THE IMPACT OF ELECTRICITY SHORTAGES ON LARGE- AND MEDIUM-SCALE MANUFACTURING INDUSTRIES IN ETHIOPIA

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Declaration

I declare that this dissertation is my original work. It is being submitted in partial fulfilment for the degree of Mater of Energy Study at the University of Cape Town. It has not been submitted before for any degree of examination in any other University.

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ABSTRACT

This study examines the impact of electricity shortages on the Large- and Medium-Scale Manufacturing Industry (LMSMI) in Ethiopia, using data obtained from a case study of 16 LMSMI firms that was undertaken in Addis Ababa from January 2004 to February 2004. In addition, the study examines the causes of these electricity shortages. Ethiopia's electricity supply relies very heavily on hydroelectric power, with geothermal, natural gas, solar, coal and diesel together providing only 1% of the total electricity supply. Significant power shortages occurred in the years 1995/96, 1997/98 and 1999/2000, with a particularly severe power shortage happening in 2002/03. The causes of these included a general increase in electricity demand, without a corresponding increase in installed hydropower capacity, and a sustained period of drought.

The case study findings showed that power outages were particularly costly in the LMSMI sector, through production and raw materials losses, damage to equipment, and the additional investment and operating costs of self-generation among those firms that purchased and used their own diesel generators as a backup source of electricity.

The case study results indicated that power outages caused firms without backup generators to lose approximately 15% to 30% of their potential production in 2002/03. Even in the other years when the power shortages were less severe, losses could reach up to 10%. By extrapolating the sampled firms' production losses to the total number of LMSMI firms in the country, it can be estimated that the country may have lost 10% to 15% of total yearly gross value of production that could have contributed from this sector and 1% to 3% of total yearly government revenue.

In the past, because of the low level of development in the Ethiopian LMSMI sector, the costs of power outages on this sector had not been as big, despite their high frequency. It is envisaged that, when the country's economy grows and the government's new policy (the Agricultural Development-Led Industrialization strategic plan) increases the economy's dependence on LMSMI production, then power outages would certainly have a much greater impact on the LMSMI sector as well as on the total economy of the country. In order to avoid this, therefore, some of the constraints which contributed to power shortages in the past (such as poor planning and governance, bad decision-making, and a lack of integrated planning), should be addressed. In addition, unplanned power outages, which, according to the firms interviewed, had an even greater impact than scheduled power outages, should be minimized. Hopefully, in the future, these mitigation measures will improve the performance and reliability of the electricity supply in the country.

Key words

Large and Medium Scale Manufacturing Industry, Power outages, Electricity shortages, Costs, Ethiopia.

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ABBREVIATIONS

ADLI	Agricultural Development-Led Industrialisation
CSA	Central Statistical Authority
EEA	Ethiopian Electric Agency
EELPA	Ethiopian Electric Light Power Authority
EEPCo	Ethiopian Electric Power Corporation
EIA	Ethiopian Investment Authority
EPA	Ethiopian Privatisation Agency
ETB	Ethiopian Birr
ICS	Inter-Connected System
IFI	International Financial Institutions
IMF	International Monetary Fund
LMSMI	Large- and Medium-Scale Manufacturing Industries Industry
LV	**Low Voltage**
GDP	Gross Domestic Product
GVP	Gross Value of Production
HEP	Hydro-Electric Power
HV	High Voltage
MEDac	Ministry of Economic Development and Cooperation
MOFED	Ministry of Finance and Development
SCS	Self-Contained System
TGE	Transitional Government of Ethiopia
WB	World Bank

IMPORTANT INFORMATION

- Exchange Rate **(From ETB to USD): marginal exchange rate**

EEY	ETB per USD
1985 (1992/93)	5.0091*
1986 (1993/94)	5.7744
1987 (1994/95)	6.2505
1988 (1995/96)	6.3178
1989 (1996/97)	6.4984
1990 (1997/98)	6.8820
1991 (1998/99)	7.5120
1992 (1999/2000)	8.2135
1993(2000/01)	8.4300
1994 (2001/02)	8.6400

Source: National Bank of Ethiopia

*for the last two months only.

- In this paper all the figures from ETB to USD were converted based on the exchange rate of 2001/02.

- 2.The **Ethiopian calendar year** is from September 1 to "*Pagumiene*" 5 or 6. (*Pagumiene* is the thirteenth month, which lasts for only 5 or 6 days).
- **3. Ethiopian Fiscal Year (EFY)** is from July 08 to July 07 ("Hamele" 1 to "Sene" 30). Most of the data in this paper refers to EFY.
- **4. Unless specified all the values in this paper are at current-market price.**
- **5. Surname:** in Ethiopia, we do not normally have a surname. Throughout this paper, all the material that had been written by Ethiopians was referenced by using the author's first name in the body of the text, and including the father's name in the references as well.
- **6**. In this paper, all the translations from Amharic into English were done by the author.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Ethiopia has vast untapped reserves of hydroelectric power. Its theoretical potential was estimated at 650,000 GWH/year, and its economically feasible potential was estimated at between 65,000 GWH/yr to 130,000 GWH/yr (Acres 2003). This ranks the country second in Africa, below the Democratic Republic of the Congo (World Energy Council 2003). Clearly, thus, hydropower is currently the major source contributing to the electricity supply in Ethiopia. For instance, in 2001/02, more than 99.12% of the electricity supplied in the country was generated by hydropower, whereas the remaining 1% came from diesel (0.83%) and geothermal (0.05%) (EEPCo 2002: EEPCo in brief). As a result of this entire dependence on hydropower, the country is vulnerable to power shortages during times of low rainfall, as were experienced during 1997, 1998, 2002 and 2003.

Although the country has long experienced variability in rainfall both over time and space, this problem has frequently happened since 1995 and it became increasingly worse. For instance, due to stagnation in investment in the electricity supply industry during the 1990s, the power deficit that had been 21MW in 1995/96 grew to 60MW in 1999/2000 (data collected from EEPCo 2004). Between 1988 and 2000, electricity consumption grew by 60% against only 3% capacity expansion.

As a result, the electricity supply, which relies predominantly on hydropower, has failed to meet the growing electricity demand, particularly during the prolonged drought years (i.e. 1995/96, 1997/98, 1999/00 and most recently 2002/03). Therefore, to mitigate the power shortage, the utility has been forced to introduce a power-rationing scheme[1], which has, in turn, adversely affected the country's economy as a result of losses in industrial productivity, commercial activities, and transport and communication networks.

Although the degree of the impacts was higher on the above economic activities, other sectors such as education and health were also affected. For instance, the power-cuts forced most of the higher educational institutions to reschedule their pre-planned academic programmes, and the extension (night) programme was particularly disordered. In the health industry, it prevented health service suppliers from giving timely medical services to their patients; this had particularly serious effects on medical centres[2] that had no standby generators. In general, it is estimated that in 2002/03 a one-day interruption in the electricity supply cost the country 17 million ETB (about USD 2 million), which accounts for about 10% of the daily Gross Domestic Product (GDP) (Addis Business 2003b; Berhanu & Said 2003).

In fact, electricity shortages in one way or another have negative influences on all economic activities. However, its impact on the Large- and Medium-Scale Manufacturing Industry (LMSMI), whose major energy source is electricity, is substantial. For instance, the high dependency of large- and medium-scale manufacturing industries on the electricity supply was clearly illustrated in a report by Berhanu and Said (2003). According to their analysis, 98% of the production of this sector was stopped as the result of electricity interruptions. The LMSMI sector's contribution toward the GDP in 2002 was 4.3%; thus, if the electricity supply was interrupted for an entire day (24 hours), the daily GDP of the country would accordingly decline by 4.2% (Berhanu & Said 2003).

1 As reported by the utility, power rationing measures were used in 1995/96, 1997/98, 1999/2000 and 2002/03 to save power. During these periods, power was switched off for one day a week (usually from 6 AM to 8 PM), except between 23 May 2003 and 30 June 2003, when the power shedding increased from one day per week to two days per week (Data collected from EEPCo 2004).

2 For example, the Ethiopian News Agency reported that one of Addis Ababa city's biggest hospitals, known as Ras-Desta, does not have an electrical generator and that this had seriously affected its surgical operations according to the Hospital Medical Director (ENA 2004a).

The costs of the power outages imposed on the LMSMI between 1995/96 and 2002/03 have been estimated by this study, using data obtained from a case study of 16 LMSMI firms undertaken in Addis Ababa between December 2003 and January 2004. It shows that a typical LMSMI firm from this study lost on average approximately 100 to 350 hours per year worth of outputs between 1995/96 and 2002//03 . Over 46% of these losses were the result of the power interruptions that happened in 2002/03. In this year, all firms operating 24 hours per day, except those firms that used backup diesel generators, lost from 660 to 1005 hours worth of production per branch. In terms of monetary value, the largest firms from this group lost as much as 40 million ETB (USD 4.6 million)[3] and even the smallest firms lost up to 800 000 ETB (USD 93,000) per year. The other firms that were operating for fewer hours lost per year two to four times less than for 24-hour firms of similar capacity.

In general, the case study results indicated that power outages caused firms, which had not obtained their own backup generators, to lose approximately between 15% and 30% of their potential production[4] in 2002/03, while in other years the value of output losses could be as little as 10% or less of their potential production. If these patterns were to be extended to the whole LMSMI sector, it is estimated that the country might have lost between 0.7 to 1 billion ETB (USD 0.08 to 0.12 billion) due to power outages in 2002/03. This accounted for 10% to 15% of the gross value of production for this sector.

Given such losses in production time and raw materials and because firms regard the electricity supplied by the utility as unreliable, many of the firms that formed part of this case study obtained diesel generators to satisfy their electricity requirements either fully or in part during the electricity interruptions from the utility. However, this measure has meant additional expenses for these businesses. Based on the case study findings, a small generator (with installed generation capacity of around 250 kVA) can cost a firm about 300 000 ETB (about USD 35 000), whereas a larger

3 Note that all conversions from ETB to USD in this paper were based on the 2001/02 exchange rate (i.e. 8.64 ETB/USD).

4 The potential production is the amount of possible value of outputs that would have been produced without electricity problems. That is the sum of actual production in the corresponding year and estimated production that could have taken place in the absence of power cuts.

one (600 – 1000 kVA) can cost more than a million ETB (more than USD 100,000). Apart from the additional capital costs, the running costs of self-generation to produce a unit of electricity were about three times greater than the electricity supplied by the utility.

In addition to self-generation of electricity, which was used by many firms, other mitigation measures were also used to minimize production losses and costs, such as the following:

- The firms, which were normally working in the daytime only, started producing at night when electricity was available.
- Some firms fired and retrenched some of their workers, or gave early retirement to others to reduce costs of employment.
- Some firms tried to reschedule their pre-planned activities to do manual (non-power) work in the daytime, and other tasks which require power during the night.

However, the above efforts made by power consumers will not by themselves mitigate the problem in a sustainable way. Firstly, having backup generators (the approach chosen by most firms to supply their own electricity needs) incurred additional costs on the firms' business due to unavoidable investment and operating costs. This reduced the competitiveness of their products both within and outside the country with particularly adverse effects on export items. Obviously, that in turn decreased the amount of foreign currency which the country could obtain from the exports. Secondly, apart from the impacts on individual firms, the electricity shortages also caused adverse impacts at a macro level, for example, by reducing government tax, GDP, and export earnings, which could have been gained from the LMSMI sector. Thus, for more sustainable measures, government involvement is crucial.

The shortage of electricity supply has become one of the government's major concerns following the huge electricity crisis in 2002/03, which crippled all economic activities in the country, resulting in pressure being placed on government by business people. Consequently, the government planned short- and long-term mitigation measures to address the problem. In order to give immediate relief in 2003, as reported in Addis Business (2003a), the government started to build twophase diesel generators in three places[5] at a collective cost of 600 million ETB (data collected from EEPCo 2004).

To overcome the problem in a more sustainable and long-term way, government planned to call on private sector intervention in power production and distribution tasks (Addis Business News 2003a). In view of the fact that the country has vast hydropower potential, government strongly believes that Hydroelectric Power (HEP) will play an important part in the development of the country's electric power industry (TGE 1994; Acres International 2003a), therefore the major focus of the government is still to emphasise hydropower projects. A number of milestone activities have been undertaken to harness this natural resource since 2003:

- Recently, the Gilgel gibe project with 192MW installed capacity was completed.
- Government is facilitating and speeding up work on other projects, which are currently in progress.
- In 2004, the government has launched the construction of four new large-scale hydroelectric power projects in the Nile Basin (ENA 2004b).

If, unlike before, all the planned projects are in fact undertaken and realised, the country will most likely not have to face the same problems as previously for a long period of time. It is true that the country is fortunate to have vast untapped HEP potential, which can be harnessed at comparatively low costs (compared with other locally available energy sources such as geothermal, natural gas, solar and coal, and imported energy sources such as diesel). However, such a high dependency on a single energy source, particularly an energy source such as hydropower, which is more vulnerable to unpredictable climatic variability, will not guarantee the energy security of the country. Therefore, to ensure energy security, emphasis should also be put on developing alternative energy sources for the production of electricity.

Based on the findings of other observers and on own analysis, various factors were identified in this study as the major causes of the electricity shortages. Apart from the frequently blamed droughts, which only exacerbated power shortages in the country since 1995, other factors included long delays in finalizing already started

5 The diesel generators were being installed at Kality (10MW), Awash Sebat Kilo (30MW) and Diredawa (40MW), in total 80MW (data collected from EEPCo 2004).

projects, very low investment in the electricity industry since 1990, financial problems, and poor governance and planning.

The main purpose of this dissertation is thus to examine the impact of electricity supply shortages on the LMSMI sector, and other related impacts, such as a loss of employment, a decline in the country's economy, reduced export earnings and government revenues. Data collected in a case study conducted in early 2004 will be used to assess these impacts, and secondary data from the Central Statistical Authority (CSA) and other sources will be used in addition. Beside this, the possible causes of the electricity shortage will be briefly discussed.

1.2 RESEARCH OBJECTIVES

The objectives of this study were:

- to assess the potential impacts of electricity shortages on the LMSMI sector in the country by using data from the case study that was conducted in early 2004;
- to examine the indirect impacts on employment, the country's economy, export earnings, etc.;
- to examine the possible causes of the electricity shortages in the country;
- to examine the mitigation measures that have been or are planned to be taken by the utility and the government to address the problem;
- and finally, to make suggestions and recommendations on the kind of energy policy, strategies and measures that could be followed to reduce future electricity supply problems by examining different alternative options currently available to the country .

1.3 BASIC CONCEPTS AND DEFINITIONS

This section provides definitions and explanations for some of the terms used in this dissertation.

Large and Medium Scale Manufacturing Industries:

- According to the International Standard Industrial Classification (ISIC Revision-3), manufacturing is defined as "the physical or chemical transformation of materials or components into new products, whether the work is performed by power-driven machines or by hand, whether it is done in a factory or in the worker's home, and whether the products are sold at wholesale or retail" (CSA 1998).
- LMSMI according to the Central Statistical Authority of Ethiopia is defined as the manufacturing industries which have 10 and more workers and in which most of the production activities are done by power-driven machinery (1998).

An establishment:

- The whole of the premises under the same ownership or management at a particular address.

Gross value of production (GVP):

- This includes the sales value of all finished products of the establishment, the net change between the beginning and the end of the reference period in the value of finished goods and value of work in-progress, the value of industrial service rendered to others, the value of goods bought and resold without any transformation or processing, and other receipts.

Intermediate cost:

- This includes the cost of raw material, fuel, transport, advertising, telephone, rent, etc. (Salary, depreciation, interest, employee benefits and dividends are not considered as intermediate costs).

Value added in the national account concept (at market price):

- This is defined as the difference between the GVP and intermediate cost. To get the same indicator at factor cost, net indirect taxes (i.e., indirect taxes less subsidies) are subtracted.

Industrial cost :

- This includes the cost of raw materials, fuels, electricity and other supplies consumed, the cost of industrial services rendered by others and, the cost of goods bought and resold without any transformation or processing.

Operating surplus :

- This is defined here as the difference between value added in the national account concept at factor cost and total wages and salaries.

El Niño-Southern Oscillation (ENSO):

- This is a coupled air and ocean phenomenon with global weather implications. "It is believed that ENSO is often associated with devastating droughts in Northeast Brazil, Australia, parts of Africa, the failure of the Indian monsoons, hurricanes along the east coast of North America, and so forth." (Tsegay 1997).

The following two terms are related to the electricity supply capacity and reliability of supply of hydropower stations. The explanations were obtained through email contact with Acres International. As described by Vice President and Manager of Central Hydro in Acres International, Dr Erzinclioglu (2005):

Firm energy capability (given as GWh/year or GWh/month)

- This is the minimum annual energy (normally given as 12 monthly values) that a hydroelectric station or a group of stations can generate under dry river flow conditions (drought).

Average energy capability:

- This is the average annual energy (normally given as 12 monthly values) that a hydroelectric station or a group of stations can generate under average river flow conditions.

Both of these can be estimated from historic records of river discharge, combined with computer modelling of the characteristics of the reservoirs and hydroelectric stations. The *"firm energy capability"* is determined as the minimum annual energy that was generated in the 1 or 2 driest years out of the total of 40 to 50 years of discharge record (Erzinclioglu 2005). The procedures are explained further in Appendix E,1.

1.4 SEQUENCE OF CHAPTERS

This dissertation consists of three main parts: information (Chapter 3, Chapter 4 and Chapter 6), methodology, analysis and discussion (Chapter 2, Chapter 5 and 7), and conclusion and recommendations (Chapter 8).

Chapter 2 explains the methodology of this thesis.

Chapter 3 presents important background information about the Ethiopian economy, the electricity industry, and the LMSMI sector. This chapter also reviews directly relevant available literature written on the impacts of electricity shortages in Ethiopia and some other countries' experiences of the same problem.

Chapter 4 assesses the electricity supply and demand in the country, focussing mainly on the years since 1992/93. In order to investigate the main causes of the power shortages, the chapter looks in detail at the demand and supply trends in the Inter-Connected System (ICS) (grid system) group and the centres that have been recently transferred into this group from the Self-Contained System (SCS) (off-grid system) between 1997/98 and 2001/02.

Chapter 5 discusses the main causes of the power shortages in Ethiopia since 1995, by utilising the findings of the analysis presented in Chapter 4, together with data obtained from sources such as the Ethiopian Electric Power Corporation and the Ethiopian Investment Authority.

As the main objective of this dissertation is to examine the impacts of power shortages on the LMSMI sector, before analyzing the impacts on this sector, it is important to understand the role of this sector in the country's economy and its energy requirements. These issues are presented in Chapter 6.

Chapter 7 analyses the impacts of power outages on the LMSMI sector, using data obtained from a case study of 16 LMSMI firms conducted in Addis Ababa between January 2004 and February 2004. In order to assess the impacts at an extended level (at sectoral and macro level) additional data obtained mainly from the Central Statistical Authority is used.

General conclusions regarding the various costs of power outages at an individual and a macro level are presented in the last chapter. Based on the discussions and findings in the previous chapters with regard to the country's electricity supply situation, the final chapter recommends and suggests some mitigation measures and strategies to address and improve the electricity industry of the country in the near future.

CHAPTER 2

METHODOLOGY

2.1 INTRODUCTION

To address the objectives of the dissertation, a number of methods were used. Foremost, a case study was conducted in Addis Ababa from January 2004 to February 2004. This covered 16 selected firms in the LMSMI sector, making use of a questionnaire to help gather the information. Further interviews were conducted with various responsible government offices and utility staff to acquire information regarding electricity supply problems, causes of electricity shortages, government plans and mitigation measures to address the problems. Additional secondary data from CSA and EEPCo has been analysed, and at various stages of this study, relevant literature sources have been drawn upon. All the data analysis was carried out using SPSS, Microsoft Access and Excel application software.

2.2 THE CASE STUDY

An in-depth analysis on the impact of power outages in the LMSMI sector was carried out based on the data collected from a case study that was conducted in the Addis Ababa region. 545 out of the 909 LMSMI establishments covered in 2001/02 by CSA (2002) are located in this region. First, the questionnaire was designed, and then 20 LMSMI firms were selected depending on factors such as their electricity consumption, value added contribution, type of ownership and date of establishment. Because the electricity problems have affected different industries in different ways, attempts were made to include firms from different industrial groups[6], e.g. food and beverages, chemical, textile, leather and plastic.

6 In this paper, industrial groups are classified according to the International Standard Industry Classification (ISIC Revision-3) that is used by CSA.

2.2.1 Questionnaire design

The draft questionnaire was designed after examining two questionnaires used in Ethiopia, the CSA LMSMI survey questionnaire and a questionnaire used by the Addis Ababa Chamber of Commerce to gather information on the cost and quality of power supply in Addis Ababa in 2003. This enabled certain standard formats and question areas to be included in the draft questionnaire which was then expanded and modified, after receiving comments from a few experienced people.

Before the actual data collection started, the questionnaire was administered to the head of the planning department in the National Alcohol and Liquor Factory in order to test its effectiveness. This firm had been highly affected by the power outages. The questionnaire was continuously modified during data collection, with some questions being re-phrased and other questions being added.

The final questionnaire which emerged as a result of the modifications stated above is presented in Appendix A. Below, I highlight the main sections of this questionnaire:

- ***Section B: Basic information on the firm, including questions on:***
  - ✓ number of working hours a day
  - ✓ ownership
  - ✓ date of establishment of the firm
- ***Section C: Electricity shortages:***
  - ✓ the number of production down-times due to power outages
  - ✓ types of measures taken by the firm
- ***Section E: Measures taken to mitigate problems:***
  - ✓ detailed questions on back-up generators
  - ✓ a few questions on the reduction of workers
- ***Section F: Perception, opinions, and planned future measures:***
  - ✓ open ended questions on the firm's opinions and perceptions on electricity supply problems

- ✓ future mitigation measures to address the problems

Section H: Monthly Electricity Consumption:

- ✓ monthly electricity consumption (planned and actual) in 2002/03 when the country experienced the most severe electricity shortages.

2.2.2 Selection of firms

The selection was made on the basis of the list of LMSMI firms obtained from CSA LMSMI survey data which was conducted in 2001/02. Initially 15 LMSMI firms had been selected from this list depending on their electricity consumption, value-added contribution, location, ownership, and date of establishment. Because five of the original selected firms and one firm selected afterwards refused to fill in the questionnaire, and some others did not fill in the questionnaire completely, these gaps were filled by selecting an additional seven firms using the same criteria. Overall 22 firms were selected. Table 2.1 shows the list of the selected firms including the six refusal firms.

Table .2.1. The list of selected firms

Sr.No.	Name of the firm	Sub Town	Date of establishment (Note 1)	Ownership	Working hours per day	Number of Estab. (Note 2)	Major Industrial Group
1	Addis Ababa Flour	Gullele	2000	Private	24	1	
2	Kality Food	Kality	1938	Government	24	6	
3	Ethiopian Spice Factory	Nifas-silk	1965	Government	24	1	Food and beverages
4	National Alcohol & Liquor Factory	Lideta	1920	Government	24	5	
5	Moha soft drink	Nifas Silk	1964	Private	16	1	
6	Shoa Cotton Ginning	Akaki	1964	Private	16	1	Textile
7	Dire leather Industry	Gullele	1973	Private	10	1	Leather and leather products
8	Ethio-Leather Industry PLC (ELICO)	Nifas-silk	1928	Private	8	1	
9	Desta Private Limited Company	Yeka	2000	Private	8	1	Footwear
10	Kadisco Chemical Industry	Akaki	1979	Private	8	1	Chemical and chemical products
11	East African Group Soap	Akaki	1996	Private	24	1	
12	Addis Tyre Company	Nifas Silk	1972	Both	24	1	Rubber and plastics
13	Ethiopia Plastic Share Company	Yeka	1960	Government	24	4	
14	Addis Ababa Cement Factor	Nifas-Silk	1964	Government	24	1	Non-metallic mineral
15	Automotive Manufacturing Company of Ethiopia (AMC)	Yeka	1979	Both	8	1	Motor vehicles and trailers
16	Mosvold	Lideta	1952	Private	8	1	Furniture
17	Addis Ababa Bottle And Glass Factory	Refusals					Non-metallic mineral
18	DH Geda Flour Factory						Food and beverages
19	Universal Plastic						
20	Thermo Plastic Industry						Rubber and plastics
21	East Africa Bottling						Food and beverages
22	Equatorial Paints Factory						Chemical and chemical

Source: case study (2004)

Notes:

1. The dates in this column refer to the year of commencement according to the Gregorian calendar. Data for three firms, who did not report in the study, was obtained from CSA LMSMI survey data. The date was checked against the CSA time series data (1998 – 2002) and accordingly modification was done on some of the reported dates.

2. One firm (enterprise) can have more than one establishment or branch. Normally one establishment produces one or more products. However if the firm has more than one branch in different locations which produce the same type of product, the number of establishments in this case is more than one (see definition in the Introduction Chapter). Following international standard industrial classification, Kality Food Factory, which produces biscuits, galleta, flour, bread, pasta and macaroni, only has four establishments. This is because biscuits and galleta are categorized in the same product group, while pasta and macaroni are similarly placed in the same product group. Nevertheless, for this study, as shown in the table, the number of establishments was six because the number of downtimes (production interruptions) for the six production lines was recorded separately. The same was true for the Ethiopian Plastic Share Company which only had one establishment in 2001/02 based on ISIC (CSA 2002).

Since their value-added contribution and electricity consumption were considered as the main criteria for selection, the selected firms were relatively large. These firms comprised 3% of the total LMSMI establishments in 2001/02. In the same year they accounted for about 13% of LMSMI electricity consumption and 28% of LMSMI value-added contribution.

Table 2.2. Major indicators comparing the selected firms with the total LMSMI sector in 2001/02

BASIC INDICATORS	PERCENTAGE SHARE OF THE TOTAL LMSMI SECTOR	SELECTED INDUSTRIES	TOTAL INDUSTRIES	NOTES
		Number of establishments		
Number of establishments	3%	23	909	
Public		12	143	
Private		9	766	
Both		2	**	Note 1
		Value in '000 ETB		
Gross value of production	13%	1,055,627	8,091,737	
Value-added contribution	28%	299,760	1,080,885	
Indirect tax contribution	4%	146,118	3,294,574	Note 2
Direct tax	11%	28,174,300	248,512,299	
Electricity consumption in value	12%	16,603	139,733	
Export	24%	154,519	646,768	

Source: Derived from CSA survey data (2002)

Notes:

1. Based on the CSA analysis, ownership is determined by the following criterion. If a company is owned by both the government and private individuals the company is categorized as either government or privately owned, depending on which side has invested higher shares.
2. The reason why the indirect taxes contribution is lower compared to other indicators is that products of most of the selected industries are exempted from excise taxes which are normally levied on luxuries and discouraged commodities such as tobacco and alcohol.

2.2.3 Data collection

The case-study data was collected from 13 January 2004 to 14 February 2004. One experienced data collector from CSA was employed to facilitate and speedup the data collection. Completing a questionnaire required on average four to five days per firm, but longer than this in the case of large firms which did not have any single department responsible for compiling and organising all the data. Apart from Section F of the questionnaire which was aimed at obtaining opinions and perceptions, the majority of the collected information was retrieved directly from the firms' recorded documents. However, some sections of the questionnaire required estimates to be made, based on recorded values for other variables. In particular, Section D of the questionnaire sought information on the loss of outputs in monetary value associated with power outages. Nearly all the firms did not have direct records of this, so instead the amounts had to be estimated based on the production capacity of the factories (See Table 2.3).

Generally, the data collection went well. It was evident that electricity is a key input for industrial production. Except for the six firms which were not willing to take part (mainly because of time or the policy of the organisation), all of the firms showed great support and willingness to assist successful data collection, and they gave the relevant information without any hesitation, as far as data-availability allowed. Nevertheless more than 50% of the firms did not have a department responsible for keeping such information. In many cases it was therefore a big challenge to collect important information for this study, such as the frequency of production interruptions (particularly those due to unplanned power outages), and especially for years before 2001. As indicated in Table 2.3, only six of the 16 firms were able to give fairly complete information on the number of production down-times due to power outages (Section C of the questionnaire).

It was also difficult to assess the operating costs of back-up diesel generators used by some of the firms. In many cases they only had records for the costs of the diesel fuel used, plus estimates of the unit cost per kWh for diesel electricity generation.

Table 2.3. Number of firms of the 16 firms responding completely or incompletely to different sections of the questionnaire

Section*	Complete questions	3/4 of the questions	Half of the questions	Less than half of the questions	None of the questions	Not applicable
Section C – Electricity shortage	6	1	1	6	1	1
Section D – Impact on production	5	1	2	3	2	3
Section E – Measures (e.g. auto-generation)	5	4		3	1	3
Section F – Perception & future measures	8	8				
Section G – Monthly production	7	1	3	2	3	
Section H – Monthly electricity consumption.	5		8		3	
Section I – Expenses	11			1	4	
Section J – Other fuels used	5					11
Section K - Other problems	8			1	7	

Source: Case study

* To see the full content of each section in the questionnaire refer to Appendix A.

2.2.4 Data capturing and analysis

The collected data was captured using Microsoft Access application software, and much of the analytical work was done using the same software. For the sake of confidentiality, the names of individual firms have not been revealed in those tables which show findings for individual firms. In addition, the data on production losses incurred by individual companies due to power outages has not been presented with reference to individual firms. Rather, the results were aggregated to present an overall picture.

Power outages have led to various costs for these firms, such as production and raw material losses, and the investment and operation costs of self-generation. The value of production losses was calculated on the basis of the production capacity of the firm (i.e. value of production per hour) and hours of number of production down-time per year. The extra running costs of self-generation compared with electricity supply by the utility were estimated by contrasting the average unit price of a kWh of electricity supply from the utility and the average unit cost of electricity production using the diesel generators.

2.3 USES OF SECONDARY DATA SOURCES

To determine the costs of power outages in the entire LMSMI and to evaluate the role of the sector in the country's economy, in addition to the primary data, some other data was obtained from secondary sources, such as five-year data (1998 to 2002) from CSA's LMSMI survey and national level data from the National Bank of Ethiopia and the Ministry of Finance and Development (MOFED). And to assess the investment trends in the country, some relevant data was retrieved from the Ethiopian Investment Authority (EIA) statistics on investment in Ethiopia, contained in their annual reports.

In the majority of the cases, the analysis of data from the CSA survey was done using SPSS software and the results were an aggregate of findings obtained from major industrial groups (e.g. food and beverages, textile, chemical and chemical products). But in some cases firms were grouped together on the basis of statistical classification methods such as the percentiles and range of production capacity.

To assess the overall situation concerning electricity supply problems in the country and to come up with reasonable conclusions and recommendations, relying on information only from the demand side would not be sufficient. Thus, other secondary data such as time series statistics on the country's electricity production and sales, and the installed capacity and the age of power plants, have been collected directly from the utility (EEPCo) and their website (http://www.eepco.gov.et).

Most of the data obtained from the utility are not directly utilised. In the majority of cases, further analysis was done on the data in order to get important statistical indicators like average growth rate, the mean, variance, percentage shares, etc.

2.4 INTERVIEWS

In addition to the case-study interviews with firms, a number of officials were interviewed. Senior members of the utility (EEPCo) were approached particularly to acquire information on the causes of the power shortages. Other questions addressed during these interviews included past and future mitigation measures, development plans of the utility, and some of the barriers and challenges faced in implementing those plans.

Representatives from the Ethiopian Electricity Agency[7] , Ethiopian Investment Office and Ministry of Finance and Development were also interviewed. Important information gained from those interviews included opinions about the role of power sector reform to improve future electricity supply in the country, some of the barriers faced by independent power producers trying to invest in the electricity industry, the causes of power shortages and the impacts of power shortages on new investments.

[7] Ethiopian Electric Agency is an autonomous government organ. It has been established with the objectives of regulating the activities of the electricity supplies, promoting the development of efficient, reliable, high quality and economical electricity services.

CHAPTER 3

BACKGROUND AND LITERATURE REVIEW

3.1 INTRODUCTION

This chapter consists of two main sections. The first section provides background information about Ethiopian economy, electricity and the LMSMI sector. The second section is a literature review which examines the impact of power outages on the Ethiopian economy[8] and then reviews the experiences of power shortages in some other countries.

3.2 BACKGROUND INFORMATION

3.2.1 Ethiopia – Overview

Ethiopia is located at the horn of Africa. When Eritrea gained independence in 1993, the country became land-locked. The country is surrounded by Sudan in the north-east, Eritrea in the north, Djibouti and Somalia in the east, and Kenya in the south. With a current population of approximately 69 million (est. 2004) and an annual population growth rate of about 2.6 percent, Ethiopia is the third most populous country in Africa, after Nigeria and Egypt. Approximately 85% of its population is located in rural areas[9]. Ethiopia's land area is 1.14 million square kilometres. With a per capita gross national income in 2002 of roughly $100 (ranked

8 Only one relatively thorough piece of research has been done to determine the impact on the country's economy of the electricity shortages that was occurred in 2002/03 when the country faced a catastrophic drought. After this, a few people added their own conclusions and opinions about the problem mainly based on results of this study.

9 National Bank of Ethiopia Website (hppt://www.nbv.gov.et) (2004).

169th out of 172 countries in the world[10]). Ethiopia is among the poorest countries in the world. The country has eight big rivers which are fairly evenly distributed throughout its width and breadth. The immense hydropower potential of these rivers enables the country to generate electricity very economically.

3.2.2 Economy – Overview

Ethiopia's economy is based on agriculture, which accounts for half of GDP, about 70% of exports, and 80% of total employment. The agricultural sector suffers from frequent droughts and poor cultivation practices. Coffee is critical to the Ethiopian economy as it contributes nearly 36%[11] of the country's exports. The country also gets export earnings from manufactured products which, in 2002, accounted for 16% of the total export earnings (particularly leather and leather products). Nevertheless there is a huge gap between imports and export earnings. In 2001/02, exports of goods and services covered only 45% of the total imports[12]. The war with Eritrea in 1998 – 2000 and the recurrent drought have buffeted the economy, in particular coffee production, which disrupted the positive GDP growth gained since 1994. However the average real GDP growth between 1993 and 2003 was still positive, at 4% (data collected from MOFED 2003). Despite this favourable growth the real GDP (below USD 2 billion) still ranks the country among the poorest in the world. And due to chronic negative trade imbalances since 1953 and budget deficits, the country's economy has relied greatly on foreign aid which accounts for 10% of the GDP. Under Ethiopia's current land tenure system, the government owns all land and provides long-term leases to the tenants.

3.2.2.1 Major historical events in Ethiopia

The following tables list some of the main historical events in Ethiopia during the last 50 years, focusing on economic impacts and industrial development.

[10] Source:-Natiomaster.com 2003-2004, original source:- CIA World Factbook December 2003

[11] The export share of both agriculture sector and coffee dropped from 85% and 65% in 1990s, to 70% and 36% in 2002, respectively, mainly because the price of coffee in the international market declined in 1998/99 (EEA/EEPRI 2003:21).

[12] Ethiopian Export Promotion Agency (2002) and EEA/EEPRI (2003:21).

Table 3.1. Major historical events during the period of imperial Government: 1930 – 1974

1954/55	Government created for the first time the national economic council to coordinate the state's development plan and to make policy.		
First plan 1957 – 61	The aim of the plan was to develop a strong infrastructure to link isolated regions.	During this period GNP grew by 3.2% per year and exports increased by 3.5% but imports increased by 6.4%.	All economic sectors failed to meet the national plan targets.
Second plan 1962 – 67	The aim of the plan was to change the predominantly agricultural economy into an agro–industrial one.	The economy achieved a sustained growth with a 4.4% annual per capita GDP growth rate and a manufacturing growth rate of 4.4% between 1973 and 1975.	
Third plan 1968 – 73	Raising the manufacturing and agricultural performance.		

During the imperial period of government, despite the fact that the country's economy showed good performance, this positive trend failed to improve the majority of the population's standard of living: four out of five Ethiopians survived on subsistence farming.

Table 3.2. Major historical events during the period of Marxist government: 1974-1991

1974	Both rural and urban land was nationalised. Most of Ethiopia's industries (more than l00 industries) were nationalised and large-scale agricultural farms, and financial institutions were brought under the control of the government. Both rural and urban communities were organised into a hierarchy of associations.	
Revolution 1974 – 78	Internal political disruption, armed conflict and radical institutional reform (Ogaden war and rebel activity in Eritrea).	The military consumed a substantial portion or the national resources (30% – 50%), and as a result the economy deteriorated, real GDP grew at an average annual rate of 0.4% and the overall fiscal deficits widened.
1978 – 80	Government consolidated power, implemented institutional reforms and used a cooperation campaign development.	The economy began recovering. During this period GDP grew at an average annual rate of 5.7%. Manufacturing production increased at an average annual rate of 18.9%. Most of the closed plants were reopened, particularly in Eritrea.
1980 – 85	All the regions in the country faced drought in 1984 – 1985. Due to this the government committed scarce resources to address the famine.	During this period the GDP declined by an average of 0.2% per annum. Budget deficits worsened. And manufacturing sector production stagnated as agricultural inputs declined.
1985 – 1991	Civil war	
1988	In January l988, because of the pressure from aid donor countries, the government agreed to restructure agricultural and farm price policies and the investment code allowed unlimited participation of the private sector in certain areas of the economy.	
in March l990	Government acknowledged the failure of socialist policy, marking the end of the country's Marxist economic system and the beginning of a mixed economy. Despite these reforms, the economy failed to improve mainly due to the civil war.	

For nearly two decades of rule by the Marxist government, Ethiopia was ravaged by droughts, regional conflicts, civil war, and inflexible government policies, etc. Falling productivity, soaring inflation, growing dependence on foreign aid and loans, high unemployment, and a deteriorating balance of payments all combined created a deepening economic crisis.

Table 3.3. Major historical events during the current government: 1991 to present date

1991	The previous command economy was re-structured into a free market economy which aimed to dismantle government influence in the economy and to limit state intervention in the economy thereby expanding and deepening the participation of the private sector in production activities.
1992 – 1998	Remarkable economic growth, a low inflation rate, budget deficit reduced until 1998. During this period the economy of the country again recovered, except in 1992 when GDP slightly declined from its level in 1991. The GDP rose at an average rate of 7%. And Government defence expenditure was reduced drastically from 30% in the 1980s to fewer than 3% in 1995. This enabled capital outlays for other development activities. In particular the share expenditure for the rehabilitation of infrastructure increased raising the share from 25% in 1991 to 40% in 1994.
1993	Eritrea becomes an independent nation.
1995	The establishment of the Federal Democratic Republic of Ethiopia.
1998 – 2000	Ethio-Eritrean war erupted in 1998 and threatened everything that had been achieved in developing a civil and democratic market economy. It resulted in a negative GDP growth in 1997/98 (-1%). The share of military expenditure increased again, reaching 10% in 2000. The slight trade balance improvement observed between 1995 and 1998, did not continue in the period 1998 – 2000. For instance, the ratio of trade deficit to GDP, that had decreased by 2% 1995-98 from the trade deficit of 1992-95, increased by 1% in 1998-2000.
2000 – 2002	After the conclusion of a cease-fire agreement in Algiers (18 June) 2000, the economy again recovered.
2003	A combination of wrong economic policies and an extended drought in 2002 managed to spiral the economic growth for 2003 down to negative levels.

As the nation depends mainly on agriculture, the current Government has launched the Agricultural Development-Led Industrialisation (ADLI) strategy and has decentralised the country into 11 regional states.

Although the current government has come with a lot of promises, during the last 13 years only limited initial positive results have been observed. Much remains to be done to modernise agriculture, given the low use of fertilizer and artificial irrigation; and heavy-handed bureaucracy remains a serious hindrance.

Ethiopia is still one of the poorest countries in the world. In 2002, it ranked 170th out of 177 countries using the UNDP human development index (UNDP 2004). Foreign companies still have a difficult time investing in Ethiopia because, as a rule, land cannot be bought and sold. As a result the country regularly needs emergency food aid and its financial dependence on outside sources is increasing. In addition liberalisation, deregulation of the national economy and privatisation of numerous state-owned enterprises have not gone far as promised toward a free market. Only one individual investor and a few private companies very close to the government led by the Ethiopian People Revolutionary Democratic Front have been the major beneficiaries of the changes.

3.2.2.2 Relevant economic and energy-related policies and proclamations.

The following three tables show relevant economic and energy-related policies and proclamations during the period of imperial, Marxist and current government.

Table 3.4. Relevant economic and energy-related policies and proclamations in the imperial government period

<table>
<tr><td>1950 – 1960</td><td>The imperial government launched new foreign investment policy. This new policy had several investment incentives, such as tax exemptions, remittances of foreign exchange, import and export duty relief, and provision of financing through the Ethiopian Investment Corporation and the Development Bank of Ethiopia.</td><td rowspan="3">Due to Government favourable policy for local and foreign investors, considerable foreign investment was attracted to the industrial sector. In 1971/72 the share of foreign paid-up capital reached 40% in the sector.</td></tr>
<tr><td>1963</td><td>Government enacted Proclamation No. 51 to extend benefits to Ethiopian investors.</td></tr>
<tr><td>1970</td><td>Industrial development policy included a range of fiscal incentives, direct government investment and equity participation of private enterprises.</td></tr>
</table>

Table 3.5. Relevant economic and energy-related policies and proclamations in the command economy period

1974	Industries activities were categorised into three parts, state, a combination of state and private and purely private-sector activities.
1988	Government initiated improved measures to attract foreign capital in the sector. It offered incentives such as five-year period of income tax relief, import and export duty relief, and tariff protection. In spite of these incentives, the foreign investors seemed reluctant to invest in the country largely because of the lack of trust in the government which had nationalised foreign industries without compensation.
1989 – 1990	Government added more attractive measures by revising 1983 policies. Finally the president of the country admitted the failure of the socialist system in the country. The government then proposed implementing a mixed economy. The new system would allow the participation of private investors in all economic sectors with no limits in capital which had been refused since the Marxist government took over power.

Table 3.6. Relevant economic and energy-related policies and proclamations in the free market economy period

November 1991	National economic policy aimed to reduce the direct control of the state, promote private investment, and encourage the participation of federal and regional governing bodies in the management of the economy, and promote public investment.
1994	The Ethiopian Privatisation Agency (EPA) was established under Proclamation No. 87/1994. As of 1994 to the present date, 195 units and whole enterprises have been privatised and transferred to domestic and foreign investors. Over the coming three years, EPA planned to privatize 117 public enterprises. The Government has a privatisation programme that also offers attractive options for investments in the country.
1994	The first energy policy was established, aiming to address the energy problems of the country and to ensure least cost development consistent with the country's energy resource endowment and socio-economic policy.
1996	Proclamation No.37/1996 announced exemption from profit tax for a minimum period of three years, which may be increased to five years depending upon the type and location of the investment, and with additional exemption of one to two years for investment in expanding enterprises. All Ethiopian products (except coffee) and services destined for export are exempted from the payment of export taxes.
1997	Proclamation No 86/1997 related to electricity. • Establishment of the Ethiopian Electricity Agency (autonomous regulatory body). • Granting lands for electrification investment.
1998	Proclamation No 116/1998. The main objectives of this proclamation are to accelerate the involvement of the private sector in the country's economic development. It provides both domestic and foreign investors with a wide of range of incentives and privileges. In line with government policy, the power sector was liberalised. With regard to hydroelectricity, both foreign and local investors can invest in the sector with no capacity limit. However electricity generation from non-hydropower sources above 25 MW capacities is left to the government.
2000	Proclamation No 1997/2000. Ethiopian water resource management proclamation aimed to create favourable conditions in which the development of the abundant hydropower resources would be accelerated.

Sources: (Table 3.1 – 3.6): Mulatu (1991); Federal Ministry Foreign Affair, Austria Development Cooperation (2004); TGE (1994); Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia (1997); EEA (2002); EPA (2002a); EEPCo (2002)..

3.2.3 Electricity in Ethiopia

3.2.3.1 Production

In 1898 Emperor Menelik II acquired a first diesel generator to light up his palace (EEPCo 2002: EEPCo Company Profile). Since then only diesel generators were used until the first hydroelectric plant was commissioned in 1939 [Aba Samuel] on Awash River basin, with a 6.6MW installed capacity (Michael 2003). After that the share of thermal energy sources decreased. In the early of 1950s its share was still around 60% (The Cartographic Department of the Clarendon Press 1972); however, hydropower progressively over took as the main source of electricity in the country.

Until 1960, the average annual electricity production (1956 – 1960) was about 43 GWh/year. During this period the average share of HEP was around 70% (data collected from EEPCo 2004). In line with the government policy that was promoting the development of indigenous resources, around 1960 a large new hydropower plant was commissioned with 43 MW installed capacity. The share of hydropower in electricity production has been steadily growing since then, increasing the dependence on hydropower for the country's electricity production. The increasing dependence on hydropower was influenced by the oil crises in the early 1970s, when a lot of countries shifted toward harnessing their own endowed natural resources. By 1974, the share of hydropower electricity production accounted for 91% of the total production (Acres International 2003a). In 2002, this figure has reached more than 99%, and according to the least cost target forecasts this figure will remain approximately constant in the foreseeable future (Acres International 2003a: Figure 3). Within five decades, the fuel mix for the country's electricity production had shifted from sole dependence on thermal energy to an almost entire dependence on hydropower.

Other energy sources for electricity production at present include a small amount of geothermal energy. According to the least cost target forecast trend (Acres International 2003a: Figure 3) only after a decade will natural gas come on line in electricity production. Alternative fuels like coal, wind and solar will not be considered as least cost options to supply the national grid system even after two decades, although the country has these resources[13]. It is considered that these resources, particularly the vast solar energy resources, can possibly be developed to supply electricity for small areas in remote or inaccessible sites (Acres International 2003a:Alternative energy resource).

3.2.3.2 *Supply system*

The Ethiopian Electric Light Power Authority (EELPA) was established in 1956. Before 1974, EELPA had supplied 80% of the country's electricity demands. The

[13] It was estimated that the country has vast natural resources, i.e. over 100 billion cubic meters of natural gas, 4000 MW of geothermal energy, 40.3 Mt of coal and vast resources of solar and wind energy (TGE 1994).

remainder had been generated by two Italian firms (16%) and independent stations (4%). In 1974, along with companies in other sectors, the Marxist government nationalized all the private-owned electricity companies and placed them under the control of state-owned EELPA (Mulatu 1991: Energy resources). In June 1997, after restructuring, the power authority was given the status of a public corporation. The name was changed to Ethiopian Electric Power Corporation. Currently, EEPCo is responsible for generating, transmitting, distributing and selling electricity throughout the nation (EEPCo 2002: EEPCo Company Profile).

Presently, the Corporation maintains two different power supply systems. These are the Interconnected System (main grid system), which is mainly supplied from hydropower plants, and the Self-Contained System (off-grid system), which consists of mini-hydropower plants and a number of isolated diesel generating units that are widely spread over the country. In 2002, the ICS generation plants consisted of seven hydro and 10 diesel plants, and one geothermal power plant, with total installed capacities of 472.6 MW, 22.2 MW and 7.3 MW respectively (EEPCo 2002: EEPCo in brief). Over 98% of the total generation of electricity in the country comes from the ICS. The SCS includes three small hydro and several diesel power plants. This system is dominated by diesel plants with an aggregate capacity of 13.9 MW, whereas the contribution from the small hydro plants was only 6.2 MW (EEPCo 2002: EEPCo in brief).

3.2.3.3 Demand and consumption

The ICS electricity demand is forecast to grow at an average annual rate of about 7.1% between 2001 and 2025[14]. Based on this trend, the demand would be doubled in ten years. The current demand is estimated at 2216 GWh/year, and it is forecast to reach 4492 GWh/year in 2014 (Acres International 2003b: Table 10.1 (c)). The growth in demand is mainly connected with forecast growth in the commercial sector and new connections[15] to the ICS group. For instance, it was estimated that the

14 This forecast is only for the ICS system.

15 The new connections to the ICS system (main grid system) are due to the electrification of additional new areas and some connections which have been removed from SCS and added into the ICS group. For example in 1995 and 1998 the two largest electricity consumers of the SCS system Bahar Dar and Mekele were added into ICS, respectively. As a result, The SCS sales were dramatically decreased from 61 GWh/year to 36 GWh/year in 1995 and from 49 GWh/year to 26 GWh/year in 1998 (see Ch4 Table 4.6).

electricity sales to the commercial sector would grow at an average rate of more than 9% per year between 2001 and 2025 (Acres International 2003b: Table 4.9). And according to the government plan, over 300 Ethiopian towns are proposed for electrification in the near future (2001 to 2005). An additional 260 towns were added to the rural electrification plan for interconnection over the period from 2006 to 2025. Most of them (76%) will be connected into the main grid system (ICS) (Acres International 2003b:4.22). The new connections would definitely increase the percentage of the population with access to electricity, which is presently only about 14% (EEPCo 2002b: Electrification status). The peak demand is also growing along with the base-load demand. According to the Acres target forecast, it will reach 1059 MW in 2014, nearly twice the current peak demand, which is 563 MW (Acres International 2003a: Table 10.1 (c))

Electricity consumption grew steadily from 1974 to 1997, at an average annual rate of 6.3%. However, after April 1997, the consumption growth decreased mainly due to tariff changes made in 1997 and 1998. In 1998/99, unlike previous years, consumption decreased by 2.04%, despite the fact that the number of customers had increased by 4% from 1998 (see Ch4 Table 4.6 & 4.7). Almost all tariff categories were affected by these tariff revisions (including domestic customers, and light and heavy industries) hence consumption decreased. In 1998/99, domestic consumption decreased by 2.6%, Low Voltage (LV) industries by 3% and High Voltage (HV)[16] industries by 6% from 1997/98 (EEPCo 2002: EEPCo in brief)[17]. The tariff revision also affected the per capita electricity consumption of the country. In 1997/98 it was 23.16 kWh/year, decreasing to 22.16 kWh/year in 1998/99 (EEPCo 2002: EEPCo in brief). The Ethio-Eritrea war taking place at almost the same time (1998 – 2000) could have also partly contributed to the drop in consumption.

