MONITORING & EVALUATION OF THE

RENEWABLE ENERGY FOR RURAL ECONOMIC DEVELOPMENT PROJECT

MID-TERM REVIEW REPORT

(1st September 2004 – 30th September 2006)

submitted to

DFCC Bank Administrative Unit

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TABLE OF CONTENTS

LIST OF APPENDICES iii

ABBREVIATIONS iv

EXECUTIVE SUMMARY 1

I INTRODUCTION 4
- 1.1 Scope 4
- 1.2 Period Covered 5
- 1.3 Methodology 5
- 1.4 Report Structure 7

II GRID-CONNECTED POWER GENERATION 8
- 2.1 Project Target & Target Achievement 8
- 2.2 Progress in Commissioning Power Projects 8
  - 2.2.1 Mini-Hydro Sub-Projects 8
  - 2.2.2 Wind Sub-Projects 10
  - 2.2.3 Biomass Sub-Projects 10
- 2.3 Difficulties Faced by Developers 10

III EFFECTS & IMPACTS OF GRID-CONNECTED POWER GENERATION 11
- 3.1 Economic Value of the Power Generated 11
- 3.2 Savings in Foreign Exchange as a Result of not Using Fuel 11
- 3.3 Savings in Carbon Emissions 11
- 3.4 Village Improvements Brought About by Grid-Connected Projects 11

IV OFF-GRID POWER GENERATION 12
- 4.1 Project Target & Target Achievement (including SHSs) 12
- 4.2 Progress in Commissioning Village Micro-Hydro Sub-Projects 12
  - 4.2.1 Micro-Hydro Sub-Projects 12
  - 4.2.2 Wind Sub-Projects 14
  - 4.2.3 Biomass Sub-Projects 14
- 4.3 Difficulties Faced by Developers 14
- 4.4 Post-Installation Performance 14
- 4.5 Solar Home Systems (SHSs) 15
  - 4.5.1 Distribution of SHSs by District 17

V EFFECTS & IMPACTS OF OFF-GRID POWER 18
- 5.1 Use of Electricity 18
  - 5.1.1 Households Switching From Kerosene to Electricity for Domestic Lighting 18
  - 5.1.2 Village Micro-Hydro Sub-Projects 18
  - 5.1.3 Solar Household Systems 19
  - 5.1.4 Other Domestic Uses of Electricity 20
  - 5.1.5 Socio-Psychological Impacts 20

5.1.6 Customer Satisfaction 20
5.2 Impact on Quality of Life 21
5.2.1 Domestic Lighting 21
5.2.2 Children's Study Time 22
5.2.3 Access to Information and Entertainment 22
5.3 Economic Benefits 23
5.3.1 Family Income 23
5.3.2 Savings on Kerosene and Other Energy Sources 24
5.3.3 Adult Working Hours 25
5.3.4 Housing Condition 26
5.4 Enterprises Using Electricity 27
5.4.1 Project Target & Target Achievement (including Institutions) 27
5.4.2 Village Micro-Hydro Projects 27
5.4.3 SHS Powered 28
5.5 Employment Creation 28
5.6 Economic Growth 29
5.7 Environmental Impacts 30

VI OTHER PROJECT COMPONENTS 31

6.1 Energy Efficiency & Demand Side Management 31
6.1.1 Project Target & Target Achievement 31
6.1.2 Energy Efficiency 31
6.2 Cross-Sectoral Energy Applications 31
6.2.1 North Eastern Province Pilot Project 31
6.2.2 Innovation Solicitation 31
6.3 Technical Assistance 33
6.4 Capacity Building 34
6.5 Institutional Framework 34
6.5.1 Institutional Arrangements 34
6.6 Micro-Hydro Institutional Performance & Sustainability 36
6.6.1 Role of Developers 36
6.6.2 Performance of Developers 36
6.6.3 Performance of VECSs 37

VII CONCLUSIONS & RECOMMENDATIONS 38

7.1 Target Achievement 38
7.1.1 Quantitative achievements 38
7.1.2 Qualitative achievements 40
7.2 Project Impacts 41
7.2.1 Economic benefits 41
7.2.2 Use of electricity 41
7.2.3 Village Improvements 42
7.2.4 Innovation Solicitation 42
7.2.5 Capacity Building 42
7.3 Issues & Recommendations 42

LIST OF APPENDICES

1 Mini-hydro Projects Surveyed Regarding Village Improvements Carried Out by Developers

2 Developers Surveyed to Ascertain Difficulties Encountered in Constructing Mini Hydro Projects

3 Five Big Project Developers and Five Small Project Developers Surveyed

4 Micro-Hydro Projects Surveyed for Focus Group Discussions

5 Village Electricity Consumer Societies (VECSs) Surveyed

6 Enterprises in 15 Village Electricity Consumer Societies (VECSs) Surveyed

7 SHSs with Enterprises Surveyed

8 Difficulties Faced by Developers of Mini-Hydro & Micro-Hydro Developers

9 Post Installation Performance of Mini- & Micro-hydro Projects

10 Village Improvements Brought About by Grid-Connected Projects

11 Distribution of SHSs and SHSs Used for Enterprises & Institutions as at 30/09/06 According to Districts

12 Uses of Electricity Generated from Off-Grid Micro-Hydro Projects

13 Additional Income Generated by Longer Working Hours

14 Village Micro-hydro Powered Enterprises

15 Performance of Developers and Village Electricity Consumer Societies (VECSs)

16 Trend Lines

ABBREVIATIONS

CEB	-	Ceylon Electricity Board
DFCC AU	-	Administrative Unit in the DFCC Bank
DSM	-	Demand Side Management
ESCO	-	Energy Service Company
ESD Project	-	Energy Services Delivery Project (predecessor of RERED Project)
FECS	-	Federation of Electricity Consumers' Societies
FGD	-	Focus Group Discussion (conducted by M&E Consultant)
FRM	-	Financial Monitoring Report (Quarterly Project Progress Report of DFCC AU)
HH	-	Household
MFI	-	Micro-Finance Institution
M&E	-	Monitoring and Evaluation
NERD	-	National Engineering, Research & Development Centre of Sri Lanka
O&M	-	Operation and Maintenance
PCI	-	Participating Credit Institution
PR	-	Public Relations
Qr	-	Quarter (of the year)
RERED Project	-	Renewable Energy for Rural Economic Development Project
SEEDS	-	Sarvodaya Economic Enterprise Development Services (Gte) Ltd
SHS	-	Solar Home System
VECS	-	Village Electricity Consumers' Society (established under RERED Project)

DISCLAIMER

Obtaining data from the various stakeholders by mailing questionnaires / survey formats continues to be difficult as their response rate is very low. In addition, some stakeholders seem to find it difficult to provide the data required correctly. DFCC AU has been helping the consultants to obtain some of the required data. This report is based on the data that the consultants have been able to gather within the resources available.

EXECUTIVE SUMMARY

This Mid-Term Review Report covers the period from the 4th quarter of 2004 to end of the 3rd quarter of 2006. Although it is called the Mid-Term Review, it is mid-term only in the context of the period for which the M&E Consultant is conducting monitoring and evaluation of this Project and not the Project itself as 69.6% of the Project duration has been already completed.

No extensive data collection was made for the Mid-Term Review as this review is part of the on-going M&E. The data collected since M&E started in Qr. 4/04 till Qr. 3/06 has been used for this review.

Altogether 24 out of 41 approved mini-hydro and 77 out of 128 micro-hydro projects serving 3,200 HHs have been completed and 73,604 SHSs have been installed[1]. 66.5% of the 85 MW target for the grid-connected power component, 76.8% of 100,000 HHs electrified for the off-grid component and 78.2% of the target of 1,000 for enterprises and public institutions have been achieved. Delays in completing grid-connected projects are caused by issues related to CEB interconnection and obtaining required approvals from CEA and other agencies. Obtaining land also delays project completion. Delays in required approvals from CEA and other agencies also affect off-grid projects; in addition to that obtaining machinery also affects them. If the trend in project implementation achieved up to now continues for the rest of the project duration, the targets for off-grid electrification of HHs and enterprises could be achieved. Project implementation needs to be speeded up to achieve the target for the grid-connected component, although the 109 MW of approved projects are 128% of target.

The replacement of kerosene for lighting with electricity from SHSs and micro-hydro projects has saved nearly 19 million litres of kerosene. Apart from its beneficial impact on the environment (54.5 million kg less of CO_2) especially in the homes, it represents a considerable saving in expense for the HHs and foreign exchange for the country. This is a benefit the consumers and the country will enjoy even after the Project is completed in December 2007.

Developers of mini-hydro projects have improved roads and other infrastructure and community facilities in the areas where they constructed the projects. The local communities appreciate these improvements as they have benefited in different ways. It has reduced travel time to service centres and improved farm-gate prices especially of green tea leaf. While most communities were pleased with benefits they have gained from developers, a few complained that the developers had failed to honour their promises.

Although the average number of HHs per kW in village micro-hydro projects is 4.7, it ranges from 1.7 to 9.5. In one-third of the projects this ratio exceeds 5.0. It could partly explain the poor quality of lighting in some projects. The lack of discipline among consumers and the weakness of VECSs in enforcing rules governing the use of electricity also affect this. Overall the payment of dues to VECSs is very good amounting to 98.0% of what is due. The surplus of revenue over expenditure that many VECSs generate helps their sustainability. This was higher in projects with a higher number of consumers per kW generated. However, a few VECSs have faced financial difficulties due mainly to machinery breakdowns that interrupted power generation.

The main benefit gained by all the HHs receiving electricity from SHSs and village micro-hydro projects is better quality lighting. That has enabled children to study longer hours which will benefit their education. Women also find it more convenient to attend to their

[1] **FMR 30 September 2006**

housework and adults have more time in the evening either to enjoy watching TV or attend to some work. The complete or greatly reduced use of kerosene has not only saved the consumers much expenditure but improved air quality. This will improve their health. A benefit that cannot be measured but is of great importance is the psychological satisfaction people feel from having electricity. As some described it, “It is a reawakening of life” and they no longer feel left out of the mainstream of development that those connected to the national grid enjoy. Although to a lesser extent, the Project has also brought them some economic benefits.

The data collected from 64 out of the 72 VECSs in 2005 and 2006 indicated that there are 50 enterprises and 46 institutions in them. Of the enterprises 42.0% are shops and another 16.0% are carpentry sheds. On the basis of the data collected we have estimated that there are 125 enterprises and institutions in the 77 VECS areas. There are 644 enterprises and 11 institutions benefiting from SHSs. Of these, 70.7% are grocery shops and another 4.5% are bakeries.

The performance of several developers has been unsatisfactory with regard to implementing social aspects of village micro-projects. A few have failed even in the technical aspects. As the performance of VECSs depends very largely on the performance of the developers, their shortcomings affect the VECSs adversely. To overcome their shortcomings, the Project has sponsored training for developers of micro-hydro projects and manufacturers of machinery and equipment for micro-hydro projects. It also instituted the Village Hydro Working Group which meets every quarter to review problems related to the implementation of village micro-hydro projects and decide on remedial action that need to be taken. To strengthen the capacity of VECSs it contracted FECS to conduct training for them. 314 VECS office-bearers and other members from 120 VECSs were trained by FECS between February 2004 and February 2005 and FECS has been contracted to train 300 more office-bearers from another 100 VECSs during 2006.

A summary of achievements of the Project as at 30/09/06 is given in Table ES 1. Finally, a set of issues and recommendations are listed in the concluding Section 7.3.

Table ES 1: *SUMMARY OF PROJECT ACHIEVEMENTS*
(as at 30/09/06)

Item	Target at appraisal	Achievement		Reference in text
		No.	%	
Project Period	66 months	48 months	69.6	---
Grid-Connected Power Generation:				
Installed capacity of mini hydro projects	85 MW	55.0 MW		Sec. 2.1
No. of mini hydro projects commissioned		24		Sec. 2.1
No. of wind projects commissioned		-		Sec. 2.2.2
No. of biomass projects commissioned		1		(*)
Installed capacity of biomass projects		1 MW		(*)
Total installed capacity		56.5	66.5	
Off-Grid Power Generation - All Types				
Power Generation (MW)		Not Available		
No. of households benefiting	100,000 HHs	76,804 HHs	76.8	Sec. 4.1
No. of enterprises & institutions benefiting	1,000	782	78.2	Table 5.9
Off-Grid Power Generation – Hydro				
Installed capacity		772.1 kW		Table 4.3
No. of micro hydro projects commissioned		77		Table 4.3
No. of households benefiting		3,200		Table 5.1
No. of enterprises benefiting		66		Table 5.9
No. of institutions benefiting		61		Table 5.9
Off-Grid Power Generation - Solar:				
No. of solar household systems installed		73,604		Table 4.5
No. of enterprises benefiting		644		Table 5.9
No. of institutions benefiting		11		Table 5.9
Off-Grid Power Generation – Wind				
Installed capacity		Cancelled		(*)
No. of micro wind projects commissioned				(*)
No. of households benefiting				(*)
Off-Grid Power Generation – Biomass				
Installed capacity		35 kW (WIP)		(*)
No. of micro biomass projects commissioned		1 (WIP)		(*)
No. of households benefiting		(not yet known)		(*)
Energy Efficiency & Demand Side Management				
Private energy service companies	3-4 ESCOs	8	200	Table 6.1

(*) As per previous Reports

1. INTRODUCTION

1.1 Scope

As the Renewable Energy for Rural Economic Development Project (RERED Project or "the Project") started in September 2002 and is due to be completed at the end of December 2007, the mid-term should have been in July 2005. However, as the contract for monitoring and evaluation was signed between DFCC and Resources Development Consultants (RDC) on 27th August 2004, the mid-term for this review is at the end of September 2006.

