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PROJECT PERFORMANCE ASSESSMENT REPORT

LAO PEOPLE'S DEMOCRATIC REPUBLIC

SOUTHERN PROVINCES RURAL ELECTRIFICATION PROJECT

(CREDIT 3047-LA)

February 4, 2008

Sector, Thematic and Global Evaluation Division
Independent Evaluation Group (World Bank)

Currency Equivalents (annual averages)

Currency Unit = Lao Kip

2004	US$1.00	K 10,646

Abbreviations and Acronyms

CAS	Country Assistance Strategy
DOE	Department of Electricity
EdL	Electricité du Laos
EPDP	Ethnic People's Development Plan
ERR	Economic Rate of Return
ESMAP	Energy Sector Management Assistance Program
FIRR	Financial Rate of Return
GoL	Government of Lao PDR
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
ICR	Implementation Completion Report
IED	Innovation Energie Développement
IEG	Independent Evaluation Group
IEGWB	Independent Evaluation Group (World Bank)
JICA	Japan International Cooperation Agency
MEM	Ministry of Energy and Mines
MIH	Ministry of Industry and Handicrafts
NORAD	Norwegian Agency for Development Cooperation
OGS	Off-Grid Promotion Support Office in DOE
O&M	Operation and Maintenance
PAD	Project Appraisal Document
PGI	Provincial Grid Integration Project
RAP	Resettlement Action Plan
REP	Rural Electrification Project
PESCO	Provincial Energy Services Company
PPAR	Project Performance Assessment Report
PRSP	Poverty Reduction Strategy Paper
PVS	Photo-voltaic Systems
SHS	Solar Home Systems
SPRE	Southern Provinces Rural Electrification Project
UNDP	United Nations Development Program
VEM	Village Electricity Manager
VOPS	Village Off-grid Promotion Scheme
WTP	Willingness to Pay

Fiscal Year

Government: January 1 – December 31

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The Independent Evaluation Group assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the Bank's self-evaluation process and to verify that the Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEGWB annually assesses about 25 percent of the Bank's lending operations through field work. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEGWB staff examine project files and other documents, interview operational staff, visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, and interview Bank staff and other donor agency staff both at headquarters and in local offices as appropriate.

Each PPAR is subject to internal IEGWB peer review, Panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible Bank department. IEGWB incorporates the comments as relevant. The completed PPAR is then sent to the borrower for review; the borrowers' comments are attached to the document that is sent to the Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

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Risk to Development Outcome: The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for Risk to Development Outcome:* High Significant, Moderate, Negligible to Low, Not Evaluable.

Bank Performance: The extent to which services provided by the Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan/credit closing, toward the achievement of development outcomes. The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Borrower Performance: The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible ratings for Borrower Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Contents

This report was prepared by Howard White, who assessed the project in March 2007. Soon-Won Pak provided administrative support.

Principal Ratings

	*ICR**	*ICR Review**	*PPAR*
Outcome	Satisfactory	Satisfactory	Moderately Satisfactory
Institutional Development Impact**	Substantial	Substantial	———
Risk to Development Outcome	———	———	Low
Sustainability***	Likely	Likely	———
Bank Performance	Satisfactory	Satisfactory	Satisfactory
Borrower Performance	Satisfactory	Unsatisfactory	Moderately satisfactory

* The Implementation Completion Report (ICR) is a self-evaluation by the responsible Bank department. The ICR Review is an intermediate IEGWB product that seeks to independently verify the findings of the ICR.
**As of July 1, 2006, Institutional Development Impact is assessed as part of the Outcome rating.
***As of July 1, 2006, Sustainability has been replaced by Risk to Development Outcome. As the scales are different, the ratings are not directly comparable.

Key Staff Responsible

Project	*Task Manager/Leader*	*Division Chief/ Sector Director*	*Country Director*
Appraisal	Veronique Bishop	Yoshihiko Sumi	Ngozi N. Okonjo-Iweala
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Preface

This project performance audit report (PPAR) covers the Southern Provinces Rural Electrification Project (SPRE, Credit 30470-LA for US$34.7 million), which was approved in March 1998 and closed in June 2004.

The PPAR was prepared by the Independent Evaluation Group (IEG, formerly OED), based upon the Implementation Completion Report (ICR), project documents, and interviews with government officials, civil society and private sector representatives and staff of the Bank and other agencies. Fieldwork was undertaken in March 2007, which benefited from the support of Ms. Mingngakham Pangnasak and Mr. Morten Larsen of the World Bank office in Vientianne in arranging the mission. Mr. Anousak Phongsavath and Mr Oudom Kasisingdeth arranged fieldwork for the mission, and accompanied it to the field. The mission is grateful to others who spared their time to share their views, and for the cooperation of the Government of Lao PDR in undertaking this study.

This project was selected for review as an input to the IEG study *The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefit*, delivered in June 2007. Baseline data were made available to IEG which allowed a more in depth analysis of impact issues than is usually the case in a PPAR.

Following standard IEG procedures, the draft of this PPAR was sent to the borrower for comments before finalization, but none were received.

Summary

The Southern Provinces Rural Electrification Project (SPRE), approved in 1998, followed on from earlier Bank projects providing electricity to rural areas of Lao PDR through the electricity utility, Electricité du Laos (EdL). There was also an off-grid component, implemented by the Department of Electricity (DOE). In summary, the project exceeded its physical goals for both the grid and off-grid components, but both suffered from institutional shortcomings.

SPRE had two objectives: (i) expand rural electricity service in seven central and southern provinces of Lao PDR, where economically justified, through grid extension and off-grid electrification; and (ii) strengthen EdL's capacity to plan and implement electrification investments and to operate on a commercial basis.

After a slow start, the project exceeded its physical goals, connecting 721 villages compared to the target of 520. Cost savings allowed for additional civil works, including a third sub-station. However, system losses remained high (at around 21% in 2004 versus a target of 16%), being highest in project provinces. The off-grid component provided electricity to 6,097 homes compared to the target of 4,600.

Performance of the grid extension component was overshadowed by continuing financial difficulties for EdL, stemming from both tariffs below cost recovery levels and arrears mainly from public agencies. By the end of the project in 2004, the performance of most financial indicators was below expectations. However, subsequent implementation of the financial recovery plan is moving EdL toward a financially sustainable situation.

The off-grid component suffered from technical problems, so that many households are receiving less than one hour a day of electricity rather than the 3-4 hours they would get were the system working satisfactorily. These technical problems are a manifestation of an underlying structural problem in the program incentives, which are oriented toward planning and installation of connections to new villages, with maintenance being financially unrewarding. However, a private company is providing solar home systems to many communities despite a much lower level of subsidies than those available through the Bank project, so there are also issues of technical capacity and delineating roles between subsidized and unsubsidized services.

SPRE was highly relevant: government has set a target of 90 percent electrification by 2020, and rural electrification is part of the Bank’s Country Assistance Strategy. The project achieved its first objective of supplying energy services, but not the second of strengthening EdL. Efficiency is measured by the ERR, which was 13 percent (lower than the 61 percent in the ICR given technical errors in the latter’s calculation). The overall outcome rating is **moderately satisfactory**, because of EdL’s unsatisfactory financial performance for most of the project’s duration and the technical problems discussed above. Bank performance was **satisfactory**, and that of the borrower **moderately satisfactory** (again reflecting EdL’s poor financial performance). The risk to development outcome is **modest** since measures implemented toward the end of, and

subsequent to, project completion have addressed the financial sustainability issue, and technical issues are being addressed under the follow-on Rural Electrification Project.

The lessons learned from the review are:

- **Consumers are willing to pay tariffs at cost recovery levels**. The willingness to pay analysis shows that consumers are willing to pay for electricity at levels exceeding supply costs. Lao PDR has been able to implement sizeable tariff increases in a short space of time with no adverse social impact or notable demand reductions (indeed it can be argued that any reduction in usage by already connected customers would help extend supply to new locations).

- **But poorer households remain unconnected**. Even after the grid has been in a village for more than 10 years, some 20 percent of households remain unconnected. Smart (i.e. efficiently targeted) connection subsidies for late connectors would help achieve government's 90 percent coverage target.

- **Explicit attention needs to be paid to technical efficiency**. Technical problems of system losses and outages reduce financial performance and undermine project benefits. Explicit components are needed to tackle such issues.

- **Off-grid components promote social equity in electrification coverage… but are not necessarily the most cost effective strategy.** The off-grid component has helped reach remote communities which would not otherwise have got electricity for a decade or more. However, the rate of return to these investments is lower than that to grid extension, or of subsidizing connections for late connectors, and it is not proven that the beneficiaries from off-grid programs are poorer than those benefiting from grid extension.

- **In countries where the private sector is relatively undeveloped, substantial support may be required to provide off-grid services in poor areas. At the same time subsidies should not crowd out purely commercial actors.** A sensible balance would direct project supported companies to the more remote areas unlikely to be attractive to purely commercial firms, but a subsidy scheme needs to ensure that such activities are sufficiently attractive.

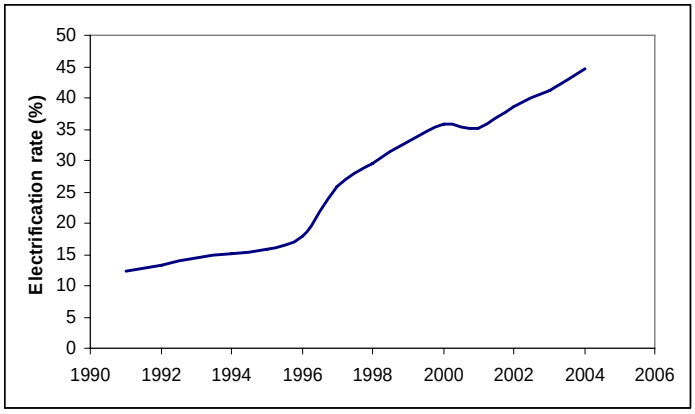
Vinod Thomas
Director-General
Evaluation

1. Introduction

1.1 Electricity in Lao PDR is largely generated by hydropower, with a limited use of diesel. Off-grid schemes are being developed in less accessible areas. The first grid system was developed around the Nam Ngum dam, completed in 1971 with assistance from a group of eight donors, including the World Bank. A large part of the electricity generated by Nam Ngum was exported to Thailand. Exports to Thailand continue to account for a large, though falling, share of the electricity generated, and have been supplemented by exports to Vietnam. However, the country's grid has developed in a fragmented manner, with four principal grids in different parts of the country (Northern Grid, Central Grids I and II and Southern Grid). Since the grid is not national, regional consumption needs are also met by imports from Thailand, making Lao PDR both an exporter and importer of electricity.

1.2 The Government of Lao PDR (GoL) places high priority on rural electrification, with the goal of electrifying 90 percent of the country's households by 2020 (of which 75 percent will be on grid) as well as increasing hydropower exports to neighboring countries. Interim targets are for 70 percent coverage by 2010 and 80 percent by 2015. Growth in coverage since the nineties has been high, averaging over 10 percent a year which is more than sufficient to meet these targets (Figure 1), and several new dams are under construction to increase power generation. Off-grid connections are needed if electricity is to be available in less accessible communities, including those in mountainous regions and on river islands.

Figure 1 National electrification rate



Source: Rural Electrification, Project Appraisal Document, Table 4, p. 20. No. of households extrapolated back from 1995 at assumed growth rate of 2.7% p.a.

1.3 The Government's strategy of electrification, adopted in 1998, gave priority to provincial capitals and areas of tourist potential. The strategy was written following the first steps towards commercialization and strengthening of the power sector, which are in turn reflected in four policy goals set out in the GoL's "Power Sector Policy Statement" issued in 2001: (i) Maintain and expand an affordable, reliable, and sustainable electricity supply in Lao PDR; (ii) Promote hydropower exports to earn revenues to meet GoL development objectives; (iii) Enhance the legal and regulatory framework to underpin power sector development; and (iv) Strengthen institutional structures, clarify responsibilities, streamline administration, and foster economic and social development. A subsequent workshop identified the following priorities: (i) expand electrification, (ii) complete commercialization of EdL, and (iii) develop a financing strategy for domestic and export power developments.

