

ROYAL MINISTRY  
OF FOREIGN AFFAIRS  
Norway

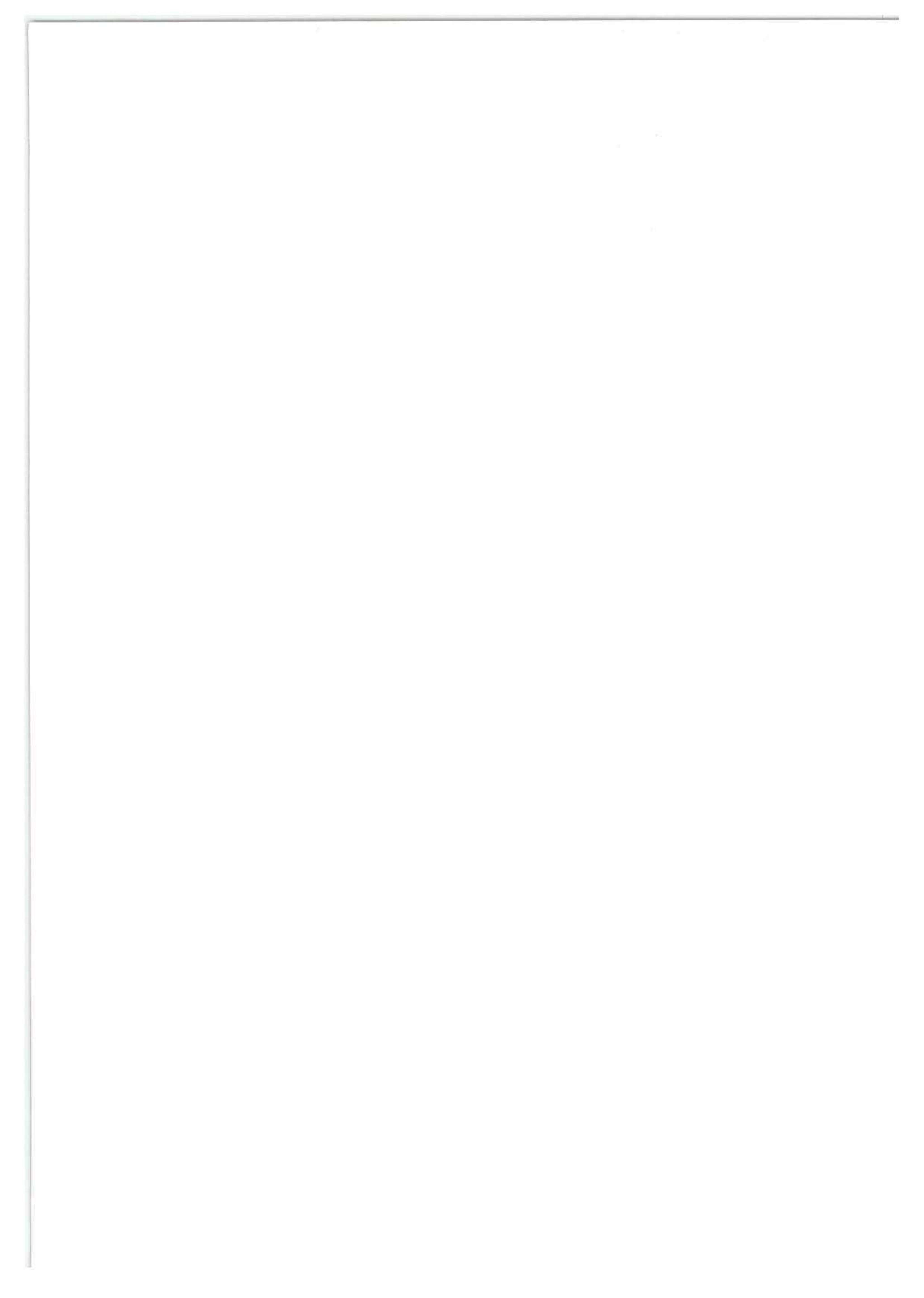
# Evaluation Report 1.90



**MINI-HYDROPOWER  
PLANTS  
IN LESOTHO**

by  
The Centre for  
Development and Technology  
University of Trondheim





# **EVALUATION OF MINI-HYDROPOWER PLANTS IN LESOTHO**

**Final report**

**Rune Skarstein**

**Frances Chinemana**

**Dagfinn K. Lysne**

**Centre for Development and Technology**

**University of Trondheim**

**July 1990**

EVALUATION OF MINI-HYDROPOWER PLANTS IN LESOTHO

Final report

Rune Skarstein  
Frances Chinemana  
Dagfinn K. Lyane

Centre for Development and Technology

University of Trondheim

July 1990



**CONTENTS**

	<b>Page</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>LIST OF FIGURES</b>	<b>vii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>viii</b>
<b>MAP OF LESOTHO</b>	<b>x</b>
<b>PREFACE</b>	<b>xi</b>
 <b>SUMMARY AND RECOMMENDATIONS</b>	 <b>1</b>
 <b>I</b>	 <b>2</b>
<b>GENERAL ASPECTS</b>	
I.1	2
Introduction	
I.2	2
Main features of the economy	
I.3	4
The energy sector	
 <b>II</b>	 <b>6</b>
<b>POLICIES</b>	
II.1	6
Lesotho's energy sector policies	
II.2	9
Principal objectives of Norwegian development assistance	
 <b>III</b>	 <b>11</b>
<b>THE MANTSONYANE AND SEMONKONG HYDROPOWER PROJECTS</b>	
III.1	11
Objectives	
III.2	12
Project implementation	
III.3	16
Economic aspects	
III.4	19
Socio-cultural aspects	
 <b>IV</b>	 <b>20</b>
<b>RECOMMENDATIONS</b>	

<b>1.</b>	<b>GENERAL ASPECTS</b>	<b>22</b>
<b>1.1.</b>	<b>REVIEW OF ECONOMIC AND SOCIAL STRUCTURES AND NATURAL RESOURCES</b>	<b>23</b>
1.1.1.	The Country	23
1.1.2.	The population of Lesotho	23
1.1.3.	Natural Resources	24
1.1.4.	Main features of the economy	24
	The role of migrant labour	25
	The agricultural sector	26
	Lesotho's balance of payments position	28
<b>1.2.</b>	<b>REVIEW OF LESOTHO'S ENERGY SECTOR</b>	<b>30</b>
1.2.1.	General aspects	30
1.2.2.	Fuelwood and biomass	31
1.2.3.	Electricity consumption and hydropower potential	33
1.2.4.	Energy demand forecasts	35
1.2.5.	Summary	38
<b>2.</b>	<b>POLICIES</b>	<b>39</b>
<b>2.1.</b>	<b>LESOTHO'S ENERGY SECTOR POLICIES</b>	<b>40</b>
2.1.1.	Policies and strategies in the energy sector	40
2.1.2.	Measures on the demand side	41
	Energy conservation in buildings	41
	Energy conservation in commerce and industry	41
	Energy saving in rural households	41
	Energy conservation in the transport sector	42

	Substitution of commercial energy sources by solar energy	42
2.1.3.	Measures on the supply side	42
	Accelerated afforestation for energy purposes	42
	Decreased use of crop residues and animal dung for energy purposes	43
	Introduction of biodigesters in rural areas and for industrial use	44
	Expansion of the indigenous hydropower potential	44
	Expansion of the mini-hydropower potential	45
	Establishment of a strategic fuel depot	45
	Exploration of potential of fossil fuels	45
2.2	<b>PRINCIPAL OBJECTIVES OF NORWEGIAN DEVELOPMENT ASSISTANCE IN THE 1980s</b>	<b>47</b>
2.2.1.	General objectives	47
2.2.2.	General objectives of Norwegian assistance to SADCC	50
3.	<b>THE MANTSONYANE AND SEMONKONG HYDROPOWER PROJECTS</b>	<b>52</b>
3.1.	<b>OBJECTIVES OF THE PROJECTS AND ASSESSMENT OF THEIR COMPATIBILITY WITH DONOR AND RECIPIENT COUNTRIES' POLICIES</b>	<b>53</b>
3.2.	<b>PROJECT IMPLEMENTATION</b>	<b>55</b>
3.2.1.	Review and feasibility studies	55
3.2.2.	Plan and contracts for implementation of the Semonkong and Mantsonyane hydropower projects	57



3.2.3.	Project organisation and institutional aspects of project implementation	57
3.2.4.	Implementation schedule	60
3.2.5.	Cost assessment	65
3.3.	<b>PROJECT DESCRIPTION IN BRIEF</b>	<b>74</b>
3.3.1.	The Semonkong project	75
3.3.2.	The Mantsonyane project	78
3.3.3.	Operation	81
3.4.	<b>TRAINING IN DESIGN, CONSTRUCTION AND OPERATION</b>	<b>83</b>
3.4.1.	Training in planning and design	83
3.4.2.	Training during construction	83
3.4.3.	Training of operating personnel for full assumption of project operations	85
3.5.	<b>ECONOMIC ASPECTS</b>	<b>86</b>
3.5.1.	Internal and financial rates of return	87
3.5.2.	Economic effects	92
	General economic effects of the Semonkong project	92
	Foreign exchange savings	95
	Employment effects	100
3.6.	<b>SOCIAL, CULTURAL AND ENVIRONMENTAL ASPECTS OF THE PROJECTS</b>	<b>102</b>
3.6.1	Socio-economic aspects	102
3.6.2	Health- and gender aspects	107
3.6.3	Environmental aspects	108

**REFERENCES** 111

**INSTITUTIONS AND PERSONS VISITED  
DURING FIELD WORK** 116

**TERMS OF REFERENCE** 119

Table 1.2.1.	Hydropower projects planned to be in operation before the year 2000	35
Table 1.2.2.	Composition of the total final energy demand by sectors in the year 2010	36
Table 1.2.3.	Final energy demand by fuel for 2010 and 1984. Comparison of scenarios	37
Table 3.2.1.	Estimated flood frequencies at Mantsonyane	63
Table 3.2.2.	Summary of cost developments. NOK '000	68
Table 3.2.3.	Professional services: Breakdown of accumulated costs at end of June 1989	72
Table 3.2.4.	Equipment from NORWAY: Breakdown of accumulated costs at end of June 1989	73
Table 3.2.5.	Total finance for Mantsonyane and Semonkong projects per Marsh 1989	74
Table 3.5.1.	The internal economics of the Mantsonyane hydropower plant	89
Table 3.5.2.	The internal economics of the Semonkong hydropower plant	90
Table 3.5.3.	The internal economics of the total project (Mantsonyane and Semonkong combined)	90
Table 3.5.4.	Annual forex costs of diesel- and hydro-electricity, respectively, at Semonkong. Maloti '000 at 1989-prices	96
Table 3.5.5.	Annual net foreign exchange savings of Mantsonyane hydropower plant. M '000 at 1989 prices	98
Table 3.5.6.	Numbers of Basotho workers employed by NOREMCO at Mantsonyane and Semonkong during the construction period. Averages in each period	101



**LIST OF FIGURES**

2.1.1.	Policy and strategies in the energy sector	46
--------	--	----

## LIST OF ABBREVIATIONS

ATS	-	Appropriate Technology Services
DOE	-	Department of Energy (within WEMMIN)
DWA	-	Department of Water Affairs (within WEMMIN)
ESCOM	-	Electricity Supply Commission (in the RSA)
forex	-	foreign exchange
FPP	-	Fuelwood and Poles Project
GDP	-	gross domestic product
GNP	-	gross national product (= GDP + NFI)
GJ	-	gigajoule (= $10^9$ joule)
GOL	-	Government of Lesotho
GWh	-	gigawatthour (= $10^6$ kWh)
GWP	-	Government White Paper (in Norwegian: Stortingsmelding)
ha	-	hectare
H.W.P.U.	-	Highlands Water Project Unit
ILO	-	International Labour Organisation
IMF	-	International Monetary Fund
J	-	joule
km	-	kilometre
km <sup>2</sup>	-	square kilometre
KOL	-	Kingdom of Lesotho
KV (or kV)	-	kilovolt
KW (or kW)	-	kilowatt
KWh (or kWh)	-	kilowatthour
LCU	-	Labour Construction Unit
LEC	-	Lesotho Electricity Corporation
LEMP	-	Lesotho Energy Masterplan
LHDA	-	Lesotho Highlands Development Authority
LHWP	-	Lesotho Highlands Water Project
LNDC	-	Lesotho National Development Corporation

LNG	-	liquid natural gas
M	-	maloti
m	-	metre
m <sup>2</sup>	-	square metre
m <sup>3</sup>	-	cubic metre
m <sup>3</sup> /s	-	cubic metre per second
MDC	-	Ministry of Development Cooperation
mill.	-	million
MJ	-	megajoule (= 10 <sup>6</sup> joule)
MPEA	-	Ministry of Planning and Economic Affairs
MW	-	megawatt (= 10 <sup>3</sup> KW)
MWh	-	megawatthour (= 10 <sup>3</sup> KWh)
NFI	-	net factor income (from abroad)
NOK	-	Norwegian kroner
NORAD	-	Norwegian Agency for International Development
NOREMCO	-	a Norwegian civil construction works contractor
NORPLAN	-	a Norwegian civil engineering consultancy firm
NUL	-	National University of Lesotho
NVE	-	Norw. abbrev. for Norwegian Water Resources and Energy Administration
NWREA	-	Norwegian Water Resources and Energy Administration (in Norwegian: NVE)
PJ	-	petajoule (= 10 <sup>5</sup> joule = 10 <sup>6</sup> GJ)
Planoff	-	Planning office (within MPEA)
R	-	rand
RSA	-	Republic of South Africa
SACU	-	Southern African Customs Union
SADCC	-	Southern African Development Coordination Conference
TB	-	tuberculosis
TJ	-	terajoule (= 10 <sup>12</sup> joule)
%	-	percent
\$	-	U.S. dollar







## PREFACE

The present report was commissioned by the Norwegian Ministry of Development Cooperation to the Centre of Development and Technology (CDT), The University of Trondheim. The team members were:

Rune Skarstein, senior lecturer  
Department of Economics  
Univ. of Trondheim - AVH (team leader)

Frances Chinemana, consultant  
Harare  
Zimbabwe

Dagfinn K. Lysne, professor  
Department of Civil Engineering  
The Norwegian Institute of Technology  
Univ. of Trondheim

The field work for the study was carried out from 3rd to 8th September 1989.

The present report is an abbreviated version of a more lengthy "Study of mini-hydropower plants in Lesotho", CDT, Trondheim, 1990. In that study, Chapter 1 is far more comprehensive. Those who are interested, may order our study through the Evaluation Office in the Ministry of Foreign Affairs or directly from the CDT.

We wish to take this opportunity to thank all institutions and persons who assisted us at various stages of our work.

The hospitality, openness and help with which we were met by people and institutions in Lesotho made our short period of

field work most successful. In particular, we are indebted to Mr. Tseliso B. Sekoli at the Ministry of Water, Energy and Mines for his excellent guidance and for all the appointments he made for us on a very short notice.

A draft version of this report was sent to some persons and institutions for comments. We acknowledge useful comments and factual corrections from the following persons: Mr. Egil Skofteland, Mr. Torodd Jensen and Mr. Steinar Grongstad in NVE, Mr. Per Bang Rolfsen in NOREMCO, and Mr. Jan Lindemark and Mr. Ove Rusten in NORPLAN. Let us haste to add that the team alone is responsible for all opinions and any remaining factual errors in our report.

Finally we would like to thank Ms. Birgit Ilstad for her conscientious and efficient typing of our manuscripts.

Trondheim/Harare, July 1990

Rune Skarstein, Frances Chinemana, Dagfinn K. Lysne



## **SUMMARY AND RECOMMENDATIONS**

SUMMARY AND RECOMMENDATIONS

## **I. GENERAL ASPECTS**

### **I.1 Introduction**

Lesotho is a landlocked country of 30400 km<sup>2</sup>, completely surrounded by the Republic of South Africa (RSA). In mid-1989, the population of Lesotho was estimated at about 1.71 mill., and the gross domestic product (GDP) per capita was 258 US \$, which is low compared to the average of SADCC countries.

Lesotho possesses few natural resources upon which to build its development efforts. Only about 13% of the land area is cultivable and there is a severe population pressure on cultivable land. There are no forests, apart from planted forest reserves covering 7000 ha in 1987. As a result of deforestation and overgrazing, there is increasing soil erosion and soil degradation. The country is today facing a mounting fuelwood crisis.

The only significant natural resource is water, including a considerable hydropower potential estimated at about 1500 GWh per year.

### **I.2 Main features of the economy**

The most outstanding feature of the economy of Lesotho is its extreme dependence on the RSA. Among the ties responsible for this dependency are the monetary union and the pegged exchange rate with the RSA, membership of the Southern African Customs Union (SACU) - implying a heavy dependence of the government of Lesotho (GOL) on customs revenues from SACU -, and the large volume of migrant workers' remittances from the RSA. In addition Lesotho is dependent on the RSA for virtually all its exports and imports, including all imports of energy.



In 1988, about 125 000 Basotho men, representing half of the total male population between 20 and 45 years of age, were working in South African mines. Migrant workers' remittances represented more than 40% of Lesotho's gross national product (GNP) and financed 60% of total imports, whereas SACU revenue financed about 10%, and export earnings only 15%. As a result of the high share of imports financed by migrant workers' remittances and SACU revenue, imports were more than six times larger than export earnings in 1988.

There are now clear signs that migrant workers' remittances as well as SACU revenue will decline significantly in the 1990s. If Lesotho does not succeed in restructuring and reviving its domestic economy, the result will be a dramatic balance of payments crisis.

In the 1970s, the GDP was growing at a relatively high rate of 7% per year; but since 1980, the economy has stagnated. A major reason for this is the stagnation of agriculture, with per capita production declining by 11% from 1980 to 1988. Droughts in the early 1980s can to some extent explain the agricultural stagnation. However, even with good rainfall later in the 1980s, food production per capita has remained far below the levels of the late 1970s. Most importantly, crop yields have remained at a low level or continued to decline. The major cause of declining yields seems to be degradation and erosion of arable lands due to deforestation, use of animal dung and crop residues for fuel, and overgrazing.

As a result of declining agricultural production per capita, Lesotho has had to import an increasing share of its food consumption. About half of the food consumption is now imported from the RSA. In 1985, imports of food, beverages and tobacco accounted for 23.3% and energy except fuelwood 8.9% of total imports. In other words, food and energy accounted for one third of the total import bill. Lesotho can hardly respond to declining mining workers' remittances and SACU revenue by restraining



imports without reducing the imports of these two commodity categories, i.e. replacing imported food and energy with domestic production.

On the other hand, increased domestic production of energy, especially substitution of animal dung and crop residues as fuels, by other sources of energy, may be an important factor in increasing agricultural yields and production.

### **I.3 The energy sector**

The Lesotho Energy Masterplan (LEMP) estimated total energy consumption in the country in 1984 at about 25 000 TJ, equivalent to 17 000 MJ or somewhat less than 400 kg of oil equivalents per capita. In 1987, consumption of commercial energy amounted to 6300 TJ, equivalent to 87 kg of oil equivalents per capita, which was 50% lower than the average level of the SADCC countries. The share of commercial energy in total energy consumption in Lesotho is about 25%.

Approximately 80% of total energy consumption takes place in rural households, 10% in urban households, 7% in transport, and the remaining 3% in industry, services and public sector activities.

In Lesotho, fuelwood accounts for only 36% of total consumption of traditional fuels, and 9% of the fuelwood supply is imported from the RSA. Shrubs account for 34% of consumption of traditional fuels, animal dung 24%, and crop residues the remaining 6%. While the use of animal dung has a long tradition, the burning of crop residues (mostly maize stalks) is a more recent phenomenon which is to be seen as a last resort if no other fuels are available. Conflicts are mounting, since these two resources should be used as manure or animal fodder. The increasing use of animal dung and crop residues as fuels is a sign of Lesotho's



mounting energy crisis. On the other hand, this energy use pattern results in further soil degradation and, as a consequence, further decline of agricultural productivity. The energy crisis and the agricultural crisis in Lesotho are intimately interconnected and mutually reinforcing phenomena.

Also with respect to commercial energy, the household sector consumes the largest share of 51% - mainly coal in urban and peri-urban households - with the transport sector accounting for 34% and the remaining 15% going to the production and services sectors.

Electricity accounts for less than 2% of total energy consumption and about 8% of total consumption of commercial energy, compared to an average of 20% in the SADCC countries as a whole. The low share of electricity reflects the low electrification rate which is estimated at about 2% of all households.

Electricity consumption increased at an average annual rate of 5.7% from 1980 to 1987 and reached 135 GWh in the latter year. Lesotho Electricity Corporation (LEC) supplies a total of about 7500 consumers, of which 1.5% (big commercial and industrial) account for more than 40% of total consumption.

Lesotho meets about 95% of its electricity needs through imports from South Africa's ESCOM system. Up to 1989, the remaining 5% were supplied by diesel generators running on imported diesel. Transmission and distribution to consumers is under the responsibility of the LEC which maintains a system of about 400 km of 33 kV and 700 km of 11 kV lines.

In 1987, urban households accounted for 34.5% of total electricity consumption, manufacturing industry consumed 16.5%, and services - mainly public offices, schools, clinics and hospitals - consumed the remaining 49%.

Hydropower is by far Lesotho's most promising energy source, potentially capable of meeting a substantial share of the



country's commercial energy demand. In 1976, a Swedish consultant estimated the total hydropower potential at over 1500 GWh per year. For comparison, total consumption of commercial energy in 1987 was equivalent to 1750 GWh, whereas total electricity consumption amounted to 135 GWh.

By the end of 1989, Lesotho had implemented four mini-hydropower projects with a total installed capacity of 3.5 MW and a possible annual production of 13 GWh per year, accounting for 9% of total electricity consumption. In the 1990s, the two hydropower projects at Muela (I) and Quthing are planned to be implemented. This will raise total installed capacity to 90 MW and total possible production to about 250 GWh per year (increasing further as the Katse reservoir supplying Muela is filled). The LEMP assumes that Lesotho will then become self-sufficient in electricity and probably even have an electricity surplus up to the year 2015.