This report will evaluate the progress of the project in relation to its objectives:

"While RERED Project's global objective is to reduce atmospheric carbon emissions by removing barriers and reducing implementation costs of renewable energy, it aims more specifically to:

1. *improve the quality of rural life by utilising off-grid renewable energy technologies to bring electricity to remote communities and*
2. *promote private sector power generation from renewable energy resources for the main grid."*

As the World Bank and DFCC AU have requested the M&E Consultant to focus on the impact of the off-grid village micro-hydro sub-projects and solar PV home systems (SHSs) on the beneficiaries, the main focus of the report will be the first of the above two objectives. Special attention will be paid on how these have affected the quality of life of the beneficiaries and contributed to rural economic development. As the benefits from village micro-hydro projects depend very largely on how well the Village Electricity Consumer Societies (VECSs) function, the report will also assess their functioning.

The overall scope of the study is to undertake a mid-term review of the RERED Project. The specific objectives are:

i. Per component, assess physical progress in terms of delivery of project outputs relative to the overall project targets;
ii. Assess the progress in achieving project results and impacts;
iii. Assess the performance and sustainability of the Village Electricity Consumer Societies (VECSs);
iv. Recommend, where appropriate, adjustments with reference to various project components in order to increase its effectiveness

Grid-connected mini-hydro sub-projects feed electricity to the national grid and do not have a direct impact on the communities of the villages where they are located. However, developers of these mini-hydro sub-projects have undertaken improvements in these villages mainly for public relations (PR) purposes. The report will describe these improvements and the opinions of the villagers with regard to them.

An important impact of the Project has been on the use of fuel for generating electricity and the use of kerosene for domestic lighting. The report will present the benefits gained in respect of these.

As advised by the World Bank and DFCC AU, the report will not analyse in detail the physical progress of implementing grid-connected mini-hydro sub-projects, off-grid village micro-hydro sub-projects and the installation of SHSs as these aspects are reported by DFCC in its Quarterly Financial Monitoring Reports. However, an overview of the physical progress made by these components will be presented. Also an evaluation of the post-installation performance of mini- and micro-hydro projects and problems faced by developers of these sub-projects will be been presented.

Energy Efficiency and Demand Side Management (DSM) and capacity building are among other objectives of the Project. This Report will evaluate the progress made with regard to the first of these two Project components. DFCC AU indicated to the M&E Consultant that it monitored and regularly reported statistics on capacity building programs undertaken under the RERED Project. The report will present information on activities undertaken under the Project's "Innovation Solicitation" component but as the time that has lapsed since many of the activities undertaken under this component has been short, they have not been evaluated in this report.

1.2 Period Covered

Although the Project implementation started in September 2002, the M&E Consultant started to monitor and evaluate it only from the last quarter of 2004. Hence this report covers the period 01 September 2004 to 30 September 2006. However, some of the data relating to the physical progress of Project components refers to the period before September 2004 also.

1.3 Methodology

Although this is a Mid-Term Review, no extensive surveys were undertaken for it as is normally done for such reviews. The on-going monitoring and evaluation surveys and studies were undertaken in the second and third quarters of 2006 and information collected in these have been consolidated with data gathered in previous quarters since the fourth quarter of 2004 to present a composite picture of the progress the Project has achieved up to 30/09/06 and highlight the issues that have emerged. The information used in this report has been gathered from diverse sources as listed in Table 1.1

Table 1.1: *Sources of Information/Data, Sampling & Methods of Collection*

Major Component	Theme of Study	Method/Source of Data	Sample
1. Mini Hydro Projects	**1.1 Physical progress**	*FMR – Project Progress Report for Quarter 3/2006,* DFCC AU	Not applicable
	1.2 Evaluation of Post-Installation Performance	5 additional mini-hydro projects were surveyed using Form GH 2. The data were consolidated with those from 5 mini-hydro projects previously surveyed in Qr. 4/2005 to assess the impact.	Appendix 1
	1.3 Assessment of Village Improve-ments undertaken by Mini-hydro Developers	Information was collected from developers of 15 of the 19 projects during Qr. 4/2005 using form GH 3 by visiting them. 5 of these mini-hydro projects were surveyed during Qr. 1/2006 to verify the information collected from the developers. During Qr. 3/2006 a further 5 mini-hydro projects were surveyed using the same sample as in # 1.2 above.	Appendix 1
	1.4 Assessment of difficulties experienced by Mini-hydro Developers	20 Developers were surveyed during Qr. 4/2005	Appendix 2

Major Component	Theme of Study	Method/Source of Data	Sample
2. Micro Hydro Projects	**2.1 Physical progress**	*FMR –Quarterly Project Progress Reports* - DFFC AU	Not applicable
	2.2 Assessment of difficulties experienced by Micro-hydro Developers	Sample of 5 big developers and a sample of 5 small developers were surveyed using a check list.	Appendix 3
	2.3 Evaluation of Post-Installation Performance	Using Form OH 2, altogether 15 micro-hydro projects were surveyed which consisted of re-survey of 7 micro-hydro projects surveyed earlier and survey of 8 new micro-hydro projects.	Appendix 4
	2.4 Assessment of use of electricity	Postal survey of 13 VECSs that did not respond to earlier surveys conducted in Qr. 2/2005 and Qr. 2/2006 and 23 new VECSs were surveyed using Form EV 3. Altogether 33 VECSs responded to the postal survey. We reported on 33 VECSs in QPR 1/05 and on 49 in QPR 1/06. We now have data for 64 VECSs	Appendix 5
	2.5 Impact Evaluation of Micro Hydro Projects on Households	25 HHs from 2 WIP projects in Qr. 4/2004 + 41 HHs from 4 WIP projects in Qr. 4/2005 were surveyed for the Baseline [Form EV 1 (Hydro)] and 172 HHs from 16 projects in Qr. 4/2004 + 60 HHs from this 172 in Qr.4/2005 were surveyed for Impact Evaluation data [Form EV 2 (Hydro)]	
	2.6 Evaluation of impact on Enterprise Development (including public institutions)	A sample of nine (09) VECSs in off-grid village micro-hydro sub-projects was surveyed Qr. 3/2005 to assess the use of electricity in 13 enterprises. The selected sample is given in Table 1.3 (QPR 3/05). 16 enterprises in 15 VECSs were surveyed under # 2.3 above using Form EV 5 (Hydro). Altogether there were 29 enterprises in the 24 VECSs.	Appendix 6
	2.7 Performance Evaluation of VECSs	FGDs were conducted in 15 VECSs in Qr 1/05. In addition to this VECSs in the sample of 15 micro-hydro projects in # 2.3 above were surveyed by conducting focus group discussions using Form EV 4 (FGD) during Qr. 3/2006. In addition, members of the M&E Team visited 2 VECSs in Qr. 3/2005 and 2 more (1 successful and 1 unsuccessful) VECS from the above 15 micro-hydro projects for in-depth study Qr. 3/2006.	Appendix 4

Major Component	Theme of Study	Method/Source of Data	Sample
3. Solar Household Systems (SHSs)	**3.1 Physical progress**	*FMR – Quarterly Project Progress Reports* - DFFC AU	Not applicable
	3.2 Progress of establishment of enterprises powered by SHSs	Data from SEEDS; *FMR – Quarterly Project Progress Reports* - DFFC AU	Not applicable
	3.3 Impact Evaluation of Solar Household Systems	A sample of 328 HHs in Qr 4/2004 and 187 in Qr 4/2005 were surveyed to establish a baseline. A sample of 697 HHs in Qr 4/2004 and 100 HHs in Qr 4/2005 were surveyed to assess the impact 515 HHs covered in consolidated baseline survey were distributed in 46 DS divisions of 10 districts while 797 HHs in two impact surveys were distributed in 21 DS divisions of 4 districts.	-
	3.4 Evaluation of Impact on Enterprises powered by SHSs	17 SHS Enterprises were surveyed in Qr. 2/2005 using Form EV 5 (Solar). Altogether 28 SHSs with enterprises were surveyed which consisted of re-survey of 8 SHSs having enterprises surveyed earlier and 20 new enterprises with power from SHSs.	Appendix 7

1.4 Report Structure

Chapter II of this report deals with grid-connected power generation.
Chapter III deals with effects and impacts of grid-connected power generation.
Chapter IV deals with off-grid power generation.
Chapter V deals with effects and impacts of off-grid power generation.
Chapter VI discusses other project components.
Chapter VII discusses conclusions and recommendations.

II GRID-CONNECTED POWER GENERATION

2.1 Project Target & Target Achievement

This sub-component of the Project has been ahead of schedule till recently, it has fallen short its target as at 30/09/06 with only 65.88 % of the target achieved within 69.6% of the project duration.

Table 2.1: *Achievement of Targets* [2]

Target	Achievement	
	No.	%
85 MW	56.0 MW (55.0 hydro + 1 biomass) 24 mini-hydro + 1 mini-biomass Projects	65.88

2.2 Progress in Commissioning Power Projects

2.2.1 Mini-Hydro Sub-Projects

DFCC AU stopped approving Refinance Applications for grid-connected projects with effect from September 2005 as the physical targets were far exceeded, and funds were nearly exhausted. The remaining refinance funds were reserved for off-grid and energy efficiency projects. The number of grid-connected mini hydro sub-projects approved has remained at 41 since the first quarter of 2006 and the number of projects completed has increased to 24 at 30/09/06. Table 2.2 and Fig. 2.1 show the progress in this component since the Project inception. As no new projects are being approved, the proportion of projects completed which was 58.5 % as at 30/09/06 would increase in the remaining 15 months of the Project.

Table 2.2: *Cumulative Position of Grid-connected Mini-hydro Sub-projects* [3]

Quarter Ending	Grid-connected Mini		% Completed
	Approved	Completed	
31/12/02	3		0
31/03/03	9		0
30/06/03	11		0
30/09/03	11		0
31/12/03	11		0
31/03/04	16	7	43.8
30/06/04	17	10	58.8
30/09/04	23	13	56.5
31/12/04	32	15	46.9
31/03/05	37	16	43.2
30/06/05	43	17	39.5
30/09/05	43	18	41.9
31/12/05	42	20	48.2
31/03/06	41	22	53.7

[2] Section C. FMR – Project Progress Reports, DFCC AU

[3] Section C. FMR – Project Progress Reports, DFCC AU. The decrease in approved projects is due to PCIs not providing supplementary information to queries raised by the AU

30/06/06	41	23	56.1
30/09/06	41	24	58.5

Fig. 2.1: ***Quarterly Progress in the Number of Approved and Completed Mini-Hydro Projects***

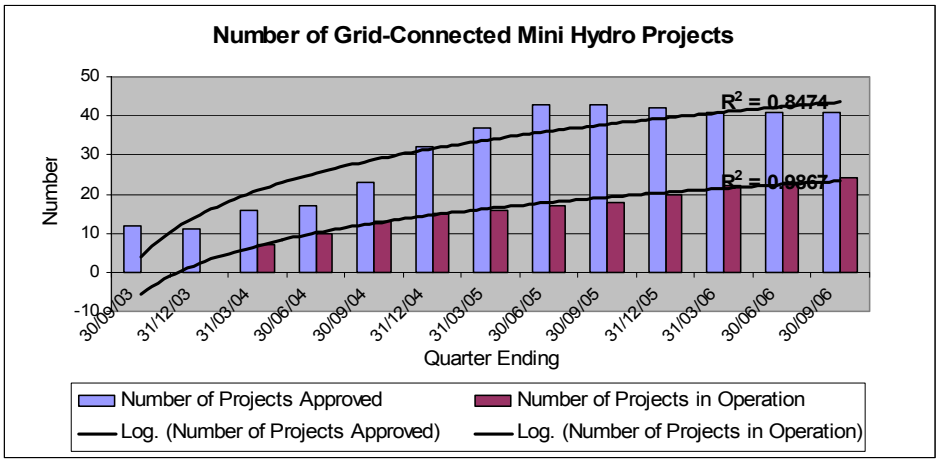


Table 2.3 shows no approvals for the past three quarters. Approved projects exceed the target of 85 MW by 23.5 MW.

Table 2.3: ***Approved Mini Hydro Projects***

Quarter ending	Projects		Capacity		Increase %	
	No.	Increase	MW	Increase	Projects	Capacity
31/09/04	23		58.5			
31/12/04	32	9	78.0	19.5	39.13	33.33
31/03/05	37	5	97.5	19.5	15.63	25.00
30/06/09	43	6	118.2	20.7	16.22	21.23
30/09/05	43	0	120.0	1.8	0.00	1.52
31/12/05	42	-1	114.9	-5.1	-2.33	-4.25
31/03/06	41	-1	108.5	-6.4	-2.38	-5.57
30/06/06	41	0	108.5	0.0	0.00	0.00
30/09/06	41	0	108.5	0.0	0.00	0.00

Table 2.4 shows that 24 sub-projects with a capacity of 55 MW had been completed as at 30/09/06.

