sorted out, it is reasonable to assume that better management techniques can be implemented towards this goal. At present, non-technical losses are on the order of 8-9% of sales, which would be equivalent to around 22GWh at 1998 sales levels. A number of factors may influence these alternative growth paths, namely:

(a) **Price effects:** the recent increase in electricity tariffs will inhibit sales growth; the extent of the price effect will depend on the short run price elasticity of demand, a notoriously difficult parameter to estimate; furthermore, as noted beforehand, any sales stimulation requires a modification to the tariff structure in order for existing consumers who possess generating capacity to switch to public supplies;

(b) **Load factor:** this parameter has been artificially high due to load curtailments, and it is expected to decrease (as shown in Table 7); however, if economic development picks up, it may stabilize at a level between 60-70% due to higher consumption by commercial, air conditioning, loads with a day peak which would counterbalance the evening peak.

(c) The information for projecting future sales may vary according to findings in the transfer of clients from wholesalers to EDC. This process raises some concerns, as it requires an update of the customer data base, which will depend on the cooperation of the wholesalers. It would be desirable to review the findings around mid 1999.

(d) Finally, the proposed demand evolution scenarios are prudent estimates of maximum growth possibilities; given the problems that can be encountered when overtaking the wholesalers, overall sales may not reach the proposed levels.

Electricity Demand in Provincial Cities

27. The most recent forecast of the annual energy consumption for Cambodia's provincial cities was undertaken by HECEC. Expected generation output is presented in Table A1.11. Peak demand for these cities is estimated to increase from 35MW in 1998 to 57MW in 2000 and around 100MW by the year 2004.

Table A1.11 - Generation Requirements for Provincial Cities (GWh)

	1998	2000	2002	2004	2006
Banteay Meanchey	26	26	30	35	40
Battambang	22	29	37	45	53
Kampong Cham	30	36	41	47	53
Kampong Chhnang	5	6	8	9	10
Kampong Speu	9	10	12	14	15
Kampong Thom	8	10	12	14	16
Kampot	15	19	25	29	38
Kandal	16	22	29	36	43
Koh Kong	5	6	7	8	9
Kratie	9	12	15	19	22
Mondul Kiri	1	1	1	1	2
Preah Vihear	2	2	3	3	3
Pry Veng	11	13	15	17	19
Pursat	8	9	12	14	17
Ratanak Kiri	3	4	4	5	5
Siem Reap	13	16	19	22	26
Sihanoukville	10	12	15	17	19
Stung Treng	1	2	2	2	3
Svay Rieng	6	7	8	9	9
Takeo	9	11	13	15	17
TOTAL	208	251	307	362	421

Source: HECEC

Annex 2: TRANSMISSION AND GENERATION OPTIONS

1. This annex complements the section on prioritized generation and transmission plans. It covers: (a) general issues and options to be addressed for expanding the Cambodian power system; (b) the HECEC Power Transmission Master Plan; and (c) a comparison of power plant costs.

General issues and options.

2. Cambodia's power system is currently characterized by:

- A medium-sized load center in Phnom Penh (currently less than 100MW);
- A large number (around 18) of small load centers in the provinces, with peak demands on the order of 2 to 5MW within 100km of one another;
- A dependence on imported fuels with costs which vary according to transport requirements: barge transportation up the Mekong river to Phnom Penh, lower costs when discharging at Sihanoukville, or higher costs if road transportation is involved; and
- High capital cost investments for developing potential hydro sites (in excess of US$2,000/kW).

3. To be able to face the inherently high cost of generation associated with such a system, three options suggest themselves:

(a) Seeking to capture economies of scale by supplying several loads from one location, as well as installing larger units to follow load growth;

(b) Seeking to reduce fuel costs by locating new plants at sites where transport costs are lower; and

(c) Purchasing electricity from neighboring countries where production costs could be lower due to more favorable circumstances (e.g. higher loads or developed hydro).

4. The tradeoffs associated with following these possible courses of action are:

(a) Installing larger units involves constraints and higher costs associated with:

- **Reliability:** assuring service continuity in a small system requires several small units, which precludes installing larger plants; and
- **Transmission costs:** serving several loads from few generation sites requires higher transmission investments which could outweigh possible economies of scale.

(b) Reducing fuel costs by installing generating plant at sites other than the demand center will require additional transmission investment and involves a tradeoff between transporting fuel vs. transporting electricity (an issue which arises also in connection with developing hydro options).

(c) Electricity imports require transmission investments to make them economically attractive and impose an indirect cost due to dependence on foreign supplies.

The HECEC Power Transmission Master Plan

5. **Background.** The HECEC study addresses these issues and seeks to identify a least cost development sequence. The proposed expansion plan is identified by analyzing 18 different scenarios which vary according to:

- Whether generation develops in isolation at different load centers;
- Whether there are interconnections and trade with neighboring countries;
- Different hydro developments; and
- Sensitivity to demand levels.

It is worth mentioning that the composition of generation options is focused towards alternative developments of hydro plants in Cambodia. Although this is understandable as a strategy oriented towards developing indigenous resources, it must be emphasized that there is a dearth of hydrological information and very little in the way of feasibility studies for some of these plants. Consequently, the different scenarios are not comparable in terms of energy reliability (as opposed to peak supply reliability). The principal value from emphasizing different hydro sequencing scenarios lies in helping to choose which plants are most suitable for undertaking further feasibility studies.