## **II POLICIES**

### **II.1 Lesotho's energy sector policies**

The guidelines and recommendations of LEMP, which was completed in 1988, have been adopted by GOL as its official energy policy.

The policy of the energy sector is to secure the energy supply for all sectors and in all regions of Lesotho. To achieve this goal, a strategy has been developed which has the following objectives:

- to meet the projected demand for the future providing the services required;
- to supply the energy at minimum social and economic cost for the country; and

- to conserve the environment.

LEMP makes a distinction between measures on the demand side and the supply side, respectively. The measures on the demand side are:

- energy conservation in buildings, in commerce and industry, and in the transport sector;
- energy saving in rural households, amongst other things through introduction of energy-efficient stoves; and substitution of commercial energy sources by solar energy (mainly for water heating).

Measures on the supply side include:

- accelerated afforestation for energy purposes;
- decreased use of crop residues and animal dung in order to release these sources for other uses (manure, animal fodder);
- introduction of biodigesters in rural areas and particularly in industry (in order to exploit methane gas accruing in sewage and other industrial waste);
- expansion of the indigenous hydropower potential, selecting future hydropower projects very carefully and implementing only those which are really needed and more economic than electricity imports;
- expansion of the mini-hydropower potential should be limited to isolated systems without connection to the LEC grid, and the economic viability has to be proven in each individual case;



- establishment of a strategic fuel depot; and
- exploration of the potential of fossil fuels.

It is emphasised that the objectives of the woodfuel sector are to avoid a further depletion of the resource base, to cater for increased energy demand, to allow for a fuel switch from the problematic use of crop residues and animal dung to woodfuel, and to substitute fuelwood imports which currently account for 9% of total fuelwood consumption. To achieve all these objectives, requires - according to LEMP - that 200 000 ha or 6.6% of the country should be under forest plantations until the year 2010.

This contrasts sharply with the current plantation area of only 7000 ha (0.2% of the country) planted during the 15 years of the Lesotho Woodlot Project (LWP), from 1973 to 1987. The plantation programme of the LWP has been hampered by among other things disputes over grazing rights and land ownership, by illegal grazing and felling of trees, and forest fires caused by arson. In its 1973-1986 Review, the LWP reported that, "At present time there is very little in the way of new establishment of private or community woodlots. Problems over land tenure are a probable reason why there is so little interest."

The LWP terminated in June 1987 and has been succeeded by the Fuelwood and Poles Project (FPP) under the Forestry Division of the Ministry of Agriculture, Cooperatives and Marketing. The FPP appears to put more emphasis on establishing nurseries in order to provide private individuals and institutions with trees for planting, and on stimulating and encouraging peasants to establish private woodlots.

Hopefully, the FPP will succeed better than the LWP did. However, the severe overgrazing caused by overstocking of cattle and the pressure on land in general represent a massive constraint to the expansion of the forest area in Lesotho.



On the other hand, the LEMP asserts that continuing the present rate of afforestation means that Lesotho will be without trees and bushes soon after the turn of the century. It is surprising to us that the LEMP recommendations do not consider more rapid expansion of the hydropower potential against this background.

## **II.2 Principal objectives of Norwegian development assistance**

The major principles of Norwegian development assistance in the 1980s have been formulated in Government White Paper (GWP) No. 36 (1984-85) and GWP No. 34 (1986-87), and can be summarised as follows:

- to contribute to lasting improvement in the economic, social and political conditions of the population in the developing countries;
- to focus particularly on the needs of the poorest groups and countries;
- to avoid creating dependence on continued aid;
- assistance should be recipient-oriented, i.e. based on the plans and priorities of recipient countries; and
- assistance should be untied, and Norwegian supplies should only be used when prices are internationally competitive. Use of Norwegian supplies are accepted if they are not more than 10% above international market prices.

In both GWP's, women as a target group are given particular emphasis. This emphasis was given additional strength by the adoption of a special strategy for assistance to women in 1985.



The strategy has two main goals:

- women's living and working conditions must be improved; and
- women must be motivated and provided with opportunities to participate in economic, cultural and political activities with a view to change the mainstream of development to make it benefit women.

In sharp contrast to the official policy of the 1970s, GWP No. 36 (1984-85) as well as GWP No. 34 (1986-87) argue for a more central role for Norwegian industry and commerce, both in relation to ordinary bilateral assistance and for promoting industrialisation in developing countries.

The general objectives of Norwegian assistance to SADCC in particular are embedded in the agreement between the Nordic countries and SADCC which was signed in January 1986. This agreement emphasises the need of the SADCC countries to reduce their external dependence, and it acknowledges the vulnerability of SADCC states towards South African aggression and destabilisation. In the agreement the Nordic countries commit themselves to increase their support to SADCC's intraregional cooperation in areas given priority by SADCC. This commitment is also reflected in the Norwegian GWPs.

The section on SADCC in the GWP No. 34 concludes with the following statement: "The government will attach great importance to supporting the SADCC region, and contribute to its economic, political and cultural development, and to reducing the SADCC countries' dependence on South Africa" (ibid). Especially this latter statement has a particular relevance for Lesotho, since the country is totally dependent on the RSA for imports of virtually all commercial energy.



### III THE MANTSONYANE AND SEMONKONG HYDROPOWER PROJECTS

#### III.1 Objectives

In Annex I to the project agreement, signed by the governments of Lesotho and Norway on 2nd August 1985, it is stated that, "The objective of this agreement is to promote Lesotho's independence from import of energy, to stimulate village development and to promote manpower development and training within the hydropower sector. The schemes are intended to serve as pilot schemes for the SADCC region".

Furthermore, it is stated that, "Particular emphasis will be given to the training element and the future maintenance aspect. Adequate spares for routine maintenance will be provided under the Project". And, "Efforts shall be made to utilize local resources as far as possible, like local manpower, local workshops, Labour Construction Unit, etc."

We have seen that LEMP, which has been adopted as the official energy policy document of Lesotho states that the realisation of mini-hydropower plants should be confined to isolated systems, and that the economic viability of the projects has to be proven in each individual case. Mantsonyane, which was planned and agreed upon before the LEMP was adopted, may appear to be in conflict with this policy objective since it is not an isolated system but connected to the grid. However, the LEMP recommendations are based on the assumption that Oxbow (54 MW and 154 GWh per year) starts production in 1993, with Muela I (72 MW) following in 1995. When Mantsonyane was planned, these projects were still on a prefeasibility stage. And until they start production, Mantsonyane can supply relatively expensive peakload power to the grid and save foreign exchange for Lesotho, in addition to reducing its dependence on electricity imports from the RSA.

Apart from the problem we have now indicated, the objectives of Mantsonyane and Semonkong appear to be in line with donor and



recipient countries' policies.

### III.2 Project implementation

The projects were implemented in a joint venture between the Consultant (NORPLAN) and the Contractor (NOREMCO). Through the subcontractor (NOREMCO), the Consultant was ultimately responsible for the execution of all civil construction works. The Project and Construction Management Contract also implied that NORPLAN signed the contracts with the different suppliers of electro-mechanical equipment and auxiliary equipment. These contracts were therefore not included under a main construction contract.

The team discussed the characteristics of the contract procedure with both the initial and present senior client staff. Their comments are consistent and can be summarised as follows:

- \* They found the contracting procedure for implementation of the power plants unusual and had taken steps to change the procedure, but had gradually accepted the contractual arrangement proposed from the Norwegian side.
- \* The joint venture formed by the Consultant (NORPLAN) and the Contractor (NOREMCO) implied an intimate relationship between the two parties. Under normal conditions, the Consultant should serve the Client and have no direct relationship with the Contractor. But in this case the Client had often felt that the Consultant was the Contractor's and not the Client's consultant.
- \* However, the communication between the parties involved had been carried out in a good professional spirit throughout.

The senior client personnel are therefore satisfied with the actual cooperation with the different executing parties, not



because of the contract arrangement, but in spite of it.

- \* The Client's senior staff would not recommend the same contractual arrangement being applied again, as it leaves too many questions related to responsibility, executing procedure and communication lines open for dispute.

The Client's original executing agency was the Highlands Water Projects Unit (H.W.P.U.). The Client side was reorganised in 1987 as the Lesotho Highlands Water Project (LHWP) was made into a separate ministry. The executing agency then became the Department of Water Affairs (DWA) under the WEMMIN. After completion, the projects are transferred to Lesotho Electricity Corporation (LEC) which will be responsible for the operation of the two power plants.

The identification and review of project alternatives seems to have been adequate in order to meet the objectives set forth by NORAD. The feasibility study is less comprehensive than what is outlined in international standards, but international standards tend to be too comprehensive when applied to small scale hydro projects. The recommendations seem to be well founded, however, and reflect good overall judgement.

The general lay-out at Semonkong represents a conventional selection tailored to the size of the project. The choice of components and the general design of the components is in reality very limited. Faults with the components normally show up during the testing programme or during the initial phase of operation. Few cases of malfunctioning have been reported. There is reason to assume therefore that the components are of good quality. The team noted that the architectural design of the power house and houses provided for the operators fits nicely into the environment.

The general lay-out of the Mantsonyane Project, is different from Semonkong. The project involves a medium-high rockfill dam, an



unlined tunnel and an underground powerhouse. The overall design reflects Norwegian practice which represents significant cost savings as underground report work is limited to the necessary minimum. This being the first unlined tunnel in Lesotho, it has attracted considerable attention from engineering firms working with other projects in the country.

Some operational difficulties were reported for the shut-off valves and control equipment. Most of these difficulties have been or are being sorted out under the guarantee clause. Hopefully, this does not indicate any permanent difficulties as the equipment should be of proven design and quality.

The construction period has been 3 1/2 years for the two projects, including access road and transmission lines. The original construction schedule was 2 1/2 years implying a delay of approximately one year. Some of this delay refers to the delay in completion of the access road to the Mantsonyane dam site and the power station, completed in June and December 1986, respectively, rather than in February 1986 as in the original construction schedule. Thus, the dam foundation works could not be completed within the dry season 1986, and the construction of the rockfill dam was delayed from 1986 to the dry season in 1987.

The Semonkong power plant was also delayed by approximately one year. Most of this delay was due to the dam failure occurring at Mantsonyane on September 22, 1987 which attracted most of the manpower and construction equipment available.

The dam failure was caused by a severe flood when the dam was approximately 80% completed. Flood analysis has indicated that the dam failed at a discharge corresponding to a flood return interval in the range of 5 to 10 years. The flood diversion system was not designed to handle floods during construction in line with normal design criteria, i.e. 25 to 50 years return interval.



This is, however, in line with the original construction schedule which was based on completion of the dam within one dry season. When the dam failed it was a few weeks short of being completed, and the construction period had been extended into October, a month with an above average probability for peak floods to occur.

The combination of a major flood occurring early in the wet season of 1987 and the fact that the actual construction schedule for the dam extended into September/October is the main reason for the dam failure. Moreover, heavy rains in February and March 1988 caused additional difficulties for reconstruction of the dam and also caused flooding of the power station damaging some of the electro-mechanical equipment. The dam failure and subsequent flood difficulties in February/March 1988, however, did not significantly delay completion and commissioning of the Mantso-nyane power plant.

The training aspect was underlined in the contract as an important issue. The civil engineering counterpart staff initially identified for the planning and design stage of the project were transferred to the LHWP. Thus only one engineer with technical college training was allocated to the projects in March 1987.

The training of personnel for operation started with one electrical engineer who worked for approximately 8 months with a power company in Norway. This engineer is no longer working with LEC. One expatriate from Norway on a three year contract has concentrated his work on a training programme for five operators. Only three operators are left with LEC and one more may be leaving his job. The lack of trained operators is an urgent problem. The problem becomes more serious as there is a free flow of personnel within and out of Lesotho. The LHWP will attract a larger number of trained personnel over the next 10 years.

It should be noted that an ambitious implementation schedule is not reconcilable with a strong emphasis on training. On the planning stage of projects, both NORAD and consultants should be



aware of this conflict between objectives.

### III.3 Economic aspects

The original budget for the two projects was NOK 57 mill. At the end of June 1989, actual costs had reached NOK 81.3 mill. Some of the reasons for this large cost overrun of 42.6% are indicated in preceding paragraphs. Another reason was a considerable cost escalation of equipment from Norway, amounting to NOK 5.6 mill. or 42.5% only from the original budget of 1985 to the first revised budget of October 1986. After receiving tenders from Norwegian suppliers in mid-1986, the consultant and NORAD decided not to invite international tenders, despite the fact that the price bids from Norwegian suppliers seemed to be considerably higher than international prices. This is surprising, since it is official Norwegian policy that use of Norwegian suppliers is acceptable only if they are not more than 10% above international prices.

The considerable cost overruns make it difficult to avoid the impression that cost estimates as well as cost control have not been satisfactory from the outset. On the other hand, the original cost estimate seems to exaggerate the cost escalation because it appears to have been far too optimistic.

The cost overruns had a strong negative impact on the internal and financial rates of return (IRRs and FRRs) which we can now expect the projects to yield. Our estimates indicate that the IRR and FRR of Mantsonyane have declined to about 2.3% and 15%, respectively. For Semonkong, the IRR has become negative, close to -4%, and the IRR will be in the range of only 4.5 to 7%.

The calculations for Mantsonyane and Semonkong separately are very sensitive to the apportioning of the costs of professional services (accounting for 31% of total project costs) to the two projects. We have therefore also looked into the economics of the



two projects combined. It turns out that the IRR has come down to about 1%, whereas the FRR will be about 13.5% if inflation in Lesotho continues as at present. That means that the two projects combined are just capable of paying the current rate of interest.

With regard to covering only operating costs (considering investments as sunk costs) it should be noted that Semonkong is more sensitive to variations in the rate of capacity utilisation than Mantsonyane. In its present design, Semonkong needs to produce at least at 46% of capacity in order to meet operating costs.

Notwithstanding their internal economics, both projects will have significant positive economic effects. In our view, service and production activities in Semonkong will be stimulated by the supply of electricity. Only from 1984 to 1988, the number of business sites in possession of a legal title in Semonkong increased from 17 to between 40 and 50. In early September 1989, only six electricity consumers had been connected. However, there were a total of 26 applications for connections to the supply system. Among these are also the anticipated heavier consumers. When these consumers are connected, the Semonkong hydropower plant will most probably be overloaded.

The production of hydropower at Semonkong could, realistically, be replaced only by diesel generation of electricity, based on imported diesel. Compared to this alternative, Semonkong I will save about 140 000 M of foreign exchange per year at 1989-prices, assuming a real rate of interest of 4 to 5 %. Construction of Semonkong II would imply about twice as large foreign exchange savings.

If Mantsonyane is connected to the grid and well operated in order to supply peak-load power it will save foreign exchange at the current border price of electricity and at a real rate of interest not higher than 3.5%. If the presently very low ESCOM tariffs for electricity exports to Lesotho ( $0.03373 \text{ M} = 0.0877$



NOK per KWh in 1989), are escalated by 20%, Mantsonyane will save foreign exchange at a real rate of interest of about 5%.

However, for the time being Mantsonyane cannot perform this function, which is its major objective. This is mainly because the central transmission line between Thaba-Tseka and Molimo Nthuse, to which Mantsonyane is connected, is not in a satisfactory state. During long periods of the year with windy weather this line cannot be used. For example in 1987, there were 42 fault days on the line; and during a normal working day in August 1989, the line suffered up to six faults. When the team visited Mantsonyane, the plant was not in operation due to fault on the line.

In addition to this problem, there is an ongoing dispute on the possible need for a substation along the central line between Mantsonyane and Roma before the Mantsonyane hydropower plant can be connected to the national grid.

Before these problems are solved, Mantsonyane cannot fulfil its objectives, and the power plant as well as Lesotho as a whole will suffer grave economic losses. But at least the problems relating to rehabilitation of the line should now be resolved, since the LEC has made a final decision that the line shall carry 33 kV.

The Mantsonyane and Semonkong hydropower plants have direct as well as indirect employment effects. The indirect effects relate to domestic demand created by the construction activity, and employment generation as a consequence of supply of electricity to various economic activities, especially in Semonkong. There is no data which could be used to quantify these effects. But it may be noted that about NOK 1.4 mill. (1.7%) of total project costs consisted of locally manufactured equipment, mainly auxiliary steel equipment like gates, trashrack, etc., produced by a Lesotho firm. Moreover, we have already noted the activities growing up with the supply of electricity to Semonkong.



Direct employment of Basotho workers by NOREMCO during construction of the two plants increased to an average of about 110 in February 1986 to March 1987, and further to about 130 in April to October 1987. Then there was a reduction to about 90 in November 1987 to May 1988, and at the end of February 1989 there were no construction workers left.

In addition, the Labour Construction Unit (LCU) employed an average of 120 workers on the road to the Mantsonyane power plant from September 1985 to August 1986. And in the period from September 1985 to October 1987, LEC employed between 7 and 13 workers building the transmission line from the plant site to Mantsonyane.

After completion of the construction work, the direct employment effect of the projects is very small. A total of 5 operators, 2 watchmen and 2 drivers will be employed at the two projects, in addition to two professionals and a secretary at LEC in Maseru dealing with the hydropower stations at Mantsonyane and Semonkong as well as Tlokoeng and Tsoelike. We should keep in mind, however, that these few posts are related to the operation of Lesotho's first hydropower plants and will therefore imply that important new skills and experiences are acquired by Basotho people.

#### **III.4 Socio-cultural aspects**

In many respects, it is inappropriate to assess the social and cultural aspects in the case of the Mantsonyane mini-hydropower station, and too early in the case of the Semonkong station. Electricity supply to potential consumers is still very limited at Semonkong and is restricted to certain sectors designated as essential.

The incorporation of electrification in an integrated rural



development programme will only over time provide important indicators for future models of rural electrification, and should therefore be closely monitored. This is particularly the case in respect of the extent to which women benefit from electrification - both within the rural service centre and its catchment area - as well as the extent to which small scale producers increase production and hence disposable income.

#### IV RECOMMENDATIONS

- \* We strongly recommend that technical assistance is made available to LEC for the training of trainers who can in turn carry out a continuous training programme for operators at LEC. The alternative is a situation where operation and maintenance of the hydroplants will suffer, and electricity generation will fall short of capacity and stated objectives.
- \* Various strategies need to be considered to speed up the delivery of connections of electricity to households and businesses in Semonkong. This should include investigation of loans and grants, subsidies, grace periods, and the availability of credit facilities for installation charges and the costs of appliances and machinery.
- \* The social and cultural impact of the projects is difficult to assess at the present time, and should be the subject of on-going monitoring and further in-depth, evaluation and review.
- \* NORAD should immediately consider support to Lesotho for rehabilitation of the central line, at least from Mantsonyane to Molimo Nthuse. Unless that is done, Mantsonyane cannot perform its function as a peak-load power supplier, and the plant will suffer severe economic losses.



- \* As soon as the applicants are connected to the electricity supply system at Semonkong, demand will exceed supply. We therefore recommend that construction of Semonkong II is considered as soon as possible. The marginal costs of such an expansion will be relatively small and improve the internal economics of the Semonkong plant considerably.
- \* The joint-venture organisation between consultant and contractor should not be repeated. It is, however, important that an efficient organisational set-up for implementation of mini-hydropower plants which is acceptable to all parties, is elaborated. Experience from these projects may provide valuable inputs in this respect.
- \* An important question in rural electrification is grid extension versus generating electricity locally. The different aspects of grid extensions should be studied more closely, either as part of feasibility studies for specific mini-hydropower plants or as a general study for the SADCC countries. The study should cover aspects such as total costs and local costs versus foreign exchange expenditures, local manpower need versus need for expatriates, and the possibilities for rural electrification as an integral process when implementing grid extensions.
- \* When local generation of electricity proves to be the most feasible solution it is recommended to implement mini-hydropower plants as a renewable source of energy. The relatively high initial capital cost for mini-hydropower plants, especially for plant sizes up to approximately 500 kW, is an obstacle; and it is recommended to support a study, possibly a study for the SADCC region. The study should cover means to reduce planning and engineering costs, increasing local manpower involvement, and possibilities for promoting local or regional production of electro-mechanical equipment for micro- and/or mini-hydropower plants.



**1. GENERAL ASPECTS**

## 1. GENERAL ASPECTS



## **1.1. REVIEW OF ECONOMIC AND SOCIAL STRUCTURES AND NATURAL RESOURCES**

### **1.1.1. The Country**

The Kingdom of Lesotho is a mountainous, landlocked country of 30400 km<sup>2</sup>, completely surrounded by the Republic of South Africa (RSA). It is situated at the highest part of the Drakensberg escarpment on the eastern rim of the South African plateau, at altitudes varying from about 1400 to more than 3000 m.

Lesotho's climate is sub-humid, with warm wet summers and cold dry winters. About 80% of the rain falls during the six summer months (November to April), and this rain supplies moisture for the bulk of the crops. Average annual rainfall varies across regions. In the lowlands it varies from an annual average of 820 mm in the north to 725 mm in the south. In the Senqu River Valley, the annual average rainfall is 500 mm, while rainfall in the foothills is similar to the southern lowlands. On the other hand, the higher mountain region receives 1300 mm per year.

### **1.1.2. The population of Lesotho**

Lesotho is one of the few countries in Africa that constituted a nation-state from the outset, because the great majority of its people - the Basotho - are of one nationality with one language. The population (including migrant workers living temporarily in the RSA) was estimated to be about 1.71 mill. in mid-1989. Close to 90% of the population live in rural areas.

More than half of the population are below 20 years of age. The population growth rate is about 2.7% per year. Among the ten administrative districts, Maseru has the largest population, totalling about 345000 in mid-1989. In the capital city of Maseru, the population is growing at about 10% per year.



### 1.1.3. Natural Resources

Lesotho possesses relatively few natural resources upon which to build its development efforts. Only 13% of the land area is arable, and there is already a severe population pressure on cultivable land. The only significant natural resource is water which is planned to be sold to the RSA through the Lesotho Highlands Water Project (LHWP). The water resources also represent a considerable hydropower potential. Besides land and water, natural resources are extremely limited.

Mineral resources are few and generally uneconomic to exploit. In the late 1970s, De Beers of South Africa opened a diamond mine at Letseng-La-Terae. However, that mine was closed again in 1983 when diamond prices plummeted, for alleged economic reasons.