Table 2.4: ***Mini Hydro Projects in Operation***

Quarter ending	Projects		Capacity		Increase %	
	No.	Increase	MW	Increase	Projects	Capacity
31/09/04	13		36.5			
31/12/04	15	2	39.0	2.5	15.38	6.85
31/03/05	16	1	40.1	1.1	6.67	2.90
30/06/05	17	1	41.7	1.6	6.25	3.91
30/09/05	18	1	45.7	4.0	5.88	9.59
31/12/05	20	2	48.2	2.5	11.11	5.47
31/03/06	22	2	52.0	3.8	10.00	7.88
30/06/06	23	1	53.0	1.0	4.55	1.92
30/09/06	24	1	55.0	2.0	4.35	3.77

2.2.2 Wind Sub-Projects

Although local and foreign investors showed some interest in investing in this sub-component, there has been no progress due unfavourable conditions pertaining to tariffs and network related technical issues.

2.2.3 Biomass Sub-Projects

Although the increase in the tariff to Rs.8.50 / kWh was expected to stimulate interest in starting new biomass sub-projects, there have been no new applications.

2.3 Difficulties Faced by Developers

Although the physical construction of a mini-hydro sub-project should take only about one year, most take two to three years to complete. Only 58.5% of approved projects had been completed as at 30/09/06. Developers gave several reasons for the delay in completing projects (see Appendix 8 for details). Among these 60.0% mentioned delays in obtaining approvals and acquiring land. Almost as important was the limited capacity of CEB to absorb additional power. This limits the possibility of utilising the considerable potential in the country to generate electricity through mini-hydro projects.

III EFFECTS and IMPACTS OF GRID-CONNECTED POWER GENERATION

3.1 Economic Value of the Power Generated

For the year 2004 the amount of energy generated by Grid-Connected power plants was 206 GWh. The average avoided cost as calculated by the CEB for this year was Rs. 5.14 per kWh. Hence the economic value of energy generated by Grid-Connected power plants for the year 2004 is. Rs. 1,059 million.

For the year 2005 the amount of energy generated by Grid-Connected power plants is 280 GWh. The average avoided cost as calculated by the CEB for this year was Rs. 5.49 per kWh. Hence the economic value of energy generated by Grid-Connected power plants for the year 2004 is. Rs. 1,537 million.

3.2 Savings in Foreign Exchange as a Result of Not Using Fuel

The most significant economic value to this is the amount of imported petroleum saved in the CEB's oil based thermal power plants. Based on the values given in the Statistical Digest published by the CEB, the average fuel cost of electricity generated by CEB for the year 2004 is US$ 0.07/kWh. Hence the value of foreign exchange saved for the year 2004 is estimated as US$ 14.42 million.

For the year 2005, the fuel cost of electricity generation by thermal power plants is US$ 0.081/kWh. Hence the value of foreign exchange saved for the year 2005 is estimated as US$ 22.68 million.

3.3 Savings in Carbon Emissions

The amount of carbon emission reduction for the year 2004 resulted from the generation of Grid-Connected renewable energy power plants amounts to 165,000 tonnes of CO_2. (@ 0.8 kg CO_2/ kWh).

The amount of carbon emission reduction for the year 2005 resulted from the generation of Grid-Connected renewable energy power plants amounts to 224,000 tonnes of CO_2. (@ 0.8 kg CO_2/ kWh).

3.4 Village Improvements Brought About by Grid-Connected Projects

Although these projects do not supply electricity direct to the communities where they are located, the developers have attempted to ensure that these communities benefit by providing them various village improvements in the form of infrastructure development. The details of village improvements made by the developers in 15 projects are presented in Appendix 10. The main benefit was the building or repair of roads and bridges. The communities agree that this has not only improved access to facilities in nearby service centres but also improved access to the villages. This has increased the farm-gate prices of what is produced in the villages, especially tea green leaf. In some of the villages people have benefited from supply of water, housing and school facilities, building community centres and improving facilities at religious places of worship. Apart from providing employment to a larger number of villagers during the construction, these projects are providing employment for about 4 persons per project from the community on a continuing basis. If this is extrapolated to the 24 projects that are in operation, the total employment generated for the community is about 100.

IV OFF-GRID POWER GENERATION

This chapter will cover power generation by off-grid village micro hydro, wind and biomass as well as Solar Home Systems (SHSs) for which the RERED Project has set a composite target of electrifying 100,000 HHs.

4.1 Project Target & Target Achievement (including SHSs)

Target achievement is well ahead with 76.8% of the target already achieved within 69.6% of the project duration.

Table 4.1: *Achievement of Targets*[4]

Target	Achievement	
	No.	%
100,000 HHs electrified	76,804 HH (73,604 SHS + 3,200village hydro) 77 Village hydro projects + (1 village biomass power project which has not been in operation due to internal problems)	76.80

4.2 Progress in Commissioning Off-Grid Sub-Projects

4.2.1 Micro-hydro Sub-Projects

60.2% of the 128 approved sub-projects had been completed as at 30/09/2006 (Table 4.2). As an important objective of the Project is to promote the sustainable development of this sector, applications for refinancing will continue to be approved even if the sub-projects cannot be completed by 31/12/2007. Sub-projects that are completed by this date will receive payments as per current RERED Operating Guidelines. It is expected that additional funding would become available to meet the commitments for other sub-projects even after the end of this Project, although the terms could be different.

A noteworthy achievement of the Project has been the entrance of regional banks like the Sabaragamuwa, Kandurata and Uva Development Banks to provide loans for community-based micro-hydro projects without any refinancing from the Project. However, they ensure that subprojects follow RERED requirements, particularly on technical standards, environmental safeguards and procurement, and the sub-projects receive the usual grant support available under the Project. This could ensure the sustainable debt financing of this sub-sector even after the Project is completed.

[4] Section C. FMR – Project Progress Reports, DFCC AU

Table 4.2: ***Cumulative Position of Off-grid Village Micro-hydro Sub-projects*** [5]

Quarter Ending	Off-grid Village Hydro		% Completed
	Approved	Completed	
31/12/02			0
31/03/03	2		0
30/06/03	4		0
30/09/03	14	4	28.6
31/12/03	27	14	51.8
31/03/04	48	26	54.2
30/06/04	55	33	60.0
30/09/04	69	42	60.9
31/12/04	82	44	53.7
31/03/05	100	51	51.0
30/06/05	103	56	54.7
30/09/05	111	61	54.9
31/12/05	112	65	58.0
31/03/06	120	72	60.0
30/06/06	120	72	60.0
30/09/06	128	77	60.2

Table 4.3 and Fig. 4.1 show the progress achieved in this sub-sector. As seen in Table 4.3 the percentage increase in the number and capacity of sub-projects in operation during Qr 3/2006 is higher than in the past few quarters. As there is no target specifically for this sub-sector, it is not possible to evaluate this progress.

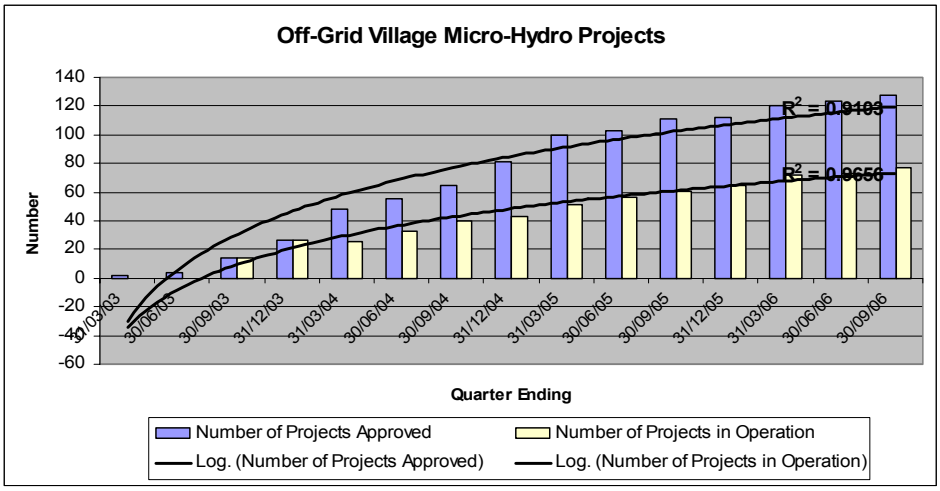
Table 4.3: ***Off-Grid Village Micro-Hydro Sub-Projects Approved & In Operation*** [6]

Quarter Ending	No. of Sub-Projects				Capacity kW			
	Appro-ved	% Inc-rease	In Oper-ation	% Inc-rease	Appro-ved	% Inc-rease	In Oper-ation	% Inc-rease
31/03/04	48		26		563.3		285.6	
30/06/04	55	14.6	33	26.9	605.8	7.5	328.5	15.0
30/09/04	65	18.2	40	21.2	748.1	23.5	431.4	31.3
31/12/04	81	24.6	43	7.5	895.1	19.7	445.7	3.3
31/03/05	100	23.5	51	18.6	1,065.2	19.0	507.9	13.9
30/06/05	103	3.0	56	9.8	1,083.3	1.7	565.5	11.3
30/09/05	111	7.8	61	8.9	1,129.3	4.3	601.8	6.4
31/12/05	112	0.9	65	6.6	1,141.3	1.2	660.5	9.8
31/03/06	120	7.1	72	10.8	1,190.8	4.2	734.2	11.2
30/06/06	123	2.5	73	1.39	1213.9	1.9	737.1	0.39
30/09/06	128	4.1	77	5.48	1,256	3.5	772.1	4.75

[5] Section C. FMR – Project Progress Reports, DFCC AU

[6] Data from Section C, FMR – Quarterly Project Progress Reports of DFCC AU and RERED website.

Fig. 4.1: ***Quarterly Progress in Number of Approved and Completed Micro-Hydro Projects***



4.2.2 Wind Sub-Projects

This sub-component has failed to attract any investment to date. One sub-project that was approved for financing was subsequently called off by the developer.

4.2.3 Biomass Sub-Projects

One pilot sub-project at Badalkumbura was completed but had to be closed down shortly after coming into operation due to internal problems. It is to be relocated as the national grid is being extended to the current location.

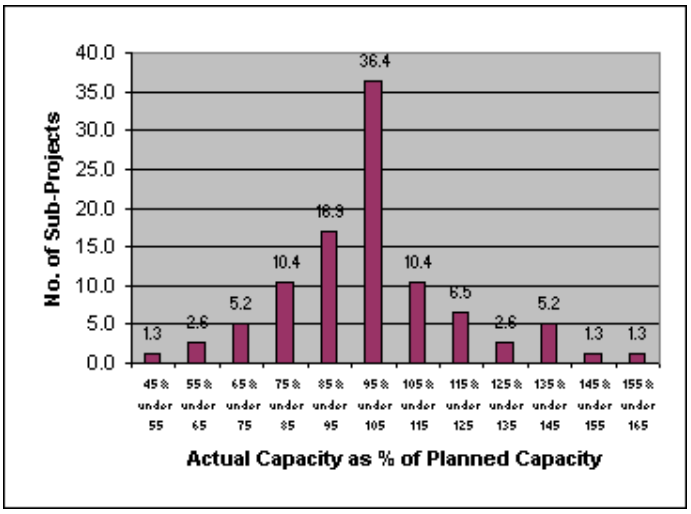
4.3 Difficulties Faced by Developers

More comprehensive information is being collected to ascertain the difficulties faced by developers of off-grid micro-hydro sub-projects. Information available suggests that delays in obtaining approvals from various government agencies are the main cause for delays in completing these.

4.4 Post-Installation Performance

Data has been obtained from Section C of the FMR – Project Progress Report for Quarter ending 30/09/06. The wide diversity in the performance of the micro-hydro sub-projects is reflected in the data (Table A9.1 and Figure A9.1 in Appendix 9). The total planned capacity of the 77 projects completed as of 30/09/06 was 781.2 kW with an average of 10.1 kW while the total actual installed capacity was 772.2 kW (99% of planned) with an average of 10.0 kW. The sub-project-wise actual capacity varied from 3.0 kW to 32.7 kW. Twenty eight (28) or 36.4% of the sub-projects are with performance in the range of '95% & under 105%'; similar amount of 36.4% of the sub-projects are with performance less than 95% and finally 27.3% of the sub-projects are with performance 105% & above. In other words, 49 or 63.7% of the sub-projects are having performance in the range 85% & 115% and 7 or 9.1% of the sub-projects are with performance below 75%.

Fig 4.2: Distribution of micro-hydro sub-projects by level of performance (= actual capacity/planned capacity x 100%)



The wide diversity among micro-hydro sub-projects is reflected in their performance. The total planned capacity of the 77 projects completed as at 30/09/06 was 781.2 kW with an average of 10.03 kW. The actual capacity varied from 3.0 kW to 32.7 kW.

Although the actual installed capacity was 772.2 (98.8%) kW overall, it varied considerably from sub-project to sub-project (Appendix 9). It was below the planned capacity in 44.2% of the sub-projects and above it in 31.2% of the sub-projects. In 32.4% it was less than 90.0% of the planned capacity. These would probably experience difficulties in meeting the demand for power by the HHs. On the other hand, in 19.5% of the sub-projects, the installed capacity was more than 110.0% of the planned capacity.