6. **Results.** The objective in developing the expansion plan is to identify today's decision agenda in order to keep onto a minimum cost path. The developments which are common to most scenarios analyzed by HECEC (i.e. the core of the planning program) consist of:

(a) the construction of a Pnomh Penh- Sihanoukville 230kV transmission line around 2004 (2002 at the earliest); and

(b) the construction of a CC gas turbine plant in Sihanoukville on the same date;

(c) the rehabilitation or reconstruction of the Kirirom hydro plant; and

(d) in several instances, an interconnection with Vietnam.

The most significant transmission component of the proposed plan consists of a south east double circuit 220kV grid from Phnom Penh (Takhmau S/S) through Takeo and Kampot to Sihanoukville, followed by an interconnection with Vietnam

7. These results appear to be reasonable insofar as they address the issues identified beforehand, namely:

- The Phnom Penh-Sihanoukville interconnection seeks to lower fuel costs and provide greater load to a Sihanoukville-based plant than an isolated one in Phnom Penh as it will supply a number of additional loads;
- The interconnection with Vietnam provides access to lower cost supplies and interconnects additional loads in the south east.

Additionally, basing generation in Sihanoukville would reduce the risk of oil spills on the Mekong.

8. **Economics of the south east grid.** Investing in a Phnom Penh-Sihanoukville interconnection involves building 230km of 230kV double circuit lines. The cost of the line and the terminal S/S would amount to around 67MUS$ (excluding S/S at Takeo and Kampot). The annual cost at 10% discount would amount to around 9MUS$ (7MUS$ capital cost and 2MUS$ O&M). This would have to be amortized through fuel savings from a power plant in Sihanoukville; a 90MW plant (as envisaged in the plan) operating 6500 hours would output about 600GWh and the fuel cost differential would have to amount to at least 1.5US¢/kWh for the transmission investment to break even. This cost differential would appear to be above the savings estimated by HECEC between Sihanoukville and Phnom Penh. If the interconnection to Vietnam takes priority, then the interconnection to Sihanoukville could be considered as incremental. In this case it would consist of (a) 160km of 230kV transmission (32M$), (b) the Takeo substation for switching and protection (7M$), and (c) the Sihanoukville substation (7.1M$) for a total of around 46M$. The annual cost would amount to 6.5M$ (5M$ capital and 1.5M$ O&M).

9. The savings estimated by HECEC for electricity deliveries in Sihanoukville and Phnom Penh are:

Table A2.1 Comparative Fuel Costs (¢/kWh)

Plant Type	Phnom Penh	Sihanoukville	Savings
Combined Cycle Gas Turbines	3.05	2.74	0.31
Oil Fired Steam	3.93	3.44	0.49
Coal Fired Steam	1.75	1.13	0.62
Gas Turbine	4.74	4.26	0.48
Slow Speed Diesel	3.56	3.12	0.44
Medium Speed Diesel	3.93	3.44	0.49

Source: HECEC Report, Chapter 4 ("Least Cost Planning")

According to these figures, the combined cycle savings would require transmission of around 2,000GWh per year in order to pay for the line, equivalent to 230MW on base load or 350MW with a 65% plant factor. The requirements with gas turbines would be lower (1,400GWh - 250MW) due to the higher savings, but these are magnitudes for the long run when there is greater assurance that the system can absorb this supply. The HECEC plan calls for open cycle gas turbines (OCGT) amounting to 90MW in 2003, a combined cycle(CC) plant (90MW) in 2005 and a 90MW OCGT plant in 2014. Given the delay between one plant and the next, the transmission costs wouldn't be justified, even if they are considered incremental relative to the Vietnam interconnection.

10. Although this is a "back of the envelope" calculation, it indicates that an interconnection with Sihanoukville may only make sense once the installable capacity in Sihanoukville reaches the 150-200MW mark. This will depend on how demand in Phnom Penh (and Sihanoukville) develops, but as long as new plants respond to increments of 30MW per year or so, it is best delayed.

11. **Natural gas.** An event that may change the decision radically would be the availability of natural gas in Sihanoukville. Offshore exploration indicates that there are natural gas deposits, but in small pockets (similar to those in the Thai area of the Gulf of Thailand) which are not commercially attractive. However, further exploration is expected to take place and, if successful, the natural use would consist of using it as power plant fuel in Sihanoukville. At any reasonable price for natural gas (e.g. $2.50/MBTU), power cost would decrease to levels where a differential of more than 1.5¢/kWh would justify a 230kV link to Phnom Penh.

12. **Economics of the hydro developments.** The proposed plan includes developing the Kirirom (10MW) and Prek Thnot (18MW) hydro plants. The Kirirom power plant is a development which dates from the late 60s and was abandoned due to war; however, in its present state it has usable civil works (dam, spillway, pressure tunnel, penstock and powerhouse) which can be put into service and should therefore reduce the required investments. However, the cost is still considerable (around 10MUS$ for the power plant and 12.5MUS$ for a transmission line to Phnom Penh), equivalent to over 2000$/kW). Moreover, considering that the energy production of Kirirom appears to be highly seasonal, the cost in energy terms may not be economical when compared to thermal alternatives.

13. **Prek Thnot:** this plant is part of a larger multipurpose development with costs of over 200MUS$. The project consists of a very large (980 Mm^3) reservoir with a firm output of 50GWh per year (only 5-6MW on average). Although some civil works are in place (coffer dam and excavations), the power component is expected to cost around 50MUS$ which would yield costs in

excess of $2000/kW. The project has significant environmental and resettlement problems and may not even prove economically attractive from the irrigation/flood control point of view.