There are no forests in Lesotho, apart from the forest reserves covering a total of about 7000 ha, which have been planted through the Lesotho Woodlot Project (LWP), which we will discuss more in detail in chapter 1.2.2.

### 1.1.4. Main features of the economy

The most outstanding feature of the economy of Lesotho is its extreme dependence on the RSA. Among the ties responsible for this dependency are the monetary union and pegged exchange rate with the RSA, membership in the Southern African Customs Union (SACU) implying a heavy dependence of the government of Lesotho (GOL) on customs revenues from SACU, and the large volume of migrant workers' remittances from the RSA, which constitute more than 40% (1988) of Lesotho's gross national product (GNP). In addition, Lesotho is dependent on the RSA for virtually all its exports and imports, including imports of energy.



In 1988, the gross national product (GNP) per capita was 1008 maloti (M) at current prices, which is equivalent to 445 US \$. This GNP-level is in the upper range of SADCC countries (higher than Malawi, Mozambique and Tanzania, lower than Botswana and Zimbabwe). However, since migrant workers' remittances contribute more than 40% to the GNP, the gross domestic product (GDP), which is a measure of domestic productive activities, is rather low. In 1988, GDP per capita was only 584 M equivalent to 258 US \$, which is low compared to the average of SADCC countries.

#### The role of migrant labour

The large gap between the GDP and the GNP which is mainly filled by migrant workers' remittances (totalling M 712 mill. in 1988), indicates that Lesotho to a large extent plays the same role as the so-called "homelands" (bantustans), as a labour reserve for the South African economy, and at the same time depends on this role.

Migrant miners' remittances financed 60% of the country's imports in 1988. Indeed, migrant workers' remittances were almost four times higher than the country's total export revenues. This indicates that a reduced number of Basotho workers in South African mines which is expected in the 1990s, will have severe repercussions on Lesotho's national income and capacity to sustain the current level of imports.

In addition, Lesotho will face the challenge of creating employment opportunities for a rapidly growing labour force which cannot find employment in the RSA. It has been estimated that the net additions to Lesotho's labour force will be 20200 per year in 1990-95, increasing to 25600 per year in 1995-2000. (cf. World Bank 1987:36). The possibilities of developing the country's hydropower potential should be viewed against this background.



### The agricultural sector

In the 1970s the economy experienced a relatively high growth, with GDP growing at an average of 7% and GNP at 7.4% per year. The foremost growth sectors in that period were construction, manufacturing and mining. But despite a rapid growth rate in the 1970s, manufacturing contributed less than 6% to GDP in 1979/80.

In 1980, less than 4000 persons were employed in manufacturing industry, rising to 6600 in 1985. But even the number of 1985 was quite low compared to the 116500 Basotho migrant workers in South African mines.

In the 1980s, the economy has stagnated. From 1980 to 1988, the growth of GNP could just keep pace with population growth. The low growth rate of the GNP was to a large extent caused by a stagnation of migrant workers' remittances in real terms, which increased by an annual average of less than 2% from 1980 to 1988.

Another significant factor was the stagnation of agricultural production. From 1980 to 1988, the average rate of growth of agricultural production was only 1.4% per year. Because the growth of agricultural production lagged behind population growth, agricultural production per capita had become 11% lower in 1988 than in 1980.

From 1977/78 to 1983/84, the production of all major crops fell dramatically; maize by 44.5%, wheat by 70%, sorghum by 60.6% and beans by 87%. This virtual collapse of agricultural production was mainly a result of severe droughts causing reductions of yields about in proportion to the fall in production in the early 1980s. As a consequence, Lesotho became increasingly dependent on imported food in order to avoid famines; and in the mid-1980s almost half of total food consumption had to be imported. According to the Bureau of Statistics, food imports amounted to M 146 mill., accounting for 20.7% of total imports in 1984.



However, even with good rainfall later in the 1980s, food production per capita has not caught up with the levels of the late 1970s. There has been a slight increase in the production of major crops. But this was the result of an increased planted area, whereas the average yield remained at a low level or even declined further. The disastrous development of crop yields even in years with good rainfall, indicates that other and more long-term causes than variations in rainfall have contributed strongly to the decline of agricultural production in the last decade.

The major long-term factor seems to be degradation and erosion of arable lands due to deforestation, use of manure and crop residues for fuel, and overgrazing. Moreover, in the 1980s, a smaller proportion of the population has found migrant work, and consequently there has been a growing population pressure on the land. The average size of farm holdings of households with land allocations had declined to less than 1.4 ha, whereas landless rural households had increased from 13% of the rural population in 1970 to over 25% in 1986 (cf. GOL: National Environmental Action Plan, Maseru 1989:11.).

In addition to severe overgrazing, the peasants are increasingly using crop residues and animal dung as fuels instead of ploughing them back into the soil to increase fertility and improve soil structure. Due to lack of trees, most people in rural areas, are also using bushes and shrubs for fuel. Many parts of the country now have virtually no bushes or shrubs. Besides rendering the landscape bare and unsightly, the elimination of indigenous shrubs and bushes removes nutrients from existing soil, inhibits soil formation and contributes to soil erosion (cf. GOL: National Environmental Action Plan, Maseru 1989:19). This indicates that Lesotho's current agricultural crisis is to a large extent an energy crisis.



Lesotho's balance of payments position

Lesotho's balance of payments position is critically dependent on migrant workers' remittances and customs revenues from SACU. In 1988 migrant workers' remittances accounted for about 70% of total foreign exchange earnings, whereas SACU revenue accounted for 12% and export earnings for the remaining 18%.

Migrant workers' remittances will most probably decline in the 1990s, because of shrinking employment opportunities in South African mines. In addition, SACU revenue is bound to decline because the RSA is placing increasing emphasis on indirect taxation instead of tariffs and has also elaborated various alternatives in order to reduce its compensatory payments to other SACU members. (cf. World Bank 1987:3 ff).

In 1988, Lesotho's imports were more than six times larger and the trade deficit more than five times larger than total export earnings. Lesotho's total export earnings increased from US \$ 66.9 mill. in 1981 to US \$ 82.2 mill. in 1988, corresponding to an annual average growth rate of 3% per year. That the sources of foreign exchange covering the huge trade deficits are now drying up at the same as exports are stagnant, should be a reason for grave concern.

The only presently visible foreign exchange source which can cover some of the foreign exchange gap left by declining workers' remittances and declining SACU revenue, is royalty income from the LHWP. This income will be somewhere between M 50 and 100 mill. (between US \$ 23 mill. and 45 mill.) per year at 1985-prices. However, the LHWP will not generate royalty income before 1996. Moreover, there is no reason to believe that the water royalty will cover the total shortfall of SACU customs revenues and migrant workers' remittances.

In the meantime, Lesotho will have to curb imports and increase exports in order to avoid devastating balance of payments crises.



With regard to exports, Lesotho is facing numerous disadvantages. The natural resource endowment is poor and the country is surrounded by the RSA. In addition, there has been a polarisation of development within the SACU as a result of attractive financial packages offered to investors in the so-called "homelands" in the RSA.

In 1986, 87% of Lesotho's exports went to or through (as re-exports) the RSA, and there were virtually no direct exports to other SADCC countries. In 1985, wool and mohair accounted for 47% of total exports of goods, with manufactures and crafts accounting for 28%. Much of the exports of manufactures reflect assembly-type operations based on South African investments, especially in clothing and footwear enterprises. Other manufactured goods include hand-made leather products, hand-knitted wool products and handmade furniture.

In recent years, South African firms have shown an increasing interest in using Lesotho for entrepôt activities or simple relabelling in order to circumvent international boycott actions and protect their export markets. The World Bank suggests that Lesotho should exploit this trend by inviting and stimulating South African firms to establish production plants in Lesotho. (World Bank 1987:43 and passim). However, it should be noted that such a policy will make Lesotho even more dependent on the RSA.

Also with regard to imports, Lesotho is critically dependent on South Africa. According to data provided by the Bureau of Statistics, imports from the RSA constituted 93% of Lesotho's total imports in 1986, whereas imports from other African countries constituted less than 0.2%. About half of the food consumption and virtually all commercial energy consumed in Lesotho is imported. In 1985, imports of food, beverages and tobacco accounted for 23.3% and energy except fuelwood for 8.9% of total imports. In other words, food and energy accounted for one third of the total import bill. Lesotho can hardly restrain imports without reducing the imports of these two commodity categories,



i.e. replacing imported food and energy for local production. The natural resource endowment is poor and the country is Apart from bushes, shrubs, animal dung, crop residues and scarce supplies of fuelwood, hydropower is the only energy source available in Lesotho. There is a considerable scope for replacing other energy sources with domestically produced hydro-electricity. Moreover, more widespread use of electricity would stimulate investment and employment growth in various types of industries. The prospects of developing hydro-electricity should be considered against this background rather than focusing on the presently relatively low share of electricity in total imports, of only 0.7% in 1985.

## 1.2. REVIEW OF LESOTHO'S ENERGY SECTOR

### 1.2.1. General aspects

There are differing estimates of total energy consumption in Lesotho. For 1980, Frolich (1984: 150) estimated it at about 20700 TJ per year. For 1984, the Lesotho Energy Masterplan (LEMP) arrived at an estimate of about 25000 TJ per year, whereas the most recent SADCC estimate, for 1987, is less than 20000 TJ per year.

It appears that the difference between SADCC and LEMP is due to different estimates of consumption of biomass, i.e. shrubs, dung and crop residues. The LEMP estimate for 1984 is about 12000 TJ, whereas the SADCC estimate for 1987 is only about 6300 TJ of this category. The LEMP report claims that their estimates have a high degree of accuracy, "given the fact that they are based on extensive surveys, especially in rural households and for traditional energies which are frequently neglected in energy planning". (LEMP, Summary Report 1988:5).



If the LEMP estimates for 1984 are fairly correct, total per capita energy consumption in that year was about 17000 MJ or somewhat less than 400 kg of oil equivalents per capita.

Comparing the per capita consumption with the specific consumptions of other SADCC member states, Lesotho is still among those with the lowest figures, but is now in the order of magnitude of countries like Malawi and Mozambique, which is more realistic given the harsh winters that require space heating during a prolonged winter season.

The traditional fuels dominate the picture with 75% of the total energy consumption in 1984 originating from fuelwood, shrubs, cow dung and crop residues. The extremely low value of 1.5% calculated for electricity consumption in 1984 reflects the low electrification rate which was estimated at about 2% of all households. Petroleum products meet about 14% of the total energy demand but represent 56% of the commercial energy demand.

The household sector accounts for the overwhelming portion of the total energy consumption of the country with nearly 90%. About 7% are consumed in the transport sector and the rest by the other sectors such as industry, commerce and government. Within the household sector, it is apparent that traditional fuels play the major role in energy consumption in the country. More than 85% of the households' energy needs are met by fuels like shrubs, bushwood, dung and crop residues. A unique feature of Lesotho is its utilisation of cow dung for energy purposes which meets 20% of the household energy demand.

The situation in the major fuel sub-sectors where domestic production takes place, is as follows:

#### **1.2.2. Fuelwood and biomass**

The consumption of fuelwood increased by an average of about 1% per year in the period 1980 to 1987, and reached about 37500



tonnes in 1987. This source now accounts for about 25% of total energy consumption in Lesotho. Since there are almost no forests, most of the fuelwood consists of small bushes which are often collected from long distances. Official documents point out that in many areas, collection of bushes and shrubs for fuel has largely destroyed the woodland cover and hence contributed to soil erosion and degradation.

In 1984, fuelwood accounted for more than 30% of the total energy consumption of rural households and 23% of the total consumption of urban households. Most of the fuelwood used in urban households is imported from the RSA. In recent years, about 9% of total fuelwood supply has been imported from the RSA.

The shortage of fuelwood and the widespread erosion due to lack of woodland cover was the reason for starting the Lesotho Woodlot Project (LWP) in 1973. At the end of 1987, this project had established 322 Forest Reserves covering a total area of 7000 ha of planted forest. Over one third of the villages now have woodlots or Forest Reserves. However, in a review of the LWP, it is stated that,

"The Woodlot Project goes a little way to meet the needs for fuel and building materials although. It is calculated that about 6.6% of the country (200000 ha) should be under plantations if the total energy needs are to be met from wood. This contrasts with the current plantation area of about 7000 ha (0.204% of the country)". (LWP, Review 1973-1987, June 1987:30).

The "total energy needs" referred to here, is the plantation area needed in order to replace animal dung, crop residues and imported firewood with domestically produced fuelwood.

The 1973-1986 Review of the LWP reports about several problems, pointing out, among other things, that, "there was a sharp increase in damage to plantations as a result of illegal grazing". (LPW, June 1987:26). And with regard to expansion of the forest area it is reported that, "At the present time there is very little in the way of new establishment of private or community woodlots. Problems over land tenure are a probable



reason why there is so little interest" (ibid:27).

The LWP terminated in June 1987 and has been succeeded by the Fuelwood and Poles Project (FPP) under the Forestry Division in the Ministry of Agriculture, Co-operatives and Marketing. The FPP appears to put more emphasis on establishing nurseries in order to provide private individuals and institutions with trees for planting, and on stimulating and encouraging peasants to establish private woodlots. However, the severe overgrazing caused by overstocking of cattle represents a massive constraint to any expansion of the forest area in Lesotho.

### **1.2.3. Electricity consumption and hydropower potential**

Electricity consumption was 135 GWh in 1987 and experienced an average annual growth rate of 5.7% from 1980 to 1987.

Total peak load increased from 7.2 MW in 1975/76 to 40 MW in 1989. The load factor was 43% in 1987, and transmission and distribution losses are in the order of 10%. LEC supplies a total of about 7500 consumers of which 1.5% (big commercial and industrial) are consuming more than 40% of the total electricity.

Lesotho meets about 95% of its electricity needs through imports from South Africa's ESCOM system. Electricity is supplied via three intake points at Maseru, Maputsoe and Hendrick's Drift, of which Maseru is by far the most important one with more than 90% of total imports. Transmission and distribution of electricity to the consumers is under the responsibility of the Lesotho Electricity Corporation (LEC) which maintains a system of about 400 km of 33 kV and 700 km of 11 kV lines. Qacha's Nek works as an isolated system supplied by a diesel generator. The electrification rate is very low even by SADCC standards and is estimated at 2% at present.



In 1987, urban households accounted for 34.5% of total electricity consumption, manufacturing industry consumed 16.5% of the total, and services, mainly public offices, schools, clinics and hospitals consumed the remaining 49%. (cf. SADCC, April 1989).

Hydropower is by far Lesotho's most promising energy source, capable of meeting a substantial share of the country's commercial energy demand. In 1976, a Swedish consultant estimated the total hydropower potential at over 1500 GWh per year (cf. Frolich 1984:166). For comparison, total electricity consumption in 1987 amounted to 135 GWh, and total consumption of commercial energy was equivalent to 1750 GWh (cf. SADCC, April 1989). Lesotho's hydropower potential could in theory meet the country's total electricity demand far into the next century. However, it would be premature to speculate about the future economic reasonableness of developing all this potential relative to the cost of alternative energy sources.

The projects that are planned to be in operation by the end of this century are listed in table 1.2.1. When Muela I is implemented in 1995, total electricity generation in Lesotho will soon reach about 250 GWh per year, which may exceed total demand. Moreover, provision is made for an extension of the power station (Muela II) when phase II of the LHWP is implemented in the year 2008. Total power output at Muela will then reach 110 MW, and annual electricity generation will build up to 500 GWh (cf. LHWP, 1989). The LEMP estimates that Lesotho will have an electricity surplus in the period 1998 to about 2015. (cf. LEMP, Summary Report 1988:46).



Table 1.2.1. Hydropower projects planned to be in operation before the year 2000.

Project	Installed capacity (MW)	Annual generation (GWh)	Project status	Year of implem.
Mantsonyane	2.0	6.7	Operating	1989
Semonkong (isolated)*	0.38	1.3	Operating	1989
Tlokoeng (isolated)	0.68	3.0	Constr.	1989
Tsoelike (isolated)**	0.41	2.1	Constr.	1989
Quthing	15.0	35.0	F. Study	1998/99
Highlands, Muela I	72.0	ca.200.0***	F. Design	1995
Total	90.47	248.1	-	-

\* After instalment of the second turbine & generator and construction of storage reservoir in the river upstreams.

\*\* To replace diesel generation at Qacha's Nek.

\*\*\* Will start at low a level and increase as the Katse reservoir is filled. (Sources:LEMP, Summary Report 1988, p.11; LHWP 1989;LEC, Sept. 1989; and NORPLAN, June 1990).

#### 1.2.4. Energy demand forecasts

In the LEMP study three demand scenarios were defined, called BASIC, S1 and S2. Differences in the three scenarios are basically in the economic growth which is expected to have repercussions on the development of the energy sector. In that way, the BASIC scenario represents a fairly smooth continuation of the present trend with minor structural changes or substitutional adjustments. The "high growth" S1 scenario can be classified as a "modern" energy system with emphasis on commercial energies, while the S2 scenario continues to concentrate very much on traditional fuels and energy use.

The demand forecasts carried out on the basis of the past development and the parameters chosen revealed that the differences in the total values of the three scenarios are rather minimal. This phenomenon stems mainly from the dominance of the household sector demand for which a major parameter - the future



population growth rate - was kept constant over time. Hence, the total value determined at 47850 TJ in the year 2010 for the BASIC scenario is only slightly different from S1 and S2. (cf. table 1.2.2). The per capita consumption in the BASIC scenario in 2010 was estimated at about 17000 MJ per year corresponding to somewhat less than 400 kg of oil equivalents. This is much the same per capita level as the actual one in 1984, which should indicate that future demand has not been overrated.

The household sector is expected to continue to dominate the energy scene although its declining proportion observed in the past will accelerate. The shares of the transport and production and services sectors increase substantially despite the substitution and conservation measures introduced. (cf. table 1.2.2).

Table 1.2.2. Composition of the total final energy demand by sectors in the year 2010

Scenario Sector	BASIC		S1		S2	
	TJ	%	TJ	%	TJ	%
Households	41294	86.3	40908	83.4	41123	89.3
Transport	3924	8.2	4611	9.4	2302	5.0
Production and services sectors	2632	5.5	3531	7.2	2625	5.7
Total	47850	100.0%	49050	100.0%	46050	100.0%

Source: WEMMIN: LEMP, Summary Report, 1988:29

Substantial differences were also found in the composition of the total demand by fuel. This is especially true for the BASIC and S1 scenarios, while BASIC and S2 are virtually the same. (cf. table 1.2.3.).



Table 1.2.3. Final energy demand by fuel for 2010 and 1984.  
Comparison of scenarios

Fuel/Scenario	BASIC		S1		S2		Base year 1984	
	TJ	%	TJ	%	TJ	%	TJ	%
Non-commercials	31150	65.1	28449	58.0	31130	67.6	18663	75.0
Coal	5407	11.3	5297	10.8	5388	11.7	2345	9.4
Paraffin	3924	8.2	6475	13.2	3914	8.5	1432	5.8
Automotive and LNG	5120	10.7	6131	12.5	3500	7.6	2059	8.3
Renewables	574	1.2	589	1.2	598	1.3	-	-
Electricity	1675	3.5	2109	4.3	1520	3.3	377	1.5
Total	47850	100.0%	49050	100.0%	46050	100.0%	24876	100.0%

Source: WEMMIN: LEMP, Summary Report, 1988:30. For base year 1984-figures, cf. table 1.2.1. above.

Non-commercial energy carriers such as fuelwood, shrubs, dung and crop residues continue to play a major role in Lesotho's energy sector, although their share will decline. Commercial fuels will compensate for the losses of the traditional fuels with paraffin and electricity occupying a much higher share than in the past.

Electricity continues to play a minor role in terms of total energy demand although it will more than double its share until 2010 compared to 1984. (cf. table 1.2.3.).

From table 1.2.3. it can be seen that demand for electricity is assumed to grow at the highest rate of all energy carriers. The growth rate of the BASIC scenario leads to a total consumption of 465 GWh in 2010, compared to 105 GWh in 1984. The estimate of the S1 scenario is 590 GWh; and for S2, 420 GWh per year in 2010.

It should be mentioned here that the electricity demand growth has been affected by the conservation and substitution parameter settings which slowed down the increase. The growth rates for electricity without conservation and substitution would be about one percent higher, i.e. 7 and 8% p.a. for BASIC and S1, respectively.



With implementation of Muela phase II, annual generation of hydropower in Lesotho will reach at least 570 GWh per year in 2010. Hence, the BASIC and S2 scenarios imply a hydropower surplus of 100 GWh or more per year, whereas the S1 scenario implies near balance between supply and demand of electricity in year 2010.

#### 1.2.5. Summary

Lesotho's energy sector can be characterised as follows:

- In commercial energy, Lesotho depends almost entirely on imports from the RSA. Even 9% of total fuelwood supply is imported.
- Traditional or non-commercial energy, such as fuelwood, bushes, shrubs, dung and crop residues are the main sources of energy in rural areas. Resources are, however, drastically dwindling due to overharvesting of bushes and shrubs, overgrazing, soil erosion and lack of sizeable forests. The resource base of these fuels is in the process of being depleted, and in the future there will be a growing shortage of traditional fuels.
- Lesotho has a substantial hydropower potential which has now been well mapped. When Muela I comes in operation in 1995/96, the country will become self-sufficient in electricity.



## **2. POLICIES**

## 2. POLICIES



## **2.1. LESOTHO'S ENERGY SECTOR POLICIES**

The guidelines and recommendations of the Lesotho Energy Masterplan (LEMP) which was completed in 1988, have been adopted by the government of Lesotho as its official energy policy. (cf. WEMMIN: *Lesotho Energy Masterplan, Annexes to the Council of Ministers Memorandum*, 1988). In the following we will present a summary of the LEMP recommendations (cf. *ibid.*).

### **2.1.1. Policies and strategies in the energy sector**

The policy of the energy sector is to secure the energy supply for all sectors and in all regions of Lesotho. To achieve this goal a strategy has been developed which has the following objectives:

- to meet the projected demand for the future providing the services required;
- to supply the energy at minimum social and economic cost for the country; and
- to conserve the environment.