The largest project in the sample had a capacity of 27 kW and served 128 HHs.[7] Overall, the consumers in these VECSs had paid 98.0% of what was due from them for the relevant quarters. The income derived from these payments provided a surplus of Rs. 818,100/- for the 18 VECSs for the quarter after allowing for O & M costs. This amounted to an average of Rs.45,450/- for the relevant quarter. However one VECS reported a net deficit because of the shortfall in collecting payments due. Another had no surplus and one had a surplus of only Rs.10/- as the generator had been burnt out and it could not supply electricity. Among the others also there was a big variation in the surplus varying from Rs.350/- to Rs.165,000/- for the relevant quarter. The overall net surplus per HH for a quarter was Rs.791.21; leaving out the VECSs that had problems with supplying electricity during the quarter and where data appeared unreliable, this varied between Rs.300/- and 2,089/-.

This bears some relationship to the number of HHs served per 1.0 kW generated which ranged from 1.7to 9.5. The surplus was higher for projects which had more consumers per kW generated. This suggests that those projects are more viable financially and are more sustainable but the quality of lighting could be less satisfactory in such projects.

4.5 Solar Home Systems (SHSs)

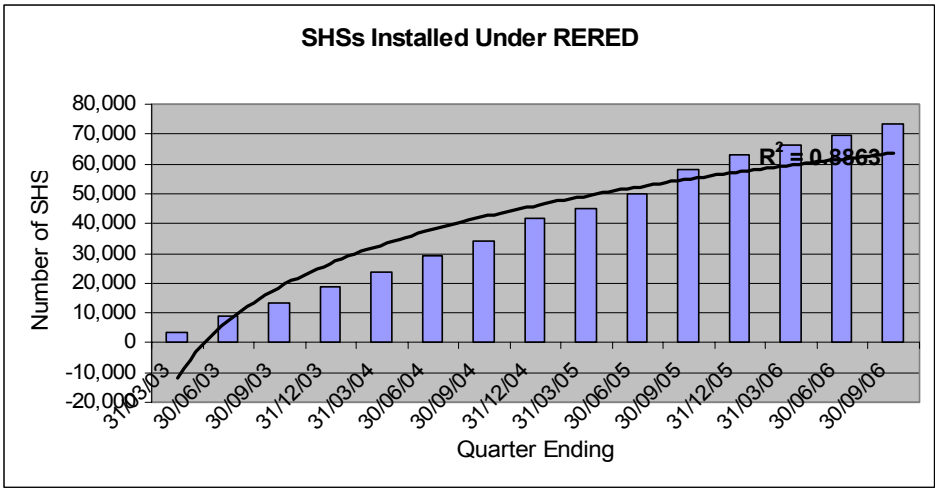
[7] The largest listed in FMR for Quarter Ended 30/09/06 had a capacity of 32.7 kW and served only 9 HHs as at that date although it planned to serve 86 HHs. This is because other HHs now use grid electricity and the excess power is used for economic activities.

Over 73,000 SHSs have been installed under the Project. As the Government has extended its subsidy to all parts of the country, we can expect more SHSs to be installed in districts other than those that have been in the lead to install SHSs.

Table 4.5: *Quarterly Progress of Installation of SHSs*

Quarter Ending	No. of SHSs	Increase	
		No.	%
31/03/04	23,777	5,200	
30/06/04	29,193	5,416	22.8
30/09/04	34,035	4,842	16.6
31/12/04	41,881	7,846	23.1
31/03/05	44,911	3,030	7.2
30/06/05	50,141	5,230	11.6
30/09/05	57,988	7,847	15.6
31/12/05	62,820	4,832	8.3
31/03/06	66,267	3,447	5.5
30/06/06	69,459	3,192	4.8
30/09/06	73,604	4,145	6.0

Fig. 4.2: *Quarterly Progress in Installing SHSs*



4.5.1 Distribution of SHSs by District

The geographic distribution of SHS is influenced by the grid penetration and climatic conditions with Ratnapura, Moneragala, Kurunegala and Ampara districts which have dry zone conditions dominating with 49.7% of the national total (Appendix 11). Among these Ampara, Ratnapura and Moneragala have also benefited from the government subsidy given to the Northeast, Sabaragamuwa and Uva Provinces. Now that this subsidy is being made available to the whole country, the installation of SHSs in other districts might also increase more quickly.

V EFFECTS & IMPACTS OF OFF-GRID POWER

5.I Use of Electricity

Electricity is used for several purposes in the households (see Appendix 12). It is also used for commercial and public purposes. As the demand for electricity for domestic purposes is low during day time, the Project had expected that the availability of cheap electricity in micro-hydro project areas would encourage the development of economic activities.

5.1.1 Households Switching From Kerosene to Electricity for Domestic Lighting

76,804 HHs have switched from using kerosene to electricity from village micro-hydro projects (3,200) and SHSs (73,604). This represents many benefits to the communities and the country as presented elsewhere in this report.

5.1.2 Village Micro-Hydro Sub-Projects

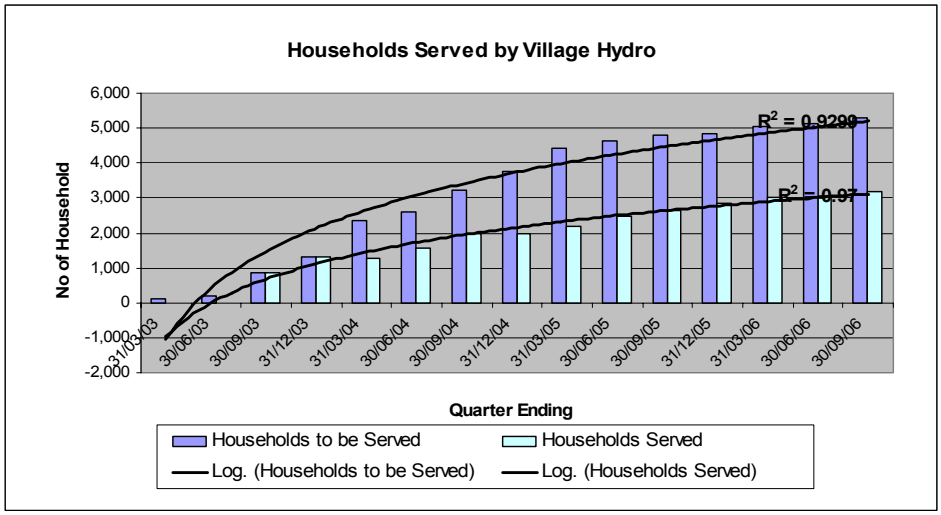
5,314 HHs are planned to be provided with electricity by the 128 micro-hydro projects approved up to now. Of these 3,200 HHs (60.2%) are provided with electricity by the 77 projects already commissioned. Table 5.1 and Fig. 5.1 show the quarterly progress in this sub-component.

Table 5.1: *Households Served with Electricity as at 30/09/06* [8]

Quarter Ending	HHs Planned to be Served by Approved Projects (1)	% Inc-rease	HHs Served by Commissioned Projects (2)	% Inc-rease	Remaining HHs to be served by Approved Projects (1) – (2)	% of Planned HHs Served
31/03/04	2,360		1,279		1,081	54.2
30/06/04	2,614	10.8	1,557	21.7	1,057	59.6
30/09/04	3,196	22.3	1,974	26.8	1,222	61.6
31/12/04	3,762	17.7	1,979	0.3	1,783	52.6
31/03/05	4,431	17.8	2,187	10.5	2,244	49.4
30/06/05	4,621	4.3	2,462	12.6	2,159	53.9
30/09/05	4,796	3.8	2,656	7.9	2,140	55.4
31/12/05	4,820	0.5	2,855	7.5	1,965	40.8
31/03/06	5,032	4.4	3,036	6.3	1,996	60.3
30/06/06	5,118	1.7	3,056	0.7	2,062	59.7
30/09/06	5,314	3.8	3,200	4.7	2,114	60.2

[8] Data from Section C. FMR – Quarterly Project Progress Reports - DFCC AU, and RERED website.

Fig. 5.1: ***Number of Households Planned to be Served by Approved Village Micro-hydro Projects and Served by Completed Projects as at 30/09/06***



Ratnapura (52.0%) and Kegalle (32.2%) districts have benefited most from the development of village micro-hydro projects. Visits by members of the M&E Team have confirmed that the villages where micro-hydro projects have been started are quite remote and access to them is very difficult. Houses within the village are scattered. Because of these reasons, the availability of electricity is a great boon to people in these communities.

Table 5.2 : ***District-wise No. of HHs Receiving Electricity from Off-Grid Micro-hydro Projects as at 30/09/06*** [9]

District	HHs Served by Village Micro-Hydro Projects	
	No.	**%**
Badulla	271	8.5
Moneragala	119	3.7
Kandy	60	1.9
Nuwara Eliya	44	1.4
Matara	38	1.2
Kegalle	1,058	32.2
Ratnapura	1,610	52.0
Total	**3,200**	**100.0**

5.1.3 Solar Home Systems

73,604 HHs are benefiting from receiving electricity from SHSs. According to the baseline and impact surveys conducted in 2004 and 2005, more than 75.0% of SHS in the sample HHs have been provided by 5 companies while 83% of credit has been provided by SEEDS. At the time of the surveys the time that had lapsed since installing the SHSs was less than 2 years in more than 90.0% of these HHs.

[9] Section C. FMR – Project Progress Reports, Quarters Ended 30/06/06 and 30/09/06

5.1.4 Other Domestic Uses of Electricity

All the 2,418 HHs in the 64 VECSs that responded to the postal survey use electricity for lighting (Appendix 12). The other main use made of electricity is to watch TV. The proportion of HHs watching TV (83.7%) has increased considerably since receiving electricity (see Section 5.3.3). This is also an indication of the economic well being of these HHs. Most HHs (62.4%) use electric irons, mainly to iron children's school clothes. Only a few HHs (14.9%) use electricity for fans probably because there is little need for it in the cooler climate in these villages. Very few HHs (1.1%) use electricity to pump water for domestic use and even less (0.5%) to pump water for farming.

One of the problems that some VECSs faced was the use of electricity for electrical appliances during evening peak hours that affected the quality of lighting. Dim lights were the main complaint about the quality of lighting. People also complained about interruptions in the power supply due to various reasons (see Appendix 10). While most of the time these interruptions were short in duration, occasionally they were prolonged due to break downs in the machinery.

5.1.5 Socio-Psychological Impacts

Electricity has benefited the people in several ways and improved the quality of their life as presented in the section 5.3. They considered getting electricity for lighting as a reawakening of their life. Other such benefits they mentioned are happiness and pride, and security in the night.

Everybody felt the benefits of having more time for work and socialization within and among families for adults and education for children in particular. The fact that over 90.0% of the HHs use electricity to watch TV indicates increased accessibility to information and entertainment. This is important for these communities which are quite remote. This has given them a new perspective on life. Exposure to the outside world through getting access to radio and TV and the ability to use various electrical appliances for household work have also made a contribution to improve their quality of life in general and living conditions of women and children in particular.

5.1.6 Customer Satisfaction[10]

Nearly one-third of the HHs receiving electricity from SHSs or village hydro projects use additional sources of power for lighting. While 56% of those using SHSs do not use anything else for lighting 38% still use kerosene lamps in addition to the lights powered by SHS. In the case of HHs receiving electricity from village hydro projects, 64% do not use any other form of lighting but 33% continue to use kerosene lamps to some extent.

78% of the HHs receiving electricity from village hydro projects stated that there are restrictions on the use of electricity or daily power rationing. This issue does not arise in the same way with SHSs but rainy or cloudy weather restricts the use of the SHS.

The users of electricity from village hydro scored around 4.0 on a satisfaction scale of 1 (low) to 5 (high) regarding the technical aspects indicating a high

[10] This section is based on data from the Draft Report on *Off-Grid Consumer Satisfaction*, ACNielsen Lanka (Pvt) Ltd., September 2006,

degree of satisfaction. On a scale of 1 (low) to 3 (high) the users scored 2.7 for their satisfaction with quality of life aspects which indicated an even higher level of satisfaction. This measured the users' satisfaction with the improvement in the quality of life of infants, small children, school going children, chief wage earner, housewife and the family as a whole. With regard to users of SHSs, the corresponding scores are 3.8 and 2.5. These scores, though less than for village hydro electricity users, also indicate a relatively good level of satisfaction.

5.2 Impact on Quality of Life

Electricity from SHSs and micro-hydro projects has made a marked difference to the lives of the beneficiaries who had never expected that they would be able to use electricity during their lifetime. Although there has been some improvement in their incomes especially in micro-hydro projects, the main benefit has been in improving the quality of life through better lighting, enabling children to study longer under better lighting, facilitating the work of women.

5.2.1 Domestic Lighting

5.2.1.1 Micro-hydro projects

Better lighting was the main benefit that 100.0% of the HHs expected from micro-hydro projects. According to the impact survey of December 2004, 99.0% achieved it and were very happy about it. However, according to the subsequent impact survey conducted in December 2005 only 66.7% of HHs said that they have better lighting. Focus Group Discussions also revealed that about 13.0% of the schemes (or HHs in 2 schemes out of 15) were disappointed because they were deprived of this benefit for several months due to breakdown of machinery. After some time from commissioning nearly 30.0 to 40.0% schemes have faced with a problem of producing adequate electricity for the HHs due to various problems. Therefore when schemes are getting older satisfactory lighting became a problem for some HHs.

According to beneficiaries better lighting has made a significant change in their life that cannot be quantified. They described it during the FGDs as a reawakening in their life because the quality of light was poor with kerosene lamps that were used before electricity became available. These lamps were not as convenient to light and accident-free as switching on an electric light. Apart from this convenience, the smoke from kerosene lamps was harmful to the health. Through this impact it contributed to improve the quality of life of HH members. Electric lighting has created a more pleasant and happy environment at home for all members, particularly for women and children who spend most of the time at home.

