

RURAL ELECTRIFICATION AND POVERTY REDUCTION: AN IMPACT EVALUATION

Approach Paper

Rationale

1. This evaluation is the fourth in IEG's current program of impact evaluations.¹ Infrastructure was selected as the sector has not been covered in the program to date. The rural electrification (RE) sub-sector was selected for the following reasons:

- It has not been the subject of an IEG evaluation since 1994.
- The 1994 IEG study found that the costs of investments in rural electrification did not appear to be justified by the benefits, although there was need for further investigation. In response, more recent work by the Bank on the Philippines quantifies a broader range of benefits, stating that the results demonstrate the possibility that "benefits will outweigh the costs of extending electricity service".² This evaluation will make an independent assessment of this statement, and the methodology used to reach it.
- The question of the viability of these investments is of operational significance as the rural electrification portfolio is growing in size, especially given the development community's new emphasis on renewable energy sources. Off-grid electrification was ignored in the 1994 IEG study, but will be covered in this evaluation. IEG's recent review of renewable energy (which is largely off-grid) concluded that the 'poverty reduction impact is largely non-evaluable' on account of lack of evidence.³ This evaluation will help fill that gap.

Background

2. Energy policy and services are linked to poverty reduction by the following possible benefits:⁴

- a. Increasing income
- b. Contributing to better health

1. The previous evaluations have been *Books, Buildings and Learning Outcomes: an impact evaluation of Bank support to basic education in Ghana* (2004); *Maintaining Momentum to 2015: an impact evaluation of external support to maternal and child health and nutrition in Bangladesh* (2005); and *Andhra Pradesh Irrigation 2 and 3: an impact evaluation* (in press).

2. ESMAP (2002) *Rural Electrification and Development in the Philippines: measuring the social and economic benefits*, Report 255/02 (p.4).

3. Independent Evaluation Group (2006) *New Renewable Energy: a desk review of the World Bank's assistance*.

4. This list is taken from 'Energy and Poverty: myths, links and policy issues', *Energy Working Notes* May 2005, Energy and Mining Sector Board, World Bank.

- c. Supporting education
- d. Improving women's quality of life
- e. Reducing environmental harm

3. Accordingly, it is argued that investment in rural electrification can make a major contribution to achieving several of the MDGs, notably in Africa where coverage rates in rural areas in many countries are around 1-2 percent (see Annex 1). In accordance with the theory-based evaluation approach adopted in the IEG impact evaluations, the study will seek to unpack the channels through which these poverty impacts can be felt (see Table 1 below).

4. But when IEG last reviewed rural electrification 12 years ago it was critical of the limited benefits realized by such investments, which appeared insufficient to justify the costs (see Box 1). Despite that finding, lending for RE has grown since the mid-90s, spurred in part by the growth of portfolio of projects supporting renewable energy. There were just 10 projects with an RE focus in the years 1990-94, compared to 23 for 2000-2004; and the number of projects with an RE component grew from 14 to 42 over the same period.

Box 1. The 1994 OED Study *Rural Electrification in Asia*

The main findings of the 1994 study were that:

- Ex-post ERRs were much lower than those at appraisal as many of the indirect and external benefits had not materialized. Notably, there was little impact on industrial development.
- RE projects ignored the financial aspects. Unit investment costs for RE are much higher than for urban because of lower population density and the low ratio of average demand to peak demand (rural use is concentrated in early evening, whereas urban demand is spread across the day). Cost recovery has been low (10-50 percent) thus imposing a financial burden on the electricity utility or government.
- The direct benefits of RE go to the non-poor. Even with low tariffs the poor cannot afford connection costs. The poverty reduction benefits are thus indirect through rising rural incomes, and these effects have been found to be limited.

5. In response to the IEG report, operational staff have introduced new evaluation tools to capture a broader range of benefits,⁵ with results so far available for the Philippines, and work on-going in Bangladesh and Vietnam. This impact evaluation will take a critical look at these new findings, undertaking new analysis of existing and new data.

6. An important development in the portfolio in the last decade has been the growth of lending for off-grid electrification. These investments were not considered in the 1994 study (which was not, anyhow, an impact evaluation), but this new study will consider both on-grid and off-grid electrification. A final rationale is that there are few impact studies on rural electrification.

5. The study was undertaken under the auspices of the Energy Sector Management Assistance Program (ESMAP), a technical assistance program of the World Bank and UNDP, with the secretariat based in the Bank's DC headquarters.

7. The evaluation will be a meta-impact analysis, drawing on evidence from a number of sources. This evidence will combine new analysis of new data for one country (Lao PDR) and re-analysis of existing data for 10 others. These findings will be combined with existing evidence to form a comprehensive summary of what is known about the impact of rural electrification, and the part played by external agencies, in particular the World Bank. This approach departs from the single country focus of previous IEG impact studies. This alternative approach is being used in this particular case to broaden the operational relevance of the study, and because it is feasible in this case given the limited range of other studies to be covered.

