KITE

KUMASI INSTITUTE OF TECHNOLOGY AND ENVIRONMENT (KITE)

Ghana Sawmill Energy Efficiency Study

FINAL REPORT

Submitted to

Intermediate Technology Consultants (ITC)
and
UK Department for International Development (DFID)

by

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EXECUTIVE SUMMARY

Introduction

The original focus of this study was to review the scope of energy efficiency options and explore experiences of energy efficiency activities in the wood processing firms. The broader objectives sought to be achieved in the project are:

- To gain a comprehensive understanding of research and work that has been carried out into improving energy efficiency in sawmills, particularly in Ghana; and
- To gain an initial knowledge of the scope for energy efficiency improvements in the small-scale sawmill industry in Ghana.

The original specific objectives of the sub-project in Ghana were to:

- identify and understand the relevant technologies and processes for energy efficiency improvements in the wood processing industry;
- gain a comprehensive understanding of the opportunities and constraints for energy efficiency improvements in the industry including social, legal and environmental issues;
- identify the key policy issues necessary to create an enabling environment for the energy efficiency improvements in the industry (i.e. national and local government regulations, guidelines and fiscal policies); and
- identify and understand options that are available for financing of energy efficiency improvements in the industry.

Although the project set out to achieve the objectives listed above, it became necessary along the life of the project to gain a very good understanding of the timber sub-sector as a whole, to be able to bring out 'hidden' barriers to a wider adoption of energy efficiency practices and related options for improving efficiency in the industry as a whole. Therefore, as the project progressed, the focus was widened to include a study of trends and dynamics in the timber sub-sector as a whole and the prospects for added value/waste minimization and residue utilization.

The Timber Sub-Sector

Overview

Timber is a key foreign exchange earner for the country and until recently, when it was overtaken by tourism, it was the third highest-ranking foreign exchange earner. The timber sub-sector is reported to employ over 100,000 people, but also provides a livelihood for about 2 million Ghanaians.

The key functions in the timber sub-sector are:

1. Timber Harvesting (Logging)
2. Log Haulage

3. Log Marketing
4. Primary Processing of Logs
5. Marketing (wholesale/retail) of primary products
6. Secondary Processing (of Boules, Beams and Rough-sawn lumber into square-edged lumber and dimensioned products
7. Marketing (exports, wholesale, retail) of secondary products.
8. Pole Treatment
9. Marketing
10. Wood Drying
11. Tertiary processing into Mouldings, Furniture parts, etc.
12. Marketing: Export, wholesale, retail of tertiary products.
13. Residue Utilisation, for:

- Chipboard Production
- Charcoal Production
- Fuelwood
- Poultry Bedding
- Briquetting
- Co-generation
- Reprocessing – furniture, doors and window frames, doors and other utility products
- Fencing

Marketing of wood and or wood products occurs at various stages within the sub-sector. The market falls into 3 distinct categories. These are Overseas Export Market, Overland Export Market and the local market and the actors involved in marketing at the various levels may be very different. Species of timber for local use are the same as those on demand on the export market even though the local market uses falldowns from the export market.

Sub-Sector Map

Firms in the wood industry of Ghana may be put into three classes on the basis of degree of value-addition/processing as follows:

- The primary operators/enterprises (i.e. Loggers);
- The secondary enterprises (sawmillers, veneer – and plywood producers as well as particleboard manufacturers); and
- The tertiary and down-stream processing enterprise (i.e. Furniture, mouldings, flooring and toy manufacturers).

Wood-processing firms in Ghana may also be classified according to size – small, medium and large. The Forestry Commission puts the number of sawmills in Ghana at 120; some 46 % of the sawmills fall in the small-scale category while the rest are almost equally distributed between the medium and large categories. The same source puts the number of veneer mills at 25, of which 15 go on further to manufacture plywood. There are 4 toys manufacturing firms and 11 curls manufacturing firms as well as 40 medium and large firms in furniture making and, in addition, there are numerous firms in the small-scale carpentry and furniture-making category. Sawmills – as well as veneer and ply mills – and loggers interact with a large number of other actors. A sub-sector map for the timber industry is presented in Figure I

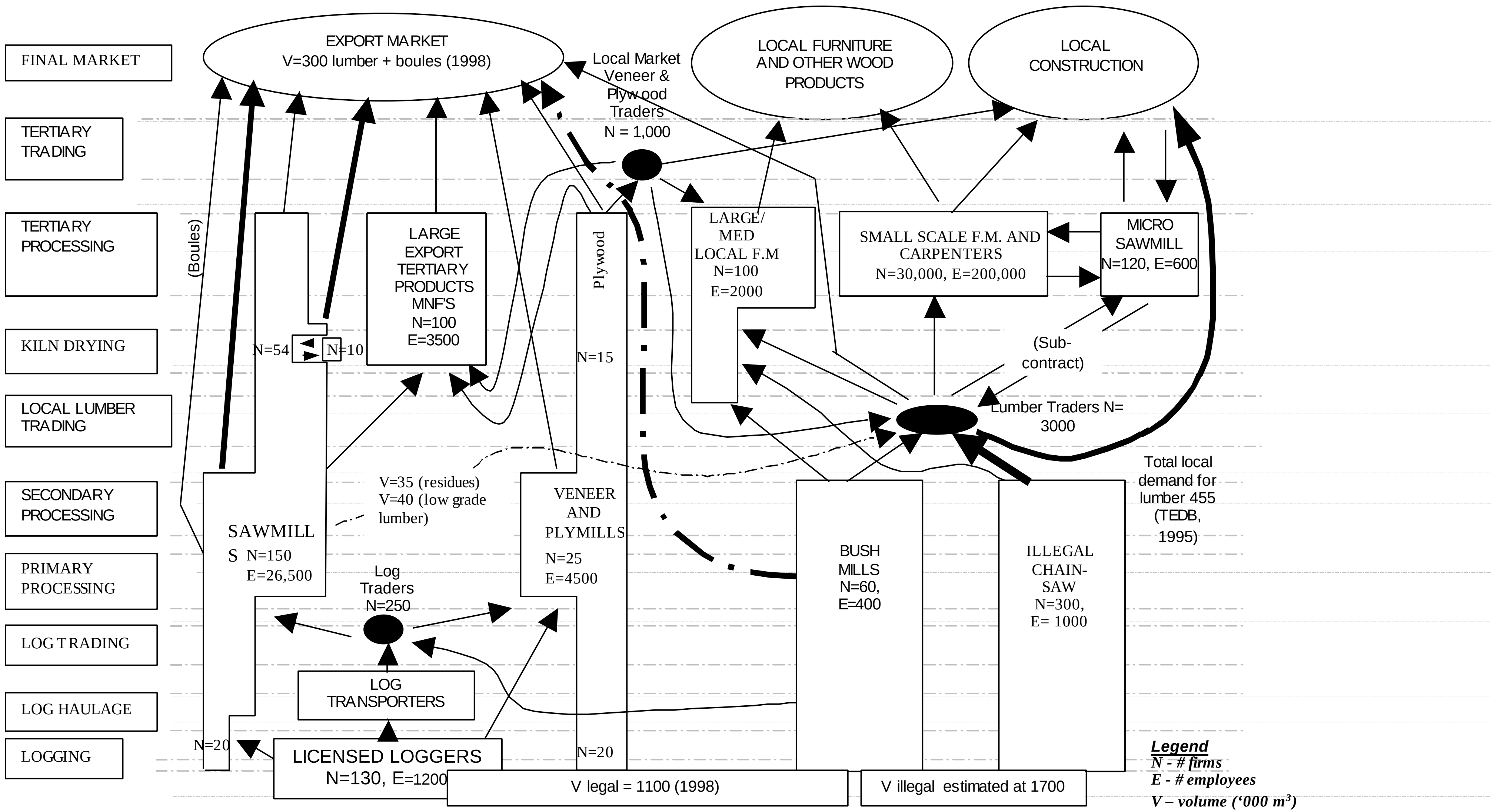

Figure I: Wood-Processing Sub-sector Map for Ghana

Wood flow through the sub-sector starts with log production which is estimated at about 3.7 million cubic metres. This estimate includes logs harvested by sawmills – including bush mills – legally (1 million m^3) and illegally (another 1 million m^3) and logs harvested by the now banned chain saw operators (1.7 million m^3). The total log harvest is thus far in excess of the annual allowable cut of 1 million cubic metres prescribed by the Forestry Commission.

Policy and Regulatory Context

The right to timber and the various fees payable have been reviewed recently. Hitherto, concessions to fell and remove trees in the closed forest were allocated for a period of 40 years. Once a concession had been acquired, a property mark had to be obtained before exploitation could commence. The Chief Conservator of Forests (now Executive Director of the FSD) issued a property mark which is specific to a concessionaire and is valid for only one year. The property mark could however be renewed on presentation of an Income Tax Clearance Certificate and a Certificate of Membership of the Ghana Timber Association (GTA) or the Ghana Timber Millers Organisation (GTMO). Several payments then had to be made (Renewal Fee, Annual Rent and Silvicultural Fees) in respect of the concession, and any outstanding royalties.

Current procedures for acquiring the right to timber and the various prescribed fees payable are all spelt out in the Timber Resources Management Regulations (LI 1649) of 1998. Under the new system, the Executive Director of the Forest Services Division (FSD) of the Forestry Commission (FC) is to identify lands suitable for grant of Timber Utilisation Contracts (TUCs). To qualify for a TUC, an applicant should satisfy the following conditions: -

1. Evidence of ownership or membership of a registered company or partnership relevant to forestry with a commercial business certificate;
2. Evidence of full payment of forest levies where applicable;
3. Income tax and social security clearance certificates;
4. Signature of an undertaking
   i.) to provide specific social amenities for the benefit of the local communities that live in the proposed contract area, and
   ii.) for the reforestation or afforestation in any area that the Executive Director of the FSD may approve; and

5. Evidence of capability to undertake reduced impact logging.

Applicants who are pre-selected at this stage will then be invited to submit proposals on:-

a) a reforestation or afforestation plan for the establishment and management of at least 10 ha for each square kilometre of the contract area; and

b) a social responsibility agreement to assist inhabitants within the contract area with such amenities as shall be specified in the agreement at a cost of not more than 5% of the annual royalty accruing from the operations under the TUC.

For areas of land not subject to timber utilization contract one would require a Timber Utilization Permit (TUP) for harvesting a specified number of trees. Any timber harvested or converted to lumber under a TUP is to be used only for social or community purposes and cannot be sold or exchanged.

In the late 70's a ban was placed on the export of logs from some 14 prime species in order to encourage value addition to these species. A temporal ban was imposed on round log export in 1995 and since then the policies and general legal environment for the timber sub-sector have seen gradual but significant changes. With time, the ban became institutionalised and this resulted in greater local processing of the logs. At the moment, some eleven species considered to be severely limited in the forests can only be felled under a special permit issued by the Executive Director of the FSD, with the approval of the Forestry Commission. There are also levies for the export of air-dried lumber from 9 timber species, a policy introduced to encourage further value addition by kiln drying. Only one tree species, Subaha (Mitragyina stipulosa) has been completely banned; this tree is mostly found along riverbanks or in watershed areas, hence the ban.

Constraints and Opportunities in the Timber Sub-Sector

The timber sub-sector may be said to be constrained by many factors. Over the last two decades the entire forestry sector, and the timber sub-sector in particular, has been in a state of flux: new policies and regulations have been introduced one after the other and there have been several institutional changes, some of which have even been cyclical. There is a lack of capacity and logistics on the part of the Forest Services Division to adequately protect the forest against encroachment and illegal felling.

Inspite of the many constraints, there are some interesting opportunities which may be summarized as follows:

- Bush mills can get TUPs if they agree to supply 100% to local market;
- Bush mills can also use mobile saws/ woodmizers;
- Tertiary processing and added value; are improving on their economics;
- Make more use of Residue utilization is becoming more financially attractive; and
- Prospects are improving for the use of alternative materials to replace wood.

Energy Efficiency in Sawmills

Energy Consumption Patterns and Efficiency Measures

The wood-processing industry in Ghana is one industry where energy consumption in the forms of electricity and heat are very significant. The government policy to develop value-added wood products before export has mandated the drying of most of the processed lumber produced in the country. The drying of lumber in the industry is largely met through the use of wood-processing residues (biomass). With the exception of one or two plants that are remotely located, all timber companies meet their electricity demand through the grid. Annual electricity charges for some of the largest mills in the country are in the region of about US$ 200,000 to 400,000. Petroleum products, mainly in the form of diesel fuel, are used for transportation of logs from the forest to the mills and transportation of wood products and residues away from the mills.

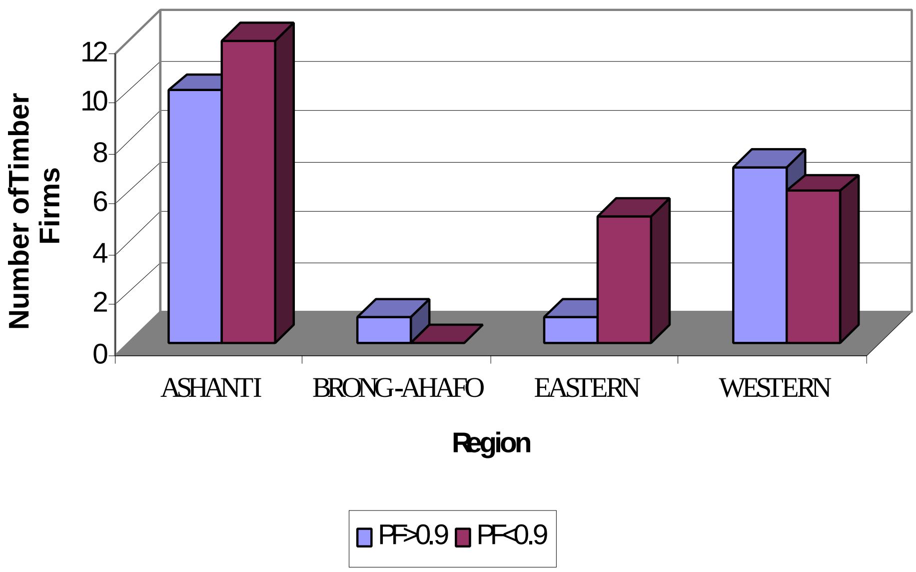

Figure II: Power Factor Analysis

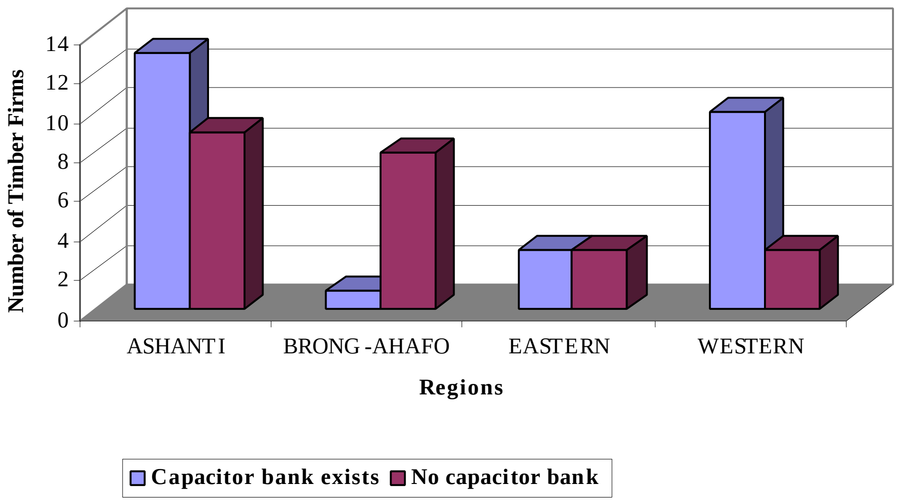

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Figure III: Capacitor Bank Analysis

The main options for ensuring efficient electricity consumption in sawmills are concerned with lighting, electric motors (including power factor correction), and machinery. The most popular measure amongst the sawmills surveyed in the early part of this study, was power factor correction; 19 of the 56 firms surveyed (or 34%) were found to have power factor values equal to or greater than 0.9 even though close to 50% of the firms surveyed had installed capacitor banks, as shown in Figures II and III. Implementation of other electrical energy efficient practices were found to be rare, although a few firms had energy efficient lights and some also used cogged V-belts.

With respect to energy for extracting trees from the forest and transporting them to the sawmill, and energy for transporting processed wood from the sawmill to the port, most of the extracting equipment and trucks used by sawmills are old, inefficient and not well maintained even by Ghanaian standards. During interviews, sawmill managers often complained of increasing fuel costs but there is little information available on the quantities of diesel fuel used for transportation and there is no evidence of actions by sawmillers to improve the efficiency of energy use in this area of activity.

Constraints and Opportunities for Energy Efficiency

Energy efficiency options identified of some timber companies, identified through energy audits by the Industrial Energy Assessment Centre (IEAC), have typical costs between $6,200 and $100,000 and payback periods mostly within a year; the longest payback period was 21 months. However, none of these projects have been implemented, pointing to a complex mix of technical and institutional barriers.

A detailed analysis of the costs and revenues for wood-processing firms reveals that the percentage of total costs attributed to electricity is about 2 % to 3 %. Thus, electricity costs constitute a very small percentage of most sawmills' production costs (and an even smaller percentage of their revenues) which explains, to quite a large extent, why many sawmills have not been very keen on energy efficiency improvement measures. Also, the cost of logs has traditionally been rather on the low side and many companies have preferred to buy from commercial loggers rather than go into logging activities themselves. Generally, management of trucks within companies has not been very effective although a handful of companies have very well organized transport sections.