5.2.1.2 SHSs

All the HHs expected better lighting as the main benefit from SHSs. According to impact surveys of Qr, 4/2004 and 04/2005, 85.0% has experienced this benefit. According to beneficiaries better lighting has made a significant change in their life that cannot be quantified. This has created a more pleasant and happy environment at home for all members particularly for women and children who spent most of the time at home. It contributed to improve the quality of life of HH members in general.

5.2.2 Children's Study Time

5.2.2.1 Micro-hydro projects

According to the baseline survey the ability of children to study in the night was another benefit expected from electricity by 84.0% of HHs. While better lighting enabled children to study longer hours it also enabled the adults, both male and female, to engage longer hours in household and home based economic activities.

Before electricity was received the children in 83.0% of the HHs studied less than 3 hours after 6.00 p.m. with mean study time of 2.0 hours. However after electricity was received, the children at more than 80.0% HHs studied more than 3 hours and the mean study time increased from 2.0 to 3.15 hours. This motivation of children for better education by studying longer will have a long-term impact on their performance at school and higher studies and eventually in securing of employment.

Focus Group Discussions have confirmed the impact of better lighting on children's education while confirming the positive impact it had on adults.

5.2.2.2 SHSs

According to the baseline survey 84.0% of HHs expected the ability of children to study in the night as the next most important benefit from electricity. Better lighting enabled children to study longer hours while it enabled the adults both male and female also to engage longer hours in household and home based economic activities.

The survey showed that 67.0% of the children studied less than 3 hours after 6.00 p.m. before SHSs were installed. The mean study time after 6 p.m. was 2.4 hours. However after SHSs were installed 55.0% of HHs believed that children studied longer. This motivation of children for education will have a long term impact on their performance at school and higher studies.

5.2.3 Access to Information and Entertainment

5.2.3.1 Micro-hydro projects

According to the baseline survey 57.0% of HHs used TVs powered by rechargeable batteries before electricity was received from micro-hydro projects. The HHs using TVs have increased to more than 90.0% after getting electricity.[11] Opportunity to use TV and radio was the expectation of 68.0% of the HHs. 72.0% confirmed that the use of electricity for TV was a benefit they gained from receiving electricity. Ability to use TV has improved their access to information as well as for entertainment for the family members.

5.2.3.2 SHSs

According to the baseline 65.0% of HHs used TVs powered by rechargeable batteries before SHSs were installed and more than 80.0% expected to use electricity from SHSs for TVs and radio after getting them. Impact surveys revealed that 76.0% of HHs enjoyed this benefit after getting SHS. Availability

[11] According to information provided by 64 VECSs, only 83.7% of HHs used electricity to watch TV. This figure too indicates a significant increase in HHs watching TV after receiving electricity from micro-hydro projects.

of electricity for TVs has improved the access to information and as well as entertainment for the family members. As with micro-hydro projects, electricity has also helped the use of mobile phones as their batteries could be charged more easily now.

5.3 Economic Benefits

Beneficiaries have also gained several economic benefits although it is not possible to quantify them reliably through surveys due to the difficulty in obtaining accurate data. Income data is most difficult to obtain. However, indirect indicators show that there has been an improvement in income although that cannot be attributed directly to the availability of electricity through SHSs and micro-hydro projects.

5.3.1 Family Income

According to the AC Nielsen Report, 49.0% of the HHs received a monthly income of Rs.4,000/- to 8,000/-. 39.0% of the remaining HHs had a higher monthly income. In the case of SHSs, 39.0% of HHs that installed SHSs fell into the same monthly income category and of the remaining HHs, 37.0% had higher incomes.[12]

5.3.1.1 Micro-hydro projects

The change of the sources of income and its pattern can be used as an indirect indicator to measure the economic growth and the increase of family income. According to the baseline survey the main source of income of about 80.0% of HHs is farming. Farming is important as a source of income for these HHs. The other important source of income is casual labour. It is the main source of income for 15.0% of the HHs. Farm and non-farm enterprises are not predominant sources of income.

According to the impact survey there has been some change in the main source of income of the HHs. The importance of farming as the main source of income has been reduced from 78.0% to 58.0% while the importance of farm enterprise has increased to 18.0%. This change in the sources of income suggests an improvement of income of HHs due to some favourable changes in the economic environment. This improvement in income is also suggested by the increased use of electrical appliances by HHs. More than 90% HHs used electric iron, TV and fans while a few have started to use rice cookers, water pumps and refrigerators.

5.3.1.2 SHSs

According to the baseline survey the main source of income of majority HHs (about 80.0%) is farming. Farm and non-farm enterprises are not significant as sources of income of the HHs. Casual employment is the important source of income for 7.0% of the HHs.

According to the impact survey there has been a slight change in the main source of income of the HHs. The importance of farming as the main source of income has reduced from 80.0% to 72.0% while the importance of non-farm employment has been increased to 24.0%. This change in the pattern of sources of income shows an improvement of income of HHs due to some favourable changes in the economic environment.

[12] Draft Report by ACNielsen Lanka (Pvt) Ltd., on *Off-Grid Consumer Satisfaction"*, September 2006, Tables 4.1.6 (p.27) and 5.1.6 (81)

The heavy dependence on farming shows the low level of development of the economy among the beneficiaries of both the SHSs and micro-hydro projects. This is not surprising as they are located in remote areas.

5.3.2 Savings on Kerosene and Other Energy Sources

All the HHs used kerosene for lighting before receiving electricity and rechargeable batteries as a source of energy for TVs and radios. The use of electricity for lighting and watch TV or listen to radio is an important source of savings for the beneficiaries although they will feel the full impact of it only after they have paid back the loans they borrowed to obtain electricity.

5.3.2.1 Micro-hydro projects

HHs spent a minimum of Rs.100/- a month on kerosene oil before electricity was received. The average monthly expenditure on kerosene oil for a HH amounted to Rs.245/- but 50.0% of HHs spent more than that amount. As per impact survey, use of kerosene has reduced significantly after electricity was received. Now more than 76.0% of HHs spend less than Rs.100/- a month for kerosene while the average expenditure has been reduced to Rs.95/ per month.

In addition to spending on kerosene more than 80.0% of the HHs had used batteries for TV and radio and had spent a minimum Rs.50/- per month for battery recharging. On an average, a HH spent Rs.107/- per month for battery recharging. The average expenditure on battery recharging has been reduced to Rs.15/- per month after electricity was received and now 73.0% HHs do not spend anything for battery recharging. In addition to the expenditure incurred, the HHs that used kerosene have experienced a number of problems such as bad light, inhaling smoke and accidents. All the HHs had experienced bad light while more than 80.0% complained about inhaling smoke.

While this change has enabled HHs to save an average of Rs 300/- to 350/- a month, it has contributed greatly to improve the quality of life by improving the quality of light and reducing smoke inhalation and accidents due to kerosene lamps.

5.3.2.2 SHSs

81.0% of the HHs used only kerosene oil for lighting while another 16.0% have used both kerosene and rechargeable battery and spent Rs.100/ to 1,000/ a month for kerosene before SHSs were installed. While about 36.0% of HHs spent more than Rs.300/ for a month on kerosene, the average monthly expenditure for a HH prior to SHSs amounted to Rs.360/. As per impact surveys the cost of kerosene and battery recharging for lighting has been reduced significantly after the SHSs were installed and thus, the average expenditure per month for a HH also reduced by about Rs.100/. However, due to the monthly instalment of SHSs amounting to Rs.1,180/- the net saving per HH is negative. Though the savings in the short run for HHs is negative SHS has greatly contributed to improve the quality of life by reducing smoke inhaling and accidents due to kerosene lamps.

In addition to the expenditure incurred the HHs using kerosene have experienced a number of problems such as bad light, inhaling smoke and accidents. All the HHs experienced bad light while more than 80.0% complained about inhaling smoke.

It is important to emphasise the impact on health as result of replacing kerosene lamps with electric lights from SHSs and micro-hydro projects. It has not completely replaced kerosene lamps as people still use them as a stand by or supplementary lighting. However, according to the reduction in the amount of kerosene used, smoke inhalation has been reduced by over 80.0%. This will reduce respiratory illnesses as smoke inhalation over many years is harmful to the health. *"Epidemiological studies in developing countries have linked exposure to indoor air pollution from dirty fuels with at least four major categories of illness: acute respiratory infections (ARI) in children; chronic obstructive lung diseases such as asthma and chronic bronchitis; lung cancer; and stillbirths and other problems at birth…..When it happens, the well-documented transition up the energy ladder from dirty to clean fuel will greatly reduce the threat from indoor air pollution in developing countries."*[13] In addition to this, better lighting will reduce the strain of studying on the eyes of school going children and reduce their vulnerability to problems associated with sight.

5.3.3 Adult Working Hours

5.3.3.1 Micro-hydro projects

Male members of more than 60.0% of HHs said at the FGDs that they can now work longer in the field as well as at home. Before electricity was received the farmers used to come home early from the field as things at home had to be done before nightfall. They said that when they came home early from the field, they lost productive hours as evening was the best time to work in the field. According to the members who participated in FGDs, better lighting has increased their labour input at least 1-2 hours a day and also their work output by being able to work a longer time in the field. Similarly according to the members who participated in the FGDs, women also worked in productive activities such as mat weaving, beedi wrapping, etc., at least 1-2 hours more in the night than earlier. According to the baseline survey only 10.0% of the HHs expected that they would save or gain time by receiving hydro electricity but impact survey shows that 44.0% of HHs had gained or saved time. [14]

Although it was not possible to obtain data on the increase in family production and income due to the increased number of productive labour hours, we can estimate this by estimating the number of labour hours and attributing a price for an hour. If we assume that each family has two adults and they add, on average, 3 hours a day, they will add 750 working hours per annum on the basis of 250 working days per annum. If we assume the value of one hour of labour is Rs. 40/-, the value of their additional input of labour would be Rs. 30,000/-. per annum per HH. Per month it will be Rs. 2,500/-. On this basis the economic value of the additional input of labour could be estimated to be Rs.63 million up to 30/09/06 (Appendix 13)

[13] *World Resources 1998-99: Environmental Change and Human Health*, A joint publication by the World Resources Institute, the United Nations Environment Programme, the United Nations Development Programme, and The World Bank. 1998.

[14] 53.0% of the SHS sample continue income generating activities after dark and 28.0% start earlier in the morning after purchasing the SHS, Draft Report on *Off-Grid Consumer Satisfaction*, ACNielsen Lanka (Pvt) Ltd., September 2006, Table 4.7.1 p.70

On the other hand improvement of home environment and happiness also contribute to increase the labour productivity of HHs. Social mobilization process can take place within a family with this kind of change at homes. That in turn will motivate people to go for higher income level.

5.3.3.2 SHSs

Comparable data is not available to quantify the additional number of working hours made possible by the use of SHSs. It is not as effective as in the case of micro-hydro projects because electricity stored in batteries can be used only for a limited number of hours. Discussion during field visits has indicated that where electricity has replaced kerosene lamps in enterprises, the convenience and better quality of lighting rather than increased period of working are the advantages.

5.3.4 Housing Condition

As collection of income data is unreliable in surveys of this nature housing condition is a more reliable indirect indicator. It is popularly and commonly used to measure the level of poverty, income and quality of life of HHs.

5.3.4.1 Micro-hydro projects

In terms of housing conditions most of the beneficiaries do not seem to be very poor and were enjoying a satisfactory standard of living. The baseline survey showed that more than 70.0% of HHs that expected to benefit from micro-hydro projects had houses with permanent roofs, walls and floors. Only 27.0% of HHs had houses of semi-permanent nature with floors and walls made of clay and 6.0% had thatched roofs. According to the impact surveys of Qr.4/2004 and Qr.4/2005 there has been an improvement in the condition of semi-permanent houses after electricity was received. The proportion of houses which had clay walls and floors (27.0%) had decreased to 11.0% while the 6.0% of houses which had thatched roofs also decreased to 1.6%. This indicates a reduction in poverty among the beneficiaries.

This could be due to the motivation of people to improve their houses after the advent of electricity. This motivation and improvement of the home environment may have encouraged people to work longer hours to earn more to invest on the house as explained earlier. In Sri Lankan culture since the house will be the top priority of the family its improvement will be a good indicator for an increase in income or savings of the family.

5.3.4.2 SHSs

According to the baseline survey more than 75.0% of HHs in the samples had permanent roofs and walls and two-thirds are with cement floors. Only about 5.0% of them had thatched roofs. In terms of housing conditions a majority of the beneficiaries are not very poor and enjoy a reasonable standard of living. Impact surveys in Qrs. 2/2004 and 2/2005 showed no significant change in their housing conditions.

5.4 Enterprises Using Electricity

5.4.1 Project Target & Target Achievement (including Institutions)

The Project has achieved 78.2% of its target for the electrification of institutions and enterprises due largely to the large number (455) grocery shops that use electricity from SHSs.

Table 5.9: *Achievement of Targets*

Target	Achievement	
	No.	%
1,000	1. 644 enterprises powered by SHSs* 2. 11 religious institutions powered by SHSs* 3. 66 enterprises powered by village hydro** 4. 61 public institutions powered by village hydro projects**	78.2

* Section C. FMR – Project Progress Report, Quarter Ended 30/09/06
** Computed on the basis of data from postal survey of VECSs conducted by consultants (see Appendix 12).