1.4 Rural electrification falls under the Ministry of Energy and Mines (MEM, formerly the Ministry of Industry and Handicrafts, MIH), with generation by Electricité du Laos (EdL) and services provided by provincial electric power authorities. In the latter half of the nineties steps were taken to commercialize of EdL as part of Government's strategy to commercialize the energy sector. Along with a reorganization of the utility into profit centers, EdL entered into a performance contract with the Government, laying out performance targets and committing GoL to take steps toward improving EdL's financial viability, including through an increase in tariffs for domestic power consumption. The utility nevertheless continues to depend on export revenue, which has historically been used to cross-subsidize domestic residential consumption. As an earlier IEG assessment pointed out, this represents an extremely regressive use of natural resource rents since it is the better off who benefit most from electricity subsidies.[1] The domestic tariff structure also cross-subsidized residential consumption from revenue from commercial users. EdL has a sizeable debt from the substantial investments of recent years, the burden of which became severe following the large devaluation of the domestic currency in the aftermath of the East Asian crisis in 1997. Successive Bank projects have sought to restore EdL to a sounder financial footing through higher tariffs.

The role of the World Bank and other donors

1.5 The Bank has been involved in the country's electrification from the outset, contributing toward the construction of hydropower facilities, and now includes rural electrification in the Country Assistance Strategy. Over the last 20 years Bank support has focused on the central and southern provinces, first through the Southern Provinces Electrification Project (SPE), then the Provincial Grid Integration Project (PGI)—which had a substantial rural electrification component —and the Southern Provinces Rural Electrification Project (SPRE); see Table 1. The latter project is being followed up by the Rural Electrification Project (REP I, but called SPRE II during preparation). This new project will support off-grid services throughout the country, though investments in on-grid services will continue to be confined to the seven southern provinces. Despite the introduction of off-grid components, on-grid has taken the bulk of the finances (Table 2).

Table 1 Recent World Bank support to rural electrification in Lao PDR

	FY (Board-Close)	*Cost (US$ million)*		*Connections*	*Outcome rating*
		IDA	*Total*		
Southern Provinces Electrification Project	1987-1995	26	31	Villages: 147 H/holds: 8,354	n.a.
Provincial Grid Integration	1993-99	36	49	Villages: 569 H/holds: 40,100	Satisfactory
Southern Provinces Rural Electrification Project (SPRE)	1998-2004	35	42	Villages: 721 H/holds: on-grid 51,805 Off-grid 4,910	Satisfactory
Rural Electrification (Phase 1)	2006-2010	10 (GEF: 4)	36	Villages: on-grid 540, off-grid 200 H/holds: on-grid 42,000, off-grid 10,000	n.a.

1. PPAR for Provincial Grid Integration, Report No. 24021, April 16, 2002.

Table 2 Share of Bank project budgets to on-grid and off-grid

	Amount (US$ millions)		*Percent on-grid*
	On-grid	Off-grid	
PGI	30.0	0.0	100.0
SPRE	31.9	2.1	93.7
RE	26.4	2.4	91.8

Source: project documents

1.6 Consistent with the Bank's emphasis on the financial viability of government-owned utilities, the conditions attached to the Bank's loans have sought tariff increases to cost recovery levels, especially since the Asian crisis worsened EdL's financial position in the years after 1997.[2] However, an earlier project evaluation by IEG concluded that although the Provincial Grid Integration Project had met its physical targets it had not achieved its institution building objective, failing to improve the poor financial position of EdL.[3] The report argued that these problems were evident at the time of project preparation and actions to address them should have been included in the conditions for effectiveness, noting also that the same argument applied with even greater force to SPRE.

1.7 The other main donor supporting the sector in recent years has been the Asian Development Bank, which has supported projects in the Northern Provinces and Vientiane Plain. In addition, UNDP supported the Vientiane Plain Rural Electrification Projects I and II while NORAD co-financed ADB's project for Vientiane Plain and Northern Provinces. Export credits from India and China are of growing importance, and both countries have projects in the southern provinces.

2. Project preparation, design, implementation and outcomes

Preparation

2.1 The Southern Provinces Electrification and Provincial Grid Integration projects established the basic infrastructure for rural electrification in the central and southern provinces, drawing largely on domestically generated energy. In principle, the Southern Provinces Rural Electrification Project (SPRE) was a straightforward extension of these previous projects, requiring a relatively small amount of high-tech investment: two new substations and less than 60 km of high voltage sub-transmission lines were included in the design. The bulk of the project cost was taken up by distribution extension (poles and lines) reliant upon the existing transmission infrastructure. Technical assistance was provided by the Swedish utility, SwedPower, which designed the proposed investments in line with agreed least-cost principles. However, preparation was delayed. Appraisal was originally planned for December 1996, but eventually took place in December 1997. The project was submitted for Board approval in March 1998 and became effective in August of that year.

2. Since 1993 the Bank has, in accordance with the new energy strategy, promoted increased private sector participation in electricity generation and distribution, which in most countries has been focused on generation. Privatization is not a political option in Lao PDR at present, so the Bank has pursued commercialization.
3. PPAR for Provincial Grid Integration, Report No. 24021, April 22, 2002.

2.2 Three factors explain the delay. The first was the resettlement policy. The Bank argued that there was little capacity and understanding of this issue on the government side, and the consultants involved in project design were not convinced of the need to address resettlement. At an internal Bank review meeting, it was decided that the issue should not be pressed, in order to retain government support for the project. But the correspondence trail after that meeting shows that resettlement was later put back on the agenda. A mission was fielded in September 1996 with the result that a Resettlement Action Plan (RAP) was in place by the time of project appraisal. However, problems relating to this issue resurfaced during implementation.

2.3 The project was also delayed by two related factors—the commercial status and financial performance of EdL. The Bank wanted a Performance Contract between the government and EdL setting out their respective responsibilities and giving the utility more independence. This contract, prepared with Bank assistance, was signed in January 1998. EdL's domestic supply operated at a substantial loss, with the utility having increasing problems servicing its debt. The performance contract agreed on a schedule of tariff increases to address these issues. There was also an average tariff increase of 63 percent in October 1997.

2.4 The original project design was built around grid extension. But government's electrification targets could not be met by grid extension alone. Therefore, at appraisal, an off-grid component was added to the project, to be operated on a commercial basis by EdL.

Objectives and components

2.5 As stated in the Project Appraisal Document (p.2), SPRE had two objectives:

(i) Expand rural electricity service in 7 central and southern provinces of Lao PDR, where economically justified, through grid extension and off-grid electrification; and

(ii) Strengthen EdL's capacity to plan and implement electrification investments and to operate on a commercial basis.

2.6 The project had three components: (i) grid extension; (ii) off-grid electrification; and (iii) institution building.

2.7 Grid extension: The Distribution Extension component was to increase electricity service in seven southern Lao provinces: Bolikhamsai, Khammouane, Savannakhet, Saravane, Champassak, Attopeu, and Sekong. It was planned to finance the construction of about 52 km of high-voltage (115 kV) subtransmission lines, 2x20 MVA of 115/22 kV of transformer capacity, 1200 km of medium-voltage (22 kV) lines, 900 km of low-voltage (380 kV) lines, 34 MVA of 220/380 kV distribution transformers, and 50,000 consumer meters. The project would also pilot the use of low-cost single wire earth return (SWER) systems in rural areas.

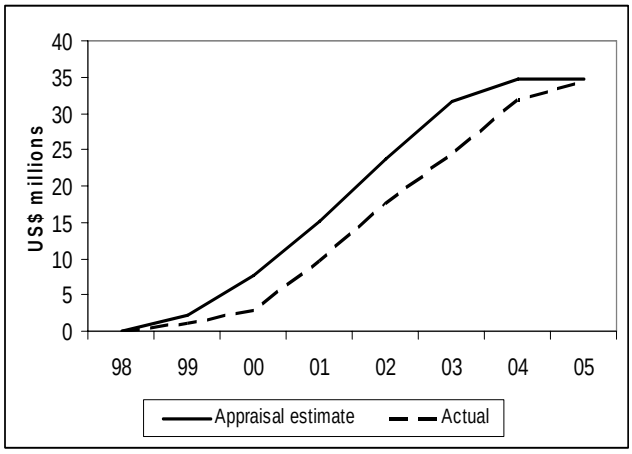
2.8 Off-grid electrification: The Off-Grid component was to test methods of providing electricity service in approximately 46 rural communities which will not receive grid access for at least 10 years. The pilot was to: (i) establish local institutional, financial, and technical capacity for sustainable implementation of rural diesel and renewable energy systems; (ii) implement small diesel, micro-hydro, photovoltaic systems (and others according to demand from operators); and (iii) identify and develop the objectives, institutional arrangements, and scope for a national off-grid rural electrification program. The aim was to make off-grid project development more sustainable by: (i) maximizing the involvement of the private sector and beneficiaries; (ii) operating the off-grid systems on a cost-recovery basis; (iii) defining and strengthening appropriate institutional and financial mechanisms; and (iv) developing designs to minimize costs.

2.9 Institutional Development: This component was intended to finance technical assistance and equipment for project management, commercialization and sector regulation and development. Project management assistance was to be provided to EdL, including (i) engineering consultants to provide hands-on assistance and training in project management, procurement, construction supervision, and monitoring; and (ii) equipment including vehicles for supervision and maintenance, computers and other office equipment. Financial management and commercialization support would be provided to EdL to finance the services of (i) the Resident Financial Management Advisor; (ii) the procurement and installation of billing and collections system; and (iii) short-term expert advice to EdL's General Manager as determined during the course of the project. This was expected to include advice with regard to corporate planning, budgeting, and training. Technical assistance was also to be provided to MIH and EdL to assist in regulatory and technical matters, including the formulation of a strategy for the power sector that would support implementation of the Electricity Law and the preparation of a sector development action plan and a hydropower development strategy.

Overview of implementation

2.10 Implementation lagged in the first two years, with only 36 percent of the expected amount disbursed by the second year of the project (Figure 2). There were initially delays in preparing bidding documents so no disbursements at all took place during the first six months of the project. But the main concern was EdL's finances, which worsened considerably following the East Asian crisis and the devaluation of the kip from less than Kip 1,000 per US$ to over 7,000 per US$ by 1999. Within a year of the project's start, the Bank considered suspending the credit unless actions were taken to resolve these financial issues.

Figure 2 SPRE disbursement profile



Source: ICR

Proposals made by the government in March 2000 were considered insufficient to remove the need for suspension. That month a supervision mission proposed a financial restructuring plan for EdL, threatening suspension unless there were signs of progress by June 2000. In April, the government wrote assuring the Bank that measures would indeed be taken to redress the situation. Its proposed plan of action included formation of a Tariff Review Committee (rather than specific proposals on tariffs). This was accepted by the Bank in October. But by mid-2001 the Bank was expressing concern that implementation of the plan had stalled. A program of tariff increases was finally introduced from May 2002 (see paragraph 2.15 below).

2.11 These problems did not hinder progress with grid extension, although there were initial procurement delays, and heavy rains slowed progress with the works. Eventually, more villages than planned were connected to the grid—721, compared to the appraisal estimate of 520, with 51,805 household connections against the planned 50,000 (Table 3). Cost savings on the planned activities allowed additional works to be undertaken. Specifically, US$3.9 million was spent on (i) upgrading of the 115/22 kV Paksan substation with 2x16 MVA transformers; and (ii) constructing a new 115/22 kV outdoor substation at Thakhek with 2x30 MVA transformers and the erection of a 3 km double circuit steel lattice 115 kV transmission line. The success of these activities demonstrates both the existing capacity of EdL in implementing grid extension, and the supportive role played by the institutional development activities to support these investments.

Table 3 Physical outputs

Component	*Target*	*Actual**	*Unit*
115 KV lines	52	53.4	km
MV (22 kV) lines	1,200	1,554	km
LV (380 V) lines	900	1,566	km
115/22 kV transformer capacity	40	132	MVA
22/0.38 kV transformer capacity	34	44.9	MVA
Household connections	50,000	51,805	-

* Latest estimate or actual output. Includes components not included at appraisal, procured from credit cost savings.