14. **Kamchay.** This project was studied in 1995 by Hydro Québec, which proposed a 127MW plant with a cost of 270MUS$. The proposal consists of a 832Mm^3 reservoir and a 1.7Mm^3 concrete dam, an underground powerhouse. The project was restudied by HECEC who designed a smaller scheme of 45MW. The initial data for the 127MW plant do not appear to be economically attractive. MME has requested funding for a feasibility study which would clarify the development possibilities. However, the plant makes sense only in conjunction with the Sihanoukville-Phnom Penh link: despite the possibility of supplying local cement plants in Kampot, a 127MW plant would be too large for the regional load. In its favor, the plant appears to have minimal environmental problems. A feasibility study would involve two phases: (a) an overview phase oriented towards defining which of the two alternatives makes economic sense and (b) if the first phase proves positive, a feasibility study of the preferred alternative.

15. **Other hydro plants.** As mentioned beforehand, the lack of hydrological information is a distinct disadvantage when considering the development of new hydro plants. HECEC's recommendation regarding the execution of detailed feasibility studies for some key hydro projects is pertinent.

Power plant selection.

16. Figure A2.1 compares the annual cost of different privately developed power plants as a function of hours of use. The basic data for the curve are based on border fuel prices plus transportation costs (i.e. the cost to Cambodia, which excludes taxes) with diesel oil (DO) at $200/tonne ($4.7/MBTU) and heavy fuel oil (HFO) at $144/tonne ($3.5/MBTU). The plant data are summarized in Table A2.2. These values impose a stiff penalty on capital costs both in terms of the discount rate and the number of years over which the investment is assessed. To some extent, these values are subjective, but probably representative of private investors expectations.

Table A2.2 - Summary of plant data (privately developed)

Type	Fuel	Capital Cost ($/kW)	Discount Rate	Years	Annual Fixed Cost ($/kW)	Efficiency BTU/kWh	Running Cost US¢/kWh + O&M	8760h total cost ($)
OCGT	DO	600	25	15	155	12000	5.6 + 0.5	690
CC	DO	850	25	15	220	8500	4.0 + 0.5	610
MSD	HFO	1200	25	15	300	8200	2.9 + 1	640
Typical Hydro		2000	30	30	600			600

OCGT= Open Cycle Gas Turbine CC= Combined Cycle MSD= medium speed diesel

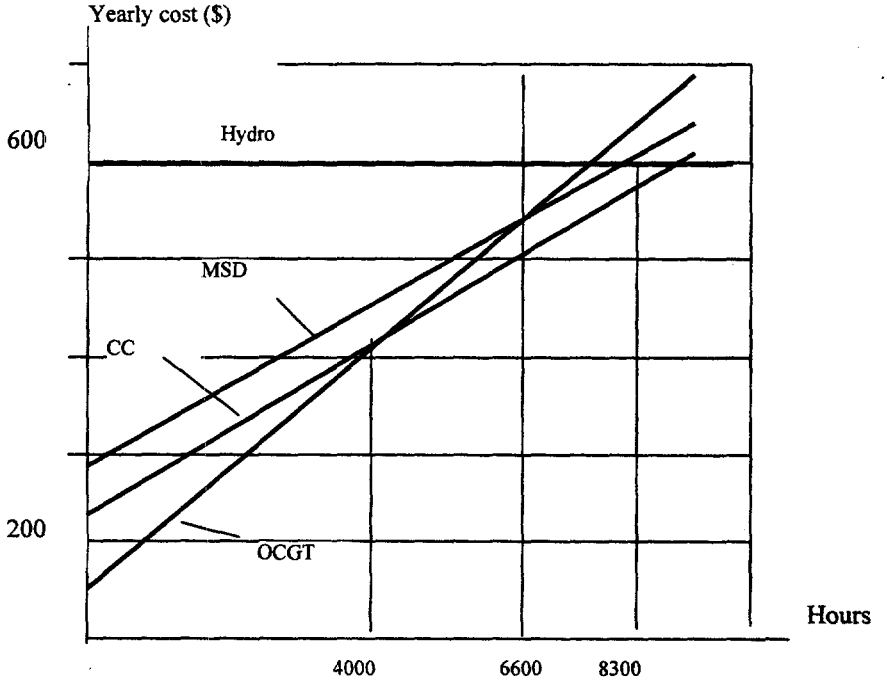

Figure A2.1: Screening curve for different types of plant

17. The screening curve shows that open cycle gas turbines would be preferred for less than around 4000 hours of operation, whereas combined cycle is preferred for 4000 hours of operation and above. Diesel units are preferred to open cycle turbines above 6600 hours, but combined cycle is less expensive than diesel engines under all operating conditions and therefore, in principle at least, diesel engines do not appear to be attractive. Private hydro is never competitive. This simple analysis (which requires going into further detail before specific decisions are made) serves to point out that a combination of thermal plants are probably the best option for supplying the load under this scenario of discount rates, capital costs and fuel costs. Some of the factors which could change these results are:

- **Unit sizes:** gas turbines and diesel engines can be obtained in modules which are compatible with the expected growth in a small system (e.g. 30MW increments per year); combined cycle requires a heat exchanger which exhibits economies of scale, and small combined cycle plants could have higher capital costs than indicated;
- **Efficiencies:** when operating at different loads (i.e. cycling duty), the combined cycle and gas turbines efficiencies decrease significantly, whereas diesel engines maintain their efficiency within a broad range of output.