The Channels for the Welfare Impact of Rural Electrification

8. The direct benefits from RE flow to households or businesses which get connections. Indirect benefits arise either from the income opportunities overspilling to others, or from benefits to unconnected households from a connection in the community. For example, villagers may watch television in a community rather than household setting.

Table 1. Benefits from Rural Electrification

<i>RE-affected input</i>	<i>Channel</i>	<i>Direct</i>	<i>Indirect</i>
Lighting	Time use	Time-saving devices Increased study time	Richer social life
	Electric lighting replaces other fuels (in principle for cooking also, but rarely in practice)	Improved indoor air quality	
Media access (radio, TV and internet)	Improved health knowledge	Health and nutrition Fertility	Health and nutrition Fertility Entertainment
Fan/air conditioning	Improved living conditions	Greater comfort	
Facilities	Better social facilities with better equipment		Clinics: longer hours and more equipment, including cold chain for vaccines, internet access Schools: available for adult literacy in evenings; computer facilities Water pumps: cleaner water supply
Productive enterprise	Electrical equipment for workshops and agricultural (including lighting and pumps)	Enhanced productivity (including irrigation)	Increased income and employment Longer business hours
Food preparation	Refrigeration and boiling water	Better nutrition and reduced ill-health	
Community lighting			Improved security Richer social life

9. Given the difficulty of quantifying all these benefits, most studies use estimates of the willingness to pay (WTP) to capture electrification benefits. WTP is an indirect measure, assuming that how much people are willing to pay gives a good measure of the value of the benefits. However, estimating WTP requires some strong assumptions and, even if done correctly, ignores the public good benefits from electrification.⁶ Hence direct measurement of the benefits, as proposed here, is to be preferred.

Evaluation Questions

10. The evaluation questions address the realization of the claimed benefits of RE, and the extent to which they are gained by the poor. The ultimate objective is calculation of private and social rates of return from investments in rural electrification. Specific questions are:

- a. What has been the growth in the coverage of rural electrification in countries receiving Bank support? To what extent has the Bank contributed to these connections? What is the distributional profile of those taking connections? What are the unit costs of connection by type of supply to the user and to the supplier?
- b. What are the direct economic benefits from rural electrification? Who gains these benefits? What are the indirect economic benefits (employment generation) and who gains them? How does the distribution of benefits change as coverage of electrification programs expand?
- c. What is the impact of rural electrification on time use and what are the welfare implications of these changes for health, education and increased leisure?
- d. How does rural electrification affect the quality of health and education services?
- e. How do the aggregate private benefits and the public good benefits compare to the willingness to pay? What is the distributional profile of these benefits?
- f. What are the private and social rates of return from investments in rural electrification?

Evaluation Approach and Data Requirements

11. The evaluation approach mostly relies upon new and existing survey data to quantify the benefits from rural electrification. Qualitative information shall come from existing material through the desk review and PPARs and a qualitative component in the in-depth country case study of Lao PDR.

12. The two main challenges in conducting an impact evaluation are contagion (the control becoming treated) and endogeneity (the selectivity bias in who is treated).

6. The problems in this approach, and the alternative 'cost savings' approach, are detailed in the ESMAP study on the Philippines (ESMAP, 2002).

Contagion takes two forms: (a) spillover effects, which are dealt with directly in this study, and (b) treatment in control communities, which is not an issue for an ex-post analysis such as this since the control can be restricted to uncontaminated communities. Those who receive electrification (at both household and community level) are better off than average, so there is a problem of selectivity bias. However, the determinants of selection (income and geographical location) are observed, so the bias can be removed.

In-depth Country Case Study (Laos)

13. An in-depth country study comprising a household survey and a qualitative study will be conducted in Lao PDR, which has had four RE projects, one of which is ongoing.

14. In Laos IEG will commission a structured survey with a sample of around 1,200-1,500 households, following up a survey conducted by ESMAP in 1997. A qualitative study of the impact of RE shall also be undertaken.