Ethiopia has one of the lowest levels of electricity consumption per capita in the world. It was 25 kWh/year in 2001/02 (EEPCo 2002: EEPCo in brief), which is very small even compared with Sub-Saharan standards. Based on the 2001 per capita electricity consumption, the country ranked 205th of 212 countries in the world. Only two African countries ranked lower than this (Burkina Faso and Lesotho)

16 High voltage industries are industries that get their power through 15 kV and 132 kV lines.

17 Only ICS

(NationMaste.com online 2003: Energy: Electricity consumption (per capita)). It is predicated to reach 84 kWh/year as a targeted scenario in 2025 (Michael 2003).

Electricity consumption in Ethiopia is concentrated in the central highland region. In 2001/02, the loads on the main ICS were concentrated in Addis Ababa, Dire-Dawa and Nazareth cities. During this time, Addis Ababa was the largest load centre accounting for 51% of total consumption (data collected from EEPCo 2004). Unlike the developed world, the majority of electricity has been consumed by domestic customers, followed by the commercial sector.

Table 3.7. The percentage share of electricity consumption by tariff group, excluding own consumption: 2001/02

TARIFF GROUP	PERCENTAGE
Domestic	35.9%
Commercial	24.2%
Low voltage industries	18.8%
High voltage industries	20.5%
Street light	0.8%

Source: EEPCo (2002: EEPCo in brief).

3.2.3.4 Future expansion and extension

As pointed out above, Ethiopia currently relies almost entirely on hydropower for electricity generation (in the ICS system) and more hydropower could be harnessed at a relatively low cost (Acres International 2003a). Hence, the growing electricity demand could be primarily met by HEP. According to the government's short to long term expansion plan, in the coming future several small to big hydropower projects will be developed. Recently one of the largest hydropower plants [Gilgel Gibe] with 192 MW installed capacity is being completed, increasing the installed capacity from 502 MW (2003) to 704 MW. At the moment, Tekeze (225 MW), which will be the biggest hydroelectric plant in the country, is under construction[18]. The Gojeb project (102 MW) is taken as committed for development. The Tekeze and Gojeb projects are expected to be completed in 2007 and 2009 respectively (Acres International 2003a: XIX).

The planned additional power capacity including both hydroelectric (big and small) and thermal power plants in the ICS and SCS will amount to about 691 MW. However, in the short-term period, until the construction of some of these plants

18 According to EEPCo, 25% work on the implementation of the Tekeze hydroelectric project has been finalised (WIC 2004).

(e.g. Tekeze and Gojeb), 291 MW of additional capacity will be available, excluding the diesel and small hydroelectric power plants which are part of the SCS. If all projects are completed according to the planned timetable, by the end of 2010 this will raise the ICS installed capacity to 1300 MW. There are also further feasibility studies under way to develop other promising hydro power projects (EEPCo 2002: power SDP-Program Summary).

3.2.4 Large and Medium Scale Manufacturing Industries in Ethiopia

The emergence of a strong central government, which resulted in political stability and the construction of the Ethio-Djibouti railway, was a notable early 20th century events which contributed to the introduction of modern manufacturing industries in Ethiopia (MEDaC 1999). The number of factories in 1925 was only 25. They were located in the major urban centres in Addis Ababa, Dire Dawa, Asmara and Massawa. From 1928 to 1941 up to 10 factories were added, and by 1973 this number had increased to 273, of which 37% were fully owned by foreigners, while the government owned only 13% of the factories. After the 1974 revolution, most of the factories which were owned by private people prior to the revolution were taken by the government. Virtually all the large-scale manufacturing industries were owned by the government until the current new government took power. The new government encouraged privatisation and the number of private-owned LMSMI establishments is gradually increasing.

A revision of the investment code, which encourages domestic and foreign private investment in the manufacturing sector, also contributed to the expansion of the private-owned manufacturing sector in the country (MEDaC 1999). As a result, private-owned LMSMI have increased both in share and in number, whereas the number of public-owned industries has diminished. For instance, the number of private-owned LMSMI establishments, which was 203 in 1986/87, rose to 766 in 2001/02, and its share also grew from 49.6% to 84% in the corresponding years. In the same period, by contrast, the number of the public-owned LMSMI establishments decreased from 206 to 143 (CSA 1987; 2002).

The Ethiopian LMSMI is mainly characterised by a high concentration in consumer and light goods (e.g. bread, edible oil, soft drinks, beer, other alcoholic drinks, household and office furniture). For instance, in 2001/02, the manufacture of food products and beverages accounted for 31% of LMSMI establishments, followed by the manufacture of furniture (16%) (CSA 2002). Another important industry for the country's economy is the manufacture of textiles. Although the textile companies are few in number (in 2001/02 only 36 out of 909 total LMSMI establishments), most are large and their labour-intensive activities engage a large number of LMSMI workers. In 2001/02 for instance, 22 388 (22%) people were engaged in this sector out of the total 98 136 manufacturing workers.

Overall, in 2001/02, the manufacturing industries engaged 79 862 permanent workers, 471 paid apprentices, 252 unpaid apprentices, and 17 551 seasonal and temporary workers (CSA 2002).

However, CSA surveys show that most previously labour-intensive industries are gradually changing into machine-intensive activities. A contributing factor here has been the revision of the investment code, which encouraged domestic and foreign investment in the manufacturing sector. Since then a number of new large and medium industries have been established. To maximize their profit and competitiveness, most of these firms use new technologies which are more computerised and less labour-intensive. For instance, according to the LMSMI surveys conducted by CSA (1987 – 2002), the operating surplus[19] per employee grew from 3 541 ETB (1992/93) to 18 245 ETB (2000/01) and similarly the value of fixed assets per employee increased from 8 654 ETB to 63 743 ETB in the same year (CSA 1992; 2002). This trend clearly shows the growth of labour productivity and machine dependency in this sector. Correspondingly, most of these activities using power driven machines could not be accomplished without energy [electricity]. Therefore, this trend will probably boost energy demand in this sector, particularly electricity demand.

Electricity is the main energy source for most industries in this sector. In 2001/02, the majority (>75%) spend more than 50% of their energy bills[20] on electricity (data compiled from CSA 2004). Therefore, reliable electricity supply is crucial for the successful development of the industrial sector (particularly LMSMI), which plays a key role in the economic and social progress of a nation.

19 Operating surplus is defined as the difference between values added in the national account concept at factor cost and total wage and salary costs.

20 In this sector, in 2001/02, out of the total industrial costs the energy costs on average account for about 10%. In the same year energy costs accounted for more than 48% of the industrial costs of the non-metallic mineral products (e.g. cement, glass and clay) manufacturers (CSA 2002) (further discussion is available in Chapter 6).

3.3 LITERATURE REVIEW

3.3.1 The impact of electricity interruptions on the Ethiopian economy

Birhanu and Said estimated the impact of electricity shortages on the Ethiopian economy using secondary data sources (EEA/EEPRI 2003:32; Birhanu & Said 2003:8 – 10). According to their estimates, a complete interruption of power throughout the country for a day would cost the nation up to 10% to 15% of the GDP[21] of the day (about 5.7 million ETB at 1987/88 constant price, which is about USD 0.66 million). Further, they stated in their report that, if the electricity interruptions of one day per week were to continue throughout the year, it would cause a 1.7 to 2.5% decline in the real GDP. Fortunately, these interruptions only lasted seven months.

The Addis Ababa Chamber of Commerce (AACC) conducted a sample study to estimate the impact of electricity shortages in 2002/03. This indicated that Ethiopia could lose 375 million ETB (USD 44 million) revenue per year from the different sectors because of the power rationing system (Addis Business 2003a:10).

To determine the impact of power shortages on the economy, Birhanu and Said (2003:8) used the contribution of each economic sector toward the country's GDP in 2002, and their link with electricity supply[22]. According to their report, in 2002 agriculture accounted for the highest share (44.5%) of total GDP. The shares of industry (including LMSMI), trade and distribution, and other sectors were 10.8%, 15% and 29.9%, respectively. Out of the 10.8% industry sector contribution, 4.3% came from LMSMI. Although the LMSMI contribution is not great, the adverse effect of power interruption on their activities is substantial, according to the report. The study indicated that in 98% of this sector's production work is interrupted due to power outages. On the same basis they estimated that 55% of the mining, 32% of small scale and cottage industry, 55% of the water and electricity, and 50% of trade, restaurants and hotel activities can be interrupted due to power outages. Thus, production loss in the LMSMI sector due to electricity shortages clearly contributed to a higher share for the reduction of GDP in the country.

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21 All the GDP figures presented here were calculated based on the country's 2001/02 GDP.

22 This was done by looking at 41 years historical data that shows the relationship between each sector and their electricity supply.

In general they considered the following were the possible electricity interruption impacts:

- Low labour productivity. (They estimated that when the electricity was interrupted two days a week, most of the workers could not work around 16 hours out of 40 working hours per week, but this could vary depending on the number of working hours of a firm.)
- Reduction of salary for industrial workers. (The salary of the industrial employees could be decreased, and indirectly this could have further negative consequences on the demand for industrial production.)
- Payment without work.
- 4.2% loss in daily GDP, if the LMSMI production is suspended for a whole day. (This is based on 2001/02 when on average LMSMI contributed 4.3% to GDP and 98% of the LMSMI production activities could be stopped due to power outages.)
- There are also relatively large impacts in other economic sectors. (As referred to above these sectors include mining, small scale and cottage industry, water and electricity, trade, restaurant and hotel work.)
- In general, according to their final result, a day's electricity interruption could lead to a 10 – 15% reduction in daily GDP.
- Finally they pointed out that a survey was needed to determine the actual figures for production losses and for the amount of production which was not sold due to power shortages.

Currently the majority of the country's GDP comes from agriculture where the impact of electricity interruption is negligible. However the authors pointed out that the crisis of electricity interruption will become even more significant and will have a huge impact on the whole economy when the country grows and transforms from an agriculture-led to an industry-led economy. They illustrated the dangers as follows:

> The effect of power interruption in the fiscal year and in fact in previous years has put a warning signal that the country may be moving from "rain-fed agriculture" to "rain-fed industry" which will obviously be dependent on power from hydroelectricity sources unless some corrective measures are taken.(EEA/EEPRI 2003:32).

In their report (Birhanu & Said 2003:8 – 10), they also discussed the possible causes of the electricity shortages:

- Although it seems that electricity generation from hydropower has increased since 1970, the development of hydropower has not been completed according to the 1970 policy plan and the planned timeframes. Coupled with the frequent droughts, this has resulted in a huge imbalance between electricity supply and demand. Thus the power supply which comes predominately from HEP has failed to meet the growing electricity demand in the country.
- They recognized the importance of hydropower for electricity production and the vulnerability of HEP to drought conditions but they clearly argued that the problem was not only caused by the drought but also the weaknesses of the government.

> Obviously, electricity demand increases with time, but on the other hand in the history of Ethiopia, it is well known that the drought has happened for a long period and it is expected to happen in the future. As a result, there was also shedding starting from 1995/96. But considering the whole facts, the use of other supplementary fuels and solving siltation problem have been totally ignored by the government. Above all the progress of new power plant expansion and finalising of already-started power plants is very slow. (Translated from Amharic[23]). (2003:8 – 10).

In general, apart from the drought, the following are the contributory causes of the problem identified in this report.

- Alternative fuels have not been considered to solve the problem.
- The implementation of additional power plants was not done according to the long-term plan.
- The progress in finalising the power plants already-started has been very slow.
- Maintenance works and removal of siltation from the dams have not been done.

23 In this paper, all the translations from Amharic to English were done by the author.

Based on lessons they learnt from past experience with electricity shortage problems, they made the following recommendations to address future electricity supply problems in the country:

- Short- term:
  - ✓ Implementation of power plants using alternative fuels.
  - ✓ Timely maintenance works on the dams.
- Long-term:
  - ✓ To ensure power security, expansion and extension of new or old power plants should be done along with the growth of electricity demand[24].
  - ✓ Finally they also added the need to consider environmental protection measures to mitigate the drought risks.

From a different perspective, a number of business people were interviewed by Makonnen in May 2003 (Addis Business 2003b) after the introduction of a new rationing scheme by EEPCo. (The electricity rationing increased from one day per week to two days per week in May 2003 [see Ch5 Table 5.3].). Some extracts from these interviews are presented below

- A member of St. Michael Pharmacy said that "the rationing has affected our business, because drugs kept in the refrigerator for days could be spoiled for lack of power. On Thursdays and Fridays, we are forced to use kerosene lamps and candles but business transactions may not be as brisk as on days when there is no electricity".
- The owner of a pastry shop in town complained bitterly that "the two-day power rationing has almost crippled our business which is serving tea and coffee as well as cakes. In addition I am paying a big amount in house rent per month in addition to the salaries of workers without work". Finally she commented that "government should pay particular attention to the plight of the service providers".

24 Bearing in mind fluctuations in HEP production at different times of the year, they also recommended that "it is important to consider the quarterly trends of energy production from hydroelectric power to draw some lessons" (EEA/EEPRI 2003:32).

- The owner of a printing press said that "the power rationing scheme has affected our operations and sometimes we are obliged to cancel contracts because we were unable to deliver the goods to our customers on time". He added that "these days we have stopped printing magazines and books due to the time factor to provide prompt services". He also mentioned that "the organization's income has equally dropped simply for these obvious reasons". Finally he recommended that "to minimise the problem, the management is planning to buy a generator that could meet at least part of the power requirement".

3.3.2 The causes and the impact of power shortages or outages in the context of other countries' experiences

Recently, in various countries (e.g. North America, Canada, Brazil, Uganda, Sri-Lanka), both developed and non-developed, electric power blackouts and brownouts have become common features of their electricity supply industry. For example, like the urban dwellers in most developing countries, the people of highly developed countries (such as North America and Canada) were obligated to stay a whole night without electricity in 2003. Different causes had led to power outages in these countries, including power sector reforms, drought, underinvestment, high dependence on HEP and lack of diversity.

3.3.2.1 Causes of power outages

3.3.2.1.1 Power sector reform

Various analysts have identified[25] power sector reform, undertaken mainly to increase the efficiency of the electricity supply, as the main cause for the electricity crisis occurring in some countries (mainly developed). In general, as pointed out in those reports, the power sector reforms, instead of bringing healthy conditions to their electricity industries as promised, have put their electricity supply in danger.

Electricity is an important input and a strategic necessity for the development of a country and the operation of developed economies. The dependence on electricity will be even greater in the future. Simply commercialising this key input, which cannot easily be substituted by other commodities, without a careful design, can

25 E.g. see Chi-Keung Woo et al (2004) Electricity market reform failure: UK, Norway, Alberta and California, Journal of Energy Policy, 31(11):1103 - 15.

lead to a power crisis in a country. This in turn could cost a lot to economies built up over many years, and highly dependent on electricity, as experienced in California (2001).

The experiences gained from those countries can be used as a lesson, to look carefully at all the implications around power sector reforms and market structures before any new plans are adopted in a particular country. However a deeper discussion of power sector reforms and their problems is beyond the scope of this thesis.

3.3.2.1.2 Drought and HEP production fluctuations

Most countries endowed with valuable hydropower resources[26], have developed and exploited these hydropower resources to satisfy their electricity needs. Due to this, hydropower is predominantly used for electricity production.

However electricity production from hydropower is in many cases at the mercy of rainfall patterns. In years of prolonged drought, electricity supplies based on hydropower often fail to meet the demand for electricity in the affected countries. As a result these countries have frequently faced electricity shortages, especially after the 1998 and 1999 *El Niño* (e.g. Brazil in 2000/01, Chile in 1998/99, Kenya in 2000, and Sri-Lanka in 2001)[27].

3.3.2.1.3 Under-investment and lack of diversity

In addition to prolonged droughts, which have led to power shortages in most of those countries where the majority of electricity comes from hydropower, under-investment and lack of diversity in the electricity supply industry were also indicated as major contributing factors (e.g. in Uganda, Sri-lanka, Norway and Brazil). For instance, as pointed out in the BusinessWeek magazine report in 11 June 2001, the electricity shortage that occurred in Brazil in 2001 was caused by both prolonged drought and under-investment in the electricity industry. As demonstrated in this report, "while demand for electricity has grown by 5% a year for the past two

26 For example: Norway from Europe; Chile and Brazil from South America; Sri-Lanka and Bangladesh from Asia; Uganda, Congo, Tanzania and Kenya from Africa.

27 Oludhe (2004) (Kenya); Wijayatunga & Jayalath (2004) (Sri Lanka), Businessweek Magazine (2001) (Brazil); Fischer (2000) (Chile), Time Europe Magazine (23 February 2003) (Norway); Tumusiime (2002) (Uganda).

decades, generating capacity has grown by just 4% a year". The Brazilian government's failure to invest and provide good conditions to private investors for alternative energy sources was pointed out in the same report as an exacerbating factor. Lack of diversity coupled with drought has even challenged the highly advanced Norwegian electricity supply industry, where HEP typically meets above 99% of the country's requirements (Time Europe Magazine 2003).

3.3.2.1.4 Rapid economic growth

Currently, electricity shortages are challenging the development of some countries (e.g. China and Korea) where the economy has shown rapid growth. In these countries, the fast economic growth has greatly increased the demand for electricity within a short period. For example in North Korea, rapid economic growth coupled with low electricity rates have increased the demand for electricity over the past three decades, at an annual rate of about 12% between 1970 and 2000. Conversely, however, their electricity production growth was slowed down because of serious natural disasters that happened over the years. Electricity demand thus far exceeded supply. In 2002, there was a huge power shortage in North Korea and the situation in turn seriously affected the national economy and caused inconveniences to the people (BBC monitoring international report 2002).

3.3.2.2 The impact of power shortages/outages

3.3.2.2.1 Economic scale

The impact of a power crisis on the economy depends on the economic scale of the country. In most advanced countries, where all the people badly need electricity for their day to day activities, even a short period of power interruption could create quite catastrophic problems, as experienced In California, Canada, and New York. Unexpected blackouts cost these nations several hundred million dollars. For instance, the power crisis in California in 2001 cost the economy USD 21 billion (constant 1996 dollars), according to Aus Consultants (2001), in spite of the fact that the situation was under control within a short period.

Although the impact of power outages on the economy of developing countries is far lower than in developed countries, it still costs their economies much particularly due to losses in industrial production. The experiences of some developing countries are given as follows:

- A 1987 study focusing on the effects of power outages in Pakistan estimated that the direct costs of load shedding to industry during a year, coupled with the indirect multiplier effects on other sectors resulted in a 1.8% reduction in GDP and a 4.2% reduction in the volume of manufactured exports (Adenikinju 2003).
- In India, the power outages have been identified as a major factor in low capacity utilisation in industry. They were estimated to have caused total production losses in 1983–84 at 1.5% of GDP (Adenikinju 2003).
- Power rationing in Colombia was estimated to reduce overall economic output by almost 1% of GDP in 1992 (Adenikinju 2003).
- In Bangladesh, nearly 14% of the industrial sector electricity demand cannot be met by the utilities due to planned and unplanned interruptions. These outages resulted in a substantial economic loss in the industrial sector amounting to USD 778 million a year (NexanT SARI/Energy 2003).
- The study done by Wijayatunga and Jayalath (2004) to determine the economic cost of both planned and unplanned power supply interruptions[28] in the industrial sector in Sri-Lanka showed that economic losses associated with 300 hours of power interruptions were estimated in the range of USD 47–117 million, which was 0.4–0.9% of the country's GDP in 2001.

3.3.2.2.2 Cost of power outages for industry sector

Various research findings have indicated that the main economic impact of power interruptions in developing countries has been the loss of output in the industrial sector, for example in Sir-Lanka, Banglish and Nigeria (Wijayatunga and Jayalath 2004; NexanT SARI/Energy 2003; Adenikinju 2003). In particular, Adenikinju (2003) indicated that the cost of electricity failures in the Nigerian manufacturing sector was remarkably high.

In addition to the loss in production, many authors have observed that industries are subjected to additional costs for the provision of auto-generation. Adenikinju (2003) for instance found that over 93% of Nigerian manufacturing companies used

28 Unplanned interruptions are often the result of either a shortfall in power generation capacity or inadequate and poor maintenance of distribution and transmission infrastructure. Planned interruptions can be due to regular scheduled maintenance in the power system or may be due to power shortages, e.g. during times of drought in countries highly dependent on HEP.

expensive back-up generators to reduce their production losses, costing firms between 10–30% of their total annual investments. This had a significant negative impact on the cost competitiveness of the Nigerian manufacturing sector.

Unplanned power outages can incur further costs, due to the losses in raw materials and possible machinery damage. For instance, the average cost of unserved energy[29]for the Sri-Lanka system is USD 0.66 per kWh in the case of planned interruptions, while it is USD 1.08 per kWh if the interruptions are unplanned (Wijayatunga & Jayalath, 2004). The corresponding figures for the Bangladesh industrial sector, were an average of USD 0.83/ kWh for unplanned electric power interruptions, and USD 0.34 / kWh for planned outages (NexanT SARI/Energy 2003).

3.3.2.3 Mitigation Measures

Most countries experiencing electricity shortages have tried to control or mitigate the problem before it developed into a total black-out. For instance Norway, to address power shortages that were expected to happen in the winter of 2002, warned its citizens in advance to conserve power (BBC News online 2002). However power conservation was not enough to equalise the imbalance between the 2002 winter electricity demand and supply. The country thus imported electricity from Denmark and Germany which have coal- and gas-fired power plants to avoid blackouts (Time Europe magazine online 2003). For most developed countries like Norway it is usually possible address power shortages without power shedding. Firstly, since their electricity consumption is often very high, it is possible for them to save electricity through power conservation; and secondly, they have enough resource to enable them to import electricity from neighbouring countries within a shortage period even if it is expensive to do so.

Mitigating power shortage problems through power conservation or by importing electricity from other countries can be more difficult, for the countries which have financial problems, whose per capita electricity consumption is very low and where electricity shortages frequently occur, and may be impossible. Thus, most

29 The cost of power outages is commonly determined using the cost of unserved energy (USD per kWh, i.e. economic loss per unit of supply loss) that comprises all the costs, such as production and raw-material losses, and additional costs incurred due to self-generation.

developing counties have been forced to introduce inevitable power rationing schemes which in turn have adverse impacts on their economies as a result of losses in the industrial, commercial, transport and communication sectors (e.g. Brazil in 2001, Uganda since 1992, Kenya in 2000). In Kenya, for instance, the severe drought in 2000 was the worst in 50 years, and electricity generation fell by 40%, forcing the Kenyan government to announce more stringent power rationing measures. Residential power was cut from sunrise to sundown and industrial power was stopped from sunset to sunrise (Oludhe 2000).

CHAPTER 4

ELECTRICITY PRODUCTION AND CONSUMPTION IN ETHIOPIA: ANALYSIS OF THE EXISTING DATA

4.1 OBJECTIVE AND SCOPE

The objectives of this chapter are to assess the past electricity supply condition of the country and to present data which help to investigate the causes of the electricity supply problem, using important time-series electricity data on the electricity generation capability, production, and consumption of the country. For this, the data obtained directly from EEPCo and their website will mainly be used.

The main scope of this sector analysis is the ICS electricity supply and demand. However to investigate the causes of electricity shortage a more detailed analysis will be done on the electricity consumption of areas recently connected to the ICS (after 1996/97). In most cases focus will be given to industrial electricity consumption. For the analysis both monthly and yearly electricity data will be used.

4.2 LIMITATIONS OF DATA AND ANALYSIS

Actual data for 2002/03 would have been useful to investigate the main causes of the electricity problems that occurred in this year. However, the data for this study was collected in the first two months of 2004, before the completion of 2002/03 data by EEPCo. As a result, actual data for 2002/03 is not considered in most parts of the analysis. An attempt is made to fill this gap using Acres's forecast data.

There were barriers in trying to get further explanations on some of the observed figures when the analysis was carried out, both because of difficulties in contacting the utility's people, and also in getting additional data required in the process of the analysis. Therefore most of the explanations are made based on the observed data and own interpretations.

4.3 DATA USED

The first part of the analysis deals with ICS electricity supply[30]. To assess the condition of the ICS electricity supply three important variables are used: the age of the power plants, their average energy capability and actual production. In most cases, the time series start from 1992/93EFY[31] but for some analysis it will go back beyond this year. In addition to the yearly data, monthly production data is used in order to see the pattern of electricity production within the year.

The electricity consumption [sales] is analysed in the next section. In this case, to examine sales trends and the shift from SCS to ICS, both ICS and SCS sales are considered. In order to see the whole picture of electricity demand in the country, the assessment is not limited to the sales, but also includes trends in the number of customers and per consumer consumption, both in the ICS and SCS groups. A relatively in-depth analysis will be done on those areas newly connected to the ICS since 1996/97, based on the availability of the data. The data used in this section almost correspond in time with supply-side data, helping to draw comparisons between them.

In general, while the different data and information will be used to reveal the electricity situation in the country since 1992/93, most attention will be given to the years which had electricity shortages.

4.4 THE ICS ELECTRICITY SUPPLY

As stated in the Introduction, the Ethiopian Electricity Power Cooperation maintains two supply systems, the InterConnected System [grid] and the Self-Contained System. The majority of electricity in the country is supplied from the ICS (98%). This section deals with only the ICS.

4.4.1 Power plants in ICS

In the 1960s after the first large hydro plant was commissioned, two hydro plants were added consequently with 32MW and 11.4MW capacity. By the end of the

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30 As stated in the Chapter 3 more than 98% of the country's electricity is supplied by the ICS.

31 Note that most of the data in this chapter refers to the Ethiopian Fiscal Year (EFY). The Ethiopian fiscal year is from July 08 to July 07 (*"Hamele" 1* to *"Sene"* 30).

1960s, the total installed capacity of HEP had reached 86.6MW. As shown in Figure 4.1, this accounted for 18% of the total ICS HEP capacity in 2002. In the 1970s the total installed capacity of the HEP rose by 132 MW, contributing a further 27% to the total 2002 installed capacity. After the largest hydro power plant with 153 MW had been commissioned during the late 1980s, the development of hydropower stagnated for more than 12 years apart from rehabilitation works on some of the existing power plants in the late 1990s, which only increased the installed capacity by 3% (12 MW). Figure 4.1 illustrates that the older hydropower plants (>30 years) shared more than 45% of the total installed capacity available in 2002.

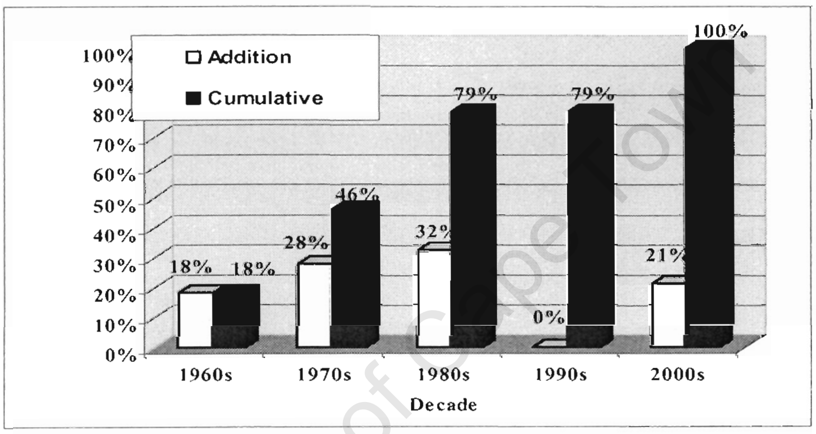

Figure 4.1. The percentage share of ICS additional and cumulative installed capacity of HEP plant per ten years (1960-2003) [32]

Source: Derived from EEPCo (2004: EEPCo in Brief)

Table 4.1 shows the age of the power plants in the ICS by source. As shown in this table, in 2003 the ICS had seven large and medium scale HEP, 10 diesel and one geothermal plants. Out of the seven HEP plants five of them had been commissioned more than 30 years ago and only one plant was added during the last five years. Most of the diesel power plants (eight out of ten) are more than 20 years old.

[32] These figures are based on the current capacity of power plants (2002) plus the dates when they were first commissioned. However, the actual figure in the referred year could be slightly lower because of possible improvement works on the original power plants. The 3% capacity addition in the late 1990s has not been presented separately because it was already added in the corresponding power plant's installed capacity.

In general the ICS is dominated by old and aged power plants, which could obviously reduce their capacity for electricity production, particularly the diesel power plants, since their age (except for two newer diesel power plants) is more than or nearly equal to their economic lifetime, which is in most cases around 15 – 20 years. It is true that the rehabilitation of four diesel power plants during the 1990s could slightly increase the production capacity and the life expectancy of these power plants. However, in any case, the share of diesel power plants in total electricity production has been very low.

Table 4.1. Power plant installed capacity and age by source (ICS): 1960 – 2003

AGE YEARS	INSTALLED CAPACITY MW			NO. PLANTS			TOTAL MW	EXTENSION WORK
	Hydro	Diesel	Geo-thermal	H	D	G		
		Note 1						
>=35	86.6	7.9	-	3	3		**94.5**	In 1984 on one diesel generator (1.1MW)
<35 & >=30	132.0	0	-	2			**132.3**	
<30 & >=20	-	8.9	-		5		**8.9**	In 1990s on four diesel plants (6.6MW)
<20 & >=15	153.0	-	-	1			**153.3**	
<15 & >=9	-	2.4	-		1		**2.4**	
<=5	101.0	3.0	7.3	1	1	1	**111.3**	
Total	**472.6**	**22.2**	**7.3**	7	10	1	**502.1**	

Source: Derived from EEPCo (2004: EEPCo in brief)

Note 1: The figures in this column could differ from the exact figures in the corresponding periods (age group), because extension works have been done on some of the diesel plants in different years (see remark column).

4.4.1.1 Average energy capability[33] and actual electricity production

Another important indicator that shows the performance of electricity supply is the percentage of reserve capacity that a country has at a given period of time. When the gap between the actual electricity production and estimated average energy capability of the power plants increasingly narrows, this could lead to electricity

33 Average energy capability is the average annual energy (normally given as 12 monthly values) that a hydroelectric station or a group of stations can generate under average river flow conditions, which is determined by averaging the energy that is generated over the 40 to 50 years of discharge records derived (for further explanations see Basic Concepts and Definitions Section in the Introduction Chapter and Appendix E).

shortages in the country. Firstly, to develop new hydroelectric power plant requires time and considerable finance. Secondly, a number of factors could lead to electricity production at less than the design capacity of the power plant, for example prolonged drought and unplanned maintenance.

The situation of the Ethiopian ICS electricity supply (HEP) is demonstrated in Table 4.2 by taking a specific year or years from each decade. As illustrated in the table, the reserve capacity has increasingly decreased from 1979 to 2002. For example in 1979 it was 764 GWh and in 1999 it had reduced to 109 GWh. Finally it reached 30 GWh in 2002. During these periods, it had decreased by more than 96%. Correspondingly, the percentage of reserve capacity also had declined from 64% to 6% and finally dropped down to 1%. As observed in the same table, after 1995 the electricity reserve capacity fell below the recommended capacity reserve rate (20%)[34] due to the remarkable drops from 1989 to 1995, especially in 1997, 1999, 2001 and 2002.

Table 4.2. Estimated average energy capability and electricity production (ICS HEP): 1969 – 2002

YEAR	INSTALLED CAPACITY MW	ESTIMATED AVERAGE ENERGY CAPABILITY GWH/YEAR	ACTUAL PROD. GWH/YEAR	DIFFERENCE (CAPABILITY - ACTPRD)	
				GWh	%
69	86.6	360	240	120	33%
79	218.6	1185	421	764	64%
89	371.6	1728	1004	724	42%
93	371.6	1728	1208	520	30%
95	371.6	1728	1402	326	19%
97	371.6	1728	1551	177	10%
99	371.6	1728	1619	109	6%
01	444.6	1849	1774	75	4%
02 Expected	472.6	2006	1976	30	1%

Source: - Acres International (2003a:IV).

In these latter years, the reserve fell below half the recommended level. During the same period however the actual production from HEP had being growing at an average rate of 5% per year.

Table 4.3 depicts the ICS annual electricity production by source in percentages. The ICS electricity production has grown at an average rate of above 4.8% per year

[34] As stated in the Acres executive summary report (2003a), a 20% capacity reserve would be needed for maintenance and forced outages.

between 1992/93 and 2001/02, of which the contribution of HEP electricity production growth was more than 98%. In the corresponding years the electricity production from this source has increased at an average rate of 6%. But the electricity production from diesel power plants has shown fluctuation.

The trend in Table 4.3 shows that the electricity production from diesel grew from 0.3 GWh to 4.0 GWh between 1994/95 and 1999/00 but fell down to 0.1 GWh in 2001/02, despite the growing installed capacity. As shown in the same table, the installed capacity of diesel power plants grew from 4.5 MW in 1992 to 22.2 MW in 1999, but this was not because of addition of new diesel power plants into the system except for one new diesel plant which was added in 1998 with 3 MW installed capacity. Apart from this, the extra diesel capacity came from plants which were added to the ICS since 1997/98 from the SCS. However, as stated in the Acres (2003a) executive summary report, these additional diesel stations in various locations in the ICS cannot be synchronised with the grid, and only serve for local standby capacity. In 1999/00 the actual thermal (diesel) capacity connected to the ICS was, therefore, only 7.5 MW out of 22.2 MW.

Table 4.3.Percentage share of ICS generation installed capacity and production by source 1992/93-2001/02 (1985 - 1994 EFY)

EFY	INSTALLED CAPACITY MW							INSTALLED CAPACITY %			ELECTRICITY PRODUCTION %			GC
	Hydro	Thermal	Geothermal	Hydro prod	Hydro Growth %	Thermal	Geothermal	Hydro	Thermal	Geothermal	Hydro	Thermal	Geothermal	
1985				1208		0.5	-	98.8	1.24		99.96	0.04		92/93
1986	360	4.5		1309	8	10.0	-	98.8	1.23		99.24	0.76		93/94
1987	360	4.5		1402	7	0.3	-	98.8	1.23		99.98	0.02		94/95
1988	371	4.5		1,495	7	0.4	-	98.8	1.20		99.97	0.03		95/96
1989	371	6.8		1,551	4	0.1	-	98.2	1.80		99.99	0.01		96/97
1990	371	18.8		1,565	1	0.3	-	95.2	4.82	0.00	99.98	0.02		97/98
1991	371	18.8	7.3	1,592	2	0.9	26.3	93.4	4.73	1.84	98.32	0.06	1.62	98/99
1992	371	22.2	7.3	1,632	2	4.0	20.0	92.7	5.54	1.82	98.55	0.24	1.21	99/00
1993	444	22.2	7.3	1,774	9	2.1	5.1	93.8	4.69	1.54	99.60	0.12	0.29	00/01
1994	472	22.2	7.3	1,976	11	0.1	1.0	94.1	4.43	1.46	99.94	0.01	0.05	01/02
1995	472	22.2	7.3	2,007	2	21.0	0.0	94.1	4.43	1.46	99.0	1.00	0.00	02/03

Source: Derived from EEPCo (1997; 2002: EEPCo in brief)

As stated by one expert from EEPCo, mainly due to technical reasons, both the production and the share of geothermal generation have dropped from 1998/99 to 2001/02. When the production of electricity from geothermal plant was started in 1999, the share of the geothermal power plant was 1.62%, and in the corresponding year the share of HEP declined by 1.66% from 1997/98. However, since then, the production of electricity from geothermal declined, and finally reached zero in 2001/02. In order to meet the growing demand, the share of HEP thus rose again and its growth rate started increasing again as in the previous years, especially in 2000/01 (9%) and 2001/02 (11%), as shown in the earlier Table 4.3.

Table 4.4. Expected energy generation by source: target forecast (ICS): 2002 - 2004

YEAR	HYDRO	THERMAL	GEO-THERMAL	TOTAL	UNSERVED ENERGY
2002	1897.6	4.1	6.8	1908.5	2.6
2003	2007.6	5.8	49.1	2062.5	2.5
2004	2167.0	0.0	49.1	2216.0	0.0

Source: Acres International (2003b).

Although the share of the geothermal power plant in electricity production was in any case small compared to HEP, nonetheless if geothermal electricity production had grown as Acres had forecast, it would have slightly decreased the magnitude of pressure on HEP and could have been used to supplement electricity production from hydro particularly during the drought years experienced in 2002 and 2003.

In general, from the above observed results, the share of HEP for electricity production lay between 98.32% and 99.99% while its installed capacity share in the ICS dropped to 92.7% (1992/93-2001/02). The electricity production from this source has been continuously growing at an average rate of 6% per year (1992/93 – 2001/02), while the electricity production from other source (diesel and geothermal) has not shown any significant increase. Instead production from geothermal decreased abruptly after 1999/00 and a similar trend occurred in diesel power plant production in the same period. Even though since 1999/00 the installed generation capacity of ICS diesel power plants had increased by three times from the 1996/97 installed capacity (6.8 MW) this was mainly due to the old plants which had been included from the SCS. Overall, these observations clearly show that the pressure on HEP plants had increased during this period, without any significant investment in expanding HEP capacity or developing non-hydro power plants.

4.5 MONTHLY AND QUARTERLY ELECTRICITY PRODUCTION

When a country's electricity is predominantly produced from hydro, the yearly production data would not be enough for a thorough assessment of the electricity supply situation of the country because the production of electricity from hydropower within a year can vary depending on the rainfall pattern. It is important to examine monthly electricity production to assess the variability of electricity production trends through a series of months.

In Ethiopia from June to September it is the rainy season *("Kremt")*[35]. Usually the strong rain stops after August, but sometime there is weak rain in September. During these months enough water is stored in the dams, enabling the utility to produce electricity for the next three or four months depending on the demand. For instance, after September, electricity production in the country grew until December or January in most of the years depicted in Figure 4.2 and started falling after these months. Usually there is no rain from October to January, this is a dry season (called *"Bega"*) and electricity production gradually declines in this season. It normally reaches the lowest level in May, but depending on the condition of the "*Belg*" rain (February to May) the lowest production could be before this month or after this month in June. If there was not enough rain during the *"Belg"* season or the rain started late (in June), this would result in very low production in the months of May, June and even in July, as experienced in 1999/00 and 2002/03 (see Figure 4.2), and normally this would be a drought year.

Figure 4.2 shows that there was monthly fluctuation in electricity production from 1995/96 to 2002/03. However the degree of fluctuation in some years was very small, for example the standard deviation of the monthly electricity production in 1995/96 and 1996/97 was 3.7 GWh and 10.9 GWh, respectively. The degree of variability has increased since 1997/98, showing particularly abrupt increases in 1999/00 and then in 2000/01, when the standard deviations of electricity production over these two years were 36 GWh and 73 GWh, respectively. There was slightly less monthly variation in 2001/02 but this condition did not continue in 2002/03 due to the low level of electricity production in the months of May and June.

[35] There are three seasons in Ethiopia, classified by the respective amounts of rainfall. They are the main rainy season "kremt" (June-September), the dry season "bega" (October-January) and the small rains season, belg (February-May).

The high fluctuations observed in the years 1999/00 and 2002/03 mainly resulted from the very low electricity production in the months of May or July, and June. In these months the electricity production dropped significantly from the previous months (see Table 4.5). As illustrated in Table 4.5, production in June 1999/00 (122 GWh) was less than production in any month in the previous two years (1997/98 and 1998/99). In 2002/03, the June production (154 GWh) was again sharply down, in spite of the growing demand.

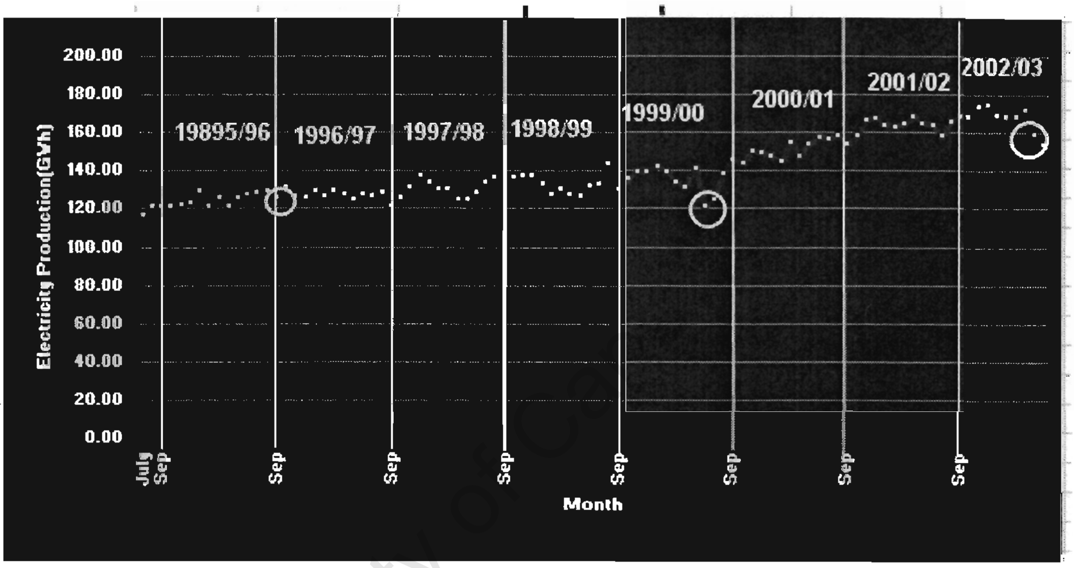

Figure 4.2. Monthly ICS generation (GWh): 1995/96 – 2002/03 (1988 – 1995 EC)

Source: Data collected from EEPCo (2004)

The fluctuation in monthly electricity production was not always only due to the effects of rainfall patterns. Other factors could play a part, such as electricity demand growth, tariff changes, machinery failures, rehabilitation or maintenance works, etc. For instance, Table 4.5 shows that in 1996/97 the electricity production in May slightly decreased from the previous month's production and this could possibly be because of tariff changes that had been undertaken in the month of April. However the impact of the tariff changes is not clearly observed over a long period of time. Electricity demand growth could offset its impact.

Electricity demand normally shows a positive growth due to the electrification of new areas and addition of new customers. For instance, in 2000/01 and 2001/02, the ICS electricity demand grew by 3% and 15%, respectively, and electricity demand in

2001/02 had increased by 21% from 1998/99 (see Table 4.6 in the next section). Based on this trend, if there were no problem in the following year 2002/03, the electricity demand would be expected to grow on average 6 to 8 percent. Table 4.5 shows that this was true in the early months of 2002/03, when the electricity production between September and December showed 4% to 9% growth compared with the corresponding months in the previous year. But after December, the year-on-year growth in electricity production had become very narrow. Finally a negative production growth was observed in the last two months (May and June) of 2002/03 compared with the corresponding months in 2001/02. This is mainly because in 2002/03 there was not enough rain during "*Belg*" season.

Table 4.5. Monthly ICS electricity generation (GWh): 1995/96 – 2002/03 (1988 – 1995 EFY)

YEAR EFY	JULY	AUG	SEP.	OCT	NOV.	DEC.	JAN.	FEB.	MAR	APR	MAY	JUN.	TOTAL[36]	G.C
1988	117	121	121	121	122	123	129	121	125	121	125	127	**1,495**	**1995/96**
1989	129	129	125	131	127	126	129	126	129	128	124	128	**1,552**	**1996/97**
1990	127	128	122	126	131	137	134	131	130	125	125	128	**1,565**	**1997/98**
1991	133	136	136	136	138	138	133	127	131	128	127	133	**1,619**	**1998/99**
1992	133	144	131	136	139	139	142	139	134	131	141	122	**1,655**	**1999/00**
1993	125	139	146	144	150	149	147	145	155	148	154	158	**1,782**	**2000/01**
1994	157	158	153	159	166	168	164	162	165	168	165	164	**1,976**	**2001/02**
1995	159	165	168	169	174	175	169	169	169	172	159	154	**2,028**	**2002/03**
Avg.	**135**	**140**	**138**	**140**	**143**	**144**	**143**	**140**	**142**	**140**	**140**	**139**	**1,709**	**Avg**

Source: Data collected from EEPCo (2004)

Could be tariff revision

In general, because the country's electricity production is predominantly based on hydro and electricity demand has increased without any significant developments on the supply-side, a slight problem in the rainfall pattern would create a higher fluctuation in the production of electricity, as experienced in 1995/96 1997/98, 1999/00 and 2002/03. This could commonly lead to a greater imbalance between electricity demand and supply in such circumstances (unless the production of electricity from HEP could be supplemented by non-seasonal fuels like diesel).

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[36] The row sum from July to June is not equal to the total because of five days electricity production deducted from the August production. The data for August production had included the electricity production of the last (thirteenth) month "Pagumiene" (only 5 or 6 days).

In the ICS group, therefore, the diesel power plants have been used as backup generators, when electricity production from HEP dropped, particularly in a drier season[37]. For instance, as shown in Figure 4.3, in 1993/94, when the HEP electricity production dropped by 5% in the fourth quarter from the first quarter production (15 GWh), electricity production form diesel power plants grew by 15% (10 GWh)[38] in the same period (In this year the ICS yearly electricity production of diesel power plants grew by 9.5 GWh). A similar trend was observed in the third quarter of year 1991/92.

The role of diesel power plants for emergency standby generation became increasingly important after 1998, due to a low level of investment in HEP and declining electricity production from the geothermal power plant. However, the generation capacity of the existing diesel power plants in the ICS group was very low, so they could only meet a small portion of the shortage in HEP electricity production. For instance, in the fourth quarter of 1999/00 when electricity production from HEP dropped by 24 GWh from the third quarter, the electricity production from diesel power plants increased by only 2 GWh. A similar situation was noticed in 2002/03 when the catastrophic power shortages happened in the country.

Electricity production from diesel power plants is much more expensive than electricity production from HEP, and even more expensive than geothermal. However, because the country's electricity supply is predominantly hydro-based, the use of non-seasonal fuels like diesel becomes very important to supplement electricity production from HEP during a drought and drier seasons.

[37] E.g. the older diesel generator units in the ICS at Dire Dawe and Alemaya with 6.8 MW installed capacity and 5.7 MW dependable capacity, are being used as emergency standby generators (Acres International 2003b: Conventional thermal generator resources present condition)

[38] This is ICS + SCS (see Figure 4.3)

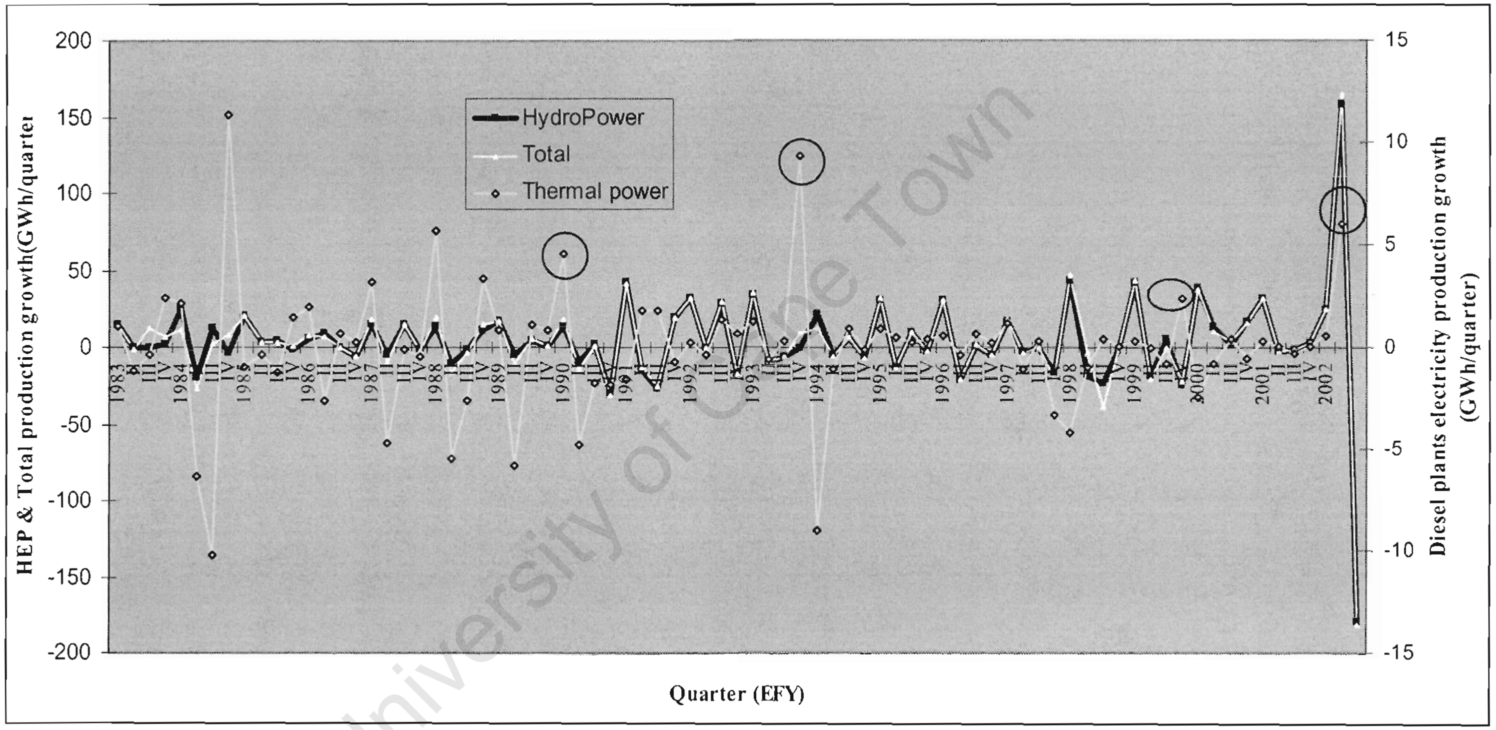

Figure 4.3. The growth rate of quarterly electricity production by source (excluding geothermal) 1983/84 – 2002/03 (1976 – 1995 EFY) (ICS + SCS).