18. It should be noted that hydro power plants could become competitive with the support of public financing (i.e. softer conditions resulting in lower discount rates). In this respect, it is recommended to seek donors support to undertake selected feasibility studies.

Annex 3: ELECTRICITY TARIFFS

This annex provides support to the tariff section in the main text. It consists of: (a) a summary and update of the EDF study and (b) an example which shows how a binomial tariff could prove beneficial to both customers and EDC.

A- EDF summary and update

1. In February 1997 Electricité de France (EDF) prepared a demand and tariff study for EDC which suggested improvements to the tariff structure as well as tariff levels which would reflect marginal costs[1]. The following analysis will follow roughly the same approach, by focusing on:

   (a) Characterizing the current load pattern;

   (b) Identifying EDC's current marginal cost structure; and

   (c) Visualizing alternative tariff schedules which can support the strategy of increasing sales to the hotel and industrial subsectors.

EDC load pattern

2. EDC's load curve exhibits a typical domestic evening peak period between 1700h and 2300h, together with a lower daytime peak which occurs between 1200h and 1700h. The daily load factor is on the order of 70% but may change easily depending on whether new customers, particularly those with large loads, connect to the grid. There is a seasonal variation which follows weather patterns in the area: the wet (hot) season load (approximately from March to August) is around 15% higher than the dry season load.

EDC cost structure

3. **Generation costs.** EDC's generation resources consist of:

   (a) Medium speed diesel plants (2x5MW JICA units and 3x6MW ADB units) currently running on diesel oil;

   (b) 4x2.5MW diesel plants with lower efficiencies than the former; and

   (c) The IPP-1 contract (35MW diesel plant).

4. The running costs associated with these units are approximately:

   (a) Medium speed diesel running on $280/tonne distillate and unit consumption of around 230g/kWh, yielding a running cost of around US$0.06/kWh;

   (b) Lower efficiency plant with a consumption of 250g/kWh, equivalent to $0.07-0.08/kWh; and

   (c) The IPP-1 contract which requires a capacity charge of $19.77/kW and a fixed operating charge of $4.83/kW per month of net dependable capacity, together with an energy charge which is currently around $0.05/kWh (base value of US$0.0344/kWh and $90/tonne of heavy fuel oil –HFO-, adjusted to take into account a current price of $140/tonne).

5. Under these circumstances, the economical loading of generating plant consists of base-running the IPP-1 units which have the lowest variable cost to EDC, followed by the medium speed diesels and the more inefficient diesels. When dispatched under the load duration curve, three cost periods appear:

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[1] Electricité de France, "Étude de la Demande et Étude Tarifaire", February 1997

- A base load period starting at 2300 (11PM) and lasting until 1100 (11AM) during which the marginal cost (highest-cost dispatched unit) would correspond to the medium speed diesels on distillate (US6¢/kWh);
- A medium-load ("shoulder") period which corresponds to the daytime peak, between 1100 and 1700 during which the marginal cost is roughly the same as the base period (US¢6/kWh); and
- A peak period with costs determined by the more inefficient units (7-8US¢/kWh)

This tallies with EDF's findings.

6. **Reliability.** These results do not take into account reserve margins which are necessary for service continuity in cases of programmed maintenance as well as outage conditions. If such margins were to be taken into account, greater installed capacity would be required. This would lead to higher marginal costs in order to induce consumers to restrain their use of electricity during peak periods.

7. **Capacity costs.** This component is perhaps the most debatable: on one hand, costs for specific types of generation are well known, but, on the other, the applicable discount rate could vary widely. EDF's study, for example, calculates capacity costs based upon a reference value of US$1000 per installed kW, a useful lifetime of 25 years and a 12% discount rate. When adjusted for availability (83%) and fixed O&M, this yields a capacity cost of 149$/kW per year. The latter estimate is only about one half the capacity cost of IPP-1 (US$295/kW per year), which can be explained by the risk premium that private sector operators and investors require for Cambodia. If the reference $1000/kW were correct, this would imply a discount rate on the order of 23%; in fact, the reference value may be too low, which would lead to a lower implied discount rate for IPP-1. In any case, at least in the short term, capacity costs over $200/kW per year are probably a better approximation to EDC's real cost.

8. **Local transmission and distribution.** These costs are difficult to estimate in the absence of a comprehensive network expansion plan, particularly at the urban level (the results of the HECEC study should be taken into account for the longer term). EDF estimated $19/kW per year at the 115kV level, $55/kW per year for the 22kV network and $156/kW per year for the low voltage level network. When losses are taken into account, the cumulative capacity cost (excluding generation) varies between $81/kW per year at the 22kV level and $263/kW per year at the low voltage level. These values were calculated using a 12% discount rate.

Costs of supply

9. To have an order of magnitude for the cost incurred when providing service to a low voltage domestic customer, it can be assumed that (i) the responsibility factor is 1.0 (i.e. his peak demand coincides with system peak); (ii) the diversity factor is relatively low –e.g. .55- (i.e. only 55% of the sum of individual demands determines system peak demand), and (iii) the customer's hours of use per year are around 2000 (i.e. an individual load factor of 23%). With these values, the cost of supplying the customer would consist of:

(a) An energy component of around 7¢/kWh at the generation level; when adjusted for losses, this becomes around 8.5-9¢/kWh

(b) A generation capacity component based on IPP-1 of, say, $295/kW adjusted by the .55 diversity factor, which yields $162/kW per year; and a network cost component of

(c) A network component of $263/kW per year adjusted by .55, i.e. $145/kW per year.