In the absence of a formalised overall development strategy or sectoral strategies, the future energy system has been based on means and measures which suit and are sensible for the energy sector. They are presented in the following sections, making a distinction between measures proposed on the demand and on the supply side, respectively. A summary is given in figure 2.1.1. at the end of this section.



### 2.1.2. Measures on the demand side

#### Energy conservation in buildings

Energy conservation in buildings by using passive solar energy can be regarded as the measure which is likely to have a major impact on the energy balance. Specific measures include the insulation of roofs and walls, tight windows and the introduction of trombe walls which are capable to absorb and store solar energy. Leaving the introduction of such measures to persuasion and dissemination would have only minimal effects.

It is, therefore, recommended to formulate regulations and norms for building construction which take care of energy-efficient buildings.

#### Energy conservation in commerce and industry

This measure encompasses the replacement of existing devices by energy-efficient equipment which is readily available on the market. Energy audits conducted in a couple of enterprises revealed substantial energy savings potentials in cooling and heating devices, boilers and lighting bulbs.

The action to be taken includes the performance of more energy audits through DOE or special companies, and the proposal of specific measures depending on each case. The economics should convince the recipients of the usefulness to invest in energy-saving equipment.

#### Energy saving in rural households

The burning of traditional fuels in open fires contributes enormously to the rapid depletion of the wood resources and is one of the reasons why crop residues and animal dung are being used as fuel. Energy-efficient stoves will substantially reduce



the energy needed to cook a meal or to heat the room.

#### Energy conservation in the transport sector

Energy conservation measures to be taken in the transport sector include the preference of public transport over individual cars and the promotion of energy-efficient diesel vehicles versus petrol. Efforts should be made to enhance the use of bicycles.

#### Substitution of commercial energy sources by solar energy

Solar energy has been proven to be very attractive if used for water heating in both the household and the production and services sector. The approaches to the two consumer groups would be different. Whereas it is believed that the production and services sector will respond to economic arguments, the household sector will need more dissemination work.

#### **2.1.3. Measures on the supply side**

Measures which concern the energy supply of a country are easier to introduce but may be very costly. They encompass the extension of the indigenous resource base such as afforestation or hydropower development. A decisive factor is the economic viability of each measure.

#### Accelerated afforestation for energy purposes

The objectives of the woodfuel sector are to avoid a further depletion of the resource base, to cater for the increased energy demand, to allow for a fuel switch from the problematic use of crop residues and animal dung to woodfuel, and to substitute



firewood imports.

The achievement of all these objectives require the planting of a total of 200000 ha of trees until the year 2010. (cf. section 1.2.2. in this report). This means that about 7500 ha of trees have to be added every year. The fact that the Woodlot Project managed to plant about 7000 ha in 15 years illustrates the tremendous task ahead. Continuing with the present rate of afforestation means that Lesotho will be without trees and bushes soon after the turn of the century. (Surprising to us, the LEMP recommendations do not consider expansion of the hydropower potential against this background).

The LEMP recommends that tree planting is emphasised as a national emergency measure and that afforestation should continue to be given highest priority. The Forestry Division has to be enormously expanded both with respect to manpower and financial means, and every support has to be given to this task. As a first action, the Forestry Division shall be requested to establish detailed plans on the extension of the resource basis covering woodlots, agroforestry, social forestry, private planting, etc. (National Forestry Masterplan), and funding has to be sought immediately to implement the project.

#### Decreased use of crop residues and animal dung for energy purposes

Animal dung and crop residues play a substantial role in the energy consumption pattern of Lesotho. Whereas animal dung is a fuel with long tradition the use of crop residues is considered as the last resort if other fuel is not available. The increasing use of crop residues documents the growing scarcity of other fuels, especially firewood.

The two sources have competitive uses as fertilizer and fodder. Both products are regarded as essential inputs to increase



agricultural crop and livestock production. The direct burning of crop residues and animal dung shall therefore be discouraged and the loss of these two fuels is intended to be compensated by the accelerated afforestation programme.

#### Introduction of biodigesters in rural areas and for industrial use

The alternative use of animal dung in biodigesters which secures the dung as a fertilizer is highly recommended, but more research and extensive dissemination is required. The impact on the whole energy balance will, however, be minimal.

The exploitation of methane gas accruing in sewage and other industrial waste for industrial use appears promising and is recommended to be further investigated.

#### Expansion of the indigenous hydropower potential

Electricity can be characterised as an efficient, clean and convenient source of energy which is, however, costly and usually serves only a minority of the population. It is pointed out that hydropower projects are highly capital-intensive, and that there are countries in the world in which the loans for electricity projects amount to more than half of their total debt. It is, therefore, recommended to select future hydropower projects very carefully and to implement only those which are really needed and more economic than electricity imports.

It is argued that the use of scarce financial resources in alternative projects such as agriculture and afforestation will have a more positive impact on the environment, serve much more people and provide more employment and income during the implementation of the projects and over a longer period. Studies carried out by LEMP recommend that the hydropower component of



the Highlands project is a worthwhile endeavour but that all other big hydropower projects are not needed before 2010. Latest demand forecasts seem to confirm this statement. The transmission and distribution system as well as the technical capabilities and organisation of LEC have to be upgraded to such an extent that the electricity provided by LHWP can be absorbed by the consumers.

#### Expansion of the mini-hydropower potential

It is recommended that the realisation of certain mini hydropower plants up to a capacity of 2 MW should be confined to isolated systems without connection to the LEC grid. The economic viability has to be proven in each individual case. Again, it has to be ensured that the requirements to successfully operate the plants are met in time (service, connections, organisational and operational arrangements).

#### Establishment of a strategic fuel depot

Lesotho depends entirely on external supplies for fossil fuels, and storage facilities for petrol, diesel and paraffin secure a safe supply for not more than 2-3 weeks. The establishment of a strategic fuel depot securing supply for 3-4 months is a necessity, and it is recommended that a feasibility study should be conducted, analyzing technical viability, costs implied, organisational requirements and financial consequences.

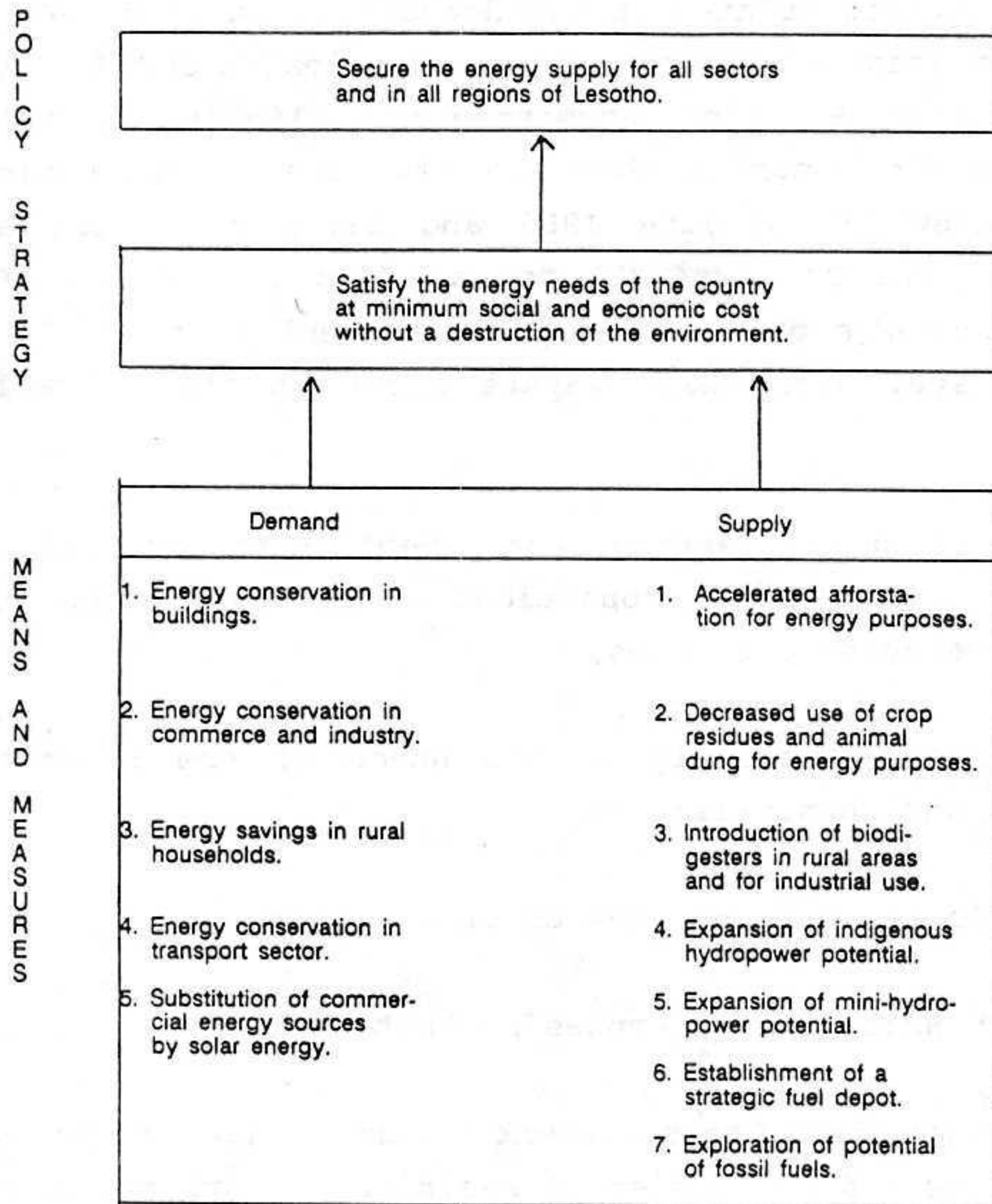
#### Exploration of potential of fossil fuels

Past exploration activities carried out have led to the preliminary conclusion that Lesotho lacks potential for commercially exploitable fossil fuel deposits. However, comprehensive investigations covering the whole country have yet to be undertaken and only one borehole has been drilled so far which



turned out to be dry. It is recommended to resume and intensify the exploration activities and the Commission of Mines should start making preparations for such a campaign.

Figure 2.1.1. Policy and strategies in the energy sector



## 2.2 PRINCIPAL OBJECTIVES OF NORWEGIAN DEVELOPMENT ASSISTANCE IN THE 1980s

### 2.2.1. General objectives

In the 1980s, the major principles of Norwegian development assistance have been formulated in two documents. In late 1984, the Centre/Conservative coalition government released GWP No. 36 (1984-85). The Foreign Relations Committee of Parliament had not yet commented on the document when the new Social Democratic government withdrew it in June 1986 and later presented a supplementary GWP No. 34 (1986-87) to be added to GWP No. 36 (1984-85). The two GWPs passed through Parliament in mid-1987, without much debate. Both White Papers agree on the overall objectives, viz.,

- to contribute to lasting improvement in the economic, social and political conditions of the population in the developing countries;
- to focus particularly on the needs of the poorest groups and countries; and
- to avoid creating dependence on continued aid.

In addition, both White Papers emphasise that,

- assistance should be recipient-oriented, i.e. based on the plans and priorities of recipient countries; and
- assistance should be untied, and Norwegian supplies should only be used when prices are internationally competitive. Use of Norwegian supplies is accepted if they are not more than 10 % above international market prices.



Both White Papers address the need to see environmental and ecological issues as an integral part of development assistance. This issue has become one of the major new relevant initiatives in Norwegian assistance to African countries in the 1980s.

The GWP No. 34 (1986-87) also makes some effort to formulate a strategy for assistance to check the excessive exploitation of natural resources and to create sustainable ecological environments. However, the analysis of the causes of ecological and environmental degradation is, in our view, too narrowly tied to demographic developments (cf. GWP No. 34, 1986-87:72-75), and the indicated strategy suffers from this narrow perspective.

In GWP No. 36, women as a target group are given particular emphasis, and a specific chapter (ch. 11) is devoted to women in development. The emphasis on women in development was given additional strength by the adoption of a special strategy for assistance to women in 1985. The strategy has two main goals:

- women's living and working conditions must be improved; and
- women must be motivated and provided with opportunities to participate in economic, cultural and political activities with a view to change the mainstream of development to make it benefit women.

Women-oriented assistance to the energy sector has been limited to date. Future strategies include the promotion of afforestation programmes through social forestry in all main partner countries, the review of the impact on the condition of women of all hydroelectric power projects, and the review of energy programmes, to ascertain the energy needs of rural women. The strategies proposed recognise the need to direct programmes with specific benefits for women at the household level, and to involve women as closely as possible in the design and implementation stages, as well as through creating job opportunities.



The GWP No. 34 (1984-85) agreed to the view on women in development presented in GWP No. 36 as well as on other major issues. However, there is some difference between the two GWPs with respect to emphasis. GWP No. 36 puts stronger emphasis on a basic needs oriented strategy, whereas No. 34 explicitly acknowledges the existence of several, at times competing objectives. The major objectives as stated in the latter GWP are in addition to those already referred to

- proper management of natural resources, nationally and internationally, to secure a sustainable development;
- economic growth is considered a necessary precondition for improving living conditions;
- improve living conditions of the poorest groups; in addition to assistance aimed at general economic growth, Norway should also give aid directly aimed at these groups;
- secure human rights;
- promote peaceful coexistence between nations and regions.

In sharp contrast to the official policy of the 1970s, GWP No. 36 (1984-85) as well as GWP No. 34 (1986-87) argue for a more central role for Norwegian industry and commerce, both in relation to ordinary bilateral assistance and for promoting industrialisation in developing countries. New arrangements are introduced to support the activities of Norwegian firms in these areas, including so-called mixed credits. These credits combine ordinary assistance with commercial export credits, and, as a consequence, blur the former distinction between assistance and business activities.

Finally, it may be noted that both White Papers present hydropo-



wer development as one of the areas where Norway is especially well qualified for rendering technical assistance (cf. GWP No. 36 (1984-85):108-109); and GWP No. 34 (1986-87):79).

### **2.2.2. General objectives of Norwegian assistance to SADCC**

An agreement on increased economic and cultural cooperation between the Nordic countries and SADCC was signed by the Nordic governments and all SADCC governments in January 1986. This agreement emphasises the need of the SADCC countries to reduce their external dependence, and it acknowledges the vulnerability of SADCC states towards South African aggression and destabilisation. In the agreement the Nordic countries commit themselves to increase their support to SADCC's intraregional cooperation in areas given priority by SADCC.

This commitment is also reflected in the Norwegian GWP No. 36 (1984-85) and No. 34 (1986-87). GWP No. 36 emphasises that Norway is prepared to support SADCC in the development of transport- and telecommunications. Moreover, it is noted that, "Energy is another important area of cooperation which SADCC gives high priority .... With the extensive professional competence and Norwegian experience from bilateral cooperation within the energy sector in Africa, energy can in the future be a natural major sector in the (Norwegian) cooperation with SADCC". (GWP No. 36 (1984-85):62)).

The GWP No. 34 (1986-87) does not mention the energy sector explicitly, but states that

" ... the government attaches importance to increasing the cooperation with the SADCC region regarding investments in productive activities, including private investments". (GWP No. 34, 1986-87):43).

Now, it is official SADCC policy that SADCC projects "should be owned, managed and operated from within the region" (SADCC, Febr. 1989, Annex 1:2). This raises the question of how private investments by Norwegian industry could be included in Norwegian cooperation with the region. The GWP No. 34 (1986-87) mentions that the MDC "is in the process of developing policy guidelines for this purpose" (p. 43), however, we have not come across any written documentation on such guidelines dealing especially with SADCC.

The section on SADCC in the GWP No. 34 concludes with the following statement: "The government will attach great importance to supporting the SADCC region, and contribute to its economic, political and cultural development, and to reducing the SADCC countries' dependence on South Africa". (ibid). Especially this latter statement has a particular relevance for Lesotho, since the country is totally dependent on the RSA for imports of virtually all commercial energy.

This commitment is also reflected in the Norwegian GWP No. 34 (1984-85) and No. 35 (1986-87). GWP No. 34 emphasizes that Norway is prepared to support SADCC in the development of transport- and telecommunication. Moreover, it is noted that "energy is another important area of cooperation which SADCC gives high priority. ... With the extensive professional competence and Norwegian experience from oil and gas cooperation with the energy sector in Africa, energy can in the future be a natural major sector in the Norwegian cooperation with SADCC". (GWP No. 34 (1984-85):22).

The GWP No. 34 (1986-87) does not mention the energy sector explicitly, but states that

"... the government attaches importance to increasing the cooperation with the SADCC region regarding investments in productive activities, including private investments". (GWP No. 34 (1986-87):11).



**3. THE MANTSONYANE AND SEMONKONG  
HYDROPOWER PROJECTS**

3. THE MANTSONYANE AND SEMONKONG  
HYDROPOWER PROJECTS



**3.1. OBJECTIVES OF THE PROJECTS AND ASSESSMENT OF THEIR COMPATIBILITY WITH DONOR AND RECIPIENT COUNTRIES' POLICIES**

There is little written documentation on the objectives of the projects. In Annex I to the project agreement, signed by the governments of Lesotho and Norway on 2nd August 1985, it is stated that,

"The objective of this agreement is to promote Lesotho's independence from import of energy, to stimulate village development and to promote manpower development and training within the hydropower sector. The schemes are intended to serve as pilot schemes for the SADCC region".

Furthermore, it is stated that, "Particular emphasis will be given to the training element and the future maintenance aspect. Adequate spares for routine maintenance will be provided under the Project". And, "Efforts shall be made to utilize local resources as far as possible, like local manpower, local workshops, Labour Construction Unit (LCU) etc."

As pointed out in chapter 3.2.1, a project review dated July 1983, covered five possible projects. Subsequently it was decided to include three of the reviewed projects, i.e. Mokhotlong, Semonkong and Mantsonyane, in a feasibility study. The feasibility study showed that the Mokhotlong project did not compare favourably with the Tlokoeng hydropower project which was already in a late stage of the planning process. On the other hand, Mantsonyane as well as Semonkong turned out to be economically feasible, i.e. both projects showed positive net present values and acceptable internal rates of return.

Now, LEMP (1988), which has been adopted as the official energy policy document of Lesotho, states that,



"The realization of certain mini hydropower plants up to a capacity of 2 MW should be confined to isolated systems without connection to the LEC grid. The economic viability has to be proven in each individual case. Again it has to be ensured that the requirements to successfully operate the plants are met in time (service, connections, organisational and operational arrangements)". (cf. WEMMIN: LEMP, Annexes to Council of Ministers Memorandum, 1988:8, Our emphasis).

Mantsonyane, which was planned and agreed upon before the LEMP was adopted, may appear to be in conflict with these policy objectives, since it is not an isolated system, but should be connected to the grid. However, the LEMP recommendations are based on the assumption that Oxbow (54 MW and 154 GWh per year) starts production in 1993, with Muela I (72 MW) following in 1995. When Mantsonyane was planned, these projects were still on a pre-feasibility stage, and Oxbow has now been postponed far into the next century. Moreover, until Muela starts operating, Mantsonyane can supply the relatively expensive peakload to the grid and save considerable amounts of foreign exchange for Lesotho. In other words, at least up to 1995, Mantsonyane will promote Lesotho's independence from imports of energy, which is an essential objective emphasised by Lesotho as well as Norway.

When Muela I starts operating in 1995, electricity generation in that plant will build up over several years until the water level in the Katse reservoir has reached the intended position. In our view, Mantsonyane may be considered as a peakload supplier, replacing imported peakload power during the six-year period 1989/90 to 1995/96. From 1996/97 onwards, the average price for Mantsonyane power will therefore be lower; and this will have some negative economic impact on the Mantsonyane project. However, the magnitude of the impact (determined by the start-up date of Muela I), will not be large, and it could not be foreseen when Mantsonyane was planned.

Apart from the problem we have now indicated, the objectives of the Mantsonyane and Semonkong projects appear to be well in line with donor and recipient countries' policies.



### 3.2. PROJECT IMPLEMENTATION

#### 3.2.1. Review and feasibility studies

The Norwegian Agency for International Development (NORAD) commissioned NORPLAN A/S in association with Hafslund A/S (both Norwegian firms) to carry out a review, feasibility study and design and tender documents of mini hydropower projects in Lesotho, the client being the Ministry for Water, Energy and Mining (WEMMIN).

The review dated July 1983, covered possible hydropower projects at the following five villages:

Mokhotlong (2 sites)

Semonkong

Sehlabathebe

Sehonghong 1st. Theresa

Mantsonyane

It was decided to include three of the above possible projects in the feasibility study, i.e. Mokhotlong, Semonkong and Mantsonyane. The main conclusions from the feasibility study can be summarised as follows:

The Mokhotlong Project did not compare favourably with the Tlokoeng hydropower project which was already planned to be implemented. This would imply no immediate need for any of the three Mokhotlong alternatives which were looked into and the project was shelved pending further growth of power demand.

The Semonkong Project was compared with the cost of building a 33 kV transmission line from Roma to Semonkong. The internal rate of return was found to be 7.5%. The line alternative would have additional advantages as connection to other consumers on the route would be possible. On the other hand, transmission lines in the high mountains of Lesotho are subject to frequent faults



due to intensive thunderstorms. A combination of the Semonkong power plant and the transmission line would also imply significant benefits, as power would be generated at the end of the line connecting to the grid and to the main load centre Maseru.

The Norwegian Agency for International Development (NORAD) For the alternative with no transmission line to Roma a 180 kW turbine was proposed for the initial installation. The power plant was, however, designed for a second 180 kW turbine to be installed when needed, to meet the growing power demand of Semonkong. The feasibility report states that a larger, single turbine unit would increase the internal rate of return to 9%. This refers to a theoretical power demand forecast and would significantly limit the possibility for flexible operation in line with variation in power demand, and expanding the generating capacity in accordance with the actual growth in demand.

The Mantsonyane Project was compared directly with the cost of continuing to supply power to the 33 kV line to Mantsonyane from Maseru. The 2 MW turbine installation at the Mantsonyane power plant was found to yield an internal rate of return of 7% based on 1983 tariffs for power imported from RSA. From the national point of view Lesotho would benefit greatly from having its own power plant supplying the Maseru grid, thus cutting back on its 100% dependence of electricity supply, particularly supply of peak power from RSA.