The key constraints with respect to energy efficiency improvement may be listed as follows:

- low electricity tariffs
- low level of Awareness of EE Options in firms
- weak legal frameworks which make performance contracting arrangements unattractive

- lack of in-house-skills/knowledge on EE/management

As far as opportunities for energy efficiency improvement are concerned, the growing number of ESCOs and possibility of increase in electricity tariffs during the next couple of weeks will be important for market development. Environment-related funds (like the GEF) and a special energy efficiency trust fund to be established in Ghana should also provide additional opportunities as far as finance is concerned.

Adding Value/Maximising Recovery and Residue Utilisation

Recovery Rates and Residue Utilization

It is estimated that as much as 45-55% of the wood volume of felled tree is left in the forest as residues. Lumber recovery in sawmills is also put at 30-45% of the log input. Thus, on average, about 80% (between 75% and just above 85%) of the standing tree in the forest ends up as residues (between the forest and the mill). Log recovery in veneer mills is usually higher than that in sawmills and industrialists often quote a conservative figure of 50% of the log input for the former.

Currently, big branches and tops of some wood species are extracted from the forest for furniture production and this has been possible through the operations of bush mills.

The sawmill residues with high energy content are mostly used as boiler fuel and most sawmills also sell some of their residues as firewood to the local townsfolk. In a couple of companies plant residues form the major raw materials for chipboard and particleboard production, respectively. A few companies have only recently begun to use finger jointers to join pieces of wood residue into exportable products.

Some saw dust and veneer residues are used in firing burners to raise process steam, particularly for kiln drying at the mills. Some residual cores are also hogged for fuelling boilers. Peeler cores of diameters in the neighbourhood of 200 mm and lengths about 2,440 mm are resawn for lumber or used directly as fence posts.

Specific processes used in increasing wood recovery and residues utilization include optimal log positioning, thin blade technology, circular saw tensioning, residual cores utilization, particle board manufacture, sawdust briquetting and residues utilization for heat and power.

Added Value

Many of the policies in the timber sub-sector have been directed at maximizing the recovery of useful products from wood harvests and to increase the contribution of the sub-sector to the national economy. In response to these policies and also as a result of the fact that the resource has severely dwindled, some 20–30% of the medium to large-scale companies have started going into down stream processing using internally generated wood residues which were hitherto sold to the small scale carpenters as 'waste'. A few mills have also emerged going solely into downstream processing and producing profile boards (e.g. T & G), furniture parts, flooring parquets and finger-jointed materials. Increased down stream processing encourages and creates job opportunities and mitigates possible unemployment associated with reduced activities in mainstream processing.

A lot of material that comes out of the wood processing industries as 'waste' finds use in the local and regional market usually as carpentry and construction material or as wood fuel in either the raw or processed forms. Solid waste comprising of off-cuts, edgings, barks, and slabs are the type of waste that are suitable for the uses mentioned as well as for possible down stream processing. Wood processing waste in the form of shavings and sawdust usually have a negative value and their disposal often poses problems for the wood industry. In an effort to minimize the problems caused by these wastes some companies in the country have acquired boilers with furnaces that are fed on sawdust and shavings.

Specific processes used in adding value (as well as increasing wood recovery and residues utilization) include kiln drying, finger jointing, moulding and ply milling.

Constraints and Opportunities for Added Value, Waste Minimization and Increased Recovery

The prices of raw materials for the timber industry are going up and there is scarcity in the supply of logs. The higher costs of raw materials and the reduced supplies is driving many firms to seriously consider adding value to the products and increase in log recovery. Nevertheless, there are some constraints such as the following:

- Lack of local technical skills;
- Improper formal strategic planning;
- Poor display of business skills;
- Changing policy and institutional environment; and
- Poor electricity supply

Opportunities identified range from those that arise from global concerns on environmental issues to prospects of using technologies that allow the utilization of wastes hitherto considered to be of no value in the industry. There are mechanisms of the Kyoto protocol which encourage creating carbon sinks through reforestation and afforestation programmes. Investment finance for such programmes could come from international financing schemes such as the Prototype Carbon Fund (PCF) instituted by the World Bank.

Conclusions and Proposed Interventions

One of the main achievements of this study has been the development of a sub-sector map for the wood-processing industry in Ghana. The map helps to focus attention on problem areas within the industry, particularly the squeeze on lumber supplies to the small-scale carpenters and furniture makers. The map also helps to reveal some of the gaps in information, as far as the structure and resource flows in the industry are concerned, and it highlights the critical role that bush mills are playing now to ease problems of log supply to the local market. As a policy tool, therefore, the timber sub-sector map developed in this project will need to be diffused as widely as possible and any effort to fill in the knowledge gaps thrown up by the map will be in the right direction.

Although there exists a broad scope to improve energy efficiency in the timber industry, activity in this area has rather been on the low side. Many sawmills (about 50% of those located in the cities) have made a go at power factor improvement through installation of capacitor banks but very little has happened with respect to other energy efficiency improvement options. This situation could be primarily attributed to large profit margins of milling operations in the country until recently. The changing policy regime (stumpage fees, export levies, etc.) and external issues like rising energy costs are reversing this situation rapidly.

There is normally a general lack of technical and financial capacity within companies to carry out efficiency improvements. Other barriers to more energy and process efficiency-improvement activity in the sector have been identified to include lack of proper assessment to invest in improved and emerging technologies at the firm level and the high rate of returns that entrepreneurs, especially those in the timber industry, expect from investments. Experience in Ghana shows that serious efforts will be made at addressing these barriers only when entrepreneurs begin to feel the pinch. As far as energy efficiency is concerned, therefore, a top priority intervention proposed in this study is for NGOs like KITE and Energy Foundation to lobby and raise awareness of the benefits of EE with particular regard to policy makers. An indirect way of implementing this intervention would be to advocate economic levels in electricity tariffs and lobby for greater attention to forest as well as environmental issues.

In the case of maximising recovery rates and residue utilization/ value added, the current trend is for mills to go into downstream processing and a few have even been set solely for the production of profile boards (e.g. T & G), furniture parts, flooring parquets, etc. The main constraints here are the lack of local technical skills and knowledge as well as the rather unstable policy and institutional environment which increases the risk of new investments in the sub-sector. A key intervention identified here would be to improve dissemination of information and knowledge relating to new added value technologies, and information on TUCs and TUPs.

ACRONYMS

CFL	-	Compact Fluorescent Lamp
DFID	-	Department for International Development
DM	-	Deutche Mark
EE	-	Energy Efficiency
EF	-	Energy Foundation
EIA	-	Environmental Impact Assessment
EPA	-	Environment Protection Agency
ECO	-	Energy Conservation Opportunity
ESCO	-	Energy Service Company
FC	-	Forestry Commission
FORIG	-	Forestry Research Institute of Ghana
FPIB	-	Forest Products Inspection Bureau
FPID	-	Forest Products Inspection Division
FSD	-	Forest Services Division
GEF	-	Global Environment Facility
GTA	-	Ghana Timber Association
GTMO	-	Ghana Timber Millers Organisation
IEAC	-	Industrial Energy Assessment Centre
ITC	-	Intermediate Technology Consultants
KITE	-	Kumasi Institute of Technology and Environment
ME	-	Ministry of Energy
MLF	-	Ministry of Lands and Forestry
MOME	-	Ministry of Mines and Energy
NGO	-	Non Governmental Organisation
PURC	-	Public Utilities Regulatory Commission
TEDB	-	Timber Exports Development Board
TEDD	-	Timber Exports Development Division
TUC	-	Timber Utilisation Contract
TUP	-	Timber Utilisation Permit
VSD	-	Variable Speed Drive
WITC	-	Wood Industry Training Centre

1. INTRODUCTION

1.1 Background

Although a lot stands to be gained by instituting energy efficiency programs, timber mills in Ghana have generally not been very keen to go into such activities. Increments in electricity tariffs in recent years have seen a number of timber firms going in for capacitor banks to improve power factor values and this seems to be the only option widely practiced and then even to a lesser extent in the wood processing industry. The situation with small companies in the industry is even worse although it is estimated that most businesses can save between 10 – 20% of their energy bills by adopting environmentally friendly policies to energy use.

Electricity tariffs in general do not reflect generating costs and the government as well as the utilities have made efforts to adjust tariffs upwards to economic levels. The last upward tariff adjustment in the latter part of 1998 brought many companies to the realization that they needed to use energy more efficiently (and some started energy efficiency programmes). This surge in interest in energy efficiency was however derailed by the depreciation of the local currency[1]. The power utilities have already advertised new tariffs which if approved could mean some 300% rise in energy costs and this is expected to cause companies to once again investigate the scope of energy efficiency options that have good prospects for their balance sheet.

The original focus of this study was to review the scope of energy efficiency options and explore experiences of energy efficiency activities in the wood processing firms. This was widened as the project progressed to include a study of trends and dynamics in the timber sub-sector as a whole and the prospects for added value/waste minimization and residue utilization.

This study forms part of a wider project being undertaken with funding from the UK Department for International Development (DFID). The project involves Policy Research International (PRI) of Canada, in addition to KITE, and the study covers the pottery sector in India and the timber sub-sector in Ghana. Intermediate Technology Consultants (ITC) of the UK is providing international coordination and project management services.

1.2 Objectives

The broader objectives sought to be achieved in the project are:

- To gain a comprehensive understanding of research and work that has been carried out into improving energy efficiency in sawmills, particularly in Ghana; and
- To gain an initial knowledge of the scope for energy efficiency improvements in the small-scale sawmill industry in Ghana.

[1] The exchange rate of the Cedi (¢) to the dollar has risen from ¢2,400 = $1 in December 1998 to ¢7,000 = $1 in March 2001.

The original specific objectives of the sub-project in Ghana were to:

- identify and understand the relevant technologies and processes for energy efficiency improvements in the wood processing industry;
- gain a comprehensive understanding of the opportunities and constraints for energy efficiency improvements in the industry including social, legal and environmental issues;
- identify the key policy issues necessary to create an enabling environment for the energy efficiency improvements in the industry (i.e. national and local government regulations, guidelines and fiscal policies); and
- identify and understand options that are available for financing of energy efficiency improvements in the industry.

Although the project set out to achieve the objectives listed above, it became necessary along the life of the project to gain a very good understanding of the timber sub-sector as a whole, to be able to bring out 'hidden' barriers to a wider adoption of energy efficiency practices and related options for improving efficiency in the industry as a whole.

1.3 Methodology

The approach adopted for the project was basically to first carry out a desktop research on general energy efficiency practices and to also carry out preliminary field studies of sawmills in the country. To this end, both foreign and local literature on energy efficiency practices in the industry was reviewed. Visits to a number of firms located in different parts of the country (46 % of the total number of firms in the country) was undertaken to gather first hand information. Some of the information collected includes the location of firms, type and output of products to type of fuel in use in the firms, environmental impacts and institutional matters. A strategy document detailing the results was prepared which listed some key recommendations for the second phase of the project.

Based on recommendations of the first phase, the scope of the project was widened to include a sub-sector analysis of the industry. More general literature on the industry was reviewed and further visits to a number of small-scale sawmills were undertaken. An attempt was also made to get more in-depth information on the processes and cost distribution of these firms. This phase was characterized by many meetings with various stakeholders in an effort to gain more knowledge of the industry. A general trend of sawmills integrating forward to process tertiary products was identified and the study was further widened to investigate the scope of savings that could be achieved through value addition/waste minimization.

1.4 Structure and Scope of the Report

This report presents the results and findings coming out of the various activities carried out in the project.

Chapter Two presents an overview of the whole timber sub-sector in Ghana presently. Ghana's forest and wood resources are reviewed and the chapter goes on to give the principal actors and functions of various players in the timber sub-sector. Activities from the harvesting of wood from the forest through processing in companies to treatment of wood for export are discussed. Issues relating to marketing of the processed wood are presented and the discussion closes with the environmental impact of wood processing activities in the country.

Chapter Three also focuses on the timber sub-sector and first discusses the structure of the industry. A map of the sub-sector is presented as well as the flow of wood through the sub-sector. Other related issues for the sub-sector such as the institutional framework, policy and regulatory context, and trends and dynamics of the sub-sector are deliberated upon. The constraints and opportunities identified in the sub-sector are addressed in the concluding section of the chapter.

Chapter Four tackles the issue of energy efficiency in the sawmills. It starts with a presentation of the baseline data on energy efficiency options that are available and goes on to do a review of the previous experiences of the range of technical measures identified to have been explored or implemented in various timber-processing companies in the country. A brief discourse of the financial implications of energy efficiency practices is presented. Discussion of barriers to a more aggressive energy efficiency implementation activity in the industry is presented towards the end and the chapter finishes with a summary of the key constraints and opportunities.

With the review of the industry pointing to a trend of companies integrating forward to further process wood into tertiary products, Chapter Five dwells on options available for maximizing recovery rates and utilizing wood residues. As in the previous chapter, baseline records of recovery rates and added value opportunities are presented. Technical measures available for maximizing recoveries and adding value to processed wood are reviewed and two case studies on the use of sawdust to meet process heat demand in the industry are presented. The last section of the chapter presents an analysis of the constraints and barriers identified.

Chapter Six presents proposed interventions for addressing the technical opportunities considered to have a positive impact on the wood processing industry in Ghana, in the light of the key issues arising from the preceding chapters. The main conclusions and recommendations arrived at, in the sub-sectoral analysis workshop and meetings, which were organized as part of the activities in this project, are presented and the chapter concludes with perceived gaps and areas for further work.

2.0 OVERVIEW OF THE TIMBER SUB-SECTOR IN GHANA

2.1 Importance of the Sub-Sector to the National Economy

The timber resource is a key foreign exchange earner for the country. Until recently when it was overtaken by tourism, it was the third highest-ranking foreign exchange earner. It earned DM 354 million for exports in 1994, which is 18% of total export income. The earnings for 1999 amounted to DM 311 million (from a volume of 433,125 cubic metres) accounting for 11% of the nation's foreign exchange earnings. The timber trade also accounts for 6% of the Gross Domestic Product (GDP) having fallen from 12% in the early 70s'. (Source: National Statistical Office)

The timber sub-sector is reported to employ over 100,000 people, but also provides a livelihood for about 2 million Ghanaians. In addition to these, the economic benefits from fuelwood, charcoal and other non-timber forest products could raise the sector's GDP contribution to 8%. (Forestry Commission, 1999; Ofosu-Asiedu, 1995).

2.2 Ghana's Forests

Ghana has two broad forest zones: The Closed High Forest in the Southwest and the Open Savannah Woodland in the north with, a band of transition zone between the two.

The Savannah Zone covers an estimated area of 9.6 million ha, of which 2.9 million is bush fallow, whilst the remainder is degraded savannah. This zone is characterised by one short wet season with low mean annual rainfall from below 1,000mm to 1,500mm. The wood is usually dense, slow-growing and highly lignified. The tree stocking is fairly low; trees are smaller and also have poor form, usually unsuitable for processing into lumber or veneer. They are more suited for fuel. Some are also used for fencing, building poles and yam staking.

The Closed Forest Zone (so named due to the originally closed nature of the canopy) covers about 8.2 million ha or slightly more than a third of the country's total land area. About 75% of the original high forest is now bush fallow or land under shifting cultivation. Twenty percent (20%) is under reserve whilst the remaining 5% is unreserved forest.

The zone is characterised by high temperatures and heavy rainfall well distributed throughout the year. Plant growth is rapid and trees are mostly low to medium density. Tree stocking in timber forests is usually higher. Tree heights in the closed forest range between 10 and 45m; in a few cases they may reach 60m. This zone thus constitutes the source of all the timber produced in the country. The forest falls into 2 types, the Rainforest or Wet Evergreen Forest located mainly in the southwestern part of the country, and the Moist Semi-Deciduous Forest to the immediate north of the latter.

2.3 Ghana's Wood Resources

About 680 tree species are known to occur in Ghana's forests. But until 1988 only 14 of these (so-called prime species) were heavily exploited and 35 others exploited to a lesser extent. Now tree species have been reclassified to broaden the timber production potential from 49 to 126 species.

An inventory by the Forest Services Division in 1988 estimated a gross national standing volume of 188 million cubic metres of trees that are of a form suitable to be classified as 'timber'. This excludes those considered non-merchantable due to poor form or defects. The annual volume increment of all species, which reach timber size in the Closed Forest, has been estimated at 2.34 cubic metres/ha. Taking into account smaller trees, the mean annual increment of the Closed Forests has been estimated at 2 tons/ha (Grut, 1986).

It is also estimated that Ghana has 76,000 ha of tree plantations. This includes industrial plantations of Gmelina (4,000 ha) and Rubber trees (about 3,000 ha). Total area under community woodlots is 2,900 ha; private holdings are estimated to total 5,000 – 10,000 ha (Cobbinah, 1999).

The estimated quantities of the growing stock (of wood resources) in the various vegetation types are given in Table 1. These are based on estimates put together by Grut (1986).

Table 1: Estimated Growing Stock of Ghana's Wood Resources

Vegetation Type	Total Area Million Ha	Growing Stock Million Tons	Annual Increment Million Tons
Closed (High) Forest	8.2	170	5.7
- Actual Forest[2]	1.6		2.4
- Bush Fallow	6.6		3.3
Open Savanna Forest	9.6	117	5.3
Other Forest Types:	0.504		
- Scrub and Mangroves	0.428	9	0.5
- Plantations	0.076	4	0.2
Non-Forest Area	5.6	22	0.6
GRAND TOTAL	23.9	322	12.3

2.4 Functions in the Timber-Sub-Sector

The key functions in the timber sub-sector are:

- Timber Harvesting (Logging)

[2] 0.4 million hectares of this is under protection and therefore not available for harvesting.