2.12 The off-grid component also got off to a slow start. The hope that the pilot program would be commercially viable proved over-optimistic, imposing an additional financial burden on EdL, the implementing agency. Hence the credit agreement was amended, allowing the Department of Energy to take responsibility for this component. As with grid extension, physical targets were exceeded, with 6,097 households receiving off-grid power compared to the appraisal target of 4,600. However, there have been problems with the maintenance of these systems (see paragraph 2.24 below).

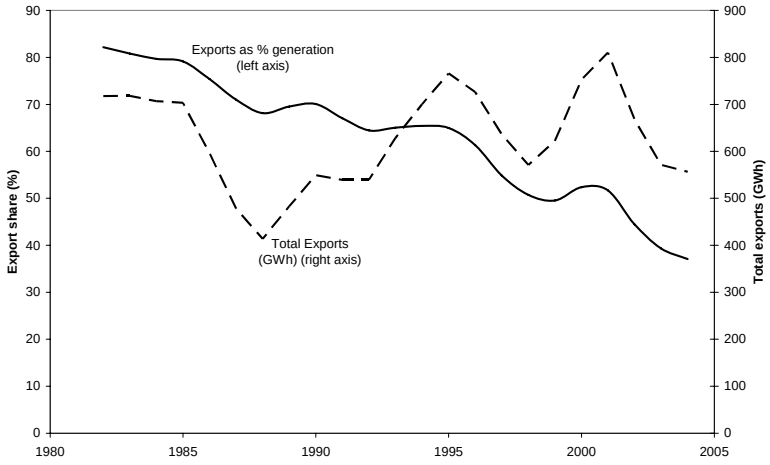
2.13 In short, during project implementation, quantitative targets were amply exceeded, but there were institutional problems with both on and off-grid programs. For the on-grid program, the central concern was the performance of EdL—its weak financial position and its failure to cope with system losses and outages. The off-grid program failed to ensure adequate maintenance, reflecting flaws in the incentive structure built into program design.

Financial performance of EdL

2.14 EdL became an autonomous agency in 1997, charged with operating on a more commercial basis. But a review of financial performance two years later found it to be unsatisfactory. Although operating profits seemed to be satisfactory, the return on capital was low (and overstated, since fixed assets had not been re-valued). Also, residential consumers were heavily cross-subsidized by exports. Growing domestic demand reduced exports, these falling from over 80 percent of generated power in the early 1980s to less than 60 percent by the late 1990s (Figure 3). In addition, EdL was unable to finance the investment program required for continued service expansion, reducing its ability to service current and future loans. Finally, there were serious payment arrears, notably from government agencies (but also irrigation users). These problems were exacerbated by the devaluation of the kip, since most materials were imported and the loans were denominated in foreign currency.

2.15 With the assistance of the World Bank and the Asian Development Bank, the government took steps to strengthen EdL's performance. The financial restructuring plan of 2001 partially converted government debt into equity, and retroactively adjusted the terms of other loans. It was also agreed that, from January 2002 onwards, tariffs should be increased by 2 percent per month for a period of 36 months. During 2002, tariffs regained their pre-crisis dollar value (Figure 4). However, the government suspended the tariff increases in 2004, pending the results of a tariff review study.[4] It then rejected the recommendations of the study so further work was done to amend the study's conclusions. The government was then invited to choose one of two deadlines for moving all tariffs toward levels sufficient to cover operation and maintenance (O&M) costs and achieve a 4 percent real return on fixed assets. It accepted the 2011, rather than the 2009 deadline. Tariff rises, in line with the agreement with the Bank and ADB, began again in July 2005 (i.e. after SPRE had closed), with further rises being built into the Action Plan for Financial Sustainability of November 2005 (prepared as a precondition for SPRE II, since renamed REP). This index links the tariff to the consumer price index and the exchange rate, in order to ensure that the real tariff rises by the agreed rate. Tariffs are now well established at a historical high.

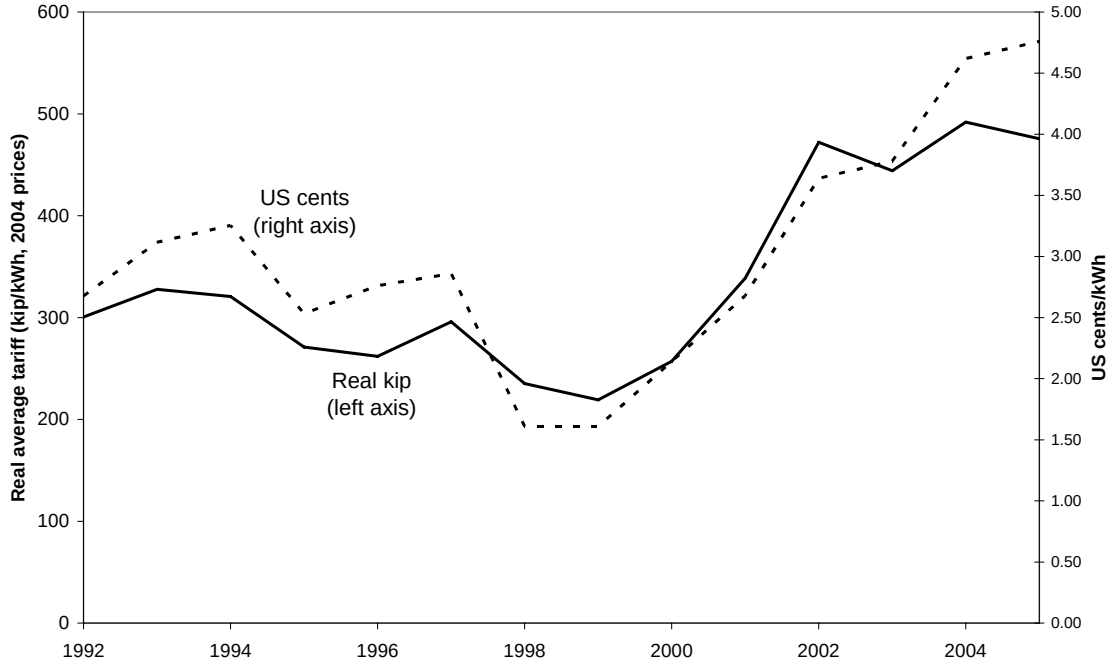
Figure 3 Share of exports in generation



Source: EdL

4. Electrowatt-Ekono Ltd. and Fichtner *EdL Tariff Study: Final Report*, December 2004.

Figure 4 Real electricity tariffs



Sources: Tariff data from EdL, price and exchange rates from IMF Statistical Annex (various years).

2.16 Under the financial plans for EdL, it was also agreed that existing arrears would be offset against taxes. However, new arrears continue to accrue which are not covered by the agreement, though three measures are in place to limit such arrears (earmarked budget allocation for bill payment, an energy audit of government customers and an agreement that government customers can be disconnected for non-payment). Continuing measures are being taken to address this situation, but it is recognized that it may take some years for it to be fully resolved.

Table 4 SPRE financial indicators

	1996	***2004***
Accounts receivable turnover declines from 4.7 months in 1996 to 2 months by 2000	4.7	~5
Ensure that government arrears to EdL do not exceed 60 days from 1999 onwards	n.a.	19 months
System losses from 30% in 1996 to 20% in 2000 and 16% in 2004[1]	30	20.7
Return on net re-valued assets in operation of 8%	n.a.	4.7
Debt service coverage equal to at least 1.5[1]	1.2	1.2
Maintain a self-financing ratio of 20% from 1998 onward and 30% from 2000 onward[1]	20	31

Note: 1/ Condition from GoL-MEM agreement. Source: ICR and EdL

2.17 Although measures are now in place to strengthen EdL's finances, progress during SPRE was only moderately satisfactory, with all but one of the performance targets being missed at the end of the project (Table 4). Only the target for the self-financing ratio was met. However, it is not clear that this is a good measure of financial performance for a utility undertaking substantial system expansion which is mostly financed by foreign loans and grants. Such aid-financed expansion will drive down the self-financing ratio, but this does not necessarily reflect weak underlying performance (the verdict on which will hinge on whether the user charges for the new capacity are sufficient to cover O&M and debt servicing).

Technical performance of the grid: system losses and outages

2.18 In 1996 system losses were very high: the cost of delivery was 30 percent higher than the cost of generation. At appraisal a target was set to reduce system losses to 20 percent by 2000, and the Performance Contract stated that they should be reduced to 16 percent by 2004. But losses remained close to 21 percent in 2004, though they had been lower in earlier years. EdL's Annual Report for 2005 states that, "system loss is high and on the rise" (p.23). The problem is worse in SPRE provinces, where system losses averaged 20.2 percent in 2004 and 20.6 percent in 2005, compared to 15.6 percent and 12.5 percent respectively for non-project provinces (*ibid.*). Continued high losses will further weaken EdL's financial position.

2.19 Both EdL engineers and Bank staff agree that system losses would almost inevitably have remained high under SPRE since it largely extended distribution systems on the basis of existing infrastructure. This results in long distribution networks using medium and low voltage lines—the source of the system losses. These engineers agree that as the network becomes denser—that is, as more substations are added—losses will decline. Also, REP 1 has a specific component to reduce system losses which is paying for the upgrading of equipment and wires; and additional substations are already being provided by other agencies (e.g. two have been built in Champasak province with Chinese funding). By April 2007, EdL had already attained the system loss target for REP of 17 percent.

Box 1 The problem of electricity outages: findings from a study of electricity supply to the private sector

Manufacturing firms identified problems with electricity services as the most important obstacle to business—more than 40 percent of firms identified this as a major or severe obstacle (more than any other issue). The estimated cost of these problems was equal to 5% of sales, double that in neighboring countries. ADB and the World Bank commissioned a follow-up report, which surveyed 34 manufacturing firms. Twelve of these reported more than 10 outages in the previous rainy season. EdL data confirm this seasonal pattern. Other service-related problems were also identified, notably EdL's slowness in providing connections to enterprises.

Source: Tokoyo Electric Power Company (2006) "Private Sector Adjustment and Investment Climate Assessment in Lao PDR: Electricity Supply Survey," report for ADB and World Bank.

2.20 Power cuts are a further problem, according to two private sector surveys (Box 1). IEG field visits confirmed that outages are a common occurrence in the rainy season; households covered by the REP 1 baseline survey reported a median of 10 outages per year, averaging three hours each. Provincial data for high and medium voltage lines confirm that cuts peak during the rainy season. IEG's impression is that the problem is

not being seriously addressed by EdL—or by the Bank. For example, there is no performance indicator on outages.

Off-grid component

2.21 A World Bank (ESMAP) study on the appropriate institutional arrangement for the delivery of off-grid services was conducted under the auspices of SPRE.[5] This study proposed that private sector operators be brought in at the provincial level, to be trained and supplied by EdL. However, the proposal was never implemented and, ultimately, responsibility shifted to the Department of Energy (Ministry of Industry and Handicrafts), with the Bank and GoL agreeing that EdL had no expertise on private sector promotion and could ill afford the financial burden associated with this component. Meanwhile, JICA had helped finance a pilot off-grid project in Vientiane Province, implemented by DOE; but it was unwilling to fund scaling up. It was this pilot which served as the basis for the SPRE-financed off-grid component (employing some of the same staff), although the model bears strong similarities to the ESMAP proposal.

2.22 The program was run by the Off-Grid Promotion Support Office (OGS) in DOE. In each province a private company was to be appointed as the Provincial Energy Services Company (PESCO). In consultation with DOE, EdL and the provincial authority, the PESCO identified those villages which would not be linked to the grid for at least ten years (this threshold is sometimes reduced to five years). From this list, the PESCO selects villages for the planning exercise: an assessment of ability to pay based on an inventory of land, livestock, and other assets drawn up in consultation with the village head. If the PESCO decides to proceed, a village meeting is held at which a Village Electricity Manager (VEM) is appointed, who is responsible for day-to-day maintenance and collecting the monthly payment. This payment is divided up between the Village Fund (10 percent), VEM, (20 percent) and PESCO (20 percent), with the remaining one-half channelled to the reflow account of OGS to maintain materials supply. For the village to be eligible for the program at least 80 percent of households must sign up at the planning stage.