Source: Derived from EEA/EEPRI (2003).

4.6 ELECTRICITY CONSUMPTION AND DEMAND[39]

It is evident from Table 4.6 that the country's electricity consumption growth rate has been highly related to the growth rate of ICS sales because, as stated in the Chapter 3 page 15, more than 98% of the country's total electricity supply is from the ICS. For example, in 1998/99 when ICS sales declined by 0.3% the country's overall electricity consumption showed a negative growth. Electricity consumption in the ICS grew at an average rate of 5.7% per year between 1992/93 and 2001/02. Conversely, during this period the average consumption growth in the SCS was negative.

In most cases electricity demand in the ICS always shows an upward growth due to the electrification of new areas and new connections. The demand in the SCS group is in a constant state of change, as new areas are electrified and added to this group, while existing centres may be connected to the ICS and therefore removed from the SCS group.

Table 4.6. Electricity sales by system: 1992/93 – 2001/02 (1985 – 1994 EFY)

YEAR		ICS		SCS		TOTAL		COMMENT
EFY	GC	Sales GWh/yr	Growth %	Sales GWh/yr	Growth %	Sales	Growth %	
1985	1992/93	978		57		1035		
1986	1993/94	1073	9.71	61	7.0%	1134	9.57	
1987	1994/95	1145	6.71	36	-40.8	1181	4.14	Tariff revision (Oct. 1993)
1988	1995/96	1231	7.51	37	2.2	1268	7.37	
1989	1996/97	1277	3.74	46	24.4	1323	4.34	Tariff revision (April 1996)
1990	1997/98	1310	2.58	49	5.9	1373	3.78	Tariff revision (April 1997)
1991	1998/99	1306	-0.31	26	-46.5	1345	-2.04	Tariff revision (April 1998)
1992	1999/00	1351	3.45	25	-3.5	1384	2.90	
1993	2000/01	1389	2.81	24	-2.8	1419	2.53	
1994	2001/02	1597	14.97	25	0.4	1630	14.87	
Average			5.7		-6.0			
		Target Forecast(Acres, 2003)						
2002/03		1642	2.8%	11	-56%	1653	1.4%	Reconnected from SCS to ICS
2003/04		1762	7.3%	13	18%	1775	7.4%	Reconnected from SCS to ICS

Source: EEPCo (2002: EEPCo in brief) and Acres International (2003b).

[39] As in other chapters, the term "demand" is used here in the broader sense of demand for electrical energy (in GWh, etc), rather than power demand (in MW etc).

In general, a number of factors, such as new connections, electrification of new areas, the incorporation of former SCS centres into the ICS, tariff revisions, electricity supply shortages, and the country's level of development can all determine electricity consumption patterns both in the ICS and SCS.

As illustrated in Figure 4.4, the consumption for electricity in the SCS group showed a sharp downward growth in 1994/95 and 1998/99. This was mainly due to the removal of large SCS loads as a result of SCS centres becoming connected to the main ICS grid. For instance, in 1994/95 more than 20,000 customers from different tariff groups were moved to the ICS (see Table 4.7); at the same time causing higher demand growth in the ICS group. In the same year, for instance, in spite of a tariff revision, ICS sales showed a 6.7% increase, resulting both from new connections and the additional inclusion of these former SCS customers. By 2001/02, the ICS sales had increased by almost 50% from 1992/93, while SCS sales had dropped by nearly the same degree (53%).

However the electricity consumption growth in the ICS group was slowed down mainly due to tariff revisions undertaken in 1994 and two consecutive years, 1997 and 1998 (see details of tariff changes in Appendix D). Referring back to Table 4.6, the growth rate of ICS electricity consumption decreased by half in 1996/97 (3.74%) from 1995/96 (7.51%) and the figure has declined since then, finally reaching a negative growth in 1998/99 (-0.31%)[40]. On average, electricity tariffs doubled between 1993 and 1998 (the average tariff in 1993 was 0.2 ETB/kWh and in 1998 was 0.4163 ETB/kWh). Obviously, a similar situation could have occurred in SCS electricity sales, but the situation in this system is less clear because the removal of load from this group also decreased the sales. For example, at the same time that the tariff was revised in 1994/95, a huge load was removed from the SCS, as a result of which the SCS sales decreased dramatically (by 40%) in this year. Such changes in the customer base make it difficult to examine the effects of tariff revisions on SCS sales.

40 The Ethio-Eritrea war could have played some role in the reduction of electricity consumption, as the economy was adversely affected by the war (see Chapter 3).

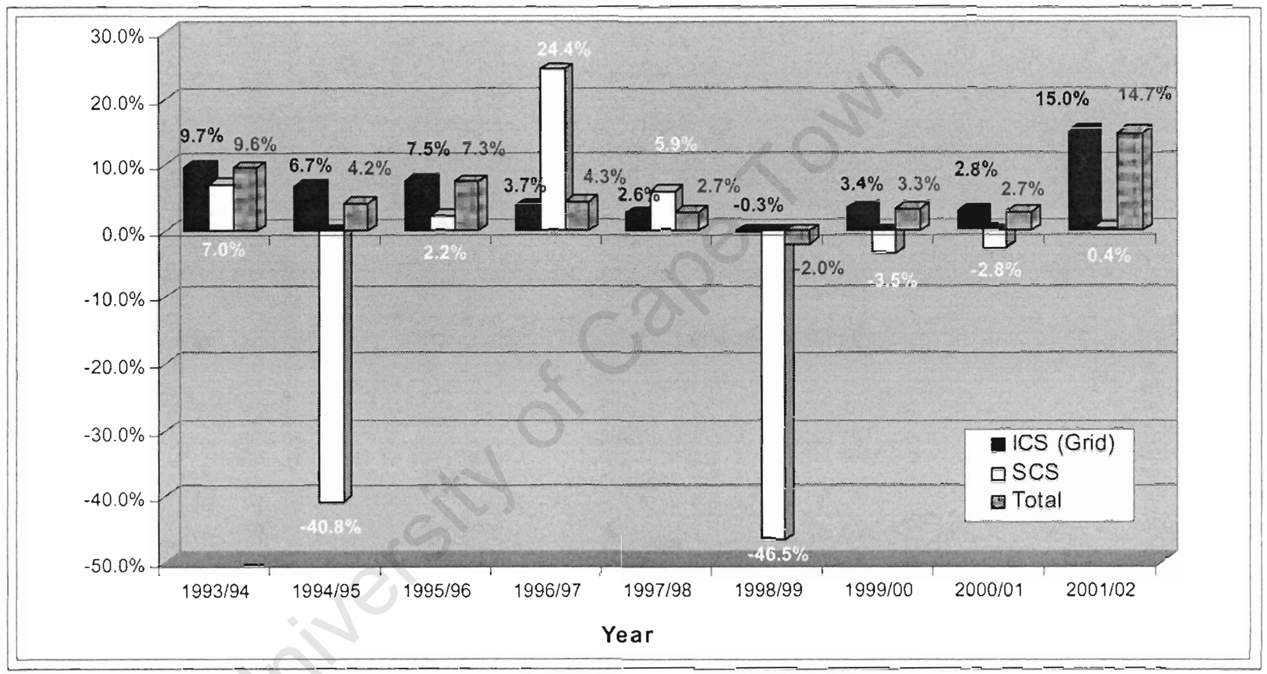

Figure 4.4. Rate of sales growth by system: 1993/94 – 2001/02 (ICS + SCS)

Source: Derived from EEPCo data (1997; 2002)

Table 4.7. Number of customers by system:-1992/93 – 2002/03 (1985 – 1995 EFY)

YEAR		NUMBER OF CUSTOMERS			GROWTH %		
EFY	GC	ICS	SCS	Total	ICS	SCS	Total
1985	1992/93	391,114	58,749	449,863			
1986	1993/94	413,399	59,213	472,612	5.7%	0.8%	5.1%
1987	1994/95	460,089	39,156	499,245	11.3%	-33.9%	5.6%
1988	1995/96	475,109	43,687	518,796	3.3%	11.6%	3.9%
1989	1996/97	487,962	47,329	535,291	2.7%	8.3%	3.2%
1990	1997/98	519,561	31,909	551,470	6.5%	-32.6%	3.0%
1991	1998/99	540,018	34,059	574,077	3.9%	6.7%	4.1%
1992	1999/00	569,280	26,959	596,239	5.4%	-20.8%	3.9%
1993	2000/01	596,505	28,580	625,085	4.8%	6.0%	4.8%
1994	2001/02	624,023	30,417	654,440	4.6%	6.4%	4.7%
1995	2002/03			698,360			6.7%

Source: Derived from EEPCo data (1997; 2002)

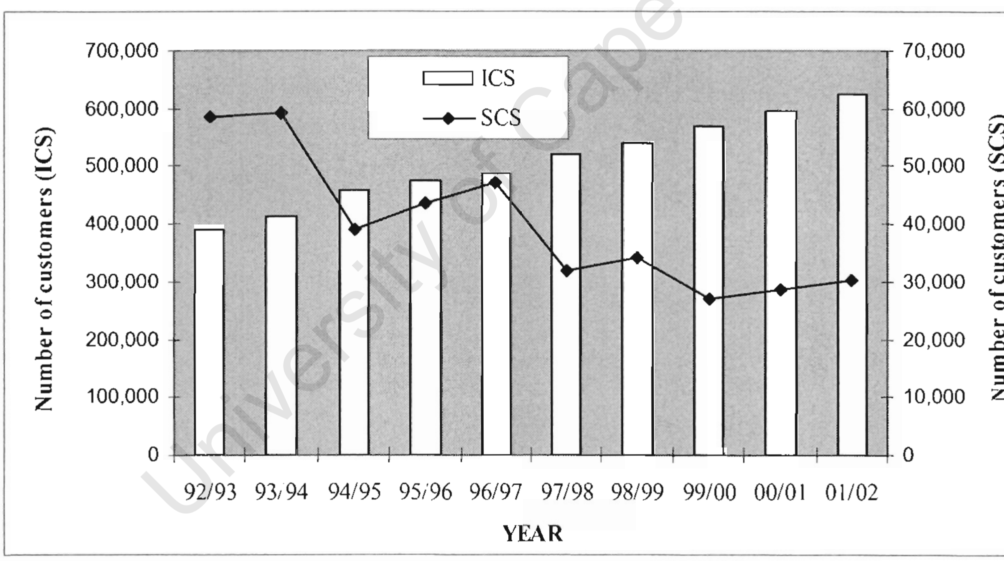

Figure 4.5. Number of customers by system: 1992/93 – 2001/02

Source: Derived from EEPCo data (2002)

Figure 4.6 shows, another interesting trend: in more than half of the years the number of customers grew faster than the electricity sales. This is particularly evident in the years when tariff revisions were undertaken. In these years electricity sales grew per year by less than 4%. The larger growth in numbers of customers indicates a reduction in consumption per customer. The opposite was observed in the years 1993/94, 1995/96, 1996/97 and 2001/02. Particularly noticeable sales growth was shown in the year 2001/02 (15%)[41] when electricity sales grew more than three times as fast as the growth in the number of customers (< 5%). The electricity sales per customer rose accordingly.

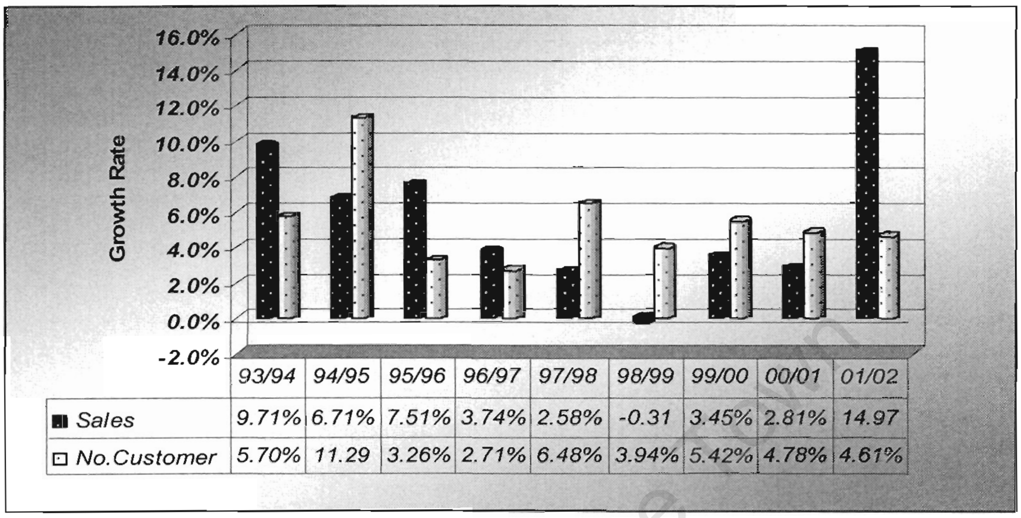

Figure 4.6. The growth rate of sales and number of customers (Only ICS) 1993/94 – 2001/02 (1986 – 1994EFY)

Source: Derived from EEPCo data (1997; 2002)

Table 4.8. The growth of electricity sales per customer 1993/94 – 2001/02 (1986 – 1994 EFY)

EFY	YEAR	MWh		
		ICS	SCS	Total
1986	93/94	0.10	0.06	0.10
1987	94/95	-0.11	-0.11	-0.03
1988	95/96	0.10	-0.07	0.08
1989	96/97	0.03	0.12	0.03
1990	97/98	-0.10	0.56	-0.01
1991	98/99	-0.10	-0.77	-0.14
1992	99/00	-0.05	0.16	-0.01
1993	00/01	-0.04	-0.09	-0.05
1994	01/02	0.23	-0.02	0.22

Source: Derived from EEPCo data (2002)

1. Note that growth Table 4.8 refers to the amount of addition or reduction in electricity sales per customer compared with the previous year. For instance in 2001/02 sales per customer increased by 0.22 GWh/year from 2000/01 per customer sales.

[41] A contributing factor for abrupt electricity demand growth could be that the border war between the country and Eritrea ceased after 2000 and the economy of the country recovered again until progress was halted in 2003 mainly due to the severe drought.

A higher electricity sales growth per customer (higher energy intensity) is partly an indication of greater economic development, particularly for a country like Ethiopia, which starts with a low level of development and follows Agricultural Development-Led Industrialisation strategy for the long-term development. Such development can be cumulative from year to year. Unless the economy is struck by unexpected drought, war or other problems, a better economic performance in previous years could enable the country to develop and expand the economy further in following years, in both agriculture and industry, leading to growth in electricity demand.

In general the tariff revisions that were undertaken repeatedly in the 1990s have actually normalised the electricity demand in this decade by decreasing the electricity consumption per consumer. However the addition of new customers to the ICS group, both due to new ICS connections and transfers of existing customers from the SCS, obscured the impact of the tariff revisions and has resulted in a positive demand growth in most of the years. The noticeable per-customer electricity consumption growth that was observed in 2001/02 threatened to create a more challenging situation for the ICS electricity supply, even leading to power shortages unless the capacity of the electricity industry was improved to meet the growing demand, or electricity consumption was modified (using measures such as tariff revisions, as in previous years).

A more in-depth analysis and discussion of the power shortages will be presented in the next chapter, while the analysis here of electricity demand trends will continue by looking at regional patterns of electricity consumption in the country. This will include an examination of electricity demand and consumption in the areas newly connected to the ICS group since 1997/98.

4.6.1.1 Electricity consumption and demand by region

The Addis Ababa region is by far the most advanced compared to any other region in the country, and in the majority of cases, it is still the region favoured by both local and foreign business people due to its much better infrastructure and market. As shown in Table 4.9[42], more than half of the total yearly ICS electricity sales have been in the Addis Ababa region, followed next by the Central region. However, the share of the Addis Ababa region seems to have declined between 1995/96 and 2001/02. On the other hand, the share of the newly connected Northern region grew from 0.15% in 1997/98 to 5.58% in 2001/02.

Table 4.9. The percentage electricity sales share for each of the regional centres (ICS) 1995/96 – 2001/02(1988 – 1994 EFY)

EFY	1988	1989	1990	1991	1992	1993	1994
GC.	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02
ADDIS ABABA	59.53%	58.61%	56.37%	51.72%	52.34%	50.85%	51.27%
CENTRAL	14.38%	15.14%	18.18%	18.77%	18.23%	18.10%	16.68%
EASTERN	6.92%	6.63%	6.89%	6.96%	6.76%	6.34%	7.76%
NORTH EASTERN	3.96%	4.04%	3.51%	3.95%	3.51%	3.68%	3.29%
OLD NORTH EASTERN	3.96%	4.04%	3.51%	3.91%	3.46%	3.60%	3.22%
NEW NORTH EASTERN			0.00%	0.04%	0.05%	0.08%	0.07%
NORTHERN			0.15%	3.13%	3.87%	5.30%	5.58%
NORTH WESTERN	4.24%	4.49%	4.47%	4.34%	4.31%	4.60%	4.50%
SOUTHERN	9.41%	9.54%	8.52%	9.43%	9.51%	9.35%	9.27%
WESTERN	1.56%	1.55%	1.91%	1.69%	1.48%	1.79%	1.65%
OLD WESTERN	1.56%	1.55%	1.91%	1.69%	1.31%	1.29%	1.15%
NEW WESTERN					0.16%	0.51%	0.50%

Source: - Derived from data collected from EEPCo (2004)

As stated earlier, some loads are periodically removed from the SCS group and added to the ICS group, based on a planned schedule. Recently, between 1997/98 and 1999/00 a number of areas (large to small urban centres) from different regions were connected to the ICS. The majority of these were in 1997/98 and most of them were the cities in the Northern region[43]. In 1999/00 two small cities and one relatively large city in the Western region were connected to the ICS. Figure 4.7 shows the electricity demand of these areas newly connected to the ICS group.

[42] The electricity sales by region were retrieved from sales figures of regional branch centres. The electricity sales of each branch could also include the electricity sold to additional nearby small areas outside the region. However their electricity consumption is very insignificant. Currently the utility has eight regional branch centres in the ICS group i.e. Addis Ababa region, Central region, Eastern region, North Eastern region, Northern region, North Western region, Western region and Southern region. Each region centre again has a number of centres. (See Appendix A. I).

[43] Virtually all the areas in the Northern region have become connected to the ICS group since 1996/97.

Between 1997/98 and 2001/02 electricity demand in all the newly connected areas has shown a positive growth rate.

A noticeable electricity demand growth in these areas newly added to ICS group indicates that their electricity demand before could have been suppressed, mainly because of the limited capacity of the SCS. Especially, the electricity consumption in the Northern region has shown by far the highest growth rate, averaging 503% per year between 1997/98 and 2001/01. For instance the total electricity production of the SCS was only about 62 GWh/year, one year before these areas were removed from the SCS group (1996/97). By 2000/01, the electricity consumption of the Northern region alone (at 73 GWh/year) exceeded this by more than 10 GWh/year, just two years after being connected to the ICS group.

Some of the cities which were connected from this Northern region were relatively larger and more advanced. They could have had a higher unmet electricity demand (while in the SCS) compared with the smaller cities which were connected in the same year.

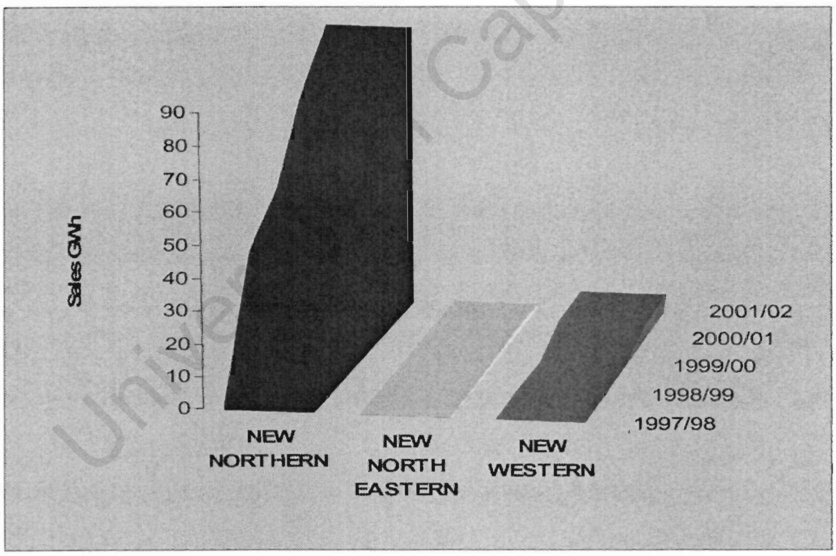

Figure 4.7. ICS Sales to the Newly Connected Centres[44]: 1997/98 – 2001/02

Source: - Derived from data collected from EEPCo (2004)

[44] This data also included the electricity sales of newly electrified areas within the regions (e.g. Northern region) but those areas are very small towns which are located close to the grid and their consumption is very low.

Because of an abrupt electricity consumption growth in the Northern region, particularly in 1998/99, the share of this region grew from 0.15% (2 GWh) in 1997/98 almost to 6% (87 GWh) in 2001/02, as a percentage of total ICS sales. This increased the ICS sales by 6%[45] in that period. During these five years the share of the Northern region has become even greater than the North Eastern and the North Western regions, which originally had more advanced urban centres and more large industries. The faster electricity demand growth in the Northern region is an indication of higher development activity in this region since connection to the ICS. In the first two years (1997/98 and 1998/99) for instance, this region did not have any industries from High Voltage industries tariff group, but after 1998/99, the electricity consumption of HV industries had grown from zero to 44 GWh/year by 2001/02. By contrast, the electricity consumption of HV industries in the North Eastern and North Western regions which had HV industries originally, has not shown any increases. In 2001/02, their HV electricity sales were 18 GWh and 15 GWh/year respectively, about one-third of the electricity consumption of the HV industries in the Northern region in the same year.

Table 4.10 shows the value of electricity consumption (in '000 ETB) of LMSMI firms in each of the administrative regional states[46], during 2001/02. The figures are derived from CSA LMSMI survey data (CSA, 2002). The table provides a breakdown according to the year in which the LMSMI firms were established. The electricity consumption (about 423 thousand ETB/year) of some firms, which did not provide their date of establishment, has been excluded from the table. It can be seen that in Tigray regional state, 82% of LMSMI electricity consumption (by value) is attributable to firms established in 1996 and 1997. This is quite different from any of the other regional states.

45 During this period (1997/98 to 2001/02) total ICS sales grew by 22% of which 6% came from the sales growth of the Northern region.

46 Note that the classification of areas here is according to the current political administrative classification (see the map in Appendix J). Nearly all the electricity of the Tigray regional state is supplied from the Northern regional branch centre. The Addis Ababa regional state is supplied by the Addis Ababa branch centre. However for the other regional states, one regional branch centre can provide electricity to more than one regional state and one regional state may be supplied by more than one branch centre.

Table 4.10. LMSMI Electricity consumption in value (in '000 ETB) by regional states 2001/02 (1994 EFY)

Date of establishment (EC)	Tigray	Amhara	Oromiya	S.N.N.P	Addis Ababa	Dire Dawa	Others*	Total	Date of establishment (GC)
Electricity consumption '000 ETB									
Before 1966	862	5,316	9,528	267	39,897	3,459	401	59,730	Before 1974
1967 - 1983	58	6,274	22,585	5,370	5,836	13	2692	42,829	1975 - 1991
1984 - 1987	506	674	1,647	1,549	3,714	21	4	8,115	1992 - 1995
1988 - 1989	6,859	265	2,609	680	3,064	1,253	10	14,740	1996- 1997
1990 - 1994	56	2,592	3,542	167	4,737	13	239	11,345	1998 - 2002
Total	8341	15121	39911	8033	57248	4759	3346	136759	Total
The share of electricity consumption									
Before 1966	10%	35%	24%	3%	70%	73%	0%	44%	Before 1974
1967 - 1983	1%	41%	57%	67%	10%	0%	12%	31%	1975 - 1991
1984 - 1987	6%	4%	4%	19%	6%	0%	80%	6%	1992 - 1995
1988 - 1989	82%	2%	7%	8%	5%	26%	0%	11%	1996- 1997
1990 - 1994	1%	17%	9%	2%	8%	0%	0%	8%	1998 - 2002
Total	100%	100%	100%	100%	100%	100%	100%	100%	Total

Source: - Derived from CSA LMSMI survey data (2002)

Furthermore, the Ethiopian Investment Authority report (2002) shows that during the last decade a number of new domestic investment projects took place in this regional state. It had a higher per capita investment level than other regional states including the Addis Ababa regional states. Between 1992 and 2002, for instance, 276 new domestic investment projects commenced, involving 3.7 billion ETB investment capital which accounted for 33% of the total domestic investment capital in all regional states. The highest share of investment in this regional state was in the manufacturing sector (55%), followed next by transport and services (22%) and construction (6%).

4.6.1.2 Electricity consumption growth by region

As shown earlier, electricity consumption grew considerably in 2001/02. In this year the electricity consumption in all regions showed an upward growth from 2000/01, but particularly in the Eastern and Northern regions. As shown in Table 4.11, the highest growth was in the Eastern region (41%) followed by the Northern region (21%). Although electricity consumption in the Addis Ababa region grew by a smaller percentage (16%), its share of total electricity sales was much greater (51%). As a result, this region contributed the highest percentage to the overall growth in electricity consumption in the ICS group. The Addis Ababa region contributed 54% of the overall consumption growth, followed next by the Eastern region (17%).

Table 4.11. ICS electricity sales growth rate by region: 1996/97 – 2001/02 (1989 – 1994 EFY)

REGION	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	CONTRIBUTION TO 2001/02 GROWTH (15%)
ADDIS ABABA	2%	-1%	-9%	5%	0%	16%	**54.00%**
CENTRAL	9%	23%	3%	0%	2%	6%	**7.30%**
EASTERN	-1%	7%	1%	1%	-4%	41%	**17.20%**
NORTH EASTERN	6%	-11%	12%	-8%	8%	3%	**0.70%**
OLD NORTH EASTERN	6%	-11%	11%	-9%	7%	3%	**0.70%**
NEW NORTH EASTERN			811%	30%	49%	5%	**0.02%**
NORTHERN			1921%	28%	41%	21%	**7.50%**
NORTH WESTERN	10%	2%	-3%	3%	10%	13%	**3.90%**
SOUTHERN	5%	-8%	10%	4%	1%	14%	**8.70%**
WESTERN	3%	26%	-11%	-10%	25%	6%	**0.70%**
OLD WESTERN	3%	26%	-11%	-20%	1%	3%	**0.26%**
NEW WESTERN					215%	14%	**0.47%**
TOTAL ICS SALES	**3.7%**	**2.6%**	**-0.3%**	**3.4%**	**2.7%**	**15.1%**	**100.00%**

Source: - Derived from data collected from EEPCo (2004).

Addis Ababa regional sales include electricity sales to the capital city of the country (Addis Ababa). A large number of domestic and commercial customers are situated here. Due to this the non-industrial sector in this region has consumed the majority of electricity out of the total electricity consumption in the ICS group. Non-industrial electricity consumers include domestic and commercial customers, street lighting and also "own" consumption. Table 4.12 shows that non-industrial electricity consumption has accounted for approximately 60% of total ICS sales, reaching 965 GWh/year in 2001/02. The analysis for 2001/02 shows that the Addis Ababa region in turn was responsible for 66% of the country's non-industrial electricity consumption. After Addis Ababa, the Central region came next with 10% of the country's non-industrial electricity consumption in 2001/02, while the share of other regions was small.

Non-industrial electricity consumption in the Addis Ababa regional also showed the highest rate of growth in 2001/02 (Table 4.12). This region accounted for 82% of the growth in non-industrial electricity consumption in the country's ICS, and for 45% of the total ICS sales growth between 2000/01 and 2001/02. The contribution of non-industrial sector electricity consumption growth in other regions was relatively insignificant; 8% in the Central region, and elsewhere 3% or less.

Table 4.12. Non-industrial sector electricity consumption/sales in the ICS 1997/98 – 2001/02 (1990 –1994 EFY)

REGIONAL BRANCH CENTRE	SALES/CONSUMPITION (GWh)					2001/02			CONTRIBUTION. TO 2001/02**	
	1997/98	1998/99	1999/00	2000/01	2001/02	Share	Growth from 2000/01 GWh		This Sector Growth	Total ICS sales growth
NON INDUSTRIAL SECTORS (domestic and commercial costumers, street light and own)										
ADDIS ABABA	508	510	535	538	632	66%	94	17%	82%	45.0%
CENTRAL	85	83	84	84	93	10%	9	11%	8%	4.3%
EASTERN	49	49	49	53	56	6%	2	6%	3%	1.4%
NORTH EASTERN	26	22	21	24	24	2%	0	0%	0%	0.0%
NORTHERN	2	28	31	38	40	4%	3	5%	2%	1.0%
NORTH WESTERN	30	30	31	36	39	4%	3	8%	3%	1.4%
SOUTHERN	56	56	57	58	62	6%	4	7%	3%	1.9%
WESTERN	15	14	14	18	19	2%	1	6%	1%	0.5%
TOTAL	**771**	**792**	**823**	**850**	**965**	**100%**	**115**	**14%**	**100%**	**55.0%**
SHARE OF THE TOTAL ICS SALES	**59 %**	**61 %**	**61 %**	**61 %**	**60 %**					

Source: Derived from data collected from EEPCo (2004).

** In this year, total ICS sales grew by 209 GWh/year, of which the ICS non-industrial sector sales contributed 115 GWh/year, which accounted for 55% of total ICS sales growth.

Table 4.13 shows total and regional ICS industrial sales (1997/98 to 2001/02). Industrial sector sales accounted for about 40% of the total ICS sales between 1997/98 and 2001/02 on average per year, of which the sales to the high voltage industry tariff group accounted for 21%. The remainder was supplied to low voltage customers. During this period, ICS sales to industrial customers in the Addis Ababa and Central regions, (favoured locations for business due to their better infrastructure and market), accounted for a major share. In 2001/02, these two regions accounted for about 57% of the country's industrial sector electricity consumption. As shown in same table, electricity sales to the industrial sector in the Eastern, Northern and Southern regions grew abruptly from 2000/01 to 2001/02, contributing a relatively large share to the growth in electricity consumption in that period. Particularly in the industrial sector of the Eastern region, the growth of electricity sales was relatively high, i.e. 16% for total ICS sales growth, and 36% electricity for total industrial sector growth

Table 4.13. **Industrial sector electricity consumption/sales in the ICS 1997/98 – 2001/02 (1990 – 1994 EFY)**

REGIONAL BRANCH CENTRE	SALES/CONSUMPITION (GWh)					2001/02			CONTRIBUTION. TO 2001/02**	
	1997/98	1998/99	1999/00	2000/01	2001/02	Share	Growth from 2000/01 GWh		This Sector Growth	Total ICS sales growth
ADDIS ABABA	173	166	172	167	187	30%	20	12%	21%	9.60%
CENTRAL	208	162	162	167	173	27%	6	4%	6%	2.90%
EASTERN	41	42	43	34	68	11%	34	100%	36%	16.30%
NORTH EASTERN	20	29	26	27	28	4%	1	4%	1%	0.50%
NORTHERN	0	13	22	36	49	8%	13	36%	14%	6.20%
NORTH WESTERN	30	27	27	28	33	5%	5	18%	5%	2.40%
SOUTHERN	56	67	71	72	87	14%	15	21%	16%	7.20%
WESTERN	12	8	6	6	7	1%	1	17%	1%	0.50%
TOTAL	**539**	**514**	**528**	**538**	**632**	**100%**	**94**	**17%**	**100%**	**45.00%**
SHARE OF THE TOTAL ICS SALES	**41 %**	**40 %**	**39 %**	**39 %**	**40 %**					

Source: - Derived from data collected from EEPCo (2004).

** In this year, total ICS sales grew at 209 GWh/year, of which ICS industrial sector sales contributed 94 GWh/year, which accounted for 45% of total ICS sales growth

Generally, the abrupt electricity consumption growth in the ICS group observed in 2001/02 resulted from a considerable electricity consumption growth among non-industrial customers and low voltage industry in Addis Ababa, and high voltage industry in the Eastern and Northern regions. The electricity demand growth in both the industrial and commercial sectors indicated improved development activities in these regions. In addition as shown in Table 4.14, the rapid demand growth in 2001/02 was not only due to growth in the number of customers in each tariff group, but more importantly an increase in per-customer consumption of the existing customers were added in 2001/02 in the ICS group. As illustrated in the same table, only five high voltage industry customers were added in 2001/02 in the ICS group. Based on previous trends, ICS HV industrial consumption growth was not expected to be more than 17 GWh/year but the actual consumption grew by 69 MWh, more than 4 times the expected demand growth. The difference between expected and actual HV industry consumption (52 GWh) was certainly influenced by an increase

Table 4.14. Actual and expected demand growth in 2001/02

Tariff group	Number of customers growth from 2000/01	Expected demand growth GWh/year	Actual consumption growth GWh/year	Per customer consumption MWh		
				2000/01	2001/02	Growth
Commercial	3938	17 - 19	52	4.4	4.8	0.4
Domestic	23466	26 - 30	59	1.0	1.1	0.1
LV Industry	68	2 – 2.5	25	34.9	37.8	2.9
HV Industry	5	14 - 17	69	2897.0	3447.0	550.0

Source : Derived from EEPCo data (2002)

in the per-customer consumption. of the existing HV industry customers. This was also true for the other customers. The per-consumption growth after capacity expansion in HEP in the ICS group (2001 and 2002) suggests that in the previous years the electricity demand could have been suppressed due to a combination of insufficient supply capacity and addition of new centres without ensuring electricity security in the ICS. In particular, the new centres' abrupt electricity demand growth after they transferred from the SCS to ICS could have suppressed the existing customers' demand to a greater extent.

In general three important points can be drawn from the above demand-side analysis.

- Firstly, in the ICS group the effects of tariff revisions were offset mainly due to the transfer of centres from the SCS to ICS. As a result, electricity consumption in the ICS group has showed a positive growth since 1992/93, except for a slight decrease in 1998/99 due to the tariff revisions undertaken in 1994, 1997 and 1998 (when the Ethio-Eritrea war could have had an additional impact).
- Secondly, the electricity demand of the newly connected centres in the ICS group grew by a faster rate than the existing centres. Previously, their development activities could have been retarded and their electricity demand suppressed due to the limited capacity of the SCS.
- Thirdly, the abrupt demand growth in the ICS group in 2001/02, after the expansion of the capacity of HEP in this group indicated that the existing ICS customers' electricity demand had been seemingly suppressed in the previous years (1997/96 - 2000/01).

4.7 CONCLUSION

In summary, from the above-observed results, the Ethiopian power supply has depended predominantly on hydro-power, particularly in the ICS. Almost 98% of the country's electricity demand has been met by the HEP plants. By the end of 2003, the ICS had seven HEP and 10 diesel power plants and one geothermal power plant. Most of these plants are very old which could possibly reduce their electricity production compared with their design capacity. In particular, the age of most of the diesel power plants is more than or nearly equal to their economic lifetime. However their contribution to overall electricity production was in any case rather negligible compared with hydro generation.

In the ICS group between 1992/93 and 2001/02, the contribution of HEP plants to the electricity production lay between 98.32% and 99.99%. However, in the same period their share of installed capacity share had dropped to 92.7%. The electricity production from this source grew continuously at an average annual rate of 6% between 1992/93 and 2001/02. Electricity from other sources, diesel and geothermal, did not show any significant increases; rather geothermal production decreased sharply after 1999/00, mainly due to technical problems. A decline in diesel power plant production was noticed in the same period. There was an apparent increase in installed diesel generation capacity, between 1996/97 and 1999/00, of 22.2 MW within the ICS. However this was largely due to the incorporation of old plants from the SCS. The actual addition of new capacity was only 0.7MW.

Although electricity production from HEP has rapidly increased during the 1990s, the investment in hydro-power has been stagnated since 1988, except for slight improvement works which were carried out on the existing power plants in 1996. Due to the high pressure on existing old HEP plants and very low investment in the industry, the gap between the actual electricity production and estimated average energy capability of the power plants became increasingly narrow. In this decade, the reserve capacity in the ICS fell below half the recommended rate of reserve (20%). By the end of the 1990s the reserve rate had fallen as low as 4%.

In spite of the stagnated investment in the ICS group since 1988, electricity consumption in this group grew at an average rate of 5.7% per year between 1992/93 and 2001/02 due to new connections, the electrification of new areas and the incorporation of former SCS centers to the ICS. The transfer of loads from the

SCS to the ICS in particular could have resulted in the upward demand growth in spite of certain factors which impeded demand growth during this period, e.g. tariff revisions (in 1994, 1997 and 1998), the Ethio-Eritrea war and drought.

Mainly as a result of slight capacity improvements in the ICS group in 2001 and 2002, there was considerable ICS electricity consumption growth (15%) in 2001/02. A higher electricity consumption growth among commercial customers and low voltage industry in Addis Ababa, and high voltage industry in the Eastern and Northern regions, contributed the main parts of this growth. The rapid demand growth in 2001/02 was not only due to growth in the number of customers in each tariff group, but more importantly an increase in per-customer consumption of existing customers. The higher electricity sales per customer (higher energy intensity) is partly an indication of better economic development, particularly for a country like Ethiopia which starts which start from a low level of development and follows Agricultural Development-Led Industrialisation strategies. Unless the economy is adversely affected by unexpected drought, or war, or other problems, such growth could enable the country to develop and expand the economy further, both in agricultural and industrial sectors, which in turn would lead to a higher electricity demand.

Unless the capacity of the electricity industry is improved to meet the growing demand, or electricity consumption is modified, using measures such as tariff revisions (as done in previous years) the noticeable per customer electricity consumption growth that was observed in 2001/02 can create an increasingly challenging situation for the ICS electricity supply capacity, leading to power shortages.

As a result of very low reserve capacity and prolonged droughts coupled with ever-growing electricity demand, the country has repeatedly faced power shortage problems since 1995; there was a particularly severe power shortage in 2002/03. A more detailed analysis of the causes of these power shortages in the country is provided in the next chapter (Chapter 5), while the impacts of power outages on the LMSMI sector will be examined in Chapter 7.

CHAPTER 5

ELECTRICITY SHORTAGE

5.1 OBJECTIVE AND SCOPE

The major objective of this chapter is to investigate the main causes of the power shortages in Ethiopia since 1995, by utilizing the findings of the analysis presented in Chapter 4 and the data obtained from different sources, such as the Ethiopian Electric Power Corporation and Ethiopian Investment Authority. In addition, this chapter will investigate the major bottlenecks in power development in the country from the days of Imperial government to the present. Information obtained from different sources (e.g. newspaper, journals, interviews, and reports) written mainly on the politics of the Nile River, will also be explored and discussed in this chapter.

The main scope of this sector analysis and discussion is the status of the country's electricity supply and demand, particularly since 1995 when power shedding was first introduced in the country due to power shortages. However, because of the lingering effects of past electricity supply decisions, the time scale of the analysis will go back further than the year of the first power-shedding measures (in 1995), to consider relevant developments from the 1950s onwards, during the periods of Imperial and Marxist government in Ethiopia. The chapter will first look at the electricity supply and demand condition at the utility level, before widening its perspective to include the governance of the country in relation to the electricity industry and related issues. Finally, this chapter will examine the impact that sharing the Nile River with neighbouring countries (specifically Egypt) has for the development of Ethiopia's electricity supply.

5.2 LIMITATIONS OF DATA AND ANALYSIS

A major challenge in conducting this analysis was to obtain detailed and reliable information about the real causes of Ethiopia's electricity supply problems (in addition to the problems caused by the drought), either from the utility's staff or from other documented sources. There are virtually no written documents recording detailed information about the condition of the country's electricity supply, and particularly not about government decisions. This is despite the fact that the figures clearly show that there have been other causes for the problems, apart from the drought. For example, it was impossible to obtain information about why and how certain hydroelectric power projects had been selected, even though there had been other, less costly projects on the list.

The investigation found that lack of right to develop any hydraulic development in the Nile Basin [part of the Ethiopian share][47] and the blocking of the country's financial requests by the Egyptian government were partly responsible for slowing down the hydroelectric development in the Nile River Basin. Nonetheless, almost none of the available documents written on the electricity shortage have revealed these two major obstacles. They are only mentioned in the literature and news written about the politics of the Nile River – most of which were written by foreign news agencies and foreigners.

5.3 INFORMATION USED

This chapter consists of two main sections, i.e. the electricity shortages in the country and their causes. The aims of the first section are to show the degree and

[47] There have been a number of treaties on the usage of Nile water since 1919. Ten African countries share this river, the longest in the world (Ilomäk, 2000: Chapter 3: Agreements and treaties over Nile's water). Nearly all were designed to give power to Egypt to use the water from the Nile River aggressively, by systematically excluding the other riparian countries from the agreement (Ethiopia was one of them). Of them the main known treaties are the Anglo-Egyptian accord in 1946 and later when Egypt included Sudan in 1956. The former (Anglo-Egypt) agreement gave Egypt the right to veto any large-scale utilization of the Nile waters by other states that could affect the level of the Nile water in Egypt. The treaty was further complemented in 1959 by an agreement between Egypt and the Sudan. Under that deal, Egypt was guaranteed the right to 55 billion cubic meters of water annually of the Nile's estimated annual allotment of 83 billion cubic meters, while 18 billion cubic meters would belong to the Sudan. Given the terms of these treaties, Egypt to this day considers itself to be in charge of the Nile River, controlling any decision making in respect of any development on the Nile. They have regarded the use of the Nile water as their natural right. (See Ilomäk's publication to get information on other previous treaties; for further clarifications on the two treaties mentioned above, see http://www.water.hut.fi/wr/research/ glob/pubications/ Ilomaki/chapters1-8/ch3_niili.html).

frequency of power shortages in the different drought years from 1995 to the present. In this regard, four important variables obtained from the utility are used, namely:

- average power deficit per day,
- duration of interruption per day and year,
- number of load shedding days per week, and
- the causes of the load shedding.

In addition, further analysis is done to investigate other possible causes of the electricity shortages (other than those put forward by the utility itself), by taking into consideration all facts presented in the following section and in Chapter Four, namely:

- electricity supply capability,
- electricity demand trends,
- drought conditions,
- financial problems,
- governance in relation to the electricity industry, etc.

5.4 ELECTRICITY SHORTAGES

There have been many notable droughts in Ethiopia throughout human history (Tsegay 1997: ENSO and Ethiopian Droughts)[48] (Appendix H). These have caused the death of over a million people in the country (in 1888, 1973/74, and 1982) and

48 Previous droughts (happened between 1988 and 1998) and the frequency of rainfall deviation from the average suggest that droughts occur in Northern Ethiopia every 3-5 or 6-8 years and in the whole country every 8-10 years (Tsegay 1997:ENSO and Ethiopian Drought). Many researchers currently believe that the drought in Southern Africa and in the so-called Horn of Africa (i.e. Ethiopia, Eritrea) is caused by El Niño-Southern Oscillation (ENSO) events (the detailed explanation of this event was presented in the Introduction Chapter). As Tsegay pointed out, there is a remarkable correspondence between annual rainfall in Ethiopia and ENSO events (1997:ENSO and Ethiopian Drought) (See also Appendix H).

an agricultural crisis throughout Ethiopia.[49] These different droughts have moreover devastated the nation's economy. In recent time their effects have not been limited to agriculture alone, but droughts have also affected the country's electricity supply and posed many challenges to the industry since 1995, mainly due to reduced investments in the industry from 1988 and the government's sluggish responses. Lack of finance from International Financial Institutions (IFI), such as the International Monetary Fund (IMF) and the World Bank (WB), for instance, in support of hydropower projects in the Nile River Basin have also been identified in the literature on the topic as causes for the current bad state of the electricity supply industry in the country (Tesfaye 2000). As a result, the country's predominantly hydroelectricity-based electricity supply has failed to meet the increasing demands for electricity in the various drought episodes.[50] This, in turn, has further damaged the economy of the country.

5.5 BACKGROUND INFORMATION

Although, as stated in the literature, the country has a long history of rainfall variability both in space and time, electricity shortages have been happening since 1995. This has been mainly attributed to the low level of water inflow into the dams, both in the *"Belg"* season (March-June) and the rainy season *("Keremt")* (July-September), during the prolonged droughts. This has particularly affected electricity production by the Melka-Wakana and Koka power plants. In some years, the water level in the biggest hydroelectric plant, viz. the Melka-Wakana dam (153 MW), dropped by about half, which similarly reduced energy production from this hydroelectric plant. Electricity production from this power plant had previously met about 30% of the country's electricity demand, before the construction of Tis Abay II

49 In 1888, about one-third of the population died because of famine, and ninety percent of the animals perished due to the rinderpest infestation and the drought (Tsegay 1997). The 1972/73 drought led to the Wollo famine, during which about 200 000 people died. Most recently, the 1983-84 drought took the lives of an estimated one million people, destroyed crops, contributed to the death of animals, and threatened the lives of millions of people with starvation.

50 There was a severe power shortage in the specific drought years, but these power shortages have occurred in most years since 1995. This information was not announced officially, but obtained by interviewing workers at the utility.

(73 MW) and Finchaa Unit Four (28 MW) in 2001 and 2003 respectively (see Table 5.2).

Table 5.1. Power plant installed capacity and average energy capability (ICS): 2002

Power plant[Note 1]	Installed capacity (MW)	Dependable Capacity MW	Average energy capability (GWh/yr)	Year of Commencement
Koka	43.2	38.4	110.0	1960
Awash II	32.0	32.0	165.0	1966
Awash III	32.0	32.0	165.0	1971
Finchaa	100.0	100.0	660.0	1973
Melka-Wakana	153.0	153.0	543.0	1988
Tis Abay I	12.0	12.0	85.0	1964
Tis Abay II	73.0	68.0	359.0[Note 3]	2001
ICS Diesel	7.5	7.2	-	1958-1995
Aluto Geothermal	7.3	1.0	-	1999
Total [Note 2]	**460.0**	**443.6**	**1,849.0**	
After Finchaa unit four & Reh.w		**479.0**	**2006.0**	
Gilgel Gibe	192			Commenced at the beginning of 2004

Sources: EEPCo (2002: EEPCo in brief); Acres International (2003a); [1] Solomon (1998: Table 4).

Notes:

1. The hydro plants Koka and, Awash I and II are situated in Awash River Basin, Melka-Wakana in Wabi-Shebelle River Basin, and Tis Abay I, II and Fichcaa in Abay River Basin (Blue Nile). The location of the hydro plants in Awash and Wabi-Shebelle River Basins is lowland where frequent drought happen. Abay River is located in the Ethiopian highlands where the rainfall performance is very good. As a result the water level in the dams of power plants in this area does not usually vary that much (See Table 5.11 & Figure 5.4).
2. The total is not equal to the sum of the average energy capability. This figure is directly taken from Acres report, which did not consider the exact value of Tis Abay II's average energy capability. In their case its value was 121 GWh/year
3. Tis Abay II average energy capability could be greater than this; 359 GWh/year is firm energy capability.

.Table 5.2 Electricity production and peak demand from hydropower plants 1996/97 & 2001/02 (1989 & 1994 EFY).

Power plant	Installed capacity MW	Production(GWh) 1996/97	2001/02	Plant Peak MW[Note 1] 1996/97	2001/02
Koka	43.2	129	91	33	34
Awash II	32.0	159	117	28	30
Awash III	32.0	183	108	30	32
Finchaa[2]	100.0	624	756	98	103
Melka-Wakana	153.0	436	347	125	153
Tis Abay I	12.0	19	47	3.57	11.85
Tis Abay II[Note 2]	73.0		508		73.30
Total	**417.2**	**1550**	**1974**	**317.57**	**437.15**

Source: - Derived from EEPCo (1997; 2002: EEPCo in brief)

Notes:

1. Peak demand does not reflect the actual demand for electricity, as there may have been further suppressed demand.
2. Tis Abay II commenced in 2001. In 2001/02, the electricity production from this HEP accounted for 25% of the ICS production, contributing 34% to the growth of electricity supply in this group in this year from previous year (i.e. 2000/01). Its installed capacity, however, only accounted for 15% of the total installed capacity from all the ICS power plants in the same year

5.5.1 The power shortage in 1995/96

Table 5.3 summarises the power shortages in the country from 1995/96 to 2002/03. As illustrated in this Table, in 1995/96 due to the low level of water inflow to the Melka - Wakana and Koka dams during the rainy season, the level of the water in these two dams was reduced by 38% and 26%, respectively. Consequently, the average power production from these two power plants to meet the prevailing electricity demand decreased by 21 MW, reducing the daily energy production by approximately 504 MWh. This forced the utility to introduce its first power-rationing scheme from 24 December 1995 to 14 January 1996, and again from 29 February 1996 to 16 June 1996, for a total of 132 days. During these two periods, the electricity supply was interrupted for 13 hours, one day per week. This power rationing scheme applied in each area in the country.