Although these enterprises use electricity, the availability of electricity has not promoted enterprise development. Only 12 out of 215 (6.0%) with electricity from micro-hydro projects and 6 out of 601 (1.0%) with electricity from SHSs had started an income generating activity after receiving electricity.[15]

5.4.2 Village Micro-Hydro Projects

Information on enterprise development is available from both the postal survey conducted and individual enterprises surveyed in the field at the time when FGDs were conducted with VECSs in 30 micro-hydro projects. While the former data gives an overview of enterprise development, the latter is a more in-depth study. We will present the overview first.

The 64 VECSs that responded to the postal surveys reported that 50 enterprises and 46 public institutions received electricity in their areas (Appendix 12).[16] Of them as many as 41 (64.1%) did not report any enterprises. The remaining 23 VECSs reported 50 enterprises and 78.3% reported only 1 or 2 enterprises. 21 grocery shops including 11 use electricity for refrigerate frozen foods were the most common users of electricity with carpentry sheds (8) being next in importance. Several other enterprises were made possible by the availability of electricity to power their equipment or machines: grinding mills, lathe works, communication centres, etc.

34 VECSs (53.1%) reported that electricity was being used by 46 public institutions. This shows that electricity was being used for public institutions in more VECSs than for enterprises reflecting the importance of culture in rural communities. The institutions are mainly religious places (54.4%), community centres (24.0%) and schools (22.0%).

[15] Draft Report by ACNielsen Lanka (Pvt) Ltd., on *Off-Grid Consumer Satisfaction"*, September 2006, Tables 4.7.1 (p.70) and 5.7.1 (114)

[16] Postal surveys were conducted in 2005 and 2006. Altogether 64 out of the 72 VECSs in operation as at 30/06/06 responded.

There has not been any noteworthy increase in enterprises and institutions between 2005 and 2006. 18 new enterprises were reported in 2006 but 11 that were reported in 2005 were not reported in 2006 and seem to have closed down.

Appendix 14 gives detailed information on the in-depth survey of 29 enterprises from 16 VECS areas. 55.0% of them had been started before they received electricity. Most of them are small enterprises with an average investment of Rs.19,300/=. Shops made up 38.0% of these enterprises but only one of them had bought a refrigerator after electricity became available. Several types of enterprises such as grinding mills, battery recharging, communication centres and electrical appliance repair shops had been made possible by electricity being available but these are few in number.

These enterprises have not provided employment for those outside the families. However, the employment of family members has almost doubled after electricity was received. An important benefit they had gained from receiving electricity is an increase in income / profit reported by 41.4% of them. Lack of finance (7) and insufficient power supply (5) were considered to be the main constraints to expanding their enterprises.

5.4.3 SHS Powered

Most (90.7%) of the 644 enterprises using electricity provided under the Project initiatives are powered by SHSs.[17] Of these 70.7% are grocery stores and another 4.5% are bakeries. It is interesting to note that 3.3% used electricity for security. SHS also provided power to 11 institutions, all of them religious places. Kurunegala (17.9%) and Ratnapura (14.1%) had the largest number of enterprises using power from SHSs. Considering that power from SHSs is not sufficient to drive any machinery, its only use in these enterprises is to provide better lighting.

A recent survey of 250 HHs with SHSs conducted by SEEDS (still on-going) in Ratnapura district has shown that 37 HHs (14.8%) were using electricity from them for various economic activities. Among them grocery shops (13), cinnamon peeling/ processing (9) and brick making (5) were the most common.

Baseline survey showed that only 6.4% of HHs expected to use solar power for income generation activities. However, according to the impact surveys, this expectation has not been met to a significant extent.

5.5 Employment Creation

Much of the direct and indirect employment created has been to install SHSs but mini-hydro projects as well as micro-hydro projects generate some employment.

The most important direct employment generation is for the installation of SHSs. On the same basis used in earlier reports[18], installing 73,604 SHSs up to 30/09/06 would have generated 220,812 person-days of direct employment and 110,406 person-days of indirect employment for installation of the SHSs making up a total of 331,218 person-days. As this work is more skilled, if we value it at Rs.500/- per day, the value of this work is Rs.165.6 million. This is the equivalent of providing employment for 276 persons per month for the

[17] Data from Section C. FMR – Project Progress Report, Quarter Ended 30/09/06

[18] 3 person-days to install one SHS unit; 1.5 person-days for support activities related to installing a single SHS for transport, documentation, etc.,

duration of the project on the basis of a 25-day month. As the government is now providing a Rs.10,000/- subsidy to install SHSs, this could be expected to continue.

According to the data collected at village level, mini-hydro projects had employed 8 – 11 persons from nearby communities for construction work and has subsequently employed 3 – 4 persons after the projects were commissioned. On the assumption that it takes 18 months[19] to construct a mini-hydro project and they work 25 days a month, if 8 persons were employed, the total of 86,400 person-days would have been generated to construct the 24 mini-hydro projects that have been completed. At the rate of Rs.300/- per day, this would have generated Rs.25.9 million for the communities concerned or an average of about Rs.1.1 million per community. If we assume that 11 persons were employed for construction, keeping the other assumptions constant, a total of 118,800 persons-days would have been generated valued at Rs.36.6 million or Rs.1.5 million per community. The construction of more projects during the remaining 15 months would increase this benefit.

On the same assumptions as above, the 3 – 4 persons who are employed after completion of the projects 1,800 – 2,400 person-days a month for the 24 projects completed. That amounts to Rs.540,000 – 720,000 /- per month for the 24 projects or Rs.22,500 – 30,000/- per month for individual projects. The completion of projects already approved would bring similar continuing benefits to other communities.

Village micro-hydro projects also generate a considerable amount of employment during the construction phase. This labour is part of the contribution the community makes towards the cost of the project. It is difficult to estimate the total amount of labour used as records have not been kept and the projects vary a great deal in size.

5.6 Economic Growth

One of the main impacts of making off-grid electricity available through SHSs and micro-hydro projects has been to use electricity for enterprises which was presented above in Section 5.5. Most of the enterprises using electricity from these two sources are grocery shops which have been able to do business for longer hours and with greater convenience. Considering that these shops are in remoter areas and serves the same clientele as before, it is difficult to consider that the volume of business would have increased very much. Box 5.1 presents some typical SHS powered enterprises.

Box 5.1: *Some SHS Powered Enterprises*

A.M. Leela Gunaratne Menike:

In addition to using solar electricity for the house, she uses it to get light for her boutique. Her son is managing the boutique, at present.

S.M. Thilakaratne

In addition to using solar electricity for the house, he uses it to power a SLT telephone and providing the service of getting telephone calls available to the villagers.

E. M. Somawathie

In addition to using solar electricity for the house, her son uses it to repair TV/Radio/Cassette players.

The main use made of electricity is for lighting. In the case of SHSs it cannot be used for any other purpose but in villages with micro-hydro projects, there are a few enterprises that use it for equipment.

In Section 5.4.3.1 it has been shown that electricity from micro-hydro projects has enabled people to work longer hours. Although no additional income is generated by that it is possible to compute the value of this additional input of work. This was estimated at Rs.2,500/- per month per HH or a total of Rs.63 million up to 30/09/06. Employment has also generated additional income to rural areas as shown in Section 5.6.

[19] Data obtained from mini-hydro developers – see Appendix 8

5.7 Environmental Impacts

There is a very favourable impact on the environment both at the HH level and at a macro level as a result of substituting electricity from renewable sources of energy instead of using fossil fuels. It is not possible to estimate accurately the savings in the use of kerosene as a result of this but Table 5.10 gives an estimate of kerosene oil saved as a result of using electricity for lighting instead of kerosene.[20]

Table 5.10: ***Saving in Kerosene as a Result of Using Electricity***

	Micro-hydro		SHSs	
Quarter Ending	**HHs Served**	**Saving/Qr (litres)**	**HHs Served**	**Saving/Qr (litres)**
31/03/03			3,660	113,094
30/06/03			8,888	274,639
30/09/03	841	14,381	13,543	418,479
31/12/03	1,305	22,316	18,577	574,029
31/03/04	1,279	21,871	23,777	734,709
30/06/04	1,557	26,625	29,193	902,064
30/09/04	1,974	33,755	34,035	1,051,682
31/12/04	1,979	33,841	41,881	1,294,123
31/03/05	2,187	37,398	44,911	1,387,750
30/06/05	2,490	42,579	50,141	1,549,357
30/09/05	2,656	45,418	57,988	1,791,829
31/12/05	2,855	48,821	62,820	1,941,138
31/03/06	3,036	51,916	66,267	2,047,650
30/06/06	3,056	52,258	69,459	2,146,283
30/09/06	3,200	54,720	73,604	2,274,364
Total		**485,897**		**18,501,190**

As our impact surveys have shown the consumers place a lot of emphasis on the improvement in the home environment as a result of using electricity for lighting instead of kerosene. The figures in this table should be considered only as an indication of savings in carbon emissions. According to Table 5.10, nearly 19 million litres of kerosene have been saved from the first quarter of 2003 till 30/09/06. This is the equivalent of 54.5 million kg of CO_2[21]. The saving in kerosene would increase and the improvement in the home environment and health as a result of less CO_2 in the air family members breathe would be a continuing benefit from the Project.

[20] Based on data presented in QPR 04/2005; see Sections 5.2.1.5, 5.2.2.4 and 5.5)
[21] 2.8 kg CO2 /litre of kerosene

VI OTHER PROJECT COMPONENTS

6.1 Energy Efficiency & Demand Side Management

6.1.1 Project Target & Target Achievement

This project component has already exceeded the target already.

Table 6.1: *Achievement of Targets*[22]

Target	Achievement	
	No.	%
3-4 ESCOs in operation	8 ESCOs	200.0

More than 8 ESCOs have been established and are providing energy saving services.

6.1.2 Energy Efficiency

Household refrigerator testing chamber was to be installed at CEB initially. Subsequently, it was decided to install it at NERD. This has been held up until a comprehensive national appliance labelling programme that will lead to a mandatory labelling scheme is in place. RERED Project has financed a few energy efficiency projects in addition to what the Energy Conservation Fund has supported through its credit guarantee programme.

6.2 Cross-Sectoral Energy Applications

6.2.1 North Eastern Province Pilot Project

A pilot energy project was initiated in the first quarter of 2005 to provide renewable energy to a hospital and a school in the North Eastern Province. These were delayed initially due to technical issues and have been on hold due to the unsatisfactory security in the province for the past three quarters.

6.2.2 Innovation Solicitation

Several activities have been promoted under this component. Some of these are economic activities that have been initiated in communities benefited by village micro-hydro projects. Among them are activities such as communication centres, grinding mills and the sale of refrigerated products that could not be done in these villages before electricity became available. Other activities have introduced new technology to improve the quality of products using renewable energy.

It can be seen from some of these innovative economic activities that have been started which are presented below, that this Project component has succeeded in promoting profitable enterprises based on using renewable energy. They are providing additional income, employment mainly for the family members of the entrepreneur and services to the community.

FECS is implementing 34 economic activities in 20 VECS areas of which 16 have been completed. It is possible to evaluate the impact of some of these

[22] Data provided by DFCC AU

projects from the report provided by FECS on enterprises it has helped to start under the innovation solicitation programme:[23]

Janith Communication in the Kitulpiti Ella Small Scale Hydro Project (Started in September 2003). In terms income, over 6 months it had generated Rs.3,584/- or on average, about Rs.600/- a month. In addition it has provided the community with access to telecommunication facilities. Before it was started people had to go to Deraniyagala for that.

Thusitha Tailors also in the Kitulpiti Ella Small Scale Hydro Project (Started in September 2003). This enterprise is generating Rs.1,500.00 – 2,000.00 income per month. It had to close down after 8 months as the person doing it died.

The Devmini garments shop it helped to start in Beraliyadola Small Hydro Project in December 2004 has been generating a monthly income of about Rs. 6000/- to 9,000/-. It had also contributed Rs.2,300/- to the society since it started till September 2006.[24]

A shop selling refrigerated food started in June 2004 in Saptha Kanya Small Hydro Project has increased its monthly profit from about Rs.800/- in the first three months to nearly Rs.5,000/- by the end of the first year.[25]

Managoda Rural Small Hydro Electricity Consumers Society reported on two economic enterprises, Managoda Communications and Weerasena Saloon.[26] According to it the communications centre had yielded a profit of Rs.10,443/- over first five months and the saloon had generated a profit of Rs.2,600/- for a 5-month period. These enterprises also paid the society Rs.1,750/- during a 7-month period. Apart from these financial benefits, these enterprises made services available to the communities.[27]

Enexe had received 24 applications from 8 villages to start income generating enterprises where electricity was available from micro-hydro projects.[28] It had selected 11 of them from 5 villages. Several technical, financial and socio-political barriers had to be overcome to start these. Sithumini Tailors had generated an income of Rs.15,291/- for a 21-month period. A computer centre that had been started in April 2004 had generated Rs.1,920/- during the first 6 months of 2005. A grinding mill that had been started in April 2005 had earned an income of Rs.6,258/- in the first 6 months of 2006.

Rural Energy & Environmental Consultation Services (REECS) has started implementing seven economic activities in three villages. Sewa Lanka has initiated action on setting up a barter scheme for SHSs.