- Log Haulage
- Log Marketing
- Primary Processing of Logs
- Marketing (wholesale/retail) of primary products
- Secondary Processing (of Boules, Beams and Rough-sawn lumber into square-edged lumber and dimensioned products
- Marketing (exports, wholesale, retail) of secondary products.
- Pole Treatment
- Marketing
- Wood Drying
- Tertiary processing into Mouldings, Furniture parts, etc.
- Marketing: Export, wholesale, retail of tertiary products.
- Residue Utilisation, for:

  - Chipboard Production
  - Charcoal Production
  - Fuelwood
  - Poultry Bedding
  - Briquetting
  - Co-generation
  - Reprocessing – furniture, doors and window frames, doors and other utility products
  - Fencing

The technology used in processing of timber and the associated environmental impacts are described in Appendix A.

2.5 Actors In The Timber-Sub-Sector

2.5.1 Harvesting

Timber felling is essentially done by means of powered chain saws. Three main categories of people are involved. They are the itinerant chain saw operator, the registered logger and the miller.

(a) The Itinerant Chain Saw Operators

These include the illegal operators and people who may fell the odd tree for self-use, or for community projects. These people usually operate on lands outside the reserves, mainly on farmlands. They have no haulage facilities and so process the logs in situ into beams and rough sawn lumber. The products are head-loaded to the roadside and carted away in hired trucks.

(b) The Registered Logger

These are usually nationals who have official access to the forest, both reserved and unreserved, through what used to be the concession system. He may or may not have any extraction equipment. He is a registered timber operator who has no processing facilities. He deals mainly in logs; these are delivered directly to a miller or to a log market in town. In some cases they may also arrange with the miller who often has trucks, bulldozers and tractors, to do the extraction altogether.

(c) Logging by the Miller

Due to capital constraints most of the processing mills, especially the big ones are owned either fully or partly by foreign investors. Such mills also have trucks, tractor crawlers and tractors to extract logs from the forest. Some of these mills are without concessions and often have to fall on the logger to access logs from the log market or from the forest. Nevertheless many of the mills have their own concessions and therefore do their own harvesting, extraction and haulage. Sometimes the miller may also harvest logs for the log market.

2.5.2 Primary Processing

Primary processing of logs involves the breakdown of the log into boules, beams or rough sawn lumber. The production of rotary veneers and cants for sliced-veneer production are also considered under primary processing. Primary processing may be done in the forest or at the factory.

a. In situ Processing

i. ***Chain sawing***

By nature, chain saws have large kerfs and therefore generate a lot of waste (sawdust). Poor operator training coupled with the rush to quickly convert the illegally felled tree, further exacerbate the waste generation. The main products from chain sawing are beams and rough sawn lumber.

ii. ***Mobile and Bush Mills***

Mobile mills are a new phenomenon on the wood-processing scene in Ghana. These mills, usually with thin band saws or circular saws, are used in the forest to convert small diameter logs and big branches into lumber, mainly for furniture production, but also for export. In some cases these mills may be located permanently in a village on the outskirts of the forest from where they operate as Bush mills. Operators of these mills usually do not have concessions or timber utilisation contracts. They are rather given permits (Timber Utilisation Permits, TUP) to produce lumber for the local market. But there are indications that some products from Bush mills also find their way into the export market.

In 1996, the number of Bush mills was put at 26[3], with an estimated production capacity of 138,628 cubic metres based on 2-eight hour shift per day. These figures need to be updated.

b. Stationary Mills

The bulk of the logs produced are processed in factories located mainly in the towns. Only a few mills are close to the resource base. Primary processing at the mills often involves large band saws (either vertical or horizontal) and also peelers. The former produces boules and boards whilst the latter produces rotary veneer. Band saws are also used in the production of cants from which sliced veneer is made.

2.5.3 Secondary Processing

Secondary processing starts with products from the primary processing stage and turns them into semi-finished products such as square-edged lumber and dimensioned stock. These may be exported, sold on the local market or further processed into tertiary products. The main actors in this aspect of the sub-sector are saw millers, producers of veneer and plywood, and curl producers. The mills undertake secondary processing of lumber mainly for the export market.

Micro Sawmills

At the small-scale level, there are mills with one or two circular saws or resaws, which undertake contract jobs for small-scale carpenters and other woodworkers. Both timber merchants (in the timber markets) and consumers do purchase the beams and rough-sawn lumber (bush-cut) at considerably low prices and get them sawn again by these stand-alone saws into square-edged and dimensioned stock. In fact the bulk of the timber supply to the local market goes through this channel. These so-called micro-sawmills are mostly owned by established small-scale carpenters who integrate backwards both to offer a service and also prepare material for their own production.

Timber Drying

Drying of timber is a very crucial step prior to downstream processing. Drying confers stability to the wood, protects it against certain forms of bio-deterioration and enhances the ability of the wood to take finish or polish. Drying also adds value to the wood, especially if it is to be exported.

As at the end of 1998, as many as 65[4] woodworking companies had installed kiln-drying facilities. For individual companies, kiln capacities range from 15 cubic metres to 1000 cubic metres. The total installed capacity per charge was about 18,500 cubic metres, having risen

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[3] Amankwah, G. (1996): Wood supply and demand in Ghana - Sustaining the Wood Industry through the creation of new resource base. A paper presented at a Workshop on Plantation Development in Ghana.

[4] Source: Forestry Commission 1999 Annual Report. P.11.

from 3,200 cubic metres in 1989. This does not include available drying capacity for veneer production. For 1998, the number of exporters of kiln-dried lumber was reported as 69. Some exporters contract out their drying services.

Of the 54 kilns[5] installed by May 1996, only one was oil-fired. All the others were fuelled by wood residues including sawdust in some cases. Ten out of the 54 mills were solely in tertiary processing. All the others were sawmills, some of which were also into tertiary processing.

2.5.4 Tertiary Processing

Actors involved in tertiary processing are furniture manufacturers, and some sawmills, which have done forward integration to further process the lumber from the secondary processing stage.

At the small-scale level, some carpenters have installed woodworking machines such as the moulding machine, which may be used to produce patterns or designs as a contract service for other producers along the lines of the micro-sawmills; they may also on their own, turn out tertiary products for the local market and the overland export market.

2.5.5 Grading of Products

Grading of all timber products is the responsibility of the Forest Products Inspection Division (FPID) of the Forestry Commission. In fact the Division is charged with the inspection, grading and certification of all forest products. However their work has been limited to the grading of logs and wood products for the export market. They have not concerned themselves with the grading of wood products on the local market.

2.5.6 Wood Treatment

Most of the tree species processed these days are low density and light coloured with high levels of carbohydrate. They are therefore very susceptible to attack by insects and fungi. Some form of chemical treatment is thus often desirable, especially for the export items. In a few cases, prophylactic treatment of the logs may be carried out in the forest to arrest attack by moulds or fungi.

Products from primary processing are seldom given any form of chemical treatment, except for the occasional end coating of boules to prevent cracks.

At the factory, often according to customer specification, the sawn products may be treated by brushing or dipping in a water solution of preservative chemical.

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5 Amankwah, G. (1996): Wood supply and demand in Ghana - Sustaining the Wood Industry through the creation of new resource base. A paper presented at a Workshop on Plantation Development in Ghana.

Pressure Treatment

There are four (4) pressure impregnation plants in the country – one each in Offinso, Takoradi, Kumasi and Accra. These plants are used mainly for the treatment of electricity poles. Water-borne preservative (Copper-Chrome-Arsenic, CCA) is mainly used. Fencing poles may also be treated on request.

2.6 Marketing

Marketing of wood and or wood products occurs at various stages within the sub-sector. The market falls into 3 distinct categories. These are Overseas Export Market, Overland Export Market and the local market. The actors involved in marketing at the various levels may be very different.

2.6.1 Overseas Export Markets

The timber industry produces various items for both the export and the local market. The complete list of the export products and their destinations are given in the Appendix B.

There are some 115 registered exporters[6] of wood and wood products. Of these, 50 deal solely in lumber, 7 export only curls, whilst the rest deal in multiple products including lumber, poles, moulding and furniture parts. The 115 would also include both millers and people without any processing facility, often referred to as non-milling exporters.

For a long time, buyers from Europe and elsewhere would often come down to negotiate for the purchases on FOB basis. Now however, some local people have also entered this segment of the trade[7]. The emergence of these local timber brokers in the export trade is a new phenomenon in the sector. These are people who have no processing facilities at all but are able to secure sales contracts. They then source the products from mills. They may also procure the logs and seek 'custom sawing' by a mill. They then take responsibility for the shipment of the products to the overseas principals or buyers.

Such brokers do not belong to any of the four trade associations (described in Section 3.3.2), but they fill a very important niche. They link the export market to the small-scale saw miller who may either not be able to meet the large export orders by himself or may not know the market too well. The brokers usually have access to credit and so could pre-finance the export orders.

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6 Source: Ghana Hardwoods, a handbook on the timber sector by the Timber Export Development Board (1997)

7 Personal communication with FPID personnel.

2.6.2 Cross- Border Trade in Lumber and Wood Products (Overland Exports)

Wood and Wood products from Ghana are also sold to some of the country's neighbours, particularly, the wood deficit ones. Cross-border trade in lumber and wood products are normally captured in the FPID Statistics as overland exports. In a few cases however, such products may be smuggled out in an attempt to evade tax. Table 2 below gives data on over-land export of lumber for 1998 and 1999. FPID records also indicate that in 1991 a total of 1,135 cubic metres of plywood were exported overland to Togo, Burkina Faso and Niger.

Table 2: Comparative earnings from over-land export of lumber for December 1998 and 1999

Product	Volume (cubic metres)			Value, US$		
	Dec. 1998	Dec. 1999	% change	Dec. 1998	Dec. 1999	% change
Overland Lumber	4.8	8.5	77.1	0.4	0.9	125
Other Lumber export	247.8	241.3	-2.6	90.5	88.3	-2.5

Source: FPID Export Permit Report - December 1999

Products for these markets include the lower grade lumber from the mills, products from the Bush mills, and finished products like school furniture, from the informal sector. This trade is handled by middlemen (and women) who order the products from the producers, or purchase from the local market. Some producers e.g. carpenters may also indulge in this.

2.6.3 Local Markets for Wood and Products

Domestic consumption of wood products (excluding firewood) is estimated to be about twice that of the export demand. Table 3 gives comparative figures for lumber from saw mills for some selected years. Making allowance for lumber from chain sawing, which normally does not enter into any official records, it becomes clear that the local demand for wood could be fairly high.

Table 3: Mill Exports and Local Consumption (1,000 cubic metres**)**

Year	Exports	Apparent Local Consumption
1975	194	291
1980	89	188
1985	96	127
1990	210	152
1995	364	569*
1997	442	663*
1998	416	772*
1999	433	879*

* Figures marked with asterisk are inferred from FPID data; all other figures are from FPID Reports.

The estimated per capita consumption of sawn timber is 24 cubic metres per 1,000 persons. This is higher than the average of 15 cubic metres for Africa, but significantly lower than the 182 cubic metres per 1,000 persons for Europe (Cobbinah, 1999). The local market for wood and wood products fall into three main segments: logs, lumber and wood products.

a. Logs Market

In the major wood processing centres like Kumasi and Takoradi, there are areas where logs are sold. Loggers without processing facilities, but who still have access to wood resources, mainly from earlier forest concessions, do send logs to such places for sale. In some cases sales/ purchase arrangements are made before the logs are brought to the market. In a few cases, loggers send their products to sawmills, looking for markets.

Normally all logs harvested are measured at designated checkpoints by the Forest Products Inspection Division (FPID) of the Forestry Commission. The data is captured on a Log Measurement Certificate (LMC). This gives the volume, which the logger presents to the prospective buyer for negotiation. The final price of the log depends on the type of species, size and quality.

b. Lumber Markets

Within the towns and cities in Ghana there are designated 'Timber Markets' where lumber is sold. Until recently, such timber markets were supplied mainly by illegal chain saw operators and bush mills, and to some extent by small-scale sawmills, and a few medium-sized ones. The current arrangement to meet the local demand however, is that saw mills that supply the local markets are to be given some concessions in the allocation of forest resources. But in spite of the ban on chain-sawn lumber, one still finds rough-sawn lumber (from chain sawing) on the market.

The timber markets provide the bulk of the lumber consumed locally. In some cases however large consumers, particularly construction firms (builders) may arrange to get their supplies directly from the sawmills, and sometimes, directly from the forest (illegally). Besides serving the building industry, the timber markets serve as the major source of timber for the furniture and small-scale wood processing sectors. These sectors depend on wood residues from the sawmills and veneer processing factories, especially for the production of utility items like kitchen stools, crates, pallets and low quality furniture.

Smaller retailers also buy quantities of lumber from the market and sell them in other villages and towns to builders, carpenters, etc.; timber merchants also buy timber from the timber market for overland export to neighbouring wood deficit countries like Togo and Burkina Faso.

c. **Wood Products Market**

There are many wood products on the local market. The following major groups may be identified.

i. Building members such as: Doors, door and window frames, flooring parquets, mouldings including T & G members.
ii. Veneer and plywood,
iii. Furniture including cabinets, wardrobes, beds tables and chairs for schools, offices and homes and specialty products like poultry feed trays, crates, pallets, coffins and chop-boxes; and
iv. Toys and utility products like kitchen stools and broomsticks.

i. Building Members

Large construction firms and estate developers would usually have their own carpenters who produce building members like door and window frames, mouldings (including skirting boards and T&G) at site or at a central workshop. Some other firms (and estate developers) may order their requirements from wood processing companies specialized in the respective products. Small-scale builders and individual house-owners do purchase their building members from small-scale wood products manufacturers who are concentrated near the timber market but are also dispersed throughout the towns and sometimes along the streets. Because of their scale of operation, most of these manufacturers do not have the capital to stock lumber, neither are they able to buy kiln-dried lumber. Therefore, the items are usually produced from low quality, cheap material, often green lumber with some sapwood. Products from this segment of the markets are therefore of much lower quality. Consequently they are also cheaper.

ii. Veneer and Plywood Markets

Plywood is sold mainly in shops, which receive supplies directly from the factories and also from middlemen. Large-scale consumers do receive their orders directly from the factory. The product is patronised by builders and furniture producers. Very little veneer is consumed as such on the local market. The bulk of the production is either exported or converted into plywood of various grades and sizes. Dealers who are often located within the precincts of the wood processing areas retail the little veneer consumed locally. Veneer finds use as overlays and lippings for the manufacture of doors and furniture.

iii. Furniture and Specialty Products Market

There are three main levels of the local furniture and specialty products market. At the highest end of the scale is the large-scale manufacturer who employs some 20 or more workers. They usually source their wood from sawmills, illegal sources (chain-sawn products) and recently from branch wood left in the forest. They may in some cases, also buy from the timber market, but this is not very common due to the relatively higher prices.

These producers are often able to purchase kiln-dried lumber or stock timber long enough to allow for adequate air-drying. Furniture products at this level of the market are therefore of better quality and do command higher prices. Few of these firms have designers who are able to come out with innovative designs. But most often, these firms copy designs from catalogues. They have showrooms and would often deliver purchased products. Poor finishing is a major barrier for such producers to enter the export market.

The second level of the furniture and specialty products market is supplied by medium to small-scale producers. These have no designers, and no showrooms. They often copy designs from the big time producers and also from catalogues. All the same, there are a few gifted innovators who produce their own designs. The input wood is often not properly seasoned. Products are therefore not of very good quality. Even though they may appear very beautiful, they usually do not last. Products are often displayed by the roadside; prices are also fairly moderate.

At the lowest level of the furniture market are products from mainly small-scale, and a few medium-scale producers. These are often dotted around in the towns and villages with a concentration near the timber markets. Even though some of these producers may be specialists in particular products, most of them are generalists, producing various wood products, usually from unseasoned low quality wood from mill residues.

iv. Toys and Utility Products Market

There are only a few large-scale manufactures of wooden toys. Such products are sold in departmental stores. In fact some of these products go on the export market. The bulk of the wooden toys and utility products on the local market are however produced by the small-scale general producers operating near the timber markets. In many cases, apprentices produce the toys as part of their training. It is not surprising therefore that product quality is very low. They are usually sold by hawkers; some are also displayed close to the manufacturing workshops.

2.6.4 Species

Species of timber for local use are the same as those on demand on the export market. The local market uses falldowns from the export market. The most preferred species is Odum, which is durable by nature and therefore good for house building and construction in general. But it is now very scarce on the market due to over exploitation.

Mahogany, Sapele, Makore, Afrormosia and Teak are usually preferred for furniture. So also are African Walnut, Avodire and Shedua. A study in 1993[8] estimated that prices for wood and wood products are 50-75% of prices on the export market, depending on grade and quality.

[8] General Woods & Veneers Consultants International Limited (1993) Technical and Financial Audit of the Ghana Timber Industry Working Document 2 p: 31, 32.

Due to the prevalence of termites and other wood destroying organisms strength, durability and workability, and lately availability and price, are the factors most considered in the choice of wood for construction. For furniture manufacture, it is colour, grain, finishing, availability and affordability that determine choice.