The Mokhotlong Project did not compare favourably with the To increase flexibility and reliability in operation it was recommended to instal two turbines, although the cost increase was estimated at 12%.

project was shelved pending further growth of power demand. The Semonkong Project was compared with the cost of building a 11 kV transmission line from Roma to Semonkong. The internal rate of return was found to be 7.5%. The line alternative would have additional advantages as connection to other consumers on the route would be possible. On the other hand, transmission lines in the high mountains of Lesotho are subject to frequent faults



### **3.2.2. Plan and contracts for implementation of the Semonkong and Mantsonyane hydropower projects**

The feasibility study report is dated February 10, 1984. The report is less comprehensive than normal international standards for feasibility investigations for hydropower development schemes. It does, however, cover the main issues for identifying and assessing the different alternatives. The recommendations seem to be sound, provided that the underlying data, calculations and overall analysis is correct. The cost overruns may, however, indicate that the cost estimates were too optimistic.

It is known to the evaluation team that NORAD at the time of this study was looking for less comprehensive (less costly and time consuming) procedures for implementing small scale hydropower projects. This reflected a recognition of the fact that the procedures established for large scale hydro projects have negative effects on efficient implementations of small scale hydro projects.

This was probably also the background for the "Project and Construction Management Services" contract between WEMMIN and NORPLAN A/S, signed on October 23, 1985.

### **3.2.3. Project organisation and institutional aspects of project implementation**

According to the contract between WEMMIN (Client) and NORPLAN A/S (Consultant), the Highland Water Project Unit (H.W.P.U.) should act as the Client's executing agency. The implementation of the hydropower projects should to a certain extent be as a turnkey delivery, but the Client would participate in the planning to a much greater degree than in the case of a fixed sum turnkey contract. The Consultant should be entitled to sign contracts on behalf of the Client after having obtained his approval. The



training component should be emphasised throughout the implementation process.

The Project Manager based in NORPLAN, Oslo, would be responsible for all aspects of the contract. Contractual matters between Client, Consultant and NORAD should go through him. The Project Manager should have close contact with the activities in Lesotho, through frequent visits to the country.

NOREMCO, a Norwegian civil construction works contractor was subcontracted by NORPLAN to provide the construction site team in Lesotho and should be responsible for the civil engineering construction works. Moreover, the NOREMCO office in Norway should provide back-up services, such as purchase of construction equipment, recruitment of any substitute personnel, advice on construction techniques, etc. To that effect a joint venture agreement was signed between the Consultant NORPLAN A/S and the Contractor NOREMCO on September 24, 1985.

Through the subcontractor (NOREMCO), the Consultant was ultimately responsible for the execution of all civil construction works.

The Project and Construction Management Contract also implied that NORPLAN signed the contracts with the different suppliers of electro-mechanical equipment and auxiliary equipment. These contracts were therefore not included under a main construction contract.

The Consultant's Resident Manager in Lesotho should be responsible for liaison affairs with the Client's executing agency, H.W.P.U. and other authorities in Lesotho. He also had the overall responsibility for all activities and aspects of the contract in Lesotho. Sub-contractors, such as LEC (transmission lines) and NOREMCO (civil works construction) would be coordinated and supervised by the NORPLAN Resident Manager. In addition he was responsible for the overall training at all levels in Lesotho.



The Client's original executing agency was, as stated above, the H.W.P.U.. The Client side was reorganised in 1987 as the Lesotho Highlands Water Project (LHWP) was made into a separate ministry. The executing agency then became the Department of Water Affairs (DWA) under the WEMMIN. This meant a change in client senior staff dealing with the Semonkong and the Mantsonyane projects. After completion of the projects they are transferred to Lesotho Electricity Corporation (LEC) which will be responsible for the operation of the power plants.

A Project Advisory Group with representatives from MPEA (Plannoff), WEMMIN (incl. DWA), LEC, NORAD and NORPLAN was formed. This group should, like the Client and NORAD, receive all progress and economic reports and give advice to both Client and Consultant. The Consultant should cover the secretarial function of the Advisory Group. Up to March 1989, the Advisory Group had convened six meetings.

We would like to point out here that NORAD was not directly represented in most of the meetings of the Advisory Group. Their representative was a technical adviser hired from the Norwegian Water Resources and Energy Administration. In our assessment, the technical adviser carried out his task in a satisfactory manner. However, he could not represent NORAD's policy views, and for that reason the Advisory Group meetings apparently suffered from the absence of a representative from NORAD itself.

The team discussed the characteristics of the contract procedure with both the initial and present senior client staff. Their comments are consistent and can be summarised as follows:

- They found the contracting procedure for implementation of the power plants unusual and had taken steps to change the procedure, but had gradually accepted the contractual arrangement proposed from the Norwegian side.



- The joint venture formed by the Consultant (NORPLAN) and the Contractor (NOREMCO) implied an intimate relationship between the two parties. Under normal conditions, the Consultant should serve the Client and have no direct relationship with the Contractor. However, in this case the Client had often felt that the Consultant was the Contractor's and not the Client's consultant.
- However, the communication between the parties involved had been carried out in a good professional spirit throughout. The senior client personnel are therefore satisfied with the actual cooperation with the different executing parties, not because of the contract arrangement, but in spite of it.
- The Client's senior staff would not recommend the same contractual arrangement being applied again, as it leaves too many questions related to responsibility, executing procedure and communication lines open for dispute.

#### **3.2.4. Implementation schedule**

The time schedules for implementation of the Semonkong and the Montsonyane hydro projects may be summarised as follows:

- The feasibility study includes the following work schedule:
  - Review of feasibility study and notice to go-ahead, March 1984.
  - Contract negotiations with civil contractors and equipment suppliers, October 1984.
  - Commissioning Semonkong, January 1986.
  - Commissioning Mantsonyane, October 1986.
- The contract between WEMMIN and NORPLAN, dated September 1985, includes the following construction schedule:



Access roads, power lines and site mobilisation, August 1985 to March 1986.

Place order for equipment, January 1986.

Commissioning of both power plants, December 1987/January 1988.

The actual commissioning of the power plants took place in December 1988/January 1989, i.e. one year later than planned.

The construction period for the two projects was thus 3 1/2 years as compared to the original construction schedule of 2 1/2 years, implying a delay of approximately one year. Some of the delay refers to the delay in completion of the access road to the Mantsonyane dam and power plant sites, completed in June and December 1986, respectively, rather than in February 1986, as planned.

Thus the dam foundation works could not be completed within the dry season of 1986, and construction of the rockfill dam was delayed from 1986 to the dry season in 1987.

The Semonkong powerplant was also delayed by approximately one year. This delay was partly due to the dam failure occurring at Mantsonyane on September 22, 1987, which attracted most of the manpower and construction equipment available.

The dam failure was caused by a severe flood at the time when the dam was approximately 80% completed. An important question is whether this flood could have been foreseen or whether it must be considered as an extreme event outside common planning procedures for construction of dams. The guidelines normally adopted for handling floods during construction can be summarised as follows:

- The responsibility for handling floods during construction may or may not be included in the contractor's contract.
- If flood damages during construction only imply economic



losses, then the design criteria for handling floods during construction are based on a cost-risk analysis. For major structures this may lead to a construction flood in the range of 25-years to 50-years floods. It is not known whether a cost-risk analysis was carried out for the Mantsonyane project.

- If the consequences of a dam failure imply risk to people's life, major damages to main communication systems, etc., then the criteria for handling floods during construction are the same as for the final project.

The flood event has been analysed by NORPLAN. (Dam Breach Damages, Final Report, Maseru 14th. November 1987). and by T.C. Sharma and S. Makhoalibe, Department of Water Affairs (not dated). Only the NORPLAN report is conclusive.

Flood measurement data for Mantsonyane River were not available, except for the new gauging station (SG 64) upstream in the Mantsonyane River. However, no rating curve exists for high flows at this gauging station. Therefore data from the neighbouring Senqunyane River was used for the flood frequency analysis, and transferred to the Mantsonyane dam site. Run-off data was available for 13 peak floods only. Also for these data, referring to gauging station G 17, it was discovered that the rating curve was unreliable. This does, of course, make the analysis uncertain, a situation which unfortunately is very common within flood hydrology.

Attempts were therefore made by NORPLAN to make use of other relevant studies such as the feasibility study for the Mohale dam on the Senqunyane River, carried out by the Olivier Shand Consortium of Consultants (OSC), the Creager formula developed for the South Africa and Lesotho region, and the analysis carried out by T.C. Sharma and S. Makhoalibe referred to above.

The different results of the flood frequency analysis and flood



assessments given by NORPLAN are shown in column 1 and 2 in the following table. The T.C. Sharma and S. Makhoalibe study indicates a different area conversion factor, however, which we have applied in column 3 and 4, while column 5 represents an average of the different flood assessments.

Table 3.2.1. Estimated flood frequencies at Mantsonyane

Discharge/interval (years)	Flood at Mantsonyane in m <sup>3</sup> /s				
	1	2	3	4	5
Q <sub>5</sub>	420 (500)	275	545	330	390
Q <sub>10</sub>	540	390	690	470	520
Q <sub>20</sub>	620	540	830	650	660
Q <sub>50</sub>	790	750	1010	900	860
Q <sub>100</sub>	900	930	1150	1120	1020

Column 1: Design flood analysis by NORPLAN (Figure in brackets from Mantsonyane Final Design Report)  
 Column 2: OSC data for Mohale Dam Site, NORPLAN "realistic estimate" and direct area conversion.  
 Column 3: Senqunyane River data applying area conversion factor indicated by Sharma and Makhoalibe study.  
 Column 4: OSC data for Mohale Dam site applying conversion factor indicated by Sharma and Makhoalibe study.  
 Column 5: Average of column 1, 2, 3 and 4.  
 Source: NORPLAN: Final Dam Breach Report, Nov. 1987.

The NORPLAN dam breach report indicates a flood of 640 m<sup>3</sup>/s, but it emphasises that the estimate is very unreliable and concludes by indicating a range between 500 and 900 m<sup>3</sup>/s for the flood peak causing the damage. NORPLAN concludes that this corresponds to a return interval between 15 and 100 years.

The capacity of the spillway, of the diversion tunnel and over the dam crest at the time of the failure has been estimated with greater certainty by NORPLAN to the range 450 to 500 m<sup>3</sup>/s, an estimate we agree to.

The maximum possible flood peak of 900 m<sup>3</sup>/s would indicate that the flood discharge almost doubled after the dam failed. The likeliness that the flood peak reached this maximum value is open for discussion, but the question is more of an academic



nature. The relevant conclusion is that the dam failed at a discharge corresponding to a flood return interval in the range of 5 to 10 years, (450 to 500 m<sup>3</sup>/s).

We may conclude, therefore, that the flood diversion system was not designed to handle floods during construction exceeding 5 to 10 years return interval. This does seem somewhat short of normal design criteria. The NORPLAN Dam Breach Report states that the construction procedure was, for the initial construction period, designed so that the dam would withstand limited overtopping. The acceptable overtopping capacity becomes significantly smaller, however, as the dam height increases.

The design chosen for handling floods during construction may, however, be acceptable providing that the construction of the dam could have been completed within one dry season. This was planned for, but some delay in the construction and a major flood early in the rainy season (which is somewhat less frequent than indicated above) caused the dam to fail.

The original flood design analysis gave a design flood of 1300 m<sup>3</sup>/s (Q 1000). After the major floods in 1987 and 1988, the design flood was increased to 1800 m<sup>3</sup>/s. The existing spillway has an estimated capacity of approximately 1900 m<sup>3</sup>/s which should meet all normal design criteria, considering also the dampening effect of the reservoir.

The construction schedule, both in the Final Design Report and the NORPLAN - NOREMCO contract assumes that construction of the dam is to be completed within one dry season. When the dam failed on September 22, 1989, it was completed to an elevation of approximately 2025.5, i.e. approximately 4 m below the final crest at 2029.5. The time needed to complete the dam is not known, but may be assumed to be a few weeks.

According to available statistics, and as stated by NORPLAN, the probability of peak floods occurring in September is low, but



rises to above average in October.

It may be concluded, therefore, that the construction of the dam was a few weeks behind schedule in order to stay within acceptable statistical probability limits of a flood to occur which could not be handled by the diversion provided for the construction phase.

Moreover, heavy rains in February and March 1988 caused additional difficulties for reconstruction of the dam and flooding of the access road to the power-station site. In fact, more of the original rock fill dam was washed away and the power-station was flooded causing damages to some of the electro-mechanical equipment. However, the dam failure and subsequent flood difficulties in 1988 did not significantly delay the completion and the commissioning of the Mantsonyane power plant.

A concrete wall in front of the entrance to the Mantsonyane power-station was included in the final reconstruction plans for this power plant. The purpose of the wall is to prevent flooding of the power-station in the future. It is difficult to assess the river hydrologics at this point in the river including the rock deposits from the dam breach, but the flooding of the power-station and damages to the electro-mechanical equipment would have been avoided if the flooding risk could have been foreseen.

### **3.2.5. Cost assessment**

In the feasibility study, dated 10th February 1984, the total costs of the Mantsonyane and Semonkong projects were estimated at NOK 57 mill. The same cost estimates were presented (as Annex I) in the Agreement between the governments of Lesotho and Norway dated 2nd August 1985. Total costs (at 1985-prices) for Mantsonyane were estimated at NOK 33 mill., and for Semonkong, NOK 13 mill. To these amounts were added price escalation and



unforeseen expenses during the construction period of NOK 9 mill. and manpower support to LEC of NOK 2 mill., making a total of NOK 57 mill.

In the final design reports, the cost estimates were much the same, viz. NOK 33.3 mill for Mantsonyane and NOK 11.6 mill. for Semonkong. The original cost budget is shown in the first column of table 3.2.2.

However, the construction work had hardly started before NORPLAN found it necessary to revise the budget upwards. After about half a year a revised budget was presented, escalating the costs for equipment from Norway by as much as 42.5%. As a consequence, the budget increased from NOK 57 mill. to 62.6 mill. (cf. table 3.2.2.). NORPLAN argued that the reason for the cost increase was "an incredible price increase for electrical equipment for small hydropower stations in Norway during the last 1-2 years (as high as 40%)". (NORPLAN: Summary Progress Report, 25.09.86). However, now the costs for equipment from Norway were escalated by 42.5% within about half a year. If price increases had been "incredible" for 1-2 years, it should, in our view, have been possible to incorporate some of this increase in the original budget from late 1985.

The original budget was based on international price quotations. But in spite of the fact that the tenders from Norwegian suppliers turned out to be substantially higher than reported international prices, NORPLAN and NORAD decided that they would not invite international bids. The alleged reason for their decision was that an invitation of international bids would cause undue delay of the project.

In chapter 2.2.1. we have seen that according to official Norwegian policy, assistance should be untied, and Norwegian suppliers should only be used when prices are internationally competitive. Moreover, use of Norwegian suppliers is accepted



only if they are not more than 10% above international market prices.

Against this background we find it quite surprising that NORAD and NORPLAN decided not to invite international tenders. Such an invitation could at least have clarified whether Norwegian prices were more than 10% above international market prices or not.

In early May 1987, another revised budget was presented, now totalling NOK 68.4 mill., i.e. exceeding the original budget by 20% (cf. table 3.2.2.). The items which were now increased, were professional services (exceeding the original budget by about 14%) and civil engineering construction work (exceeding the original budget by 21.6%). NORPLAN explained that the main reason for the increase of professional services costs was "the execution of the enforced working programme to keep the time schedule". The reasons for the enforced working programme were "loss of working time, personnel problems, breakdown of major equipment, increased working volumes etc.". However, NORPLAN emphasised that the working programme was "not made so tight that the important training element should suffer". (NORPLAN: Summary Progress Report, 01.05.87).

In addition to the enforced working programme, NORPLAN referred to salary escalations in Norway which would be "far higher than the 7-8% included in the original budget for the contract period". (ibid). It is true that the salary and wage increases in Norway in May 1986 were quite high. However, from 1987 onwards, the Norwegian government enforced a salary and wage freeze which lasted throughout the project period. In our view, the 7-8% salary escalation included in the original budget for the contract period cannot therefore have been quite wrong. In spite of that, the item professional services was later increased even more.

The reasons for the increased costs of civil engineering construction work in the revised budget from May 1987 were



reported to be threefold. First, staff houses at Semonkong and Mantsonyane (estimated total cost NOK 0.5 mill.) had not been included in the original budget. Second, the government of Lesotho put an unexpected surcharge of 50 to 60% on the invoice price for purchases of explosives which accounted for a large proportion of the civil construction works. And third, the enforced working programme also had a "severe effect on the civil construction cost". (ibid.).

On December 4th, 1987, yet another revised budget was presented, exceeding the budget from May 1987 by NOK 6.2 mill and the original budget by NOK 17.56 mill. or 32% (cf. table 3.2.2.).

Table 3.2.2. Summary of cost developments. NOK '000

	Original budget	Revised budget Oct. 1986	Revised budget May 1987	Revised budget Dec. 1987	Revised budget Dec. 1988	Actual costs end of June 1989
Professional services	18153	18253	20651	22251	25550	25396
Equipment from Norway	13300	18955	18955	19315	20365	20196
Locally man. equipment	700	950	950	950	1375	1386
Transmission & distr. lines	1900	1500	1500	1500	1430	1376
Civ. engineering construction work	20397	20397	24800	28500	32500	21513
Contingencies	2550	2550	1544	2044	400	406
<b>Total</b>	<b>57000</b>	<b>62605</b>	<b>68400</b>	<b>74560</b>	<b>81620</b>	<b>81273</b>

Sources: NORPLAN: Summary Progress Report, several issues; and NORPLAN Sept. 1989 (for June 1989- figures).

The cost increase in the revised budget of December 1987 was exclusively due to the dam breach at Mantsonyane on 22.09.87. The Final Dam Breach Report estimated the extra costs incurred to be about NOK 6.16 mill. This estimate was made up of the following components:



Professional services	NOK 1.60 mill.
Equipment from Norway	NOK 0.36 "
Civ. engineering constr. works	NOK 3.70 "
Contingencies	NOK 0.50 "
<hr/>	
Total costs	NOK 6.16 mill.
<hr/>	

In December 1988, another revised budget was presented. The total budget now amounted to NOK 81.62 mill., exceeding the original budget by NOK 24.62 mill. or more than 43% (cf. table 3.2.2.). Compared with the budget from December 1987, the costs of professional services were now escalated by NOK 3.3 mill or about 15%. Some part of this cost increase, i.e. about NOK 1.2 mill., is explained by the one year extension of the contract of the Norwegian electrical engineer working at the LEC. But for the remaining NOK 2.1 mill. of the increase we have found no clear explanation.

Again, there was also budgeted an increase in costs for equipment from Norway. These costs had now been escalated by a total of more than NOK 7 mill. or more than 53% compared to the original budget. (cf. table 3.2.2.). Only NOK 0.36 mill. or 2.7% of this total increase was due to the dam breach of September 1987. In other words, from the original budget at the end of 1985 to the revised budget three years later, in December 1988, the costs of equipment from Norway were escalated by more than 50% for other reasons than the dam breach in September 1987.

The civil engineering construction costs in the revised budget from December 1988 were increased by as much as NOK 4 mill. or 14% compared to the revised budget from December 1987.

The only possible explanation we have found for the cost increases in the revised budget of December 1988, are the adverse weather conditions. In the *Summary Progress Report* of 16.06., 1988, NORPLAN reported that November 1987, and February and March 1988 had been periods with what they considered as "abnormally"



heavy rains. During the last weekend of February, the access road to the Mantsonyane power station was blocked, the station was flooded with water to about 1 m above the main floor, and some of the permanent electro-mechanical equipment was drowned.

In March, "an even bigger flood .... than the flood that caused the dam breach in September 1987" occurred. (Our emphasis). NORPLAN added that,

"The new floodpeak in March eroded about 5000-8000 m<sup>3</sup> of the remaining dam-body, filled up the division channel/tunnel and also filled up the riverbed. Down by the power station the concrete rig was destroyed when the silo for sand and crush was washed away together with aggregates for concrete mixing". (NORPLAN: Summary Progress Report, 16.06.88).

From November 1987 to the end of March 1988, the access road to the Mantsonyane power station was blocked for 4-wheel drive vehicles for altogether one month (cf. *ibid.*).

The bad weather continued also in June 1988 to February 1989. According to NORPLAN's *Summary Progress Report* covering that period, "Heavy snowfalls and rainfalls have followed the project the whole period, and this has caused stoppage to the transport and hampered the work several times".

In any event, the heavy rains and floods after September 1987, causing destructions of the dam-body, of electro-mechanical equipment and construction equipment and long delays in the construction work at Mantsonyane, seem to be the major cause of the increase of the cost budget of NOK 7 mill. from December 1987 to December 1988. (cf. table 3.2.2.).

The last column of table 3.2.2. shows the actual costs of the projects at the end of June 1989. The actual total project costs had then exceeded the original budget by NOK 24.37 mill. or 42.6%. The item Equipment from Norway had exceeded the original budget by NOK 6.9 mill. or almost 52%, and actual costs for civil engineering construction work had surpassed the original budget estimate by NOK 12.1 mill. or almost 60% (cf. table 3.2.2.).



It should be noted that the item Civil engineering construction work also comprises such sub-items as four staff houses, which were not included in the original budget, and the road from Mantsonyane to the power-station. The costs of the staff houses cannot be identified exactly because construction workers at the power plants built them. We would assume that total costs for the four houses amounted to about NOK 0.5 mill. The costs for the road from Mantsonyane to the power-station was NOK 1.15 mill.

At most NOK 6.1 mill. or 25% of the total cost escalation of NOK 24. 27 mill. can be ascribed to the dam breach at Mantsonyane. The preceding review indicates that the remaining cost overrun of more than NOK 18 mill. was caused mainly by two factors. First the tenders from Norwegian suppliers of equipment turned out to exceed international price quotations by about NOK 5.7 mill. (cf. revised budget, Oct. 1986). Second, adverse weather conditions and floods, especially in the period from November 1987 to March 1988, caused serious destructions of the dam and the equipment at Mantsonyane, resulting in a budgeted cost increase of about NOK 6 mill. from December 1987 to December 1988. (cf. table 3.2.2.).