2.23 The options are for diesel powered small generator, pico-hydro, or solar home systems (SHS). Wind power is considered not economically viable in Lao PDR and biomass systems are currently under development. To date, all villages have opted for SHS, except one which chose a pico-hydro system. The household can choose different panel sizes and pay an installation fee (the lowest being US$16) and then monthly payments under hire purchase arrangement over five or ten years. The cheapest panel costs Kip 10,000 (US$1) a month for ten years (Table 5). The solar power is routed through a controller to a car battery for recharging, which can then power light bulbs, radio, and TV for up to 4 hours per day.

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5. ESMAP, *Lao PDR: Institutional Development for Off-grid Electrification*, June 1999.

Table 5 Solar Home System options and payments under OGS

		Installation Fee (kip)	*Monthly Payments for solar kit (kip/month)*	
			5 year repayment period	*10 year repayment period*
20W	1 or 2 lamps for 2-3 hours on evenings following sunny days. Radio-cassette. B+W TV, 1 hour.	160,000	20,000	10,000
30W	1 or 2 lamps for 3-4 hours on evenings following sunny days. Radio-cassette. B+W TV, 3 hours.	190,000	30,000	15,000
40W	2 or 3 lamps for 3-4 hours most evenings except when no sun for two days. Radio-cassette, TV, other 12 V appliances.	220,000	40,000	20,000
50W	3 or 4 lamps for 3-4 hours most evenings. Radio-cassette, TV, other 12V appliances.	250,000	50,000	25,000

Source: *Village Energy and Electricity: Best Practice in Lao PDR*, February 2004, Ministry of Industry and Handicrafts, Vientiane.

2.24 Over 6,000 households were connected to off-grid supply under SPRE, exceeding the appraisal target by one-third. However a survey undertaken in Vientiane Province in 2006 revealed a number of operational problems, with over 80 percent of SHSs not working properly or at a low level of service.[6] Most controllers were no longer working: 40 percent were absent, and most of the others had been bypassed so the panel was connected directly to the battery. The resultant power fluctuations shorten battery life (which was anyway only 2-3 years), as does excess use by connecting too many lights or appliances. As a result nearly all batteries were past their useful life, with over half the batteries being more than four years old. Most households have not replaced these batteries (which cost US$20-50), but continue to charge the battery getting just 30 minutes to one hour of electricity each day. Consequently, project benefits are much lower than expected.

2.25 These problems are partly technical and partly incentive-based. There is disagreement about the technical flaws. The rival private scheme (Sunlabob; see next paragraph) uses five-year solar batteries, arguing that these are superior. OGS (now called the Village Off-grid Promotion Scheme, VOPS) program managers argue the greater cost of these batteries is not warranted. The second technical issue is the quality of training and capacity of the field staff recruited under the project (the PESCO and VEM). Sunlabob provides its engineers a higher level of training. But it is the incentive structure which puts the greatest constraint on maintenance. Payments to the provincial company, the PESCO, are

6. IED, *SHS Inventory, Diagnosis and Troubleshooting: pilot survey report from Vientiane Province*, October 2006.

geared toward planning and installation: the PESCO receives US$2 for each household which signs up and US$1 for installation. By contrast, the cost involved in collecting the monthly fee means that the PESCO barely breaks even (source: IED). Overall, being a PESCO (or a VEM) appears not to be that financially attractive. One PESCO withdrew and VOPS is having trouble recruiting in new provinces, though three new PESCOs were eventually established under REP in early 2007.

2.26 A further issue is the channel through which the service is delivered. Although the PESCO is a private company, the scheme is subsidized by Bank resources. But at the same time there is a private company that delivers SHS which has won several international awards, including one from the Bank's Development Marketplace. There is clearly not a level playing field. Sunlabob has received assistance (e.g. GTZ financed its initial training) but not on the scale of the subsidies to OGS/VOPS. In addition, Sunlabob has to pay other duty and taxes from which the government program is exempt. As a result the minimum monthly payment for a Sunlabob system is Kip 35,000, compared to Kip 10,000 for OGS/VOPS. It is telling that no Sunlabob trained engineers have applied to become PESCOs, suggesting that there is not money in it.

2.27 Is it appropriate for the Bank to subsidize a government program in direct competition with a private company? This is a question which need be confronted even if it is recognized that government's electrification targets are very unlikely to be met by relying on the private sector alone. The response under the Bank's follow-on Rural Electrification Project has been to make VOPS more commercially viable. To begin with, management of the scheme was contracted out. Although DOE retains oversight, a French company, IED, is responsible for implementation, allowing a greater degree of flexibility. IED has been discussing with the ministry the possibility of raising tariffs closer to commercial rates. While ensuring that operations are sufficiently financially attractive for the VEM and PESCO, steps have been taken to encourage VOPS to focus its activities on the less accessible and poorer regions that are less likely to attract commercial suppliers – hence leaving a market space for Sunlabob rather than acting in direct competition. This approach supports the government's goal of a 90 percent electrification rate by 2020.

Resettlement, environmental and social issues

2.28 SPRE did not require large-scale land acquisition or resettlement; there were only three substations constructed, all on land already owned by the government. A small length of high-voltage transmission line was built. These are meant to have a 30-metre channel cleared on either side of them, requiring land acquisition, some forest clearance, and a very small number of homes to be resettled. Distribution lines, which nearly all follow the line of the road in order to keep down installation costs, have a very small "footprint." However, government is meant to provide compensation per square meter of land used where appropriate.

2.29 The Resettlement Action Plan (RAP), prepared by the government before appraisal, was approved by the Bank. Some problems arose during implementation—there are differences of opinion about their nature and extent. The Bank's Implementation Completion Report, in line with supervision reports, states that some provincial authorities were unwilling to reimburse owners for land acquired for public works, as this was not normal practice. Where there was reimbursement it was not at the agreed rates. The report also notes that some provincial authorities were unaware of the RAP. On the other hand, EdL states that the disagreement arose over scrub land. They agree that the Plan allows for compensation but argue that it was not appropriate to compensate households for land in which the household had not invested. Following the visit of a resettlement specialist (and a revision of the Plan) a compromise was reached. Compensation was paid for scrub land, but the money went to the village fund rather than to the household. The independent evaluation report of the resettlement component, commissioned by EdL, takes a middle line. It notes that EdL and the provincial authorities were new to the idea of a RAP, accepting that there may have been misunderstandings at first and pointing to scrub land as the main bone of contention. But, the report goes on to argue, EdL did draw up the maps that would be needed to assess the terms of compensation and it did acquire the necessary expertise in resettlement planning.

Box 2 Voluntary resettlement in response to electrification: Don Khor village, Champasak Province

Don Khor village is situated on the banks of the Mekong, but some village families live on an island in the river. It will be uneconomic to extend the grid to the island, so in 2004 the PESCO supplied solar power which was taken up by all 34 island households. In 2006, the grid arrived in the mainland part of the village. Less than one year later 10 of the 34 households had relocated to the mainland.

Source: IEG field visit

2.30 For the reasons outlined in paragraph 2.28, the environmental impact of the project was slight, though not nil. The category B rating was therefore appropriate. The procedure is that once trees are identified for clearance, EdL notifies the Forestry Department which then sells the concession to a commercial company. According to the Forestry Law an equivalent area should be replanted elsewhere, but this does not appear to be monitored or enforced (although there are other schemes to encourage investment in tropical hardwoods, notably teak).

2.31 A final issue was the failure to enforce the safeguard for indigenous people. Many of those living in project areas are from minority ethnic groups. The Bank's Operational Directive (OD 4.20, now replaced by OP 4.10) required that an Ethnic People's Development Plan (EPDP) be prepared. No such plan was prepared, the appraisal report making no mention of the ethnic composition of the population in the project area. An EPDP has been prepared for the follow-on project, REP I, and this sets out a consultation process, in order to ensure that ethnic identity is respected.

2.32 The benefits from rural electrification are not to be denied, and are documented later in this report. However there is one issue not referred to in Bank discussions, which is that of involuntary resettlement. The government's position on resettlement admits of various interpretations. Government has in the past attempted involuntary resettlement, especially of people in remote areas. It is currently promoting a policy of "village clusters" to

facilitate service delivery. Clustering might entail some measurement of resettlement, potentially violating the terms of the new resettlement policy worked out with external agencies which does not permit involuntary resettlement. In some respects, government is complying. Communities on the far side of the new Theun 2 dam were encouraged by the government to resettle. But when they refused to do so the government agreed to provide them with off-grid electrification. It remains to be seen whether the resettlement policy will be honored in the long term. Rural electrification may still potentially provide a platform for involuntary resettlement. But at present rather the contrary is the case, with households voluntarily moving in order to be closer to the grid (Box 2).

Monitoring and evaluation

2.33 Project monitoring was oriented toward EdL performance, in particular monitoring of compliance with the performance contract. Information was also collected on the overall outputs from the project (connections). This report has already made some suggestions on the indicators used: specifically that system loss data should also be collected specifically for the project provinces; that outages should be included as a performance indicator; and that the self-financing ratio is not necessarily an appropriate measure of financial performance at times of aid-financed expansion. Overall, the monitoring system was satisfactorily incorporated into EdL's operations, was well focused and served the project well.

2.34 At appraisal there were no plans for a comprehensive evaluation; no survey was undertaken. There had been a baseline survey under the earlier Southern Provinces Electrification Project and government had felt that the benefits were so self-evident that there was no need for an end-line survey in that case. However a baseline survey was undertaken for REP I in 2004. EdL commissioned an evaluation of the RAP (see paragraph 2.29).

2.35 Monitoring and evaluation of the off-grid component was weak, so that the extent of technical problems was not appreciated until the survey carried out by IED in 2006 (paragraph 2.24). A systematic monitoring system has been introduced under VOPS.

3. Impact of rural electrification and economic analysis

3.1 The economic analysis in this PPAR is based on data collected in the project areas in 2004 as the baseline for the follow on project, REP. This analysis underpins the ERR analysis, which addresses the efficiency question. But the data also shed light on patterns of electricity coverage and usage.

Coverage and distribution of rural electrification in the Southern Provinces

3.2 The background documents for the baseline survey present data on the number of electrified households (Table 6). The first four columns show data for villages electrified by the three World Bank projects (though only the earlier years of SPRE) and other projects. The electrification rate is 31 percent in the seven provinces as a whole and 41 percent in

project areas (i.e. including those not yet reached under SPRE and REP 1). These figures rise to 43 percent and 69 percent respectively once the additional households electrified under SPRE by project close are included in the total. At the time of the survey, Bank-supported projects accounted for 60 percent of the electrification in rural areas of the seven provinces, rising to 69 percent including the additional households electrified under SPRE.

Table 6 Breakdown of households and villages

	Villages with electricity				*Villages not yet electrified*			
	SPE	***PGI***	***SPRE1A***	***Other projects***	***SPRE1B***	***REP 1***	***Not electrified***	***Total***
Villages	191	572	86	480	375	540	2969	5213
Households								
Electrified*	19661	46633	3508	46546	0	0	1264	117612
Non-electrified**	5110	11418	4258	14340	32917	48600	145015	261658
Total	24771	58051	7766	60886	32917	48600	194879	379270

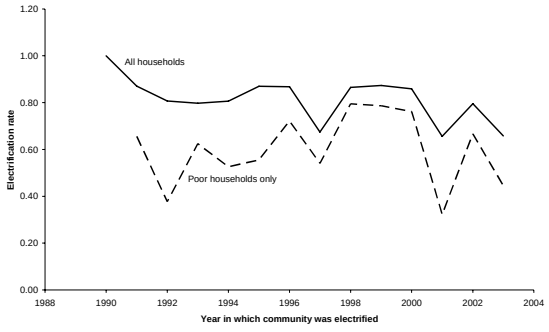
Source: REP baseline survey sampling document.

* 1264 households in "not electrified" row are off-grid.