2.6.5 Local Market Areas and Pricing

The most important markets are Accra/Tema, Kumasi, Bolgatanga and Sekondi-Takoradi. Over 75% of all the country's sawmills are located in Kumasi, which is also in the centre of the forest zone. Consequently, timber is cheapest in Kumasi from where most timber is sold and distributed to other regions. The 1993 study cited above reported that "the price of lumber in other areas is determined by the distance from Kumasi, e.g. lumber in Tema some 300 km away, can be 25% to 40% more expensive; in Bolgatanga some 520 km up country, it can be as much as 50% to 60% higher".

The imperial units of measure are still used in the local timber trade. Common sizes of lumber for the construction industry are 2" x 4", 2" x 6", 4" x 4" and occasionally 2" x 2" or 2" x 3". Preferred sizes for furniture and joinery are 1" x 12" and 2" x 4". Lengths vary but are usually 12 feet, or 16 feet. Shorter lengths of between 4 and 10 feet are also accepted. But generally lengths below 10 feet are sold cheaper and are referred to as ‘shorts’. The 1993 study indicated that such lengths may be 10% to 25% lower in price.

There is no apparent pricing policy by government. Prices of lumber and wood products on the local market are determined by supply and demand. They are not regulated. Of late however there are complaints that lumber is very expensive on the market. This, to a large extent, would be due to the squeeze on the supply of now illegal chain-sawn lumber.

3.0 THE TIMBER SUB-SECTOR ANALYSIS

3.1 Introduction

This is a very important chapter because it provides the basis for much of what is happening in sawmills with respect to energy efficiency, however narrowly or broadly it is defined. As explained earlier in Chapter 1, about halfway through this study it became very clear that one needed a good understanding of the many forces and factors at play in timber sub-sector. Some considerable amount of time and effort was put into the attempt to reach just such an understanding which is captured in this chapter.

The next section of the chapter starts with an exposition on the structure of the timber industry with much of the findings coming from the sub-sector analysis workshop organised as a major component of this study. Subsequent sections address issues relating to firm ownership, inter-firm linkages and the policy framework. These sections are followed with a discussion of the policy framework, with reference to the key institutions and the regulatory context. The sub-sector trends and dynamics as well as the constraints and opportunities are addressed in the concluding section of the chapter.

3.2 Structure of the Industry

3.2.1 Sub-Sector Map

Firms in the wood industry of Ghana may be put into three classes on the basis of degree of value-addition/processing as follows:

- The primary operators/enterprises (i.e. Loggers);
- The secondary enterprises (sawmillers, veneer – and plywood producers as well as particleboard manufacturers); and
- The tertiary and down-stream processing enterprise (i.e. Furniture, mouldings, flooring and toy manufacturers).

Wood-processing firms in Ghana may also be classified according to size – small, medium and large – as shown in Table 4. The Forestry Commission[9] puts the number of sawmills in Ghana at 120; some 46 % of the sawmills fall in the small-scale category while the rest are almost equally distributed between the medium and large categories. Of the 120 sawmills categorized in Table 4, there are 10 flooring parquets manufacturers, 4 doors manufacturing firms and 30 firms making other building members (profile boards/mouldings, joinery firms, etc.) One of the sawmills plus one other factory also produce particleboards.

The same source puts the number of veneer mills at 25; of which 15 go on further to manufacture plywood. Apart from the saw and veneer mills, there are 4 toys manufacturing firms and 11 curls manufacturing firms. There are also 40 medium and large firms in furniture-making and, in addition, there are numerous firms in the small scale carpentry and

[9] Forestry Commission, 1999, Annual Report.

furniture-making category, many of which would be members of the Small-Scale Carpenters' Association.

Table 4: Sawmill Population and Size Distribution

Mill category	Input capacity	Total No. of Mills	% of Total
Large scale	10,000 cubic metres and above	33	27.5
Medium scale	5,000 – 10,000	32	26.7
Small-scale	Below 5,000	55	45.8
TOTAL		120	100

There are no reliable figures on the number of sawmills throughout the whole of Ghana and how many of such firms are also involved in logging activities. Nevertheless, between the Forest Products Inspection Division (formerly Forest Products Inspection Bureau) and the Ghana Timber Association, it is possible to construct a table – as shown in Table 5 – which gives the total numbers of wood-processing and logging firms and their distribution across the country. This table gives the total numbers of wood-processing and logging firms at 153 and 374, respectively,

Table 5: Timber Firms and Loggers in Ghana

Region	**Timber Processing Firms***		**Logging companies/ concessionaires****	
	Number	%	Number	%
Ashanti	85	56	115	31
Western	24	16	58	16
Eastern	18	12	69	18
Brong-Ahafo	15	10	79	21
Central	8	5	53	14
Others	3	2	-	-
Total	153	100	374	100

* Source: Forest Products Inspection Bureau Reports, (1999). The figure is for all types of wood processing, but does not include small-scale carpenters and wood-workers.

** Source: Ghana Timber Association (GTA) office in Kumasi, 1999.

Sawmills – as well as veneer and ply mills – and loggers interact with a large number of other actors described previously in Chapter 2. These actors together with the sawmills and the markets that they relate to, are captured diagrammatically in a wood-processing sub-sector map for Ghana presented in Figure 1.

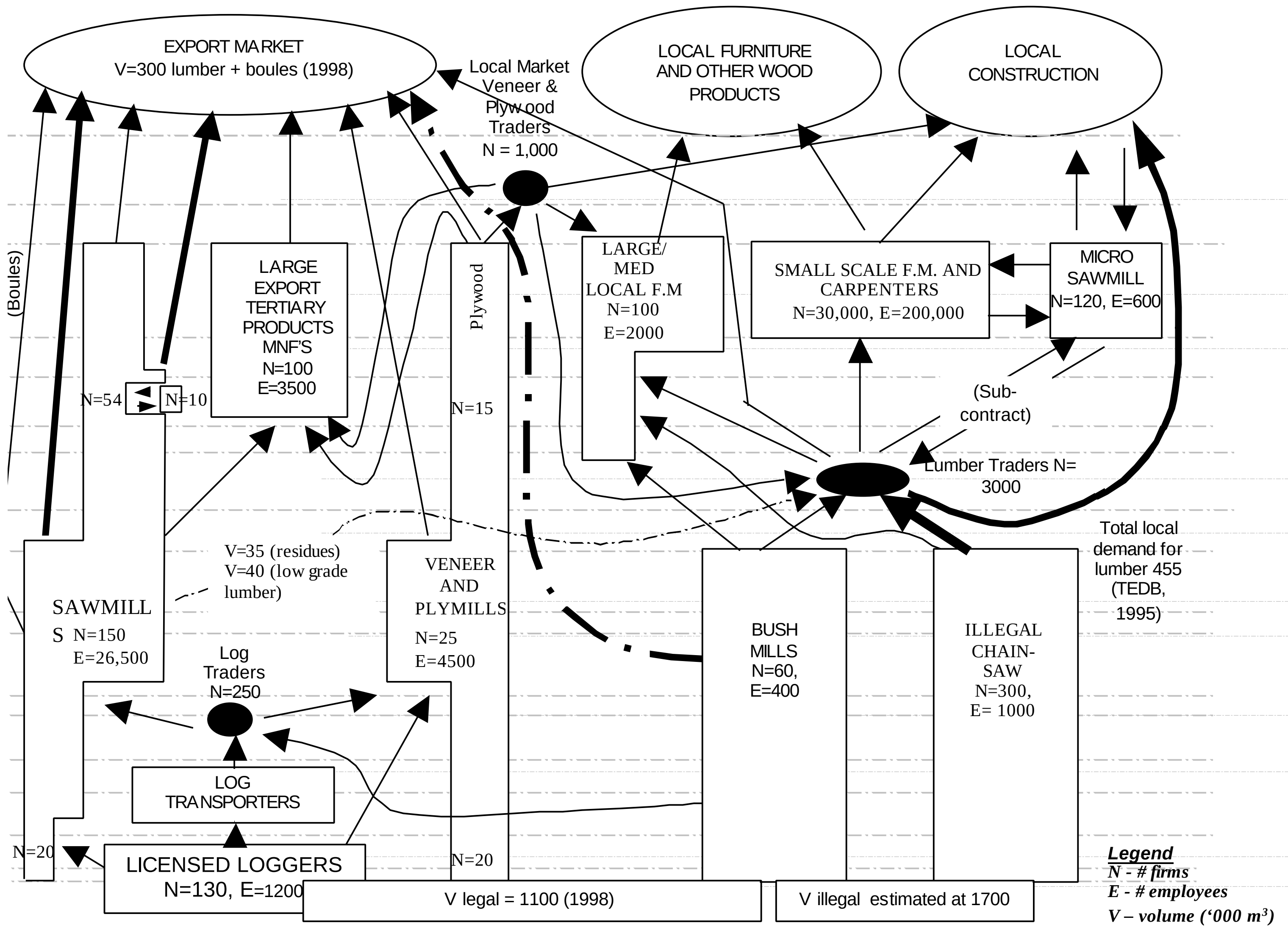

Figure 1: Wood-Processing Sub-sector Map for Ghana

The numbers shown for the various actors are the best estimates agreed by participants at the Sub-Sector Analysis Workshop among whom were a few industry experts. Thus, excluding specialized small, medium and large tertiary products manufacturers (including carpentry and furniture making), the total number of sawmills was agreed at 150 and that for veneer mills at 25. Similarly, at the logging end of the map the agreed numbers are 20 each for sawmills and veneer mills who are also into logging, 130 for licensed loggers who are into logging only, 60 for bushmills and 300 for illegal chain saw operators, making a grand total of 530 legal and illegal logging entitities. Table 6 presents the estimated number of employees together with the number of firms for many of the actors shown in the sub-sector map.

Table 6: Estimated Numbers of Firms and Employees

Actors	**No. of Firms**	**No. of Employees****
Saw mills	150*	26,000
Veneer & Plymills	25*	4,500
Licensed Loggers	130*	1,200
Bush Mills	60**	400
Illegal Loggers	300	1,000
Log Transporters	-	-
Log Traders	250**	-
Lumber Traders	3,000**	3,000
Local Traders in veneer/plywood	1,000**	1,000
Large Export Tertiary Products manufacturers	100	3,500
Large/Medium local Furniture Makers	100*	2,000
Small-scale Furniture Makers/ Carpenters	30,000**	200,000
Micro-Saw mills	120**	600

* Forestry Commission 1999 Annual Report
** Estimates by Workshop Participants; official data is unavailable.

With respect to downstream activities in the sub-sector map, it is important to observe that there are a few of the sawmills who do not have their own kiln drying facilities, and so make use of the facilities of other firms who have spare capacity – this is shown as a sub-contract. Micro-sawmills also perform subcontracts for lumber traders, other carpenters, and final customers who may wish to process lumber for produce furniture parts, construction, etc.

It should also be pointed out that although charcoal producers, chipboard manufacturers (there are 2) and residue transporters are all participants in the sub-sector, they have been left off the map, for the sake of simplicity.

Two features that are also really interesting to note are the strong nodal points in the map, represented by log traders, lumber traders and local market veneer and plywood traders, and the multiplicity of supply links emanating from bushmills (a pointer to their increasingly critical role in the sub-sector.

3.2.2 Wood Flows

Log production was very high in the early 90's reaching a peak of 1.800 million cubic metres in 1994, according to the official statistics. This has now been greatly reduced to 1.102 million cubic metres in 1999, as shown in Table 7, which is fairly close to the annual allowable cut of 1.000 million cubic metres prescribed by the Forestry Commission. However, this prescribed quantity is known to be far below the actual log production.

Table 7: Official Statistics for Log Production in Ghana

Year	**No. of Trees Felled**	**No. of Logs**	**Log Volume cubic metres**
1997	117,539	227,156	1,202,893
1998	107,848	210,280	1,147,566
1999	96,423	202,367	1,102,203

Source: FPIB Statistics Section, April 5th, 2000

Table 8: Log production in 1999

Category	*Volume* **(Million m3)**
Legal log harvest ('AAC')*	1.095
Illegal logs**	0.925
Chainsaw lumber (log equivalent)**	1.696
Total	3.716

* Forestry Commission Estimate (Unpublished)
** Industry Survey by Forestry Commission (Unpublished)

Table 8 presents an alternative set of data obtained from the Forestry Commission. This data set gives an amount for the legal log harvest which is similar to that indicated in the preceding table. This together with illegally felled logs and chainsaw lumber (also illegal) yields a total of about 3.7 million cubic metres.

Table 9: Wood Flows through the Various Production Channels for Exports in 1999

Product Group	Volume of Wood Products Exported* ’000 m^3	Export Volumes as % of Total Exports	Conversion factor**	Required Log Input ‘000 m^3	Log Input as % of Total Log Input
a. Boules	30	7	0.80	38	4
b. Lumber	241	56	0.37	652	71
c. Veneers	101	23	0.60	168	18
d. Plywood **(60% is from veneer waste)**	25	6	0.80	13	1
e. Processed Lumber/Moulding **(50% is from lumber waste)**	17	4	0.40	22	2
f. Other Processed Wood Products. E.g. Furniture parts, flooring, and dowels **(50% from (b) and (e))**	18	4	0.35	26	3
Totals	433	100	0.47	919	100

* Data from FPID
**The Conversion factors are average estimates from available data.

Due to the uncertainty in available data on the current amount of lumber still produced illegally, an attempt was made in this study to estimate the wood flow using 1999 data. For an estimated annual housing delivery of 30,000[10] units with an average of 3 bedrooms per unit, wood requirement is 1.38 million cubic metres. In the absence of hard data on local demand, if we allow for 10% of this figure for furniture, formwork for road construction and other civil works as well as other wood products, then total local demand comes to 1.518 million cubic metres.

For 1999, the volume of wood products exported was 433,100 cubic metres. Thus total wood required for export production for the year was 1.951 million cubic metres. Based on an overall average recovery rate of 60%, the total round wood equivalent would be 3.25 million cubic metres. The permissible extraction from the country's forests, i.e. the Annual Allowable Cut (AAC) is set at one million cubic metres. But the official records indicate that this was exceeded by only 10% (see the above Table). Based on the results presented here, the estimated supply by the illegal producers would be about 2.15 million cubic metres implying that the allowable cut was exceeded by over 200 %. Details of the calculations are presented in Appendix C.

Table 9 captures the wood flows for different product groups. In terms of cross flows for the tertiary products, it is estimated that 60 % of the wood used in plywood production comes from veneer wastes while 50 % of wood flow for processed lumber and mouldings comes from lumber wastes. Also, 50 % of the wood supply for other processed wood products (e.g. furniture parts, flooring parquets and dowels) come from lumber wastes and processed lumber/moulding wastes.

The third column of Table 9 shows that lumber products (by volume) account for 56 % of the total export volume. However, lumber production is where the highest level of wastage occurs. Therefore, as shown in the last column of the table, the required log input (round wood equivalent) for export lumber production accounts for as much as 71 % of the total log input. Thus, lumber production alone accounts for a large percentage of all the wood flowing through the sub-sector. Similarly, veneer production accounts for 18 % of the total wood flow and plywood (which lies at the bottom end of the scale) accounts for only 1 %.

3.3 Institutional Framework

3.3.1 Ownership Patterns For Firms

Logging Firms

All the registered loggers i.e. members of the Ghana Timber Association (GTA) are Ghanaian nationals. Only a few of them are women. The companies are mostly under sole proprietorship. Due to capital constraints not many of the logging companies have the requisite equipment or facilities.

[10] Data from Mr Owusu Tawiah, Building and Roads Research Institute.

Sawmills and Plymills

The processing mills are owned mostly by foreign investors, particularly Lebanese, and lately a few Europeans. Some of them also have Ghanaian partners as shareholders. There are three (3) state-owned mills, but two of them have been put on the divestiture list waiting for bidders.

Downstream Processing Mills

As a result of the recent policy shift, most of the medium to large scale sawmills are integrating forward to process the short pieces and solid residues into value added products like mouldings, furniture parts and flooring parquets. Ownership patterns for such integrated mills will be fairly similar to the situation discussed above. But besides the integrated mills, there are some mills established solely to undertake downstream processing. Such factories make various products like profile boards, Tongue and Groove (T&G) doors, flooring parquets and finger jointed materials.

Ownership of the big mills in this category is mainly in foreign hands. Most of the small ones and a few of the big mills are owned by Ghanaians. In a few cases an individual or group of people may own two or more processing mills.

Linkages Between Firms

With the change in the concession system, many sawmills, which hitherto had no concessions, are aggressively seeking to take advantage of the new system to get access to timber trees under the Timber Utilization Contract (TUC) system[11]. This will enable them integrate backwards into logging.

The general thrust of the new government policy is to encourage mill integration. It is therefore expected that under the TUC system, large and medium sawmills without concessions would be favourably considered for access to timber. This will make backward integration possible.

Government is also urging mills to do forward integration by processing the residues and fall outs from the secondary processing. As logs become less available, many mills are taking advantage of this move and install facilities for downstream processing. Already about 20-30% of the medium and large-scale mills have installed facilities including finger jointing and moulding machines. A lot more, including some small-scale ones are also contemplating the move. A couple of mills are even considering producing glue-laminated (glu-lam) products.

[11] See Section 3.4.2 for discussion of TUC system.

3.3.2 Industrial Associations and Technical Institutions

Various associations and technical institutions that deal directly with the timber industry are presented in Table 10. The Wood Industry Training Centre (WITC) is one institution that needs special mention, due to its crucial role in upgrading the performance of the entire timber industry. It also serves as a key information provider for the industry.