Against this background of considerable cost overruns it is difficult to avoid the impression that project planning as well as cost estimates and cost control have not been satisfactory from the outset. We would like to add that NORPLAN alone cannot be made responsible for this. It was NORAD who refused to accept invitation of international tenders when it turned out that the costs of Norwegian equipment would be escalated by almost 50%.

Finally, it may be noted that in the original budget, professional services accounted for about 32% of total project costs, decreasing slightly to 31.2% of actual costs at the end of June 1989 (cf. table 3.2.2.). It is extraordinary that professional services account for as much as one third of the total costs of hydropower projects.



Table 3.2.3. Professional services: Breakdown of accumulated costs at end of June 1989.

	NOK '000	%
Professional fees	18824	74.1%
Housing, accommodation, daily allow.	2446	9.6
School expenses	106	0.4
International travel	1155	4.6
Vehicle expenses, car and aircraft hire	477	1.9
Travelling expenses in Norway	44	0.2
Support from consultants	424	1.7
Rent of office and salaries to office staff, Maseru	872	3.4
Copying etc.	154	0.6
Post & telecom. services and courier serv.	723	2.8
Training	171	0.7
<b>Total, professional services</b>	<b>25396</b>	<b>100.0 %</b>

Source: NORPLAN, Sept. 1989

There could be reason to believe that the distance between Norway and Lesotho would cause exceptionally high costs of professional services in terms of travels, telecommunication services and the like. But a breakdown of these costs, presented in table 3.2.3., shows that professional fees, accounting for 74% of the total, is the dominant item; and this item alone exceeds the original budget for total costs of professional services (compare with table 3.2.2.). On the other hand, international travel and post- and telecommunication services do not amount to more than NOK 1.88 mill. or 7.4% of total costs of professional services. (cf. table 3.2.3.).

It should be noted that the item Training in table 3.2.3. comprises only direct training costs, whereas on-the-job-training is included in Professional fees (table 3.2.3.) Civil engineering construction work and Equipment from Norway, (tables 3.2.2. and 3.2.4.) and other cost items, and cannot, therefore, be identified.

Table 3.2.4. shows a breakdown of Equipment from Norway. It



turns out that Deliveries alone surpass the original budget for total costs of Equipment from Norway by NOK 1.7 mill. or 13%. Moreover, the item Installation and training is relatively high, which should be expected since that item contains a considerable training component.

Table 3.2.4. Equipment from NORWAY: Breakdown of accumulated costs at end of June 1989

	NOK mill.	%
Deliveries	15.0	74.3%
Freight & insurance	1.3	6.4
Installation & training	3.9	19.3
Total equipment from NORWAY	20.2	100.0%

Source: NORPLAN, Sept. 1989

In Mantsonyane, total investment cost per kW of installed capacity amounts to about NOK 28000, which is in the higher cost range for that plant size. In Semonkong, investment cost per KW is as high as NOK 113000. Semonkong demonstrates clearly the dilemma that investment costs per kW for hydropower plants of that small size tend to become unacceptable.

In order to make assistance to mini-hydropower plants economically acceptable it will be of great importance for NORAD, to find means to reduce project costs in the future.

On the other hand, we think that the original budget was far too optimistic, and that the cost overruns were not as bad as the budget figures indicate. It appears to us that the cost estimates as well as the progress schedule were too ambitious from the outset. Mantsonyane and Semonkong were pilot projects with a heavy training component to be implemented in a developing country. It would be quite mistaken to compare the costs and speed of implementation of such projects with Norwegian stan-

dards. Neither are we convinced that the enforced implementation programme from early 1987 onwards was "not made so tight that the important training element should suffer". (cf. NORPLAN: Summary Progress Report, 01.05.87).

**Table 3.2.5. Total finance for Mantsonyane and Semonkong projects per March 1989.**

Agreement Lesotho - Norway of 02.08.85:		57.0 mill. NOK
Addendum No. 1 to Agreement, Sept. 1987:		9.5 " "
Addendum No. 2 to Agreement, March 1988:		9.0 " "
Contributed by government of Lesotho, Febr. 1988:		2.0 " "
Insurance claim (dam breach):		3.0 " "
Contributed by government of Lesotho, May 1989:		1.12 " "
<b>Total</b>		<b>81.62 mill. NOK</b>

(Source: NORPLAN: Summary Progress Report, 11.03.89)

Table 3.2.5. shows the total financing of Mantsonyane and Semonkong. It appears that NORAD had to increase its grant by NOK 18.5 mill., or 32.5% above the original budget. Another NOK 3.0 mill. of the cost overrun was covered by the insurance claim for the dam breach at Mantsonyane, and NOK 3.12 mill. have been raised by the Government of Lesotho.

### 3.3. PROJECT DESCRIPTION IN BRIEF

The two hydropower projects are significantly different in installed capacity, design and objective for consumption of electric energy.



### 3.3.1. The Semonkong project

The Semonkong hydropower project presently has an installed capacity of 190 kW at a mean head of 18.5 m. This is referred to as the first stage of development, or Semonkong I with a possible mean annual power production of 0,7 GWh per year.

Preliminary plans exist for a Semonkong II, which would add another 190 kW to the installed capacity, but would also require an additional storage reservoir in the river upstreams of the present power plant intake.

The hydropower project comprises intake structure, headrace and penstock piping, power house and power generating machinery. The intake structure consists of a 100 m long concrete weir, a headrace inlet with trash rack and a simple pipe with a light steel gate for flushing of sediments in front of the intake.

The low pressure headrace is a 290 m long concrete pipe and the penstock is a 150 m long glassfibre-polyester pipe. A standard design, cast in place, concrete surge chamber is located at the upstream end of the penstock.

The power house has been given a nice architectural design with a straw roofing and exposed locally found rock in the walls. The power house contains space for two 190 kW hydro generating units, one stand-by, peak load 120 kW diesel unit, control room, switchgear room and an office/shop/storage room. There is a small wash room attached to the building, whereas the step-up transformer and the transformers for the local supply of electricity are located in open air outside the building.

The Semonkong hydropower project also includes approximately 3300 m of 11 kV transmission lines and step-down transformers.

One hydro turbine is installed with a maximum discharge  $1.2 \text{ m}^3/\text{s}$ .



A second equal size unit is planned for. The mean annual discharge in the river is estimated to be  $2.25 \text{ m}^3/\text{s}$ . The existing turbine is designed to be operated for discharges down to  $0.25 \text{ m}^3/\text{s}$  or 30 kW corresponding to approximately 16% of rated capacity. This wide range of operating possibility is very suitable for the growing demand of Semonkong.

A small reservoir with an estimated live storage of  $25000 \text{ m}^3$  has been provided. This reservoir provides possibility for meeting day term peak demand for some hours, also during the dry season. The reservoir is thus very important for operation of the power plant in line with the variation in power demand. Accumulation of sediment deposits will, however, gradually reduce the live storage volume. In the feasibility study it is theoretically indicated that the life time of the reservoir should be one year, but as pointed out, this estimate is false for various reasons. Extreme floods carry by far the largest silt quantities and a significant amount of silt is then carried in suspension past the intake weir. Field inspection in September 1989 revealed that the siltation rate has been very limited though it was reported that there had been a major flood in March 1989. The size of this flood is not known as the water level recording at the weir is not put into operation.

The siltation rate seems to be much less than indicated in the feasibility report. This is fortunate as no stop-log openings or other means have been provided at the weir which would allow for efficient flushing of the reservoir. A certain reservoir volume for peaking is essential, and removal of sediment deposits from the reservoir will therefore be necessary in the future. By placing the deposits along the river it may be possible to raise the water level in the reservoir by installing stop-logs on top of the concrete weir, thus providing extra peaking volume.

This problem may also be solved by an upstream reservoir as proposed in the plans for Semonkong expansions.



The choice of design, materials and equipment is traditional, though tailored down to this small size of hydropower plant.

The electro-mechanical equipment (turbine, generator, transformers, control apparatus) are major items of a hydro plant, both with respect to cost, quality, operation and maintenance. For this size of power plant (190 kW units) there is some choice in overall design (sophistication) and selection of components. There is considerable variation in cost between the different suppliers on the world market, but there are unfortunately also significant differences in quality and reliability. The degree of sophistication versus consistency, quality and operator training needs, is thus an important but complicated question. For Semonkong (as for Mantsonyane) the main electro-mechanical components have been supplied by Norwegian companies. No major faults or operational difficulties were reported after approximately 8 months of operation. As most operational difficulties due to faulty equipment normally show up relatively soon, there is reason to assume that the equipment is of standardised, well proven quality.

The auxiliary steel equipment like gates, trashrack, etc. is of a simple design and supplied from Lesotho by a Lesotho manufacturer. The concrete headrace pipe is supplied locally while the glassfibre-polyester penstock piping is supplied by a Norwegian company. The headrace and penstock should be maintenance free, but the cost seems relatively high. It is not known to us whether other types of piping, e.g. ordinary steel or welded-in-plane steel pipe, would be less costly, and whether such pipes are available from Lesotho or other countries Lesotho would like to deal with. Corrosion on steel is normally not a problem in the mountain climate of Lesotho.

The concrete weir is of standard design and quality, while the power house has been given a design which nicely fits into the environment. The space is adequate, but with no extra. The same applies to the two houses provided for the plant operators.



The overall impression from the field inspection of the Semon-kong hydropower plant is that the project is technically well planned and built, based on proven design and components.

### 3.3.2. The Mantsonyane project

The Mantsonyane hydropower project has an installed capacity of 2000 kW, with two units, 500 kW and 1500 kW, respectively. NORPLAN has informed us, however, without providing explanation, that the rated output after testing is 2.4 MW. The mean head is 36 m and maximum discharge for power generation is  $6.3 \text{ m}^3/\text{s}$ , while the estimated mean annual discharge in the river is  $4.4 \text{ m}^3/\text{s}$ . The possible mean annual power production is 6.7 GWh. The power station is also equipped with a 50 kW diesel generator for stand-by/emergency.

The provided reservoir has a volume of  $600,000 \text{ m}^3$ , of which  $450,000 \text{ m}^3$  is live storage.

The hydropower project comprises an 18 m high rockfill, bitumen core dam and spillway, a gated headrace tunnel intake, also with a short gated tunnel for flushing of sediment deposits in front of the intake. Access road on top of the dam and a simple steel truss bridge downstream of the spillway crest are included in the project.

The  $12 \text{ m}^2$ , 740 m long headrace tunnel is unlined and the power house is located underground, also unlined, and with minimum of rock support work. The tunnel cross section is determined by the construction method based on truck transport of spoil material (blasted rock). Thus the tunnel cross-section of  $12 \text{ m}^2$  is larger than necessary based on optimum friction loss calculation. The larger cross-section has apparently eliminated the need for surge chamber.

The underground power house contains the turbines, generators,



control apparatus, control room, switch gear room, toilet, workshop and storage area. The two steel penstocks, including shut-off valves between the headrace tunnel and the turbines are only 9 m and 12 m, respectively. The transfer, stand-by diesel generator and cooling water reservoir are located in the outer end of the supplementary access tunnel used during construction of the headrace tunnel.

Two houses for the plant operators are included in the project and are of the same design as at the Semonkong project.

The Mantsonyane project also includes 33 kV transmission lines and step-down transformers to Mantsonyane and a shorter line to Auray.

The present rockfill dam and spillway were redesigned after considerable damages were caused by a major flood in September 1987. (Discussed in more detail in Section 3.2.4.). The new design has added to the overall safety with respect to spillway capacity and top dam elevation. The bitumen core in the rockfill dam is a design used when suitable soil for a centre cone is not available. It is not the most common design, but has been used for much larger dams than at Mantsonyane.

The intake and flushing devices are of standard design. The field inspection revealed very moderate volumes of sediment deposits in the reservoir. This indicates that the estimates of sediment transport volume included in the feasibility study are too conservative. This further indicates that the surface erosion and sediment yield from some of the high-land areas in Lesotho are less than assumed in available literature, a very favourable discrepancy when building water storage reservoirs.

The headrace tunnel and underground power house is unlined with a minimum of support works. Being the first unlined tunnel in Lesotho it has attracted considerable interest from other engineers planning similar projects in Lesotho. This represents



a design which is more widely used in Norway than in most other countries. The cost savings for the Mantsonyane project, when compared with a fully lined tunnel can be assumed to be several mill. NOK.

The electro-mechanical equipment (turbines, generators, transformers, control apparatus, valves, etc.) is of standard design and has been supplied by Norwegian companies, as at the Semonkong project. Some operational difficulties were reported for the shut-off valves and control equipment. Some of these difficulties have been sorted out under the suppliers' guarantee clause. The operators seemed to consider the difficulties as connections normally imply during the initial stage of operation.

The auxiliary equipment like gates and other steel works is of standard design, supplied from Lesotho by a Lesotho manufacturer.

The power house may seem slightly more spacy than necessary. This is due to the layout close to the river which requires that the entrance to the power house must be on a higher level than the centre of the turbines.

In addition, a concrete wall between the river and the entrance was necessary to prevent flood water entering the power house. This happened during the unexpectedly high flood level in March 1988.

The new transmission line to Mantsonyane is connected to the existing central transmission line which in turn links the Mantsonyane power plant to the main grid, including Maseru. We were informed by LEC that the central transmission line, which was built in 1979, is in a bad order between Thaba Tseka and Molimo Nthuse. In windy weather the line cannot be used, and for example in 1987, there were 42 fault days on the central line. This also implies that the Mantsonyane power plant cannot be connected to the central line in windy weather. When the team visited Mantsonyane, the plant was not operating for that reason.



There can be no doubt that the central transmission line urgently needs rehabilitation. Now there should be no obstacle - except financing - to getting that work started, since the LEC has made a final decision that the line shall carry 33 kV.

There is also an ongoing technical, possibly academic discussion about whether an additional substation along the central line is needed before the Mantsonyane power station can be connected to the main grid.

The evaluation team does not have, within the team, an expert who can recommend a solution to this discussion. A solution should be found soon, however, because the Mantsonyane power plant is now running far below capacity, which represents a considerable loss of revenue. It also implies that the main objective of this project, to reduce dependence on the RSA for supply of peak power, is not met.

### **3.3.3. Operation**

The main operational functions of the staff at the Semonkong and Mantsonyane hydropower projects can be summarised as follows:

- Routine checking of all mechanical installations, note needs for maintenance, reveal and repair smaller faults and be aware of symptoms of faulty functioning of technical components before a breakdown is a fact.
- To operate the power plants in line with power demand. That implies planning of the reservoir operation, particularly during the dry season and handle low load and peak load situations within the limitations of the generating capacity.
- Follow up on the power transmission system and adjust operation in line with any limitations imposed by the



transmission system.

- Keep accurate accounts of the daily operation and equally consistent reporting of the accounts to headquarter.

For most of these operational tasks working routines must be worked out and should, for these two power plants, be easy to follow as the different plant components are easily accessible and within short distances. This does, nevertheless, not remove the need for awareness and initiative.

The basic training for operators are technical colleges of good standard, which are available in Lesotho. Operational training on the job is, however, essential and necessary. The operation of hydropower plants is different from many other operational jobs. The plant will run for long periods and only routine checks are necessary while the actual operating work is very limited. This may easily lead to a relaxed attitude towards following up of the routines and gradually also towards lack of initiative. This will invariably lead to stop in generation of power, which for hydropower plants represents a 100% loss of revenue.

Faulty operation may and eventually will develop and lead to breakdown of major components which have to be brought in from the original supplier of the equipment. Expatriates may be needed for the repair work.

The operators' understanding, devotion and personal discipline is of utmost importance. This is reported as being a problem as discussed in more detail in Chapter 3.5.

There are no indications of choice of design or choice of components which should imply excess need for expatriate personnel. The need for expatriates is mainly related to training of operators.



### **3.4. TRAINING IN DESIGN, CONSTRUCTION AND OPERATION**

The contract between the government of Lesotho and NORPLAN A/S describes the scope of training of local employees and counterpart staff. The Terms of Reference also stress the training objectives and state that counterpart personnel shall be involved, if available.

#### **3.4.1. Training in planning and design**

The training of counterpart personnel in planning and design seems to have been seriously hampered due to lack of personnel.

Civil engineering counterpart personnel were identified by Lesotho authorities, but they never participated in the planning and design work because they were transferred to the Lesotho Highlands Water Project (LHWP).

A civil engineering counterpart with background from the Lesotho technical college joined the project in March 1987. He participated mostly in land surveying at the different construction sites. This work was in line with his educational background and was carried out in a professional manner. The counterpart returned to the Department of Water Affairs, but has later been transferred to the Water Branch. When the team visited Lesotho, he was working at water supply construction sites. As a consequence, no counterpart personnel participated in the planning of the civil engineering design.

#### **3.4.2. Training during construction**

The staffing during construction of the Semonkong and the Mantsonyane projects can be summarised as follows:



NORPLAN: One full time resident engineer in Lesotho

NOREMCO: The Resident Manager working full time on the projects. Three site engineers/foremen working full time in Lesotho. Short-term assignments of specialised foremen for work like tunnelling, rockfill dam construction, etc.

Lesotho staff: In addition to the expatriate personnel listed above, the work force during construction varied from 80 to 150 persons. With the limited number of expatriate staff there must have been a need to train local staff to assist in different types of foremen work. This was confirmed by the contractor; but according to the contractor, the training programme for foremen was not very successful. The contractor argued that this was mainly due to lack of disciplinary understanding of foremen's responsibilities.

From early 1987 onwards, the implementation of the construction work was enforced because it had come far behind schedule (cf. chapter 3.2.4.). The consultant argued that the implementation was "not made so tight that the important training element should suffer". (NORPLAN: Summary Progress Report, 01.05.87). We are not convinced that this turned out to be true. Towards the end of the construction period it was proposed to arrange a seminar for some of the construction staff in order to summarise the experience and possibly issue a certificate for specialised construction work. This proposal was, however, not supported by NORAD.



It should be noted that an ambitious implementation schedule based mainly on economic considerations is not reconcilable with a strong emphasis on training. Adequate training will require that the speed of implementation is considerably reduced compared to usual Norwegian standards. Both NORAD and consultants should be aware of this conflict of objectives when planning projects in African countries.

#### **3.4.3. Training of operating personnel for full assumption of project operations**

Lesotho Electricity Corporation (LEC) has established an organisational unit, the Generation Department, to take care of the daily operation of the power plants. The generating function is a new task within LEC's organisation. The Semonkong and the Mantsonyane projects are the first two hydropower plants in the country. Two more small hydro plants are under construction with french aid financing. To establish the necessary basis of knowledge and procedures is therefore an ongoing process within LEC.

One senior electrical engineer (expatriate from Norway) has been working with LEC over the past three years, mostly dealing with training of personnel for operation. His term with LEC expired in September 1989.

In line with the Terms of Reference and Control with NORPLAN one electrical engineer was given approximately 8 months training in Norway. He spent most of his time with a power company engaged in installing small hydro turbines and equipment. This engineer is no longer with LEC, due to lack of understanding of the responsibilities which are involved in being a senior operational engineer.

A programme for training of 5 operators has been carried out at



LEC. Only 3 operators are still left (September 1989) and one more may have to leave his job as operator.

The operator situation is therefore a serious problem both for LEC in general and for operation of the two hydropower plants in particular. Due to the following reasons it will take time to solve this problem:

- There is a free movement of labour out from Lesotho.
- The Lesotho Highlands Water Project (LHWP) will gradually attract more and more staff and will offer more challenging and better remunerated jobs.
- Trained personnel will need some time in assuming the responsibilities which are required of a hydropower plant operator.

These problems need urgent and thorough consideration by the Norwegian authorities. We suggest that Norway should support a programme with the necessary expatriate assistance for training of operators. To limit the scope of the programme the emphasis should be put on training of trainers from Lesotho, i.e. Basotho engineers in Lesotho. An initial 5 year horizon for the programme is indicated.

The alternative will most likely be faulty operation with the result that the hydropower projects will not meet the stated objectives, and that the loss of revenue in relation to the invested capital will be considerable.

### 3.5. ECONOMIC ASPECTS

In this section we shall discuss the two projects' internal and financial rates of return, their foreign exchange savings impact,



and other economic effects including their employment impact.

### 3.5.1. Internal and financial rates of return

Already at the end of 1987, the investment costs of the two projects, then reaching NOK 58.7 mill (net of diesel generators) had exceeded the original budget (NOK 57 mill). In section 3.2.5. we have seen that at the end of June 1989, total investment costs had exceeded the original budget by more than NOK 24 mill. or 42.5%.

In the feasibility study, the (real) internal rate of return (IRR) was estimated at 7% for Mantsonyane and 7.5% for Semonkong, based on the original cost estimates of NOK 13 mill. for Semonkong and NOK 33 mill. for Mantsonyane. The cost overruns have of course had a strong negative impact on the IRRs which we can now expect the projects to yield. In the following we will present our revised estimates of (real) IRRs and financial rates of return (FRRs) for Mantsonyane and Semonkong separately and for the two projects combined.

Our estimates are based on the following assumptions:

- The costs of professional services have been apportioned with 65% to Mantsonyane and 35% to Semonkong. (This sharing may of course be disputed, and any change of it will favour the economics of one of the projects and disfavour the other).
- The costs of the expatriate senior electrical engineer at LEC have been deducted from costs of professional services. We have assumed these costs to be NOK 550 000 for 1986 and 1989, respectively, and NOK 1.1 mill. for each of the years 1987 and 1988.
- The costs of training and staff houses which should normally



- not be included in IRR-estimates for the power plants as such, have not been excluded because we cannot assess their exact magnitude.
- In order to analyse the economics of the hydropower plants only, the investment costs of diesel generators, i.e. NOK 300000 at Mantsonyane and NOK 400000 at Semonkong, have been left out. Similarly, total operating costs of the diesel generators have been excluded. We have assumed these costs (at 1989-prices) to be M 2500,- per year at Mantsonyane and M 12500,- per year at Semonkong.
  - We have assumed total annual operating costs of the hydropower plants (at 1989-prices) to be M 74100,- at Mantsonyane and M 58400,- at Semonkong.
  - When the projects are completed, the GOL is supposed to take over the construction equipment. The sales value of the equipment, estimated at M 457000 (cf. Minutes from 6th Advisory Group Meeting:2) has been deducted from the project costs for 1989, with 75% apportioned to Mantsonyane and 25% to Semonkong.
  - When converting operating surpluses in maloti to Norwegian kroner, we have assumed the exchange rate of 1 M = 2.60 NOK for 1989 and all subsequent years.
  - We have assumed that the economic life-time of the projects is 40 years, and that their residual value is zero.
  - The exact cost inflation during the construction period is not known to us. According to data provided by the Bureau of Statistics, the consumer price index as well as the GDP deflator increased at annual averages of 13 to 14% between 1985 and 1989. Against this background we have estimated IRRs on three different assumptions of annual inflation rates during the construction period, viz. 10%, 13% and 15%.