**To be electrified or villages not yet electrified.

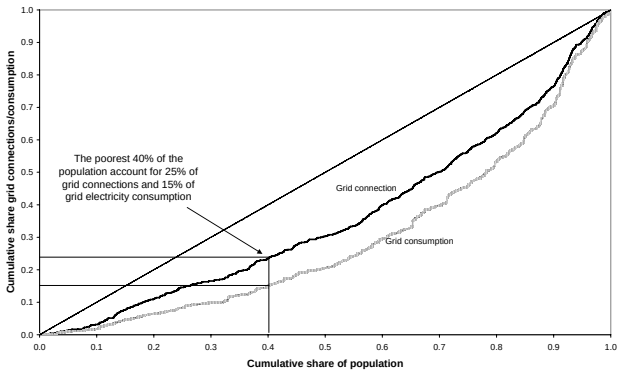
3.3 Just over three-quarters (77 percent) of households in electrified villages are electrified, with this rate being lowest in most recently connected communities (Figure 4). For most communities which were connected more than three years ago, 80 to 85 percent of households have a grid connection. Connection rates are, as expected, lower for poor households: 65 percent of poor households in electrified villages are connected to the grid. This bias in connections is shown in Figure 5, which shows the Lorenz curve for grid connections and electricity consumption. The bottom 40 percent of the population (ranked by a wealth index, see Annex B) have just one quarter of the grid connections and account for just 15 percent of consumption of electricity supplied by the grid.

Figure 4 Electrification rates by year of community grid connection



Source: REP 1 baseline data

Figure 5 Lorenz curves for grid connection and electricity consumption



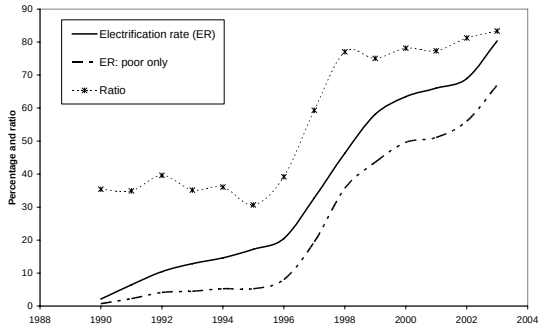
Source: REP 1 baseline data

3.4 However, the gap in the electrification rate between the poor and non-poor has closed over time. In the early nineties the electrification rate for the poor was only one-third

of that for the population as a whole, but then grew rapidly from 1996 to reach 80 percent by 2004 (see figure 6). This increase came about as electrification reached poorer villages, as shown by the poverty rate in communities by year of grid connection.

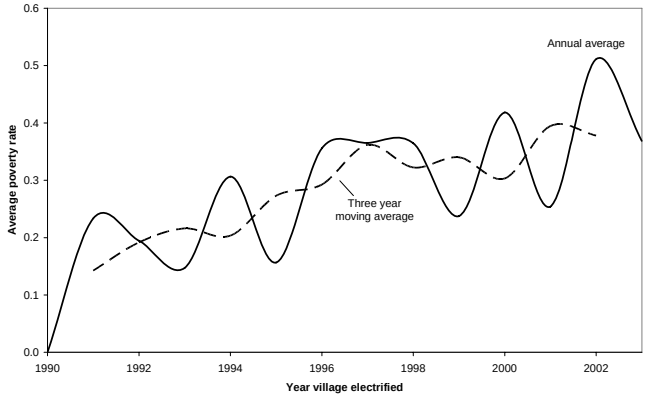
3.5 These results raise a question about which communities are connected. The Bank projects have begun from the main population centers, which are to the west of the country along the Mekong River, and then spread out from there, following the road in the interest of least cost. Regression analysis of the survey data confirms that villages nearer to roads and the provincial headquarters are more likely to be connected (see Annex B). More remote villages – those in mountainous areas or on river islands (see Box 2 above) – are less likely to be connected.

Figure 6 Electrification rates for villages electrified 1990 - 2004



Source: REP 1 baseline data

Figure 7 Community poverty rate by year of grid connection

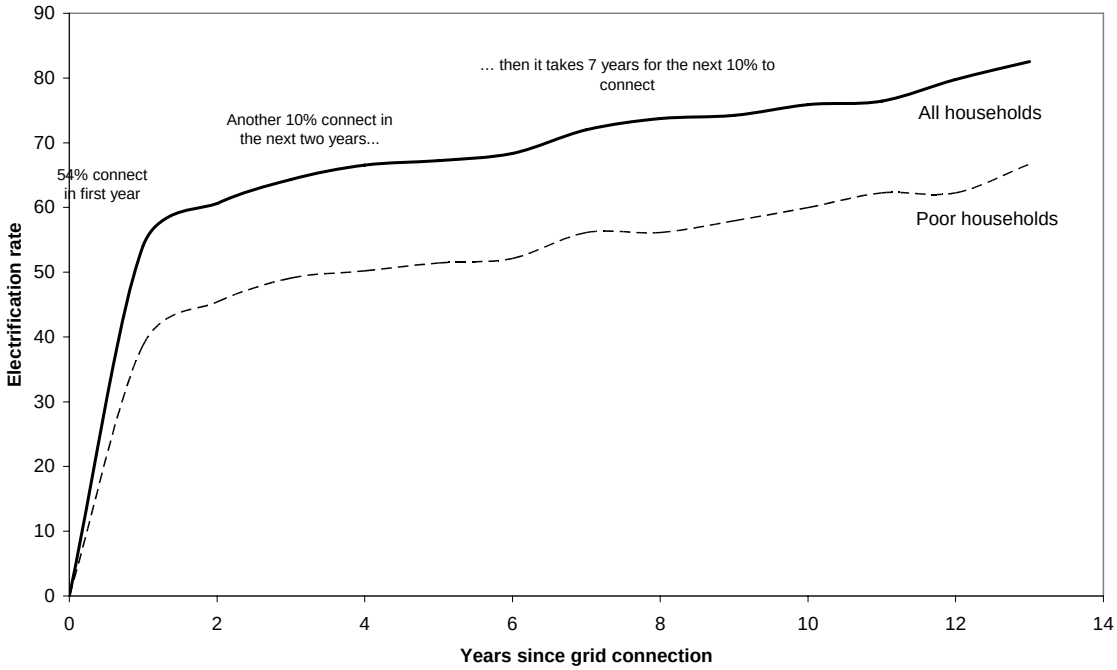


Source: REP 1 baseline data

3.6 Thus far, EdL has been increasing coverage by extensive growth (that is extending the grid to more communities) rather than intensive growth (that is expanding coverage to households in already connected communities). As shown in Figure 4, even in communities connected 10-15 years ago, there remain around one-fifth of households which are not connected. These are poorer households who cannot afford the connection fee of around US$100 (Kip 1 million). This pattern was evident under SPRE, when there was a substantial increase in the number of connected communities – 721 versus 520 planned at appraisal, a 39 percent increase, but a much smaller increase of less than 4 percent in the number of connected households (from 50,000 to 51,805). Analysis of the survey data shows that the vast majority of houses that will connect do so in the first year, with most of the remainder doing so in the following two years (Figure 8). Reaching the poorer households, who can be designated as "late connectors" will require some subsidy if government's target of 90 percent coverage is to be met.[7] Finding a way of doing this would be consistent with the Bank's energy strategy in which the first of four pillars is directly benefiting the poor.

7. Economic theory suggests that monopoly suppliers should practice price discrimination if they can segment the market. The market for electricity is readily segmented, since most households take the connection

Figure 8 Connection rate by years since grid reached village



Note: Graphs are based on fitted values from Cox (survival) regression. Sample is electrified households in electrified villages only.

Source: IEG analysis of REP baseline data

Uses of electricity

3.7 Lighting is the most common use for electricity: all electrified households get their light from this source. However, the majority of electrified households also have appliances that are less common in non-electrified households, notably TVs and fans, both of which are owned by over 70 percent of electrified households. Grid households watch 2.5 hours of TV a day on average, compared to less than 15 minutes for non-grid households. A significant minority of electrified households (27 percent) have rice cookers. But in general electrified households still use fuelwood for cooking purposes, though on average electrified household use less than do non-electrified ones.

3.8 There is less evidence of the use of electricity for productive purposes and it is not clear how many new enterprises have been created as a result of electrification. Less than 10 households covered by the REP baseline survey have separate workshops using electricity, and there is no evidence that these were set up as a result of electrification. There is one type of electricity-related enterprise that can be identified: the community at "the end of the line" operates battery charging centers

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immediately and are unlikely to wait. The connection subsidy could thus become available three years after the grid first reaches the community. Such a connection subsidy would qualify as a "smart subsidy" in recent terminology.

3.9 for areas not yet connected, though this business shifts once grid extension takes place.

4. Rate of return analysis

The financial rate of return (FIRR)

4.1 The financial rate of return is relatively straightforward. On the benefit side are the revenues earned from new electricity sales. On the cost side are the investment costs to create the new capacity and the O&M expenses for that capacity. Given the assumptions stated in the ICR, a financial rate of return of 6.5 percent is obtained (Annex C). This is the real return, so it is more than sufficient to service the credit, which government on-lends to EdL at 7 percent (a real interest rate of zero at the current inflation rate). Since the tariff increases are index linked, this return should be protected --unless average real tariffs are allowed to fall below cost recovery at some point in the future. In addition, there is no explicit treatment of system losses in the analysis. It should be assumed that the data build in the existing level of losses, at 20 percent in 2004. Achieving a reduction in these losses to 12 percent (a 3 percent reduction in system losses a year) will increase the financial rate of return to 7.0 percent. The financial rate of return to off-grid investments is 15.9 percent (ICR calculation), reflecting the fact that this is a subsidized program.

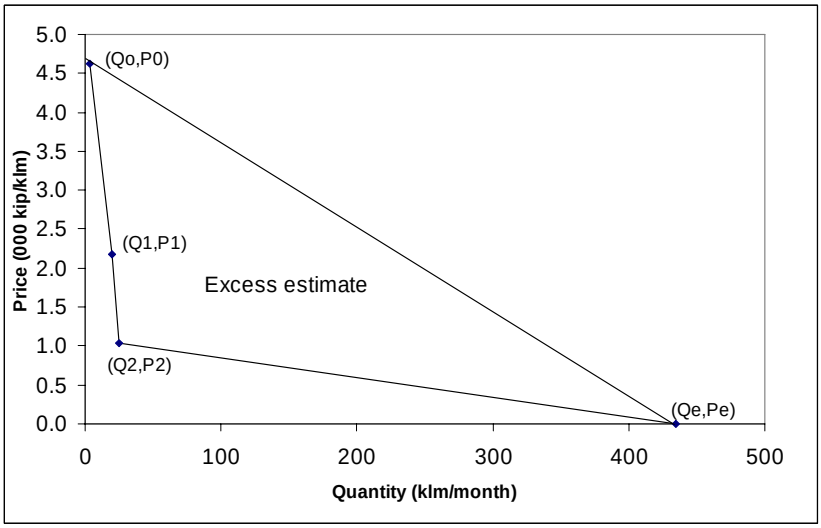
The economic rate of return

4.2 The ICR estimates the rate of return to the grid extension component to be 60.5 percent, compared to the appraisal estimate of 22.8 percent. This higher rate of return is attributed to a higher willingness to pay (WTP) than anticipated at appraisal. The WTP estimate is based on the survey data from 2004. These data were also used as the appraisal estimate for REP; the appraisal report presents the calculations in more detail. The latter analysis estimates that the WTP for grid connection for lighting alone is US$72 per month per household (equal to US$866 per year although the SPRE ICR takes a lower figure of US$584). This is a remarkably high figure, rather in excess of the total income of many households in the area, though it is commonly recognized that households are generally willing and able to devote up to 10 percent of their income to energy needs. The high estimate comes from an error in the calculation of the WTP.

4.3 The most common means of calculating WTP is to obtain two data points on the demand curve: the price and quantity of consumption with electricity and with the main fuel source (usually kerosene) of non-electrified households. The demand curve is interpolated between these two points, preferably by assuming a constant elasticity of demand, so that the area under the demand curve can be calculated as the willingness to pay. The Lao survey allowed observation of four, rather than two, data points, corresponding to those using candles and lamps, those using car batteries, those using a mixture of these sources, and those with access to electricity. As shown in Figure 9, joining these four points gives a reasonably shaped demand curve.

4.4 However, the WTP calculation did not generate the demand curve from joining the four points. Rather it estimated the WTP from three separate linear demand curves, each created by joining the respective unelectrified option to the electricity (price, quantity) point, resulting in a substantial over-estimation of WTP. Table 7 shows the derivation of the PAD/ICR estimate of US$72, and estimates using the same underlying data assuming a single demand curve (US$23) and a single demand curve in which interpolation between the points assumes constant elasticity (US$6). This final estimate of US$5.60 seems far more plausible and is the figure used here.