Wood Industry Training Centre

The Wood Industry Training Centre (WITC) is located near Kumasi, the heart of the timber industry. It provides hands-on training with a good dose of theory. The mission of the Centre is "to provide technical and managerial training, consultancy and extension services to the wood-based industry to ensure efficient capacity development on a sustainable basis." The training activities are broadly categorized into two, namely: Regular Short Skill Upgrading Courses and Customized Factory Training schemes. They also organize seminars, conferences and workshops.

The target trainees include carpenters, machine operators, mill supervisors, technicians, managers and executives. The Centre draws heavily on the expertise at the Forestry Research Institute of Ghana (FORIG). But they also have a core of qualified and experienced staff that handles the training. In some cases, expertise is sourced from reputable institutions like TRADA of the UK and FTP of Finland. Such foreign experts often come in as consultants with sponsorship from bi-lateral or multi-lateral donor agencies.

A few of the training courses are sponsored by the TEDD and the FPID, both of the Forestry Commission. But for most of them, trainees have to foot the bills themselves, or by their companies. This no doubt, presents a problem to the small-scale carpenter. Another weakness in the system is the mode of advertising the courses. The Centre advertises training courses for each quarter in a publication, which is widely distributed to the industry. But given the high level of illiteracy in the industry, especially at the small-scale level, the trade associations could also help get more of their membership to benefit from the opportunities offered by the Centre.

The Centre also serves as the focal point for most of the training offered under the Woodworking Sector Development Programme, which is managed by the TEDD and the FPID through an internationally recognized consultancy group, Kilkenny Development Partners (KDP), in association with Vernon Associates. The programme is funded by the EU and the Ghana Government; it has the overall objective to 'raise the growth rate of the Ghanaian economy by stabilizing and increasing export revenue through promotion of exports of value-added products in the woodworking industry'.

This laudable objective is to be achieved by improving the technical, marketing and managerial skills of selected firms in the sector, either directly through Technical Assistance to individual firms or indirectly through support to training institutes in the wood sector. A number of training courses in both technical and managerial aspects have so far been hosted by the WITC. These courses have covered topics like kiln drying, production and productivity, and wood machining.

Table 10: Organizations/Associations related to the timber industry

	Name	Functions
1	Ghana Timber Millers Organizations (GTMO)	This association represents the interests of its members, which are mainly sawmillers.
2	Ghana Timber Association (GTA)	This association is made up of companies involved in logging even though some of the logging companies also process the logs into finished products.
3	Furniture and Wood-workers Association of Ghana (FAWAG)	This is the umbrella organization, which seeks the interest of all furniture manufacturers.
4	Small-scale carpenters Association (SSCA)	This is a grouping of the SMEs in the carpentry and joinery trade; include those who operate from roadsides.
5	Forest Products Inspection Division (FPID) of Forestry Commission	Quality control or regulatory body, which ensures that before timber products are exported, they comply with local regulations and meet acceptable international standard.
6	Timber Export Development Division (TEDD)	This board helps with the pricing of timber products for export etc. Officials ensure that timber companies do not sell below the minimum market prices.
7	Wood Industry Training Centre (WITC)	A training institution where the technicians from various timber industries are sent from time to time for upgrading their skills. Workshops, seminars, etc. are also held here.
8	Forestry Research Institute of Ghana (FORIG)	A research institution where forest crops and products are researched. Various timber species are usually sent here for research into their market value, uses, etc. The International Tropical Timber Organization (ITTO) funds many of the research projects carried out by FORIG.
9	Institute of Renewable Natural Resources (IRNR)	This is an Institute in the Kwame Nkrumah University of Science and Technology. It trains middle level manpower (graduate and post-graduate) for the sector as a whole.

3.3.3 Regulatory Authorities

The Forest Services Division of the Forestry Commission

The government agency that directly handles forestry issues in Ghana is the Forestry Department of the Ministry of Lands and Forestry. This agency oversees the protection and production on forest reserves and the annual allowable cut that it has set for timber from forest reserves is 500,000 cubic metres. Until recently, the off-reserve areas were under the Lands Commission and not the Forestry Commission. The situation however, is now different; the Forest Services Division (former Forestry Department) of the Forestry Commission controls such lands as well. Fifty per cent of the annual allowable cut of one million cubic metres (i.e. 500,000 cubic metres) is supposed to come from these areas.

Apart from the Government of Ghana, the following people also have rights and impacts on the forests:

- Farmers
- Forest fringe communities
- Traditional land- and forest- holding authorities

Those people whose interest in forestry products is indirect comprise civil society groups and to a large extent the global economy. The Forestry Department (FD) oversees a series of forest reserves across the high forest zone. The reservation policy of the FD, among other things ensures efficient use of timber resources. Off-reserve forests are administered by local chiefs and or traditional rulers who usually negotiate their own precise agreements with loggers or timber concessionaires; they also determine and collected royalties. The degradation of the forest reserves as a result of logging activities of the timber industry threatens important timber species with extinction in view of the fact that the annual allowable cut stipulated by the GOG bears little relation to estimates of sustainable yield.

b) The Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) was formed in 1994 as a regulatory body on all matters concerning the environment. The EPA ACT 490 was promulgated by parliament in 1994. The EPA replaced the then Environmental Protection Council (EPC) which served as a GOG environmental issues advisory arm. Some of the objectives of the EPA include:

- Ensuring environmentally sound use of both renewable and non-renewable resources in the process of national development; and
- Guiding development to prevent, minimize and as far as possible, eliminate toxic pollution.

Most of the timber industries existed for a very long time before the EPA came into existence in 1994 and so had been having their own way prior to the establishment of the EPA [Omane, 1999].

3.4 Policy and Regulatory Context

3.4.1 Timber Rights And Fees

The right to timber and the various fees payable have been reviewed recently. Hitherto, concessions to fell and remove trees in the closed forest were allocated for a period of 40 years. Once a concession had been acquired, a property mark had to be obtained before exploitation could commence.

The Chief Conservator of Forests (now Executive Director of the FSD) issues the property mark. It is specific to a concessionaire and is valid for only one year. It may however be renewed on presentation of an Income Tax Clearance Certificate and a Certificate of Membership of the Ghana Timber Association (GTA) or the Ghana Timber Millers Organisation (GTMO). The following payments should also be made: Renewal Fee, Annual Rent and Silvicultural Fees in respect of the concession, and any outstanding royalties.

Current procedures for acquiring the right to timber and the various prescribed fees payable are all spelt out in the Timber Resources Management Regulations (LI 1649) of 1998. The next sub-section presents a modified extract of the Legislative Instrument.

3.4.2 Procedures for Accessing Timber

Under the new system, the Executive Director of the Forest Services Division (FSD) of the Forestry Commission (FC) is to identify lands suitable for grant of Timber Utilisation Contracts (TUC). He will then take the necessary steps to have the land inspected and to seek the consent of the landowner, if it is not public lands. Where it has been determined to grant timber rights in an identified area, and after the consent of the owners (where applicable) has been obtained, the said land will be advertised by publishing in the Lands Concession Bulletin and by at least two (2) insertions in national daily newspapers. Any interested person can then arrange to inspect the site, after which he may apply for it using statutory application forms obtainable from the FSD.

To qualify, an applicant should satisfy the following conditions: -

6. Evidence of ownership or membership of a registered company or partnership relevant to forestry with a commercial business certificate;
7. Evidence of full payment of forest levies where applicable;
8. Income tax and social security clearance certificates;
9. Signature of an undertaking

    i.) to provide specific social amenities for the benefit of the local communities that live in the proposed contract area, and
    ii.) for the reforestation or afforestation in any area that the Executive Director of the FSD may approve; and

10. Evidence of capability to undertake reduced impact logging.

A Timber Rights Evaluation Committee will evaluate all applications. Applicants who are pre-selected at this stage will then be invited to submit proposals on:-

c) a reforestation or afforestation plan for the establishment and management of at least 10 ha[12] for each square kilometre of the contract area; and
d) a social responsibility agreement to assist inhabitants within the contract area with such amenities as shall be specified in the agreement at a cost of not more than 5% of the annual royalty accruing from the operations under the TUC.

The Committee will evaluate the proposals of all pre-selected applicants and make recommendation to the Forestry Commission, which will then forward the recommendation to the Minister responsible for Forestry. The Minister will then notify the successful applicant and request him to submit a performance bond. This is an undertaking for the satisfactory implementation of the contract terms, the reforestation or afforestation plan and the provision of social amenities as agreed upon in writing and signed with representatives of the inhabitants of the area in question.

Below is a description of the situation as at the end of 1999:

> *"An initial 51 Timber Utilization Contract (TUC) areas comprising nineteen (19) forest reserves and thirty-two (32) off-reserve areas were identified and applied {for} by companies. In all, there were one hundred and ninety-two (192) applications by sixty-nine (69) companies. The Timber Rights Evaluation Committee (TREC) completed evaluation of the first set of 192 applications for these areas and submitted its report to the Forestry Commission for approval."*
> *(Source: Forestry Commission of Ghana Annual Report, 1999, page 32)*

It has to be explained that for some reasons including the change in government and the ministerial positions, none of the approved TUCs had been given a ministerial assent as at the end of February 2001.

3.4.3 Other Obligations of the TUC Holder

The TUC holder shall pay stumpage fees representing royalty to the landowner and charges for the cost of felled timber. It also provides a basic return to the landowner and contributes to the cost of forest management and timber regulation. The TUC holder would also require a conveyance certificate to haul any timber felled. He finally has to pay rent for his contract area (¢2,000/ha per annum if the area is in the reserves or ¢1,000/ha/yr, if outside).

For the purposes of determining the stumpage fees payable, all tree species have been grouped into 3. For those in group A, high demand or depleted species, the stumpage fee is 20% of the FOB price of the air-dried lumber. For the 2nd group, i.e. moderate demand, or available species, the rate is 10% and for the 3rd group, those in low demand or abundant

[12] Even though 10 ha is only 0.1 km^2, it is assumed that under the selective felling system only a tenth of the logging area would be effectively logged.

species, the rate is only 5%. Currently the fees range from ¢7,350/cubic metres for the ordinary, lesser-used tree species to ¢117,600/cubic metres for endangered species like Afrormosia (Pericopsis elata), as shown in Appendix D.

3.4.4 Logging outside Areas under TUC: Timber Utilisation Permits (TUPs)

For areas of land not subject to timber utilization contract one would require a timber utilization permit (TUP) for harvesting a specified number of trees. Any timber harvested or converted to lumber under a TUP is to be used only for social or community purposes and cannot be sold or exchanged[13].

It is possible that people clandestinely export timber felled under permit but this is illegal. Normally TUC operators will saw the log in a mill so that the lumber comes out neater and square-edged. Also registered bushmills which are permitted to process the logs in or close to the forest do produce square edged lumber. People who fell with TUPs usually would not have access to haulage facilities and would be obliged to saw the log in-situ, using chain saws or woodmisers. Chain sawn lumber is rough sawn, and can be easily differentiated from lumber from the mills. Thus, the rough sawn lumber will be covered by the general ban on the sale of chain-sawn lumber. The enforcement, no doubt is fraught with a lot of difficulties, not so much with the identification of the lumber (i.e. whether it is from a TUP or TUC area), but rather from connivance between the policing bodies and the illegal producers

3.4.5 Procedures for Log Harvesting in Forest Reserves

Guidelines regulating the extraction of timber are detailed out in the Logging Manual (FD, 1992). First the stock survey for the compartments constituting the annual coupe is carried out at the expense of the concessionaire. The stock survey covers all tree species above 10cm diameter at breast height. A stock map is then prepared indicating the position of every tree. Tree lists and summaries by compartments, species and diameter class distribution are prepared.

The selection of any species constituting the yield is based on its relative abundance. The selection of trees to be felled from the yield is based on removal of the largest trees first, subject to the provision of a 40-year felling cycle to allow the forest adequate time to recover from logging damage and to permit more growth on the residual crop.

During extraction it is required that care be taken to avoid creating large openings at any point by removing too many trees close by. In the high forest reserves, the logging intensity is about 2 to 3 trees (15-30 cubic metres) per hectare, whilst in the Transition (Savannah) zone about one tree may be extracted per hectare. There is also a prescribed minimum exploitable diameter for the various species. Felling of undersized trees attracts a penalty of 1,000% of the royalty payable.

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[13] Source: Legislative Instrument (LI) 1649:35(3).

The yield is offered to the concessionaire on coupe basis. But exploitation is allowed compartment by compartment. Normally a compartment will be fully exploited before the next one is entered.

The concessionaire is allowed three (3) years to complete the removal of the prescribed yield from an annual coupe after which re-entry is not allowed until the next felling cycle (i.e. 40 years later).

3.4.6 Logging outside Reserves

Timber exploitation from lands outside the reserves was, until fairly recently (April 1991) under very little control. The land is earmarked for agriculture ultimately and so little attempts were hitherto made at controlling the rate of timber extraction. Nevertheless a logger still needed a timber lease/licence for the extraction. Such lands have been creamed over the years for the most preferred species. Nevertheless, some of such lands still have substantial amounts of timber trees.

Outside the reserves the concessionaire or logger is not subject to any restrictions as to type of species or number to be felled. However he still has to abide by the minimum girth limit regulation.

3.4.7 Restrictions On Exports

In the late 70's a ban was placed on the export of logs from some 14 prime species. The objective was to encourage value addition to these species. In the early 90's there was a boom in the log market in South East Asia. All kinds of species were accepted on the market. This led to high levels of log harvesting and export. So lucrative was this business that for a long time, the harbour was congested or choked with logs. The situation was so bad that at some point, the logs at the harbour had to be auctioned. This was followed with a temporal ban on round log export in 1995. Since then the policies and general legal environment for the timber sub-sector have seen gradual but significant changes. With time, the ban became institutionalised. This resulted in greater local processing of the logs.

3.4.8 Restrictions on different species

Some eleven species considered to be severely limited in the forests can only be felled under a special permit issued by the Executive Director of the FSD, with the approval of the Forestry Commission; these species are listed in Table 11. Only one tree species, Subaha (Mitragyina stipulosa) has been completely banned. The tree is mostly found along riverbanks or in watershed areas, hence the ban. It cannot be felled, let alone processed for local sale or for export.

Table 11: Restricted Timber Species

Local Name	Trade Name	Botanical Name
Edinam	Gedu-Nohor	*Entandrophragma angolense*
Penkwa	Sapele	E. cylindricum
Efobrodedwo	Utile	E. utile
Penkwa	Candollei	E. candollei
Krumben	Mahogany	Khaya anthotheca/gramdifolia
Dubini	Mahogany	K. ivorensis
Odum	Iroko	Milicia excelsa/regia
Kusia	Opepe	Nauclea diderrichii
Kofrodua	Afrormosia	Pericopsis elata
Baku	Makore	Tieghmella hecklii
Hyedua	Black Hyedua	Guibortea ehie

Again in 1997, another policy was introduced to encourage further addition of value to the wood by kiln drying. Levies were introduced for the export of air-dried lumber from 9 timber species. The list of species and the levels of the levies are given in Table 12 below. All the other species could be exported without levy, once they were processed.

Table 12: Species for which air dried lumber attracts levies

Species Local Name	Botanical Name	Levy % of FOB Price
Odum	Milicia species	15
Afrormosia	Pericopsis elata	30
Hyedua (Black)	Guibourtea ehie	15
Makore	Tiegmella heckelii	10
Edinam	Entandrophragma angolense	10
Mahogany	Khaya species	10
Sapele	*Entandrophragma cylindricum*	10
Utile	Entandrophragma utile	10
Wawa	Triplochiton scleroxylon	10

The government is gradually encouraging the installation of drying facilities by the processing mills. In some cases installation of communal kilns has been considered for the provision of service to small-scale mills including furniture manufacturers who may not be able to afford their own kilns. It is anticipated that before long, there will be a total ban on the export of air-dried lumber.

In line with increased value addition, some mills have installed finger jointing and moulding machines. This is a very positive move, since much of the wood can now be redeemed from the 'waste bin'. But this may have serious implications for small-scale carpenters and other wood workers who depend on the fallouts and the residues from the sawmills for their wood raw material.

3.4.9 Enforcement of the Laws

To a large extent, the laws are well enforced. Laws regarding export restrictions in particular are very well enforced. But due to inadequate staffing and lack of logistics, laws regarding logging and extraction are not so well enforced. The limitations imposed by shipping arrangements would also account for the higher level of enforcement of the laws regarding exports.

All these notwithstanding, there are some unscrupulous officials who may still collude with exporters and also loggers for the circumvention of the laws.

3.5 Sub-Sector Trends and Dynamics

In recent times, the forestry sector as a whole has seen numerous changes, both in the policy arena and also at the institutional level. All these have been targeted at addressing the critical issues which may be listed as follows:

- Sustainable management of the remaining forest;
- Expansion of the forest cover (10%) to cater for the growing needs and increasing population;
- Reduction of waste associated with resource extraction, processing and utilization;
- The industry is characterised by an over-capacity of out-dated and inefficient equipment, rated at some 2 million cubic metres per year[14]; and
- Value-added processing of wood to minimise waste and increase returns.

The rest of this section is a summary of the trends and changes that have arisen out of increased regulations in the timber Sub-sector. It also discusses the nature of the trends and their likely implications for the sub-sector.

[14] This figure is based on a projected 3- eight hour shifts per day (Amankwaah, 1996). This is for both saw mills, veneer and ply mills, valid for 1996. Recent estimates are not available. This 1996 estimate also took into account small saw facilities that start their operations from the log as against those processing only residues.