- In estimating the cash flows, we have used the average electricity tariff charged by the LEC in 1989 (0.18 M per KWh) throughout.
- We have assumed that Mantsonyane produces 2.28 GWh, i.e. 30% of capacity, in 1989 and 6.7 GWh (full capacity) in all subsequent years.
- For Semonkong we have assumed a production corresponding to 50% of capacity in 1989 and full capacity production in all subsequent years.
- For the two projects combined we have assumed a total production of 3.7 GWh in 1989 and 7.4 GWh in all subsequent years.

It should be noted that contractor and consultant did not keep separate cost accounts for each of the two projects. Our estimates for each separate project should therefore be considered as approximations only.

The results of our calculations are listed in tables 3.5.1. to 3.5.3.

Table 3.5.1. The internal economics of the Mantsonyane hydropower plant

Assumed annual inflation rate <sup>1</sup>	IRR <sup>2</sup>	Approximate FRR <sup>3</sup>
10%	2.6%	12.0%
13%	2.3%	15.0%
15%	2.0%	16.5%

<sup>1</sup> With respect to (real) IRRs, assumed annual inflation rates refer to the construction period; with respect to FRRs, reference is to the period of operation (40 years).

<sup>2</sup> (Real) IRRs (internal rates of return) are estimated on the assumption of constant prices throughout.

<sup>3</sup> FRRs (financial rates of return) are estimated on the basis of actual cost figures during construction and assumptions of future annual inflation rates of operating surpluses as shown in the first column.

Table 3.5.2. The internal economics of the Semonkong hydropower plant\*

Assumed annual inflation	Internal rate of return (IRR)			Financial rate of return (FRR)		
	0.7 GWh per year	0.8 GWh per year	0.9 GWh per year	0.7 GWh per year	0.8 GWh per year	0.9 GWh per year
10%	- 4.9%	- 4.2%	- 3.5%	2.5%	3.5%	4.5%
13%	- 5.1%	- 4.4%	- 3.7%	5.0%	6.0%	7.0%
15%	- 5.3%	- 4.6%	- 3.9%	6.5%	7.5%	8.5%

\* For explanations, see footnotes to table 3.5.1.

Table 3.5.1. shows that mainly as a result of the cost overruns, the IRR of Mantsonyane has been reduced to about 2.5%. The FRR shows the nominal rate of interest the project is capable of paying (at zero net present value) in the long run. In recent years, the rate of inflation in Lesotho has been about 13 to 14%, whereas the interest rate has fluctuated between 11 and 15%. Table 3.5.1. shows that under these conditions, the Mantsonyane project is just capable (in the long run) of paying the current rate of interest.

Table 3.5.3. The internal economics of the total project (Mantsonyane and Semonkong combined)\*

Assumed annual inflation	Approximate	
	IRR	FRR
10%	1.3%	10.5%
13%	1.0%	13.5%
15%	0.8%	15.5%

\* For explanations, see footnotes to table 3.5.1.

According to our calculations, Semonkong has apparently suffered more from the cost overruns. The IRR has become negative on all assumptions under which it was calculated. Experience from 1989 indicates that it may be possible to produce more than 0.7 GWh,



possibly as much as 0.9 GWh per year, at Semonkong because the waterflow in the river is apparently higher than originally assumed. From table 3.5.2 it appears that the economics of the Semonkong power plant will improve slightly if production is increased beyond 0.7 GWh. However, in any event, Semonkong cannot pay a long-run interest equal to the current one of about 12 to 13%. In purely economic terms, the project is not viable.

The IRR (and FRR) calculations for Mantsonyane and Semonkong are very sensitive to the apportioning of the costs of professional services to the two projects. In our calculations we ascribed 65% of these costs to Mantsonyane and 35% to Semonkong. The dam breach at Mantsonyane in September 1987 and further destruction of the dam and power station in February and March 1988, caused considerable extra efforts also by the consultant. Against this background, the 65/35-sharing may be wrong. To avoid this problem we have looked into the economics of the two projects combined, cf. table 3.5.3.

Table 3.5.3. shows that for the two projects combined, the IRR is about 1%, which is of course extremely low. However, with the present inflation in Lesotho the two projects are just capable in the long run of paying the current rate of interest. Our calculations are based on the assumption of (near-)optimal operation of the projects. In purely economic terms we may therefore conclude that the two projects combined are at the very best only marginally viable.

Since the projects have to a large extent been financed by grants from Norway, it may be of some interest to consider the investments as sunk costs and determine at what level of production operating costs are just covered at the prevailing electricity tariff, i.e. the break-even points. It turns out that Mantsonyane has to produce at least 0.41 GWh per year (i.e. only 6.2% of designed capacity) in order to cover operating costs; whereas Semonkong has to produce at least 0,32 GWh per year (46% of designed capacity) in order to meet operating costs.



With respect to covering operating costs, Semonkong is therefore far more sensitive to variations in the rate of capacity utilisation than Mantsonyane.

### 3.5.2. Economic effects

It would be quite wrong to draw conclusions about the economic significance of the two projects only on the basis of their economics at the plant level. Both projects have various economic impacts which may be difficult to quantify, but are nevertheless very important in the context of Lesotho. For example, they will save foreign exchange for Lesotho, reduce the country's dependence on imported energy and stimulate economic activity in general. Since the projects are significantly different in design and objective, such effects will of course work out differently.

Mantsonyane is to be connected to the grid, and its main purpose is to replace electricity imports and supply peak-load power to the grid (so-called peak-logging). But in addition it will contribute to a more reliable electricity supply in the Mantsonyane area. Since Semonkong is an isolated system, its major impacts will be observed in and around Semonkong, where it will stimulate economic activity in general. But in addition it will, other things being equal, save foreign exchange and contribute, although marginally, to reduced dependency on imported energy.

#### General economic effects of the Semonkong project

In the last decade there was a high population growth in the Semonkong catchment area, from 14000 in 1976 to about 25000 in 1988, corresponding to an average annual growth of 5%, which was about twice the national average. (cf. LEC 1988:7). In later years, most of the population growth has taken place in the centre of Semonkong which in 1988 had reached 5000 inhabitants. Only from January 1984 to October 1986, the number of development



sites at Semonkong increased by 65%, from 108 to 178 sites. In the same period, the total number of business sites in possession of legal title in Semonkong more than doubled, from 17 to 38, with 24 of the businesses in late 1986 being operated by local Semonkong people. In 1988, the number of businesses had increased further to between 40 and 50. (ibid.). At our visit to Semonkong in September 1989, we could observe that there is a lively construction activity in the village, with new houses and buildings almost mushrooming. Among the institutions and business activities which are now established in the centre of Semonkong, we may mention:

- Agric Bank
- Frazer Lodge
- Frazer Shop
- Mountain Delight Lodge
- Market/Handicraft centre/estate
- Livestock centre
- Woodlot project/nursery
- Petrol station/workshop
- A large number of small private shops
- Post office
- Police station
- Airport
- Government Clinic
- Methodist Hospital
- High School
- Court House
- Rural Development Project centre

Most of the activities in the centre of Semonkong would probably have been established also without the power project. However, at our visit we got a clear impression that the construction of the hydropower plant and the expectation of getting electricity supply has represented a stimulus to the growth of activities.



In 1984, LEC estimated that the electricity demand in Semonkong would be 0.54 GWh in 1990 with a peak-load of 156 KW. In view of the rapid growth of service institutions and economic activities in the area, LEC in 1987 adjusted its estimate for 1990 to 0.83 GWh and a peak-load of 270 KW (cf. LEC 1988. Annex:2). It is now expected that electricity demand in Semonkong will grow at about 6% per year in the next few years and surpass 0.95 GWh and a peak-load of 310 KW in 1993. In our assessment, this demand forecast is quite realistic. That implies that the Semonkong hydroplant will be overloaded quite soon. This is also indicated by the fact that for shorter periods in June to August 1989, total production corresponded to about 0.30 GWh per year, and the peak-load was 42 KW (cf. Grongstad, Sept. 1989:10-11). This took place with only six connected consumers. However, in September 1989 there were a total of 26 applications for connections to the supply system from the station. Among these are also the anticipated heavier consumers. (cf. Grongstad, *ibid.*). Against this background, Semonkong will most probably be overloaded in the near future. We will therefore recommend that the construction of Semonkong II is considered as soon as possible.

The growth of electricity consumption in Semonkong is presently kept back because a large number of prospective consumers are waiting for connections. A major reason for this delay seems to be that many applicants do not have acceptable house-wiring, partly due to formerly inadequate information by LEC on wiring requirements. Moreover, there is dispute between some applicants and the LEC on connection fees which vary from 500 M to 3000 M, and in some exceptional cases up to as much as 9000 M. At our field visit in Semonkong we were also told by the artisans in the crafts estate that the government had promised them to cover the connection costs, but had now withdrawn that promise due to lack of funds. All people working in the estate were anxious to get electricity, but now they did not know how to finance the connection costs.



There is reason to believe, however, that these problems will be solved quite soon; and as a result, the electricity consumption in Semonkong will make a considerable leap.

#### Foreign exchange savings

In our estimates of foreign exchange (forex) costs of the two hydropower plants we have assumed that all equipment imported from Norway, all vehicles and construction equipment, all contingencies, all costs of professional services and 10% of labour and material costs represent forex costs. On this assumption, NOK 39.1 mill. or about 70% of total investment costs at Mantsonyane and NOK 16.9 mill. or about 79% of total investment costs at Semonkong turn out to be forex costs.

The annual forex costs of the investments have been estimated by amortising the investments over the assumed economic life-time of the projects (40 years). The operating costs of the hydropower plants have been assumed to be in local currency only. The forex costs of the supplementary diesel generators at Semonkong and Mantsonyane have not been included in these calculations.

The production of hydropower at Semonkong can, realistically, be replaced only by diesel generation of electricity based on imported diesel. In order to estimate the forex costs of the diesel alternative, we have assumed that the hydropower facilities are replaced by a diesel generator, the cost of which was assumed to be M 327000 at 1989-prices. The diesel generator is assumed to produce 0.75 GWh per year. We have assumed a diesel consumption of 0.3 litre per KWh. At a price of 0.80 M per litre, total annual fuel consumption amounts to M 180000. Moreover, we have assumed that the annual forex costs of maintenance of the diesel generator are M 35000, and that the economic life-time of the generator is 17 years.

We have assumed that the following hydropower facilities are



replaced by a diesel generator: turbine and generator with accessories, parts of the control panels, including control panel at the dam (all these components including installation costs), pipes imported from Norway, 60% of costs of labour and materials (mainly dam construction), 40% of vehicles and construction equipment, and 15% of professional services. The total forex costs of these components have been estimated at NOK 5.3 mill. or M 2038450. We have assumed that the remaining structures (power house, transformers, distribution lines, etc.) are common to the two alternatives. For the diesel alternative we have assumed that the economic life-time of these structures is 40 years. (An assumption of 25 to 30 years would have been more realistic here, and by making an assumption of 40 years we have given the diesel alternative some advantage in the forex cost estimates).

The results of our estimates of the forex costs of hydropower versus diesel generation of electricity at Semonkong are shown in table 3.5.4.

Table 3.5.4. Annual forex costs of diesel- and hydroelectricity, respectively, at Semonkong. Maloti '000 at 1989-prices.

Real rate of interest	Diesel '000 M	Hydro '000 M	Diesel minus hydro '000 M
10.0%	717.73	664.69	53.04
5.0	512.98	378.81	134.17
4.0	475.07	328.40	146.67
3.5	456.97	304.38	152.59
3.0	439.51	281.21	158.30
2.5	422.71	258.94	163.77
2.0	406.60	237.62	168.98
0	349.62	162.50	187.12



It is notable that the hydro-alternative turns out to be the less expensive in terms of forex costs even at a real interest rate as high as 10%. In section 3.5.1 we observed that the internal and financial rates of return of the Semonkong hydro project are very low, and the diesel alternative would, no doubt, perform better in terms of these indicators. However, in a country such as Lesotho, facing serious balance of payments problems, we think that the forex saving capacity of energy projects should be given far more weight than their internal economics. Against this background we think that hydropower was the right choice at Semonkong. (Additional arguments in favour of hydropower are, among other things, that it is a reliable and clean source of energy and that it will make Lesotho less dependent on imports from or through South Africa).

Mantsonyane was designed with the major objective to supply peak-load power to the grid, so-called peak-logging. Each month, ESCOM charges Lesotho 18220 rand per MW of peak-load power (1 rand = 1 maloti), which is the highest load within a month with a duration of at least 30 minutes. In May to August 1989, the average monthly peak-load was 40 MW, whereas the average monthly imports of electricity amounted to 12 GWh, for which ESCOM charged 0.03373 M per KWh. As a consequence, the average monthly import bill for electricity was as follows:

	Maloti	%
Peak-load power	728800	64.3%
General consumption charge	404760	35.7%
Total per month	1133560	100.0%

In other words, about two thirds of the import bill for electricity is a peak-load charge, and one KWh of peak-load power is



extremely expensive compared with the general ESCOM charge of 0.03373 rand (about 0.088 NOK) per KWh. It is therefore in the interest of Lesotho to use domestic resources for peak-logging, which is a major objective of the Mantsonyane hydropower plant.

When well operated, Mantsonyane can supply 2.2 MW of peak-load power each month and a total of 6.7 GWh of electricity per year. Its total annual gross foreign exchange savings will be

Peak-load savings:	481 000 M
General consumption savings:	225 990 "
<b>Total annual gross foreign exchange savings:</b>	<b>706 990 M</b>

**Table 3.5.5. Annual net foreign exchange savings of Mantsonyane hydropower plant. M '000 at 1989 prices.**

Real interest rate	At current ESCOM tariffs	Current ESCOM tariffs escalated by:	
		10%	20%
10.0%	- 830.79	- 758.09	- 689.39
5.0	- 169.40	- 98.70	- 28.00
4.0	- 52.78	+ 17.92	+ 88.62
3.5	+ 2.80	+ 73.50	+ 144.20
3.0	+ 56.41	+ 127.11	+ 197.81
2.5	+ 107.93	+ 178.63	+ 249.33
2.0	+ 157.27	+ 227.96	+ 298.66
0	+ 331.04	+ 401.74	+ 472.44

In other words, about two thirds of the import bill for electricity is a peak-load charge, and one kWh of peak-load power is



Our estimates which are summarised in table 3.5.5, show that Mantsonyane, at current ESCOM tariffs, becomes a net forex saver at a real interest rate of 3.5%. If the investment costs at Mantsonyane are considered as sunk costs, i.e. the interest rate is zero, the annual net forex savings will be about M 330000 per year.

Now, the ESCOM tariffs for electricity exports to Lesotho are remarkably low. In 1989, the ESCOM tariff for regular electricity imports at the Maseru intake point was only 0.03373 M, or 0.0877 NOK per KWh, which is, no doubt, far below the average as well as the marginal cost of electricity production in the RSA. (Only the average variable cost of diesel-generated electricity is close to 0.20 M per KWh).

For this reason we have calculated net forex savings of Mantsonyane with ESCOM tariffs of 1989 escalated by 10% and 20% respectively. The table shows that Mantsonyane becomes a net forex saver at a real interest rate of 4% when the tariffs for imported electricity are escalated by only 10%.

Provided that Semonkong and Mantsonyane are well operated, both plants will save foreign exchange for Lesotho. With regard to Mantsonyane we may assume that this will be even more the case in the future, as we may expect that the presently very low ESCOM tariffs for electricity exports to Lesotho will be increased far more than the general price increase. But the forex savings cannot materialise unless Mantsonyane is well operated as a peak-  
loading plant.

For the time being, Mantsonyane cannot perform this function, mainly because the central transmission line from Thaba-Tseka (through Mantsonyane) to Molimo Nthuse is not in a satisfactory state. During long periods of the year with windy weather conditions this line, which was built in 1979, cannot be used. We were told at the LEC that for example in 1987, there were 42 fault days on the line; and during a normal working day in August



1989, there had been up to six faults along the line. In addition to this problem there is an ongoing dispute on the possible need to establish a substation along the central line between Mantsonyane and Roma before the Mantsonyane hydropower plant can be connected to the national grid.

Before these problems are solved, Mantsonyane cannot fulfil its objectives, and it will suffer grave economic losses. At least the problems relating to rehabilitation of the central line should now be resolved, since LEC has made a final decision that the line shall carry 33 KV. Mantsonyane can carry out its objective of substituting imported peak-load power only until 1996, when Muela I starts production. After that date, the price of Mantsonyane power will be reduced below the level determined by peak-load power imports. This is another reason why Mantsonyane should come into full capacity production as soon as possible.

#### Employment effects

The Mantsonyane and Semonkong hydropower plants have direct as well as indirect employment effects. The direct effects relate to employment during construction and the supervision, maintenance and administration employment during operation. The indirect effects relate to employment generation due to increased effective demand generated by the project during construction, and electricity supply to various economic activities, especially in Semonkong, during operation. Although such indirect effects surely do exist, there is no data which could help us to quantify them. We may only note that equipment for about NOK 1.4 mill. was purchased from local suppliers, and these purchases of course had some employment effect. (cf. table 3.2.2.).

In the following we will confine our discussion to the direct



employment effects.

Table 3.5.6. shows the number of Basotho workers employed by NOREMCO at Mantsonyane and Semonkong during the various stages of the construction work. After the start-up phase, the work force was increased to a total of about 110 on average in February 1986 to March 1987, and about 130 in April 1987 to October 1987. Then there was a decline to an average of about 90 in November 1987 to May 1988. At the end of February 1989 there were no construction workers left.

In addition to the Basotho workers employed by NOREMCO, the Labour Construction Unit (LCU) employed 120 workers on the road between Mantsonyane and the plant site from September 1985 to August 1986; and in the period September 1985 to October 1987, LEC employed on average about 10 workers building the transmission line from the power station to Mantsonyane.

Table 3.5.6                      Numbers of Basotho workers employed by NOREMCO at Mantsonyane and Semonkong during the construction period. Averages in each period

	Mantsonyane	Semonkong	Total
September 1985 to January 1986	30	-	30
February to August 1986	68	49	117
September 1986 to March 1987	64	37	101
April 1987 to October 1987	97	32	129
November 1987 to May 1988	72	20	92
June 1988 to February 1989	33	2	35

Source: NORPLAN: September 1989.

Many of the Basotho construction workers had previously been working in South African mines and were therefore acquainted with



working in South African mines and were therefore acquainted with rockdrilling and blasting, which was a definite advantage for the contractor. On the other hand, these workers had the advantage that they did not need to go to the RSA to find work during the construction period at Mantsonyane and Semonkong.

After completion of the construction work, the direct employment effect of the projects is small. At Mantsonyane, two operators, one watchman and one driver will be employed; at Semonkong, one district supervisor/head operator, two operators, one watchman and one driver. In addition, the recently established Generation Department at the LEC in Maseru will employ two professionals and a secretary dealing with the hydropower stations at Mantsonyane and Semonkong as well as Tlokoeng and Tsoelike. We should keep in mind, however, that these few jobs are related to the operation of Lesotho's first hydropower plants and will therefore imply that important new skills and experiences are acquired by Basotho people.

### 3.6. SOCIAL, CULTURAL AND ENVIRONMENTAL ASPECTS OF THE PROJECTS

#### 3.6.1 Socio-economic aspects

There are some difficulties associated with assessing the social, cultural and environmental impacts of the mini-hydropower stations at Mantsonyane and Semonkong. The Mantsonyane plant is at present connected to the central line, which itself is not in proper order when required to provide power at peak load periods to the national grid. No new connections or installations have arisen as a result of the operation of the new power station, and until the problems relating to connection to the main grid are resolved, are unlikely to do so. In terms of the increased availability of electricity supply, therefore, there is no



observable social or cultural impact either within the Mantsonyane area, or within the wider catchment area which it supplies. Stimulation of local employment creation, or of village development is not yet apparent. Any broader social impact, in relation to decreasing dependence on electricity imports, could also only be realised in the long term.

The situation at Semonkong is very different, but equally difficult to assess fully. Primarily, this is because of the existence of an integrated Development Project in the Semonkong area which was established in 1984. The project is supported by a number of bilateral agencies, including NORAD, whose contribution has financed the mini-hydropower station. Because the station is not fully operational as yet, and because of difficulties associated with connecting individual houses and other establishments with electricity, it is difficult to assess how far electricity has been, or will be, a necessary or prerequisite factor in the (further) development of activities within the Semonkong Development Project.

What is clear, however, is that the Semonkong Development Project, including the rural electrification component, is an extremely important pilot project, which will serve as a model for future decentralised development efforts in the underserved areas of Lesotho. Initiatives in Semonkong arose out the need recognised by the Government of Lesotho to ameliorate the regional disparities which characterise the rural areas. The mountain areas, within which Semonkong is located, in Maseru District are particularly disadvantaged in respect of infrastructure and social services. This is principally because of the sheer logistical difficulties associated with service delivery in such remote and isolated areas, where climate and environmental conditions are harsh.

Phase 1 of the Semonkong Development Project (1984-1987) had the following objectives:



- improvement of socio-economic background of the rural populace where they are, by providing them with necessary social infrastructure to make their life bearable;
- to curb town migration that contributes to bottle-necks and problems in the social services.

The objective of Phase 2 starting in March 1988, is to:

- move to production orientated activities to make sure that the populace of the region is able to sustain itself economically by motivating them to use to maximum capacity the resources at hand.