5.5.2 The power shortage in 1997/98

A similar power shortage happened two years later, in 1997/98. It was shorter than the previous one, with power shedding only lasting for 76 days, and it was less severe, with the average power shortage per day being only 8.5 MW.

5.5.3 The power shortage in 1999/2000

The third power shortage, which took place in 1999/2000, was much worse than the first two, despite the fact that the water level in Melka-Wakana's dam was only slightly lower than that of 1997/98.

As indicated in Chapter 4, since 1988 there had been no significant investment to improve the capacity of the electricity supply. At the same time, though, since then until 1999/2000, the ICS electricity demand had grown by more than 60%, progressively increasingly the pressure on the Melka-Wakana power plant over this period. The power requirement from this plant grew by above 16 MW from 1997/98 to 1990/2000. Because of the dam's location, water inflow into the hydroelectric power dam is easily affected by recurrent droughts (and even by only slight rainfall variations). The *"Belg"* season drought in 1999/2000 thus resulted in the highest power deficit between 16 June and 31 July (during these period the average power deficit per day reached about 35 MW). Consequently, the power shortage for this year was extended to the rainy season, which had not happened before in the country.

5.5.4 The power shortage in 2002/03

The energy shortages that had happened frequently every two years since 1995 did not re-occur in 2001/02. In this year, good rainfall and improved electricity supply (the result of expanding and extending HEP by building one new power plant with installed capacity of 73 MW) increased and stabilised the electricity supply within the country. As indicated in Chapter 4, an abrupt growth of 15% in electricity demand was noticed in 2001/02.[51]

Unfortunately, however, this positive situation in the electricity supply of the country did not last more than a year. In 2002/03, the country suffered severe energy deficiencies with widespread power cuts over an extended period. This was much worse than any of the previous periods. According to Table 5.3, the average power deficit per day in 2002/03 was as great as the one in either 1995/96 or 1999/2000.

[51] As stated in the same chapter, after the ceasefire agreement in 2000 between Ethiopia and Eritrea, the economy, that had retarded due to the war, recovered. This and a good rainfall condition resulted in a good economic performance in 2001/02 which could have definitely contributed to the abrupt electricity demand growth in this year.

Table 5.3. Electricity shortage summary: 1995/96 – 2002/03 (1988 – 1995 EFY)

Year	Load shedding period		Causes for the Load Shedding	System power demand	Average power required	Possible extractable power	Average power deficit per day	Average power saved during the load shedding period	Duration of interruptions/day (hours per day)	Load shedding no. of days per week and year
	From	To		MW						
1995/96	Dec 24 Feb 29	Jan 14 Jun 17	Due to less water stored at Koka and Melka-Wakana dams during the rainy season and *"Belg"*	176.0	86.0	65.0	21.0	38.77	13	One 132
1997/98	Oct. 6	Dec. 20	Due to less water stored at Koka and Melka-.Wakana dams during the rainy season	186.0	77.0	68.5	8.5	15.69	13	One 76
1999/00	Mar 24	May 10	Reduced "Belg" inflow to Melka .Wakana and Koka Dams	203.0	98	75	23.0	42.51	13	One 48
	Jun 16	Jul 31	Low rainfall in May	203.0	95.4	70.4	34.6	60.0	13	46
2002/03				Area affected		Duration				
	Dec 07	Dec 09	Maintenance	Addis Ababa & Regional SS		08:00 – 18:00	10.0	24.0	10	One 3
	Dec 09	Jan 26	Decrement of the water level in the dams	Addis Ababa & Regional SS		08:00– 18:00	10.0	24.0	10	One 48
	Jan 27	Feb 07		Regional substation		08:00: – 18:00	5.0	12.0	10	One 12
	Feb 08	May 22		Addis Ababa & Regional SS		08:00 – 21:00	15.0	27.69	11	One 104
	May 23	Jun 05		Addis Ababa Regional SS		08:00 – 19:00 06:00 – 22:00	20.0 20.0	25.16 36.92	11 16	Two 14
	Jun 06	Jun 30		Addis Ababa & Regional SS		06:00 – 22:00	30.0	51.42	16	Two 25
	Jul 01	Jul 07		Addis Ababa & Regional SS		06:00 – 20:00	20.0	30.77	14	One 7

Source: Data collected from EEPCo (2004)

Note: SS is Sub-Station (outside Addis Ababa region.)

Nonetheless, an abrupt increase in electricity demand[52] in the previous year of 15% had also markedly increased the country's dependence on the existing power plants. In order to save energy, thus, the number of hours per day on which the supply was interrupted (in particular after 23 May) was increased by 3 hours. For example, from 23 May to 30 June, the power shedding lasted almost the entire day (16 hours/day).

In addition, since the drought lasted almost the entire year, the average power shortage per day had also increased since 23 May 2003, reaching 30 MW in June 2003. During these months, to save the country from a total blackout, the utility increased the frequency of power rationing from one day to two days per week. In general, as the result of a combination of other factors and drought, in this year, there was power shedding for about 7 months.

To summarise, then, the main differences between the electricity supply shortages in 2002/03 compared with the other electricity shortage years were as follows:

- There was a continuous electricity shortage, which lasted about 7 months (from 07 December 2002 to 07 July 2003 (213 days)).
- The power was interrupted for longer hours every day (14 hours and, in the worst months, 16 hours per day).
- After 23 May until the end of June 2003, the power rationing was increased from one to two days per week.

Although both the government and the utility have blamed the drought as being the main cause of electricity shortages in the country (IRIN new online 2003; WIC 2001), it is my contention in this thesis, that this was not in fact the major factor. Rather, the variability of rainfall was the exacerbating factor. In fact, according to a recent study by Meze-Hausken (2004) of the major drought-prone area in the country and Conway's study (cited by Meze-Hausken 2004) of similar areas, showed that the annual rainfall in these areas had not declined significantly. It is true that, as indicated in Meze-Hausken's study, there have been rainfall variations throughout the country's history, and that, in some years, there was very low rainfall in the rainy and "Belg" seasons (e.g. 2002). However, based on her findings, between 1964 and 2002, only the 1984 rainfall would be classified as below average rainfall (2004:27). The same study analysis showed that 2002 was a

[52] In this year, electricity consumption increased by 21% from the 1999/2000 consumption.

year with normal rainfall, although "the people in the North Afar zone considered 2002 as the worst drought year in human memory, even worse than 1984-85 due to the combination of high loss of animals and yield. The media declared 2002 as a devastating drought year, due to the huge amounts of food aid needed" (2004:28).

In the same climate research paper, Conway (cited by Meze-Hausken 2004: 28) states that, "studies of Northern Ethiopia have shown no specific change in climate, including rainfall, during the last four decades."

However, any deviation from normal rainfall timing might have adverse effects on the agricultural activities of the country's subsistence farmers, which are highly correlated with rainfall. However, if variations in the timing of the rainfall were put forward as a major cause for power shortage in the country, this would be misleading. Overall the country gets considerable high rainfall every year and has a number of big rivers with a huge hydroelectric power potential, of which only 2% has been harnessed.

As the country has a huge untapped and economically viable hydroelectric power potential that is immune to significant rainfall variations, the perceived drought theoretically has little to do with the country's electricity shortages since 1995. Instead, other causes such as very low investment in the electricity industry (particularly during the 1990s), financial problems, and poor governance and planning, should be seen as the more significant causes of the problem. A brief discussion of these causes will be presented in the next subsection.

5.6 OTHER CAUSES OF ELECTRICITY SHORTAGE

5.6.1 Low investment in the electricity industry versus growth in demand

If a country's electricity supply is predominantly based on hydroelectricity, then, to ensure energy security, the reserve capacity should be reasonably high. Otherwise, unless the electricity supply can be supplemented by using other non-seasonal fuels (e.g. diesel and geothermal power), even a slight rainfall variation may lead to power shortages, as experienced in 1995/96, 1997/98, 1999/2000 and 2002/03. As experience has shown, developing a large-scale hydroelectric plant requires a huge investment, long construction periods and a careful feasibility study. In the majority of cases, it may take 5 to 7 years for construction alone; this could be even longer, depending on the availability of finance and the financing capacity of the country.

5.6.1.1 The power shortage in 1995/96

As illustrated in Chapter 4 (page 46), due to very low investments in the electricity industry during the 1990s, the gap between actual production and potential energy production from the existing power plants became very narrow. Moreover, since 1994/95, this gap became even less than the recommended rate of reserve capacity (20%). In short, the dependency on existing power plants with limited reserve production capacity has become progressively higher, putting electricity supply in the country at a higher risk. In addition, in 1994/95, as pointed out in Chapter 4 (page 55), relatively large loads (the biggest load being Bahir Dar in 1995[53]) were transferred from the SCS group to the ICS group, raising electricity consumption by 4% from the normal growth rate.

In the following year (1995/96), a higher electricity demand growth coupled with no investment in the supply side reduced the gap even more to 13%[54]. This was much less than the recommended reserve amount, and put the electricity supply at an even higher risk. Any unfavourable conditions that might decrease electricity production would thus easily create imbalances between electricity demand and supply.

As a matter of fact, in 1995/96, as mentioned earlier, the water level of the largest Melka-Wakana and Koka hydroelectric power plants dropped by approximately 38% and 26% respectively, reducing the possible electricity production from these two power plants by the same rate. In this year, although the energy required to meet the prevailing demand was lower than the possible production from these two power plants, the remaining small reserve generation capacity was easily cancelled out by a slight variation in rainfall, resulting in lower water inflows into the dams after the rainy season of that year. Ultimately, this situation created an imbalance between

[53] Bahir-Dar is one of the most advanced cities in Ethiopia, with a relatively high number of large- and medium-scale industries. This sector alone consumed about 20 GWh/year of electricity in 1995/96.

[54] 1995/96 is the first year in which the power rationing scheme was introduced due to power shortages (see the above illustrations on 76).

electricity supply and demand, forcing the utility for the first time in the country to implement power shedding.

Paradoxically, even without transferring load from the SCS to the ICS group, it was imperative to expand and increase power generation to meet (albeit barely) the existing customer demand of the ICS group. For instance, the Acres country's power system expansion master plan study in 1995 also clearly indicated that unless expansion were undertaken in the electricity industry starting 1995, severe power shortages would occur in the coming years (cited in Acres International 2003b). However, without any significant changes in the supply side, a huge load, particularly from an advanced city such as Bahir Dar, was added to the ICS group. In 1995/96, the electricity consumption in Bahir Dar was about 40 GWh/year, which was approximately 3% of total ICS electricity sales in that year; and the daily average electricity consumption in this area alone was approximately equal to 22% of the average energy shortage per day in that year.

5.6.1.2 The power shortage in 1997/98

Although there had been no significant improvements in capacity since 1995/96, the drought in 1997/98 did not lead to significant electricity shortages. This was mainly because the tariff revisions undertaken both in 1997 and 1998 slowed down the growth in electricity demand in the corresponding years, resulting in only 6% electricity consumption growth between 1995/96 and 1997/98. (Normally, the expected growth is approximately 10% per two years.)

5.6.1.3 The power shortage in 1999/2000

Surprisingly, as shown in Chapter 4, again in 1998/99, relatively big loads of more than 40 GWh/year were transferred from the SCS to the ICS group without any significant supply-side capacity expansions[55] (Chapter 4: 54: Table 4.6). In addition, in 1999/00, two large manufacturing industries commenced in these newly added areas (non-metallic minerals in Mekele, and textiles in Adaw) (EIA 2002). Due to their size, a large amount of electricity was required for these industries, particularly

[55] Electricity consumption was calculated based on their consumption in 1998/99. However, experience has shown that the electricity consumption of former SCS centres would most likely grow rapidly after they had been added to the ICS group. The majority of the loads were from Mekele and Adaw cities in the Northern regional branch centre.

to run the power-intensive non-metallic mineral processes in Mekele city (see next Chapter 6).

As illustrated in the previous chapter (page 47), the capacity of the diesel power plants in the ICS group had increased slightly from 1998/99 to 1999/2000, increasing electricity production from this source by 3 GWh/year. This additional production in the ICS group was, however, insignificant when compared to the added load in 1998/99. For instance, in 1999/2000, the electricity consumption of the new centres that had been transferred in 1998/99, increased by 12 GWh/year from 1998/99, nearly four times more than the additional electricity production by diesel power plants in the same year.

In 1999/00, the new centres' electricity consumption alone reached more than 52 GWh/year. Leaving aside the Northern region's electricity consumption, the additional production from the diesel power could not even have met the electricity consumption of the other relatively small cities that had been added into the ICS group since 1997. In general, the total electricity production in 1999/00 from diesel power plants, including the existing ones in this group, met only a very small portion of the energy requirement of the newly added centres (i.e., only about 8%). The remaining demand, thus, had to be met by the existing HEP plants in the ICS.

In spite of the sudden growth in electricity consumption in the newly added areas, however, the total electricity consumption of the ICS grew by only 3% in 1999/2000 from 1998/99. This growth rate is very low compared to the normal growth in electricity demand. According to previous trends, and 25-year electricity supply forecasts for Ethiopian power system expansion in Acres' Master Plan study (2003b: Table 4.9: Forecast summary by tariff category) electricity demand normally grew between 5% and 8% per year. Two prominent factors can be seen as main causes for this lower demand growth: the Ethiopian-Eritrean border war which erupted in May 1998, and the tariff revisions which were undertaken in two consecutive years (1997 & 1998). Despite this lower growth in electricity consumption, however, the energy that would be required from the Melka-Wakana power plant grew by 42% from 1997/98.

As pointed out earlier, the drought in 1999/2000 was more prolonged. In addition, as of December 1999 about 64 MW of generation was out of service for rehabilitation (i.e., at Koka, Finchaa, Awash and Tis Abay I) (Acres International 2000). As a result, the power deficit in this year (in "Belg" season) reached approximately four times more than the power deficits in 1997/98 (see Table 5.3 above). These shortage amounts would certainly have been even more substantial if there had not been a war, and if the government had not undertaken tariff revisions.

In general, while the electricity consumption of the ICS group grew by about 60% between 1988 and 2000, the generation capacity in this group expanded by a mere 3%. The 2000 Acres power system expansion master plan study pointed out that the main factor for the rapid growth in electricity demand in the ICS group during this decade was the earlier extensions and additions of new centres to the ICS group (e.g., under the Northern electrification program[56], Bahar Dar and Mekele cities).

5.6.1.4 The power shortage in 2002/03

In 2000/01 and 2001/02, after the war ceased[57], the economy showed a better performance, assisted by good rainfall conditions, particularly in 2001. Furthermore, within these two years, as stated earlier, the capacity of the ICS group increased because of the completion of various improvement activities that had been undertaken since 1998, such as rehabilitation work on the existing hydropower plants, the addition of one power plant (73 MW) and the installation of the last unit of Finchaa with 34 MW installed capacity. These expansion and extension works raised the dependable capacity by 103 MW (about 28%) in 2002 (including the rehabilitation work on HEP), an increase from 375.6 MW in 2000 to 479 MW in 2002 (see Table 5.1). As pointed out above, this situation created favourable conditions to improve the electricity supply within the country, which in turn, coupled with good economic performance, boosted electricity demand in the country.

As a result, in 2001/02, the electricity consumption of the ICS group suddenly grew by 15%, resulting in an increase in electricity consumption from 1389 GWh in 2000/01 to 1597 GWh in 2001/02. Electricity consumption from 2000/01 to 2001/02 increased by 208 GWh (see Chapter 4: 54:Table 4.6). The actual electricity consumption was thus even 77 GWh/year more than what Acres had forecast. Based on this trend, electricity demand in the following year would most likely be even greater than had been forecast.

56 The Northern electrification program includes the Northern, North Eastern and Western parts of Ethiopia.

57 On 18 June 2000, the ceasefire agreement in Algiers was signed by both parties. They undertook to "permanently terminate military hostilities between themselves" (UNMEE 2004: Background).

Based on the trends forecast by Acres in 2002/03 the electricity demand of the ICS group had been estimated to grow by 7 – 8% (because they expected that some centres would be transferred from the SCS group to the ICS group) (Acres International 2003b). Without transfers from the SCS, the growth rate would normally be in the range of 5% to 6% per year.

Based on the above, three electricity demand growth scenarios could have been considered for 2002/03. The best-case scenario, if everything developed according to the scheduled plan, would imply about 7.5% growth. The normal case scenario, i.e. normal growth with no centres being transferred from the SCS group, would be 5.5%, and the worst-case scenario would be a very low growth of about 3%.

As shown in Table 5.4, in the former two cases, there might have been unserved energy (see Chapter 3: 40: in the footnote for the further explanation of unserved energy). In the best-case scenario, this would have been about 46 GWh/year, and in the normal case, 8 GWh/year. Therefore, using the existing ICS group's power plants alone in both of these cases, electricity shortages would most likely have happened, even if no drought occurred.

The Acres 2003 power system expansion master plan report also indicated that "the risk of energy shortages in the case of poor hydrologic conditions will, however, remain until completion of the Gilgel Gibe development" (2003b: 10-8). Despite the fact that the utility thus knew about the problem and even though it knew that Gilgel Gibe would not be completed before 2003, no mitigation measures were taken in advance. The only step was to construct the emergency diesel power plants (9 MW) at the end of the Ethiopian fiscal year (which is at the beginning of July), which was too late to address the problem.

Table 5.4. Estimated unserved energy, using the three electricity demand growth scenarios: 2002/03

SCENARIOS	2002/03	2002/03 (ESTIMATED) GWh/YEAR		
	Estimated average energy capability (GWh/year)[1]	Additional demand	Total demand	Unserved energy
Best-case scenario (according to the plan) (7.5% growth)	2079	148	2125	46
Normal growth , with no new SCS connections (5.5% growth)	2079	109	2086	7
Worst-case scenario, very low growth (3% growth)	2079	59	2036	-43

Source:-Derived from 2001/02 electricity production (1977GW) from EEPCo (2002); Acres International: (2003b: Table 10.1 (c))

1. Includes existing Diesel (until 2003) and Geothermal (rehabilitated). This figure could be lower depending on the rehabilitation stage of geothermal power plants in 2003.

Another interesting figure is shown in Table 5.5. The electricity generation in 2003 from HEP was expected to be 2007.6 GWh, according to the Acres forecast, and the actual electricity production from this source in 2002/03 (2007 GWh) was almost equal to this. It should be borne in mind, however, that the electricity production in 2002/03 included six months' production in 2002 (July to December), which would obviously reduce the expected HEP production.

Table 5.5. Actual and forecast electricity production (ICS): 2001 - 2003

Hydro plant	Actual production (GWh/yr)		Target forecast[Note 1] production GWh/year	
	2001/02[1]	2002/03	2002	2003
Hydro	1976.0	2007.1	1897.0	2007.6
Thermal	0.1	21.1	4.1	5.8
Geothermal	1.0	0.0	6.8	49.1
Total	**1977.1**	**2028.2**	**1908.4**	**2062.5**
Forecast[Note 2]	1849.0	1998.0	1911.0	2065.0
Unserved energy			2.6	2.5

Source: - Derived from EEPCo data (2004: EEPCo in brief) and Acres International (2003a).

Notes:

1. 2001/02 includes months from July/2001 to June/2002, and the same is true for 2002/03.
2. This was expected production, as forecast by Acres International.

Instead, as seen in the same table, it seems that the utility expected more electricity production from the geothermal power plant in 2003. If the rehabilitation work on the geothermal plant had been completed at the beginning of 2003, production in 2002/03 from this could have been 6.8 GWh to 49 GWh. In this year, however, as stated in Chapter 4 (page 48), there was no production from the geothermal power plant due to technical reasons. In any event, even if the electricity production in 2002/03 had been equal to the forecast geothermal production for 2003, at 49 GWh/year, there would still have been unserved energy (more than 2.5 GWh/year), according to Acres' international estimates (2003b).

As stated earlier, although the earlier completion of Gigel Gibe was indicated by Acres as crucial to overcoming electricity shortages in 2002/03, delays in rehabilitating the geothermal plant exacerbated the problem. Electricity production from this source could have reduced the electricity shortage by an estimated 15% or more, depending on the condition of the rehabilitation stage.

In summary, then, the following can be regarded as the main causes of the electricity problem in 2002/03:

- An abrupt growth in electricity demand occurred in 2001/02 (15%).
- There were further delays in completing the Gilgel Gibe power plant. (For instance, the most recent report of Acres in 2003 indicated that it was only expected to be commissioned by mid-2003. Finally it was completed in 2004).
- No electricity production from the geothermal power plant was expected, due to delays in rehabilitation work.

5.6.2 Government decisions and HEP development

The Ethiopian energy sector has a history of poor governance[58], with an apparent lack of clear objectives and of a legal and regulatory framework, and with vaguely defined policy-making, ownership and operational activities (Jones 2001: Energy sector overview: Sector reform). Until recently, the country has not even had a separate energy policy (the first energy policy was only formulated in 1994). This has hindered the growth of the country's electricity supply. The current very low per capita electricity consumption, the lowest in Sub-Saharan Africa, can be seen in part as one of the results of this unclear governance.

The lingering effects of this are also reflected in bad decision-making, which has resulted in non-effective power development. In the past and in the majority of the cases, the development of power projects had been done without looking more deeply at the country's development stage and potentially available resources. The government had commonly played an influential role in the decision-making processes (IEO of IMF 2004).

In fact, development of a project like hydropower can be seen as a strategic activity that needs huge finances. In such a case, clearly, the role of government is crucial. However decision-making processes should not seek to achieve particular political goals and agendas, forgetting the country's sustainable development path. Instead,

58 Governance in this context can be defined as the exercise of political power to manage a nation's affairs.

the focus of government should be limited to facilitating and streamlining the process, and removing bottlenecks encountered in the development and utilization of energy resources. Untimely development of the necessary electricity in accordance with the country's level of development, therefore, has led to either a surplus or a shortage of electricity in different years since the country's large hydroelectric plants commenced operations in 1960.

5.6.2.1 Imperial government (1930 - 1974)

During the period of imperial government, the government had a keen interest in uplifting the country's economy from one based on agriculture to one based on industrial activities, and to achieve a level of development similar to the rest of the world. During this period, a number of different noticeable development activities took place in the country, particularly in the 1960s. The development of hydropower was one of them. During the 1960s three medium-scale hydroelectric power plants were commissioned and in the early 1970s one large hydroelectric power plant (Koka, Awash I & II, Finchaa), dramatically increasing the country's HEP production capability from almost zero in 1960 to 218 MW in 1973.

The former three plants were developed in the biggest river basin of the country, viz. the Awash River[59] Basin, to the southeast of Addis Ababa. There are three important reasons for this:

- Firstly, the biggest agro-industries (sugar factories) were situated in the same basin; the water could thus be used for irrigation, and at the same time to supply electricity to the factories.
- Secondly, the proximity of the river basin to the capital city of the country (Addis Ababa) makes it both easier and cheaper to transmit electricity to this city.
- Thirdly, no feasibility study had been done beforehand to determine the country's hydroelectric potential, and to enable the government to choose which locations and projects would be the most cost effective and the most reliable.

After all, during that time, the country had very little experience with the effective usage of resources for electricity production. The government of the time thus focused on using the power for the effective development of industry and to boost

[59] This river travels the longest distance within the country and remains inside the borders of the country (see Figure 5.4).

productivity, thereby improving the economy of the country sufficiently so that it could compete with the rest of the world.

Due to rapid developments in the electricity industry from 1960 up to 1973, the electricity supply capacity of the country in most years was far greater than the prevailing demand. For instance, in 1973, the surplus reached more than 64% (only the HEP of the ICS group) (see Chapter 4: 46: Table 4.2). However, the electricity demand also showed substantial growth. For example, between 1956 and 1973, it grew on average by 16% per year (see Appendix B.1).

5.6.2.2 Marxist Government (1974 - 1991)

The 1974 revolution handed over the country to an extremely rigid military government (called Derg). All the country's major economic and service activities were transferred under the control of the government, including the electricity industry. Virtually almost all the decisions with regard to socio-economic development activities now came from the top governing bodies. Moreover, the government had fixed most commodity prices (resulting in a command economy). In addition, these two decades (1974 - 1991), with the exception of a few years, were characterized by prolonged civil and external wars (as a result of which the regime was sometime called "bloody government"). Consequently, most of the government's revenue (up to 50%) was used to fund the war (Mulatu 1991: Revenue and expenditure)[60], severely restricting the government's financing capacity in support of other socio-economic activities. Stagnating GDP growth, soaring inflation, severe budget deficits and trade imbalances, falling exports and an overvalued domestic currency deepened the economic crisis (Acres International 2000; Mulatu 1991: Economy[61]).

However, thanks to the previous government's last decade of excessive development in the electricity industry, coupled with the retarded economic growth, particularly in the industrial sector, problems with the electricity supply had never challenged the Derg government. Instead, a portion of the population (< 7%), who had electricity access, had enjoyed the cheapest and most highly subsided

60 See http://reference.allrefer.com/country-guide-study/ethiopia/ethiopia92.html

61 See http://reference.allrefer.com/country-guide-study/ethiopia/ethiopia87.html

electricity.[62] Consequently, most urban dwellers (i.e. in Addis Ababa, Nazareth and Asmara) began to use electricity for cooking, more particularly for baking of "injera".[63] As a result, and despite the fact that the regime was generally characterized by downward economic growth, the electricity consumption of domestic customers grew on average by 10% per year between 1974 and 1991 (See Appendix B.2).

In contrast, the electricity consumption of the industrial sector showed a slow growth over the same period (on average only 4% per year). The economic condition of this sector was more devastated in the last three years of the Derg regime, due to a progressive deterioration of the society's living conditions and a deepening economic crisis. Their electricity consumption thus equally dropped, showing negative growth. As a result, the industrial sector's share of electricity consumption dropped from 50% in 1973 to 33% in 1991 (see Appendix B.2), in spite of government lowering the electricity tariffs and promoting higher electricity consumption[64].

During nearly two decades the electricity consumption of domestic customers grew by five times, whereas that of the industrial sector merely doubled (see Appendix B.2). In the end, the previous imperial government's aspirations during their last decade, i.e., shifting the country from an agricultural toward an industrial economy, and initiating many positive programs, had been progressively killed by the "bloody" government's command economy.

Because the government fixed most commodity prices, the electricity price was not set in accordance with the long-run marginal costs of the electricity supply. Moreover, nearly all the decisions about power development were top-down, aiming to address short-term problems without looking at the country's long-term

62 In 1986, the domestic tariff had two steps. The tariff structure was designed to encourage high electricity consumption. The tariff of the first 50 KWh block was 0.17 Birr/KWh and the second step was 0.12 Birr/KWh (See Appendix D).

63 " Injera" is the staple food of most Ethiopian people. It is made up of a unique cereal grain known as Teff, and it looks like soft spongy pancake bread. It is baked using a large circular plate (about 1.5 meters circumference). Baking "injera" requires high power [much heat].

64 For example, due to excessive capacity in the electricity supply, industries were forced to use electricity for boilers, which require high energy (interview with a worker from the Ethiopian Electricity Agency).

development (Mulatu 1991). This poor system of governance ultimately meant that the utility had to rely entirely on government finance.

5.6.2.3 The current government (1991 to the present)

The Marxist government's regime ended in May 1991, overthrown by guerrilla freedom fighters forces from the Tigray region, calling themselves the Tigray People's Liberation Front (TPLF). The new government, the Transitional Government of Ethiopia (TGE), was confronted by an economically, socially, morally and politically devastated society, in response to which it designed a number of promising strategic development plans. Since the current new government came into power, a number of radical structural adjustments occurred both in the economy and the politics of the country. For instance, the economy was changed from a complete command economy to a free market economy, and state-owned large industries and commercial companies were progressively privatized (EPA 2002a[65]; Selam 1998). In 1997, in line with the government free market economic policy, as stated in the Introduction of this thesis, the electricity supply utility was re-established as a public enterprise or corporation and an independent regulatory agency was established.

5.6.2.3.1 Investment

In order to create a free market economy, far-reaching steps were taken by the current government. These included the liberalization of prices, the devaluation of the local currency, the privatization of stated-owned enterprises, and the formulation of facilitating and encouraging policies and proclamations (e.g. the economic policy in 1991, the investment policy in 1998, and the electricity proclamation no. 86/1997). These activities have attracted potential foreign and local investors who had retreated in the previous two decades[66].

Thus, since 1992, a large number of potential investors have shown their interest in investing in different sectors and places throughout the country. The quantity of domestic investment is particularly substantial. According to the 2002 annual

65 See http://www.telecom.net.et/~epa/Agency/status.html, update in 29th of march 2002

66 These investors retreated mainly because of rigid price and investment policies, and because of a lack of trust in a government that had nationalized all privately owned large industries and the commercial sector without any compensation (Mulatu 1991: Economy).

statistical report of the Ethiopian Investment Authority (EIA), between 1992 and 2002 the authority approved 1486 primary, 2791 secondary and 2497 tertiary sector domestic investment projects. In total, 6774 domestic projects[67] with an average investment capital of 7.42 Million ETB have been approved. In addition, the authority also approved 307 foreign investment projects (about 50% are jointed with domestic investors) with 50 million ETB average investment capital and 41 public investment projects with 309 million ETB average investment capital. Of the total approved projects (7122), 2075 projects commenced between 1992 and 2002. More than 88% of these projects were embarked upon before 2000, and the manufacturing industries made up 51% of these projects.

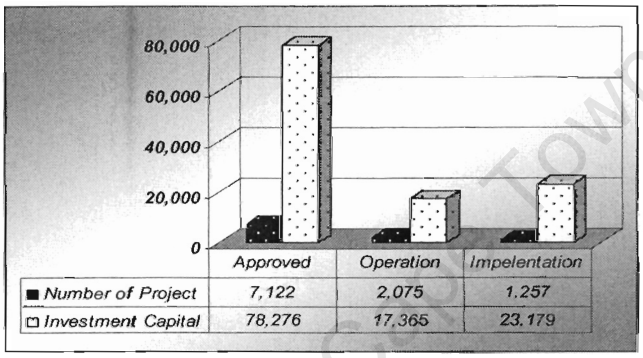

Figure 5.1. Number of new projects and investment capital (in million ETB) by status: July 1992 – 7 July, 2002

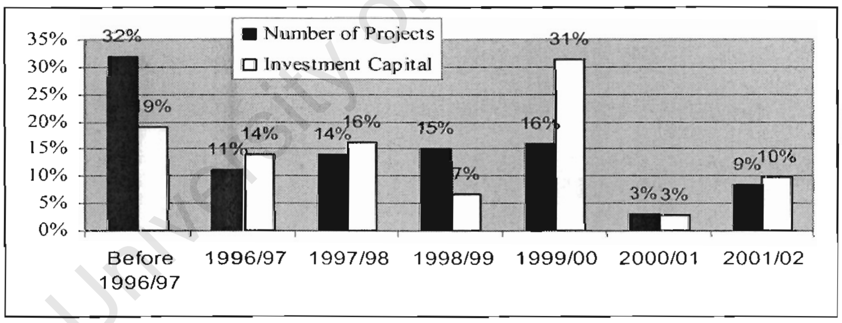

Figure 5.2. Percentage share of new projects and their investment capital by year of commencement: 1992 - 2002.

Source: the data of both figures were derived from statistics on investment in Ethiopia, from the EIA (2002)

Note:

Investment share of 1999/00 was very high due to two large industries which were commenced in Tigria regional state (around 1.6 billion ETB)

67 Note that the EIA only gives approval for projects with more than 500 000 ETB capital; therefore this data does not include a smaller project that received approval from the regional state offices. The primary sector includes agricultural activities and mining, quarrying activities, etc. The secondary sector refers to manufacturing industries. The tertiary sector includes electricity generation, construction, real estate development, etc.

Despite the large number of projects in different sectors, all of which have dramatically increased the demand for electricity, the government's responses in developing the electricity utility have been very sluggish until recently. As clearly pointed out in the Transitional Government's energy policy paper, one of the main rationales for their energy policy is to support other economic sectors in meeting their development objectives (TGE 1994). Nonetheless, until recently, this energy policy had been neglected and not implemented by the current government.

5.6.2.3.2 Government decisions in respect of the development of the electricity industry

Initially, of course, the current ruling government took charge of power plants with excessive average energy production capabilities. For instance, in 1988, after the Melka-Wakana power plant commenced operations, the surplus reached 42% (see Chapter 4: 46: Table 4.2). Even so, that surplus was not enough to allow the utility to continue to meet growing electricity demand in the 1990s. Additional capacity would have been required to accompany the faster investment growth that took place. For instance, between 1992 and 2002, an average of 207 relatively large new projects per year became operational (excluding smaller new projects and domestic customer growth). Manufacturing industries accounted for the highest share of demand growth in this period (EIA 2002).

By looking at the rapid investment growth trends in the different sectors since 1995, some observers and researchers strongly warned that there was an urgent need for capacity expansion in the electricity industry (Acres International 2003b: 10.8; Solomon 1998; MEDaC 1999). For instance, the 1995 Acres power system expansion master plan study recommended that, "as a short-term measure, it was necessary to use alternative energy (e.g. thermal generation) to minimize the expected electricity shortage in 2000 and to compensate for delays in the Gilgel Gibe development" (cited by Acres International 2003b:10.8). Similarly, Solomon (1998: Chapter 4: Section 4.1.2: Future Plan for Hydropower Developments[68]) reckoned that:

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68 See http://www.mediaethiopia.com/Engineering/hydropower_of_ethiopia.htm

> The present capacity deficit is estimated to be about 300 MW. This indicates that power generation needs to grow at an annual rate of about 10% to reach an approximate target of around 1600 MW by the year 2000 to sustain economic development and to fulfil the domestic needs of the Ethiopian people. This program should be taken seriously because it is strongly contended that the country could face a severe shortage of hydroelectric energy for many years to come.

In spite of all these warnings, study findings and the government's ambition of bringing a free market economy to the country, in 1995 the government came up with completely new ideas, Government initiated a preliminarily study to identify sites in the Tekeze (Nile tributary) and Gojeb River Basins for medium-scale hydroelectric power plants, thereby ignoring all the potentially cost-effective hydroelectric power plant projects that had been identified and recommended by Acres (e.g. in 1982 and 1995) and the short-term remedy measures proposed by the same study group (in 1995).

Based on the 1982 Acres power system expansion master plan study (1982), the previous plan had been to build power plants on Aleltu River Basin (a Blue Nile tributary) adjacent to the Melka-Wakana. Aleltu I, II and III were expected to come into operation in 1994, 1997 and 2001 respectively. Perhaps because of the existing problems with the Egyptian government, the plan was changed, and the Ethiopian government decided to build a hydroelectric power plant in Gilgel Gibe River Basin.

Problems with the Egyptian government and their alliance with western countries have created barriers for Ethiopia to receive loans from International Financial Institutions (IFI) in support of any hydroelectric projects in the Nile River Basin. At the same time, given the country's severe and prolonged budget deficits and other socio-economic problems, it would be very difficult and perhaps impossible to develop the identified and potentially cost-effective hydroelectric projects in this basin using only the government's funds.

The potential of the sites identified in the Abay River Basin is far greater than the potential of all the other rivers in the country. There were, however, some other cost-effective projects, which have been identified both in the Omo and Genale River Basins. Some of them had even been identified as among the best candidate projects, e.g. the Halele-Webessa hydropower project in the Omo River Basin (see Table 5.6).

Table 5.6. On-going and planned hydropower programs

Name of the project	Energy (GWh/year) Average	Firm	River Basin	Remarks
Gilgel Gibe	864	670	Gilgel Gibe	Under Construction
Chemoga Yeda	3031	2526	Abay (Bule Nile)	Pre-feasibility level
Upper Beles	1617	1100	Abay (Bule Nile)	Advanced identification
Halele-Werabessa	1475	1180	Omo	Identification level
Aleltu	3550	3484	Abay (Bule Nile)	Pre-feasibility level
Tekeze		981	Tekeze	Design level
Gojeb		364	Omo	Works out for tender
Tis Abay II		359	Abay (Bule Nile)	It was completed (2001)
Total		**10,664**		

Source:-Solomon (1998).

Notes:

1. The list shaded in gray were identified as the least-cost projects for future expansion by Acres (2003a).

Given the situation in the country, there were a number of convincing reasons to proceed with the Gilgel Gibe project, according to the original 1982 plan, which was expected to become operational in 1993.

- Firstly, the project had nothing to do with the current problems around the Nile River. Given the country's urgent need for additional power, it would have been easy to negotiate with the financial institutions.
- Secondly, work on the project had already started.
- Thirdly, the project is strategically located to develop south-western Ethiopia. This is among the areas in the country that are the richest in natural resources, and it is the primary source of the country's main export-earning commodity, coffee.
- Fourthly, the project is located in a relatively secure area.

However the government did not bring the Gilgel Gibe project into operation in 1993. The project posed a challenge for the ruling party. The decision would have favoured an area of the country far from where most of the party members had been born.[69] They only faced this challenge in 1997, after the country had experienced

69 The ruling party is dominated by the Tigreans (EPRDF). They control 90% of the seats in the Council of People's Representatives, the parliament, according to Bertelsmann Stiftung

two power shortage periods (in 1995/96 and 1997/98). As pointed out earlier, to save the country from an even more severe power shortage, it had been strongly recommended by Acres International that the Gilgel Gibe project should be completed as quickly as possible. It was not realistic, after all, to create an entirely new project at a time when the country urgently needed additional power, and when there was barely enough time to conduct a feasibility study.

5.6.2.3.3 Tekeze and Gojeb projects[70]

The government gave two reasons for why they decided to create two entirely new projects, the Tekeze and Gojeb Projects. As stated by Solomon (1998:Introduction), although a number of potential sites in different rivers had already been identified for the development of large-scale hydroelectric power plants (see Table 5.9) these were not on the government's priority list, because their construction would have been very expensive and would have needed more time. In addition, the government would not have been able to use them to address its urgent need for capacity expansion. Consequently, the government initiated a preliminary study in both the Tekeze and the Gojeb River basins. The study ultimately recommended, in response to a policy decision by government, that the deficit in electrical capacity would best be addressed by concentrating initially on medium-scale projects (Solomon 1998: Chapter 2: Hydropower development in Ethiopia).

Surprisingly, however, both new projects are neither medium-scale nor economically attractive in comparison with other projects. They also would not have enabled the country to address its power shortage urgently. Moreover, according to the country's current classification system, both of them are large-scale hydroelectric power plants.

country reports (2003: 2). During 1991-2000 the ruling party (EPRDF) was led by the Tigray People's Liberation Front, as pointed out by the same source.

70 Note that the Tekeze project is located in the Tigray regional state in The Nile River Basin, whereas the Gojeb project is situated in Southern Ethiopia in the Omo River Basin.

Table 5.7. Hydroelectic power projects selected in 1996

Selected hydroelectric power plant	Installed capacity	Target energy GWh/Year	Estimated Cost (In million Birr)
Tis Abay II	73	331	116.4
Tekeze	250	981	2,131.7
Gojeb	150	364	1,524.0

Source: EEPCo (2002: PowerSDP– Program summary).

Notes:

1. Note that the actual production from Tis Abay II in 2001/02 was higher (it was 509 GWh/year)

Interestingly, no-one, either in the utility or in the infrastructure department of the Ministry of Finance and Economic Development, has given clear information about these two projects or their selection criteria. Nothing has been mentioned about their selection in documented information, such as on the Internet, in any of the Acres System Power Expansion Master Plan reports, or in other sources writing about them. If these two projects were indeed selected after thoroughly examining and analysing the country's power needs and in line with the existing policy, why was important information, such as the government's rationale for developing the Tekeze and Gojeb projects, not revealed? For instance, Solomon had clearly proposed logical reasons why the Tis Abay II project, which had been selected along with Tekeze and Gojeb, should be developed (Solomon 1998: Chapter 3: Section 3.1.2: Medium Scale Hydro Projects)[71].

According to some observers from the Ministry of Finance and Development and from the electricity utility, the feasibility study of the Tekeze project clearly showed that the project was not economically attractive or viable. In addition, its location is very vulnerable to climate changes and social problems. They argue the following:

- Firstly, the project is located far from the rest of the country (see figure on Appendix C.4).

[71] As pointed out by Solomon (1998), the Tis Abay II project is economically attractive because no dam is required to regulate flows or to provide the generating head. He argued that, "it is likely to provide electrical energy at a lower unit cost than other potential selected schemes in the program". He also added that "the project should receive first priority because of its short expected duration of construction and its strategic location with respect to the Northern electrification program".

- Secondly, the surrounding area of the project has been severely affected by recurrent droughts throughout the country's history (Ahmed & Dechassa 2003; Meze-Hausken 2004; see also Appendix H).
- Thirdly, there have been prolonged wars in the area, both due to external and internal conflicts (Ahmed & Dechassa 2003). For instance, the recent border war between Ethiopia and Eritrea from 1998 to 2000 took place near this area. This conflict has still not been properly addressed to this day[72]; this unstable political situation makes the area very vulnerable. Given the country's huge hydroelectric power potential in other areas, it is unthinkable to locate such an important and strategic project in an area nearby a border conflict, even if the project were economically attractive.

In addition, the Tekeze (Atbara) River is one of the tributaries of the Nile River. As the IFIs are more closely affiliated with Egyptian interests, they use double standards to reject financial requests from Ethiopia on any hydroelectric projects in the Nile River Basin. This would make it cumbersome to obtain financial support for a project like this from any other development institutions. Because of the above situation, as well as for other reasons, the Ethiopian government's request for financial assistance in this regard was rejected by IFIs. Finally, the government decided to pay all the costs itself, despite the severe budget deficit. Even though they could have gone ahead with various other, very attractive and more viable hydroelectric power plant projects in another river basin, which had been suspended for several years for financial reasons, the government leadership group decided to proceed with the Tekeze project, because it would improve the economy of their birthplaces.

Surprisingly, even though one of the world's poorest countries is financing the project, and despite a severe budget deficit, the Tekeze project is progressing well[73].

72 According to a recent Ethiopian News Agency press release on 11 May 2004, Prime Minister Meles Zenawi (the current Prime Minister of the country) said that "the decision of the Ethio-Eritrea Border Commission should not be put into practice, as it would bring about danger to peace", (ENA 2004c).

73 It must be borne in mind that the total costs of the Tekeze project were estimated to be 2.2 billion ETB, which was equal to 17% of the total government revenue including grants in 2002/03, and 46% of the country's budget deficit in the same year.

According to Walta Information Centre news release in October 2004,[74] the Project Manager Abebe Tesfaye reported that 25 per cent of the implementation work had been completed, within two years. This contrasts dramatically with the smaller capacity Gilgel Gibe hydropower project (184 MW). That project was first committed in 1976, but the plant only became operational in 2004.

The progress of the Tekeze project also contrasts markedly with that of the Gojeb power plant project. This started at the same time and was expected to be operational before the Tekeze project, i.e. by 2005-06 (Acres International, 2003b: 10-9). But progress has been extremely slow. In fact, the only step taken so far was that the Saudi-based Mohammed International Development Research Organisation & Companies (Midroc), an independent power producer (IPP), signed a memorandum of understanding with EEPCo at the beginning of 2001. However, according to recent information from the utility, the original agreement has not been progressing as expected. In February 2004, the utility therefore began to develop this project itself, organizing the necessary documents to obtain funds from external sources.[75]. Given the speed of construction of the Tekeze project and the challenges of realizing the Gojeb project, it is likely that construction work on the Gojeb project may not have started by the time that the Tekeze project becomes operational.

The aim of the above explanation is not to show which of the projects is first or which should be next. Nor is it to criticize the good performance of the Tekeze project. What is important here is the point that proper planning is not just paperwork, or achieving temporary political interests, or benefiting only a specific area of the country. A hydroelectric power project should be carefully designed by looking at both its constraints and its benefits from different perspectives, always with the ultimate aim of achieving sustainable development goals for the benefit of the entire country. Expanding the power supply, in particular hydroelectric power is not simple. It demands a large share of the nation's capital (a significant challenge in a poor country such as Ethiopia), it has high opportunity costs, and it needs long-term planning and follow-through. Above all, though, it is a strategic element of ensuring the successful development of present-day Ethiopia.

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74 The information was extracted from Walta Information Centre's website (http://www.waltainfo.com/ennews/2004/oct/03oct04/oct03e4.htm).

75 This information was obtained by interviewing the Gojeb Project Manager, in February 2004.

5.6.2.3.4 Some of the challenges of power sector reforms in the country

Initially, the Gojeb project, which could perhaps have been developed with the support of the IFIs because it is located outside the Nile River Basin, was handed over to an IPP. Even at the beginning, when the plan was first formulated, it was doubtful that the project would be effectively realized. Based on many different countries' experiences with power sector reforms, it is a given that IPPs have not attracted investments in large hydroelectric power plants. In addition, Ethiopia's relatively low electricity demand, low prices and the purchasing power of the society are also major bottlenecks to attract private investors into the electricity industry.

The status of the Gojeb project in general is very doubtful, unless it was used to please or to support the advocates of power sector reforms. Power sector reform in a country such as Ethiopia, whose electricity production is predominantly based on hydroelectricity, and most of whose society is living in absolute poverty, and which has very low electricity consumption, does not only mean commercializing of the utility, creating an independent regulatory body and allowing private investor involvement in the industry. The government is still very involved in the decision-making processes, and there are no clear-cut boundaries in responsibilities between the utility and the Ethiopian Electric Agency (the independent regulatory body), mainly because the agency does not have enough skilled manpower and experience.

Much work is still needed to attract investors in the industry. No sensible investor will be willing to spend even a cent without ensuring that there will be good returns and profits, especially when developing a high-risk business such as a hydropower plant in a poor country. The exception, of course, is if the investment is done for humanitarian reasons and the project is a non-profit business, whose main aim is to develop an area.

Although the government has invited both foreign and local investors to help in developing the electricity industry, and has given many incentives and privileges since 1998 to such investors, the responses have not been encouraging. One of the Agency's workers stated during an interview that initially a few investors had shown interest, but that they withdrew because of disagreements between the investors and the utility. The main reason for these disagreements, according to the same source, was that the current market structure of the power sector in the country is the Single Buyer industry model. In this model, EEPCo (the sole buyer of the power) would buy electricity generated by IPPs, based on a selling price agreed between the parties (a Power Purchase Agreement) (EEA: 10 2002). However, the utility did not agree to pay the IPPs according to their requests. In addition, as pointed out by another worker from the same agency, the existing low level of electricity demand in the country and the low purchasing power of the society are also a source of concern for investors.

Therefore, for the effective development of the country's electricity, EEPCo in conjunction with the Federal Government's full and unbiased support plays a major role.

5.6.2.3.5 Current developments

Although the country has been experiencing power shortages since 1995, the current capacity expansions and additions in the electricity industry are very encouraging. Even more encouraging is that the relevant role-players seem to be learning from past mistakes. Despite the many problems identified in this chapter, the current positive developments may indeed ensure the security, efficiency and reliability of energy in the near future. Nonetheless, it is crucial for government and all parties involved in the electricity industry to use proper integrated planning, to decide on the direction of socio-economic growth, and to proceed in accordance with a scheduled timetable. This is crucial for the successful development of this industry.

Moreover, it can be suggested that the top governing leadership group needs to change their attitude towards the other nationalities living in Ethiopia, by considering the country as a single nation. Any strong interventions based on biased decision-making could have detrimental effects for the country as a whole. As the nation of Ethiopia is ultimately the beneficiary and the owner of this development activity, a more responsive, transparent and accountable system of power sector governance is required. More widely, as a result of globalisation and the strong socio-economic links between the people living in different parts of the contemporary world today, let alone within a single country, the failure of one area of the world can have adverse effects for people living in other areas of the world.

5.6.3 Financial problems and lack of right to develop own resources

Poor governance in the electricity industry can be seen as exacerbating the barriers for the effective development of hydroelectric power resources in the country. However, as reported by Ethiopian Herald in 1956, since 1956, a major problem is the country's so-called 'lack of right' to harness her share of immense hydropower potential in the Nile River basin (cited by Tesfaye 2000:12). Tefera Beyene from the Hydroelectric Design Department of the Ethiopian Ministry of Water Resources also pointed out this problem as one of the major constraints for development of the country's hydroelectric power[76].

This has prevented the country from receiving financial support from IFIs (i.e. the World Bank and the International Monetary Fund) and from any other external sources for hydroelectric development in this basin (Tesfaye 2000:10).