Desk Reviews

15. Desk reviews will be undertaken for the following countries:⁷

- Bangladesh: the Bank has supported three rural electrification projects in the 1990s and a fourth project with a RE component. There is a continuing program. Along with the Bank, USAID was the main financier of the program and undertook one of the most substantial RE impact evaluations of any program anywhere in the world. In addition there are PPARs of the last two Bank projects. RE was covered in the IEG impact study, and Bangladesh shall be included amongst the countries in which analysis is carried out of Demographic and Health Survey (DHS) data (see below).
- Philippines: The Bank supported rural electrification through two projects in the 1990s, for which there are PPARs. The only ESMAP study on economic and social benefits so far published is for the Philippines. The Philippines is also amongst the countries included for analysis of DHS data.
- Ghana: rural electrification was supported through two Bank projects, for one of which there is a PPAR. Ghana is also amongst the countries included for analysis of DHS data, and new analysis of the Living Standards Measurement Survey (LSMS, a household income and expenditure survey) data will be undertaken regarding test scores and possibly rural enterprises.
- Sri Lanka has a well-documented rural electrification program, especially its experience with off-grid electrification. The Bank has supported four RE projects

7. The choice of case study countries is still under review. Indonesia may be substituted for the Philippines. The latter is included as it is the subject of the ESMAP study, but the Bank's operations in the country have made little direct contribution to rural electrification coverage.

in the country. A survey was undertaken in 2002 as part of the EnPoGen project; IEG may re-analyze this rich, but under-exploited, data set.⁸

16. The case study evidence shall be synthesized on a thematic basis. The synthesis will also include impact studies conducted for other countries.

Further Analysis of DHS Data

17. The Demographic and Health Surveys (DHS) contain data on a range of health and fertility outcomes, as well as output measures on knowledge and practice. The household data contains a variable on electrification (though not the source), and variables which can be used to construct an asset index to proxy for income (which needs to be controlled for).⁹ Several countries have DHS for more than one year, which will allow analysis of the changing distributional pattern of access to electricity.

18. Since the DHS questionnaire is standardized across countries, the data are suitable for pooling – or at the very least in realizing economies of scale in estimating the same models for multiple data sets. Whether or not pooling the data will strengthen the analysis will be determined once the country-level analysis is completed.

19. The countries to be included in this analysis are: Bangladesh, Philippines, Indonesia, Ghana, Vietnam, Pakistan, Morocco, Uganda, Guinea, and Senegal. All of these countries have received Bank support for rural electrification. For each country a ‘mini-desk review’ will be undertaken to provide the country context.

Review of PPARs

20. A review shall be made of PPARs for rural electrification projects completed since the 1994 OED review. These cover (see Annex 2 for a complete list): Bangladesh, Ghana, India, Indonesia, Kenya, Laos, Mozambique, Níger, Pakistan, Philippines, and Sri Lanka (and one for Uganda which is currently being prepared).

Review of Existing Impact Evaluations

21. This review will be conducted early in the study to inform the evaluation design, but the results will also be utilized. The studies which have been identified come from three sources:¹⁰

8. The report relies on bivariate tabulations and so does not control for other determinants of the outcome variables (René Massé “Impacts of rural electrification on poverty and gender in Sri Lanka”, World Bank, 2003). The data will allow multivariate analysis which will do so.

9. These asset indices usually contain items such as ownership of a radio and TV. Since these variables are a function of electrification status they will be excluded from the indices.

10. GEF has made some estimates of impact at both local and global levels, which shall be included in the review, but has not used intensive field-level data collection.

- ESMAP: quantification of benefits for the Philippines, and women's time-use in India, and other pieces of on-going work (e.g. study time in Ecuador and indoor air quality in India).
- EnPoGen (Energy, Poverty and Gender):¹¹ country case studies for China, Indonesia and Sri Lanka produced in 2003.
- USAID: impact studies for USAID's support to rural electrification in Bangladesh and Colombia.

The meta-analysis

22. This evaluation is a meta-analysis drawing together the evidence from the approximately 20 countries included in the study. A matrix will be constructed in which the research questions (or more detailed questions derived from those questions) are the rows and the countries are the columns. As many cells as possible will be filled, but using only those findings based on technically rigorous methods. Thus a summary of all available evidence on each question can be made in a systematic manner.

Collaboration with Other Agencies and Peer Review

23. Collaboration shall be sought with relevant government officials or research institutions in the country selected for in-depth analysis. Funding from the NORAD partnership has been sought. NORAD is embarking on its own impact study of rural electrification, and possibilities for collaboration shall be sought, at least at the level of sharing approaches and findings. The study has been discussed with staff of ESMAP and GEF, and we shall share findings as they emerge.

24. Advice from both internal and external peer reviewers will be sought on intermediate and final findings.

Schedule and Task Management

25. The schedule for the study is as follows:
- a. Inception phase, June-September, 2006: development of approach and design papers, and visit to selected case study country (possibly October). Review of existing impact evaluations.
 - b. Preparatory phase: September-October, 2006: questionnaire design and collection of materials.
 - c. Desk reviews: September-December, 2006.