3.5.1 Regulatory Instruments

On the regulatory side, policy changes effected since the early 1990's include:

- A reduction in the annual allowable cut of timber from 1.2 million cubic metres in 1996 to 1.0 million cubic metres in 1999;
- A ban on export of round logs;
- A complete ban on the harvesting of some ecologically sensitive tree species;
- A revision of the felling limits (minimum diameter of tree that can be felled);
- A ban on the production and sale of chain sawn lumber;
- Institution of a levy on the export of green (un-dried) lumber;
- Indexation of timber royalties to the FOB price of the air-dried lumber;
- Guidelines on pricing of export commodities – TEDD sets a price range to guide price negotiations;
- Promulgation of the 1994 Forest and Wildlife Policy Act, which calls for a sustainable forest management throughout Ghana;
- New legislation providing for replacement of concession with timber rights contracts (this legislation requires better landholder and farmer rights over trees as well as stronger environmental and social commitments);
- General policy of encouraging plantation development – e.g. teak, eucalyptus (exotics), as well as indigenous species – mixed plantations are favoured;
- Requirement in Timber Utilization Contracts (TUCs) for replanting at replacement rate;
- Introduction of Timber Utilization Permits (TUPs) for felling a limited (specified) amount of timber for the domestic market; and
- Decommissioning of old inefficient sawmills – (this is however left to the market forces, given the new policy environment).

Recently, an independent verification that a forest is well managed or that products are from properly (sustainably) managed forest has started in Ghana. Since trading partners of timber products have begun to favour certified timber, timber trade organizations have shown keen interest in certification even though land owners' interest in certification is spurred on by the desire to increase accountability [Kotey et. al, 1999]

3.5.2 Institutional Changes

At the institutional level, many changes appear to be taking place in an often-unpredictable manner. Several measures have been put in place in recent times. The control of off-reserve lands has been taken from the lands commission and given to the Forest Services Division of the Forestry Commission. The Forestry Department has been transformed from a civil service institution into a semi-autonomous self-financing Forest Service. Also, mobile forest protection Task Force teams have been put in place to check encroachments on the forest

And it is expected that these teams will be phased out as the Forest Services Division (of the Forestry Commission) becomes fully operational.

With respect to local communities, they have now been involved in the management of forestlands. This makes for better policing of the forest; it is also expected that communities fringing the forests will enjoy more of the benefits from the forest.

Recently too, a new set-up, Plantations Development Centre, has been put in place to stimulate and provide technical support for private-sector involvement in plantations development.

3.5.3 Dynamics of the Sub-Sector

Until the early 90's, the logger was mainly producing logs for export. This situation created a shortage of logs on the local market for the mills. Since the mid-90's, the export of round logs has been banned. The supply of logs to the local market is however far from adequate. This is partly attributed to the transition from the concession system to the TUC system, and partly due to the stricter controls put in place even in respect of logging outside the reserves. Also, logging is generally controlled by buyer contract preferences, and not so much by the availability of any particular species so changes in the types of species harvested have occurred rather slowly. There have been efforts at promoting lesser-known or lesser-used timber species, the response is now beginning to show, mainly due to the shortage of the hitherto preferred wood species on the market (and also in the forest).

The regulatory measures and institutional changes outlined earlier have resulted in some trends in the timber sub-sector. These measures are discussed below together with some anticipated effects, which could not be confirmed under the current study:

- There has been a complete curtailment in log exports. In 1993, log exports accounted for over 34% of the earnings from the timber sub-sector, but available records indicate that logs no longer contribute to the export earnings at all.

- There has been a shift towards more value-added processing. As evidenced by Figure 2 (see Appendix E for raw data), earnings from kiln-dried lumber, for instance have been rising steadily since 1996 whilst there is a trend towards a decrease in earnings from air-dried lumber.

- Similarly there has been a steady increase in earnings from tertiary products, sliced veneer and rotary veneer over the same period. This trend means that mills are processing more of their wood residues and processing new tree species more suitable for veneer production. The increasing residue utilization, however, may have implications for small-scale woodworkers and carpenters who depend on to some extent the residues from the mills for their raw materials.

- The increases in stumpage fees should not only bring in more revenue; it should also encourage mills to be more efficient. It should encourage optimum extraction from any tree that is felled; this could engender branch wood utilisation. In fact there are reports of some furniture mills extracting big branches from logging residues in the forest.

- The new system of allocating the resource should ensure that only companies with the requisite facilities will gain access to the trees. Since most of such companies also happen to have Sawmills, there will be a trend of the mills moving upstream into logging. Thus, timber harvesting would be done more efficiently and effectively, with minimum environmental degradation. This trend is however likely to eliminate many members of the Ghana Timber Association (loggers) who have no extraction facilities. In the interim, this has created a shortage of logs on the local market. It is however expected that this will only be temporal. The supply situation should improve once the new system becomes fully entrenched.

The new system also ensures that communities fringing the forest also derive some benefits from the forest. This should contribute to the general well being of the rural poor.

The various bans enumerated above are aimed at protecting the resource and also ensuring increased availability of raw material for the local processing industry. This should lead to the creation of more jobs or at least the retention of existing ones and also increase earnings by the sub-sector from the value-added products.

The ban on chain-sawn lumber in particular has resulted in a stifling of the local wood market, at least for the present. To address this, some mills were mandated to service this market and, as an incentive to these mills, they were given easier access to trees but the system is not working well.

There is also the possibility of a total ban on the export of air-dried lumber. This again will increase the demand for wood energy for heating in the drying kilns, which will affect the availability of the residues for the small-scale producer down the line.

The shifting away from rare species to more common ones means a broadening of the timber resource base. This is good for biodiversity conservation and general sustainability of the forest. This however presents more challenges for the processing and marketing sectors. Appropriate processing techniques, particularly in terms of drying schedules and preservative treatment chemicals have to be found. Markets for the lesser-known or lesser-used wood species also have to be developed; this is not always easy since the market is fairly conservative.

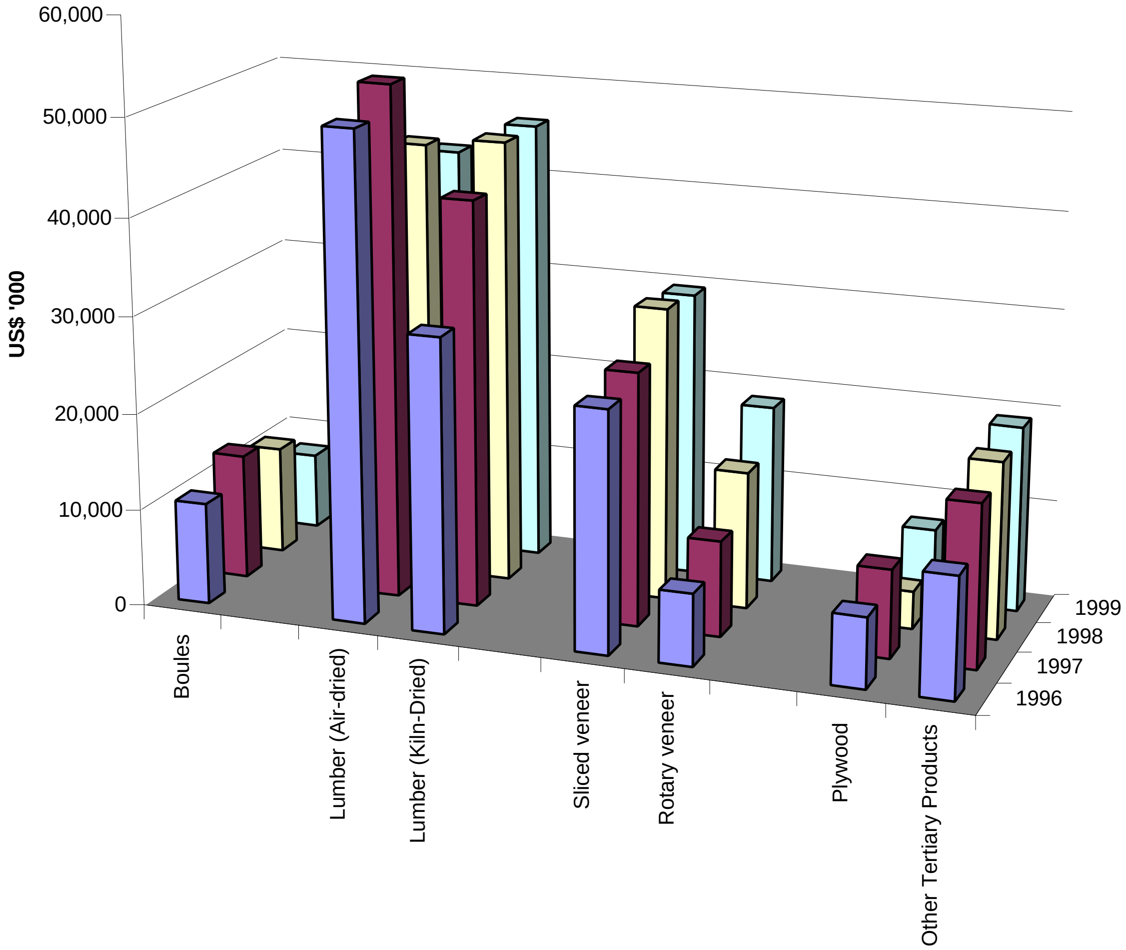

Figure 2: Export Earnings from Timber Products for 1996 - 1999

Over last 5 years, Local demand for wood products has increased, driven by demand for new houses (construction and furniture). There also seems to be more re-processing by micro-sawmills. This is most probably due to the increases in chain sawn lumber prior to the ban. Further increases in the reprocessing by micro-sawmills will depend on how well the ban is enforced and the level of growth in local demand for lumber.

The key driver for the above changes has been the environmental lobby; there has been a general decrease in the number of trees, and logging has previously been carried out at an unsustainable rate. The new policies are therefore designed to lead to sustainable management of Ghana's timber resource.

The impacts of the policies have generally been to increase the price of the raw material (wood) on the local market, and to encourage value addition/ increased tertiary processing.

Other trends and dynamics, primarily as a result of the above, may be listed as follows:

- Processing of smaller diameter logs;
- Growth in the bushmill (mobile sawmill) channel;
- Decreasing supply of illegal lumber which will continue to decrease (as long as adequate enforcement);
- More tertiary processing to add value (as a result of increased price of raw material, and levies on non kiln-dried lumber);
- Increased rotary veneer export, using softer, less endangered species (driven by shortage of species used for sliced veneer);
- Increased export of kiln dried lumber and decrease of air dried lumber, leading to an increased need for kiln drying facilities;
- More on-site use of residues by sawmills (as fuel for kiln dryers) as well as for tertiary processing;
- Increasing local demand for plywood due to a new demand for roofing tiles in local construction;
- Decrease in logging as a stand-alone activity (because the TUCs require contractors to have processing facilities);
- Shortage of lumber in the local market, which is due to the fact that the sawmills have no interest in supplying the local market with lumber since the local market cannot afford export prices, so the vast majority of this lumber is exported. For this reason, the local market is heavily dependant on rough (chain sawn) lumber, the supply of which has now been made illegal. Although some 60 bushmills have been licensed to supply the local market via TUPs, they are in fact breaching these contracts and exporting as much of the lumber they produce as possible

3.6 Constraints and Opportunities

In conclusion, the timber sub-sector may be said to be constrained by many factors, key among which are the following:

1. Over the last two decades the entire forestry sector, and the timber sub-sector in particular, has been in a state of flux: new policies and regulations have been introduced one after the other; and there have been several institutional changes, some of which have even been cyclical. For example, the Forestry Commission, the umbrella organization for the sector has gone through at least three metamorphoses before assuming its current status. This apparent absence of consistency in the policy environment in particular, has been a source of worry to the industry.

2. Lack of capacity and logistics on the part of the Forest Services Division to adequately protect the forest against encroachment and illegal felling.

3. Absence of qualified middle-level personnel to run and service/maintain machinery of the processing mills in particular.

4. Intermittent problems with power supply.

5. Short supply of logs on the local market. But as discussed elsewhere, this should be a passing phase. The problem is also related to the over-capacity in the sawmill operations.

6. The weak local currency means that imported spares and supplies to the industry are very expensive. This problem is felt the most by companies who sell only to the local market. Exporters are allowed to retain a percentage of their earnings in hard currency to meet such needs.

7. The industry also complains of too much taxation; but this is because for a long time the value of the resource was grossly under-valued. Even now, the stumpage fees are far lower than the cost of replacement of the wood. Again some of the taxes are avoidable since they are meant to encourage further processing.

Inspite of the many constraints, there are some interesting opportunities which may be summarized as follows:

A. Bushmills can get TUPs if they agree to supply 100% to local market;

B. Bushmills can also use mobile saws/ woodmizers;

C. Tertiary processing and added value; are improving on their economics;

D. Make more use of Residue utilization is becoming more financially attractive; and

E. Prospects are improving for the use of alternative materials to replace wood.

Interventions to address these constraints and opportunities will be explored in the last chapter of this report.

4. ENERGY EFFICIENCY IN SAWMILLS

4.1 Introduction

This chapter dwells on energy efficiency, which was originally meant to be the focus of this study. As explained earlier in Chapter 1, the focus was broadened to cover the wider policy dynamics in the wood sector when it became clear in the course of the study that energy constituted a rather small percentage of production costs and a much smaller percentage of revenues for the average sawmills.

The chapter starts with a presentation of baseline data on energy efficiency options and goes on to review the range of technical measures for improving energy efficiency in sawmills as well as previous experiences with the implementation of these measures. The chapter then enters into a broad discussion of the constraints and opportunities for energy efficiency. This discussion takes off with a review of the energy sector institutions in place, paying particular attention to private sector ESCOs. The discussion next examines the available information on sawmill production costs and revenues, on the one hand, and the financial costs and benefits of energy efficiency measures, on the other hand. The latter parts of the discussion analyse the multifaceted mix of barriers for energy efficiency in industrial firms in general and sawmills in particular, and finally summarizes the key constraints and opportunities as captured in the sub-sector analysis workshop organized as part of this study.

4.2 Baseline Data on Energy Efficiency Options

4.2.1 Electricity Consumption Patterns

The wood-processing industry in Ghana is one industry where energy consumption in the forms of electricity and heat are very significant. The government policy to develop value-added wood products before export[15] has mandated the drying of most of the processed lumber produced in the country. The drying of lumber in the industry is largely met through the use of wood-processing residues (biomass). With the exception of one or two plants that are remotely located, all timber companies meet their electricity demand through the grid. Annual electricity charges for some of the largest mills in the country are in the region of about US$ 200,000 to 400,000 as evidenced in Table 11 below.

Some of the companies presented here are large ones and have been considered only for the purpose of comparison bearing in mind the fact that this project is focused on small firms. Data on the heat consumption patterns is absent in the timber companies and as such only electricity was considered. As stated earlier, heat requirements in the companies are met by the use of wood waste in boilers to produce steam or hot water. These wastes are at no cost to the sawmills and hence little is done to make sure that the wastes are utilized efficiently.

[15] There is a high penalty for exporting untreated/green products

Table 11: Electricity Consumption Patterns of Some Timber Companies

Company Name	**Average Annual Electricity Consumption, kWh**	**Annual Costs of Electricity, US$**
IEAC/002/99	5,105,375	189,223
IEAC/003/99	5,997,240	391,661
IEAC/004/99	418,770	32,262
IEAC/005/99	345,799	29,817
IEAC/006/99	548,780	33,871
IEAC/007/99	1,350,543	68,782
IEAC/008/99	318,645	28,380

Source: Industrial Energy Assessment Center (IEAC) Audit Reports

4.2.2 Product Output Versus Electricity Consumption

Ideally the kind of product a timber company deals in should have an effect on the energy or electricity consumed and an attempt was made in this study to capture the pattern of consumption of energy by the type of product. Many wood companies deal in more than one product and it is difficult to assess the energy requirement for one product type amongst the rest. The available information summarized in Table 12 is highly inconsistent. Company IEAC/006/99 that produces only lumber utilises 114 units of electricity per m^3 of product as against 36 units used by company IEAC/004/99 that processes lumber further down stream into T&G and panel boards. The information suggests that either the former, which is using about four times as much electricity per m^3 as the latter, is highly inefficient or there is some under reporting on the volume of products. Analysis for the veneer stream of production is similar (see companies IEAC/005/99 and IEAC/008/99).

Table 12: Electricity Consumption by Product Type

Company Name	**Type of Products**	**Product Output, m^3**	**Electricity Consumed/ Product Output, kWh/m^3**
IEAC/002/99	Lumber, Veneer, Mouldings	35,088	146
IEAC/004/99	Lumber, Tongue and Grooves, Panel Boards	11,520	36
IEAC/005/99	Veneer and Ply Boards	8,640 – 14,400	30
IEAC/006/99	Lumber	4,800	114
IEAC/008/99	Veneer and Plywood Products	4,800	114

Source: IEAC supported by FPID

4.3 Key Technical Measures

The key energy efficiency (EE) options experimented/practiced or considered to date in wood processing companies in Ghana are discussed below.

4.3.1 Electricity

The main opportunities available to ensuring efficient electricity consumption in sawmills are concerned with lighting, electric motors (including power factor correction), and machinery. Each of these is discussed below. The most popular measure amongst the sawmills surveyed in the early part of this study, was power factor correction. Implementation of other electrical energy efficient practices were found to be rare, although a few firms had energy efficient lights and some also used cogged V-belts.