It is widely recognized that developing hydroelectric power plants requires a huge initial capital investment. Given the country's severe financial problems and chronic budget deficit, it is very unlikely that the country will be able to utilise the hydropower potential of the Nile River without funding from external sources. Even building only one relatively large-scale hydroelectric power plant would use up more than 15% of the current total government revenue. Given that the majority of the population (80%[77]) (UNDP 2004: 149) is living in absolute poverty, this revenue is badly needed by the government to support other socio-economic activities, such as education, the health service, salaries of civil servants and the provision of other infrastructure.

5.6.3.1 Borrowing money from the International Financial Institutions

For more than four decades in the lives of the poorest countries in Africa, they were unable to access and use their own rivers for development activities without Egyptian blessing, as these rivers flowed into the Nile River (Foulds 2002: Part III: Challenges to implementation: World Bank Participation; Council of Ministers of Water Affairs of the Nile Basin States 2001: 2). Six out of the ten riparian countries along the Nile River are among the ten poorest countries in the world (Foulds 2002: Part III: Challenges to implementation: World Bank Participation). The same nations

76 Source: Report on the workshop on linkages between the Ministry of Water Resources, Ethiopian Science and Technology Commission, Regional Water Resources Bureaux, Academic Institutions and the Nile Basin Initiative: Presentation and Discussions, Section II, April 10 – 11/2003, Addis Ababa. (see http://geoinfo.uneca.org/geoinfo/ethiopia/water/workshop_p.htm)

77 Absolute poverty' is defined as having an income of less than USD 2 per day (UNDP 2004: 149).

have lost thousands of people due to starvation and droughts. No one has forgotten what has happened in Ethiopia (see the information presented in this chapter page 73), the country that is known as "the water tower of North Eastern Africa" and which provides 85% of the Nile River's water.

In spite of the above, Egypt and the western countries that support her have expected Ethiopia and the other riparian countries to rely on unpredictable rainfall to meet their water needs. They have restricted the right of these countries to use water from rivers and tributaries flowing through their own territories, in case that would reduce the water inflow to Egypt, and even though it could help prevent painful deaths through starvation and thirst. On 24 March 2004, the News reported that, "Sharing the Nile is a sensitive issue for Egypt, which depends on its waters and has long challenged any initiative that would squeeze the flow of the river to its frontiers" (CNN.com online 2004).

Mainly since 1999, after the Nile Basin Initiative (NBI) was established, various researchers and observers have tried to reveal the main reasons behind the IFIs' fears of lending money for the development of any projects on the Nile (Foulds 2002; Tesfaye 2000:10). Foulds in her report makes the following astute statement:

> The WB and its members (specifically the US, European Union, and Canada) are concerned with Egypt's interests because of its strategic location as an entry into the Middle East. Egypt's stability directly affects the stability of the Middle East, which influences the petroleum market, an area of greater importance to the Western world than stability in the Nile Basin. (2002: Part III: Challenges to implementation: World Bank Participation).

Smith, similarly, stated that:

> As one of the biggest recipients of US aid ($ 2.2 billion/year) and good friends to the west, a friendship that was forged after the signing of the Camp David Accord with Israel in 1979, the Egyptians are sure they have both the political clout and economic leverage over the giant international financial institutions such as the World Bank and the International Monetary Fund.".(Cited by Tesfaye 2000:10).

Tesfaye reckoned that "it was using this changing political and economic circumstance that the Egyptians have in the past blocked loans that were directed to finance hydroelectric projects in Ethiopia" (2000:10).

Further evidence is supplied both in Tesfaye (2000) and other observers' reports with regard to Egypt blocking Ethiopian financial requests to the IMF and the Word Bank to develop any hydroelectric projects in the Nile River basin. In the 1990s, for instance, Postel pointed out, "Egypt was reported to have blocked an African Development Bank (ADB) loan to Ethiopia for a project that Cairo feared would reduce downstream supplies" (cited by Tesfaye 2000:10). More recently, in 1998, the financial request of Ethiopia for funding to conduct a feasibility study on the Tekeze (Atbara) and Abay (Blue Nile) Rivers was also rejected (Tesfaye 2000:10).

The natural right of Ethiopia to access the rivers flowing through its own territories has been consistently overlooked and denied by all International Financial Institutions. Furthermore, the country was systematically excluded from the Anglo-Egyptian accord in 1946 and later when Egypt included Sudan in 1956 (Tesfaye 2000:12).

By means of this clearly selfish treaty, the Egyptians prevented all development activities in the Blue Nile River Basin by blocking the relevant country's loan requests. Even more dramatically, Egypt went so far as to threaten Ethiopia on various occasions when it wished to develop irrigation and hydropower plants in this basin. Waterbury stated in this regard:

> The Egyptians do also have other vested interests in the Sudan. In the case of Ethiopia's utilization of the Nile water, they would like to use Sudanese air space and airbases to bombard Ethiopia. (Cited by Tesfaye 2000: 12).

The BBC also reported on these drastic and excessive measures:

> In 1991, Cairo warned that it was ready to use force to protect its access to the waters of the Nile in case Ethiopia and the Sudan plan to build dams on the Nile. (Cited by Tesfaye 2000: 2.1 Egypt's water security policy).
>
> More recently, being suspicious of Addis Ababa's designs on the Nile, President Mubarak of Egypt threatened to bomb Ethiopia if they plan to build any dams on the Nile. (Cited by Tesfaye 2000: 2.1 Egypt's water security policy)

All the financial barriers in favour of a wealthier Egypt and the threats of military violence from that country have effectively prevented Ethiopia from implementing planned development strategies. Consequently, since the days of the imperial regime, the Ethiopian government has been forced to follow short-sighted and unwise development strategies so as not to antagonise Egypt or to provoke an attack. These strategies have, however, jeopardised economic development in Ethiopia itself, which has led to the country lagging far behind the rest of the world and created a population that lives in absolute poverty. Currently, the country has utilized only 1% of its irrigation potential and 1% of the hydropower potential of the Nile Basin Rivers (see Table 5.8).

Ethiopia is far poorer in respect of energy than Egypt, and of all the Sub-Saharan countries, it is the poorest with regard to electricity consumption. In 2000/01, for instance, Egypt produced 73 TWh/year of electricity, whereas Ethiopia only produced 1.8 TWh/year in that same year (EEHC 2005; EEPCo 2004). A similar pattern manifests in the per capita electricity consumption: whereas Ethiopia's per capita electricity consumption in 2001 was only 23.94 KWh/year (which means that the country is ranked 205th of 212 total countries in the world in this regard), the Egyptian per capita electricity consumption reached 936.31 KWh/year (NationMaster.com online 2003).

Another important factor to be borne in mind is that these two countries have different natural resources for electricity production. For instance, Ethiopia is only able to harness hydroelectric power economically, of which only 2% has been utilized so far. Egypt, in contrast, has immense and diverse resources, such as natural gas and oil in addition to hydropower. Her proven recoverable reserves of natural gas are particularly substantial (1223 billion cubic metres, second in Africa), of which only 1% had been harnessed up to 1999 (WEC 2003). In spite of this, however, Egypt's installed hydroelectric power capacity at the famous Aswan Dam is the highest of all African countries with 2810 MW, accounting for 22% of the country's total technically exploitable hydropower capacity. Nevertheless, in 2001, only 19% of the country's electricity was met by HEP, while thermal energy sources contributed the majority of the share (EEHC 2005).

From an international perspective, by applying the wise judgements of the human mind and by considering all the facts above, it is clear that Ethiopia should be assisted in harnessing its potential hydroelectric power.

However, as the head of EEPCo's Power System Operations department, Tesfaye Delessa, said: "To approve a loan, the World Bank always asked us to provide enough proof concerning the economic benefit of the power plants."(interview with Tesfaye Delessa 2004). Yet in the contemporary world, no one can deny the benefits of and need for electricity to drive economic development. Today, development without electricity is no different to playing football or soccer without a ball. Without power, many development activities, both economic and social, are unthinkable. Power is also crucial to ensuring the country's major challenging problem, that of food security, in an effective and sustainable way.

In spite of these facts, the World Bank demands additional proof. Why is this necessary? After all, various news sources (e.g. IRIN news online 2003; WIC news online 2001) have highlighted the country's electricity shortage. Beside this, how is it possible that the following factors were overlooked:

- Ethiopia has a very low per capita electricity consumption (205th of 212 countries in the world);
- only 14% of the population had access to electricity in 2003;
- more than 90% of the population depend on traditional energy ;
- it has a very high infant mortality rate due to a lack of necessary medical care (102 deaths/1,000 live births (2004 est.), putting it in the 15th worst place out of 255 countries);
- high numbers of people have died as a result of drought episodes (e.g. in the 1983-84 drought, it was estimated that one million people died);
- it ranks 170th out of 177 countries (in 2002) in respect of the human development index [78]
- in terms of the GDP (Purchasing Power Parity (PPP)), it ranks 220th out of 231 countries;
- it has a high budget deficit (in 2002/03 it was 4.8 billion ETB, more than 26% of the government total expenditure in the same year);
- it has a negative balance of payments, with exports only covering 49% of imports in 2002/03;
- currently only 3% of the original forested area is covered by forest as a result of environmental degradation and deforestation;

78 This index was The UN Human Development Index (HDI) measures poverty, literacy, education, life expectancy, and other factors. It is a standard means of measuring well-being, especially child welfare. The index was developed in 1990 by the Pakistani economist Mahbub ul Haq, and has been used since 1993 by the United Nations Development Programme in its annual report. (Wikipedia the free encyclopaedia 2005).

- its population growth rate (natural rate) is 2.7% (2003);
- its population is the third highest in Africa (69.1 million est. 2003);
- its hydroelectric power potential is 2nd in Africa; its economically viable potential of 30 TWh/yr could be developed cost-effectively and it is the cheapest energy source in the country.[79]

5.6.3.2 Ethiopia's right and government interest to harness her share of the Nile River hydroelectric potential

First and foremost, Ethiopia has a natural right to the Nile, because the Nile River runs through her territories. According to the Helsinki[80] and the International Law Commission (ILC)[81] Rules, this would entitle the country to a fair and equitable share of the waters of the Nile (Tesfaye, 2000:14). Jovanovic (1985) considered that "Ethiopia has all the right to claim up to 40 billion m^3 of water per year for irrigation,

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79 Source: NationMaster.com online (2004); TGE (1994); UNDP (2004: 149), National Bank of Ethiopia (2004), EEPCo (2002: EEPCo in brief : Electrification status).

80 The Helsinki Rules on the Uses of the Waters of International Rivers was adopted by the International Law Association at the fifty-second conference, held at Helsinki in August 1966. Chapter Three of the rules stated that "Each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin". Further in the rules, reasonable and equitable share were described as follow: to determine these different factors are considered depending on the condition. Moreover, the relevant factors were listed in the Committee's report. (Report of the Committee on the uses of the Waters of International Rivers, International Law Association London, 1967). (International Law Association 1967) (The full text of the report can be read from www.internationalwaterlaw.org/IntlDocs/Helsinki_Rules.htm).

81 The International Law Commission (ILC) was established by the General Assembly (G.A.) of the United Nations in 1947 to promote the progressive development of international law and its codification (United Nations 2005). "For information about the ILC and its work, see: http://www.un.org/law/ilc/introfra.htm". Due to an absence of a binding legal authority in respect of the regulation of international rivers, the United Nations in 1970 instituted an international effort to create a legal framework to address this growing problem. This thorough effort to codify the law of international watercourses was undertaken by the United Nations affiliated International Law Commission in its Draft Articles on the Law of the Non-Navigational Uses of International Watercourses (in 1970). Finally, in 1997, the Convention was adopted by the UN General Assembly in Resolution 51/229 of 21 May 1997, and was called "Convention on the Law of the Non-navigational Uses of International Watercourses." (United Nations 1997) "For more information, see http://www.un.org/law/ilc/texts/nnavfra.htm"

reducing a flow to Sudan and Egypt by 23% for irrigation within the Nile Basin and 39% if irrigation is extended out of the Basin" (cited by Tesfaye 2000: 14).

In addition, as stated above, the country's rivers contribute 85% of the Nile water and out of all the potential of these rivers, the country presently utilizes not more than 2% for irrigation and hydropower. On the other hand, the pressure of the population is growing by 2.7% per year, and it is estimated that Ethiopia's population will be 112 million by the year 2025 (nearly double what it is today in 2004). Moreover, the majority of the peasants, who make up 85% of the population, are subsistence and traditional farmers. Owing to the fast population growth and to realise the government's long-term strategy goals for "Agricultural Development-Led Industrial", there is a serious need to utilize this immense potential, both for agriculture and power development.

Ethiopia is not selfish or greedy, and it would not deny any other country access to the various rivers' resources, but the Abay River Basin (the Blue Nile) is a far more important river than any other river in the country. In addition, one third of the country's population is living in this basin area. The following factors may be main reasons why the government is now prioritizing the development of hydroelectric projects in the Nile River Basin, in particular the Abay River Basin (the Blue Nile).

- Firstly, the technical potential of the Abay River is considerable, accounting for more than 48% of the country's total technical hydropower potential. However, in spite of this, until recently (i.e. before 2001), the country's major power plants (except for one) had been located in other river basins, with lower potential and less reliable hydrology. Three of them were located in the Awash River Basin, and the largest power plant in the Melka-Wakana River Basin. The water flow of the Abay River is steadier and more reliable, due to high rainfall patterns in its catchment area. For instance, the water level in the existing Abay River power plant dams, even in drought years, has not shown any significant changes. In contrast, irregularities in yearly rains can severely jeopardise the full utilization of the Melka-Wakana and Koka hydroelectric power plants (see Tables 5.3 and 5.11).
- Secondly, the country's hydropower potential on the Abay River can be harnessed more economically, given the natural landscape and hydrology of that area. For instance, four out of five of the most cost-effective projects for future expansion are located in the Abay River Basin (Acres International 2003b:

Table 10.2 ; see also the description given about the Abay II power plant in the earlier section page 96).

- Thirdly, very little of the irrigation potential of the Abay River; Tekeze (Atbara) and Baro (Akobo) Rivers, has been tapped to date. The government is presently expressing a keen interest in ensuring that the society is self-sufficient with regard to food. Drought, combined with awkward, old-fashioned and ineffective farming methods, and a high dependency on rainwater, have challenged the development of the country for many centuries.

  For instance, as stated in a UNDP monthly .situation report (1998), the current Ethiopian Foreign Minister, Seyoum Mesfin, in a press interview strongly indicated the need to develop these resources:

  > Ethiopia, a country affected by recurrent droughts, should make use of its water resources in a bid to achieve food self-sufficiency as it would be rather difficult to bring about sustainable agricultural development relying on rain-fed farming alone.

To ensure the security of both food and electricity supplies simultaneously, the Ethiopian government has therefore initiated integrated projects to harness this untapped resource, thereby achieving its long-term development goals [ADLI goals] (WIC news online 1999, Mekonnen 2003: Chapter 4: Water sector development[82]).

5.6.3.3 *The status of the Nile Basin Initiative*

After five years of intense negotiations since 1999, subsequent to a series of convincing research works, historical information and pressure from all the previously excluded riparian Nile Basin countries, Egypt could no longer ignore them. Ultimately, though, Egypt tried to accept the right of equitably sharing the Nile resources with other riparian countries, for mutual development (International CustomWire newspaper 2004a; 2004b; Sudan Tribune 2004).

Surprisingly, the Egyptian stance changed after a meeting was held between 15 and 19 March 2004. On 31 March 2004, as reported by CustomWire News (2004a), Egypt finally adopted a reasonable position on the Nile River Treaty. Subsequently, on 6 June 2004, Egyptian Foreign Minister Ahmed Maher said that "there was no

82 See http://eea.ethiopiaonline.net/Econ-foc/ef2-5/mekman.htm

contradiction between positions taken by all countries participating in the Nile Basin Initiative aimed at ensuring equitable sharing of the waters" (CustomWire 2004b).

Hopefully, Egypt will respect Ethiopia's rights to the Nile water, stop interventions and loosen her strong hold over Nile developments. After all, Ethiopia can present many convincing facts to support making use of her share of the economically huge potential capacity of the Nile River, with assistance from external financial institutions and bilateral and regional co-operation. Recently, western countries have shown a positive tendency to support any development activities undertaken on the Nile, particularly projects which address famine (Times 2004). According to an Ethiopian News Agency report on 23 March 2004, the country's Minister of Water Resources, Tefera Beyene, said that "funds for carrying out most of the projects which Ethiopia started to undertake, have already been secured from the international community". In the same report, Tefera added that "40 million kroners was obtained from the Norwegian Government for the construction of the Baro-Akobo hydroelectric power project" (2004b). If everything proceeds according to plan and without any obstacles, these initiatives would definitely improve and stabilise the country's power supply. Effective production of electricity from this enormous potential would not only ensure the country's electricity security alone, but would also enable the country to export electricity to neighbouring countries through mutual co-operation, as had been planned by both the Nile Basin Initiative and NEPAD.

5.7 CONCLUSIONS

In Ethiopia, electricity shortages have been happening since 1995. This has been mainly attributed to low levels of water inflow into hydro-power dams during drought periods, both in the March-June *"Belg"* season and the July-September "Keremt" rainy season. This has particularly affected electricity production by the Melka-Wakana and Koka power plants. The drought in 2002/03, combined with other factors, resulted in the most severe power shortages. In this year, the country suffered severe energy deficiencies with widespread power cuts over an extended period, much worse than in any of the previous periods.

It is widely recognised that as long as a country's electricity demand is met predominantly by hydro-based power plants, electricity supply in that country can be vulnerable to rainfall variability. Below-average rainfall can reduce the possible electricity production of affected HEP plants to below their average energy production capability. However, this study suggests that the drought conditions in the 1990s and more recently in 2002/03 in Ethiopia were not exceptional, and that they should not be identified as a single major factor responsible for the electricity shortages experienced. A number of other factors contributed to the electricity shortages.

This study found that low levels of investment in the electricity industry during the 1990s were one of the prominent contributing factors. This was particularly true within the ICS group, which meets 98% of the country's electricity demand. Since 1992, ICS electricity demand has grown substantially. Various reasons for this include the transfer of previous SCS centres to the ICS grid, growing investments in other sectors (reflecting changes in the country's economic system, towards a free market economy, encouraging investment and private sector involvement) and a growth in electricity demand among existing customers. However, the installed electricity production capacity in the ICS group was not significantly expanded over this period, and did not keep pace with the country's development in other sectors. In short, during the 1990s, the government's response towards the development of the electricity industry was sluggish. Between 1988 and 2000, electricity consumption grew by 60%, while generation capacity in the ICS group increased by a mere 3%.

Low investment in Ethiopia's electricity industry may have been aggravated by financing difficulties related to problems around Nile River rights (i.e. competition for trans-boundary waters). In addition, the failure to ensure sufficient electricity supply capacity to cope with growing development activities in other economic sectors, and the progressive transfers of load centres from the SCS group to the ICS group, could be viewed as poor governance, showing a greater need for integrated planning across sectors.

The severe electricity shortages in 2002/03 were exacerbated by further contributory factors, including a sudden increase in electricity consumption in 2001/02, extended delays in the completion of the Gilgel Gibe hydro plant, and non-rehabilitation of the geothermal power plant.

In summary, the ICS electricity supply, relying predominantly on hydropower, has failed to meet growing electricity demand, particularly during the prolonged drought years (i.e. 1995/96, 1997/98, 1999/00 and most recently 2002/03). This forced the utility to introduce power-rationing schemes during those periods which, in turn, have adversely affected the development of the country.

Chapter 7 deals with the impact of power shortages on the LMSMI sector, utilising case study data from the Addis Ababa region. However, before analysing the impacts of power outages on the LMSMI sector, it is important to understand the role of this sector in the country's economy and its energy requirements. These aspects will be discussed in the next chapter (Chapter 6).

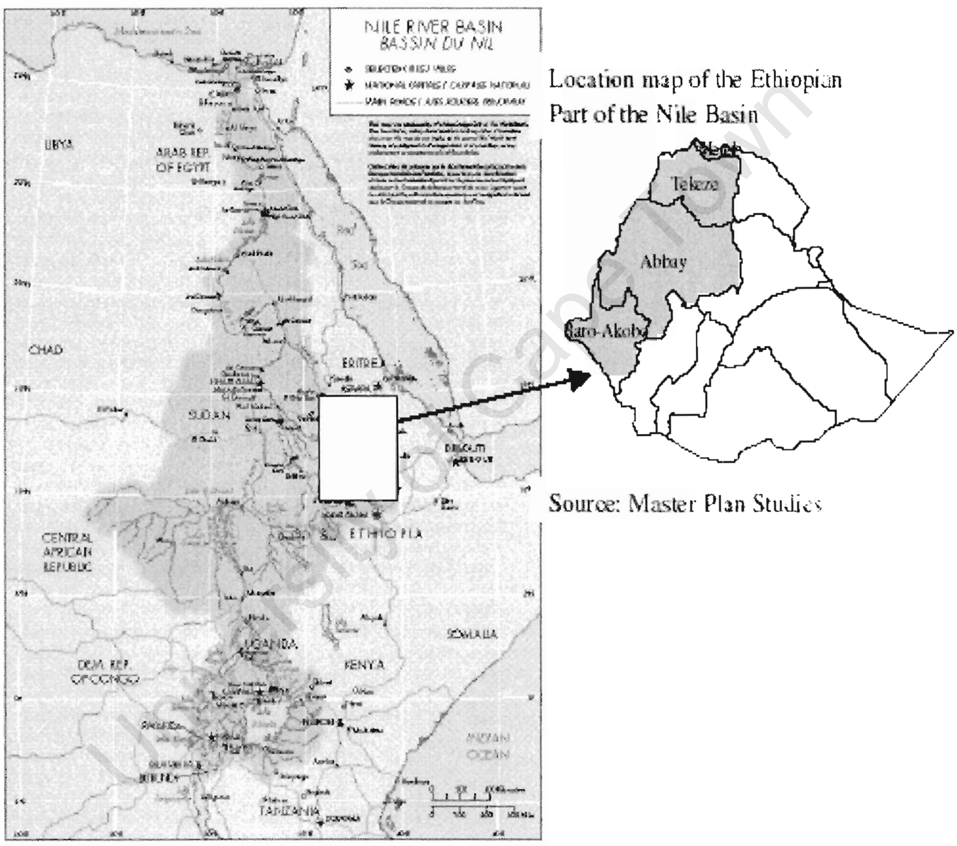

Figure 5.3.The location of the Nile River Basin in Ethiopia

Source: - Wubeshet (2003)

Table 5.8.Nile Basin water flow, and hydroelectric power and irrigation, potential and utilized

Nile Basin Countries	Actual flows		Hydro electric potential TWh/year[1]	Actual generation GWh/year[1]	Area already under irrigation (Ha)	Irrigation potential (Ha)
	inflow (km3/yr)	outflow (km3/yr)				
Burundi	0.0	1.5	>1	98	0	80 000
Rwanda	1.5	7.0	NA	110	2 000	150 000
Tanzania	7.0	10.7	20	1 748	10 000	30 000
Kenya	0.0	8.4	9	3 294	6 000	180 000
Zaire	0.0	1.5	774	5 350	0	10 000
Uganda	28.7	37.0	>7	1 600	9 120	202 000
Ethiopia	0.0	80.1	>260	1 600	23 160	2 220 000
Eritrea	0.0	2.2			15 124	150 000
Sudan	117.1	55.5	19	1 000	1 935 200	2 750 000
Egypt	55.5	rest to sea	>50	1 1450	3 078 000	4420 000
Sum					**5 078 604**	**10 192 000**

Source: Ilomäki (2002); [1] WEC (2003).

Table 5.9. Water resources, irrigation and hydroelectric power potential, areas under irrigation, and utilized hydropower in the different Nile Sub-Basins in Ethiopia

Nile sub-basin	Annual surface runoff (km³)	Irrigation potential (ha)	Irrigated area in 1989 (ha)	Technical hydroelectric power potential (GWh/year)	Utilized capacity (GWh/year) [1]
Baro-Akobo	13.4	905 500	350	18,900	-
Blue Nile (Abbey)	54.7	1 001 500	21 010	78,800	1 076
Setit-Tekeze/Atbara	12.0	312 700	1 800	6,000	
Total Nile basin	**80.1**	**2 219 700**	**23160**	**103,700**	**1 076**

Source: Ilomäki (2002); EEPCo (2002:EEPCo in brief)

Figure 5.4. The location of Major Rivers in Ethiopia

Table 5.10. Hydroelectric power potential of Ethiopia

Name of River Basin	Number of Potential Sites				Technical HEP potential (GWh/year)	% share of the Total
	Small - scale < 40 MW	Medium- scale 40-60 MW	Large- scale > 60 MW	Total		
Abay	74	11	44	129	78 800	48.9
Rift Valley Lakes	7	-	1	8	800	0.5
Awash	33	2	-	35	4 500	2.8
Omo – Gibe	4	-	16	20	35 000	22.7
Genale – Dawa	18	4	9	31	9 300	5.8
Wabi Shebelle	9	4	3	16	5 400	3.4
Baro Akabo	17	3	21	41	18 900	11.7
Tekeze – Angereb	11	1	8	20	6 000	4.2
Total	173	25	100	300	159 300	100%

Source: - Solomon (1998).

Table 5.11. Water levels (%) in some of Ethiopia's major power plant dams in October 2002

Power plants	Amount of water level	Decreased by	Location (major river basin)
Melka-Wakana	55.85%	44.15 %	Wabi Shebell
Koka	45.75%	54.25%	Awash
Tana (Tis Abay)	85.80%	14.20 %	Abay
Finchaa	90.00%	10.00%	Abay

Source: Derived from Data collected, from EEPCo (2004)

CHAPTER 6

THE ROLE OF THE LMSMI SECTOR IN THE ETHIOPIAN ECONOMY

6.1 OBJECTIVE AND SCOPE

Before analysing the impacts of power outages on the LMSMI sector, based on the data obtained from the case study, it is important to understand the role of this sector in the country's economy and its energy requirements. This chapter first deals with the role of the LMSMI sector in the country's economy and then secondly examines the energy requirements of this sector. Most of the data obtained for this chapter has been from CSA LMSMI annual surveys. In addition relevant information has been included from other sources.

6.2 LARGE AND MEDIUM SCALE INDUSTRY IN ETHIOPIA

As stated in the in Chapter 3 page 30, the Ethiopian LMSMI sector is mainly characterized by a high concentration of industries producing consumer and light goods (e.g. bread, edible oil, soft drinks, beer, alcoholic drinks, and household and office furniture). For instance, in 2001/02, the food and beverage manufacturing industries accounted for 31% of the total number of LMSMI establishments, followed by the furniture manufacturing industries (16%). The food and beverage manufacturing industry group has an important place in socio-economic development of the country. In 2001/02, it accounted for nearly 50% of the LMSMI total value added (at market price)[83]; contributed 52% of the indirect taxes collected from the sector, and engaged 29% of LMSMI workers. The summary of major indicators by major industrial group is shown in Table 6.1.

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83 Value added in the national account concept (at market price) is defined as the difference between the gross value of production and intermediate costs (see definitions section in the Introduction Chapter).

Table 6.1.Basic indicators by industrial group: 2001/02 (1994 EFY)

Industrial group	No .of establishment	No. Employee in '000	GVP Note 1	Value Added Note 2	Indirect taxes	Energy Cost	Electricity cost	No. of establishment	Indirect taxes	GVP[1]	Value Added[2]	Energy cost	Electricity cost
			In million ETB					Percentage Share					
Food and Beverage	282	28	3136	1568	563	91	38	31.0	52.1	38.8	47.6	23.1	26.4
Tobacco	1	1	257	142	52	1	5	0.1	4.8	3.2	4.3	0.3	3.5
Textile and Wearing apparel	65	26	733	213	89	64	35	7.2	8.2	9.1	6.5	16.2	24.3
Tanning and Dressing of leather and leather products	52	7	825	189	38	11	7	5.7	3.5	10.2	5.7	2.8	4.9
Wood and Wood Products	21	1	41	21	4	4	2	2.3	0.4	0.5	0.6	1.0	1.4
Paper and Paper Products	73	6	431	182	37	12	5	8.0	3.4	5.3	5.5	3.0	3.5
Chemical and Chemical products	41	5	513	165	47	11	4	4.5	4.3	6.3	5.0	2.8	2.8
Rubber and Plastic products	39	4	467	197	63	22	11	4.3	5.8	5.8	6.0	5.6	7.6
Non-Metallic Mineral Products	100	8	694	301	86	161	29	11.0	8.0	8.6	9.1	40.9	20.1
Basic Iron and Steel	11	1	454	123	54	7	3	1.2	5.0	5.6	3.7	1.8	2.1
Fabricated Metal Products, Machinery, and Equipments	69	3	169	66	20	6	3	7.6	1.9	2.1	2.0	1.5	2.1
Motor Vehicles, Trailers & Semi-Trailers	7	1	229	69	14	2	1	0.8	1.3	2.8	2.1	0.5	0.7
Furniture	148	5	141	57	12	2	1	16.3	1.1	1.7	1.7	0.5	0.7
Total	**909**	**98**	**8090**	**3293**	**1081**	**394**	**144**	100	100	100	100	100	100

Source: Derived from CSA LMSMI Survey Report (2002)

Notes:

1. Gross value of production
2. Value added in the national account concept at market price (see the definitions section in the Introduction).

As stated in Chapter 3 and in Chapter 5, more recent government policy has promoted the involvement of foreign and local investors in this sector. More than 22 relatively large industries previously public-owned have been gradually privatised since 1996. Nonetheless, the public-owned large manufacturing industries still dominate this sector. They accounted for only 16% of the LMSMI establishments, but as shown in Table 6.2, in 2001/02, those public-owned larger industries contributed nearly twice as much as the private-owned manufacturing industries toward the economy of the country.

Table 6.2. Major indicators by ownership: 2001/02 (1994 EFY)

Major indicators	Public	Private	Percentage		Per establishment	
			Pub.	Priv.	Public	Private
Number of establishments	143	766	16%	84%		
Number of person engaged	56 588	42 398	57%	43%	396	55
	In '000 ETB				In '000 ETB	
Gross value of production	4 946 951	3 144 786	61%	39%	34 594	4 105
Value added at market price	2 317 780	976 795	70%	30%	16 208	1 275
Indirect taxes	718 970	361 914	67%	33%	5 028	472
Exports	342 789	303 979	53%	47%	2 397	397

Source: Derived from CSA LMSMI survey (2002)

Table 6.3 and Figure 6.1 show that there is a considerable variation in the value of production among all the LMSMIs in the country. For instance, in 2001/02, there was a huge gap between the median and mean of this value. In this year, the median was 0.534 million ETB and the mean was 8.8 million ETB, which indicated that the value of production was highly skewed toward the largest manufacturing industries. The frequency distribution of the value of production across all the LMSMIs shows this in more detail (see Figure 6.1).

Most of the establishments (about 60%) in the sector are relatively small with production of less than a million ETB (USD 116 thousand) per annum. However, although the sector is dominated numerically by relatively small industries, a very few large-scale industries in the sector contribute more towards the country's economy. As shown in Table 6.3, for instance, in 2001/02 more than 65% of indirect taxes and export earnings in the LMSMI sector came from the top 10% large-scale industries, those with production greater than 23 million ETB per year. In the same year more than 30% of LMSMI workers were engaged in these companies. Among these, the top 1% relatively very large industries, whose production was above 214 million ETB per year, contributed nearly 19% of taxes and export earnings, and engaged 7% of the LMSMI workers.

Table 6.3.Value of production* by percentiles in '000 ETB: 2001/02 (1994 EFY)

Percentiles	All industry	The Top 10%	The top 1%
10	76	26 731	240 683
20	139	33 361	240 683
30	217	35 379	292 002
40	345	40 129	343 321
50	552	61 368	347 049
60	1,005	74 958	350 776
70	2,302	88 988	375 230
80	6,280	111 337	399 683
90	23,451	213 637	399 683
	The percentage share from the total LMSMI		
Number person engaged	100%	31%	7%
Value of production	100%	56%	17%
Export	100%	66%	20%
Indirect tax	100%	67%	19%
Electricity consumption	100%	68%	16%
Energy consumption	100%	78%	37%

Source: Derived from CSA LMSMI survey data (2002)

1. Value of production here is the value of production sales in 2001/02 and the net change of both finished and in-processed stocks between the beginning and end of the reference period, excluding other incomes. (I.e. gross value of production minus other income).

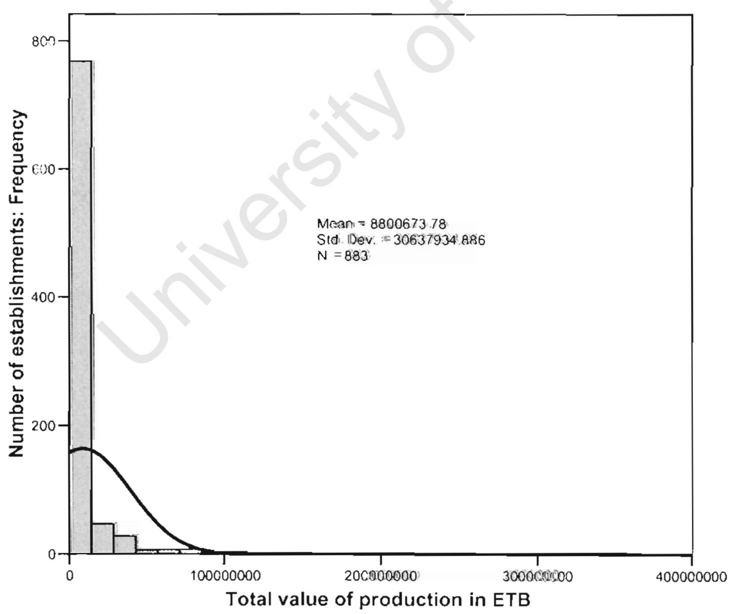

Figure 6.1. Frequency distribution of total value of production

Source: Derived from CSA LMSMI survey data (2002)

6.2.1 The Role of LMSMI in the Country

The Ethiopian LMSMI plays a major role in the country's economic development, second to the agricultural sector. **Firstly**, the LMSMI contribution towards the country's value added and GDP is relatively higher compared with the contribution of other industrial sectors (i.e. construction, quarrying and mining, small-scale and handicrafts industry, and the water and electricity industry). As illustrated in Table 6.4 and Table 6.5, all industries contributed an average of 10.8% to the country's GDP between 1995/96 and 2002/03, and within this the share of the LMSMI sector was 4.3%.

Table 6.4. Gross domestic product by sector in million ETB (at constant price) 1995/96 – 2002/03 (1988 – 1995 EFY)

E.F.Y	1988	1989	1990	1991	1992	1993	1994	1995
G.C.	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03
						Estimated		
Agriculture & Allied activities	7,206	7,454	6,621	6,874	7,025	7,831	7,651	6,664
Industry	1,435	1,531	1,567	1,701	1,731	1,818	1,923	2,017
Mining & Quarrying	55	63	69	75	83	90	98	108
LMSMI	558	594	587	688	713	736	773	812
Small Scale Industry & Handicrafts	269	280	275	294	302	317	324	325
Electricity & Water	203	215	223	226	235	243	260	270
Construction	349	380	412	418	399	431	468	502
Distributive Services	1,915	2,062	2,178	2,254	2,423	2,550	2,663	2,749
Other Services	3,375	3,594	4,064	4,466	4,933	5,155	5,395	5,472
	13,931	14,640	14,429	15,294	16,112	17,354	17,632	16,902

Source: Data compiled from MOFED (2003)

Table 6.5. Percentage distribution of GDP by sector (at constant price) 1995/96 – 2002/03 (1988 – 1995 EFY)

E.F.Y	1988	1989	1990	1991	1992	1993	1994	1995
G.C.						00/01	01/02	02/03
	95/96	96/97	97/98	98/99	99/00	Estimated		
Agriculture & Allied activities	51.73	50.91	45.88	44.94	43.60	45.12	43.39	39.43
Industry	10.30	10.45	10.86	11.12	10.75	10.48	10.91	11.93
Mining & Quarrying	0.40	0.43	0.48	0.49	0.51	0.52	0.56	0.64
LMSMI	4.00	4.06	4.07	4.50	4.42	4.24	4.39	4.80
Small Scale Industry & Handicrafts	1.93	1.91	1.91	1.92	1.87	1.83	1.84	1.92
Electricity & Water	1.46	1.47	1.55	1.48	1.46	1.40	1.48	1.60
Construction	2.51	2.59	2.86	2.74	2.48	2.49	2.65	2.97
Distributive Services	13.74	14.09	15.09	14.74	15.04	14.69	15.10	16.26
Other Services	24.23	24.55	28.17	29.20	30.62	29.70	30.59	32.37

Source: Data compiled from MOFED (2003)

Secondly, since the agricultural sector[84] is the backbone of the Ethiopian economy, the government recently has launched an Agricultural Development-Led Industrialisation strategy for long-term development. The country's LMSMI sector is important for the successful implementation of this development strategy because it plays a vital role as a marketing channel for agricultural products. A better market for agricultural products will certainly boost production and productivity. Thereby, the wellbeing of the majority of the country's population which engages in this activity will improve. Most importantly this will possibly help to ensure food security and self-sufficiency.

Currently most of the industries in food, leather, textiles, and the wood and furniture groups predominantly use the direct and indirect products of agriculture. In 2001/02, for instance, three huge sugar factories contributed the highest value-added in the food industry (18%), and about 95% of their inputs were agro-products (CSA 2002). Most of the companies in the sector which play a key role in the country's economy predominantly use agro-products. As illustrated earlier in Table 6.1, for example, manufactures of food and beverages, textiles, tobacco and leather products contributed more than 65% of the LMSMI value-added and indirect taxes to the country's economy. More than 62% of LMSMI workers depend on them, and all the export earnings of the LMSMI sector come from manufactures that mainly use agricultural products (CSA 2002).

Thirdly, it is widely recognized that a greater utilisation of local products in manufacturing could place the country in a better position by encouraging local producers, and reducing the consumption of inputs from foreign markets. This in turn would reduce the foreign currency that is needed to import raw materials and finished goods, which would again greatly benefit the country by minimising the prevailing severe negative balance of payment between imports and exports. As illustrated in Table 6.6, for instance, for the last four years between 1999 and 2002, the value of exports of goods and services was only between 45% to 50% of total imports of goods and services.

84 In 2000/01 about 80% of the country's population earned their livelihood from this sector. It contributed about 44% to the GDP, and about 70% to the export earnings. The sector is also a major source of raw material to industry.

Apart from the above mentioned industrial groups which mainly use the country's agro-products, other large manufacturing industries in the country, like cement and glass factories, also depend on the local products from other sectors (quarrying and mining). In 2001/02, for example, more than 95% of their raw materials came from the products of local quarrying industries (CSA 2002). There are many direct interdependencies within the LMSMI, such as between the wood and furniture manufacturing industries, textile manufacturing industries providing inputs for the garment sector and wearing apparel manufacturing industries, and between the leather and shoes manufacturing industries.

Table 6.6. Government revenue and trade (at current market price) 1999/00 – 2002/03 (1992 – 1995 E.F.Y) In million ETB

EFY	1992	1993	1994	1995
EC	1999/00	2000/01	2001/02	2002/03
Government revenue and Grants	**11872**	**12805**	**12835**	**13596**
Total Tax revenue	6483	7440	7928	8243
Income and profit taxes	2169	2495	2980	2878
Domestic indirect tax	1440	1382	1499	1668
Foreign trade taxes	2676	3233	3308	3565
Revenue from others and grants	5389	5365	4907	5353
Government Expenditure	**17181**	**15383**	**17652**	**18402**
Overall budget deficit including grants	**-5309**	**-2578**	**-4817**	**-4806**
Revenue from LMSMI	**1289**	**1326**	**1330**	
Direct Tax	285	281	249	
Indirect Tax	1004	1045	1081	
Percentage share of total government domestic indirect tax	70%	76%	72%	
Trade				
Total Exports	8018	7982	8025	9015
Total Imports	15969	16194	17710	18490
The share of value of exports from imports	50%	49%	45%	49%
Balance	-7951	-8212	-9685	-9475
Export Revenue from LMSMI Products			**647**	
Food products			154	
Textile & Textile products			48	
Semi process leather & leather products			445	

Source: Derived from CSA LMSMI Survey Report (2002); National Bank of Ethiopia (2004); data compiled from MOFED (2003)

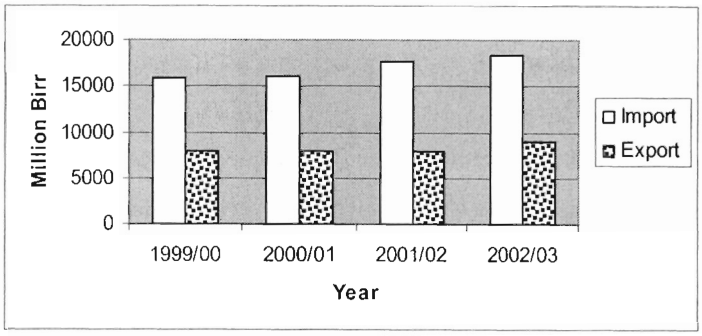

Figure 6.2. The value of imports and exports: 1999/00 – 2002/03 (1992 – 1995 EFY)

However the linkages within the manufacturing sector are not fully developed and remain rather poor when compared with other countries in the world. For example, many metal and chemical producers depend heavily on imported inputs. Only a few industries in the country produce inputs for chemical and metal industries (two or three manufacturers). In addition, virtually all of the firms in the sector use imported spare parts which obviously require quite a large amount of foreign currency. Due to this the total costs of imported raw materials plus spare parts reached 1.6 billion ETB[85] (approximately USD 0.19 billion) in 2001/02 (CSA 2002). This was just slightly less than the costs of local raw materials, despite the fact that the majority of inputs in this sector are local products.

Investment in industries such as chemical and metal products requires a lot of skilled labour, finance, and a secure and reliable local market. Currently, the numbers of manufacturers which demand the products of those industries are not sufficient to secure the market. All these factors together with the price and quality of the same products from foreign market sources could discourage the local or the foreign investors to invest in these types of industries in the country.

Besides this, while the main inputs of most of the LMSMI are agro-products, the linkages between LMSMI and agricultural production are still very poor when compared with the amount of agro-products and agricultural potential of the country, particularly in vegetable, fruit and animal products. Only very limited agricultural products are being processed and preserved by a few LMSMI companies in the country. Every year, therefore, there are huge wastages of agro-products, and their

85 Which accounted for about 10% of total value of the country's imports in 2001/02.

economic values remain very low. This again has serious effects on the development of agriculture, and on the economy of the country, by discouraging farmers involved in such agricultural production.

Fourthly, the LMSMI sector not only plays a vital role for import substitution but is also important for export earnings. Currently, the majority of Ethiopian LMSMI products are produced for local use, and the value of export earnings out of the total LMSMI revenue is low. As shown in Table 6.8, for example, the share of export revenue from the total LMSMI revenue in 2001/02 was only 9%. Nevertheless, the country's second largest export earnings, after coffee, are from the sales of leather and leather products, representing about 14% of the total earnings of 2001/02. Unlike other LMSMI products, the majority of the leather products (more than 60%) are exported to foreign countries. The country has built a reputation for producing world-quality hides and skins, which are attractive to international buyers, and recently the country has started producing export-quality leather garments.

In addition to leather garments, the country also exports a few final other products of the LMSMI, including textiles, footwear, sugar and mineral water (see Table 6.7). Sugar has become particularly important for the country's export earnings in the last two or three years. For instance in 2001/02, the country's earned 129 million ETB (USD 15 million) from the sales of sugar in foreign markets, which accounted for 20% of total export earnings from LMSMI products and 4.5% of the total export earnings of the country over the same year.

In total the products of LMSMI accounted for more than 16% of the total export earnings in 2002.

Table 6.7. The share of Ethiopian exports by commodity: 2000 – 2002 G.C

Commodity	2000	2001	2002
Manufacturing Products	**11.68%**	**19.70%**	**16.21%**
Hides and skins	**9.87%**	**17.28%**	**13.76%**
Hides (semi processed)	0.82%	3.93%	1.80%
Skins (semi processed)	7..94%	13.31%	11.95%
Leather products	1.10%	0.04%	0.01%
Sugar	2.14%	0.22%	4.53%
Spices	0.68%	1.07%	0.94%
Meat & meat products	0.49%	0.35%	0.38%
Molasses	0.04%	0.13%	0.12%
Beverage	0.03%	0.04%	0.04%
Footwear	0.02%	0.02%	0.01%
Textile, clothing & apparel	0.56%	0.79%	0.96%
Ceramic products	0.01%	0.00%	0.00%
Agricultural products	**77.99%**	**67.38%**	**67.80%**
Coffee	53.00%	33.52%	35.62%
Chat	14.31%	12.52%	9.42%
Oil Seeds	5.96%	8.69%	8.83%
Pulses	2.13%	4.76%	6.83%
Cotton	1.20%	1.50%	1.48%
Fruits & vegetables	0.66%	1.96%	2.48%
Cereals	0.73%	4.44%	3.14%
Gold	**5.74%**	**8.05%**	**8.42%**
Others*	**2.48%**	**4.70%**	**3.08%**

Source: Derived from Ethiopian Export Promotion Agency (2002)

* **Note:** the majority of others are agricultural products

Table 6.8. Revenue from sales - local and export (LMSMI): 2001/02 (1994 EFY)

Type of ownership	Local	Export	Total	Local	Export	Total
	Million of ETB			Percentage Shares		
Public	4291	343	4634	93%	7%	100%
Private	2592	304	2896	90%	10%	100%
Total	**6883**	**647**	**7530**	**91%**	**9%**	**100%**

Source: - Derived from CSA LMSMI survey report (2002)

In relation to the country's agricultural potential, particularly the livestock sector capacity[86], the export earnings from agro-industries products remain very small. With approximately 30 million cattle, 24 million sheep and 18 million goats, Ethiopia has the largest livestock herd in Africa, and the tenth largest in the world (EPA 2002b). Currently, as in most developing countries, livestock farming is subsistence based, with very little commercial ranching. If both the agricultural and LMSMI sectors are properly developed, the country could earn quite considerable foreign currency from the sales of agro-industrial products. Obviously, this in turn could reduce the severe imbalance between internal and external trade. The country could possibly even earn more than the required foreign currency to import products and services, helping to make the country self-sufficient and promoting higher socio-economic development.

Fifth, government revenue is important for the effective involvement of government in the socio-economic development of the nation. The majority of Ethiopian government revenues come from taxes that are collected from different sectors. Between 1999/00 and 2001/02, for instance, the share of the tax revenues on average was 44% of government expenditures; the remaining balance came from non-tax revenues, grants and external borrowing.

Unlike the other industry sectors (e.g. construction, quarrying and mining, small-scale and cottage industry), the Ethiopian LMSMI are formal in nature (i.e. most of them keep books of account and are licensed, relatively large and have a fixed address). This makes the tax collection from this sector easier, and has allowed the Ethiopian government to collect the necessary taxes (direct and indirect) from this sector on a more regular basis than in the other sectors. Thus, government earns quite a large amount of revenue from LMSMI taxation every year. As shown in Table 6.9, for instance, the share of indirect tax revenue from this sector was on average 72% of total indirect taxes collected from the domestic sectors in the country, from 1999/00 to 2001/02. In addition government also generates revenue from the income taxes on LMSMI companies and their workers. Again unlike the other industries which in most cases employ daily labourers, most employees in the

86 Hide skins, leather and leather products represent a significant proportion of the value of world trade in agricultural commodities, amounting to approximately USD 35 billion per annum (EPA 2002b).

LMSMI are permanent and formal, due to which they are subject to pay income taxes.

Table 6.9. Percentage share of government revenue by source: 1999/00 – 2002/03

EFY	1992	1993	1994	1995	
GC.	1999/00	2000/01	2001/02	2002/03	Average
Government revenue and Grants	**69%**	**83%**	**73%**	**74%**	**75%**
Total Tax revenue	38%	48%	45%	45%	44%
Income and Profit Taxes	13%	16%	17%	16%	15%
Domestic Indirect Taxes	8%	9%	8%	9%	9%
Foreign Trade Taxes	16%	21%	19%	19%	19%
Revenue form others and grant	31%	35%	28%	29%	31%
Government Expenditure	**100%**	**100%**	**100%**	**100%**	**100%**
Overall budget deficit including grants	-31%	-17%	-27%	-26%	-25%
Revenue from LMSMI (In million ETB)	**1289**	**1326**	**1330**		**1315**
Direct Tax	285	281	249		272
share of the country's total income and profit taxes	13.1%	11.3%	8.4%		11%
Indirect Tax	1004	1045	1081		1043
share of the country's total domestic indirect tax	70%	76%	72%		72%

Source: - Derived from data compiled from CSA data (2004); National Bank of Ethiopia (2004)

Sixth, LMSMI industries also play a vital role for job creation; especially they act as a base for technology transfer that can take place through human resource development and management creation. The skills obtained through the technology transfers increase the know-how of local LMSMI workers. It is widely recognized that human development through technology transfer is crucial for the sustainable development of a country.

Quite a number of workers engage in the Ethiopian LMSMI sector from different occupation groups, ranging from unskilled labourers to top experts. In particular, a large number of experts in the country have jobs in the fields of electrical, mechanical, and chemical engineering and chemistry. In total about 98,136 workers were engaged in this sector in 2001/02, of which more than 99% were employees, most of them permanent workers (about 80,000 or 82%).