Figure 9 Demand curve for lighting



Source: derived from REP PAD, p.69

Table 7 Different estimates of the WTP for lighting (US$/household/month)

	Multiple demand curves	***Single linear demand curve***	***Single demand curve with constant elasticity segments***
Candle and lamp users	90.6	24.68	7.18
Candle, lamp and battery users	44.4	19.69	2.92
Car/motor cycle battery users	21.2	18.89	2.16
Total (weighted average benefit)	72.13	22.78	5.56

Source: IEG calculations.

4.5 The revised estimate can be checked for plausibility in a number of ways. Compared to the ICR figure of US$585, the PPAR figure is well less than 10 percent of household income rather than nearly all of it. As the ICR itself says a number of times, many households can only afford to pay US$1-2 a month, though the survey shows that on average unelectrified households pay US$3, and IEG calculation suggest that they would be willing to pay US$5.60, which is higher but plausibly so. Other sources of data can help triangulate IEG's WTP estimate. First the 2004 survey data used to estimate WTP in the ICR also contained two direct questions on WTP. The first of these was whether or not the household would be willing to pay for electrification if the cost were 1,000,000 kip (approximately

US$100),[8] to which the majority of households (57 percent) replied in the negative. A second question asked those not willing to pay 1,000,000 kip how much they would pay, to which the median answer was 500,000 (US$50). A second source of information comes from the break during project, during which supplies of project-supplied light bulbs ran out. Anecdotal evidence is that many households chose not to replace the bulbs through commercial purchases (costing around US$7, compared to the project-supplied price of US$3.50), preferring to go six months without electricity than pay this additional amount.

4.6 The revision of WTP has, of course, affected the ERR quite considerably. Using IEG's estimate of the WTP decreases the ERR for the grid extension component from 60.5 (ICR estimate) to 12.6 percent (Table 8). The return to the off-grid component is adversely affected by not only the lower willingness to pay estimate, but also because actual hours of electric power fall considerably short of that planned because of the technical problems outlined above. The combination of these factors reduces the ERR for the off-grid component to 1.5 percent (see Annex C). In consequence the ERR for the whole project is 12.1 percent.

Table 8 Estimates of the Economic Rate of Return

	PAD	***ICR***	***PPAR***
Grid extension	22.8	60.5	12.6
Off-grid component	14.0[1]	26.0	1.5
Whole project	21.6[2]	59.1	12.1
Notes: 1/ PAD presents separate ERRs for different off-grid options, that for solar home systems is reported here as all but one village have adopted this technology. 2/ Not reported in PAD, the figure given is an average, weighted by the cost of the respective components.			

5. Ratings and lessons learned

Outcome: Moderately satisfactory

5.1 Relevance: The project was highly relevant, and remains so, being consistent with both the 1996 and 2005 Country Assistance Strategies. In the latter, electrification is listed under improving infrastructure to support regional integration and private sector development. Government is strongly committed to electrification, having adopted a target of 90 percent electrification coverage by 2020. Rural electrification is seen as a supporting sector for growth in the 2004 Poverty Reduction Strategy Paper (PRSP), and electrification explicitly listed in the priority sectors for poverty reduction. The off-grid component, added at appraisal, has helped electricity reach more remote communities which would otherwise have been excluded. However, the design did not explicitly address how to encourage connections amongst poor households.

8. Although the exchange rate fluctuates, many prices in Lao are quoted in dollars but paid in kip at the exchange rate of US$1=10,000 kip.

5.2 Efficacy: The IEG definition of efficacy is where the project objectives are met, which they were for the physical aspects of the project (with targets being exceeded), showing also the success of the project in meeting ID objectives related to technical support. But the objective of EdL operating on a commercial basis was not met in the lifetime of the project, though the basis was laid for this to be achieved at a later date. Similarly, the off-grid component achieved its physical objectives. But the aim of providing these services on a cost recovery basis was not achieved, and it has proven difficult to stimulate private sector interest in the project – despite the fact that there is a private sector firm also in operation.

5.3 Efficiency: The ERR for the grid extension component was at the threshold, and that of the off-grid component well below it, with an overall average return also at the threshold. In aggregate, the project was efficient at providing electricity to rural households because of the focus on grid extension. However, the off-grid component can be considered justified, despite the low ERR, as it was a pilot which will provide lessons for the future.

5.4 Taking into account relevance, efficacy and efficiency with respect to the two project objectives, the overall outcome rating is Moderately Satisfactory (see Table 9 for summary).

Table 9 Summary of outcome ratings

	Objective	
	System expansion	***Institutional development***
Relevance	High: Rural electrification a GoL priority, and contained in CAS	High: EdL needs to be put on sounder financial footing for program to be sustainable
Efficacy	High: Physical targets exceeded	Low: Targets not met during project, though basis laid for subsequent improvements
Efficiency	Moderately satisfactory for grid, failure to reduce system losses. Off-grid ERR below threshold.	Low as efficacy was low.
Overall outcome	Satisfactory	Unsatisfactory

Risk to development outcome: Low

5.5 The principal source of risk is the financial sustainability of EdL's operations. The Financial Recovery Program has put in place a program, agreed with government, to tackle this problem. With the agreed program of tariff increases, tariff rates will be at a level to achieve cost recovery and a return on capital. There has not been social resistance to these increases, partly since tariffs had initially fallen substantially in real terms, and remain around the average for the region.

Bank performance: Satisfactory

5.6 As stated in the ICR, project preparation was sound. Agreement of the performance contract between EdL and government was a condition for negotiations, though in the event

proved insufficient to ensure adequate steps being taken, which only finally happened once the project was underway and the Financial Recovery Program was proceeding. Bank staff kept up pressure on this issue; but without compromising the pace of overall project implementation.

Borrower performance: Moderately Satisfactory

5.7 Borrower performance was sound with respect to grid extension—where a sizeable expansion was accompanied by significant cost savings; and establishment of a successful off-grid program, albeit with some technical problems. However, overall borrower performance is rated as only moderately satisfactory on account of the time taken to resolve EdL's financial problems, leaving most financial performance indicators unmet at the close of the project, and the technical problems in both grid and off-grid components. This rating is lower than that in the ICR. However, the ICR's rating, which indicates a more positive view of the financial performance issue, appears based on developments which have largely taken place since SPRE closed. The assessment in this PPAR is based on actions taken during the lifetime of the project.

Lessons learned

5.8 **Consumers are willing to pay tariffs at cost recovery levels**. The willingness to pay analysis shows that consumers are willing to pay for electricity at levels exceeding supply costs. Lao PDR has been able to implement sizeable tariff increases in a short space of time with no adverse social impact or notable demand reductions (indeed it can be argued that any reduction in usage by already connected customers helps extend supply to new locations). Tariffs have already reached historical highs, and will reach full cost recovery for short run marginal cost (O&M) plus a return on capital by 2011 – the WTP calculations show that these levels will be acceptable to consumers.

5.9 **But poorer households remain unconnected**. Even after the grid has been in a village for more than 10 years some 20 percent of households remain unconnected. Smart connection subsidies for late connectors would help achieve government's 90 percent coverage target.

5.10 **Explicit attention needs to be paid to technical efficiency**. Technical problems of system losses and outages reduce financial performance and undermine project benefits. Explicit components are needed to tackle these issues.

5.11 **Off-grid components promote social equity in electrification coverage… but are not necessarily the most cost effective strategy.** The off-grid component has helped reach remote communities which would not otherwise have got electricity for a decade or more. However, the rate of return to these investments is lower than that to grid extension, or of subsidizing connections for late connectors, and it not proven that the beneficiaries from off-grid programs are poorer than those benefiting from grid extension.

5.12 In countries where the private sector is relatively undeveloped substantial support may be required to provide off-grid services in poor areas. At the same time subsidies should

not crowd out purely commercial actors. A sensible balance would direct project supported companies to the more remote areas unlikely to be attractive to purely commercial firms, but the subsidy scheme needs to ensure that such activities are sufficiently attractive.

Annex A. Basic Data Sheet

LAO SOUTHERN PROVINCES RURAL ELECTRIFICATION PROJECT

Data *(amounts in US$ million)*

	Appraisal estimate	*Actual or current estimate*	*Actual as % of appraisal estimate*
Total project costs	39.3	40.8	105
Loan amount	34.7	34.4	99
Cofinancing	0.74	0.7	100
Cancellation	-	0.2	-

Cumulative Estimated and Actual Disbursements

	FY99	*FY00*	*FY01*	*FY02*	*FY03*	*FY04*	*FY05*
Appraisal estimate (US$M)	2.2	7.7	15.2	23.8	31.7	34.7	34.7
Actual (US$M)	1.0	2.8	9.7	17.5	24.5	31.9	34.4
Actual as % of appraisal	45	36	64	74	77	92	99
Date of final disbursement: FY2006							

Project Dates

	Original	*Actual*
Project concept note	-	07/12/1996
Appraisal	-	02/15/1998
Board approval	-	03/17/1998
Effectiveness	08/29/1998	08/12/1998
Mid-term review	6/30/2001	04/11/2002
Closing date	6/30/2004	12/31/2004

Staff Inputs (staff weeks)

Stage of project cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation	42.5	250.0
Appraisal/Negotiation	14.7	86.3
Supervision	82.9	487.9
ICR	6.3	32.5
Total	146.4	856.6

Mission Data

Stage of Project Cycle	No. of Persons and Specialty		Performance Rating	
Month/Year	Count	Specialty	Implementation Progress	Development Objective
Identification/Preparation				
2/25/97	*4*	MISSION LEADER (1); SR POWER ENGINEER (1); FINANCIAL ANALYST(1); RENEWABLE ENERGY SPEC (1)		
Appraisal/Negotiation				
12/16/97	*4*	MISSION LEADER (1); FINANCIAL ANALYST(1); ENERGY ECONOMIST (1); ENVIRONMENTAL SPEC (1)		
02/11/98	*1*	TASK TEAM LEADER		
Supervision				
10/13/98	*3*	ENERGY ECONOMIST (1); FINANCIAL ANALYST (1); RENEWABLE ENERGY SPECIALIST (1)	S	S
02/12/99	*2*	ENERGY ECONOMIST (1); FINANCIAL ANALYST (1)	S	S
05/24/99	*2*	TASK MANAGER (1); ENGINEER (1)	S	U
11/11/99	*3*	TASK MANAGER (1); FINANCIAL ANALYST (1); POWER ENGINEER (1)	S	U
03/17/00	*4*	TASK TEAM LEADER (1); RESETTLEMENT SPECIALIST (1); RENEWABLE EGY.SPECLST. FINANCIAL ANALYST (1)	S	U
09/28/00	*2*	TASK TEAM LEADER (1); FINANCIAL ANALYST (1)	S	U
02/02/01	*3*	TASK TEAM LEADER (1); RENEWABLE ENERGY SPEC. (1); RURAL ENERGY SPEC. (1)	S	U
04/11/02	*5*	TASK TEAM LEADER (1); HYDROPOWER ENGINEER (1); POWER ENGINEER (1); FINANCIAL ANALYST (1); RENEWABLE ENERGY SPEC. (1)	S	S
02/14/03	*6*	TASK TEAM LEADER (1); SR.OPERATIONS OFFICER (1); FINANCIAL ANALYST (2); ENVIRONMENT SPECIALIST (1); RESETTLEMENT/LAND ACQ. (1)	S	S
10/03/03	*4*	SR. POWER ENGINEER (1); FINANCIAL SPECIALIST (1); RESETTLEMENT SPECIALIST (1); ALTERNATIVE ENERGY SPEC.	S	S
05/11/04	*7*	TASK TEAM LEADER (1);	S	S

	10/04/04	*3*	POWER ENGINEER (1); ALTERNATIVE ENERGY SPEC. (1); RESETTLEMENT SPEC. (1); ENERGY SPEC. (1); FINANCIAL ANALYST (1); PROCUREMENT ASSISTANT (1) TASK TEAM LEADER (1); PROCUREMENT SPEC. (1); ENERGY SPECIALIST (1)	S	S
ICR	01/24/05	*3*	TASK TEAM LEADER (1); PROCUREMENT SPEC. (1); ENERGY SPECIALIST (1)	S	S

Other Project Data

Borrower/Executing Agency:

FOLLOW-ON OPERATIONS

Operation	*Credit no.*	*Amount (US$ million)*	*Board date*
Rural Electrification Project 1		36.27	04/27/2006

Annex A

Annex B. Analysis of RE I baseline data (2004)

Description of survey

The survey was carried out in the seven provinces covered by SPRE I and REP 1. The sample was divided into four groups (Tables 1 and 2). Group 2 comprised households electrified under earlier projects (SPE, PGI or SPRE), group 3 was non-electrified households in the same community and group 4 was made up of households in villages to be electrified under REP 1. Finally Group 1, considered the baseline, was made up of households in villages scheduled for electrification under SPRE but not yet reached. Electrification here refers to grid connection. The sample included a small number using solar home systems (SHS) or pico-hydro, and a substantial number obtaining electricity from car batteries.