Lighting

<u>Energy Efficient Lights</u>
Electricity consumption in sawmills could be reduced through energy efficient lighting techniques. The primary techniques available are:

- replacement of high energy consumption lights with energy efficient lights as indicated in Table 13:
- maximum use of skylights to utilize daylight;
- ensuring lights are turned off in areas where they are not required, both during the day and at night.

Table 13: Energy Efficient Lighting Options

Old Light	**Energy Efficient Replacement**
Incandescent bulbs	Compact Fluorescent Lamps (CFLs)
40 W (T12) fluorescent tubes	34 W (T8) fluorescent tubes
Mercury vapour lamps	High-pressure sodium lamps

Figure 3 gives a graphical representation of the lighting situation that came out of the surveys.

Almost all of the firms surveyed (84%) as part of this project were using ordinary 40W (T12) fluorescent lights which are not as energy efficient as 34W (T8) fluorescent lights; the latter were not being used by any of the firms. Mercury vapour lamps were also being used on a large scale, by 43 of the 56 firms, or 77%. The more energy efficient high-pressure sodium lamps which could easily replace the mercury vapour lamps for energy saving purposes were being used by only 5 sawmills (9% of the firms surveyed).

Energy audits conducted by the Industrial Energy Assessment Centre (IEAC) on a number of timber firms revealed, as presented in Table 14, favourable simple payback periods for the installation of EE lamps, ranging from 46% to 222% with an average of 125%. The payback periods ranged from 7 months to just over two years.

Table 14: Installation of Energy Efficient Lamps

Sawmill Reference	**Energy Savings (kWh/yr)**	**Demand Savings (kVA/yr)**	**Annual Cost Savings ($)**	**Implementation Cost ($)**	**Simple Payback (Months)**
IEAC/003/99	134,445	5,875	10,480	20,186	23
IEAC/004/99	18,529	59	1,557	870	7
IEAC/005/99	10,416	34	952	1,125	14
IEAC/006/99	15,036	644	1,237	2,687	26
IEAC/007/99	15,620	36	1,190	536	4
IEAC/002/99	109,292	353	7,751	4,699	7
Average					13.5

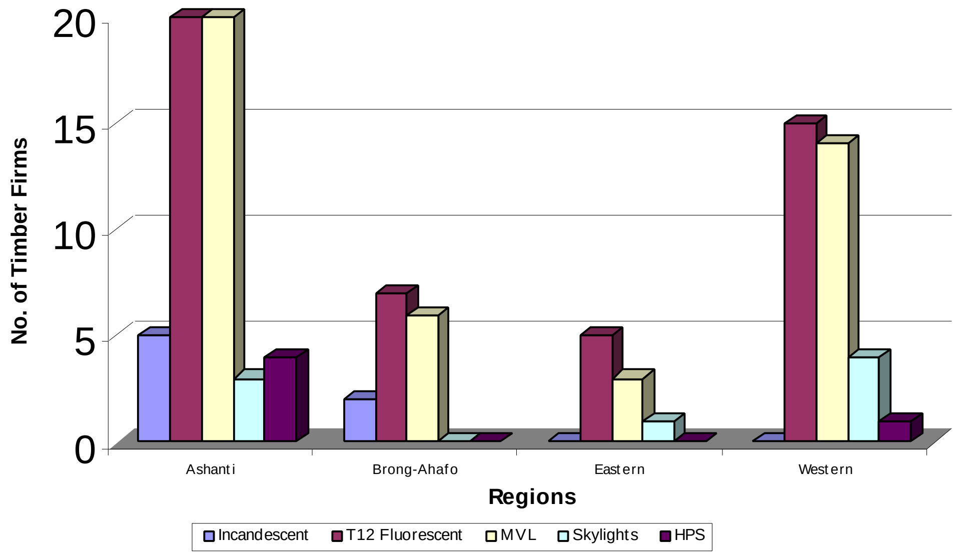

Fig.3 Lighting System Analysis

Skylights

Skylights, an important energy saving measure where use is made of daylight rather than using conventional lighting systems were used by only 8 (14.3%) of the firms in the survey. Nevertheless, IEAC's energy audits and calculations revealed generally favourable simple payback periods for the installation of skylights (see Table 15), the best case being a simple payback period of 1.2 years.

A further opportunity for energy efficiency in the area of lighting is lighting controls. Such controls include:

- Occupancy Sensors for activating a device that turns lights on or off depending on occupancy;
- Scheduling Sensors for activating lights on pre-programmed time scheduling; and
- Photocell Controls for sensing light levels and adjusting accordingly.

Currently however, no sawmills are using these sophisticated controls.

Table 15: Installation of Skylights

Sawmill Reference	Energy Savings (kWh/yr)	Annual Cost Savings ($)	Implementation Cost ($)	Simple Payback (Months)
IEAC/003/99	134,445	7,791	20,912	32
IEAC/004/99	8,364	565	667	14
IEAC/001/99	15,244	254	1,557	73
IEAC/002/99	32,614	2,370	3,204	16
Average				33.8

Electric Motors

Electric motors are used by all sawmills in Ghana and are the major electricity-consuming units. The primary methods by which the energy efficiency of motors can be increased, and thus electricity consumption reduced, are discussed below.

<u>Power Factor</u>

Usage of motors is the main cause for power factor values less than unity. Theoretically where power factor is less than unity electricity is wasted. In Ghana there is a power factor threshold value of 0.9; all industrial firms running at a value of less than 0.9 are obliged to pay a surcharge. The formula for calculating the surcharge is as follows:

$$\text{Power Factor Surcharge} = \frac{(0.90 - PF_{actual})}{0.90} \times MD \times MD_{charge}$$

where PF is power factor and MD is maximum demand

34% of the firms have PF> 0.9 and so pay no power factor surcharges, 41.1% of them have PF<0.9 and so pay power factor surcharges. Figure 4 below gives an indication of the number of firms with power factor less than or more than the threshold value of 0.9.

Table 16: Power Factor Surcharge for Three Sawmills

Company	Average Monthly Values					
	Total Energy Con.(kWh)	Maximum Demd. (kVA)	Power Factor (P.F.) Value	P.F. Sur charge, $	Total Elec. Charges, $	P. F. Sur. as a % of Elec. Cost
IEAC/008/99	53,108	297	0.65	252	4,730	5
IEAC/005/99	28,817	1,809	0.61	155	2,485	6
IEAC/004/99	34,898	326	0.55	263	2,689	10

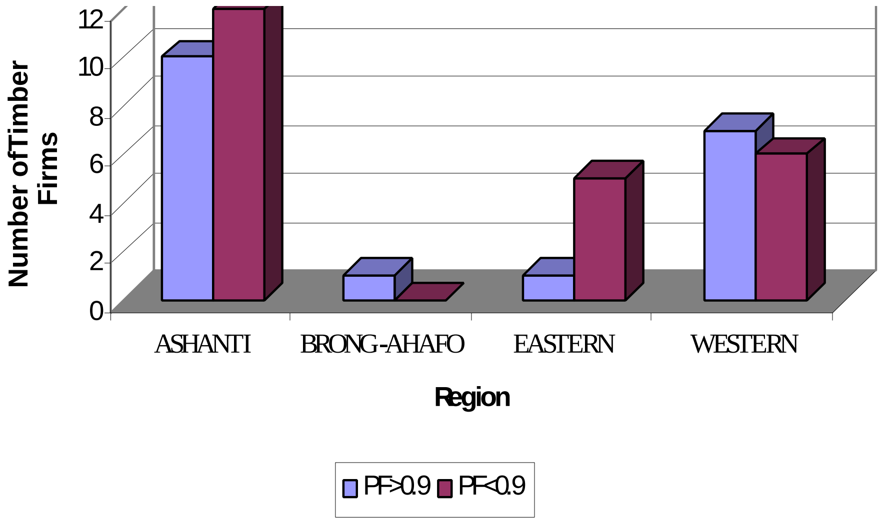

Fig. 4 Power Factor Analysis

Only 19 of the 56 firms surveyed or 34% were found to have power factor values equal to or greater than 0.9. The 23 sawmills (41.1%) with power factor less than 0.9 were thus paying surcharges. Typical power factor surcharges for three firms are indicated in Table 16. Note that power factor surcharge alone could constitute some 10% of the total electricity cost.

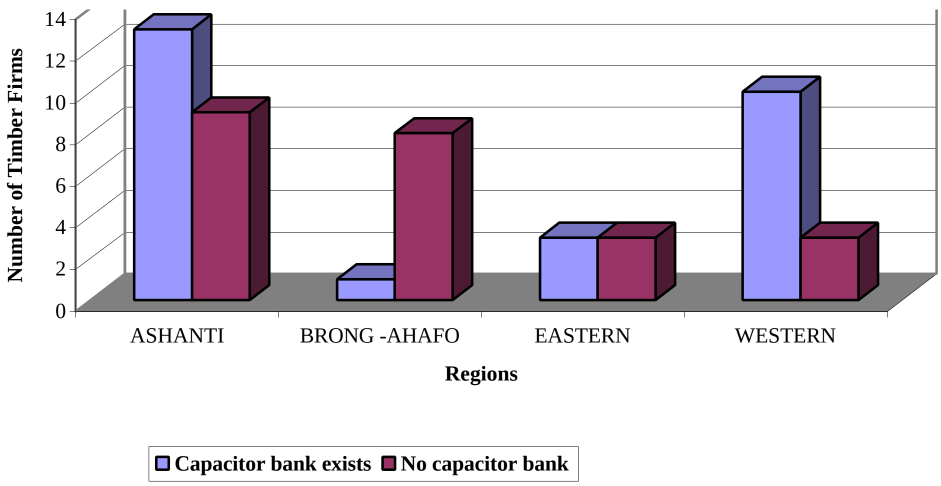

Fig. 5 Capacitor Bank Analysis

Power factor is corrected to a value equal to or above 0.9 through the installation of a capacitor bank. These can be installed at the terminals of electric motors or at a central capacitor bank; this will ensure the efficient use of electrical energy. Installation of capacitor banks to check low power factor values was the most popular energy efficiency measure employed by the sawmills surveyed. Capacitor banks had been installed in some 48% of firms. Figure 5 shows the distribution of firms which have installed or not installed capacitor banks.

Table 17: Recommended Capacitor Bank for Various Sawmills in Kumasi

Name of Firm	Average Power Factor Values	Recommended Capacitor Rating, KVar	Total Cost of Installation and Implementation, Millions of Cedis	Annual Cost Savings Millions of Cedis,	Payback Period, Months
1. Bondplex	0.89	200	11.71	3.47	41
2. Ehwia Wood Products	0.69	50	4.08	6.41	7.5
3. MOW	0.80	200 (faulty)	1.00 for Repairs 11.,40 Repair of one half plus implementation of other half	8.69	1.5 b) 15.5
4. LLL	0.85	625	49.84	46.90	13
5. Fares	0.61	150	12.58	17.40	8.5
6. ACLP	0.65	75	7.92	10.39	9
7. AG Timbers	0.85	250	18.,82	39.32	6
8. Hanmax	0.65	200	14.83	22.25	8
9. Nafy	0.68	150	19.22	11.87	19.5
10. Sunstex	0.82	45	5.77	2.69	26
11. KLL	0.59 0.55	245 300	23.10 21.69	27.35 37.35	10 7
13. Star Sawmill	0.75	210	19.95	10.99	22

A summary of some of the firms studied and the recommended capacitor bank sizes and payback periods, is presented in Table 17.

Switching Off

The simplest way to reduce the electricity consumption of motors is to switch them off when they are idle. This can be done manually; alternatively, time switches and load sensing controls can be implemented. The surveys of sawmills revealed that motors are often left running when they are not in use.

A number of sawmills expressed concern about potential adverse effects on the motors of frequent switching on and off. Unfortunately there does not seem to be any conclusive data in Ghana on this topic.

Concern has also been expressed about staggered starts, soft starts and low-voltage increasing electricity demand and in turn electricity costs. Although motors draw a higher current and higher power during starting, this is small for the most commonly used motors[16]. The reasons for this include the fact that the starting time period is short compared to usual demand intervals[17]. Also electricity meters measure demand over a period and thus cannot respond completely to the starting spike[18].

Variable Speed Drivers

Electronic variable speed drives (VSDs) control the speed of a motor; they reduce a motor's output to a level that matches the demand placed upon it. This optimises the power consumption of the motor and is a proven method of energy conservation. VSDs can reduce electrical energy consumption by between 20%-40%. Electronic VSDs also have a number of important ancillary benefits such as: unity power factor, improved process control and therefore enhanced product quality, facility to control multiple motors, programmable soft starting, soft stopping and dynamic braking, etc. The payback period for purchase and installation of VSDs is relatively short and they are offered as a competitive investment.

However, there is very little experience of the use of VSDs in Ghana. Industry personnel consider VSDs as rather cumbersome devices which require a higher level of technical expertise than is available in most firms. It has also been difficult to locate suppliers of VSDs in Ghana even though this situation is changing. There are some suppliers of these devices in the country now but there are no prevailing studies on payback periods and other economic indicators.

Motor Maintenance, Repair and Replacement

Regular maintenance will ensure that motors are running efficiently. However, only about 20-30% of sawmills have a planned maintenance program and even then it may not be carried out regularly. Motors also require repair throughout their lifetime. Attention must be given

[16] Proceedings of Energy Foundation Workshop on Energy Management in Industry And Commerce, Kumasi, Takoradi, Accra, July 1998.

[17] Ibid.

[18] Ibid.

to several factors during reparation to ensure that efficiency is not comprised, including the following:

- the gauge and number of turns of the replacement wire;
- the temperature to which the stator is heated for winding removal;
- use of correct spare parts and
- general mechanical handling.

When standard electric motors are due for replacement they should be replaced with more energy efficient motors. Electric motor-driven equipment can also be replaced with low-energy consuming hydraulic devices when new machines are installed in the sawmill. In Ghana however, firms, including sawmills, have a strong tendency to go for repairs even when replacement is required. Moreover, there is little knowledge amongst sawmill managers of energy efficient motors. Furthermore, as per variable speed drives, there has been difficulty in finding local suppliers of energy efficient motors.

The IEAC has recommended the installation of more energy efficient motors when motors are due for replacement. Data from energy audits conducted for some timber mills is presented in Table 18. The average simple payback period for the seven sawmills to which this measure was recommended was 16 months.

Table 18: Installation of Energy Efficient Motors

Sawmill Reference	**Energy Savings (kWh/yr)**	**Demand Savings (kVA/yr)**	**Cost Savings ($/yr)**	**Implementation Cost ($)**	**Simple Payback (Months)**
IEAC/003/99	430,757	10,384	33,970	41,035	14
IEAC/004/99	97,083	312	8,163	7,001	11
IEAC 005/99	34,125	108	2,759	3,694	16
IEAC/008/99	42,976	105	3,028	4,119	16
IEAC/006/99	15,036	644	1,237	2,687	26
IEAC/007/99	87,869	172	6,572	9,106	17
IEAC/002/99	455,353	841	29,834	24,242	10
Average					16

4.3.2 Transmission and Drives

Machinery also offers various opportunities for enhanced energy efficiency which are discussed below.

Gearbox Efficiency

Worm gearboxes typically have an efficiency of 85-90% whereas helical gearboxes have an efficiency of about 98 %. Replacing worm gearboxes with helical gearboxes may therefore yield electrical savings but the increased size and cost of helical gearboxes as compared to worm gearboxes must be considered.

Belt Drives

Cogged v-belt drives are about 20 - 30% more energy efficient than standard v-belt drives. They also last 20 – 30% longer and that means that their life cycle costs are the same. Use of cogged v-belts is thus considered as a no-cost venture and savings occur due to increased efficiency.

Table 19: Implementation of Cogged V-Belts

Sawmill Reference	**Energy Savings (kWh/yr)**	**Demand Savings (kVA/yr)**	**Cost Savings ($/yr)**
IEAC/003/99	190,000	379	13,466
IEAC/004/99	47,166	13	3,251
IEAC/005/99	14,690	169	1,109
IEAC/001/99	44,971		805
IEAC/008/99	19,119	41	1,487
IEAC/007/99	54,364	9	3,705

Note: implementation costs reported by IEAC as zero.

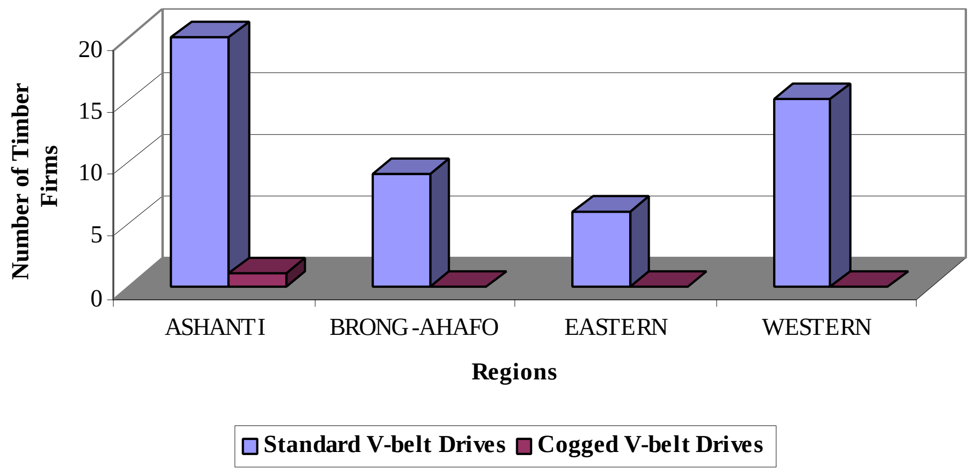

Fig. 6 Power Transmission System Analysis

The cost savings that would be elicited through the implementation of cogged v-belts for six firms are shown in Table 19 below.