Mr Kapila Weeratunga Aarachchi through Alliance for Appropriate Technology Exchange (AfATE)[29] introduced the solar powered SAVIRU Spice Dryer designed by the University of Ruhuna for spice drying. Apart from introducing improved technology, AfATE has organised spice growers into enterprises

[23] Reported earlier in QPR 3/2005
[24] Report provided by DFCC AU
[25] Report provided by DFCC AU
[26] Report provided by DFCC AU
[27] Report provided by DFCC AU
[28] *Innovative Proposals Linking Energy and Rural Economic Development,* Final Report (Contract No.2003/05), September 2006 (Report provided by DFCC AU)
[29] This has been reported in earlier M&E reports as a project implemented by Kapila Weeratunga.

and linked them with buyers who pay them almost double the local market price for their better quality products. The cost of the dryers has increased from Rs.36,000/- in 2003 to 42,000/- in 2005 but the farmers have earned an additional income of Rs.180,000/- during this period as a result of improving the quality of their products and linking directly with buyers.[30]

Practical Action project in Anamaduwa introduced a solar drier to dry medicinal herbs available in the area.[31] This has added value to the product by improving its quality and increased the price at which the people can sell their products. As a further improvement, the project is helping the people to grind the dried medicinal herbs and produce dipping bags.

Ruhuna University is helping Practical Action to overcome some technical problems the beneficiaries faced with dipping bags and Rural Enterprise Network (REN) is helping the beneficiaries to market the product more profitably. Although this stage of the processing is not using renewable energy it is enabling the producers to get more income. Mr Kapila Weeratunga Aarachchi is implementing another project to introduce biomass heated driers to dry fruits and vegetables.

The information available is not sufficient to compute the additional income gained from these improvements. As the numbers involved in these projects are limited, the value addition by these improvements is relatively small from a national perspective but the additional income is significant for the beneficiaries. Once these improvements are adopted more widely, they would contribute to the national income more substantially.

6.3 Technical Assistance

A major problem that VECSs have faced is the shortcomings of machinery, especially turbines, supplied to village micro-hydro projects by developers / suppliers. A turbine testing facility has been established at NERD and developers have been encouraged to have turbines produced by various manufacturers / suppliers tested. It is proposed to make turbine testing mandatory to ensure better quality turbines are installed in micro-hydro projects.

A complaint by some VECSs is the difficulties they experience in getting technical assistance when their machinery and equipment breakdown. However, a majority of consumers are satisfied with the service provided when there are breakdowns.[32]

In the case of SHSs breakdowns were far less. Most the problems are experienced by those who do not follow the advice given by suppliers on the proper use of the system. The beneficiaries are satisfied with the service provided by the largest of the SHS suppliers but there was much dissatisfaction expressed by those who had obtained their SHSs from other suppliers.[33]

[30] *Renewable Energy Technologies for Spice Drying*, Final Report, Alliance for Appropriate Technology Exchange, Kandy

[31] Reported earlier in QPR 4/2005

[32] Draft Report by ACNielsen Lanka (Pvt) Ltd., on *Off-Grid Consumer Satisfaction"*, September 2006, Table 5.5.8, p. 108

[33] Ibid., Table 4.5.10, p. 64 (Names of suppliers have been left out deliberately.)

6.4 Capacity Building

Capacity building has been undertaken at various levels through training. The developers are expected to train the office-bearers of VECSs on managing their societies but many developers do not do this adequately. Also when office-bearers change, the new office-bearers lack the required knowledge. FECS was contracted to conduct 10 training courses in 2004 to strengthen the management capacity of 300 VECSs office-bearers and other members. In fact it had trained 314 representatives from 120 VECSs. It was contracted again in 2006 to conduct 10 more training courses to strengthen the capacity of office-bearers and members from VECSs that had not received training earlier. Until now it has conducted 5 training courses for 161 office-bearers and members from 34 VECSs. The M&E consultant was making arrangements to gather data that could be used to evaluate the impact of training but this was possible only for one training course so far due to various problems. Fresh attempt by M&E consultant to evaluate at VECS level the impact of training undertaken by FECS has now been launched and its findings will be included in the next report.

Other training courses have been conducted to strengthen the capacity of developers and manufacturers of machinery and equipment. NERD Centre conducted training for 13 developers in April-May 2006.

6.5 Institutional Framework

The different components of the RERED Project have required different institutional arrangements.

6.5.1 Institutional Arrangements

There are 13 registered suppliers of SHSs and 30 registered developers for off-grid village hydro projects. The performance of developers is monitored by DFCC AU and those whose performance is unsatisfactory could be blacklisted.

6.5.1.1 Grid-Connected Projects

Developers are able to borrow funds from PCIs on a long-term basis, but technical assistance is limited because the projects are envisaged as commercial investments. Being private enterprise investments, the developers benefit from successfully completing and operating these projects under a standardised Small Power Purchase Agreement (SPPA) signed with the CEB.

6.5.1.2 Off-Grid Community Based Projects

These are envisaged as community investments. In addition to being able to get loans from PCIs and even non-PCIs and technical assistance grants, they are entitled to receive a subsidy also on completion of the projects. In some Provinces, Provincial Councils also provide a grant towards the project costs. The community is expected to provide labour and other contributions towards the cost of the project.

The developers are responsible for designing and implementing the projects after the designs have been approved. They are required to organise the consumers into Village Electricity Consumer Societies and enable them to manage their organisations and the project by providing required training. PCIs / MFIs grant loans to the consumers but the VECSs act as

intermediaries to obtain the loan and repay it. The long-term sustainability of these projects depends on how well the developers implement the physical aspects of the projects and on how well they mobilise the communities and train the VECSs to perform their responsibilities.

Several problems were experienced in the micro-hydro project component due to the failure of some developers to fulfil these responsibilities. Some developers have been delinquent in completing the physical aspects of the projects. Social mobilisation and organisational development knowledge and skills of several developers have not been adequate to mobilise the communities and organise effective organisations (see Appendix 15).

To overcome this problem, DFCC AU decided to register developers; 30 developers have been registered as at 30/09/06. They are admitted based on basic criteria regarding qualifications and experience and their performance is tracked by DFCC AU. Blacklisting is also possible. Operating procedures have also been tightened. Hatton National Bank which is main PCI that finances micro-hydro projects has also started to interview developers before approving loan applications. These measures have substantially reduced the delinquency rate in project completion.

Below stated capacity performance and breakdowns are problems that several micro-hydro projects have experienced. As has been stated in Section 4.4 the actual capacity in 44.0% of the micro-hydro projects is below the planned capacity. VECSs experience problems with turbines and other equipment that affect power generation. Breakdowns might be due to below standard machinery as well as unsatisfactory O&M. To overcome these problems DFCC AU is now registering manufacturers and suppliers. The Project is moving towards mandatory testing of turbines at NERD testing facility which has been established with funds from other sources.

6.5.1.3 SHSs

The installation of SHSs is very much a private transaction between the purchaser, supplier and credit provider. Uva Provincial Council supported this initially in 2001 by providing a subsidy to enable HHs in the province that had no access to grid electricity to purchase SHSs. DFCC AU (under the ESD Project) assisted the PC with technical advice on implementing the subsidy more effectively. Due to financial constraints it could not continue this and the Government stepped in and extended the subsidy programme to the North Eastern, Sabaragamuwa and Uva Provinces in 2003-2005. The implementation of this extended subsidy programme was administered by DFCC AU, and in 2006 the programme was made islandwide.

The GEF cofinancing grant available under the Project is available countrywide, and is based on system capacity. This is also administered by DFCC AU which ensures that SHSs installed comply with Project requirements DFCC AU pays the GEF grant direct to the suppliers of SHSs on evidence of installation. It is intended as much to develop the infrastructure of the suppliers in order that they become viable as to make the purchase of SHSs affordable to low income HHs. As was expected the Government extended the subsidy programme to the whole island in 2006 with the phasing out of the GEF subsidy. This is also being administered by the DFCC AU.

To facilitate local certification of solar panels and balance of system components, the RERED Project provided technical assistance to NERD

Centre to get its solar PV testing facility accredited to international standards. This has helped the local solar companies to introduce new products to the market at competitive prices.

6.6 Micro-Hydro Institutional Performance & Sustainability

The off-grid micro-hydro component makes up only 0.4% of the approved credit programme and 0.2% of the credit disbursed up to 30/09/06 for the grid-connected mini-hydro, SHS and off-grid village-hydro components[34] but for the village communities that invest in micro-hydro projects, its importance is beyond quantification. They invest their hard earned funds but more importantly they invest their hope for a better life in these projects. Even the very poor HHs make their contribution foregoing their essentials to get electricity and undergo many difficulties as they had to contribute their labour too for the projects. Sheer determination and commitment of the people to realise their dream made everything possible.

While the level of performance of micro-hydro projects depends on the performance of developers, machinery/equipment suppliers and VECSs, the long-term sustainability of these projects depends on the performance of the VECSs (see Appendix 15).

6.6.1 Role of Developers

Developers have a key role not only in planning and implementing micro-hydro projects but also in mobilising communities to organise themselves to operate and maintain these projects. The long-term benefit from these projects depends largely on how well the developers fulfil their responsibilities. FGDs conducted in 2005 indicated that about 50.0% of VECSs were disappointed with the work done by the developers. FGDs conducted in 2006 revealed that 3 out of the 15 VECSs (33.0%) were unhappy with the developer.

As the following sections will show, communities have had to face hardships as a result of the failure of some developers to fulfil their responsibilities. FGDs in 2006 revealed that 11 out of 16 projects (68.0%) faced problems with their machinery/equipment.

6.6.2 Performance of Developers

Power interruptions and poor quality of lighting are the main complaints consumers have about village hydro sub-projects. All VECSs complained that the installed capacity is less than the planned capacity.[35] This could account partly for the poor quality of lighting.

The FGDs conducted with VECSs in 2005 showed that about 50% of the developers had not created a proper awareness among rural communities on the benefits and limitations of micro-hydro projects and instead created high expectations.

Communities were pleased especially with developers who had previously engaged in community development, as they had implemented the projects successfully. However, developers who were competent only technically lacked competence in social mobilisation and organisational development. One developer even lacked competence in technical aspects and abandoned the project. 2006 FGDs indicated that two-thirds of the 16 projects

[34] Data up to 30/09/06 provided by DFCC AU

[35] Installed capacity was below the planned capacity in 44.2% of the sub-projects (see Appendix 9)

experienced problems with machinery and equipment. Two projects needed complete rehabilitation.

6.6.3 Performance of VECSs

Of the 31 VECSs with which FGDs were conducted in 2005 and 2006, only 13 (42.0%) are functioning well. 16 societies (51.6%) exist in name only. They perform the functions necessary to maintain the micro-hydro projects but hardly conduct regular meetings, elect office bearers, keep proper records or do their transactions in a transparent manner. The remaining 2 had ceased to function as the projects had come to a standstill.

M&E team has identified 13 characteristics that are desirable for VECSs to acquire for effective performance:

1. Adoption of a well formulated Constitution with authority for the Executive Committee to impose penalties on consumers who do not abide by the rules governing membership and use of electricity.
2. Proper understanding of the Constitution by all members.
3. Preparation and implementation of an Annual Plan by the Executive Committee.
4. Regular General and Executive Committee meetings.
5. Majority of the members attend General Meetings.
6. Maintenance of transparency in the conduct of the affairs of the Society, especially in financial matters. Presentation of information on income and expenditure at General Meetings.
7. Regular auditing of accounts by an internal Audit Team appointed annually.
8. Imposition of penalties on consumers who infringe rules regardless of their status. Majority of the membership appreciate imposition of penalties.
9. Appointment of office-bearers from among members who demonstrate commitment.
10. Commitment of the successive office bearers, caretakers and the general membership to adhere to the Constitution and general functions of the VECS.
11. Continued support by the Developer for a limited period after completing the project and the cordial relationship it maintains with VECS. This helps to get prompt services at times of breakdowns, etc.
12. Supply of electricity to non-members for special occasions such as a weddings, funerals, etc.
13. Paying attention to factors contributing to sustainability of the power station and VECS.

These could be used to evaluate the effectiveness of VECSs before developers are paid their final instalment.

Where developers have trained office-bearers of VECSs to manage the society and caretakers to operate and manage the project, the societies are functioning well and the VECSs appreciate the service of the developer. They also appreciate the training provided by FECS to strengthen their capacity. This demonstrates the need for follow up action to strengthen VECS capacity to ensure their effectiveness and sustainability.

VII CONCLUSIONS & RECOMMENDATIONS

The Project is satisfactorily in the process of achieving its two objectives: improve the quality of life of rural people by using off-grid renewable energy technology to bring electricity to remote communities and promote private sector generation of electricity to supply to the main grid. Availability of electricity has improved the quality of life of rural people, especially of women and children, in several ways and also helped them to gain some economic benefits. Despite some impediments to expanding capacity of grid-connected projects, significant achievements have been made.

Building on the achievements of the ESD Project, RERED Project has achieved commendable progress in demonstrating how the private sector can play an active role in developing the renewable energy sector.