Table B. 1 Survey design

	Electrified village	Non-electrified village
Electrified household	G2: 1,000 (actual: 1,043) households	
Non-electrified household	G3: 1,000 (actual: 818) households	G1: 500 (actual: 428) households G4: 1,000 (actual: 915) households

Table 2 shows the number of villages and households under the various projects. The sample design was also stratified for province and project but in a way that was self-weighting. Therefore survey weights need only be used to join the different groups together into a single sample. Doing so gives a sample which is representative of the areas surveyed, i.e. past and current project areas. The sample is not representative of rural areas in the seven provinces since no data were collected from non-project villages. These data cannot be used for analyzing inter-community targeting, nor for estimating access to electricity.

Table B. 2 Breakdown of households and villages

	Villages with electricity				***Villages not yet electrified***			
	SPE	***PGI***	***SPRE 1A***	***Other project***	***SPRE1B***	***REP 1***	***Not electrified***	***Total***
Villages	191	572	86	480	375	540	2969	5213
Households								
Electrified*	19661	46633	3508	46546	0	0	1264	117612
Non-electrified**	5110	11418	4258	14340	32917	48600	145015	261658
Total	24771	58051	7766	60886	32917	48600	194879	379270

Source: REP baseline survey sampling document.
* 1264 households in "not electrified" row are off-grid.
**To be electrified or villages not yet electrified.

The total electrification rate in the seven provinces is 30 percent as shown in Table B. 2 and B. 3, whereas it is 40 percent in Bank project areas alone if including those villages not yet reached under SPRE and REP 1 – a discrepancy which illustrates that the sample is not representative of the provinces as a whole. Table B. 3 also shows that, at the time of the survey, Bank-supported projects accounted for 60 percent of the electrification in rural areas of the seven provinces surveyed.

Table B. 3 Electrification rates in all seven provinces, by project

	(1) Households electrified by project	*(2) (1) as % of electrified households*	*(3) (1) as % total households*
SPE	19,661	17	5
PGI	46,633	40	12
SPRE1A	3,508	3	1
Other	46,546	40	12
Total	116,348	100	30

Source: Table 2

Sources of energy

Table B. 4 shows the sources of energy. The main points are as follows: (1) there is negligible use of pico-hydro, photo-voltaic systems (PVS), and small-generators, certainly too few to analyze these users statistically; (2) grid households reduce their use of kerosene/diesel and car batteries for lighting once they are connected to the grid[9]; and (3) electrified households continue to use firewood (for cooking).

Table B. 4 Percentage of households using each energy source

	Non-grid	*Grid*	*All*
Small generator	0.5	0.0	0.3
Pico-hydro Mini	0.5	0.0	0.3
PVS	0.9	0.0	0.5
nCar battery	37.5	1.6	21.9
Firewood	94.4	80.3	88.3
Kerosene	0.7	0.3	0.5
Diesel	89.8	12.9	56.5
Candle	5.6	7.7	6.5
Grid	0.0	100.0	43.3
No. of households	2,152	1,029	3,181

Note: Sums to over 100% as households use more than one source.
Source: Household survey

Energy consumption can also be shown in a common metric, such as kg of oil equivalent (koe, see Table B. 5). Electrified households consume more than twice as much energy as non-electrified ones. This is partly an income effect, but also because electrified households pay much less for their energy (Table B. 6) – this is the "unequalising effect of electrification" whereby the better off capture the bulk of the benefits.

9. Kerosene is little used; most of the households shown in this row consume diesel.

Table B. 5 Consumption of different fuels, koe/household/month

	Non-grid	*Grid*	*All*
Firewood	56.8	39.4	49.2
Charcoal	5.6	9.6	7.4
Diesel and kerosene	8.1	1.4	5.2
Candles	0.0	0.0	0.0
Car batteries	2.3	0.3	1.3
Small generator	0.0	0.0	0.0
Electricity	0.0	61.4	26.6
o/w lighting	0.0	2.4	1.0
appliances	0.0	59.0	25.6
Total	72.8	173.5	116.3

Source: household survey

Once income is taken into account, electrification increases energy consumption by 35 percent as shown by the regressions reported in Table B. 7. There is a small, just significant, difference in the use of firewood and charcoal by grid connected households (Table 6), reflecting the use of electric rice cookers by these households (Table B. 8).

Table B. 6 Energy expenditure and the cost of energy

	Expenditure (kip)			*Price*	
	Non-grid	*Grid*	*All*	*kip/koe*	*US$/koe*
Firewood	48,652	33,808	42,225	858	0.08
Charcoal	2,551	9,119	5,395	729	0.07
Diesel and kerosene	27,702	5,486	18,083	3,471	0.31
Candles	8,000	8,000	8,000	562,703	50.21
Car batteries	9,062	412	5,317	4,090	0.36
Small batteries	836	42	492	4,665,319	416.25
Electricity	-	9,317	4,034	152	0.01
Total	96,804	66,184	83,546	718	0.06

Table B. 7 Regression of fuel consumption on income (logged) and grid connection

	Biomass		*Total*	
Intercept	2.50	***	1.4	***
	(16.92)		(6.35)	
Income	0.11	***	0.20	***
	9.04		(11.13)	
Grid	-0.04	*	0.35	***
	(-1.66)		(9.68)	

Note: OLS with robust standard errors. Source: survey data

Uses of energy

Appliances

The most common appliances are TV and fan, which are owned by almost 80 percent of households connected to the grid and one-third of those using car batteries (Tables B. 8 and B. 9). Of course there is also an income factor in the ownership of these items – but a probit regression shows that being

connected to the grid increases the likelihood of owning a TV by 84 percent (Table B. 10).[10] The result is that TV usage is, on average, over 2.5 hours a day in grid-connected households compared to less than 15 minutes for unconnected households. Comparing TV owners only, the difference is smaller, but still substantial and significant. On the other hand, grid connection has no significant impact on radio ownership or usage.[11]

Table B. 8 Ownership of electricity-related consumer goods

	Non-grid	*Grid*	*Total*	
TV	12.93	78.15	41.16	***
Radio	19.27	15.25	17.53	
Fridge	0.00	52.54	22.74	***
Rice cooker	0.00	26.90	11.64	***
Fan	0.00	72.48	31.37	***
Iron	0.00	52.54	22.74	***
Memo items:				
Daily TV usage (hours)	0.24	2.56	1.25	***
for owners only	1.86	3.29	3.03	***
Daily radio usage	0.38	0.40	0.38	

Note: final column is t-stat on difference in proportions. *** indicates significant at the 1% level. Source: survey data.

Table B. 9 TV and radio ownership by source of electricity

	TV	*Radio*
Grid	78.2	15.3
Car battery	35.8	31.8
Alternative energy	23.8	33.3
Small generator	10.5	25.0
All households	41.2	17.4

Source: survey data

Table B. 10 Probit regression of TV and radio ownership on wealth index (log) and electricity source

	TV			Radio		
	dF/dX	t-stat		dF/dX	t-stat	
Wealth (log)	0.31	7.78	***	0.14	5.4	***
Grid	0.84	35.12	***	0.00	-0.02	
Alternative energy	0.23	1.58		0.12	0.59	
Car battery	0.65	12.48	***	0.18	4.68	***

Children's homework

Data are available on how long children spend doing homework each evening. This is given as an average for all children in the household. Hence the relevant sample is households with children of

10. Interpreting the probit may seem odd when non-electrified households cannot have TV. Another way of doing the calculation is as follows. In a non-grid community, one-third of households use car batteries, and one third of these (i.e. one-ninth of the community) own TVs. Once the community is connected to the grid then 80% of households acquire TV, which is an incremental increase of 69%.

11. This finding is consistent with a weak relationship between electrification and radio ownership in cross-country data.

school age who are attending school, so the model needs to correct for sample selection bias. The selection equation is identified with distance to school. Other conditioning variables for homework are household income and parental education, plus the number and age of the children. Lighting source does not have a significant impact on time spent doing homework (see table 11).

Table B. 11 Determinants of average homework time each evening

	Children		Adult	
	Propensity to study	Study Time	Propensity to read	Read Time
Wealth	0.27*	1.10*	0.78***	-0.14
Education (no. of years) of head	0	0.10***	0.08***	0.11***
Age of the head (log)	-0.09		0.14	
Occupation of head of household				
Farmer	0.02	0.38	-0.12*	-0.2
Home business	0.19**	0.38	0.13	0.14
Children in the household				
Number		0.71***		-0.19***
Child of more than 10 years age (0/1)		2.79***		
Children in school (0/1)	1.07***			
Household size			0.04***	
Source of Light:				
Grid	0.14**	1.12***	0.14*	0.43**
Kerosene		-0.44**		-0.38**
Candle		-0.22		0.2
Others		-0.25		0.68**
Regional Dummies Suppressed				
Constant	-0.4	-4.56***	-1.65***	2.34***
Observations		1992		1992
Wald Chi		407.65***		95

Source: ESMAP (2000)*

* ESMAP (2002) *Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits*, Report 255/02. The analysis is based on data collected from 2000 households in four regions of the island of Luzon.

Who has electricity? Determinants of grid connection.

There are two aspects to this: (1) being in a community which is connected, and (2) taking the connection.

Community level connections

The first question can be analyzed using community level data, and is a function of ease of access to the community and its wealth – we should expect this to be the case as most companies used a financial return decision rule which accounts for costs (ease of access) and expected benefits (number of connections, which is a function of wealth).

There are three aspects of location. First, the grid has been extended from provincial headquarters in stages. Towns and areas close by were electrified under PGI, the lines extended under SPRE and the lines are being extended further still under REP 1. These extensions mostly follow the main roads,

helping to reduce construction costs. In Champasak, for example, many villages are along the Mekong river, whereas the road south is some 10-20 km east of the river. Hence many of these villages were missed under SPRE, though lines were run to them for larger villages, and more are being "filled in" under REP 1. Three factors are important: distance to district headquarters, distance to road, and size of village. A second factor is village income, since utilities connect those communities which can afford the connection (meaning that at least 60 percent of villagers are projected to connect). In practice this factor may not matter, since, as outlined elsewhere, the cost of electricity is less than that of alternative energy sources, so the 60 percent target is likely to be met in all communities, though there will be non-connectors who cannot afford the connection fee. The final factor is locational: it is not economic to connect smaller island communities or those in mountainous regions. These are the areas unlikely to get a grid connection in the next ten years which are targeted by the off-grid program. Unfortunately the questionnaire did not collect information on these variables. However, ethnicity can be a proxy for living in a mountainous region, with the Lao Tueng in particular living in more mountainous regions.

The model was estimated using probit (community connected to grid or not) and tobit (proportion of community which is connected). The community size variable is positive and significant, and distance to district capital significantly negative. Distance to road is negative but insignificant; but the variable is correlated with distance to the district capital and when that variable is dropped the distance to the road becomes significant.