The total capacity cost would amount to $307/kW which, charged to 2000 hours of peak utilization, yields an equivalent cost of 15¢ per kWh; when adding the energy component, the cost would reach the 24¢ level.

10. By contrast, a medium voltage customer would require supply costs of:

(a) an energy component of around 7¢, adjusted for losses, which would yield about 7.7¢/kWh;

(b) capacity costs which could be considerably lower depending on the customer's load pattern; one extreme would be a very high load factor user (e.g. 6000 hours/year), in which case peak demand would coincide with system peak at all levels, which would yield a cost with a generation capacity component of 295$/kW per year adjusted for losses plus $81 per kW per year for network costs, amounting to a total of around 390$/kW per year.

The average cost in this case would be 7.7¢ plus another 7¢ for capacity costs, for a total 14¢/kWh on average.

11. Taking things further, a customer whose load pattern is such that its contribution to system peak load is minimal could incur very low capacity costs (which would consist of network costs, excluding the large generation-level capacity component). Such a customer could cost less than 10¢/kWh. Given these significant variations in costs, it would desirable to design a tariff schedule that allows customers with different load patterns to be charged according to the real costs they impose on the system. A number of remarks regarding these calculations:

(a) A change of fuel from diesel to HFO in the medium speed diesel units would lower the energy component of marginal costs outside the evening peak;

(b) The generation-level capacity cost should decrease for two reasons: (i) due to economies of scale, which should allow the introduction of larger unit sizes, and (ii) due to lower implicit discount rates as the private sector gains additional confidence in Cambodia;

(c) The network costs estimated in EDF's study should be reassessed; in particular, the cost associated with low voltage extensions appears to be unusually high;

(d) Customer-related costs were not estimated, and they could be quite significant relative to the energy components of a user's bill; they should be estimated and incorporated into the tariffs.

Suggestions for tariff schedule design.

12. The previous overview of EDC's tariffs indicates that, unless the structure of the tariffs is revised, larger users may be facing the alternative of paying a single kWh price or shunning EDC's supply altogether. Given the structure of EDC's costs, a reasonable tariff schedule could include:

(a) A medium voltage tariff with a capacity and an energy component; given the differences between peak/off-peak costs, time of day metering could be an option;

(b) A medium voltage, interruptible, tariff which mainly reflects energy costs; and

(c) Two low-voltage tariffs (domestic and general) to reflect different contributions to peak loads, possibly with a fixed cost component.

Otherwise, it is possible that the existing tariff could accomplish a short run increase in revenues (due to low short run elasticities), but it may not provide a way out of EDC's longer term pricing problems.

13. The tariff schedule design should be complemented with an assessment of expected revenues in order to determine whether financial requirements are met. This phase of the analysis should help to point out where there may be room for adjustments (hopefully downward) given that a number of costs are not actually incurred by EDC (e.g. those network extensions which are financed by grants from aid agencies); in this case, adjustments should be made with a view to not distorting the economic signals perceived by customers.

B- Illustration of effects of a binomial tariff

14. A straight kWh price for electricity incorporates an energy component and a capacity component. The latter is usually associated with investments and the former consists mainly of running costs. The straight kWh price is applied only to a customers kWh consumption. A binomial tariff consists of an energy element which is applied only to a user's consumption and a capacity element which is applied to its peak demand. The difference between the two pricing alternatives appears relative to users' consumption patterns. Users who have few possibilities of changing their pattern, such as domestic users, would have essentially the same consumption at the same times with a straight tariff or with a binomial one. On the other hand, a large user who can generate his own supplies will adapt to one or the other tariff differently.

15. The following is an example of how a large user operating his own generation facilities might react to the two alternative pricing schemes. The data are:

- The electricity provider has an overall cost of (a) \$100/kW per year for capacity and (b) 8¢/kWh as running (energy-related) costs;
- The straight kWh tariff is calculated according to overall hours of use of peak load, 5000 hours/year (i.e. a 57% load factor):

  Straight Tariff = \$0.08 + \$100/5000 = \$0.10/kWh (10¢/kWh)
- The user has a maximum demand of 1000kW and runs a 700kW diesel with a running cost of "c" ¢/kWh; initially a value of c=9¢/kWh will be assumed;
- The user's load pattern exhibit a peak load during 6000 hours per year and a low-demand load during the remaining hours:

16. When facing a straight tariff of 10¢/kWh, the user will limit his purchases to the minimum required above his own variable cost of 9¢/kWh, as shown in Fig.A3.1:

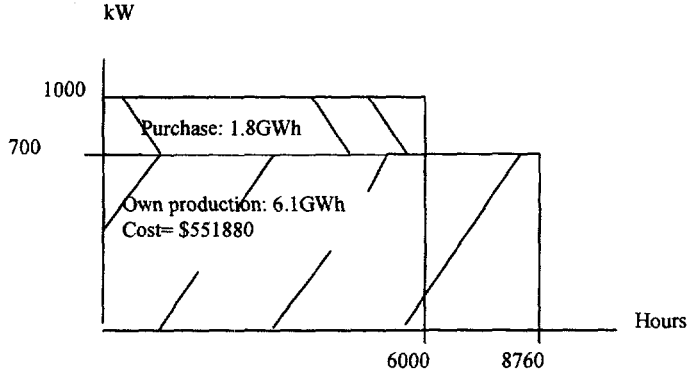

Fig.A3.1: Purchase and production pattern with straight kWh tariff

Total user costs are \$180,000 (purchase) plus \$551,880 (fuel) for a total of \$731,880

17. When facing a binomial tariff, the user will exhibit a different behaviour: the energy purchase cost is 8¢/kWh and, if he must pay a capacity cost anyway, he should purchase as much energy as possible under his minimum requirement of 300kW. He doesn't substitute all of his own production because the average purchase price on base load is 100/8760+0.08=0.091 (9.1¢) which is higher than his own variable cost. His purchase pattern is shown in Fig.A3.2.