Due to their highly labour-intensive production, the Ethiopian textile and textile products manufacturing industries are more important in regard to employment, especially for unskilled labourers, and more particularly for women workers. Despite the fact that the textile industries are fewer in number compared with the number of establishments in the other LMSMI groups, the majority of LMSMI workers are engaged here. For instance, in 2001/02, 22% of the LMSMI workers were engaged in 36 textile manufacturing establishments (these establishments consisted of only 4% of the total LMSMI establishments), with an average about 622 workers per establishment, of which 40% were women workers.

In general the following factors make the Ethiopian LMSMI more important with regard to the country's employment situation.

- Unlike the other industrial sectors which in most cases employ seasonal or daily labour, the majority of the LMSMI workers are permanent, and can earn regular salaries.
- The majority of the permanent workers receive various benefits from their employer, such as payment for their education, free training, and pensions.
- Due to the non-seasonable nature of most of the manufacturing production activities (unlike construction and quarry activities), the jobs in the LMSMI are more secure and stable.
- Unlike the services sectors, they employ relatively large number of unskilled workers and give training to them.
- Many production workers gain various skills, such as in technical, electrical, mechanical, and chemical fields, through formal and informal training. By pursuing their careers in those fields many of them can get a better job and even open their own businesses.
- Workers are relatively well-paid; In 2001/02 the average salary of LMSMI workers, including both permanent and temporary workers together, was above 600 ETB per month, which is nearly 4 times higher than the minimum wage in the country.

In general, successful development of the LMSMI sector plays a key role for the socio-economic development of the country. To realise this, provision of quality and reliable infrastructure is crucial. Of course energy is one of the most important infrastructural requirements, as all the firms in this sector use power-driven machines to accomplish most of their production tasks. The next parts of this chapter deal with the energy requirements of the sector.

6.2.2 Energy requirements for LMSMI production activities

As mentioned above in the introductory definitions in Chapter 1, the LMSMI are those industries which use power-driven machines to accomplish the majority of their tasks. Accordingly these industries need energy to drive the machines. Electricity is the main energy source for this, used by nearly all industries. In addition to electricity, some very large industries use furnace oil, mainly for boilers. The main reason for this could be that furnace oil is relatively cheaper for such purposes (case study finding). Wood and charcoal are used by some industries, particularly the food industries (e.g. manufacturing of bakery products), but those fuels are usually only needed for emergency reasons, when electricity is interrupted.

A summary of the fuel use by major industrial groups is shown in Table 6.10, derived from the 2001/02 CSA survey results. Electricity was used by 850 firms/companies, 78 firms used furnace oil and 62 used wood and charcoal in addition. The total electricity consumption in value was 139 million ETB per annum (USD 16 million), which was approximately 300 GWh, accounting for above 48% of the total electricity consumption by all industries[87] (high voltage and low voltage industry) and 18% of the total electricity sales in the same year (see Chapter 4:54: Table 4.6).

Despite the fact that energy is required by all industrial groups in this sector, some industries, like non-metallic mineral products, textile and wood industries, whose production activities are highly energy-intensive, need quite a large amount of energy in order to create the same amount of added value to the country's economy. It is evident from Table 6.10 that in 2001/02 non-metallic mineral manufacturing industries spent more than 160 million ETB per year on energy; on average each firm in this industrial group spent approximately 1.8 million ETB. The share of their energy costs as a proportion of total industrial cost is quite substantial, about 48% in this year. For one ETB added value to the economy, these industries spent more than 0.5 ETB on energy. The costs of energy in other industry groups with less energy-intensive activities were generally less than 10% of their value-added contribution, except for the textile and wearing apparel manufactures (30% of value-added), wood and wood products (18% of value-added), and rubber and plastic products (11%).

.[87] Note that all industries mean here LMSMI, construction, quarrying and mining, small-scale and handicrafts industries, and the water and electricity industries.

Table 6.10. Numbers of firms[88] and costs of energy by fuel type (in '000 ETB) 2001/02 (1994 EFY)

Industrial group	No of Firm by type of fuel use			Energy costs by fuel type				Total Industrial costs	Percentage share of energy costs of the total industrial costs	Ratio of energy costs to value added
	Wood And Charcoal	Furnace Oil	Electricity	Furnace oil	Electricity	Other fuel	Total			
Food and beverage	43	28	252	20 567	38 352	31 733	**90,652**	1 218 500	7%	0.06
Tobacco	-	-	1	-	716		**721**	96 124	1%	0.01
Textile and wearing apparel	-	7	62	15 483	34 852	12 942	**63 277**	473 227	13%	0.30
Tanning and dressing of leather and leather products	1	7	51	1 907	6 848	2 046	**10 801**	600 716	2%	0 06
Wood and wood products	3	3	20	785	2 115	957	**3 857**	17 225	22%	0 18
Paper and paper products	-	6	71	6 784	4 792	914	**12 490**	226 973	6%	0.07
Chemical and chemical products	3	6	40	4 697	4 377	1 593	**10 667**	308 343	3%	0.06
Rubber and plastic products	1	4	36	9 996	10,707	1 559	**22 262**	238 750	9%	0.11
Non-metallic mineral products	6	6	91	121 873	29 107	9 940	**160 920**	332 301	48%	0.54
Basic iron and steel	-	-	10	-	2 963		**7 038**	319 346	2%	0.06
Fabricated metal products, machinery, and equipments	4	5	66	274	2,770	2 801	**5 845**	92 524	6%	0.09
Motor vehicles, trailers & semi-trailers	-	2	6	254	825	447	**1 526**	148 328	1%	0.02
Furniture	1	4	144	80	1 307	227	**1 614**	71 059	2%	0.03
Total	**62**	**78**	**850**	**182 698**	**139 731**	**65 161**	**391 670**	**4 143 416**	**9%**	**0.12**

Source: Derived from data compiled from CSA (2002)

88 In this paper, firm and company are synonymous.

The other factor that determines the energy requirement of the industries in the sector is the size of the firm or the amount of production per year. Just as there are highly skewed distributions in value of production across all firms in the sector, there is also considerable variation in energy consumption. For instance, the larger firms consume more than a hundred times that of the smaller industries. Energy and electricity consumption of LMSMI by value of production per hour (value in ETB/hour) are shown in Table 6.11 and Figure 6.2.

As shown in the table, in 2001/02, the large industries in the sector with production levels of more than 50 000 ETB per hour comprised only 0.79% of the LMSMI establishments, but their share of LMSMI energy and electricity consumption was 39% and 18%, respectively. These industries are particularly important due to their higher production capability, high contribution of value-added and taxes toward the country's economy, and because relatively large numbers of workers are also engaged here.

Table 6.11 also shows how firms working more than 18 hours per day tend to consume more energy than the firms with lower working hours per day (<12 hours). In 2001/02 the share of the total energy consumption of the former group was 29%, which is about four times their numerical share in the sector (7%). The total energy consumption of the latter group, which consists of most of the LMSMI establishments (77% of the establishments), was 57%, which is less than their numerical share in the sector. This pattern was also true for electricity consumption.

Table 6.11. Cost of energy by the value of production of the firms in 2001/02 (1994 EFY)

Value of production per hour*	Number of working hours									
	Not stated	< 12 hours	12 - 18 Hours	19-24 hours	Total	Not stated	< 12 hours	12 - 18 Hours	19-24 hours	Total
	Number of Firms					Percentage share of number of firms				
Not stated	73				73	8.27%				8.27%
< 1000		525	48	18	591		59.46%	5.44%	2.04%	66.93%
1000 - 5000		80	14	25	119		9.06%	1.59%	2.83%	13.48%
5000 - 10000		29	7	5	41		3.28%	0.79%	0.57%	4.64%
1000 - 20000		21	3	6	30		2.38%	0.34%	0.68%	3.40%
20000 - 50000		12	5	5	22		1.36%	0.57%	0.57%	2.49%
> = 50000		6		1	7		0.68%		0.11%	0.79%
Total	73	673	77	60	883	8.27%	76.22%	8.72%	6.80%	100.00%
	Costs of Energy (in million ETB)					Percentage share of energy cost				
Not stated	25				25					6.55%
< 1000		10	2	5	17		2.46%	0.49%	1.35%	4.30%
1000 - 5000		12	8	23	43		3.08%	1.97%	5.97%	11.02%
5000 - 10000		24	4	12	41		6.28%	1.15%	3.07%	10.50%
1000 - 20000		12	7	36	55		3.01%	1.89%	9.31%	14.20%
20000 - 50000		22	5	28	55		5.77%	1.26%	7.13%	14.16%
> = 50000		144		8	152		37.31%	0.00%	1.96%	39.27%
TOTAL	25	224	26	111	387		57.91%	6.75%	28.79%	100.00%
	Costs of Electricity (in million ETB)					Percentage share of electricity cost				
Not stated	13				13	9.28%				9.28%
< 1000		7	1	3	11		4.78%	1.08%	2.23%	8.08%
1000 - 5000		7	4	14	25		5.06%	2.79%	10.20%	18.05%
5000 - 10000		7	2	7	16		5.23%	1.75%	4.77%	11.76%
1000 - 20000		6	7	16	29		4.31%	4.83%	11.98%	21.12%
20000 - 50000		10	2	7	19		7.01%	1.48%	5.33%	13.82%
> = 50000		24		1	25		17.47%	0.00%	0.43%	17.89%
TOTAL	13	60	16	48	137	9.28%	43.85%	11.93	34.94%	100.00%

Source: - Derived from data collected from CSA (2004)

* Value of production here is the value of production sales in 2001/02 and the net change of both finished and in-processed stocks between the beginning and end of the reference period, excluding other incomes. (I.e. gross value of production minus other income).

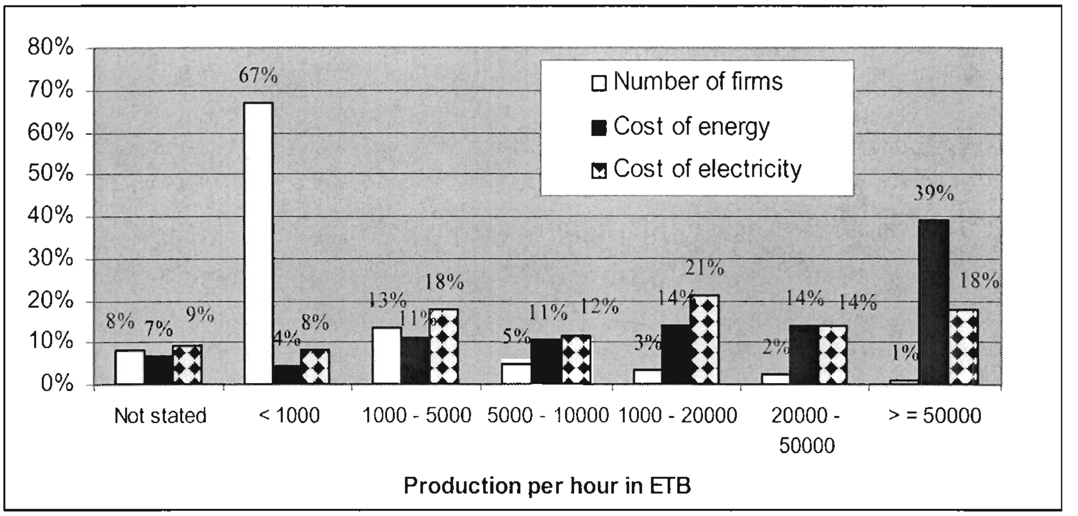

Figure 6.3. Percentage share of energy and electricity consumption by value of production of the firms in LMSMI sector in 2001/02 (1994 EFY)

Source: - Derived from data collected from CSA (2004)

In addition to the quantity of supply, the quality and reliability of electricity is very important for some industries in the sector, which undertake a long process of manufacturing such as leather, polypropylene, pharmaceutical, tyre, and chemical industries. The working hours of these industries are normally more than one shift (e.g. 16 hours and more). These industries badly need uninterrupted electricity supply during their working hours, particularly during the process of production; even a very short period of power supply interruption could have a serious adverse effect on their production. In-depth analysis of the impact of power outages on those industries will be presented in the next chapter.

Electricity demand in the LMSMI sector is expected to grow, mainly as a result of newly opened establishments. Due mainly to the revision of the investment code, which has encouraged investment in the manufacturing sector by domestic and foreign private investors, quite a number of manufacturing industries have been launched since 1992 as shown in Table 6.12. The average number of newly-added industries in the sector per year in the last decade, from 1992 to 2001, was five times more than the average number of newly-added industries in the previous two decades (from 1974 to 1991). On average per year from 1992 to 2001, 44 firms were commenced, whereas between 1974 and 1991 only eight new industries were launched per year, on average. As evidenced in the same table, in 2001/02, the share of electricity consumption of the former group (firms established since 1992) was 25% and the latter group was 31%. Together these two groups shared more than 55% of the total electricity consumption in the LMSMI sector in 2001/02.

Table 6.12. Electricity consumption by year of commencement and ownership 2001/02 (1994 EFY)

Year of commencement		Number of firms				Electricity consumption in '000 ETB				Gross Value of Production Share
Gregorian calendar	Ethiopian calendar.	Private	Public	Both	Total	Private	Public	Both	Total	
Before1974	Before 1966	103	69	7	179	12 390	37 245	10 095	59 730	
1974- 1991	1967 -1983	144	33	1	178	5 523	37 132	175	42 829	
1991+	1984 -1994	472	17	0	489	27 101	7 098	0	34 199	
Total		719	119	8	846	45 014	81 475	10 270	136 759	
Before 1974	Before 1966	14.3%	58.0%	87.5%	21.2%	27.5%	45.7%	98.3%	43.7%	52.0%
1974- 1991	1967 -1983	20.0%	27.7%	12.5%	21.0%	12.3%	45.6%	1.7%	31.3%	20.0%
1992-2001	1984 -1994	65.6%	14.3%	0.0%	57.8%	60.2%	8.7%	0.0%	25.0%	28.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

E.C,.			Share		G.C
Date of Comm	No.firms	Elec.Cons In' 000 ETB	No Firms	Elec Cons	Date of Comm.
1984	30	2 059	3.5%	1.5%	1992
1985	42	2 047	5.0%	1.5%	1993
1986	33	1 631	3.9%	1.2%	1994
1987	48	2 378	5.7%	1.7%	1995
1988	54	10 314	6.4%	7.5%	1996
1989	57	4 425	6.7%	3.2%	1997
1990	64	4 378	7.6%	3.2%	1998
1991	53	2 845	6.3%	2.1%	1999
1992	49	1 432	5.8%	1.0%	2000
1993	31	2 230	3.7%	1.6%	2001
1994	28	460	3.3%	0.3%	2001
Total	489	34 199	57.8%	25.0%	Total
Average	44	3 109	5.3%	2.3%	Average

Source: - Derived from data compiled from CSA (2004)

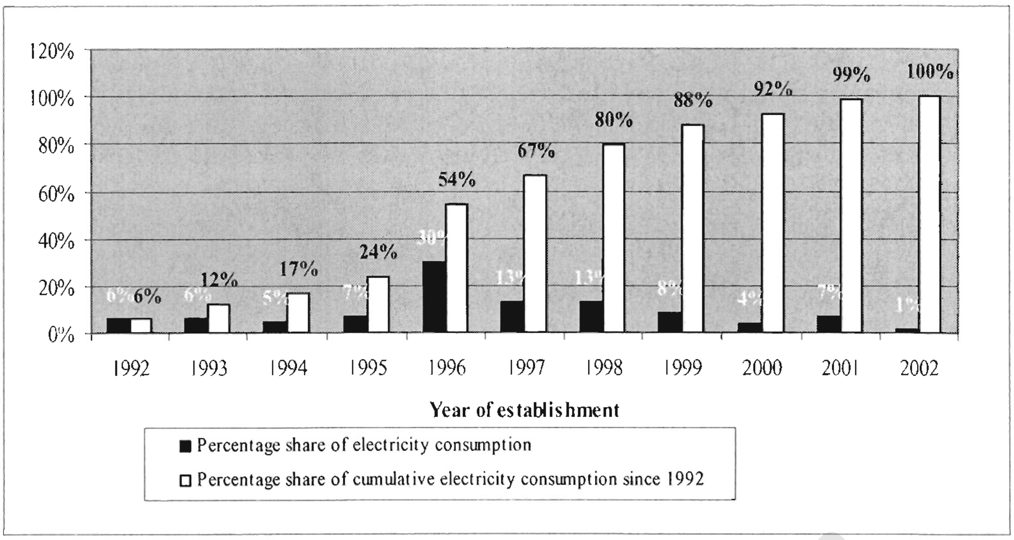

Figure 6.4. Percentage share of electricity consumption (in value) by year of commencement and cumulative electricity consumption since 1992

Source: - Derived from data compiled from CSA (2004)

Another factor that could possibly increase electricity demand in the sector in the foreseeable future is a growing dependency on computerised machines and other new technology which is only powered by electricity. It is envisaged that to increase profits and competitiveness, the Ethiopian LMSMI will increasingly use new technologies which are more automated and less labour-intensive. This change has already been seen in the sector with firms gradually changing to less labour-intensive methods, by shifting the majority of their tasks to computerised processes.

Other indicators of growing capital intensity are depicted in Table 6.13, derived from LMSMI surveys (CSA, 1988; 1998; 2002). Both gross value of production and fixed assets per employee have shown an upward trend since 1987. By 2000/01, GVP and the value of fixed assets per employee had increased by three and seven times respectively, from 1987 corresponding indicator figures. This indicates increasing labour productivity and a reduction in the labour forces needed to run equipment. At the same time, the value of fixed assets per unit of GVP has increased. In 1987 the value was 0.29, and in 2000/01 it reached 0.7, growing by 241% from the year 1987. These three indicators reflect how industries previously depending on large labour inputs have gradually given way to more capital-intensive manufacturing methods, including greater use of automated machinery requiring less human power intervention. It is envisaged that this is increasing the dependency on energy for nearly all LMSMI production activities, particularly electricity, which is necessary for computerised processes and electric machinery. Based on the past and current technology development scenarios, it is likely that the dependency on electricity in the LMSMI sector will become very high in the foreseeable future.

Table 6.13. Major indicators: 1987/88 – 2000/01 (1980 - 1993 EFY)

	1980	1985	1988	1990	1993
Indicators	1987/88	1992/93	1995/96	1997/98	2000/01
Gross value of production per employee	29 792	32 579	64 407	68 585	90 035
Value of fixed asset per employee	8 654	16 166	24 324	33 472	63 743
Fixed assets to gross value of production	0.29	0.50	0.38	0.49	0.71
Number of employees per establishment	185			123	118

Source: CSA (1988; 1998; 2002

6.3 CONCLUSION

In general, as discussed above, the Ethiopian LMSMI is very important for the country's socio-economic development. Although the economy is still dominated by agriculture, the LMSMI sector plays a vital role, particularly in regard to export earnings, import substitution, GDP contribution, employment, government revenue and foreign direct investment. Successful development of this sector, especially in the leather and leather products manufacturing industries, will be crucial in order to reduce the prevailing severe negative trade imbalance and the country's huge burden of debt. In addition to this, for the realisation of the government's long-term development strategy (Agricultural Development-Led Industrialization), the LMSMI sector should play a vital role as a marketing channel for agricultural products.

However for the successful development of this sector and to attract local and foreign investors in the sector, in addition to the government tax incentives and other encouraging initiatives, it has become very important to have a reliable and high quality electricity supply. These industries use electrical equipment to accomplish most of their tasks, and this dependence is likely to increase in the foreseeable future. In order to achieve competitiveness in the local and foreign markets, most of the firms in the sector will progressively replace old equipment with new modern machines and processes which increase the reliance on electricity.

Conversely if the quality and reliability of electricity are not maintained, this will have adverse impacts on the LMSMI sector, including the loss of outputs, wasted raw materials, damage to machinery and equipment, and other problems. It will discourage the involvement of foreign and local investors in the sector, particularly in view of the increasing reliance on manufacturing processes which are only powered by electricity.

The next chapter deals with the impacts of the past and current electricity supply problems in the LMSMI sector, using the data obtained from the case study undertaken in Addis Ababa between January 2004 and February 2004.

CHAPTER 7

THE IMPACT OF POWER OUTAGES ON THE LMSMI SECTOR: ANALYSIS OF THE CASE STUDY DATA

7.1 OBJECTIVE AND SCOPE

This chapter examines the various costs of power outages experienced in the Ethiopian LMSMI sector, using data obtained from a case study of 16 LMSMI firms undertaken in Addis Ababa between January 2004 and February 2004. Using the same data the chapter also examines the impact of power outages on related issues like employment, export earnings and Government revenues. Some more general views about electricity supply problems in the country, obtained from interviews with the firms are presented at the end of the chapter.

The scope of the analysis is mainly limited to the data obtained from the selected 16 LMSMIs in Addis Ababa. As explained in the Methodology Section (Chapter 2) this data included both public and private manufacturing companies from different manufacturing groups. They are relatively large and in 2001/02 accounted for 13%

Table 7.1. List of firms in the case study

Name of the firm	Working hours per day	No. Branch	Major Industrial Group
Addis Ababa Flour	24	1	Food and Beverages
Kality Food Factory	24	6	
Ethiopian Spice Factory	24	1	
National Alcohol & Liquor Factory	24	5	
Moha Soft Drink	16	1	
Shoa Cotton Ginning	16	1	Textile
Dire Industries (PLC)	10	1	Leather and Leather Products
Ethio-Leather Industry (PLC) (ELICO)	8	1	
Desta Private Limited Company	8	1	Footwear
Kadisco Chemical Industry	8	1	Chemical and Chemical Products
East African Group Soap	24	1	
Addis Tyre Company	24	1	Rubber and Plastics Products
Ethiopia Plastic Share Company	24	4	
Addis Ababa Cement Factory	24	1	Non-metallic Mineral Products
Automotive Manufacturing Company of Ethiopia	8	1	Motor Vehicles and Trailers
Mosvold Private Limited Company	8	1	Furniture

Source: Case study (2004)

of the total LMSMI gross value of production; and 12% of electricity consumption and 7% of energy consumption, and 24% of the total export earnings of the LMSMI. Some conclusions from the sample of 16 LMSMI firms will be extended to the entire LMSMI sector, as covered by the CSA survey between 1997/98 and 2001/02.

Most of the data obtained relates to the period between 1995/96 (when the first power shedding was introduced in the country) and 2002/03. However, particular focus will be given to the year 2002/03 (the most severe power-shortage year).

7.2 LIMITATIONS OF THE DATA AND THE ANALYSIS

In the survey, a number of limitations were encountered, including the following:

- Some of the firms had not kept records of the number of power interruption hours each year. For those firms which had recorded the number of downtimes due to power outages, a major challenge was to get the planned and unplanned electricity interruption hours separately.
- Although some firms mentioned subjectively high raw material losses due to unplanned power outages, the costs of the raw material losses were not recorded, except for one firm, which gave the amount and value of scrappages.
- The same was true for the costs of reported damage to machinery, etc., as a result of power outages or instability of supply.
- Another challenge was to estimate a unit operating cost (cost/kWh of electricity production) of using back-up diesel generators. All firms in the study said that the electricity from self-generation costs more than electricity from the utility, but in most cases it was difficult to quantify the additional costs. Due to this the additional costs of running diesel generator have been estimated from more detailed data obtained from three of the firms[89] and own estimation.
- The total investment cost of a firm in the reference year is important in order to calculate the relative investment costs of installing and maintaining generator[s].

89 By the end of 2003, 12 firms of the 16 interviewed firms had generators. The unit cost of operating diesel generators may not vary that much between different firms because the unit price of diesel fuel is commonly the same in Addis Ababa. However it is possible that different firms have spent different amounts on maintenance or operate diesel generators at different capacity factors and efficiencies.

Unfortunately, this question was not included in the questionnaire. In the analysis below, this share is calculated based on data obtained from CSA LMSMI surveys, but is restricted to those firms which bought their generators before 2003.

- A wider limitation of the analysis is that firms which recorded the number of downtimes as a result of electricity interruptions have not quantified the output losses in terms of monetary values. It is true that actual losses may not just be the number of electricity interruptions multiplied by the production per hour. There are other factors which could limit the amounts of production, even if the electricity were not interrupted, particularly lack of market and raw materials. However, a more complete analysis considering all the variables would require more data and a deeper understanding of each firm's business in relation to those variables. This in turn would require more time, finance and research resources which were not possible in the present study. Thus the estimation of the loss in outputs in terms of monetary value has been calculated only by multiplying the durations of downtimes due to power outages by the normal rates of production per hour.

7.3 COSTS OF POWER OUTAGES IN THE LMSMI SECTOR

The power shortage problem together with poor and unreliable electricity supply in Ethiopia has incurred significant costs on the LMSMI sector. Based on the case study findings, it is estimated that typical firms have lost approximately 100 to 350 hours per year worth of outputs between 1995/96 and 2002/03 on average, due to the planned and unplanned power outages. And while most of the firms in the case study have not kept records of the amount of raw materials lost in terms of monetary value, their subjective accounts of this problem indicated that some of them have lost quite a substantial amount of raw materials, mainly due to unplanned electricity interruptions. The same was true for the costs of damage caused to machinery and equipment.

In addition, the case study findings show that most of the firms (12 out of 16) have been subjected to additional costs of installing and operating their own diesel generators. A small generator (installed generation capacity <=250 KVA) can cost a firm about 300,000 ETB (about USD 35,000) and larger ones (600 – 1000 KVA) more than a million ETB (more than USD 100, 000).

In general, according to the case study findings, power outages have imposed several costs on the LMSMI sector, including losses in outputs, raw material losses, some damage to equipment, and the capital and operating costs for the self-generation. As well as these adverse effects on individual LMSMI manufacturers, the power supply problems have also had negative effects at a macro level, such as on employment, export earnings, and government revenues. The section below provides a more detailed analysis of these various costs.

7.3.1 Power outage costs resulting from losses of outputs

As mentioned above, because of planned and unplanned power outages, depending on the number of working hours within a day, a typical firm has lost an average of approximately 100 to 350 hours/year worth of outputs per branch between 1995/96 and 2002/03. Firms operating 24 hours a day could lose twice as much output, or more, as those firms working eight hours per day. The majority (more than 75%) of these output losses in 1995/96, 1997/98, 1999/00 and 2002/03 were attributable to planned outages, when power shedding was introduced as a result of power shortages. The production losses were greatest in 2002/03 (see Table 7.2).

Table 7.2 shows recorded production downtimes due to power outages for ten of the firms interviewed in the case study. As illustrated in Table 7.2, some of the firms have several branches, and in these cases the figures for production downtime refer to averages across all their branches (A special case is Firms No. 6, 10 and 16).The other six firms were not included in this analysis due to the following reasons:

- Firm No. 2 started operation in 2000. It has used a generator since 2002/03. No data was available for 2001/02.
- The hours of interrupted production of Firm No. 3, (which operated eight hours per day), were not recorded. They were in any case insignificant, mainly because this firm tried to compensate for the lost hours by doing non-power operations during the day time and operation requiring power at the night when electricity was available.
- Firm No. 4 had used auto generators since 1999/00 but was not operational in 1997 and 1998.
- The production activity of Firm No.5 was highly affected by the power outages but they had not kept records of interruption hours. However they tried to estimate these losses, in value and quantity.

- Firm No 8 had incomplete data because of documentation problems.
- The operation of Firm No 15 only commenced in 1999. They have used a generator since 2000.

The table shows that firms operating 24 hours per day generally experienced the most serious production losses. For example Firm No. 9 was able to provide complete data for production downtimes from 1995/96 to 2002/03 (except for 1996/97). This firm, which operates 24 hours per day, lost 1707 hours worth of production over these seven years (approximately 244 hours per year). Over 46% of these losses were the result of the power interruptions that happened in 2002/03. As illustrated in the same table, in this year all firms operating 24 hours per day, except those firms (e.g. Firm No 6) which have used diesel generators, lost from 660 to 1005 hours worth of production per branch; whereas the other firms which work fewer hours per day lost about half as many production hours.

In general based on the case studying findings between 1995/96 and 2002/03, the highest production losses resulting from both planned and unplanned power outages happened in 2002/03. The firms without generators lost 9% to 14% of their potential production hours[90] in this year, ranging from 198 hours in a firm operating 8 hours per day, to 1005 hours in a firm operating 24 hours per day.

The next highest losses were in 1999/00. The years 1995/96, 1997/98, 1999/00 and 2002/03 (when power shedding took place) accounted for more than 80% of the total losses from 1995/96 to 2002/03, of which more than 75% were due to planned power outages (as a result of power shortages).

90 The potential production hours used here is the maximum number of hours one firm can work per a year without any problems such as shortage of raw materials, market demand, or capital. It is approximately 7200 hours for firms working 24 hours per day and 2400 for firms working 8 hours per day.

Table 7.2. Hours of production downtime due to power outages, per branch: 1995/96 – 2003/04 (1988 - 1996 EFY.)

Firm No.	Working hours per day	Number of Branches	Hours of production downtime per year									Remark
			1988	1990	1991	1992	1993	1994	1995	Average	1996	
			1995/96	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03		2003/04	
										Note 1	Note 2	Note 3
1	16	1	276	140	119	234	9	8	13	114		Used generator since 2001
6	24	6	*Not stated*	117	44	317	128	11	520	190	43	Used generator for some works since 2000
7	24	1	*Not stated*		190	618	210	166	1005	438		Has generator but only for office use
9	24	1	109	146	126	310	109	123	786	244		Has small generator for emergencies
10	24	4	*Not stated*	225	207	392	301	185	671	330	99	No generator
16	8 & 24	5	Not stated	102	81	169	116	33	475	163	5	No generator
	8	*2*	*Not stated*	*64*	*23*	*167*	*63*	*19*	*198*	*89*		
	24	*3*	*Not stated*	*127*	*120*	*170*	*249*	*42*	*660*	*228*		
14	10	1	*Not stated*			208	26	21	0		0	Generator since 2002
11	16	1	*Not stated*						239		17	No generator
12	24	1	*Not stated*								9	No generator
13	08	1	*Not stated*						409		54	Small generator for emergencies

Source: Case study (2004). The columns shaded in grey indicate power shortage years. 2002/03 was the most severe power shortage year.

Notes:

1. The average includes only recorded data.
2. The data for 2003/04 is only from July to December (6 months).
3. Although Firm No. 9 and 13 have generators, they are very small compared to their energy requirement and had only been used to save production on sensitive processes

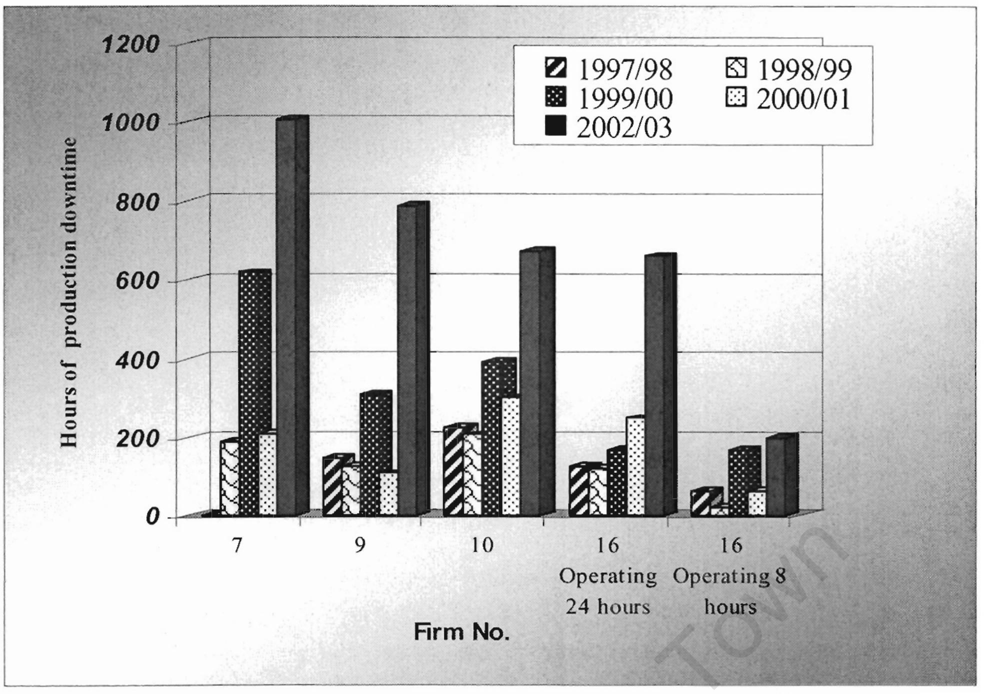

Figure 7.1. Hours of production downtime due to power outages: 1997/98 – 2002/03

Source: Case study (2004).

Table 7.3. Percentage of production hours lost of the potential production hours in the year due to power outages: 1997/98 – 2002/03 (1990 – 1995 EFY)

Firm Number	1990 1997/98	1991 1998/99	1992 1999/00	1993 2000/01	1994 2001/02	1995 2002/03
1	3%	3%	5%	Had used generator		
7		3%	9%	3%	2%	14%
9	2%	2%	4%	2%	2%	11%
10	3%	3%	6%	4%	3%	10%
16-24 hours operating	2%	2%	2%	4%	1%	9%
16- 8 hours operating	3%	1%	7%	3%	1%	9%

Source: Case study (2004)

7.3.2 Power outages compared to other problems

Table 7.4 shows the percentage of lost production hours which were attributable to power outages, for those firms with sufficient records. Among firms, which recorded significant power-related interruptions, as a proportion of total production losses, the share of production losses due to power outages was quite large compared with other problems which have interrupted the firms' production activities between

1995/96 and 2002/03, particularly during the power shortage years[91]. Other factors associated with reduced production included lack of raw materials, maintenance and low market demand. Before Firm No. 1 had started using a generator, the percentage of production losses attributed to power outages in 1995/96 and 1999/00 were 20% and 18%, respectively. For Firms No. 7, 9 and 16, the corresponding shares in 2002/03 were 63%, 18% and 16%, respectively. This illustrates showed that how power outages could be one of the major reasons for a firm not being fully operational, particularly in the power shortage years. In some cases, it could also be the primary reason, especially for those firms experiencing good market demand and no raw material problems.

Table 7.4 shows that the production downtime of Firm No. 7 was attributed entirely to power interruptions in 1999/00 and 2002/01, resulting in 828 hours worth of production losses in these two years combined (see Table 7.2).

An expert from the same Firm No.7 stated that: "Even the market problem our firm faced in 2002/03 was an indirect impact of the power outages problem." He argued that, as a result of inter-connection between different sectors in the country, the losses of production and reduction of employment and income in other economic sectors could possibly decrease the demand for LMSMI products in the country. "The adverse effects of power shortages on the economy could be one of the main reasons why our products have lacked market demand in the year."

However, in two other firms which reported market problems over the same period, Firms No. 6 and 10, the impact of electricity outages was of little significance compared with other problems. Reported power-related production losses were generally less than 2% even in the most severe power shortage year of 2002/03. It is true that if the market demand for the products of these firms was very low, they would mostly likely not be in operation even if electricity were available. The findings from the case study show that these two firms were not in operation for nearly half of the planned time, and that lack of market demand accounted for more than one

91 According to EEPCo information, there were also power shortages in other years between 1995/96 and 2002/03 (i.e.1996/97, 1998/99, 2000/01 and 2001/02). However they were not so significant. In this study, therefore, power shortage years refers to years when power shedding was employed (planned outages) due to severe power shortages, namely 1995/96, 1997/98, 1999/00 and 2002/03 (see also Chapter 5).

third. In these circumstances, the potential for electricity interruptions to impact on the production losses in these firms could be rather negligible.

By contrast, the findings from the case study show that Firms No. 1, 9 and 16 did not experience market problems between 1995/96 and 2002/03. These firms had more significant losses of production attributed to power outages at various times during this period.

Table 7.4. Percentage of lost production hours attributed to power outages 1995/96 – 2002/03 (1988 – 1995 EFY)

Firm Number	1988 1995/96	1990 1997/98	1991 1998/99	1992 1999/00	1993 2000/01	1994 2001/02	1995 2002/03	Other Main Problems
1	20.1%	10.3%	9.7%	18.3%	0.7%	1.0%	1.4%	Maintenance and lack of raw materials
6		1.68%	0.22%	1.18%	0.42%	0.04%	1.98%	Lack of market and maintenance
7			10.3%	100%	100%	31.6%	63.6%	Lack of market and other problems except 1999/00 & 2000/01
9		3.8%	3.2%	7.0%	3.5%	3.4%	18.4%	Maintenance
10		0.9%	0.5%	2.2%	1.4%	0.5%	1.6%	Maintenance and lack of market
16		1.6%	1.2%	2.4%	3.9%	0.9%	16.6%	Maintenance and lack of raw materials

Source: Case study (2004)

From CSA's LMSMI surveys conducted in five consecutive years between 1998 and 2002, as depicted in Table 7.5, in the total LMSMI sector, 9% of firms on average have not been fully operational at least six months per year (more than half of the planned working time). Another 12% firms were not fully operational for 3 to 5 months per year. In combination, 21% of the LMSMI firms have not been fully operational for 3 to 11 months per year. Lack of market demand was identified as the primary reason, followed by lack of raw materials. In 2002/03, for instance, more than 35% of the LMSMI firms reported that lack of market was the primary reason why their firm had not been operation for a period of six months or more. A similar pattern was seen in the other years between 1998 and 2002.

Table 7.5. CSA report of the (first) main reason for firms not being fully operational in the LMSMI sector between 1997/98 and 2001/02.

	Number of LMSMI firms				
	Number of months that firms were not fully operational/year				Total number of LMSMI firms (averaged over 1997/98 – 2001/02)
Type of reasons	**>=6 months**	**3 – 5 Months**	**1 – 2 Months**	**Total**	
Lack of raw materials	22	29	19	70	
Lack of market demand	28	34	21	83	
Shortage of electricity and water	3	7	9	19	
Sub total	**52**	**70**	**50**	**172**	
Others	20	26	29	74	
Total	**72**	**95**	**79**	**246**	771
% of LMSMI firms not fully operational	**9%**	**12%**	**10%**	**32%**	
Breakdown of reasons as a percentage share from total number of not operational firms per each month group					
Lack of raw materials	30%	30%	24%	28%	
Lack of market demand	38%	36%	27%	34%	
Shortage of electricity and water	4%	7%	12%	8%	
Sub total	**73%**	**73%**	**64%**	**70%**	
Other reasons	27%	27%	36%	30%	

Source: Derived from data collected from CSA (2004)

As described earlier, those firms (nearly 21%) which were not operational for 3 - 11 months in a year between 1997/98 and 2001/02 for various reasons would possibly not have been in operation even if electricity had been continuously available. Power outages in these cases could not have had such significant impacts on these firms' production. On the other hand, the impact of power outages could have been relatively higher among the remaining LMSMI firms (79%) which did not report any major problems such as market demand, raw material shortages, and which were working nearly the whole year. Fully-operational firms, due to their better market situation, do not normally carry much surplus stock throughout the year. Therefore, any problem which suspends their production activities could reduce the amount of products immediately available for market. Obviously this in turn would reduce revenue earnings from the sales of these products.

7.3.3 The loss of outputs in term of monetary value

Across all the firms in the case study which reported their attainable capacity or planned production per hour, and number of interrupted production hours per year due to power outages, the loss of outputs in term of monetary values was estimated based on these two variables.

Obviously, the monetary value of lost outputs is greater for those firms which have longer production hours within a day and/or higher production capacity per hour. In

2002/03, large firms in the case study could lose in the order of ten thousands of ETB (thousands of USD); while relatively small firms could lose in the order of thousands of ETB (hundreds of USD) per hour.

Table 7.6 shows the case study results for the years 2001/02 and 2002/03. In this table, the firms are grouped according to their production capacities and in terms of the number of normal working hours per day. As shown in this table, an hour of interrupted production can cost larger firms more than 20 000 ETB worth of lost output (above USD 2,300), but less than 1 000 ETB for the smallest firms[92]. The estimated annual value of outputs lost as a result of power outages could be as high as 40 million ETB (USD 4.7 million), in 2002/03, for a large firm operating 24 hours per day. The smallest firms operating 24 hours per day lost up to 0.8 million ETB (USD 0.09 million) of the potential outputs in the year. The comparable value of lost outputs for firms operating fewer hours per day was generally two to four times less than for 24-hour firms of similar capacity.

Table 7.6. Value of lost output attributed to power outages (in ETB/annum), firms without generators: 2001/02 (1994 EFY) and 2002/03 (1995 EFY)

Production capacity in ETB/hour	Working hours within a day			
	2001/02 (1995 EFY)		2000/01 (1994 EFY)	
	Number of working hours per day			
	8	24	8	24
Number of Branch	3	16	3	16
The range of firm's annual output losses in '000 ETB				
> 20,000	5000 – 26 000	20 000 – 40 000	> 350	3 000 – 6 000
5,000 – 10,000	< 2 000	15 000 – 8 000	> 150	74 – 300
1,000 - 5,000		700 – 2 000		20 – 232
< 1,000		< 800		
Average* output losses in '000 ETB/annum				
> 20,000	10 650,	27 207	367	4 440
5,000 – 10,000	2 112	3 859	177	
1,000 - 5,000		1 116		85
< 1,000		972		
Average	**11,354**	**4,757**	**330**	**727**

Source: Case Study (2004). *The average was calculated per branch of the firm.

92 Based on the production capacity of all LMSMIs from the 2001/02 CSA survey data, about 7% of the LMSMI firms from the total LMSMI are categorised as larger firms while most of them are relatively small firms (more than 55%) with a production capacity of less than 1 000 ETB per hour (see Appendix G).

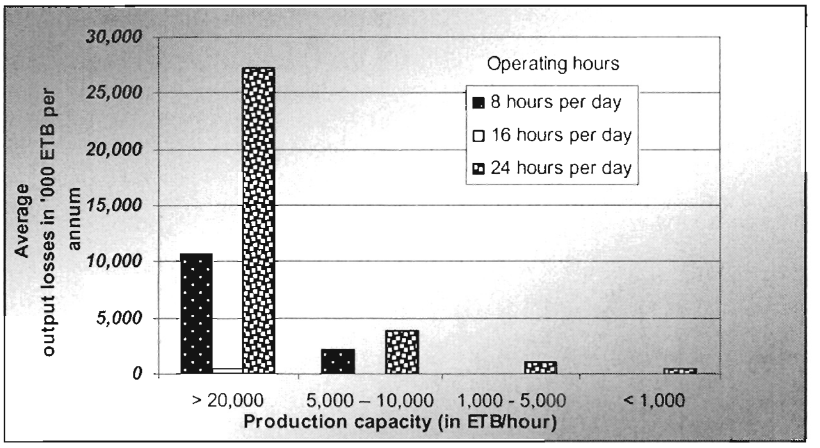

Figure 7.2. Estimated average annual value of production losses per branch, attributed to power outages: 2002/03 (1995 EFY)

Source: Case study (2004)

The value of lost outputs in other years, particularly in the years when there was no power shortage, was certainly less than in 2002/03 when long-lasting power interruptions occurred. However the outputs loss even in these years was not insignificant as a proportion of their total production. In these years, firms could lose 1 – 5% output of their potential[93] production due to unplanned power outages (see Table 7.7).

In general the case study results indicate that power outages caused firms with no generators to lose approximately 15 to 30% of their potential outputs in 2002/03, while in other years the value of output losses could be up to 10% of the total value of potential production.

If these patterns could be extended to the whole LMSMI sector, it is estimated that the country could have lost around 700 million ETB due to the power outages in 2002/03 (above 81 million USD). (The assumptions for this estimate are that 30% of all LMSMI firms have used backup generators during interruption periods and that average outputs loss was approximately 12% of the potential production in this year). In the non-power shortage years (1998/99, 2000/01 and 2001/02) unplanned

93 The potential production is the amount of possible value of outputs that would have been produced without electricity problems. That is the sum of actual production in the corresponding year and estimated production that could have taken place in the absence of power cuts

power outages could have led to losses of over 100 million ETB per year (USD 12 million)[94] on average across the entire LMSMI sector.

Table 7.7. Estimated percentage of outputs loss due to power outages 1997/98 – 2002/03 (1990 – 1995 EFY)

Firm number	1990	1991	1992	1993	1994	1995	Remark
	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	
	Outputs loss as percentage of potential production						
1	2.57%	4.00%	7.35%	0.26%	0.20%	0.34%	Had used generator since 2000/01
5	*Not stated*			0.08%	0.49%	18.6%	Incomplete data from 1997 to 2000
6	1.86%	1.67%	6.25%	4.59%	0.60%	20.90%	
7	0.00%	4.40%	10.40%	3.52%	2.65%	16.30%	
9	7.03%	4.79%	9.60%	3.29%	3.81%	15.48%	
10	1.01%	1.52%	3.17%	3.61%	1.33%	4.85%	
13	*Not stated*					27.48%	Incomplete data from 1997 to 2001
14	*Not stated*		8.64%	0.49%	0.36%	0.00%	Had used generator since 2000/01
16	3.70%	3.47%	9.81%	3.68%	1.29%	15.51%	
Total*	**3.12%**	**3.55%**	**9.95%**	**1.89%**	**1.49%**	**12.39%**	

Source: Case study (2004)

Notes

1. The percentage of outputs loss for all firms combined in 2002/03 was quite similar to the percentage in 1999/00 because two relatively large firms have used generators since 2000/01.
2. The percentages in this table are higher than the percentages of lost production hours in Table 7.3, because the latter was calculated as a percentage of possible number of production hours without any problems, (market demand, raw materials, etc). Here the calculation was done as a percentage of the sum of actual production and lost production due to power outages.

However the value of output losses due to power outages could be less than or greater than these estimates, for various reasons. Firstly, as stated above, a number of factors could limit the amount of LMSMI production, especially for those firms which have had market and raw materials problems. These firms most likely would not have produced during all the interrupted hours even if the electricity were available. For these firms, therefore, calculating the output loss by considering all the interruption hours due to power outages could exaggerate the figure. But these factors would be unlikely to affect the figure for those firms which have not experienced such problems.

94 All the calculations here were based on the LMSMI 2001/02 sector total gross value of production, excluding other income, taken from CSA survey data in 2001/02 (Appendix G).

Secondly, the national estimates above are based on the findings obtained from the case study, and the firms in the case study might not be representative of the entire LMSMI sector. They are also relatively large compared with most of the LMSMI firms. In order to reduce possible errors the conservative assumption of 30% having generators and an average production loss of 12% were used for 2002/03 production loss estimates. However, considering all the facts, the former figure could be too big and the latter too small, leading to a possible under-estimation. If the assumptions instead used figures of 10% for the former and 15% for the latter, the production losses could have reached more than a billion ETB in this year. In light of the above arguments, the LMSMI production losses could have been either smaller or higher than the estimates made earlier.

In 2002/03, due to the LMSMI production losses that were attributed to power outages, the country could have lost 10% to 15% of the Gross Value of Production that could have been contributed from the LMSMI sector.

7.3.4 Cost of raw materials losses

The impacts of power outages have not been limited to losses in output. In addition, some firms have lost quite considerable amounts of raw materials in-process at times of unexpected electricity interruptions.

According to the case study findings, bread, pasta, beverage and tyre manufacturing industries reported a large amount of raw material losses as a result of un-planned power outages. Although these firms, except one, have not recorded the amount of raw material losses in quantity and value, they said that even a few minutes (a very short period) of electricity interruption can cost them in the order of thousands of ETB, due to the loss of in-process raw materials. One expert from the bread and macaroni manufacturing industry said: "Our firm has lost a hundred quintals of production which has been in the oven at the time of an unexpected electricity interruption." (Kality Food Factory, 2004). The expert from a beverage manufacturing firm also witnessed that "we lost a lot because our prepared raw material has been contaminated and spoiled due to the interruption of production by unexpected power failures" (National Alcohol & Liquor Factory 2004).

As mentioned earlier, only one firm reported the amount of raw material losses in quantity and monetary value. These are illustrated in Table 7.8. This firm lost products in-process in every year from 1998 to 2003 due to unplanned interruptions. As shown in the table, the highest losses were in 1999/00, followed by the losses over six months in 2003/04. Although there was no officially announced power shortage problem in 2003/04, this firm lost quite a large amounts of tyres in-process between July to December due to unplanned electricity interruptions, costing them more than 47 thousand ETB (USD 5 thousand).

As a result of unplanned power interruptions, Addis Tyre Company lost a total of about 265 175 ETB (USD 31 thousand) from 1998/99 to 2002/03, including the six months raw material losses in 2003/04.

Table 7.8. Tyre scraps due to power interruptions: 1998/99 – 2003/04 (1991 – 1996 EFY)

EFY.	In Quantity (PCS)	In value ETB	GC.
1991	21	33,251	1998/99
1992	84	120,917	1999/00
1993	8	18,018	2000/01
1994	12	6,246	2001/02
1995	36	38,925	2002/03
1996	69	47,818	2003/04
Total	230	265,175	

Source: Case study (Addis Tyre Company)

Raw material losses could be substantial at a national level, when combining all similarly affected LMSMI firms. As shown in the previous chapter and in Table 7.9, the total share of food and beverage, chemical and chemical products, and tyre and plastic manufacturing industries is a large proportion of the LMSMI sector in the country, and these industries could lose relatively large amounts of raw materials in-process as a result of unplanned power interruptions. For instance, as shown in Table 7.9, between 1997/98 and 2001/02, on average, firms in these manufacturing groups comprised more than 40% of total number of LMSMI firms. In addition to these industries, there could be other firms from other categories which could lose substantial quantities of raw materials in-process.