Activities in Phase 1 have thus concentrated on infrastructural development, with the following establishments having been constructed or upgraded:

- bridges on existing roads and upgrading of the main access road from Ramabanta to Semonkong
- a community hall
- primary schools
- a building to accommodate banking facilities
- a market hall and adjoining workshops
- village water and sanitation supplies
- a tree nursery and woodlots
- a livestock improvement Centre
- a block of Rural Development Offices
- a multi-purpose Assembly Place
- a Nutrition Centre
- a Young Farmer's Training Centre
- a Government-operated clinic.

In addition, not as directly funded project components, but provided by the Government or private interests, the following have been established:

- a post office and radio call telephone station



- a number of private businesses, including a petrol station, resthouse and small scale enterprises
- residential housing.

Training in agriculture and livestock production has been implemented, as well as vocational and business management training courses for small-scale entrepreneurs and a credit scheme for existing enterprises in Semonkong.

The extent and content of project activities is indicative of the extreme under-servicing of the area which pertained prior to implementation. Together, they have transformed Semonkong from an isolated and virtually undeveloped village to a busy and productive rural service centre. Semonkong now provides a range of services to a catchment area having, by 1988, an estimated 25 000 inhabitants, some 5 000 of whom live in Semonkong itself.

Whilst the bulk of project activities have been funded by grants from donors, there is evidence that this has stimulated considerable local investment in business and small scale enterprise development. Approximately two-thirds of the 38 businesses having legal title in Semonkong are operated by local people. Whilst we have been unable to measure the specific socio-cultural impact of local investment and involvement during a limited fieldwork period, it is clear that the developments in Semonkong have had an important influence in stimulating growth.

It has been similarly difficult to assess how far the incentive of electricity connection was influential in attracting this investment, as for the vast majority of potential consumers, the promise of electrification has not yet materialised. By mid-1988, the extent of actual and potential demand for power had outstripped the capacity of the power plant as it was currently installed. Priority consumers had thus to be identified, which in the event were designed as:

- the strategic part of the public service, i.e. security and



medical services  
 - the production and distribution sector.

At current capacity, however, the power supply is unlikely to be sufficient for all those who qualify under these criteria, but it is estimated that upon completion of stage 2 of the hydropower installation, demand could be met for about 10 years.

Problems relating to the connection of electricity into buildings, and to internal wiring, have, in a sense, deferred the problem, however. Many households and business premises have experienced difficulties in obtaining the services of electrical contractors to undertake internal wiring to the standard required by LEC at a cost they can afford.

Small businesses visited by the fieldwork team, operating in the workshops adjacent to the market hall, included a saddle maker and a group of carpentry workers. Both were waiting for the free connection of electricity to be made to their workshops, as promised by Government officials some nine months previously. It appears that financial constraints within WEMMIN have given rise to the Ministry's inability to proceed with installation. On the other hand, there is some doubt as to whether this promise was ever actually made, it seems more likely that a financial contribution was expected from the small scale entrepreneurs, who were now unwilling or unable to provide it.

Whilst both of the artisan groups visited claimed that they required electricity for lighting, and the carpentry group maintained that they would purchase mains driven machinery to replace hand tools, once connected, which would improve their productivity and the finish of their products, there was a measure of resignation about the situation. Both groups were only averaging a monthly income of M 600-800, a figure considerably lower even than the rural Poverty Datum Line calculated at M 1200 for 1984, particularly for the carpentry group where three workers were sharing the income.



The social impact of rural electrification in communities where one of the central characteristics is poverty, as is the case in Semonkong, must in large measure be determined by the extent to which productive activities generate disposable income. Thus, if and when electricity is available to those and other small scale entrepreneurs, there will be need to monitor their production output and subsequent increase in income generation, if any, as against overhead costs. It will be difficult for small scale producers to operate at realistic profit margins - or even, perhaps at break even point - where the costs of installation, wiring, machinery and supply tariffs are not off-set by increased production which has a ready market.

### **3.6.2 Health- and gender aspects**

The health profile of Semonkong is similar to that of the mountain areas of Lesotho as a whole, characterised by high rates of TB and sexually transmitted diseases in adults, and diarrhoea, measles and other infectious diseases in children. Whilst the clinic sister at Semonkong felt that the connection of electricity to the clinic had helped in respect of facilitating some medical and hygiene procedures (boiling instruments, for example), it was not clear how far, if at all, the electrification component of the project have had a direct impact on changes in the health situation of the clinic's patients.

TB cases were seen to be on the decline, for example, but this was apparent primarily amongst the inhabitants of the outlying areas, who travelled anything up to 20 km to the clinic in Semonkong, and whose households were not electrified. Where electricity replaces the use of more traditional fuels such as dung, crop residues and shrubs, a decrease in respiratory diseases would be anticipated, but supply in Semonkong is not yet that widespread. Similarly, the noted decline in infant and child mortality is likely to be associated with the increased provision



diseases would be anticipated, but supply in Semonkong is not yet that widespread. Similarly, the noted decline in infant and child mortality is likely to be associated with the increased provision of water and sanitation facilities through the Semonkong Development Project.

Women are not identified as a particular target group of the Semonkong Development Project, or as special beneficiaries of the electrification component. Given the extent of migrant labour from the rural areas of Lesotho, however, their needs should be given priority, although as reported in the UNICEF Situation Analysis (1986:38) this has not always been the case:

" .... the importance of women in development is not recognised as rural women are not the beneficiaries of a number of services including credit facilities, extension services, direct labour programmes, etc. Those households which have limited or no access to wage income, which are landless and without livestock, or which are female headed are likely to constitute the poorest groups in rural areas."

Women are responsible for the greater part of agricultural and domestic work, and the promotion of labour saving appropriate technology devices has been recognised as critical to reducing the arduous nature of their tasks, and the health- and social problems which they give rise to. As extension of the electricity supply is unlikely beyond Semonkong Centre itself, it will be important to identify these needs and implement appropriate programmes as an integral part of project activities.

### **3.6.3 Environmental aspects**

Similarly, the introduction of electricity in the Semonkong Centre should not detract from the need to continue the extensive promotion of woodlot and reforestation programmes. Woodfuel and other traditional sources will no doubt remain the favoured fuels



for space heating, particularly in low-income households, but even where in the long term extensive fuel-switching may occur, the imperative of stabilising the area's highly eroded soils, through revegetation and the regulation of rainfall flow as a result of fencing off land and establishing woodlots should not be neglected. Whilst no other environmental impacts of the power plants were observable, there is potential for a negative impact of this sort to occur in the long term.

The Lesotho Household Energy Survey (Gay, 1984) illicited a relatively high demand for electricity amongst both rural households and small scale producers. As a part of an integrated programme such as that underway in Semonkong, it will be important that the availability of such a resource becomes a reality for those consumers requesting it, under financial conditions which are not beyond their means to realistically sustain.

If electricity is not made available under such circumstances, the social impact of the integrated programme of which it forms a part will be limited. More importantly, however, reduced availability or nonavailability, high costs and long waiting lists may de-motivate programme participants and lead to a falling off in locally based support to and investment in development activities. Whilst it is too early to determine whether this somewhat pessimistic scenario will occur in respect of the Semonkong hydropower plant, it will be important that these kinds of potentially negative side effects be avoided by careful monitoring and continuous review exercises.

We have noted above that significant environmental impacts of the power plants are not observable. Semonkong is basically a run-of-river-project with a quite small reservoir providing some 25,000 m<sup>3</sup> of live storage. The reservoir is located in a mountain area, and no human settlements are affected by it.

The Mantsonyane reservoir is situated in a narrow valley with



steep and rocky slopes which are quite unsuitable even for grazing of animals. The live storage of the reservoir is 450,000 m<sup>3</sup> and its volume 600,000 m<sup>3</sup>. The mean annual discharge in the river is 4.4 m<sup>3</sup>/s. Hence, the size of the Mantsonyane reservoir will to some extent result in a more stable water supply and lower floods downstreams, improving the conditions of agriculture in downstreams areas.

In both projects, the river between the water intake and the power station will be drained during long periods of the year, preventing fish migration in those periods. Possible consequences of this are not known to us. Neither the size of the fish resources nor the pattern of fish migration have been investigated. The reason for this is probably that Basotho people dislike fish, which is completely absent in their diet.



**REFERENCES**







- Agreement between The Government of the Kingdom of Norway and The Government of the Kingdom of Lesotho regarding Norwegian assistance for the planning and construction of Mantsonyane and Semonkong hydropower schemes. Signed in Copenhagen, 2nd August 1985.
- Bureau of Statistics (1988): Incomes, Expenditure and Consumption of Basotho Households. Main Results from the Household Budget Survey 1986/87. Maseru.
- Bureau of Statistics (1988): Incomes, Expenditure and Consumption of Basotho Households. Tabulation Report from the Household Budget Survey 1986/87. Maseru.
- Bureau of Statistics (1989): Statistical Yearbook 1989. Draft. Maseru.
- Economist Intelligence Unit (1989): Lesotho - Country Report No. 1, 1989. London.
- Endresen, Isobel et al. (1988): Report by Appraisal Mission Regarding Possible Norwegian/Swedish Support to Improved Sub-transmission and Distribution Networks in Lesotho. SIDA, Stockholm.
- Fluitman, Fred (1984): Socio-economic impact of rural electrification. ILO, Geneva.
- Foley, Gerald (1989): Electricity for Rural People. The Panos Institute, London.
- Forestry Division/Ministry of Agriculture, Cooperatives and Marketing (June 1987): Woodlot Project - Annual Report 1st July 1986 to 30th June 1987 and Review 1973-1987. Maseru.



- FPP (July 1988): Fuelwood and Poles Project - Progress Report Ending 30th June 1988. Maseru.
- Frolich, Alan (1984): "Lesotho", in: Energy and Development in Southern Africa. SADCC Country Studies, Part I (eds. P.O'Keefe and B. Munslow). The Beijer Institute, Stockholm/The Scandinavian Institute of African Studies, Uppsala.
- Gay J., (1984): Lesotho Household Energy Survey (Lowlands and Foothills) for ATS. Maseru.
- Grongstad, Steinar (Sept. 1989): Engineer Assigned to Lesotho Electricity Corporation. Final Report. Maseru.
- Guy Jeff and Motlatsi Thabane (1988): "Technology, Ethnicity and Ideology: Basotho Miners and Shaft-Sinking on the South African Gold Mines", Journal of Southern African Studies, Vol. 14, No. 2, 1988.
- GWP (Stortingsmelding) No. 36 (1984-85): Om enkelte hovedspørsmål i norsk utviklingshjelp. MDC, Oslo.
- GWP (Stortingsmelding) No. 34 (1986-87): Om hovedspørsmål i norsk utviklingshjelp. MDC, Oslo.
- IMF: International Financial Statistics. Several issues, Washington D.C.
- Kingdom of Lesotho (1989): National Environmental Action Plan. Maseru, June 1989.
- Kingdom of Lesotho (August 1989): Rural Development, Agriculture and Environment. Retrospect and Prospect. Maseru.
- LEC (1988): Energy demand and hydropower development in light of total development in Semonkong Village. Maseru.

- LHDA (June 1989): Rural Electrification in the LHWP area. Draft, Maseru June 1989.
- LHDA/LEC (March 1989): Investment and Tariff Study - Tariff Structure. Draft Version. Maseru.
- LHWP (undated, 1989): Lesotho Highlands Water Project. Maseru.
- Makakole B. and Tracey D. (1989): "TB in Lesotho - 1988", in: Ministry of Health Epidemiological Bulletin 2nd Quarter. Maseru 1989.
- Ministry of Planning, Economic and Manpower Development (1988): Fourth Five Year Development Plan, 1986/87-1990/91. Vol. II: Public Sector Investment Programme. Maseru.
- NORPLAN: Summary Progress Report, several issues from 25.09.86 to 11.03.89.
- NORPLAN (Nov. 1987): Final Dam Breach Report. Maseru, 24.11., 1987.
- NORPLAN A/S and Hafslund (undated): Mantsonyane Hydropower Project - Final Design, Vol. I. Maseru/Oslo.
- NORPLAN A/S and Hafslund (undated): Semonkong Hydropower Project - Final Design, Vol. I. Maseru/Oslo.
- SADCC Energy Bulletin, Vol. 5, No. 13 (1987): Energy in Lesotho: An Overview.
- SADCC (Nov. 1985): Energy - Proceedings of the Seminar on Energy Planning in the SADCC region, Luanda, Angola 30.10-02.11, 1985.
- SADCC (undated, 1988): Annual Technical Report - Energy Sector 1987. TAU, Luanda.



SADCC (Febr. 1989): Energy - Southern African Development  
Coordination Conference 1st-3rd February 1989. Luanda.

SADCC (April 1989): Energy Statistics 1987. Vol. I. TAU, Luanda.

Sharma, T.S. and S. Makhoalibe (undated): A regional frequency  
study of extremal rainfall and runoff processes, DWA,  
WEMMIN, Maseru.

Simoes, J.T.C. ed. (1984): SADCC: Energy and Development to the  
Year 2000. Beijer Institute, Stockholm/The Scandinavian In-  
stitute of African Studies, Uppsala.

UNICEF (1986): The Situation of Children and Mothers in Lesotho.  
Central Planning and Development Office. Government of  
Lesotho. Maseru.

WEMMIN (1988): Lesotho Energy Masterplan. Summary Report. Maseru.

WEMMIN (1988a): Lesotho Energy Masterplan. Annexes to Council  
of Ministers Memorandum. Maseru.

WEMMIN (1988b): Lesotho Energy Masterplan. Vol I: Energy  
Resources and Technology Assessment. Maseru.

WEMMIN (1988c): Lesotho Energy Masterplan. Vol. III: Guidelines  
for the Formulation of Energy Strategies. Maseru.

World Bank (1987): Lesotho - Country Economic Memorandum. Report  
No. 6671-LSO. Washington D.C.

SADCC (Nov. 1985): Energy - Proceedings of the Seminar on Energy  
Planning in the SADCC region, Luanda, Angola 10-12.11.  
1985.

SADCC (undated, 1988): Annual Technical Report - Energy Sector  
1987. TAU, Luanda.

**INSTITUTIONS AND PERSONS VISITED DURING FIELD WORK**



INSTITUTIONS AND PERSONS VISITED DURING FIELD WORK

(September 3 to September 8, 1989)

- September 3: NOREMCO, Maseru. Resident manager Per Bang Rolfsen
- September 4: Ministry of Water, Energy and Mining (WEMMIN). Mr Sekoli, Head Dept. of Metereology; Ms Mtasawo, Hydrologist, Dept. of Hydrology; Mr. Lekoetje, Deputy Director, DOE; Mr. Mayer, economist, technical adviser to DOE.
- Bureau of Statistics. Mr. Phamtose, Director; Mr. Mokhahlane, Head of National Accounts; Mr. Redeby, technical adviser.
- September 5: Visit to Semonkong hydropower plant and Semonkong village, accompanied by Ms. Mtasawo, WEMMIN; and Mr. Grongstad, LEC; Interviews with two plant operators. Government Clinic, sister Mosiwoa; Woodlot Nursery; Frazer's Shop; Market centre/handicraft estate.
- September 6: WEMMIN. Mr. Mokhalibe, Director, DWA. Visit to Mantsonyane power plant, accompanied by Mr. Sekoli, WEMMIN; and Mr. Rolfsen, NOREMCO. Interviews with two plant operators.
- September 7: WEMMIN. Ms. Mpetta, Chief Planning Officer.
- Ministry of Agriculture, Co-operatives and Marketing. Mr. Thulo, Chief Forestry Officer; Mr. May, Forestry Adviser, Forestry Division.
- Lesotho Highlands Development Authority (LHDA). Mr. Ramollo and Mr. Rafonene, Senior Engineers.



September 8: LHDA. Mr. Bereng, Public Relations Officer; Mr. Mashologu, Economist; Mr. Matsoha, Senior Civil Engineer. Mr. Mochebelele, Chief Delegate, Joint Permanent Technical Commission of Lesotho Highlands Water Project (LHWP); Mr. Malapo, Delegate; Mr. Sibolla, Land Use Planner.

Appropriate Technology Services (ATS). Mr. Mohasoane.

Lesotho Electricity Corporation (LEC). Mr. Matsau, Managing Director; Mr. Sengupta, Financial Manager; Dr. Bulane, Planning Engineer; Mr. Grongstad, technical adviser to LEC.

Ministry of Interior. Ms. Machai, Planning Officer; Mr. Mdee, Planning Officer at Dept. of Physical Planning.

September 6: WEMMIN. Mr. Mokhalibe, Director, DWA. Visit to Mantsosanyane power plant, accompanied by Mr. Sekoli, WEMMIN; and Mr. Rolfsen, WOREMO. Interviews with two plant operators.

September 7: WEMMIN. Ms. Mpetla, Chief Planning Officer. Ministry of Agriculture, Co-operatives and Marketing. Mr. Thulo, Chief Forestry Officer; Mr. May, Forestry Adviser, Forestry Division.

Lesotho Highlands Development Authority (LHDA). Mr. Ramolio and Mr. Ralofane, Senior Engineers.

**TERMS OF REFERENCE**





## T E R M S   O F   R E F E R E N C E

## FOR EVALUATION

## HYDRO-ELECTRIC POWER PLANTS IN LESOTHO (LES 401)

October 31, 1988

---

1.0 BACKGROUND

Lesotho is a small mountainous country completely surrounded by the Republic of South Africa, and highly dependent on its neighbour. Today, approximately 99 % of the power supply is imported from RSA. Lesotho has a hydro-power potential in excess of the requirements of the country. Several hydropower projects have been considered, but the annual debt servicing and operating costs have in general been uncompetitive to the rates paid for electricity from RSA.

It is a political target to reduce Lesothos dependency of the RSA within the energy sector. A list of energy projects were approved by the SADCC Minister Meeting in Angola, September 1984. Among the projects were the two small scale hydropower plants in Mantsonyane and Semongkong.

The Mantsonyane hydropower plant comprise a dam (height 16m), a tunnel (length 700 m) and a power station with two Francis turbines. Total installed effect 2,00 MW. Transmission lines access road are also part of the project.

The Semongkong hydropower project comprise a dam (height 2,5 m), a pipeline (length 400 m) and a power station with one Francis turbine and a stand-by diesel generator. Installed effect 0,18 MW.

The project started in 1985 and is scheduled for completion by the end of 1988. The project has been implemented by the Ministry of Water, Energy and Mining/ Lesotho Electricity Corporation with financial and technical assistance from the Norwegian Ministry of Development Cooperation/NORAD.



The first allocation in 1985 was NOK 57,00 mill.

An additional allocation of NOK 9,50 mill. was made in 1987.

The development objectives of the projects were:

- To promote Lesotho's independence from import of energy (diesel, electricity, etc.);
- To provide regular and relatively cheap electric power to remote districts, and thereby stimulate district development;
- To promote manpower development and training within the hydropower sector, and thereby support future development of the country's natural potentials in this field.

In view of the pilot-project nature of these first hydroelectric power schemes in Lesotho, the experience gained in project planning and implementation should be of interest to the Governments of Lesotho and Norway as well as the SADCC Office. For the purpose of compiling and analysing such experience, the Norwegian Ministry of Development Cooperation (MDC) now intends to carry out an independent evaluation of the projects in Mantsonyane and Semongkong.

## 2.0 EVALUATION-PROJECT DESCRIPTION.

### 2.1 Aspects to be addressed by the evaluation team.

The evaluation team shall evaluate the project's activities and achievements in relation to goals, production targets and inputs as these are stated in project plans and related documentation. In particular the team shall:

- i) Assess whether the project has been implemented in accordance with the principal objectives of Norwegian development assistance and the specific development objectives for the project.
- ii) Assess whether the project has been implemented in accordance with Lesotho's policies within the sector and to what extent it has been coordinated with government activities in general.
- iii) Describe changes in the original implementation schedule and budget, and review the circumstances



- leading to the alteration.
- iv) Assess the project's impact on economic, social, cultural and ecological conditions, and whether unexpected negative or positive consequences are in evidence.
  - v) Assess whether project design, implementation and operation is in accordance with needs and wishes of the target group, and whether local participation is adequate.
  - vi) Consider the adequacy of institutional and administrative procedures, communication between the authorities and the project personnel, training of local staff members, and progress towards full assumption of responsibilities by local institutions and persons.
  - vii) Discuss choice of technology of machinery, equipment and materials, as well as the project's organizational model, in view of foreign exchange requirements, need for expatriate personnel, employment creation and maintenance.
  - viii) Assess the adequacy of design, quality and durability of physical structures in view of existing and planned methods of operation and maintenance, and (if applicable) give possible alternative suggestions.

## 2.2 Recommendations.

On the basis of the conclusions of the above studies and assessments, the evaluation team shall discuss options and recommend possible future development assistance to Lesotho in the field of hydro-electric power.

## 3.0 PREMISES, IMPLEMENTATION, REPORTING.

### 3.1 Premises

The implementation of the evaluation will include desk-studies and field studies.

The desk studies will be based on project documentation and other relevant information material, as well as on interviews with MDC/NORAD staff and other resource persons.



To the extent that project documentation and other information is readily available, the desk studies shall be carried out as part of the necessary preparatory works for the field studies.

The field studies include visits to the recipient country/districts, and discussions with local authorities at central and district level, beneficiaries, users, local staff and trainees, project staff, and other resource persons.

### 3.2 Work Programme and Coordination.

The evaluation shall be carried out as a separate study, but for the purpose of rationalization of economic and human resources the work shall be coordinated with the evaluation of the energy sector and the telecommunication sector. This implies, inter alia, that the field studies will be timed to coincide, and that duplication of document collection, meetings, interviews etc. will be avoided.

Deadlines for completion of reports will be given in the consultancy Agreement.

### 3.3 Evaluation Team.

The evaluation project, pending on an acceptable proposal and agreement, will be commissioned to the University of Trondheim, Centre for Studies of Development and Technology Transfer (CDT). The team shall comprise 3-5 resource persons, together covering the following disciplines

- (a) and special experience (b):
- a) Energy engineering, economy and social science.
  - b) Relevant working experience from Africa, knowledge of development assistance cooperation, and project management experience.

Both men and women should preferably be represented in the team.

### 3.4 Language.

All reports and documentation shall be presented in English.





ISBN 82-7177-301-1

GCS A/S, Oslo