In this case, the user incurs a total cost which consists of:

(a) A capacity charge: 300x100=$30,000

(b) An energy charge for 2.628GWh: 2.628 10^6.x0.08=$210,240

(c) A production cost of: 5.304 10^6 x0.09= $477,360

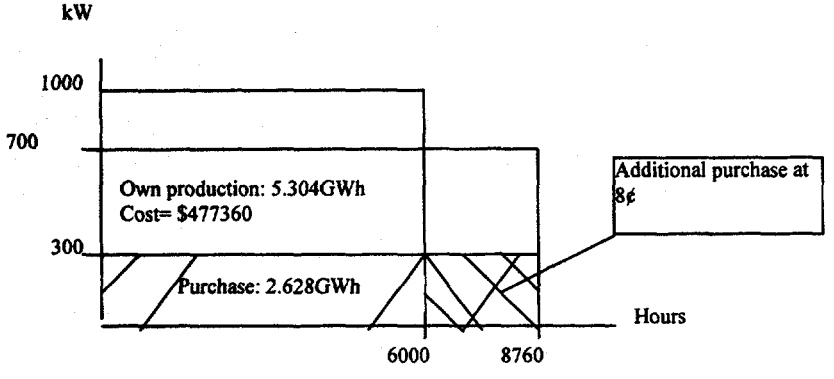

Fig.A3.2: Purchase and production pattern with binomial tariff

Which yields a payment to the electricity supplier of $240,240 and production costs for a total expenditure of $717,600. The user has saved $14,280 (2%) and the electricity company has increased its sales by $60,240 (33%) relative to the straight kWh tariff. Both are better off as a result.

18. Now, suppose that the cost of generation for the user becomes c=9.5¢/kWh. In this case, the cost of purchasing 1kW of base load (8760 hours) is $100+8760 x 0.08= $800.8, whereas the cost of generating 8760kWh is 0.095 x 8760= $832.2. Therefore the user will prefer to purchase base load from the electricity company. As for peak load, the cost of 1kW purchased during 6000 hours is $100 + 0.08 x 6000 = $580, whereas the cost of generating 6000kWh is 0.095 x 6000 = $570. Consequently the customer will purchase base load and generate during peak hours. Note that with the straight kWh price the customer will continue to purchase as before. The user's pattern of demand is shown in Fig. A3.3.

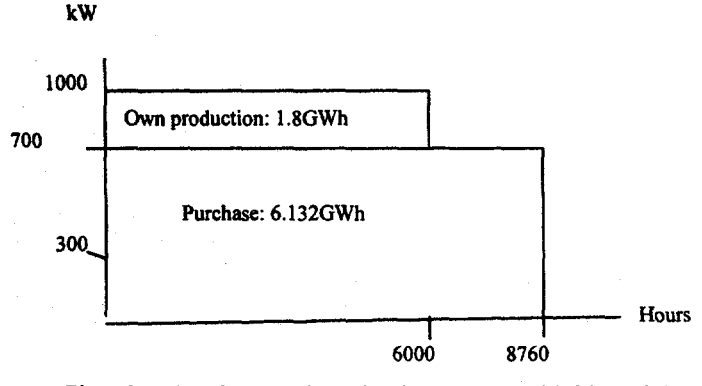

Fig.A3.3: Purchase and production pattern with binomial tariff and c=9.5¢/kWh

19. In this case, the total cost to the user becomes:

- Capacity cost: \$100 x 700= \$70,000
- Energy purchase: 6.132 10^6 x 0.08 = \$490,560
- Generation cost: 1.8 10^6 x 0.095 = \$171,000

And the total electricity expense would amount to \$731,560 against \$762,540 with the straight kWh price. The user saves \$30,980 (4%) and the electricity company sells \$560,560 instead of only \$180,000, an increase of over 200%.

20. Finally, for generation cost ("c") in excess of 9.67¢/kWh (e.g. 9.8¢), the user purchases 100% of his needs from the company. The results are summarized in Table A3.1.

Table A3.1: Summary of Purchases

Generation Cost ("c")	MWh purchased		Power Co. Sales- \$ Thousands	
	Straight kWh	Binomial	Straight kWh	Binomial
9.0¢	1,800	2,628	180	240
9.5¢	1,800	6,132	180	560
9.8¢	1,800	7,932	180	735

The total cost to the user of purchases and generation is summarized in Table A3.2.

Table A3.2. Cost to the customer (\$ Thousands)

	Straight kWh price			Binomial Tariff		
Fuel Cost	Purchase	Fuel	Total	Purchase	Fuel	Total
9.0¢	180	552	732	240	477	717
9.5¢	180	583	763	560	171	731
9.8¢	180	601	781	735	0	735

In every case, the binomial tariff yields a lower overall cost to the customer and greater sales to the power company.