Table B. 12 Determinants of community connection

	Probit			***Tobit***		
	Coefficient	***t-stat***		***Coefficient***	***t-stat***	
Proportion poor	0.65	0.24		0.19	0.48	
No. of households	0.00	0.01	***	0.00	0.03	**
Village layout (reference category: dense)						
Community along road	0.54	0.15		0.23	0.17	
Scattered community	-0.05	0.90		-0.06	0.71	
Hamlet						
Hamlet population	0.00	0.80		0.00	0.40	
Distance to hamlet	0.01	0.73		0.01	0.56	
Ethnicity (reference category Lao Lum)						
Lao Sung	-0.89	0.43		-0.48	0.29	
Lao Tueng	-1.71	0.00	***	-0.89	0.00	***
Village location						
Distance to HQ (logged)	-0.45	0.00	***	-0.16	0.01	***
Distance to read (logged)	-0.12	0.14		-0.04	0.23	
Intercept	0.58	0.22		0.28	0.19	
No. of observations	148			148		

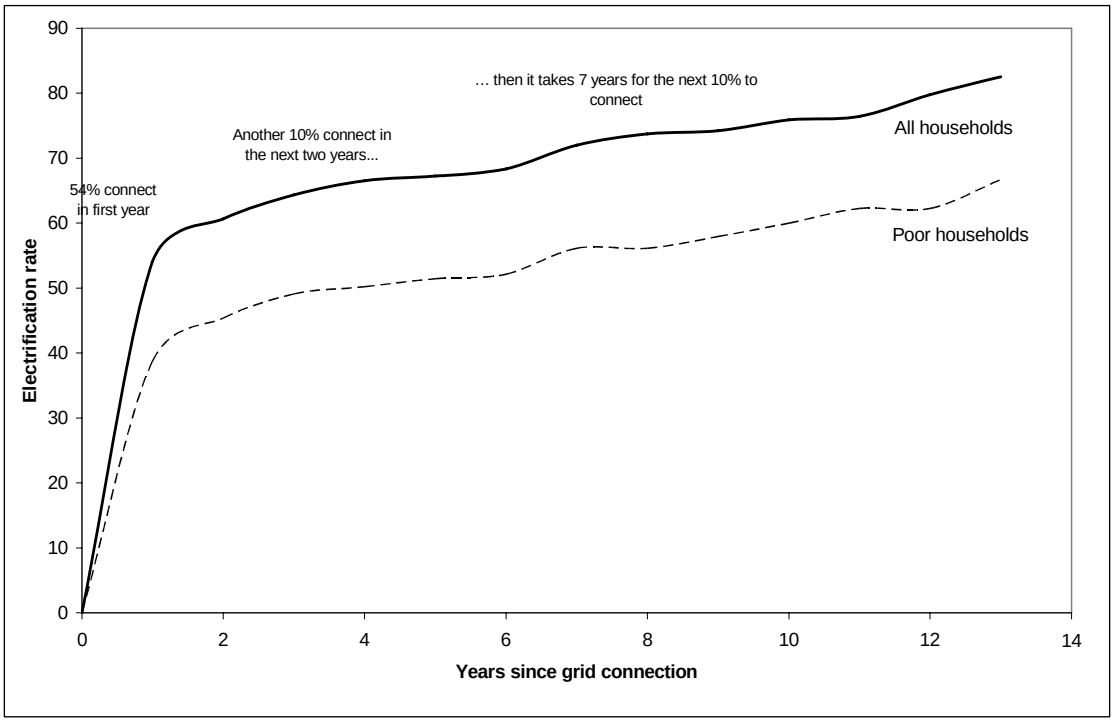
Note: ** significant at 5%, *** significant at 1%

Household connection decision

Whether a household decides to connect to the grid once it is available in the community is a function of wealth. This is so since, although electricity is available, the poor may not be able to afford the service, high connection charges being a frequent barrier. In Lao PDR it is estimated that 30 percent of the population cannot afford the connection charge of $100.

The implications are that those who can afford to do so connect to the grid once it becomes available, though they may retain off-grid sources as a backup in case of power outages, whilst others may wait many years to connect. Figure B. 1 shows that around 60 percent of households in Lao PDR connect within the first year; the vast majority of households that will connect do so in the first three years of the grid reaching the community.

Figure B. 1 A Large Proportion of Households Connect to the Grid Immediately When it Becomes Available - But Some Remain Unconnected after Many Years



Source: REP I baseline data

Annex C. Economic Rate of Return

Grid extension

As discussed in the main report, the ICR calculation relies on the calculation in the PAD for REP I. That analysis used three separate linear demand curves to give a willingness to pay (WTP) of US$72 per household per month. Using instead a single, constant elasticity demand curve, gives a WTP of US$5.60 per household per month. This figure is 11.4 percent of the WTP used in the ICR. Hence the IEG calculation takes the WTP to be 11.4 percent of that given in the ICR, although this is not reduced as consumption expands as is done in the ICR (this in turn results in a small over-estimate for IEG calculations whereas the ICR approach gives an under-estimate). Using this lower estimate of WTP reduces the ERR to 12.6 percent.

Table C.1. Grid component economic rate of return (US$)

	Energy sales (GWh)	Consumer surplus = SalesxWTP	Tariff	Revenue	Investment cost	Energy cost = salesx61.24	O&M	Total cost	Producer surplus	Net benefit
1998	0.00		0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
1999	0.00		0.00	0.00	0.11	0.00	0.00	0.11	-0.11	-0.11
2000	0.00		0.00	0.00	4.21	0.00	0.09	4.30	-4.30	-4.30
2001	0.00		0.00	0.00	6.98	0.00	0.23	7.21	-7.21	-7.21
2002	0.00		0.00	0.00	7.36	0.00	0.37	7.73	-7.73	-7.73
2003	30.80	1.38	37.80	1.16	5.6	1.89	0.49	7.97	-6.81	-5.43
2004	72.27	3.24	48.28	3.49	0.89	4.43	0.50	5.82	-2.33	0.91
2005	84.08	3.76	49.06	4.13	0	5.15	0.50	5.65	-1.53	2.24
2006	97.87	4.38	49.86	4.88	0	5.99	0.50	6.50	-1.62	2.77
2007	113.92	5.10	50.66	5.77	0	6.98	0.50	7.48	-1.71	3.39
2008	119.62	5.36	51.49	6.16	0	7.33	0.50	7.83	-1.67	3.69
2009	125.60	5.62	52.32	6.57	0	7.69	0.50	8.19	-1.62	4.00
2010	131.88	5.91	53.17	7.01	0	8.08	0.50	8.58	-1.57	4.34
2011	138.47	6.20	54.03	7.48	0	8.48	0.50	8.98	-1.50	4.70
2012	145.39	6.51	54.03	7.86	0	8.90	0.50	9.41	-1.55	4.96
2013	152.66	6.84	54.03	8.25	0	9.35	0.50	9.85	-1.60	5.23
2014	160.30	7.18	54.03	8.66	0	9.82	0.50	10.32	-1.66	5.52
2015	168.31	7.54	54.03	9.09	0	10.31	0.50	10.81	-1.72	5.82
2016	176.73	7.91	54.03	9.55	0	10.82	0.50	11.33	-1.78	6.14
2017	185.56	8.31	54.03	10.03	0	11.36	0.50	11.87	-1.84	6.47
2018	194.84	8.72	54.03	10.53	0	11.93	0.50	12.44	-1.91	6.82
2019	204.58	9.16	54.03	11.05	0	12.53	0.50	13.03	-1.98	7.18
2020	214.81	9.62	54.03	11.61	0	13.16	0.50	13.66	-2.05	7.57
2021	225.55	10.10	54.03	12.19	0	13.81	0.50	14.32	-2.13	7.97
2022	236.83	10.60	54.03	12.80	0	14.50	0.50	15.01	-2.21	8.39
2023	248.67	11.13	54.03	13.44	0	15.23	0.50	15.73	-2.30	8.84
2024	261.11	11.69	54.03	14.11	0	15.99	0.50	16.49	-2.39	9.31

Off-grid component

The ICR reported an ERR of 26 percent. The analysis in this report makes two adjustments to the calculation. First, as argued for grid connections, consumer surplus is over-estimated. For off-grid connections this surplus is estimated at US$90.59 a year, equivalent to US$7.55 a month; this is more than the IEG estimate for the consumer surplus from grid connection, which is not plausible. However, insufficient information is available on the method of calculation of the consumer surplus to re-estimate it as was done for grid connections. Two approaches are used here. The first, as an upper-bound, is to use the same consumer surplus as that calculated for grid connections, which was US$5.60 a month, equal to US$67.20 a year. The lower bound is to take the same percentage of the ICR's consumer surplus as that from the grid estimate, which was roughly 10 percent (5.60/584.7=9.5%), i.e. US$9.06 a year. Making this adjustment gives an upper bound of the ERR of 19.9% and a lower bound of -1.7%. A final alternative approach is to assume that a linear demand curve was used in the consumer surplus calculation. Adjusting for a constant elasticity demand curve usually gives a consumer surplus around 50-65 percent less. Taking the value of one half (i.e. US$45.30 per household per year) gives an ERR of 13.5%

Table C.2 Off-grid component economic rate of return (US$)

	No. of households	*Consumer surplus per household*	*Total consumer surplus*	*Supplier benefit*	*Total benefit*	*Total costs*	*Net benefit*
1998							0
1999	210	5.60	0	0	0		0
2000	210	5.60	0	0	0	350104	-350104
2001	210	5.60	1176	0	1176	90583	-89407
2002	686	5.60	3842	14440	18282	522576	-504294
2003	2896	5.60	16218	78520	94738	638203	-543465
2004	4764	5.60	26678	101320	127998	678640	-550642
2005	5888	5.60	32973	123224	156197	49536	106661
2006	5888	2.80	16486	106290	122776	41156	81620
2007	5888	2.80	16486	106290	122776	41156	81620
2008	5888	2.80	16486	106290	122776	41156	81620
2009	5888	2.80	16486	105521	122007	40772	81235
2010	5888	1.68	9892	104442	114334	40232	74102
2011	5888	1.68	9892	104442	114334	40232	74102
2012	5888	1.68	9892	104442	114334	40232	74102
2013	5888	1.68	9892	94411	104303	36888	67415
2014	5888	1.68	9892	39361	49253	16360	32893
2015	5888	1.68	9892	6116	16008	2587	13421
2016	5888	1.68	9892	0	9892	0	9892
2017	5888	1.68	9892	0	9892	0	9892
2018	5888	1.68	9892	0	9892	0	9892
2019	5888	1.68	9892	0	9892	0	9892
2020	5888	1.68	9892	0	9892	0	9892
2021	5888	1.68	9892	0	9892	0	9892
2022	5888	1.68	9892	0	9892	0	9892
2023	5888	1.68	9892	0	9892	0	9892
2024	5888	1.68	9892	0	9892	0	9892

A second adjustment is required to reflect the technical problems which mean that many households get power for between 30 minutes and one hour a day rather than the intended 3-4 hours. Consumer surplus is not adjusted from 2001-2005, from 2006-2009 it is taken as half the estimate from full power, and from 2010 onwards at 30 percent. This adjustment alone reduces the ERR from 26.0% to 16.0%. Combining with the re-estimates of consumer surplus gives a range of -7.3% to 10.4%, resulting in an average of 1.5%. Using the alternative approach of estimating consumer surplus at half the ICR level gives an ERR of 1.2%.

Annex D. List of people met

Philippe Arnou	IED, VOPS office
Phakdy Dindavong	Manager of Finance and Debt Office, Electricite du Laos
Gnanhkham Douangsavanh	Project Manager REP, Electricite du Laos (former Acting Project Manager SPRE)
Jill Engen	International Technical Advisor, UNCDF
Morten Larsen	World Bank, Vientiane
Peter Logan	Asian Development Bank
Anousak Phongsavath	Deputy Chief, Rural Electrification Department; Manager PMU REP MEM Component, Ministry of Energy and Mines
Keiichi Sato	JICA Expert, Power Sector, Ministry of Energy and Mines
Andy Schroeter	Sunlabob
Anjali Shanker	IED, VOPS office
Hatsady Sisoulath	Deputy Director General, Electricite du Laos
Seumkham Thoummavongsa	Deputy Chief of Social and Environmental Division, Electricite du Laos
Vilaphorn Visounnarath	Manager, Environmental Office, Electricite du Laos
Bounkeua Xayasone	Deputy Project Manager REP, Electricite du Laos