As shown in the earlier Table 7.8, some manufacturing industries experienced serious raw material losses even in the recent year of 2003. The six months loss in 2003/04 was even greater than the yearly losses in other years between 1998/99 and 2002/03, other than 1999/00. This indicates that the reliability of electricity supply in the country has not improved, but rather has become worse. In turn this can be expected to result in increasing raw material losses, unless some mitigation measures are taken to improve the reliability of electricity supply in the country,

Table 7.9. Percentage distribution of LMSMI by industrial group 1997/98 – 2001/02 (1990 – 1994 EFY)

Industrial Group	1990	1991	1992	1993	1994	Average
	1997/98	1998/99	1999/00	2000/01	2001/02	
Food and Beverage	29%	29%	30%	32%	31%	**30%**
Tobacco	0%	0%	0%	0%	0%	**0%**
Textile and Wearing apparel	8%	8%	8%	7%	7%	**8%**
Tanning and Dressing of leather and leather products	7%	6%	7%	7%	6%	**7%**
Wood and Wood Products	2%	2%	2%	2%	2%	**2%**
Paper and Paper Products	7%	8%	8%	7%	8%	**8%**
Chemical and Chemical products	6%	6%	5%	5%	5%	**5%**
Rubber and Plastic products	3%	4%	4%	4%	4%	**4%**
Non-Metallic Mineral Products	11%	11%	11%	11%	11%	**11%**
Basic Iron and Steel	1%	1%	1%	1%	1%	**1%**
Fabricated Metal Products, Machinery, and Equipments	8%	8%	8%	8%	8%	**8%**
Motor Vehicles, Trailers & Semi-Trailers	2%	1%	1%	1%	1%	**1%**
Furniture	15%	16%	15%	15%	16%	**16%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Derived from CSA LMSMI Survey Report (2002)

7.3.5 Other costs of power outages

In addition, some of the firms in the case study mentioned that unexpected power interruptions have caused machinery and equipment damage. Further extra costs which impacted on the firms' business included additional fuels used for start up. For instance the technical manager at the Addis Tyre Company said that 4000 litres of heavy fuel were required every time to start up the factory, which costs the firm more than nine thousand ETB. Beside this the start-up process takes about 1 to 4 hours. The costs of raw material losses, machinery and equipment damage, additional start-up fuel and other associated costs are simply additional expenses imposed on the business due to the poor management of the utility.

7.3.6 Self-generation and saved production

Because the country's LMSMI found the electricity supply from the public-owned utility unreliable, some firms have operated their own generators to ensure a supply of electricity themselves during interruptions. However, self-generation incurs additional costs for these firms due to capital costs for purchase and installation of generators, and their higher operating and maintenance costs compared to the electricity supply from the utility.

Table 7.10 provides general information about the generators used by the firms in the case study. It is evident from the table that 12 firms of the 16 firms had obtained their own generators by 2002/03. Of the remaining four firms, two public-owned firms had not obtained generators mainly because of financial problems, but they were planning to purchase their own generators in the near future. The same was true for one of the private-owned firms.

As shown in the same table, most of the firms had only one generator. Four firms had more than one, because two of them have more than one branch, and the other two are relatively large firms which have different production lines requiring more than one generator.

Since 1996, the supply of electricity from the utility became increasingly worse and unreliable mainly due to power shortages. Table 7.10 shows that the majority of the firms in the case study obtained their generators during the last five years. Most of these generators are less than four years old.

Table 7.10. Number of firms by number of generators and date of purchase

Public/Private	Number of generators				Total	Date of Purchase					
	0	1	2	3		Before 1988 Before 1996	1990 1998	1992 2000	1993 2001	1994 2002	1995 2003
Both			2		2	2					
Public	2	1	1	1	5		1				2
Private	2	7			9	1		2	2	2	
Total	4	8	3	1	16	3	1	2	2	2	2

Source: Case Study (2004)

The installed capacity of these generators is summarised in Table 7.11. The capacity varies across firms, depending on their scale of operations and the power needed. As shown in the table, two small-scale firms (< 5 000 production capacity per hour) had generators with less than 250 kVA installed capacity, while three large-scale firms maintained from 600 to 1 000 kVA installed generation capacity.

However the smaller firms with 250 kVA or less self-generation capacity were able to supply electricity for all their operations during electricity interruption periods, while the larger firms even if they had twice or more times the generation capacity of smaller firms could only use self-generation to save raw materials in-process, due to their high overall power requirements. For example, one of the firm which produces bread, flour, biscuits and pasta has used the generators mainly for the pasta production line, because here even a short period of electricity interruption easily damages a large amount of raw materials in the process. They need to make such choices because the capacity of their generators is less than the total power requirement of their factory.

Table 7.11. Number of firms by installed self-generation capacity and production capacity of the firm

Production capacity per hour in ETB	Installed capacity of the generator (kVA)			Remark
	<= 250	400	600 - 1000	
	Number of firms			
Not stated	2			Partially operational
<=5000	2			Fully operational
20,000 - 30000	2	1		One was not in full operation
>30,000	1		3	All of them were partially operational
Total	7	1	3	

Source: Case Study (2004).

Note: Out of the 12 firms one firm did not give its generator installed capacity

For another two large firms with power requirements of over 1 MW, it is very uneconomic for them to maintain a self-generation capacity sufficient to supply all the energy requirements of their firm, hence they have maintained generators with an installed capacity two times less than their total power requirements. Self-generation in these firms has normally been used to protect the most sensitive part of production lines, e.g. for emergency purposes such as saving raw materials in-process.

The capital costs (purchase and installation) of self-generation differ depending on the installed generation capacity. Larger generators with capacities of 600 kVA and more have cost more than 1.2 million ETB (USD 0.14 million). Smaller generators (< 250 kVA) have cost between 120 000 to 350 000 ETB.

Three firms with generators of more than 600 kVA installed capacity (which only supply electricity for partial production operations) thus paid more than a million ETB for the installation and purchase of their generators, which accounted for 0.5% to 4% of total book value of their fixed assets[95] at the beginning of the year 2001/02. The two other relatively smaller firms (generator capacity <= 250 kVA) also spent on

95 Fixed assets are those with a productive life of one or more years which are intended for the use of the establishment. The net book value of fixed assets in Ethiopia is normally calculated for the beginning of the fiscal year, July 8.

generators approximately the same percentage (1 to 4%) of total book value of their fixed assets at the beginning of the same year.

According to the case study and CSA survey results (2002), capital expenditure for the provision of self-generation made up a significant proportion of total investment in corresponding years. In 2001/02, two firms from the case study for instance spent about 75% of their investment on provision for self-generation.

In addition to these additional investment costs, firms have also spent more money on operating costs to generate the same amount of electricity using their own generators, compared with the electricity supply costs from the utility. According to firms' rough estimation, the average unit operating costs of electricity from self-generation were nearly twice the average price of electricity from the utility. For instance, between 1997/98 and 2002/03, the average unit price of electricity from the utility was around 0.40 ETB/kWh[96] (from recent tariff revision history, see Appendix D), whereas electricity production from their own diesel generators has cost in the region of 0.71 to 0.80 ETB/kWh, according to rough estimations by three firms (they estimated the costs based on their diesel, maintenance and handling expenses, excluding capital depreciation costs).

7.3.6.1 Ethiopia case study, diesel generation in 7 firms, 2002/03

Only three firms were able to provide such estimates for the unit operating costs. A further four firms provided information on the amount and costs of diesel. Based on this information, further estimates were made to explore the probable range of their unit operating costs for diesel generation. For this purpose, the following assumptions were made:

Diesel generator overall efficiency assumptions

The actual diesel generator efficiency conversion would depend on various factors, including the size and type of the engine, and load factor (ITDG 2005; Massie & Kang 2004; Willis 2000: 386 – 7; Genset Central Generator Warehouse 2005). Most of the seven firms with generator, had generators of more than 100 kVA capacity. For the purpose of this study, to make rough cost estimations an estimated 30% average conversion efficiency from diesel to electric power output was assumed (Massie & Kang 2004).

96 The average flat rate tariff of both low and high voltage industry.

Based on this assumption the electric power output from one litre of diesel would be 3.09 kWhe (i.e. 30% of the caloric value of diesel, which is approximately 10.3 kWh/litre).

Estimated electricity production in 2002/03 (kWhe)

Using the firms' data for diesel consumption in 2002/03, and the average conversion efficiency assumption above, Table 7.12 estimates the corresponding electricity production in kWhe.

Table 7.12. Estimated kWhe based on diesel consumption in 2002/03

Diesel, litres consumed	Electricity production (kWhe)
dc0203	**ep0203 = dc0203 * 3.09 kWh/litre**
54 369	168 000
9 476	29 281
5 475	16 918
128100	395 829
1 010	3 121
6 400	19 776
26 280	81 205

Source. Case study (2004)

Cost assumptions

Fuel cost	based on information from the firms
Lubricant costs	assumed 1% of fuel costs (KHD-DEUTZ 2005)
Diesel lifespan	was taken as 30 000 hours (ITDG 2005) (without considering the capital investment in the future)
Capital costs	derived based on the initial capital costs of the diesel generator and the number of operating hours in 2002/03, as reported by the firms (interest rates etc were not considered)
Routine handling and minor maintenance	including other costs approximately 10% of the fuel costs (this assumption was made based on the information obtained from two firms and own estimations).

Using the above cost assumptions, and data obtained from the firms for their recorded fuel costs and initial capital costs, Table 7.13 shows the estimated total costs of diesel generation for seven firms in 2002/03.

Table 7.13. Estimated total operating costs of diesel self-generation (ETB/year) in 2002/03

Actual reported fuel costs	Capital costs derived				Estimated routine handling and maintenance costs	Estimated lubricant costs (1% of the fuel cost)	Estimated Total costs
	Reported Initial costs	Reported operating hours in	Estimated yearly capital [depreciation] costs in	% of the fuel costs			
fc	ic	oh	cc= oh/30000 hours *ic	fc/cc *100	Mc = 0.10*fc	lc = 0.01*fc	tc= fc + cc + mc + lc
14 6796	1 252 522	1029	42 962	29%	14 680	1 468	205 905
26 059	330 000	412	4 532	17%	2 606	261	33 457
14 892	111 800	275	1 025	7%	1 489	149	17 555
349 713	2 382 992 Note1	915	81 515 Note2	21%	34 971	3 497	469 696
27 47.2	113 600	126	477	17%	275	27	3 527
17 408	Note 3: 181 500	384	2 323	13%	1 741	21 646	21 646
70 956	Note 3: 297 000	1 460	14 454	20%	7 096	93 215	93 215

Source: Case study (2004)

Notes:

1. This data included building costs (which were 452,992 ETB).
2. Capital costs [depreciation] of building were considered only for this firm.
3. These two prices were estimated, based on prevailing 2002 generator prices (since information was not provided by these two firms).

Based on own estimates, the unit costs could have reached about 1.26 ETB/kWh for 30% assumed diesel generator efficiency. As shown in Table 7.14, the estimated unit costs for fuel only were almost similar over seven firms, which were 0.87 – 0.89 ETB/kWhe, which is already more than two times the electricity costs from the utility. It is apparent from the same table that when unit costs are estimated by considering all the costs (i.e. fuel, capital costs, lubricant, maintenance and handling costs), they varied among the seven firms in 2002/03. This was mainly because of the variations in capital costs (which depend on the initial costs and operating hours of the diesel generator in the considered year). As shown in the table, the unit costs of electricity production using self-generation could have been nearly three times more than those from the utility (based on the average flat rate tariff), except for one case. The one case (with an estimated unit cost of 2.59 ETB/kWhe) was due to lower initial capital costs. This firm had obtained the generator in 2000 when generator prices were cheaper compared with 2002. However, the unit costs of generating electricity by diesel generator could be higher than these estimates if capital deprecation costs took account of interest rate and included building costs. The real costs of maintenance and handling could also be higher.

Table 7.14. Estimated unit costs of diesel generation (ETB/kWh) and comparison with utility tariff (% extra cost)

Fuel only ETB/kWh	Total (est.) ETB/kWh	Diesel generation unit costs as a proportion of utility cost		Costs of electricity from the utility as reported by the firms ETB/kWh
ucdof = fc/ep0203	ucd = tc/ep0203	r= ucd/0.4	r=ucd/ucrf	ucrf
		Note 1	Note 2	
0.87	1.23	3.06		
0.89	1.14	2.86	2.66	0.43
0.88	1.04	2.59	1.97	0.53
0.88	1.19	2.97	2.50	0.48
0.88	1.13	2.82	2.39	0.47
0.88	1.09	2.74	2.31	0.47
0.87	1.15	2.87		

Source: - Case study (2004)

Notes:

1. Based on the average flat rate tariff (i.e. 0.4 ETB/kWh) (see Appendix D).
2. The calculation was based on the electricity unit price from the utility in 2002/03, as reported by the firms.

Using the above estimated unit costs, diesel self-generation costs are compared with utility provision, for the same (estimated) kWhe per firm, in Table 7.15. As shown in this table, two firms which obtained generators with higher installed generation capacity could have spent an additional 138 705 and 311 364 ETB, respectively, for electricity supply from their own generators, compared with electricity coming from the utility. The firms with smaller capacity generators and which used their generators for fewer hours could have spent up to 60 000 ETB more in 2002/03.

Table 7.15. Comparison of diesel self-generation costs compared with utility provision in 2002/03

Installed capacity of the generators kVA	Total operating costs of diesel generator in 2002/03 (ETB)	Utility charge for the same kWh (ETB) at 0.4 ETB/kWh	Additional costs from diesel self-generation (ETB)	They obtained the generator for
892	205 905	67 200	138 705	full operation
250	33 457	11 712	21 745	full operation
210	17 555	6 767	10 788	Full operation
1 000	469 696	158 332	311 364	Partially operational.
75	3 527	1 248	2 278	For emergency purpose
138	21 646	7 910	13 736	for sensitive production
225	93 215	32 482	60 733	Full operation

Source: Case study (2004)

It is estimated that firms which used their own generators during all the interruption hours for nearly for all their operations could have lost approximately from 1% to 1.5% of their total profit (before income tax) in 2002/03. The percentage could be worse for low profit making firms. For example from the case study, the value for one firm was as high as 40% of its narrow profits.

Compared with using electricity supply from the utility, the use of their own diesel generators not only incurred additional operating and capital costs on the firms, but also brought other problems. Table 7.16 indicates some of the main problems mentioned by the firms in the case study.

Table 7.16. The major problems of self-generation as reported by the firms

Problems	Number of firms of 12 firms
The price of diesel varies from time to time	1
Transportation and handling problems	1
Availability and cost of spare parts	1
Higher running costs (maintenance, lubricant, and diesel)	7
Noise	4
As the generator became older it could not run at full capacity daily	1
Self-generation need more attention	2
Power fluctuations	1
Over-heating after 24 hours	1
High wear and tear of machine elements	1
Environment problem	2

Source: Case study (2004)

In summary, power outages have led to losses in outputs and raw materials in the LMSMI sector, and the additional costs of self-generation which have certainly reduced revenue and the profits of the individual firms. This in turn has had adverse impacts at a macro level, for example adversely affecting government revenue (due to the reduction of indirect and direct taxes collected on the firms' revenue and profit), export earnings, and employment.

7.4 COSTS AT A MACRO LEVEL

It is widely recognised that for any type of economic system a country follows, taxes are the most reliable and main source of government earnings. Government, in turn, uses this income to finance major development activities in the country, such as infrastructure, education and health services.

As illustrated in the previous chapter, the Ethiopian government has earned on average about 13 billion ETB per year (USD 1.5 billion) between 1998/99 and 2002/03, including income from grants, of which the share of total tax revenue was more than 60%, with 20% of this coming from the indirect taxes on domestic products. The majority of indirect tax revenue over those years has been collected from the LMSMI sector, accounting for 72% of the total indirect tax collected from different sectors (above one billion ETB), which was 14% of the total tax revenue (direct and indirect taxes) and 9% of total government revenue (including grants).

If firms produce less due to the power outages, their revenue and profit earnings would be reduced, in turn decreasing the amount of indirect taxes (sales, VAT, excise, etc.) and direct tax (income or profit taxes) collected from them. For instance, based on the case study findings, it was estimated that LMSMI firms with no generators lost up to 15% to 30% of their potential outputs in 2002/03 (see Table 7.7, page 149 of this chapter) as a result of power outages, and the government revenue from LMSMI taxes could, therefore, have decreased by the same rate. For instance, in 2001/02, the total indirect taxes collected from LMSMI were more than a billion ETB (CSA, 2002). As illustrated in Table 7.17, if 50% - 70% of the LMSMI firms in 2002/03 had production losses in the estimated ranges of 15% to 30%, the government could have lost between 75 000 and 210 000 ETB of the potential taxes collected from the LMSMI sector them in 2002/03. Based on this, government revenue from indirect taxes could have decreased in the range of 5% to 15%, reducing total government revenue between the ranges of 1% to 3%[97] (Government revenue here includes income from grants).

[97] All the tax calculations here were based on the 2001/02 government indirect tax revenue from LMSMI sectors, which was about 1009 million ETB.

The loss in government revenues shrinks government financing ability for major development activities. This in turn could have multi-dimensional adverse impacts on the social and economic activities of the nation, such as on education, health and infrastructure services.

Table 7.17 Estimated LMSMI indirect tax losses due to power outages 2002/03

Estimated Percentage of firms affected	Estimated range of production losses per firms, due to power outages	
	15%	**30%**
	Estimated LMSMI indirect tax losses (At current market price)	
50%	75,000	150,000
70%	105,000	210,000
	Estimated tax losses as a percentage of total LMSMI indirect taxes	
50%	7.5%	15.0%
70%	10.5%	21.0%
	Estimated tax losses as a percentage total (national) indirect taxes	
50%	5.4%	10.8%
70%	7.6%	15.1%
	Estimated tax losses as a percentage of total government revenue (including grants)	
50%	1.1%	2.2%
70%	1.5%	3.0%

Source: derived from CSA (2002)

Another adverse impact is on export earnings. In order to support the balance of payments, any country needs export earnings. However for a country like Ethiopia, with an economy highly reliant on imported goods and services, and a huge negative trade imbalance between imports and exports, low export earnings are particularly important. As shown in Chapter 6: Table 6.6 (page 121), Ethiopia's negative balance of payments has been around 9 Billion Birr per year. The majority of the country's export earnings come from agricultural products, followed by LMSMI sector products. The LMSMI share of exports was 16% (647 million ETB) on average between 1998 and 2003, with leather and leather products accounting for more than 85% of LMSMI export earnings.

Obviously, the power outages that happened in the last five years, particularly in 2002/03, could have had an impact on exporting firms, due to the loss in outputs and raw materials, and quality degradation, which would have decreased the export earnings the country obtained over these years. However, it was not easy to estimate the losses in export earnings based on the total outputs and raw materials losses:

- Firstly, the Ethiopian LMSMI exporting firms produce both for the local and foreign market, and they most likely give priority to the production of export goods if there are production constraints such as power shortages.
- Secondly, the data collected from the three exporting firms in the case study was unfortunately not sufficient to evaluate the impact of power outages on their export production. One firm had used a generator for all their operations during power outages. The second firm gave only the number of total interruption hours per year but not the amount of export earnings lost. The third firm had been non-operational for about seven months due to market problems.

For these reasons it was not possible to make an estimate of the loss of export earnings in monetary value. The three exporters however pointed out two main impacts of the power outages on their export production. It had affected the quality of their products and the delivery time was lengthened, creating inconvenience for their clients.

Another related issue that could be affected by the negative outcomes of the power outages on the LMSMI is employment in the country, due to LMSMI worker job losses. As stated in Chapter 6 (126), there were more than 98 thousand LMSMI employees in 2001/02, of which 17 thousand workers were temporary and seasonal. As a result of the power outages, particularly in 2002/03, firms in this sector could be reluctant to pay for under-utilised labour. Due to the nature of their agreement with their employees, which was commonly based on the availability of work, the temporary and seasonal workers were more vulnerable to such measures. Based on the case study findings, one medium scale firm in 2002/03 laid off 300 temporary workers, as a result of power outages. For the same reason about 100 workers were retired before their retirement date at another firm.

The findings from the case study therefore indicate that power outages have imposed various costs on Ethiopian LMSMI firms at an individual level, and they have also adversely affected the contribution of LMSMI at a macro level. However in order to save least to some of their output losses and to make use of idle labour power, some firms have tried adopt mitigation measures. The next section will examine these.

7.5 MITIGATION MEASURES BY FIRMS

As stated above, because firms see the electricity supplied by the utility as unreliable, many have obtained diesel generators in order to supply themselves with electricity during the periods of power interruption. Most of these firms bought their generators after 1996, as electricity supply problems became more serious. Before these firms had obtained their own generators, or in the cases of firms with no generators until recently (2003) and/or firms not able to use their generator for all their production lines, one of the mitigation strategies has been to shift their operations to different times of day. Activities not requiring electrical power would be shifted to times when the electricity was not available, while operations requiring power would be shifted to times (e.g. at night) when utility supply was still available.

As shown in Chapter 5 in: Table 5.3 (page 77), the duration of scheduled power shedding has been from sunrise to sunset. Hence, firms normally working eight or sixteen hours per day have the advantage of the opportunity to make use of power available at night. For instance, based on the case study information, five firms out of seven in these groups have shifted operations requiring power towards the night. However, firms normally operating 24 hours per day had less flexibility to reschedule their operations, and only one of these firms reported increasing its work loads during the night.

Therefore, firms working eight and sixteen hours per day had a better chance to use their idle labour power and to reschedule operations requiring power towards times when electricity was available. But firms operating 24 hours per day had less opportunity for this, except using the day time for activities not requiring electric power.

Table 7.18. Mitigation measures by normal working hours per day

Number of working hours	Number of firms	Measures
24 hours/day	3	Used a diesel generator but only for some operations
	2	Have not taken any measures
	2	Shifted operations not requiring power toward the night time when electricity was not available.
	1	Concentrated the work load to the night time when power was available
16 Hours/day	2	Worked during the night & shifted operations not requiring power toward the day when electricity was not available
8 Hours/day	3	Obtained and used a diesel generator
	3	Used a generator, worked during the night & shifted operations not requiring power toward the day time

Source: Case study (2004)

Firms were also asked about their future mitigation plans. Almost all firms without a generator were planning to buy one. One relatively large firm was considering the use of solar heating for the boiler. However most large firms normally working 24 hours per day said that they were not willing to operate generators to provide all the energy required by their factories. They only planned to use reasonably large generators for emergency purposes.

Table 7.19. Future mitigation plans for similar electricity supply problems

Future plan	Number of firms of 16 firms
Giving leave to the workers	1
Obtaining new diesel generator	10
Make use of available generator	6
Have a generator for sudden interruptions, but no further measures planned and self-generation is too expensive for this in case of power-shedding because the firm requires large amounts of energy which is expensive for our firm	2
Shifting operations not requiring power toward the day time when electricity is not available	2
Try to reschedule working time	1
Using solar water heating	1

Source: Case study (2004)

7.6 FIRMS' OPINIONS ABOUT ELECTRICITY SUPPLY PROBLEMS IN THE COUNTRY

Apart from their future mitigation plans, all the firms in the case study were also asked to give their broader opinions about electricity supply problems in the country, including opinions about planned and unplanned power outages, and the utility's advance announcement of the power shedding program in 2002/03.

7.6.1 Advance notification of electricity interruption

Despite the fact that the utility gave an advance announcement about the power-shedding program in 2002/03, according to most of the firms (11 out of the total 16 firms in the case study) it was not enough. For instance, three firms felt this was not enough notice for them to take mitigation measures by themselves, such as preparing alternative power sources. One of the firms commented: "Even if our firm has enough capital, there should be enough time to make the generator ready for work." Other firms pointed out that the price of generators went up at the same time as the announcement. "It became too expensive to purchase. For example, a generator which was 100,000 Birr went up to 145, 000 ETB in less than a week."

In addition, another three firms mentioned problems that arose because the power-shedding did not always occur at the scheduled times. "EEPCo made changes to the schedule without our knowledge. Due to unexpected changes we thus had to re-plan our programme within a few days." "Our workers came to the office for nothing but they paid for transport and they also lost their time." It is obvious that this could increase the cost of transportation for those firms which provide this service to their workers. Due to mismanagement of the utility, that would be an added expense for the firms' business without any production activities.

Most of the firms however did not deny the advantage of advance announcements of the electricity interruptions compared with no announcement. Nearly all the firms agreed that it really helped them to reschedule their production programme and to use their idle labour forces for operations not requiring power like maintenance and cleaning operations during the day time. One respondent expressed the benefits of an advance announcement as follows:

> Production was rescheduled, labour was shifted to do other work, machinery was stopped before the electricity interruptions and it helped us to eliminate the wastage of input and output.

Similarly, an expert from the National Alcohol and Liquor Factory said:

> The following are some of the benefits of an advance announcement for our firm's production activities. We can reschedule some of our activities, specially the liquor line and sales program; we also take measures on cost reduction; and we can also make our workers psychologically ready in advance.

These and other advantages mentioned by firms are summarised in Table 7.20.

Table 7.20. Advantages of advance announcements of power interruptions, according to firms interviewed

Did advance announcement help the firm?		Advantage of advance announcements for the firms' operation	Number of firms of 13 firms
Yes	No		
13	3	To eliminate the wastage of input and output	1
		To inform the customers in advance about the sales program	1
		To make the back-up generator ready	6
		To make the workers psychologically ready in advance	1
		To plan start-up programs	1
		To re-plan the production based on available energy	5
		To reschedule work to other activities(e.g. maintenance & sanitation)	5

Source: Case study (2004)

It is evident from Table 7.20 that three firms did not mention any advantages. However all of them believed that advance notifications about the power-shedding programs would help them in many respects if it were done sufficiently early. For instance one of the firms said. "If it is announced early, our firm would try to take some actions, like installing other power sources." One high level expert from another firm pointed out that "to buy or install any alternative power supply needs a big investment which may not be affordable by the company within a short period and also investment approval is needed. In general, it requires a longer time to obtain a generator therefore the information did not help us to take any measures". The third one commented: "For us to take measures, the announcement should be made with a reasonable time gap."

While most firms found it useful to know about the power interruptions programme beforehand, they expressed bitter opinions about unannounced power outages and their adverse impacts on their business. The following are some of the negative impacts of unexpected power interruption mentioned by some of firms:

> We have lost hundreds of quintals of production in the ovens and dryers so that there were large production losses. If the back-up generator might be under maintenance or out of fuel, it is difficult to start it automatically. (Kality Food Factory 2004).

Similarly an expert from Addis Tyre Factory referred to their losses of raw materials or products in-process:

> The losses of the tyres were dependent on the stage of the tyre production. If the electricity interruption happens at an early stage, it damages the tyres which are curing. The amount of this damage depends on the number of moulds in the curing process affected." (Addis Tyre Company 2004).

The same firm added that:

> Due to electricity interruptions the temperature would suddenly drop, and we need an additional start-up time of four hours or more to start the machinery again." (Addis Tyre Company 2004).

A chemist from the production department of National Alcohol and Liquor Factory said that:

> We have lost chemicals like methanol, ethanol and acetone. The motor and electrical accessories suffered over-heating and may be damaged. The fuel consumption to heat water increased. (National Alcohol & Liquor Factory 2004).

Some of the firms pointed to negative impacts on their market. On this matter the operations manager of East African Group Soup Factory said:

> Unless we produce and supply to the customers on time we will lose our market. It may lead to dissatisfaction among customers, causing them to shift to other suppliers." (East African Group Soup Factory 2004).

Similarly the production manager of one of the leather exporting companies said:

> Tannery processes are highly dependent on time. If there are power interruptions, the quality is seriously affected, the processes are extended, additional cost is incurred and the next day's production processes are affected. In general we could not reach the planned quantity thus it will extend our delivery time." (Ethio-Leather Industry PLC 2004).

7.6.2 General views about electricity supply problems

Finally all the firms were invited to give their general views about the past electricity supply problems and any suggestions about what should be done to improve the future electricity supply situation in the country.

The firms believed that electricity is one of the most important inputs for a country's development. For instance one firm said: "Electricity is one of the important inputs for most economic activities and daily life. It is also an important factor for the development of investment and the country's economy." For similar reasons, other firms expressed the opinion that unless Government takes immediate measures to address electricity supply problems in the country, the country's development will stagnate, and this will exacerbate the prevailing social and economic problems of the nation. For instance one firm bitterly expressed this situation as follows:

> Electricity supply shortage is really a discouraging factor for investors. It is a symptom of our under-civilisation, and we are walking many steps backwards. (East African Group Soup Factory 2004).

Another firm commented on the impacts of power outages in relation to their business, manufacturing sector and the stage of a country's development:

> Most of our processes depend on electricity supply. When there is a shortage, the processes and products are affected. This affects quality, quantity and delivery time. Due to this we are very much disappointed and we are not comfortable. In general, electricity shortage is a nuisance in the manufacturing sector. It is a sign of technology retardation and under-civilisation. When we look at the highly advanced industrialised countries, they use electricity for various and numerous purposes let alone for manufacturing. (Ethio-Leather Industry PLC 2004).

Firms made various suggestions about the mitigation measures to address the electricity supply problems in the country. For example:

> ... I strongly propose that the supply of electricity should be enlarged in our country. This was discussed in a one-day seminar sponsored by EEPCo recently. (Mosvold Private Limited Company 2004)

> ...The further development of local hydro electric power is inevitable either by the local government or by the foreign investors." (National Alcohol & Liquor Factory 2004)

Most of them mentioned the need for alternative energy sources. For instance one firm said that "since it causes negative impacts on the economy of the country, the government itself should try to find other power sources" (Shoa Cotton Ginning 2004). In the same way another firm commented: "It is true that electricity problems retard the growth of any country, therefore EEPCo should employ other alternative energy sources to generate electricity." (Addis Ababa Flour 2004).

They all agreed that the provision of services like electricity requires very large investment, which is beyond the capacity of an individual firm. Instead Government should take responsibility for the provision of this service and also ensure the reliability and quality of electricity supply.

In fact, based on the case study findings, due to unreliability of the service in the past and because of the bad reputation of the utility, firms have lost their trust in the utility. In order to reduce their costs from power outages, many are operating their own generators and firms with no generators or with insufficient self-generation capacity are also planning to buy new generators in the near future.

However, even if firms are forced to have their own generators due to the bad electricity supply by the government-owned utility, they said that using self-generation was very costly compared to electricity supplied by the utility. It is also inconvenient and has other problems. Several large firms found it also uneconomic to operate diesel generators large enough to provide electricity for the entire firm's energy requirements. One of these firms remarked: "Providing electricity for our entire business is beyond our capacity." Due to this and other reasons, finally they all put forward a request towards the government and EEPCo to provide them with reliable and high quality electricity.

7.7 CONCLUSION

The case study findings have shown that power outages in Ethiopia have imposed various costs on the LMSMI sector due to the losses in outputs, losses of raw materials, the additional capital and operating cost for self-generation, and other factors. It was estimated that firms with no generators could have lost 15 to 30% of their yearly production (the production that could have taken place in the absence of power cuts) due to the severe electricity shortages that happened in 2002/03 (planned and unplanned power outages) and in the other power-rationing years (i.e,.1997/98, 1999/2000), production losses could have reached up to 10%. While in the non-rationing years (1998/99, 2000/01 and 2001/02), they could have lost 1 to 5% of their yearly production, as a result of unplanned power outages.

It was estimated that the country could have lost 700 million to 1.1 billion ETB (USD 81 - 128 million) as a result of lost outputs in the LMSMI sector in 2002/03 alone, due to the power outages, while in non-power rationing years (1998/99, 2000/01 and 2001/02) unplanned power outages could have caused the country losses in LMSMI outputs averaging 100 million ETB per year (above USD 11 million).

In addition to production output losses, some LMSMI factories, e.g. in the food and beverage, chemical and plastic and tyre industries have lost substantial quantities of in-process raw materials, as a result of unplanned power interruptions. The impacts of such in-process materials losses are significant at the country level since these industries comprise about 40% of LMSMI establishments in Ethiopia.

To reduce the impacts of utility power outages on their production many LMSMI firms have installed their own diesel generators. In the case study findings, 12 of the 16 firms operated diesel generators. However, this has incurred additional costs for these firms, both in investment and operating costs.

Operating and maintenance costs for in-house diesel electricity generation are higher than the costs of the same amount of electricity provided by the utility. The case study indicated that firms using their own diesel generators during power-interruption periods could lose around 1% to 1.5% of their potential profit (before income tax) in 2002/03, or in one case as much as 40% of their narrow profits.

Extrapolations from the case study sample indicate that total LMSMI losses in output as a result of power outages could amount to approximately 10% to 15% of the gross value of production for this sector in 2002/03, and it could have been 1% to 5% in the non-power rationing years considered. In addition to these estimated production losses, further negative affects at a macro level also need to be considered such as on employment, export earnings, government revenues, etc. For instance, it was estimated that the country could have lost in the range of between 7% and 21% of the potential indirect tax collection from the LMSMI sector in 2002/03, as a result of that year's power outages (decreasing government total revenue in a range of between 1% and 3%). Reduction of government revenues reduces the finance available for major development activities in the country, and this could have multidimensional adverse impacts on the socio-economic development of the nation as a whole.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

This study has analysed the costs of power shortages and outages for Ethiopian Large- and Medium-Scale Manufacturing Industries (LMSMI), as well as related impacts, such as on employment, on the country's export earnings, the national economy, and on government revenue. It has also identified and discussed possible causes of the power shortages (apart from the recurring droughts) that have plagued the country since 1995.

The impacts of power outages on the LMSMI sector

The findings of the study have clearly shown that LMSMI firms have incurred significant costs as a result of the power shortages that have happened in Ethiopia since 1995, in conjunction with a generally poor and unreliable electricity supply. The severe power shortage of 2002/2003 resulted in particularly severe industrial production losses. The paper has identified the following main costs, both at an individual and at a macro level:

Costs for individual firms

- Based on the findings of the case study, it is estimated that firms typically lost between 100 to 350 hours worth of outputs per year, on average, between 1995/96 and 2002/03. These interruptions of production were due to both planned and unplanned power outages, but the majority (more than 75%) of these output losses in 1995/96, 1997/98, 1999/00 and 2002/03 were attributable to planned outages, when power shedding was introduced as a result of power shortages. In 2002/03, the year in which the power shortages were most severe, firms without back-up generators lost 9% to 14% of their potential production hours[98], ranging from 198 hours for firms operating 8 hours per day, to 1005 hours for firms operating 24 hours per day. In the other power shortage years (i.e. 1995/96, 1997/98 and 1999/2000), lost hours added up to 9% of the potential production hours. Among these years, 1999/2000 was the worst, with some firms losing from 7% to 9% of their potential production hours.

- The estimated value of production losses per year was also calculated, based on the actual production achieved in a year, incremented by the proportion of potential production hours lost through power interruptions. This estimate indicated that firms in the case study without back-up generators lost 15% to 30% of their potential value of outputs in 2002/03. In other less severe power shortage years, the corresponding losses were less, reaching a maximum of about 10% in some instances (particularly in 1999/2000).
- If these patterns were to be extended to the entire LMSMI sector, it is estimated that the country could have lost in the range of 700 million to 1.1 billion ETB from LMSMI production (i.e. more than 81 million USD) due to the power outages in 2002/03. The values of the production losses in 1997/98 and 1999/2000 were estimated (respectively) as one fourth and one half of the losses incurred in 2002/03.
- In comparison, unplanned power outages in the non-power shortage years (1998/99, 2000/01 and 2001/02) could have led to losses of more than above 100 million ETB per year (i.e., USD 12 million) on average across the entire LMSMI sector.
- However, the above estimated values of production losses due to power outages could be either greater or less in reality, because a number of other factors could also have limited the amount of LMSMI production, especially for those firms which in addition had market and raw materials problems. These firms most likely would not have operated during all the power outages even if electricity had been available. In the case of these firms, therefore, calculating the actual output losses by taking into consideration all the hours lost due to power outages could exaggerate the figure.

98 The potential production hours used here is the maximum number of hours one firm can work per a year without any problems such as raw material, market, and capital. It is approximately 7200 hours for firms working 24 hours per day and 2400 for firms working 8 hours per day.

- On the other hand, the impact of the power outages was not limited only to losses in outputs. Some firms lost significant quantities of raw materials that were in the process (and then spoiled) at the time of unexpected electricity interruptions. According to the case study findings, companies manufacturing bread, pasta, beverages, and car tyres reported large raw material losses as a result of un-planned power outages. (In 2001/02, such companies comprised about 40% of all LMSMI activity in Ethiopia.). At a national level, the raw material losses of similarly affected LMSMI firms across the country could be substantial.
- In addition, some of the firms in the case study mentioned that unexpected power interruptions had also caused damage to machinery and equipment.
- Further extra costs included additional fuels needed to start up production again, and additional service transportation costs (for those firms that provide transportation for their workers) as a result of un-notified power-shedding.
- Some firms said that the power outages (particularly unplanned ones) resulted in market losses. These were mainly firms facing local competition for their products, and firms producing goods for export (e.g. in the soup and leather manufacturing industries). These market losses were mainly due to quality maintenance problems and delays in delivery.
- In order to mitigate some of their production losses, most of the firms in the case study (12 out of 16) had obtained their own diesel generators. However, this created additional costs for the firms. Firms that obtained smaller generators (with an installed capacity of around 250 kVA) spent about 300,000 ETB (about USD 35,000) on purchase and installation, while firms that obtained larger generators (600 – 1000 kVA) spent more than a million ETB (more than USD 100,000). These capital costs accounted for 0.5% to 4% of the total book value of their fixed assets at the beginning of the year 2001/02.
- In addition, using diesel generators to supply their own electricity needs increased these firms' energy costs. The average unit operating costs of electricity from self-generation were estimated to be about three times the average price of electricity from the utility. The case study findings indicated that firms using their own diesel generators to cover power-interruption periods could lose around 1% to 1.5% of their profits (before income tax) in 2002/03, or in one case as much as 40% of their narrow profit margins.

Costs at a macro level

Reduction in revenues and profits at the level of individual firms has in turn had adverse impacts at a macro level. Extrapolating the case study results across the entire LMSMI sector would lead to the following estimates, for the country as a whole.[99]

- The country may have lost an estimated 10 to 15% of total yearly gross value of production in the LMSMI sector, as a result of the power outages in 2002/03. The actual loss in GVP could even be higher than this figure, if all the losses were considered, such as losses in raw materials and in-process products.
- In addition to the above, the country lost an estimated 7% - 21% of potential taxes collected from the LMSMI sector in 2002/03, due to the power outages (decreasing total government revenue by around 1% to 3%). Reduced government revenues in turn reduce the finance available for major development activities in the country, which inevitably has multidimensional adverse impacts on the socio-economic development of the nation as the whole.
- Although the exporting firms identified in the case study were not able to calculate the exact export earning losses that could be attributed to power outages, their subjective explanations indicated that power outages had two main impacts on their export production. It negatively affected the quality of their products, and lengthened delivery times, creating inconvenience for their clients. The impact on export earnings had substantial adverse effects on the country's economy as a whole, by further widening the imbalance between exports and imports. This in turn increased inflation and weakened the local currency.
- Apart from the above, some firms fired their workers; temporary workers, in particular, were often the first to be fired or retrenched. Based on the case

[99] Extrapolating from the case study findings across the entire LMSMI may not be valid: The firms in the case study are much larger than most of the LMSMI firms. They thus might not be representative of the total LMSMI firms. In addition, the sample size is very small. Moreover, even if electricity were available, other problems could have limited production by the LMSMI (e.g. a lack of market demand). Consequently, to reduce possible errors of estimation for the entire LMSMI sector, attempts were made to consider reasonable assumptions (see Chapter 7 for further explanations).

study findings, one medium-scale firm in 2002/03 laid off 300 temporary workers as a direct result of the power outages. For the same reason, another firm retired about 100 of its workers before their retirement date.

Nevertheless, despite all of the above, the impact of power shortages on the Ethiopian LMSMI sector has actually been quite low in relation to the high frequency of electricity interruptions. Some of the main reasons for this could be the following:

- The economic scale of most of the LMSMI firms in the country is very low. Numerically, most of them (more than 55%) are relatively small firms with a production capacity of less than 1000 ETB per hour.
- This sector has experienced several other problems, not just power interruptions, which have impeded production performance. These have included weak local and international market demand, inconsistent supplies of raw materials and difficulties obtaining spare parts and foreign currency. In such circumstances, the relative impact of power shortage problems becomes less noticeable.
- Most of the relatively large industries in the sector are very old, and use outdated equipment. As a result, their production operations are both manual and automated, which tends to reduce their overall dependency on electricity.

These and other reasons have reduced the severity of impact of the power shortages in the recent past. However, it is envisaged that similar electricity problems would result in substantial adverse impacts on the LMSMI sector in the foreseeable future, because of the following reasons:

- Firstly, the government has recently launched an Agricultural Development-Led Industrialization strategy for long-term development of the country, which will definitely increase the number of privately-owned advanced industries in the sector, particular in the food and leather manufacturing industries.
- Secondly, most of these privately-owned industries are very likely to use more advanced production processes (highly dependent on electricity) in order to increase their competitiveness in both foreign and local markets.
- Thirdly, because the country has a large range of animal, vegetable and fruit products, it is expected that many of the newly created industries (e.g. in leather and food products) will produce for foreign markets. Power outages would affect

product quality and delivery time, and could therefore seriously affect the viability of such businesses.

- In general, as the country's economy shifts from agriculture towards agricultural-led industry, the impact of power outages on the LMSMI sector and the country's economy would become greater in the future.

The causes of power shortages in the country

The study indicated that a combination of various factors, together with repeated droughts, had caused the power shortages which occurred in various years since the 1990s. A low level of investment in the electricity industry during the 1990s was identified as one of the prominent reasons for electricity shortages. The main constraints affecting the declining development of the electricity industry in this decade (particularly in the case of HEP, which, in 2001/02 accounted for more than 99% of the country's electricity), were as follows:

- A lack of financial support due to the so-called 'lack of right' to harness the immense hydroelectric power potential in the Nile River Basin prevented the country from receiving financial support from International Financial Institutions for any hydroelectric projects in the Nile River Basin.
- The country has very limited internal financing capacity. Even if the country's hydroelectric power could be developed economically, and even though it is theoretically the cheapest available energy source for electricity production, due to the high upfront investment requirements, and given the country's severe financial problems and chronic budget deficit, it is very unlikely that the country could have been able to utilise the hydropower potential of the Nile River without funding from external sources. Even building only one relatively large-scale hydroelectric power plant would require more than 15% of the current total government revenue.
- Questionable decision-making and governance retarded the development of electricity supply capacity in the country. For instance, although there was an urgent need to expand capacity in the electricity industry, and barely enough time to conduct a feasibility study, the government decided to create an entirely new project, instead of completing a project that had already been started (Gilgel Gibe). Recommendations to harness alternative energy sources (e.g. thermal

generation) as a short term protection measure and to compensate for delays in the Gilgel Gibe project were also not followed.

- Instead of pursuing more cost-effective and viable recommended HEP projects, the selection of certain projects in the 1990s, in particular at Tekeze River Basin, seemed to benefit the born place of the prevailing leadership group.

Such constraints resulted in delays in completing the Gilgel Gibe hydroelectric power project, and also slowed down development of previously identified, cost-effective and viable projects in the Nile and the Omo River Basins. These could otherwise have been developed in time to improve the electricity supply and prevent power shortages, due to their lower capital requirements. Some of them could also have been developed with the support of IFIs (because there were identified projects outside the Nile Basin).

Consequently, because of stagnation in electricity development during the past decade, the reserve margin between potential energy production from existing power plants in the ICS (main grid system) and actual production became very narrow, and insufficient to cope with demand growth and variations in rainfall. The ICS supplies Generation capacity in this group was expanded by only 3% since 1988, while on the other hand, electricity consumption within the ICS group had grown by about 60% between 1988 and 2000.

This study identified various factors relating to the growth in electricity consumption in the ICS group in the past decade. The following are the main ones:

- Due to the policies of the current government, which promote and encourage private sector involvement in the economy, there was more rapid investment growth in various sectors including the LMSMI sector. This in turn most likely boosted electricity demand. For example, 2075 relatively large projects were started in different sectors between 1992 and 2002. More than 88% of these projects were embarked upon before 2000, and the manufacturing industries made up 51% of these projects.

- Earlier extensions and additions of new centres before the scheduled time to the ICS group from the SCS group (off-grid) also increased consumption in the latter. This happened, for example, under the Northern electrification program, specifically in Bahar Dar and Mekele cities.

- Abrupt economic growth and higher development activities occurred in former SCS areas newly transferred to the ICS group. This took place particularly in the Northern region, where a significant number of new LMSMI businesses were initiated between 1997 and 2002.

In the 1990's, the three main reasons above resulted in a growth in electricity demand in the ICS group. Combined with stagnation on the supply side and coupled with prevailing drought conditions, all these factors together led to electricity shortages in the different drought years (specifically 1995/96, 1997/98 and 1999/2000). At the same time, it is likely that electricity shortages led to a situation of suppressed demand.

The improved supply capacity in 2001 and 2002, the previously suppressed demand, and better overall economic performance in these years, resulted in a sudden growth in electricity consumption in 2001/02 (15%). Ultimately, however, delays in rehabilitating the geothermal plant and in the completion of the Gilgel Gibe HEP project, in combination with the drought conditions of 2002/03, led to severe electricity shortages in that period.

In 2002/03, the prolonged power deficit and severe energy shortages resulted in power cuts lasting one day a week (which increased to two days/week from 23 May to June 30) for seven months.

8.2 RECOMMENDATIONS

- This study has shown that *unplanned* power outages, in particular, have resulted in higher costs of production in the LMSMI sector, due to losses in raw materials, damage to equipment and additional costs. Manufacturing process industries (such as foods, beverages, chemical, and leather and tyre production) reported substantial raw material losses as a result of unscheduled power interruptions. Considering the country's long-term development plans, such impacts could become increasingly significant in the future, especially in the food and leather manufacturing industries. Therefore, the utility should as far as possible develop a mechanism to reduce the occurrence of un-notified electricity interruptions. Particular attention should be given to ways of notifying such customers about the times of interruption (e.g. through the internet or by telephone).

- In 2004, EEPCo organised a workshop in order to increase the awareness of the large electricity customers (the majority of whom come from the LMSMI sector) about the electricity supply situation, and to seek mutually acceptable solutions, taking account of those customers' opinions. In addition, EEPCo has also been planning to establish an environment for a regular dialogue between end-users and themselves. This kind of end-user participation in the electricity supply industry, particularly with large and sensitive clients, should be strengthened and fostered, and designed in a sustainable way. Such engagement can also serve to increase customers' awareness about energy conservation and demand-side efficiency, create a greater feeling of responsibility on the part of the clients, and improve trust between clients and the utility. Most importantly, it would enable the utility to understand the extent of the impact that power outages have on firms' businesses, and help the utility to take appropriate actions by prioritising what is most important.
- Based on the current government's long-term development plan (ADLI) and different encouragement and initiation activities (e.g. the liberalisation of prices, the devaluation of the local currency, and tax exemptions) that aim to attract foreign and local investors in different economic sectors, it is envisaged that the number of relatively large companies, particularly in the LMSMI, will grow progressively. This will in turn boost the country's demand for electricity in the near future. Given that the country has vast un-tapped hydropower potential (only 2% is being harnessed at present), which can be developed fairly cost-effectively and economically, the government strongly believes that HEP will play a prominent role in meeting the 25 years forecast electricity demand in the ICS group (see also Acres 2003a; 2003b). Therefore, effective development of this resource will be crucial for the growth of electricity in the country.
- In the past, the development of this huge resource has been slow for several reasons discussed in this study. The study indicated, for example, that poor planning and poor decision-making were two main reasons for stagnation in HEP development in the 1990s, and the main reasons for electricity shortages in this decade. Thus, hydroelectric power projects should be carefully designed and planned by looking at both their constraints and benefits from different perspectives, always with the ultimate aim of achieving sustainable development goals for the benefit of the entire country.

- The country's vast and as yet undeveloped hydroelectric power potential could be used for integrated development, particular for irrigation and electricity production. This would address the country's major prevailing problems around both food and energy. A lack of finance, however, has been a major constraint in both electricity and agricultural development. The recent integrated development plans by government, in particular, have created a more positive framework for obtaining international funds to develop the hydropower potential in the Nile River basin. These funds had been denied for several years due to competition for trans-boundary waters. Further feasibility studies, research and human capacity building at all levels (i.e. technical, administrative, researcher and policy maker) are required to negotiate for and substantiate loan requests. Human development is particularly crucial; in order to train effective and skilled negotiators who are able to promote the country's right to trans-boundary water and who have the financial and technical skills to get loans from IFIs. This will further empower the nation to stand up for its rights.
- As pointed out in this study, it is clear that there are sufficient hydropower resources in total to meet forecasted ICS electricity needs for the next 25 years. Currently, the country's electricity supply is predominantly hydro-based (about 99%). However, the high dependency on a single energy source, particularly an energy source like hydropower, which is vulnerable to unpredictable climatic variability, will not guarantee the energy security of the country. Therefore, to ensure energy security and to compensate for delays in hydro development, emphasis should also be given to diversification of the electricity supply in the country, by developing other energy sources (e.g. geothermal, diesel, coal and natural gas). Especially, more focus should be placed on harnessing the country's geothermal potential.
- In the past, a lack of sound integrated planning and bad timing were identified as among the major causes of the electricity shortages of the 1990s. In order to supply electricity effectively and efficiently, in line with socio-economic growth in the country, it is crucial for government and all parties involved in the electricity industry to use integrated and proper planning. An integrated planning unit should thus be established in the utility or in the responsible government offices. It should be organised in such a way that it can gather information about the development activities of different socio-economic sectors and give timely feedback to the utility about the amount of electricity required.