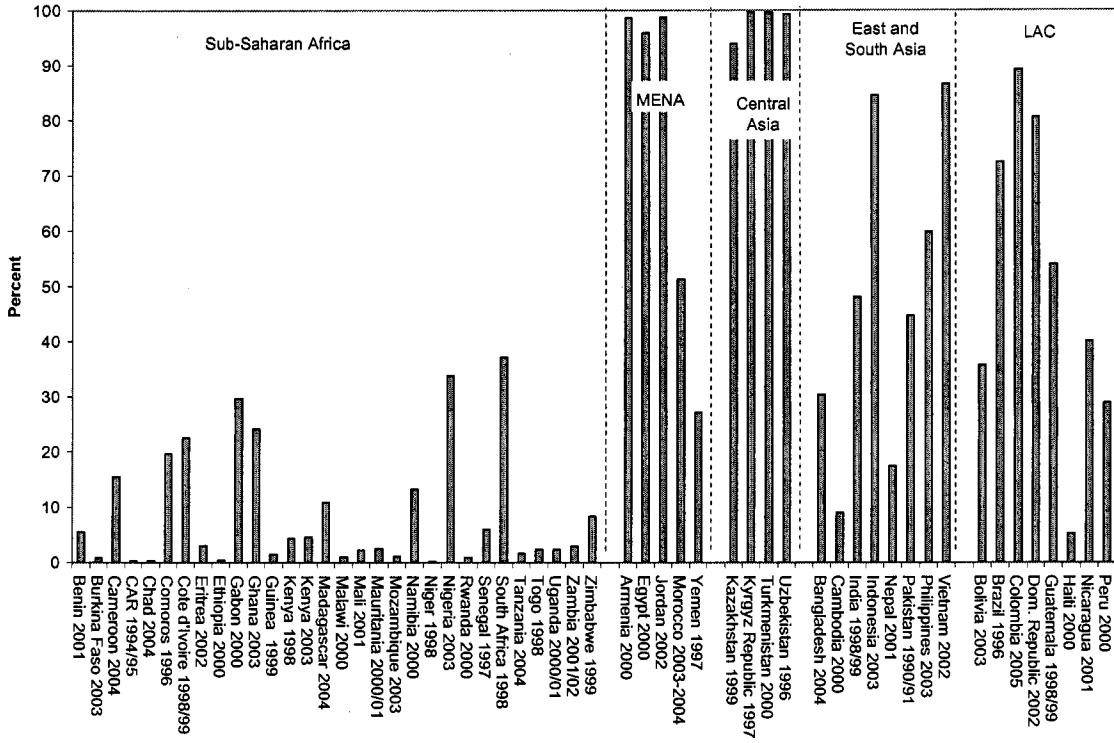
11. This was a World Bank research initiative to better understand the links between energy and poverty, for which case studies were undertaken in the three countries mentioned.

- d. Analysis of existing data sets: October-November, 2006
- e. Survey: fielded by December 2006, with cleaned data by February 2007.
- f. Data analysis and synthesis: February-March, 2007
- g. Report writing: First draft by mid-April, final report to CODE by June, 2007
- h. Dissemination September-December 2007. Dissemination includes the usual report distribution internally and externally, plus presentations to targeted agencies with an interest in RE (e.g. USAID, NORAD and the Swiss aid agency, Seco). Additional publications from the study shall be prepared as part of dissemination.

26. The evaluation will be carried out by a team of IEG staff and consultants with the assistance of in-country consultants for the survey under the Task Management of Howard White (IEGSG).

27. The cost of the study is estimated at US\$450-500,000, of which US\$150,000 for survey costs and US\$150,000 for consultants and travel. Part of these costs are expected to be met by NORAD Trust Funds.

Annex 1. Rural Electrification Coverage (DHS Data)



Annex 2. Available PPARs for Review

Country	Project Name	Fiscal Years	ICR Outcome Rating	PPAR Rating	Loan Size (US\$ millions)
Bangladesh	Third Rural Electrification	1990-2000	HS	HS	105.0
Ghana	Fifth Power Project	1990-1997	S	MS	40.0
India	Renewable Resources Development	1993-2002	S	S	190
Indonesia	Kecamatan Development Project	1998-2002	HS	MS	225
Kenya	Geothermal Development and Energy Pre-Investment Project ¹	1989-1996	S	S	40.7
Laos	Provincial Grid Integration Project	1993-1999	S	U	36
Mozambique	Urban Household Energy Project	1989-1998	U	MS	22
Niger	Energy Project	1988-1997	S	MS	31.5
Pakistan	Rural Electrification Project	1990-1997	U	U	160.0
Philippines	Rural Electrification Revitalization Project	1992-1998	U	U	91.3
Philippines	Energy Sector Project	1990-1996	S	MU	390
Sri Lanka	Energy Services Delivery Project	1997-2003	S	HS	24.2
Sri Lanka	Second Power Distribution and Transmission Project	1992-1998	S	MS	50

Note: 1/ RE component was a study.