21. **Conclusions.** Although simple tariffs are easy to manage, the only signal they send to the customers is how much they should consume, i.e. this type of tariff will simply act on users' gross purchases. By contrast, the binomial tariff not only sends a signal as to how much but also as to when and how to use substitutes (i.e. own generators).

Annex 4: EDC PROJECTIONS OF PERFORMANCE 1999-2003

Assumptions	1996	1997	1998	1999	2000	2001	2002	2003
1. Exchange Rate	2813	3062	3775	3900	4134	4382	4645	4924
(rate of Increase)		9%	23%	3%	6%	6%	6%	6%
2. Local Inflation		----	----	6%	6%	6%	6%	6%
3. Foreign Inflation		----	----	----	----	----	----	----
4. Tariff Increase- Nominal								
(for local+foreign inflation)		----	----	As done	6.0%	6.0%	6.0%	6.0%
5. No fuel price increases from 1997 assumed over and above what would be neutralized under item 4)								
PHYSICAL DATA								
Dispatch in Gwh								
EDC	211	159	156	132	221	32	166	260
IPPs	5	119	180	300	300	620	620	672
	216	278	336	432	521	652	786	932
T & D Losses	22%	22%	21%	18%	15%	15%	14%	13%
Sale Units Gwh								
Residential				124	133	161	183	211
Comml. & Industrial				142	195	249	318	389
Govt. Agencies				53	66	83	101	122
Hotels & Foreigners				35	49	61	74	89
Total Sale Gwh	169	218	266	354	443	554	676	811
Annual increase %		29%	22%	33%	25%	25%	22%	20%
FINANCIAL DATA- Nominal								
Average revenue/riels/kWh	342	353	370	567	619	659	706	752
Total Revenue- Billion Riels	57.7	77.1	98.3	200.8	274.2	365.3	477.2	610.2
Other Income	4.50	3.50	11.10	3.10	4.00	4.00	4.00	4.00
Total Income- Billion Riels	62.2	80.6	109.4	203.9	278.2	369.3	481.2	614.2
IPP purchase price/riels/kWh	260	279	321	355	364	372	395	419
Total Cost of Power Purchase	1.4	33.1	57.8	106.5	109.1	230.9	244.8	281.3
Other expenses-								
Distrbn. & Own generation	51.6	41.0	72.1	70.2	107.4	55.6	93.3	123.1
Fuel tax-for IPP B. Riels/			3.0	8.2	8.7	19.0	20.2	23.2
Fuel tax-EDC own B. Riels			8.1	5.8	10.3	1.6	8.7	14.4
Other taxes on EDC (excl. I.tax)			6.1	12.2	14.8	20.8	34.1	39.3
Income tax					6.9	9.6	19.5	30.5
Total taxes- B. Riels	17.1	19.5	17.2	26.2	40.7	51.0	82.4	107.4
Profit/ Loss	(7.9)	(13.0)	(37.6)	1.0	21.0	31.8	60.6	102.4
Aprox.Value of Optg. Assets		199.1	333.0	402.3	556.8	609.1	631.3	757.3
Rate of Return on Assets				1%	5%	7%	11%	15%

Annex 5: SCENARIO 'II': LIKELY PERFORMANCE OF EDC 1999 TO 2003

Assumptions	1996	1997	1998	1999	2000	2001	2002	2003
1. Exchange Rate	2813	3062	3775	3900	4017	4138	4262	4389
(rate of Increase)		9%	23%	3%	3%	3%	3%	3%
2. Local Inflation		----	----	6%	6%	6%	6%	6%
3. Foreign Inflation		----	----	2.5%	2.5%	2.5%	2.5%	2.5%
4. Tariff Increase- Nominal								
(for local+foreign inflation)		----	----	As done	4.5%	4.5%	4.5%	4.5%
5. No fuel price increases from 1997 assumed over and above what would be neutralized under item 4)								

	1996	1997	1998	1999	2000	2001	2002	2003
PHYSICAL DATA								
Dispatch in Gwh								
EDC	211	159	156	124	171	12	14	41
IPPs	5	119	180	250	300	549	620	673
	216	278	340	374	471	561	634	714
T & D Losses	22%	22%	21%	18%	15%	15%	14%	13%
Sale Units Gwh								
Residential			164	187	228	257	293	331
Commercial			21	25	29	34	39	44
Govt. Agencies			55	60	68	76	84	93
Hotels & Industrial			29	35	75	110	129	152
Total Sale Gwh	169	218	269	307	400	477	545	621
Annual increase %		29%	23%	14%	30%	19%	14%	14%