- The current capacity expansions and additions in the electricity industry are encouraging, as is learning from past mistakes. However, as stated earlier, proper integrated planning in advance (identifying cost-effective approaches, and designing and working according to a timetable to develop the electricity industry pursuant to the country's development in other sectors) remains very important for the successful development of this industry.
- It is also recommended that there should be open access to the wealth of experiences gained from pre-feasibility studies and feasibility studies of all the previous power plant projects (particularly the large- and medium-scale hydroelectric plant sites within the Tekeze, Omo and Abay River basins). Open information about major events in the electricity industry (e.g. power shortages) would further benefit all concerned. An integrated planning office could be responsible for organising such documentation in a systematic way.

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APPENDIX A

THE SURVEY QUESTIONNAIRES

SECTION A
QUESTIONNAIRE IDENTIFICATION

1. Name of Establishment						
2 Town	3 Sub town	4 Woreda	3 Kebele	4 House No	5 Telephone	6 Estab. No.

SECTION B
THE FIRM BASIC INFORMATION

QUESTION	Code(for office use)
7. Main Products?	
8. Date of establishment?	
9. Ownership? Private = 1 Government = 2 Both = 3	
10. Initial Capital (in Birr)?	
11. Number of working hours within a day?	
12. Do you keep books of accounts Yes = 1 No = 2	
13. If the answer of question no 12 is **yes**, state according to which calendar year you accounts and books are being kept Ethiopian Fical year (year ending July 7) = 1 Ethiopian Calendar year (year ending Sept. 10) = 2 Gregorian calendar year (year ending Dec. 31) = 3 Other (specify)_______________________ = 4.	

SECTION C
ELECTRICITY SHORTAGES/ INTERRUPTIONS

1	2	3	4	5	6	7
		How many hours?				
Year	Was the firm production interrupted because of electricity problem?	Announced in advance (shifting)	Not announced in advance	Do not know	Did you take measure to reduce the problem?	If yes what type of measures?
1995	1 = Yes 2 = No				1 = Yes 2 = No	1 = Backup generator 2= Reduction of workers 3 = Working during the night. (How many hours.) 4 = Shifting to other non power activities

SECTION D
IMPACT ON PRODUCTION

1	2	3	4	5
Year	Approximately, how much amount of products was not produced due to electricity interruption in each year?			
	Unit	Unit price	Quantity	Sale value
e.g. 1995				

SECTION E
MEASURES

Part I. If the backup diesel generator was used/purchased to solve the problem of power shortages

For office use

1. How many generator do you have

I. **Duration**

2. When did you buy the generator(s)
   Month _Year___________E.C.

3. When the generator was started the operation?
   Month ___ Year___________E.C.

II. **Total Capacity**

4. How much is the installed capacity of the generator(s)?
   (kWh)

III. **Initial investment cost**

*The **initial cost** should includes all the expenses until the machine arrived at the firm, such as purchase price, custom taxes, transport and others.*

5. How much was the initial cost of the generator(s)
   . Birr

6. How much was the installation cost of the generator(s)?
   Birr
   . Birr

IV. **Operation Cost. If the generator was used for the shortage time, specified the years**

7	8	9	10	11	12
Year	For how long was the generator used(hours)	How many litres of diesel were used	The cost of the diesel	Maintenance cost	Others cost
e..g 1995					

V. **Current use**

13. Do you use the diesel generator currently/this year?
    1 = Yes 2 = No
14. If the answer of question number 13 is **yes,** why?
15. If the answer of question number 13 was **no**, what do you want to do on your generator?
    1 = to keep it for the future (during the electricity supply shortage time)
    2 = to resale it
    3 = to use it for other purposes? Please specified them \

VI. **Diesel generator compare with electricity from EEPCO (grid)**

16. What do you think the cost of the using diesel generator when compare with the cost of the electricity?
    1 = greater 2 = the same
    3 = lesser
17. Approximately how much is the cost of diesel generator to produce a unit (kWh) of electricity
    ____________ (Birr).
18. What are the major problems of using diesel generator?
    /
    :
    :

Part II .If others fuels(except diesel) were used as substitute during the electricity shortage time (specified them if they are not in the list)

19.	20.	21.	22.	23.	24.
Year	What type of fuel? Name	How much quantity did you use?	How much did it cost?	To produce the same amount of products, compared its costs with the costs of electricity 1 = greater	Remarks
	e.g Wood				

Part III. If the workers were reduced

25. How many workers were reduced?
26. How many
    1 = Production workers?
    2 = Administrative workers?

SECTION F
PERCEPTION/FEELING AND FUTURE MEASURES

6. What were the negative / adverse impacts of the electricity supply shortages/interruptions on the firm business in 1995 EC (Ethiopian Calendar)? (Please list all the impacts)

e.g . 1 = Approximate the firm lost ______________ Birr

2. Did you think the announcement, which was made in advance by EEPCo, on the date of interruption was enough (only for the year 1995 EC)?

1 = Yes 2 = No

3. If the answer of question number 2 is **no**, would you please explain briefly why did you think it was not enough?

4. Did EEPCo in advance announcement help you to take actions (make decisions) on the problem?

1 = Yes 2 = No

5. If yes, explain how?

6. If no, why?

7. What were the negative impacts of electricity interruptions when the firm did not know in advance about it?

8. In general what is your perception/feeling on the electricity supply shortage?

9. If similar problem happens in the future, what measures would you take to mitigate it?

The next two sections (section G and H) will ask the actual monthly production and electricity consumption and the planned one in 1995 EC (2002/2003 GC). This would be used to see the impact of the electricity supply shortages in different months (i.e. to calculate the deviation of the amount of production and electricity consumption from the planned and to look at the degree of variation in different months

SECTION G
MONTHLY PRODUCTION - 1995 EC (2002/2003G.C)

Actual D.1

1	Products					Export	
	2	3	4	5	6	7	8
Month	Main products	Unit	Unit Price	Quantity	Value	Quantity	Value
e.g. July							
Remark							

Planned D.2

1	Products					Export	
	2	3	4	5	6	7	8
Month	Main products	Unit	Unit Price	Quantity	Value	Quantity	Value
e.g. July							
Remark							

SECTION H
MONTHLY ELECTRICITY CONSUMPTION – 1995 EC (2002/2003G.C)

Month	Actual		Planned	
	Quantity(kWh)	Value	Quantity(kWh)	Value
e.g. July				
Remark				

SECTION I
EXPENSES -1995 EC (2002/2003G.C)

1. Raw material_______________
2. Salary._______________
3. Employee benefits_______________
   a. Car allowance and transport _______________
   b. Per-diem _______________.
   c. Training for firm's job._______________
   d. Commission and Bonus._______________
   e. Medical, education, food and others._______________
4. Fuel expense (except electricity)_______________
5. Interest_______________
6. Dividend_______________
7. Indirect tax (i.e. Sales tax, VAT, Excise tax and etc)_______________
8. Deprecation_______________
9. Other Expenses _______________

SECTION H
INCOME & STOCK_1995 EC (2002/2003G.C)

1. Sales _______________
2. other income _______________
3. Profit _______________

4. Stock	4 1	4.2
	Beginning	Ending
Finished goods		
Working in process		

SECTION H

OTHER FUEL

Answer the next part if the firm/factor uses other fuel in addition to electricity to drive the machine

1	2	3	4	5
Type of fuel	**Quantity (In 1995 EC)**	**Value (In 1995 EC)**	**End use (e.g. for boiler, baking)**	**Why do you use this fuel? (e.g. it is cheaper)**
Wood				
Furnace oil				
Fuel oil				
Other specified				

SECTION I

OTHER PROBLEMS

Year (from 1995/96 to 2002/03)	Was the operation of the firm interrupted because of other problems	What are the reasons?	How many hours?
(e.g. 2002/03 GC)	1 = Yes 2 = No	1. Lack of raw materials	
		2. Lack of spare parts	
		3. Lack of foreign currency	
		4. Lack of market	
		5. Lack of working capital	
		6. Shortage of water	
		7. Others, specified	

SECTION J

REMARKS

YOUR ANSWERS WILL BE AN IMPORTANT CONTRIBUTION

WE THANK YOU VERY MUCH INDEED FOR YOUR TIME AND PARTICIPATION IN THIS STUDY

SECTION K

NAME OF PERSON TO CONTACT REGARDING THIS REPORT

I certify that the preceding information is complete and correct to the best of my knowledge

NAME ____________________________TITLE__________________________________

SIGNATURE _________________________________ TEL. NO____________

DATE _________________________________

Well Done!

APPENDIX B

Historical Electricity Production and Consumption

B.1.Historical electricity production, sales and losses: 1956 – 2003 (ICS + SCS)

YEAR (GC)	Electricity production by source (GWh/year) Hydro Power	Diesel	Geo-thermal	Total	Growth	Sales	Loss	Regime
1956	24	10	0	35		25	27%	Imperial government
1957	26	11	0	37	6%	26	29%	
1958	29	12	0	41	11%	29	30%	
1959	33	14	0	47	15%	35	26%	
1960	39	17	0	55	18%	43	23%	
1961	50	21	0	71	29%	59	17%	
1962	92	5	0	97	36%	83	15%	
1963	104	8	0	111	14%	97	13%	
1964	136	10	0	146	31%	125	14%	
1965	144	33	0	177	22%	152	14%	
1966	152	40	0	192	9%	166	14%	
1967	210	19	0	229	19%	197	14%	
1968	233	21	0	255	11%	221	13%	
1969	240	26	0	266	4%	227	15%	
1970	259	28	0	287	8%	246	14%	
1971	300	31	0	331	15%	286	14%	
1972	307	35	0	343	3%	299	13%	
Average	140	20	0	160	16%	136	18%	
1973	327	38	0	365	6%	320	13%	Marxist government
1974	350	33	0	383	5%	314	13%	
1975	355	36	0	391	2%	343	13%	
1976	363	36	0	399	2%	348	13%	
1977	377	42	0	419	5%	371	12%	
1978	392	44	0	436	4%	386	12%	
1979	449	45	0	494	13%	433	12%	
1980	484	54	0	538	9%	469	11%	
1981	489	73	0	562	4%	489	13%	
1982	534	91	0	625	11%	573	8%	
1983	616	38	0	654	5%	598	9%	
1984	657	57	0	714	9%	594	17%	
1985	749	43	0	792	11%	665	16%	
1986	829	45	0	874	10%	732	16%	
1987	912	33	0	945	8%	809	14%	
1988	987	27	0	1014	7%	840	17%	
1989	1027	22	0	1049	3%	879	16%	
1990	1098	31	0	1129	8%	916	19%	
1991	1109	20	0	1129	0%	947	16%	
Average	637	43	0	680	7%	580	14%	
1992	1127	20	0	1147	2%	1001	13%	Current government
1993	1251	27	0	1278	11%	1034	19%	
1994	1350	45	0	1395	9%	1134	19%	
1995	1416	36	0	1452	4%	1178	19%	
1996	1507	43	0	1550	7%	1268	18%	
1997	1566	48	0	1614	4%	1323	18%	
1998	1580	48	0	1628	1%	1359	17%	
1999	1606	21	26	1653	2%	1332	19%	
2000	1645	23	20	1688	2%	1376	20%	
2001	1790	17	5	1812	7%	1412	22%	
2002	1991	17	1	2009	11%	1621		
2003	2007	40	0	2047	2%			
Average	1570	32	4	4.333	5%	1,276		

B.2. Historical electricity sales by tariff category (GWh/year): 1973 – 2000 GC

Year	Domestic	Growth	Commercial	Light	Industry	LV	HV(=>15kV)	LV + HV	Growth	Special //Rate	Boiler	Own Consumption	Total	Growth
1973	66		30	7	31	51	109	159		26	0	0	320	
1974	58	-11%	28	6	28	48	121	169	6%	24	0	0	314	-2%
1975	73	25%	37	7	34	52	111	163	22%	28	0	0	343	9%
1976	76	5%	37	8	35	49	112	161	-2%	31	0	0	348	2%
1977	83	9%	41	8	39	51	119	171	6%	29	0	0	371	6%
1978	95	15%	42	8	41	52	118	170	-1%	30	0	0	386	4%
1979	109	15%	48	13	46	56	128	185	9%	32	0	0	433	12%
1980	119	9%	48	8	46	72	144	215	16%	31	0	0	469	8%
1981	131	10%	50	7	49	73	146	219	2%	32	0	0	489	4%
1982	161	23%	64	11	60	77	150	228	4%	28	20	0	573	17%
1983	160	-1%	59	7	57	91	163	254	12%	22	39	0	598	4%
1984	173	8%	62	9	60	91	139	230	-10%	20	40	0	594	-1%
1985	191	10%	66	8	68	87	161	248	8%	17	66	0	665	12%
1986	199	4%	72	9	74	94	196	290	17%	0	88	0	732	10%
1987	216	9%	92	9	92	103	229	332	15%	0	68	1	809	11%
1988	230	6%	94	9	102	113	230	343	3%	0	61	1	840	4%
1989	262	14%	101	10	105	119	227	345	1%	0	54	1	879	5%
1990	292	11%	104	8	115	130	221	351	2%	0	45	1	916	4%
1991	346	19%	112	9	126	127	186	314	-11%	0	40	1	947	3%
Average		10%							4%					6%

	Percentage share			Total	Domestic customers	Large Industry
Year	Large industry	domestic customers	Period	Average Growth per year		
1973	50%	21%	1973 – 78	4%	8%	2%
1991	33%	37%	1978 – 80	10%	12%	13%
			1980 – 88	8%	10%	9%
			1988 – 91	4%	15%	-3%
			1973 - 91	6%	10%	4%
					Growth	
			1973 – 92	196%	427%	97%

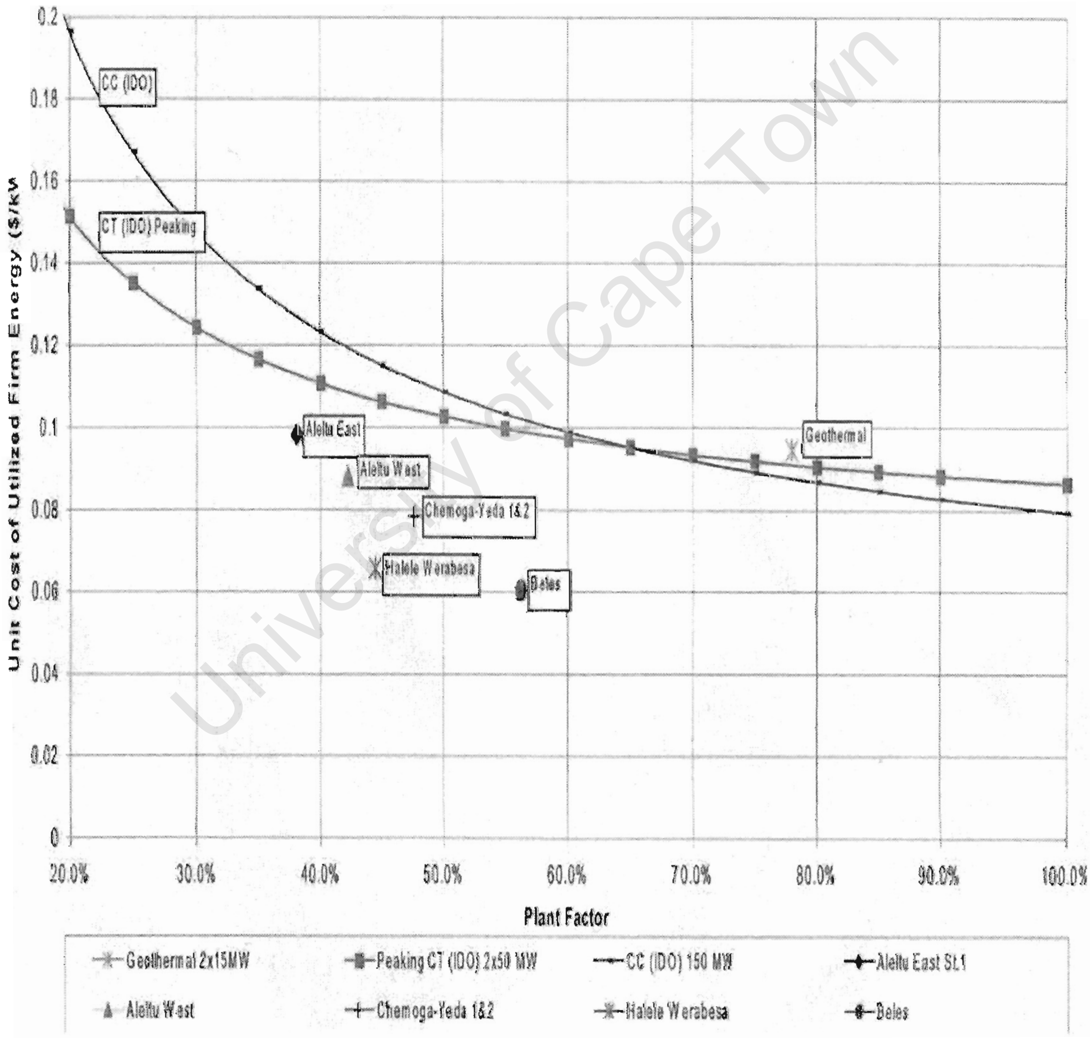
Year	Domestic	Growth	Commercial	Light	Industry	LV	HV(=>15kV)	LV + HV	Growth	Special //Rate	Boiler	Own Consumption	Total	Growth
1992	404	17%	131	20	121	106	191	297	-5%	0	25	3	1001	6%
1993	420	4%	121	13	124	99	220	319	7%	0	36	2	1034	4%
1994	459	9%	137	8	133	110	245	355	11%	0	41	1	1134	10%
1995	511	11%	142	8	33	240	201	441	24%	0	43	1	1178	4%
1996	551	8%	155	7	0	291	212	502	14%	0	52	1	1268	8%
1997	572	4%	190	8	0	284	234	518	3%	0	33	1	1323	4%
998	523	-9%	278	9	0	273	274	547	6%	0	0	1	1359	3%
1999	497	-5%	304	11	0	262	256	518	-5%	0	0	1	1332	-2%
2000	504	1%	328	9	0	262	270	532	3%	0	0	2	1376	3%
Average		5%							8%					4%

Source: B.1 & 2: Data derived from EEPCo (2004)

APPENDIX C

LEAST- COST GENERATION AND TRANSMISSION EXPANSION PLAN (Target forecast)

C.1. Screening of generation alternatives. Short-listed hydro, thermal and geothermal



C.2. Least Cost Plan – Installed Capacity - Target Forecast (ICS)

Year GC	Hydroelectric	Diesel	Combustion Turbine	Combince Cycle	Geothermal	Total	Forecast Peak Demand
2002	463.8	7.2	0		1	**472.0**	*376*
2003	647.8	0	0		7.2	**655.0**	*406*
2004	647.8	0	0		7.2	**655.0**	*435*
2005	647.8	0	0		7.2	**655.0**	*466*
2006	647.8	0	0		7.2	**655.0**	*499*
2007	773.8	0	0		7.2	**781.0**	*535*
2008	899.8	0	0		7.2	**907.0**	*574*
2009	974.8	0	0		7.2	**982.0**	*616*
2010	984.8	0	0		7.2	**992.0**	*663*
2011	984.8	0	0		7.2	**992.0**	*712*
2012	984.8	0	0		7.2	**992.0**	*765*
2013	984.8	0	49.3		7.2	**1041.3**	*822*
2014	984.8	0	98.6		7.2	**1090.6**	*883*
2015	984.8	0	98.6		7.2	**1090.6**	*948*
2016	1081.2	0	98.6		7.2	**1187.0**	*1018*
2017	1421.1	0	98.6		7.2	**1526.9**	*1092*
2018	1421.1	0	98.6		7.2	**1526.9**	*1173*
2019	1421.1	0	98.6		7.2	**1526.9**	*1259*
2020	1641.0	0	98.6		7.2	**1746.8**	*1353*
2021	1641.0	0	98.6		7.2	**1746.8**	*1454*
2022	1759.0	0	98.6		7.2	**1864.8**	*1563*
2023	1851.0	0	14.9		7.2	**1873.1**	*1681*
2024	1851.0	0	98.6	146.0	7.2	**2102.8**	*1808*
2025	1851.0	0	98.6	292.0	7.2	**2248.8**	*1946*

C.3. LEAST COST PLAN – EXPECTED ENERGY GENERATION-TARGET FORECAST (ICS)

Year GC	Hydroelectric	Diesel	Combustion Turbine	Combince Cycle	Geothermal	Total	Forecast Energy Demand
2002	1867.6	4.1	0.0	0.0	6.8	**1878.5**	*1911.0*
2003	2007.6	5.8	0.0	0.0	49.1	**2062.5**	*2065.0*
2004	2167.0	0.0	0.0	0.0	49.1	**2216.1**	*2216.0*
2005	2319.9	0.0	0.0	0.0	49.1	**2369.0**	*2369.0*
2006	2492.7	0.0	0.0	0.0	49.1	**2541.8**	*2542.0*
2007	2676.1	0.0	0.0	0.0	49.1	**2725.2**	*2725.0*
2008	2874.0	0.0	0.0	0.0	49.1	**2923.1**	*2923.0*
2009	3086.9	0.0	0.0	0.0	49.1	**3136.0**	*3136.0*
2010	3326.0	0.0	0.0	0.0	49.1	**3375.1**	*3375.0*
2011	3574.0	0.0	0.0	0.0	49.1	**3623.1**	*3624.0*
2012	3842.7	0.0	0.0	0.0	49.1	**3891.8**	*3892.0*
2013	4091.8	0.0	38.3	0.0	49.1	**4179.2**	*4183.0*
2014	4198.2	0.0	242.1	0.0	49.1	**4489.4**	*4492.0*
2015	4270.6	0.0	468.9	0.0	49.1	**4788.6**	*4824.0*
2016	4648.1	0.0	449.9	0.0	49.1	**5147.1**	*5179.0*
2017	5510.8	0.0	0.3	0.0	49.1	**5560.2**	*5560.0*
2018	5831.3	0.0	88.0	0.0	49.1	**5968.4**	*5969.0*
2019	5969.6	0.0	372.0	0.0	49.1	**6390.7**	*6410.0*
2020	6837.3	0.0	0.8	0.0	49.1	**6887.2**	*6887.0*
2021	7014.7	0.0	324.8	0.0	49.1	**7388.6**	*7400.0*
2022	7539.9	0.0	353.7	0.0	49.1	**7942.7**	*7957.0*
2023	7834.0	0.0	659.6	0.0	49.1	**8542.7**	*8557.0*
2024	7953.4	0.0	249.2	926.5	49.1	**9178.2**	*9204.0*
2025	8046.6	0.0	143.5	1647.3	49.1	**9886.5**	*9903.0*

C.4. Existing and short-term transmission system

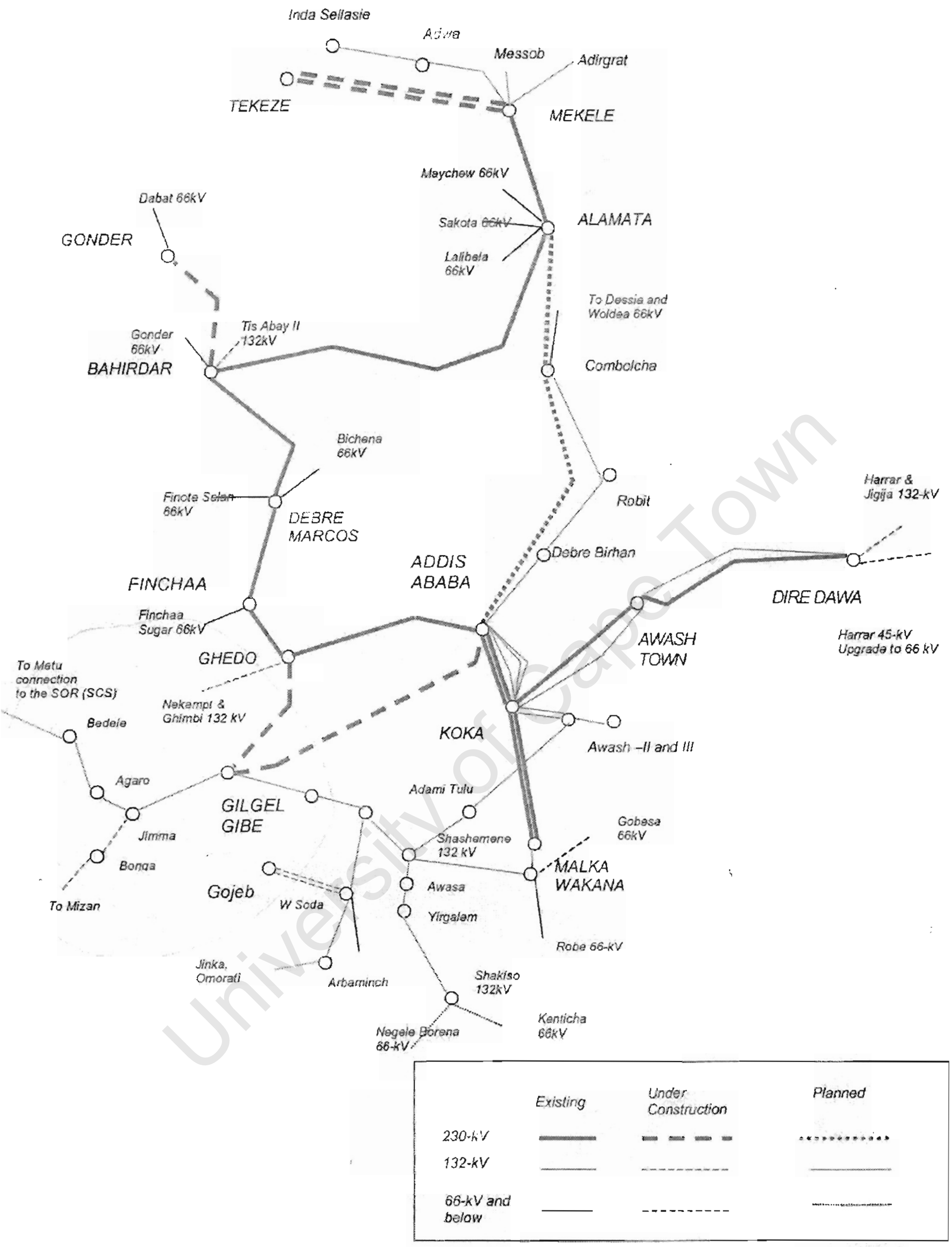


Figure 1
Existing and Short-Term Transmission System

Source: C1 – 3: Acres international (2003a)

APPENDIX D

TARIFF CHANGE SINCE 1978

D. Tariff change since 1978

Category and Block	October 1978*	March 14, 1986**	October 11, 1994	April 9, 1997	April 9, 1998
Domestic					
0-50		0.1700	0.1545	0.2109	0.2730
51-100		0.1200	0.1600	0.2235	0.2921
101 - 200			0.1819	0.2930	0.4093
201 - 300			0.1873	0.3165	0.4508
301 - 400			0.1917	0.3265	0.4644
401 - 500			0.1973	0.3371	0.4820
501+			0.2113	0.3657	0.5691
Equiv. Flat Rate	**0.1448**	**0.1500**	**0.1772**	**0.2809**	**0.3897**
(USD/kWh)	***0.0700***	***0.0725***	***0.0295***	***0.0427***	***0.0562***
General* **					
0 -25			0.3096	0.3890	0.4990
26 - 50			0.3522	0.3890	0.4990
51 -100			0.3522	0.4443	0.5691
101 - 1000			0.3666	0.4443	0.5691
1001+			0.3727	0.4443	0.5691
Equiv. Flat Rate****	**0.1517**	**0.3436**	**0.3653**	**0.4301**	**0.5511**
(USD/kWh)	***0.0733***	***0.1660***	***0.0609***	***0.0654***	***0.0794***
Industrial					
LV Industrial					
Peak			0.2842	0.4755	0.6087
Off Peak			0.2407	0.3469	0.4455
Equiv. Flat Rate	***0.1420***	***0.2232***	***0.2563***	***0.3690***	***0.4736***
(USD/kWh)	***0.0686***	***0.1078***	***0.0427***	***0.0561***	***0.0683***
HV industrial (15kv)					
Peak			0.2530	0.3243	0.4168
Off Peak			0.2230	0.2499	0.3224
Equiv. Flat Rate	**0.0803**	**0.2029**	**0.2341**	**0.2597**	**0.3349**
(USD/kWh)	***0.0388***	***0.0980***	***0.0390***	***0.0395***	***0.0483***
HV industrial (132kv)					
Peak				0.3017	0.3882
Off Peak				0.2325	0.3003
Equiv. Flat Rate				**0.2416**	**0.3119**
(USD/kWh)				***0.0367***	***0.0449***
Street Lighting					
Flat Rate	0.1197	0.3320	0.3333	0.3087	0.3970
(USD/kWh)	***0.0578***	***0.1604***	***0.0556***	***0.0469***	***0.0572***
Over all Average Tariff (ETB/kWh)	**0.1231**	**0.2000**	**0.2254**	**0.3141**	**0.4163**
(USD/kWh)	***0.0595***	***0.0966***	***0.0376***	***0.0477***	***0.0600***
ETB/USD	***2.0700***	***2.0700***	***5.9980***	***6.5800***	***6.9390***

Source: Mengistu (2004)

*. The 1978 tariff carried graduations pertaining to monthly consumption levels.

** Both the 1978 and March 1986 tariffs included a separate (and higher) schedule for SCS consumption.

*** General tariff came into being in 1986; before then it was known as"commercial" tariff

**** "Equivalent flat rate tariff" is the average tariff in each tariff category.

APPENDIX E

FIRM AND AVERAGE ENERGY CAPABILITY

E.1. Procedures of calculating firm and average energy capability

Step 1. Existing historic records of river discharge are used to determine the flow entering the reservoirs or head ponds located upstream of the hydroelectric stations for a number of years (normally flows are derived for each month over a period of 40 to 50 years).

Step 2. Computer model is used, along with the characteristics of the reservoirs and hydroelectric stations, to determine how much energy can be generated at each of the stations for each month during the 40 to 50 years of discharge records derived in Step 1.

Step 3. The firm energy capability of an individual station or of all stations in the system (system firm) is determined as the minimum annual energy that was generated in the 1 or 2 driest years out of the total of 40 to 50 years of discharge records derived in Step 1.

Step 4. The average energy capability of an individual station or of all stations (system average) is determined by averaging the energy that is generated over the 40 to 50 years of discharge records derived in Step 1.

E.2. Installed capacity, firm and average energy capability of HEP in Ethiopia (ICS) in 2004

Name of hydropower Scheme	Installed capacity (MW)	Annual energy (GWh/year)		Name of the river Basin
		Average	Firm	
Existing power plants				
Koka	43	110	80	Awash Basin
Awash II	32	165	120	Awash Basin
Awash III	32	165	120	Awash Basin
Finchaa	134	617	613	Melka-Wakana Basin
Melka Wakana	153	560	440	Abay Basin (Blue Nile)
Tis Abay I	11	68	55	Abay Basin
Tis Abay II	73		359	Abay Basin
Gilgel Gibe	184	864	670	Omo-Gibe Basin
On-going and planned hydropower programs				
Tekeze	250		981	Tekeze Basin
Gojeb	150		359	Omo-Gibe Basin
Aleltu		3350	3484	Abay Basin
Chemoga Yeda		3031	2526	Abay Basin
Beles		1617	1100	
Halel-Werabessa		1475	1180	Omo-Gibe Basin

Source: Solomon (1998)

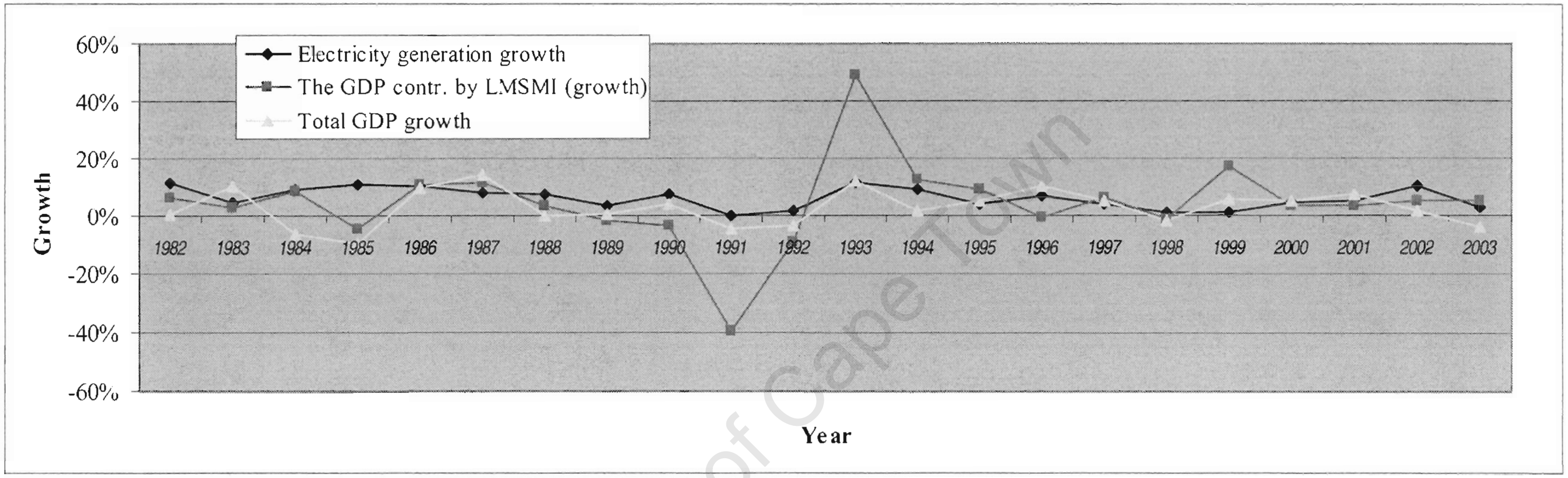
APPENDIX F

MAJOR ECONOMIC INDICATORS (HISTORICAL DATA)

F.1. Gross Domestic Product by sector at constant market price: 1980/81 – 2002/03 (1973 – 1995 EFY) in million ETB

EFY.	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
G.Y.	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03
																					Estimate	Pr.Est.	Pr.Est.
AGRICULTURE & ALLIED ACTIVITIES	5385	5190	5895	5156	4079	4732	5620	5465	5521	5814	6115	5948	6308	6078	6284	7206	7454	6621	6874	7025	7831	7651	6664
INDUSTRY	1012	1098	1162	1232	1285	1369	1479	1422	1328	1265	1024	951	1222	1307	1413	1435	1531	1567	1701	1731	1818	1923	2017
Mining & Quarrying	12	15	15	19	25	24	21	17	20	19	52	39	57	45	49	55	63	69	75	83	90	98	108
LMSMI	406	432	443	481	458	508	566	585	576	557	336	306	456	514	562	558	594	587	688	713	736	773	812
Small Scale Industry & Handicrafts	196	209	232	219	202	233	253	234	211	233	201	201	234	237	257	269	280	275	294	302	317	324	325
Electricity & Water	116	123	129	130	136	146	154	164	171	175	180	187	198	208	219	203	215	223	226	235	243	260	270
Construction	281	319	343	384	464	457	484	423	350	282	255	218	277	303	325	349	380	412	418	399	431	468	502
DISTRIBUTIVE SERVICES	1293	1349	1387	1391	1404	1453	1671	1728	1633	1706	1305	1272	1555	1651	1757	1915	2062	2178	2254	2423	2550	2663	2749
OTHER SERVICES	1635	1737	1882	1897	1967	2043	2179	2333	2504	2648	2494	2364	2714	2963	3191	3375	3594	4064	4466	4933	5155	5395	5472
TOTAL	9325	9374	10327	9676	8735	9597	10949	10948	10986	11433	10938	10535	11799	11999	12644	13931	14640	14429	15294	16112	17354	17632	16902
	Growth																						
LMSMI (GDP)		6%	3%	9%	-5%	11%	11%	3%	-1%	-3%	-40%	-9%	49%	13%	9%	-1%	6%	-1%	17%	4%	3%	5%	5%
GDP total		1%	10%	-6%	-10%	10%	14%	0%	0%	4%	-4%	-4%	12%	2%	5%	10%	5%	-1%	6%	5%	8%	2%	-4%

F.2 Growth trends: Electricity production, GDP and LMSMI-GDP



Correlation coefficient

Total GDP and LMSMI GDP contr. = 0.51 Total GDP and electricity production = 0.12 LMSMI GDP contr.& Elec production = 0.50

F.3. Import and export at current market price: 1980/81 – 2002/03 (1973 – 1995 EFY)

E.FY	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
GC	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
TRADE BALANCE	-603	-826	-791	-960	-1026	-1055	-1152	-1193	-869	-765	-1336
EXPORTS of GOODS & N. SERVICES	1072	1007	1065	1165	1057	1272	1187	1205	1423	1295	1062
IMPORTS of GOODS & N. SERVICES	1675	1833	1856	2125	2083	2326	2338	2398	2292	2060	2398

E.FY	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
GC	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01 Estimate	2001/02 Pr.Est.	2002/03 Pr.Est.
TRADE BALANCE	-1286	-2298	-2868	-3052	-3752	-3854	-4224	-7224	-7952	-8212	-9682	-1035[illegible]
EXPORTS of GOODS & N. SERVICES	938	2223	3223	4898	4970	6731	7117	6878	8018	7981	8027	977[illegible]
IMPORTS of GOODS & N. SERVICES	2223	4521	6091	7950	8722	10585	11341	14102	15969	16194	17709	20137

Source: F1, F2 & F3: data collected from MOFED (2003) and EEPCo (2004)

APPENDIX G

LMSMI PRODUCTION (2001/02)

G.1 Number of establishment and gross value of production[100] by capacity of production: 2001/02 (1994 EFY)

An hourly production	Number of working hours per day									
		< 12 hours	12 - 18 Hours	19-24 hours	Total		< 12 hours	12 - 18 Hours	19-24 hours	Total
	When an hourly production calculated based on the actual production in 2001/02									
	Number of Establishments									
Not stated	73				73	8.3%				
< 1000		525	48	18	591		59.5%	5.4%	2.0%	66.9%
1000 - 5000		80	14	25	119		9.1%	1.6%	2.8%	13.5%
5000 - 10000		29	7	5	41		3.3%	0.8%	0.6%	4.6%
1000 - 20000		21	3	6	30		2.4%	0.3%	0.7%	3.4%
20000 - 50000		12	5	5	22		1.4%	0.6%	0.6%	2.5%
> = 50000		6		1	7		0.7%		0.1%	0.8%
Total	73	673	77	60	883	8.3%	76.2%	8.7%	6.8%	100.0%
	Actual value of production in 2001/02 (in '000 ETB)r									
Not stated	652,554				652,554	8.5%	0.0%	0.0%	0.0%	8.5%
< 1000		219,796	31,487	43,821	295,103		2.9%	0.4%	0.6%	3.9%
1000 - 5000		363,508	120,360	382,659	866,528		4.8%	1.6%	5.0%	11.3%
5000 - 10000		406,284	190,733	214,155	811,172		5.3%	2.5%	2.8%	10.6%
1000 - 20000		593,295	153,173	446,407	1,192,875		7.8%	2.0%	5.8%	15.6%
20000 - 50000		789,945	458,428	1,079,158	2,327,531		10.3%	6.0%	14.1%	30.4%
> = 50000		1,160,396		343,321	1,503,717		15.2%	0.0%	4.5%	19.7%
Total	652,554	3,533,223	954,182	2,509,521	7,649,481	8.5%	46.2%	12.5%	32.8%	100.0%
	When an hourly value of production calculated based on production at full capacity in 2001/02									
	Number of Establishments									
Not stated	58	[illegible]	3	1	70	6.7%	0.9%	0.3%	0.1%	8.1%
< 1000		429	39	10	478		49.4%	4.5%	1.2%	55.1%
1000 - 5000		130	14	20	164		15.0%	1.6%	2.3%	18.9%
5000 - 10000		34	2	9	45		3.9%	0.2%	1.0%	5.2%
1000 - 20000		30	6	10	46		3.5%	0.7%	1.2%	5.3%
20000 - 50000		26	9	6	41		3.0%	1.0%	0.7%	4.7%
> = 50000		16	4	4	24	0.0%	1.8%	0.5%	0.5%	2.8%
Total	58	673	77	60	868	6.7%	77.5%	8.9%	6.9%	100.0%
	Production at Full Capacity in '000 ETB									
Not stated	1,231,983				1,231,983	7.6%	0.0%	0.0%	0.0%	7.6%
< 1000		250,179	38,001	28,976	317,156		1.5%	0.2%	0.2%	2.0%
1000 - 5000		595,273	108,788	364,734	1,068,795		3.7%	0.7%	2.3%	6.6%
5000 - 10000		469,106	65,091	427,413	961,610		2.9%	0.4%	2.6%	5.9%
1000 - 20000		897,784	293,058	884,372	2,075,214		5.5%	1.8%	5.5%	12.8%
20000 - 50000		1,579,218	976,991	1,047,874	3,604,083		9.7%	6.0%	6.5%	22.3%
> = 50000		3,810,746	1,586,692	1,540,892	6,938,331		23.5%	9.8%	9.5%	42.8%
Total	1,231,983	7,602,306	3,068,622	4,294,261	16,197,172	7.6%	46.9%	18.9%	26.5%	100.0%

Source: Data collected from LMSMI (2004)

[100] Note is that gross value production does not include other incomes.

APPENDIX H

CHRONOLOGY OF EL NIÑO AND DROUGHT/FAMINE IN ETHIOPIA (2001/02)

El Niño Years	Drought/Famine	Affected Regions
1539-41	1543-1562	Hararghe
1618-19	1618	Northern Ethiopia
1828	1828-29	Shewa
1864	1864-66	Tigray and Gondar
1874	1876-78	Tigray and Afar
1880	1880	Tigray and Gondar
1887-89	1888-1892	Ethiopia
1899-1900	1899-1900	Ethiopia
1911-1912	1913-1914	Northern Ethiopia
1918-19	1920-22	Ethiopia
1930-32	1932-1934	Ethiopia
1953	1953	Tigray and Wollo
1957-1958	1957-1958	Tigray and Wollo
1965	1964-66	Tigray and Wollo
1972-1973	1973-1974	Tigray and Wollo
1982-1983	1983-1984	Ethiopia
1986-87	1987-1988	Ethiopia
1991-92	1990-92	Ethiopia
1993	1993-94	Tigray, Wollo, Addis
1995		Ethiopia
1997	1997	Ethiopia

Source: Tsegay (1998)

APPENDIX I

THE LIST OF ELECTRICITY SALE BRANCH CENTRES IN 2002

ADDIS ABABA REGION	CENTRAL REGION	EASTERN REGION	NORTH EASTERN REGION
ADDIS ABABA NORTH	DEBRE ZEIT	DIRE DAWA	AXUM
ADDIS ABABA SOUTH	AMIBARA	JIJIGA	MEKELE
ADDIS ABABA WEST	NAZARETH	HARRARA	SHIRE
AKAKI	HAGERE HIWOT	ASEBE TEREFI	HOREM
	DEBRE BERHAN	GELEMSO	MAYCHEW
	ASSELA	ALEMAYA	WUKRO
	ZIWAY	DEDDER	ALAMATA
	BAKO		ADWA
			ADDIGRAT
	WELISO		WAJA
	FICHE		BIZEN
	BUTAJIRA		KOREM
	MODJO		
	SHAMBU		
	WOLKITIE		
	METEHARA		
	ADDIS ALEM		

NORTH WESTERN REGION	NORTH EASTERN REGION	SOUTHERN REGION	WESTERN REGION
DEBRE MARKOS	DESSIE	WOLAYITA SODDO	JIMMA
DEBRK	DEBRE SINA]	ADABA DODOLLA	AGARO
GONDER	BATTI	YIRGALEM	BUNNO BEDELLE
BAHIR DAR	WOLDIYA	HOSSANA	SHAMBU
DEBR TABOUT	KOBA	SHASHEMENEN	BUNO BEDELE
BITHCENA	KOMOBOLCAH	DILLA	NEKEMPTE
PAWIE	LALIBELA	ARBA MINCHE	GHIMBI
DENGILA	SEKOTA	BALE GOBA BEDELL	
FINOTE SELAM		KIBRE MENGIST	
		YRGA CHEFIE	
		ALABA	
		AWASSA	

- The branch centres in the shade are big urban centres
- All the branches in the Northern region centre were newly transferred (since 1997)

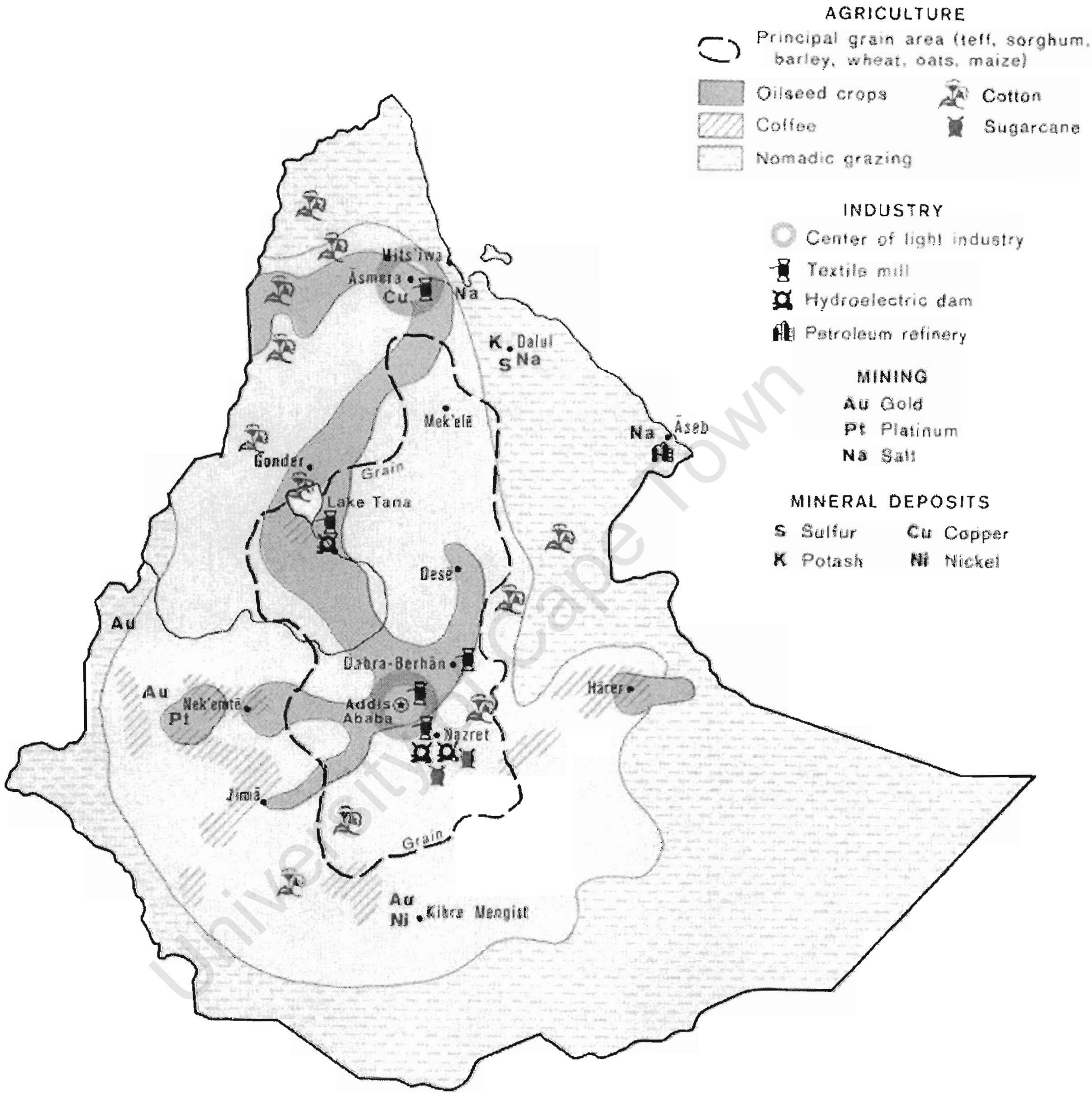
Source: Data collected from EEPCo (2004)

APPENDIX J

ETHIOPIAN-MAPS

Map.1 Administrative regional states

Source: FAO/GIEW



Map 2 Economic activity

Source: University of Texas Library Perry-Castañeda Library (2005)