There is considerable private sector interest to invest in mini-hydro projects but investment in this sector is constrained by the inability of the CEB to absorb the power generated. Communities are quite interested to develop off-grid micro-hydro projects. Manufacturers of turbines and other machinery for these projects have improved their skills and NERD has established a testing centre for turbines. Non-PCIs have come forward to finance such projects. The decision of the government to provide a subsidy of Rs.10,000/- per off-grid HH is encouraging, and is in line with the phasing out of the GEF grant. A few problems have to be overcome to make these projects more effective and sustainable. In some areas, the demonstration effect has encouraged groups of individuals to generate hydro power on a very small scale. 13 suppliers of SHSs have strengthened their capacity to supply and service SHSs and MFIs have been successful in providing credit for these. More than 8 ESCOs are providing energy efficiency services. All these achievements have contributed to promote private sector investment in power generation from renewable energy resources.

The areas of Project activity that are of some concern are the performance and sustainability of some of the VECSs and the delays in completion of mini-hydro and micro-hydro projects.

7.1 Target Achievement

7.1.1 Quantitative Achievements

While overall the Project has made good progress in achieving its targets, the grid-connected mini-hydro component has fallen behind recently. With 69.6% of the project duration completed, the target achievement in the main project components is as follows:

Grid-connected	65.9%
Off-grid Electrification of HHs	76.8%
Electrifying Institutions & Enterprises	78.2%
ESCOs	200.0%

With 15 months to complete approved mini-hydro projects, only 58.5% of them had been completed generating 55 MW. A further 30 MW have to be completed within the next 15 months to achieve the target of 85 MW.

The Project is due to end by 31/12/2007 but micro-hydro projects should be completed by Qr. 3/2007 to avail of the GEF grant and project preparation fees under RERED. On the basis of the trend lines fitted (Appendix 16), quarterly forecasts from Qr. 4/2006 up to Qr. 4/2007 have been calculated in respect of;

i. Capacity (MW) of Grid-Connected Mini-Hydro Schemes,

ii. No. of households served by Solar Systems (SHSs), and
iii. No. of households served by Village Micro-Hydro Schemes.

The results are given in Table 7.1. For easy comparison, the last two rows of the table indicate the Project targets for each variable under study. On comparison of the forecast for end of the Project with the Project targets, it can be seen that according to the current trend, Project targets of 100,000 HHs will be exceeded in the case of households served by SHSs and village micro-hydro projects, whereas, although 108.5 MW of mini hydro have been approved, the Project target of 85 MW capacity for grid-connected projects will not be achieved. As this is a forecast based on past performance, acceleration of project implementation during the remaining period of the Project could make the target achievable.

Table 7.1: Quarterly Forecasts from Qr. 3/2005 up to Qr. 4/2007 on the basis of Trend Lines [36]

Quarter (x value)	Capacity (MW) of Grid-Connected Hydro Projects (1)	No. of HHs with SHSs (2)	No. of HHs served by Village Micro-Hydro Projects (3)
4/2006	57	81,116	3,563
1/2007	58	86,255	3,759
2/2007	59	91,395	3,954
3/2007	60	96,534	**4,150**
4/2007	**62**	**101,674**	
Forecast	***62***	***105,824***	
Targets	**85**	**100,000**	

(*) Trend Lines:

Whereas there is a considerable potential to develop the mini-hydro sector, the most serious problem faced by developers of mini-hydro projects is the issue of grid interconnection because sub-stations of CEB are unable to absorb additional power. Delays in obtaining various approvals (see Appendix 8) is also a serious problem as the completion of mini-hydro projects is delayed by it.

The performance of the micro-hydro sub-sector has been hindered by shortcomings of developers, machinery and equipment problems and weaknesses of VECSs. As there is no specific target for this sub-sector, it is not possible to measure progress relative to target but the forecast for end of 2007 is around 4,300 HHs electrified. On that basis, SHSs need to provide electricity to 95,700 HHs to reach the target of providing electricity to 100,000 HHs from off-grid sources.

73,604 SHSs have been installed up to 30/09/06 requiring the installation of another 22,000 by end of 2007 to achieve the target. Considering that about 4,500 SHSs per quarter have been installed on an average during the past year, the target is achievable. With the extension of the government subsidy

(1) $y = 17.586\ln(x) + 12.810$ $R^2 = 0.9592$ x = 12 for 4/2006, 13 for 1/2007 and so on.

(2) $y = 5139.6x - 6257.6$ $R^2 = 0.9969$ x = 17 for 4/2006, 18 for 1/2007 and so on.

(3) $y = 195.6x + 824.69$ $R^2 = 0.9772$ x = 14 for 4/2006, 15 for 1/2007 and so on.

to the entire country which will balance the phasing out of the GEF co-financing grant the prevailing pattern of installing SHSs could be expected to continue. Half the SHSs installed under Project support have been in Ratnapura, Moneragala, Kurunegala and Ampara districts as the government subsidy was available only for Northeast, Sabaragamuwa and Uva Provinces which have the lowest grid penetration. The extension of the subsidy to other Provinces also should encourage a higher rate of installing SHSs in other districts.

It had been envisaged that with the phasing out of the GEF co-financing grant the government would take over the subsidising of SHSs. This has now come into effect and the government has decided also to extend the subsidy to HHs that receive electricity generated from other sources of renewable energy.

With 782 enterprises and institutions already electrified either by SHSs (655) or village micro-hydro sub-projects (127) 218 more need to be electrified to achieve the target of 1,000. If we assume that the ratio of enterprises and institutions to the number of HHs receiving electricity from SHSs and micro-hydro remains the same as it is now, the number of enterprises and institutions electrified will exceed the target.

Although the Project targeted 4, more than 8 ESCOs are providing energy saving services. However, standards and capabilities vary among ESCOs. Energy users are able to use their services, and banks that lend for energy efficiency projects are in a position to take comfort by using the partial credit guarantee facility made available by the Energy Conservation Fund. The RERED Project has funds to refinance sub-loans granted by participating credit institutions for such projects.

7.1.2 Qualitative Achievements

The 5 mini-hydro sub-projects surveyed showed a plant factor of 27.0% which is not satisfactory. This could be due to this quarter being the driest months of the year. Grid failure factor of 4.0% is very high. This is about 1 hour failure every day. Equipment down time of 1.0% is also high.

The quality of electricity supply from micro-hydro projects varies considerably with the performance of developers and VECSs, machinery and equipment, weather conditions and the discipline of consumers in the use of electricity. Because of the unsatisfactory situation with these variables, power failures and low voltage cause dissatisfaction among consumers. In some projects the situation is so bad that consumers have stopped paying their dues. Enterprises using electricity in these projects have also complained about low voltage affecting their machines and power interruptions affecting production costs. Consumers are not allowed to use electrical appliances during peak load hours in these projects but the failure by some consumers to abide by that condition has caused inconvenience to other consumers. Where the VECS is functioning well and can exercise its authority, this problem is kept under control.

SHS users do not experience that type of problem as they are responsible for operating and maintaining their own SHS. Their main problem arises from the overuse of the power stored in the batteries, usually to watch TV for too long. They also experience problems during rainy seasons when the amount sunlight is not sufficient to charge the batteries fully.

7.2 Project Impacts

7.2.1 Economic Benefits

Project has already saved the country much foreign exchange by substituting the use of electricity from fossil fuels with electricity from mini-hydro and biomass projects, SHSs and micro-hydro projects. This is a continuing benefit to the country and, in the case of SHSs and micro-hydro projects, represents a saving to more than 70,000 HHs. The generation of direct and indirect employment has brought additional income to the communities where mini- and micro-hydro sub-projects are located (see Sections 5.6 and 5.7).

7.2.2 Use of Electricity

The only domestic uses that can be made of electricity from SHSs are for lighting, watch TV or operate a radio or cassette player. Electricity from micro-hydro projects is used for several other purposes, in addition to the above uses. At home, it is used to iron clothes, operate fans and, in a few cases, to pump water or operate a refrigerator or a rice cooker.

Several enterprises are powered by village micro-hydro projects and SHSs. SHSs are used mainly to provide lighting as in grocery shops that make up 71.0% of the enterprises and to operate electronic equipment in enterprises like communication centres of which there are only two listed. In villages with micro-hydro projects a few enterprises use it to run machinery in carpentry sheds or rice/chilli grinding mills, refrigerate perishable foods in shops, operate telephones and computers. The enterprises that use electricity from these sources are almost entirely service activities catering to the local market.

As shown in the ACNielsen report also, most of them had been started before electricity was available and the availability of electricity has not led to many new enterprises being started. This is to be expected in these remote villages. Remoteness and other constraints make enterprises unprofitable in these villages even if electricity is available. It has, however, enabled the introduction of new types of enterprises and new technologies to these remote communities. A few that use electricity from micro-hydro projects to power machinery / equipment complain about the low voltage and power breakdowns.

The main benefit from electricity in these areas is the better quality of light and convenience compared to kerosene lamps. This has improved the quality of life and provided much psychological satisfaction to the people. It has also cut down smoke pollution in the house. Nearly 19 million litres of kerosene have been saved from the first quarter of 2003 till 30/09/06. This means 54.5 million kg less of CO_2 has been released into the air the consumers breathe at home. This is a continuing benefit and has a very important impact on health.

It has also enabled children to study longer duration in the night and adults to work longer hours at home or at their economic activities which has brought economic benefits to the communities.

7.2.3 Village Improvements

There is no benefit for local communities in the way electricity from mini-hydro projects as they feed electricity to the national grid. In order to win the goodwill of these communities, mini-hydro developers have undertaken many improvements in these communities. Apart from providing employment to several persons in the community they have improved roads and developed educational, health and religious facilities in the community. Village level survey of mini-hydro projects confirmed that, except for a few developers, they have improved infrastructure in the village. This has created a cordial relationship between the management of mini-hydro projects and the communities.

7.2.4 Innovation Solicitation

The Project has supported the introduction of solar driers to dry medicinal herbs and spices. This has improved the quality of the products and increased the earnings of the producers. A biomass drier is being introduced to dehydrate vegetables and fruits. A few organisations have introduced economic enterprises into a few villages with micro-hydro projects. These are providing additional income for those who own the enterprises and services to the community.

7.2.5 Capacity Building

Developers, VECSs, suppliers and manufacturers of machinery and equipment have benefited from opportunities that the Project has provided to improve their capacity.

7.3 Issues & Recommendations

The issues to be raised in this report are ones which have been raised in earlier reports also. However, looking at them from the perspective of a longer period gives them more significance.

1. Developers of both grid-connected mini-hydro and off-grid micro-hydro projects experience several difficulties related to obtaining necessary approvals from government agencies at national, provincial and divisional levels that delay the completion of projects. This delays the completion of sub-projects and represents an additional cost to the developers and, in the case of micro-hydro projects, to the village communities also.

   The government decisions to increase the tariff for power generation using biomass, extend the subsidy for SHSs to the entire country and for power generation from micro-hydro projects will make the investment environment in these sectors more favourable. More needs to be done to streamline the approval procedures to avoid the delays and make the utilisation of renewable energy more convenient and advantageous economically.

2. There is a considerable potential to generate power through mini-hydro and biomass projects but problems connected with grid failure and absorption capacity of sub-stations are hindrances to utilising this. This is a loss to the country as the use of fossil fuels to meet the increasing demand for electricity will cost the country much foreign exchange.

   The Project can take up this issue with the CEB to seek a way to solve this problem.

3. The potential to develop the village micro-hydro potential is affected by problems connected with the failure of developers to fulfil their responsibilities and shortcomings in the machinery and equipment. Tightening of procedures by DFCC AU has improved this situation. Some developers have lacked expertise in mobilising and organising communities to develop strong and effective VECSs. O&M in some projects has been adversely affected by inadequate training. The checking of project completion at present does not pick up these shortcomings. VECSs have found it difficult to get after sales service from some suppliers of machinery and equipment.

   The Project has started to register developers based mainly on their technical qualifications and experience about a year ago and the Project monitors their performance. This has improved the situation with regard to the developers. It is proposed to make turbine testing mandatory which would overcome some of the problems connected with machinery.

   It is desirable to grade developers and machinery/equipment suppliers on the basis of their performance. It is also desirable to institute a system of monitoring project implementation from design verification to installation verification to make it possible to detect problems as they occur and take remedial action. At present this happens at quarterly meetings of the Working Group on Village Hydro (WGVH) and the projects discussed are the problem cases.

4. Not many new economic enterprises have started as a result of electricity being available but it is also difficult to promote economic enterprises through the kinds of organisations presently undertaking such activities. It requires specialised skills in the preparation of business plans, marketing and other areas of enterprise promotion. Problems connected with power supply are also a constraint.

   The present practice of promoting improved technologies and introducing enterprises that can make use of electricity might be the best way to proceed as it is unrealistic to expect significant economic development as a result of electricity being made available, especially through SHSs. It is desirable to assess the experience of promoting enterprise development of organisations when selecting them to start economic activities in project areas.

5. The capacity building that VECSs have received from developers has not been sufficient for most VECSs to manage their societies and operate the sub-projects effectively. Many developers who have implemented village micro-hydro projects do not have much competence in social mobilisation and organisational development. Recent courses to strengthen their capacity have attempted to overcome this deficiency by including some modules on these subjects.

   It is unrealistic to expect developers who are not competent in social mobilisation and organisational development to acquire the necessary skills through short training courses. It is better to require them to contract field workers with such experience when undertaking micro-hydro sub-projects or get that aspect of the project implemented by organisation with the necessary competence. Before developers are paid their final instalment, the performance of VECSs should be evaluated. The characteristics of a well functioning VECS that have been identified (in sub-section 6.6.3) could be used to evaluate this. Monitoring and training of VECSs should be continued for a limited period even after project completion to ensure that VECSs are fully competent on carrying out their responsibilities.