FINANCIAL DATA- Nominal								
Average revenue/riels/kWh	342	353	370	483	519	555	580	608
Total Revenue- Billion Riels	57.7	77.1	99.4	148.2	207.7	264.5	316.1	377.6
Other Income	4.50	3.50	11.10	3.10	4.00	4.00	4.00	4.00
Total Income- Billion Riels	62.2	80.6	110.5	151.3	211.7	268.5	320.1	381.6
IPP purchase price/riels/kWh	260	279	321	355	353	352	362	373
Total Cost of Power Purchase	1.4	33.1	57.8	88.7	106.0	193.1	224.6	251.1
Other expenses-								
Distrbn. & Own generation	51.6	41.0	72.1	68.6	86.7	48.1	52.1	60.3
Fuel tax-for IPP B. Riels/			3.0	4.3	5.3	10.0	11.6	13.0
Fuel tax-EDC own B. Riels			8.1	6.7	9.4	0.7	0.8	2.5
Other taxes on EDC (excl. I.tax)			6.1	12.0	7.0	12.2	15.1	18.1
Income tax					0.0	0.0	0.0	0.0
Total taxes- B. Riels	17.1	19.5	17.2	23.0	21.7	22.9	27.5	33.6
Profit/ Loss	(7.9)	(13.0)	(36.6)	(29.0)	(2.8)	4.4	15.9	36.6
Aprox.Value of Optg. Assets		199.1	333.0	402.3	540.9	575.1	575.1	675.1
Rate of Return on Assets					1%	3%	5%	8%

Annex 6: CAMBODIA POWER DEVELOPMENT PROGRAM 1999 TO 2016

Power Stations						Transmission Lines		
Description	Year of Service	Capacity Added MW	Type	Location	Original Cost $ MM-199	GWh Estimated Prodn.	Year of Service	Transmission Lines & New Consuming Centers Under Transmission Lines	Capital Costs T/L & Centers $ MM-199
IPP 2	1999	60	CCGT	Pnom Penh	72.8	587	1999	IPP2-GS1-GS3 in PhnomPenh	2.9
	2000					679	2000		
	2001					773	2001		
Kirrirom+Prek Th	2002	29	Hydro	Kirrirom	36.6	871	2002	Kirrirom-Phnom Penh	19.9
								Thailand-Bantey Mean Chey (impo	7
IPP3 SC SV	2003	90	SCGT	Sihanoukvil	70.8	967	2003	Sihanouk-Takhmau-PhnomPenh	86.1
	2004					1065	2004	Bantambang-Bantey Mean Chey	6.9
IPP4 CC SV	2005	90	CCGT	Sihanoukvil	81.8	1181	2005	IPP4 to Sihanoukville	4.5
	2006					1284	2006		
	2007					1396	2007	GS1 to North Phnom Penh	6.3
Kamchay	2008	47	Hydro	Kamchay	61.9	1517	2008	Kamchay-Kampot	6.9
								Bantey Mean Chey-Siem Reap	17.4
	2009					1658	2009	Takeo-Viet Nam (export)	9.2
								In East Phnom-Penh- Kompong Ch	19.7
	2010					1802	2010		
Battambang 2	2011	36	Hydro	Battambang	74.9	1953	2011	Battmbang 2- Battambang	11.8
								In Phnom-Penh (South)	8.9
Stung Atay	2012	110	Hydro	Stung Atay	179.9	2132	2012	Stung Atay-Pursat	75.6
								Phnom Penh-PreY Veng	6.1
	2013					2319	2013	In Phnom-Penh (West)	14.1
IPP5 SC SV	2014	90	SCGT	Sihanoukvil	69.7	2526	2014	IPP5-Sihanoukville	3
	2015					2723	2015	In Phnom-Penh (Central)	18.6
Mid. St.Russei Ch	2016	125	Hydro	Mid S.R.C	315.9	2953	2016	Mid S.R.C-Strung Atay	12.7
								Kampong Chhnang connected	6.2
								Battambang-Pursat	19.7
Total		677			964.3				363.5

Annex 7: ACTIONS REQUIRED TO ESTABLISH THE ELECTRICITY AUTHORITY OF CAMBODIA

EAC Organization

- Preparation of an organization chart for EAC and duty statements for key positions (SD Article 4);
- Terms and conditions of employment of officers and employees of EAC including for termination of employment (Article 9)
- Preparation of EAC operating budget (Article 21)

EAC Procedures & Rules

- Procedures and standards for investment programs to be submitted to EAC by licensees (Article 9);
- Procedures for EAC informing the public about issues within its jurisdiction (Article 9)
- Procedures for obtaining a license, license application forms and information needed to evaluate applications (Article 17)
- Procedures for licensees to enter into power purchase agreements (SD Article 20);
- Procedures and time limit on license applications (Article 34)
- Rules for meetings of the EAC to establish a tariff or grant a license (Article 18)
- Procedures for determination of disputes (Article 40)
- Procedures and standards for provision of information on investment and power acquisition programs of licensees (Article 45)
- Procedures governing termination of electric power service for non-payment and imposition of penalties to ensure recovery of costs associated with payment of arrears (Article 55)

EAC Regulations & Conditions

- Regulations relating to reports by licensees on annual activities, work plans, reports, statements and information to be submitted to ERA (Article 35 & SD Article 40)
- Regulations regarding activities and operation of subcontractor licensees (Article 35)
- Regulations for imposing sanctions and penalties for violation of license conditions and procedures for revocation of licenses (Article 54)
- Conditions applying to grant, rejection, amendment and revocation of licenses (Article 38)
- Draft model licenses – including term of licenses, license conditions and conditions for license modification or withdrawal (Article 15)
- Service obligations and conditions to be included in licenses (Article 32)

Standards

- Electric system performance and protection standards (Article 36)
- Establish a uniform system of accounts based on generally accepted accounting standards (Article 50)

- Requirements of licensees concerning provision and quality of service (Article 44)
- Standards and requirements for metering equipment and testing (Article 47)

Fees

- Charges for testing, calibrating, inspection and replacement of metering equipment (Article 48);
- Method of calculating license fees (Article 21).