Flat belts and wedge belts are also more energy efficient than standard v-belts. Other factors to be considered regarding V belts are: proper sizing of belt drives, proper tensioning of belts, correct pulley alignment, and avoidance of multiple belt drives.

Figure 6 shows the distribution of standard versus cogged V-belts in the four key wood-processing regions of Ghana. The majority of sawmills surveyed, 89% or fifty firms, were found to be using standard v-belt drives as compared to only one firm which was using cogged v-belt drives.

Use of synthetic lubricants

Use of synthetic lubricants, which have a low coefficient of friction, in place of petroleum lubricants reduces friction in the bearings and can decrease motor energy losses by 10-20%. Since synthetic lubricants are also resistant to oxidation they have a longer life than petroleum lubricants. This longer life of synthetic lubricants tends to offset their higher cost, thus there is no implementation cost.

Table 20: Savings from Use of Synthetic Lubricants

Sawmill Reference	Energy Savings (kWh/yr)	Demand Savings (kVA/yr)	Cost Savings ($/yr)
IEAC/003/99	242,228	5,831	19,075
IEAC/004/99	52,513	169	4,416
IEAC/005/99	14,866	56	1,399
IEAC/001/99	77,185	6	3,002
IEAC/007/99	43,055	84	3,220
IEAC/002/99	11,636,696	224	7,661

The potential electricity savings from usage of synthetic lubricants in six timber firms audited by IEAC is shown Table 20.

Interactions with wood processing firms revealed that some know about synthetic lubricants and the benefits they offer, and indeed several had attempted to use them. The sawmills had since given up however, due to the difficulty of sourcing the lubricants on the market. For example, often personnel at fuel stations had not heard of synthetic lubricants.

4.3.3 Other Options

Transport

This section addresses the energy costs associated with extracting trees from the forest and transporting them to the sawmill, and also the transportation of the processed wood from the sawmill to the port. With respect to the former, the GTMO figures – compiled from GTMO members' operational records – indicate a 43% increase over the period 1995 to 1999, from $8.51 to $12.21 per cubic metre of log respectively. Transportation costs (referred to as haulage fees in the GTMO analysis) fluctuated between a low of $6.86 (1999) to a high of $7.76 (1995) per cubic metre of log, remaining relatively stable. Further information on specific costs contained in both categories, and therefore what might be responsible for the increase in transportation costs, were unavailable from GTMO.

During interviews, sawmill managers often complained of increasing fuel costs However, it would be problematic to attribute the 43% increase in transportation costs to fuel prices given that a similar trend was not exhibited in haulage costs, an activity also involving fuel.

Whilst there is little information available on the energy costs associated with transportation, it was observed that most of the extracting equipment and trucks used by sawmills were old, inefficient and not well maintained even by Ghanaian standards. Thus there is significant opportunity for energy efficiency improvement in these areas. Enhanced managerial expertise in the management of transport fleets would also aid efficiency.

Insulation of Steam Pipes

Exposed steam pipes from boilers can be covered with requisite insulation material to reduce heat losses. This venture could have low implementation costs and attractive payback periods as evidenced in Table 21 below.

Table 21: Insulation of Steam Pipes

Sawmill Name	Energy Savings (kWh/yr)	Cost Savings ($/yr)	Implementation Cost ($)	Simple Payback (Months)
IEAC/005/99		1,951	1,111	7
IEAC/001/99	385GJ	1,483	356	3

Repair Air Leaks From Compressor

Leaking compressors are repaired with easily available materials. This would reduce electricity consumption. This option provides attractive simple payback period with moderate implementation cost. In one case that IEAC surveyed, it was going to cost the company (IEAC/001/99) $742 to repair the air leaks from a compressor and the payback was about 9 months. Energy and Demand savings were 64,011 kWh and 1,029 kVA respectively.

Age of Machinery

Most of the equipment in use in sawmills in Ghana is obsolete which causes a lot of inefficiencies in the processing of timber. Most sawmill managers do little about the state of their machinery by way of purchasing new equipment or updating parts with more efficient ones. As per electric motors, machinery and equipment maintenance is not particularly common. Improved machinery and more vigilant maintenance would increase energy efficiency and contribute to reducing electrical costs.

4.3.4 General Remarks

The information presented above indicates that most of the companies are under utilizing electric power. This is because most of the firms use inefficient power-consuming equipment such as v-belt drives instead of the more energy-efficient cogged v-belt drives and mercury vapour lamps (MVL) instead of the more energy-efficient high pressure sodium lamps (HPSL). One half (50%) of the firms are operating below the more acceptable power factor (PF) of 0.9. Whereas 37.5% of the firms are prepared for an energy audit, 8.3% are not.

Nevertheless, it must be pointed out that a small number of sawmills – some two or three firms – are very innovative. In general, innovative activities are undertaken when the owner/managers are people who are inclined towards technological change and continuous improvement. One company in particular offers a very interesting case where hydraulic equipment is being used to replace automated d.c. motor-driven equipment to save more than 50% of electric energy (kVA).

Whilst in general EE practices were not widely practiced, they were more commonly found amongst sawmills in the Ashanti and Western regions. This is likely to be due to the high concentration of timber firms in these areas. For example, EE equipment suppliers or institutions promoting EE would be likely to focus their activities in these areas due to the access to a large number of firms. The high concentration of firms would also facilitate greater information flows between the firms, and perhaps a more keenly felt competitive pressure, as compared to those firms spread across more rural and dispersed locations

4.4 Constraints and Opportunities

4.4.1 Institutions

Energy Support Institutions

There are many energy support institutions in the country that are either governmental or private. A lot of private ESCOs have also emerged offering efficiency services to firms in all sectors of the economy. Some of the key institutions and their functions, as well as the extent to which they have been able to promote energy efficiency in Ghana, are discussed below.

<u>Ministry of Energy</u>

The Ministry of Energy (ME) is the apex body in charge of government policy in the energy sector. It’s origins go back to the early 1980s when the Ministry of Fuel and Power (MFP) was established to deal with the aftermath of the first oil price shock and until the beginning of this year it was the Ministry of Mines and Energy (MOME). For two decades the ME (under MFP and MOME) undertook various programmes to lay the foundations for energy efficiency improvement activities in Ghana.

There was a National Energy Conservation Programme (NECP) in the late 1980s whose objectives included the creation of a higher level of awareness of the opportunities and benefits of energy conservation among all energy users, and the development of an indigenous Ghanaian professional capability for the identification and implementation of energy conservation measures. Some twenty or so Ghanaian professionals were trained in energy auditing techniques and a few of these went on much later to establish energy service companies (ESCOs).
The mid 1990s saw the implementation of an Electricity Demand Management Project (EDMP) as an integral part of a World Bank funded combined cycle gas turbine power project. One of the primary objectives of the EDMP was the promotion of private sector participation in delivering energy management services and many workshops and seminars were held with the view to providing further training for local engineering professionals and consultants on energy auditing techniques, in-plant energy management procedures, etc. The EDMP made it possible to implement a major power factor improvement programme during which most of the capacitor banks mentioned earlier in this chapter were installed. A lease finance facility was established for the purchase of capacitors but this facility was very poorly patronised [Brew-Hammond, 1998]. Most of the potential beneficiaries found the procedure for obtaining the lease finance to be too cumbersome. Another issue was with the interest rates which, though not too different from market rates[19], were considered too high.

More recently, ME has been working through the Energy Foundation (described later in this section) to promote energy efficiency in the sawmilling industry. Energy audits of some of the largest sawmills have been performed by the Industrial Energy Assessment Center (IEAC) whose activities are supervised by the Energy Foundation acting on behalf of ME. The audits carried out by IEAC are paid for by the Energy Foundation using funds obtained from ME.

<u>Energy Commission</u>

The Energy Commission was established by the Energy Commission Act, 1997 (Act 541) with the object of regulating and managing the utilisation of energy resources in Ghana and coordinating policies in relation to them [Section 2 (1)]. Among the specific objectives of the Commission, contained in section 2 (2) of the Act, are the following:

(a) recommend national policies for the development and utilisation of indigenous energy resources;
(b) advise the minister on national policies for the efficient, economical, and safe supply of electricity, natural gas and petroleum products having due regard to the national economy;
(c) prepare, review, and update periodically indicative national plans to ensure that all reasonable energy demands are met;
(d) establish and enforce, in consultation with the Public Utilities Regulatory Commission, standards of performance for public utilities engaged in the transmission, wholesale supply, distribution and sale of electricity and natural gas;

(a) An important provision under the Act (section 41) is the establishment of the Energy Fund which is fed primarily by a proportion of government levy on petroleum products and electricity.[20]

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[19] Interest rates for loans from the banks in Ghana have tended to be in the region of 40 – 50 % over the last few years.
[20] The levy on petroleum products is ¢1/litre while that on electricity is ¢1.70/kWh

Monies generated through the Fund shall be used for various purposes including the following:

(a) promotion of energy efficiency and productive uses of electricity, natural gas and petroleum products;

(b) promotion of projects for the development and utilisation of renewable energy resources, including solar energy; and

(c) human resource development in the energy sector.

Unfortunately, the Energy Commission has done very little by way of directly promoting energy efficiency in Ghana. The priority of the Commission has been placed on the development of regulations for energy companies and resource assessments in renewable energy, particularly wind energy. For all intents and purposes there have been no disbursements from the Energy Fund; there have been differences in the interpretation of the law specifying the use of the fund and this has made it impossible for the Commission to agree on the areas of disbursement.

Public Utilities Regulatory Commission (PURC)

The PURC was also established by an Act of Parliament (Act 538) to regulate and oversee the provision of utility services by public utilities to consumers and to provide for related matters. The specific functions of the PURC, which are listed in Section 3 of the Act, include:

(a) to provide guidelines for rates chargeable for provision of utility services;
(b) to examine and review rates chargeable for the provision of utility services;
(c) to protect the interest of consumers and providers of utility services;
(d) monitor standards of performance for provision of services;
(e) to conduct studies relating to economy and efficiency of public utilities;

The main objective of the PURC up till now has been to rationalise the tariff structure and bring electricity prices from prevailing low levels to much higher levels which will attract private investors into wholesale power production. Upward review of tariffs is also expected to provide a level playing field for the renewable energy and fossil fuels, and also send a strong price signal to consumers to conserve energy. Table 22 shows the tariffs prevailing in December 1998 and March 2001. Generally, the sawmills fall in the Special Load Tariff (SLT) category; smaller sawmills pay the low voltage tariffs and the larger sawmills pay the medium voltage tariffs. Tariff increases are expected to be announced by the PURC within the next few weeks.

Energy Foundation (EF)

The Energy Foundation (EF) is a non-governmental organization established in November 1997 and inaugurated in August 1998. The EF is the brainchild of the Private Enterprise Foundation (PEF)[21]. The then Ministry of Mines and Energy endorsed the idea and collaborated with PEF to establish the EF.

[21] PEF brings together the major energy consumer groups including the Association of Ghana Industries, the Ghana Chamber of Mines, Ghana Chamber of Commerce, Ghana Employers Association, Federation of Associations of Ghanaian Exporters, etc.

Table 22: Electricity Tariffs in Ghana for December 1998 and March 2000

CATEGORY	TARIFF*		
	Cedis/kWh	1998 US cents/kWh	2001 US Cents/kWh
RESIDENTIAL			
0 - 50 (Block Charge)	4,000	166.7	57.1
51 – 150	120	5.0	1.7
151 – 300	150	6.3	2.1
301 – 600	220	9.2	3.1
601+	350	14.6	5.0
NON-RESIDENTIAL			
0 –100	220	9.2	3.1
101 – 500	220	9.2	3.1
501+	320	13.3	4.6
Service Charge/month	5,000	208.3	71.4
SPECIAL LOAD TARIFFS (SLT)			
Low Voltage			
Capacity Charge/kVA	10,000	416.7	142.9
Energy Charge/kWh	180	7.5	2.6
Service Charge/month	20,000	833.3	285.7
Medium Voltage			
Capacity Charge/kVA	10,000	416.7	142.9
Energy Charge/kWh	170	7.1	2.4
Service Charge/month	20,000	833.3	285.7
High Voltage			
Capacity Charge/kVA	10,000	416.7	142.9
Energy Charge/kWh	150	6.3	2.1
Service Charge/month	20,000	833.3	285.7

* Exchange Rate: US$1 = C2400 in December 1998; US$1=C7000 in March 2001

The specific objectives of the EF are to:

- promote sustainable development of energy resources and efficient consumption of energy in all its forms;

- educate consumers through publicity campaigns, educational programs and seminars about the rights and responsibilities of consumers, the benefits of reducing energy waste, and assist residential, commercial and industrial consumers in improving energy efficiency;
- advocate policies that address customer service issues and promote national policies for the sustainable development of energy and adoption of energy-saving technologies;
- strengthen the private sector, to improve economic productivity by developing energy efficiency, renewable energy and productive use of electricity programs and businesses; and
- undertake other energy related research and development activities for itself and on behalf of other entities.

The Energy Foundation has the full backing of the government and the private sector and has been quite instrumental in fostering the right environment for ESCOs. The EF's strategy is to create a machinery that supplies public information and awareness through campaigns using advertisements in the press and other medium of mass communication, as well as educational programs and seminars, to sensitize all categories of energy consumers about the potential benefits associated with energy efficiency and conservation. This strategy is being implemented vigorously through some powerful TV adverts, very active elementary school eco-clubs, colourful calendars, etc. Energy efficiency today is very much on the lips of the general public, thanks in part to the EF's public awareness campaign but it is clear that more will have to be done in order to see significant increases in the actual implementation of energy efficiency measures. Indeed, the EF is addressing this implementation challenge by organizing a series of programmes to build capacity among ESCOs in Ghana. The EF is also carrying out case studies of successful practices and going on to disseminate the information among key stakeholders.

Industrial Energy Assessment Centre (IEAC)

The IEAC was established at the Kwame Nkrumah University of Science and Technology, Kumasi, in the latter half of the 1990s. The main aim of the centre is to train students in energy auditing techniques through classroom teaching and practical sessions to conduct energy audits in industrial establishments which focus on the identification of energy conservation opportunities (ECOs); waste management options and analysis of processes in order to recommend changes for process improvement and increased productivity.

The IEAC has so far, on its own, undertaken energy audits in 10 wood processing facilities[22]. IEAC has also teamed up with another establishment, Centre for Innovation and Enterprise Development, CIED[23] of Kumasi to conduct an energy survey of a rotary veneer-processing mill in Kumasi bringing to 11 the number of timber processing firms audited.

The reception accorded to IEAC trainees by the staff of companies audited has been excellent. The audits include assessments of wastes and their costs, in recognition of the fact

[22] IEAC has conducted energy audits of 18 facilities altogether, the rest being in other industries.
[23] CIED is a registered Energy Service Company with Energy Foundation.

that invariably waste reduction leads to increased profits. The reports for all but four of the facilities audited by IEAC have been completed. The main reason given for the non-completion of the four reports has been inadequate funds to run the center. The audits are carried out at no cost to the companies involved so IEAC is dependent on the support it gets from the ME through the Energy Foundation.

A survey of the audited companies revealed that none of them had implemented the recommendations made by IEAC. IEAC asserts that the reason for many companies not taking up the recommendations is because no implementation agency takes up after the audit is done. The full explanation appears to lie within a mix of institutional and financial barriers which are discussed throughout this section.

IEAC has so far conducted energy audits of 18 facilities altogether, including 11 timber firms mentioned earlier (one of which was audited jointly with CIED). In more than 50% of the cases, the energy audit reports had not been delivered to the companies mainly because IEAC was waiting for an implementing agency to come forward in order to ensure that when the reports were submitted, the recommendations would be implemented. The absence of such an implementing agency (or agencies) constitutes a major bottleneck with respect to achieving the more fundamental objective of realising concrete energy efficiency improvements in firms (including sawmills) and elsewhere throughout the country.

Energy Service Companies (ESCOs)

The general growth of the private sector in the country has had a similar influence on the energy efficiency market. There is in general a growing number of ESCOs resulting mainly from donor funded training of existing and prospective entrepreneurs in the energy efficiency business. An association of Ghana Energy Services Companies (GHAESCO) was launched recently. GHAESCO has a large membership comprising of researchers, EE equipment suppliers and other industrialists who are in general concerned with the environment.

International concern over environmental issues has also been a real boost to EE activities in the country. The prospects and opportunities in this line of business have had the positive impact of getting the country a number of well qualified personnel who could support the energy efficiency needs of various industries in the country as the demand for such services arise.

Prior to the establishment of the IEAC, a study tour was organized for a number of Ghanaian energy efficiency experts in March 1996 to institutions in the USA to acquaint them with the operations of the US DOE Industrial Assessment Program. The study tour enabled the consultants to acquaint themselves with best-practice technologies in America and to develop their management capabilities. Some of these experts together with the dozens of people trained in the 1980s and 90s are involved in the activities of the few energy service companies (ESCOs) indicated in Table 23 below. Some of these ESCOs (like AB Management and Dekon Engineering) have their own financing schemes and others (like CIED) have been working at developing proposals for the establishment of donor-funded mechanisms for financing energy efficiency in Ghana.

Table 23: ESCOs in Ghana

	ESCO	LOCATION	SERVICES RENDERED
1.	AB Management & Agency	Accra	Local agents for Power Economy in the UK.
2.	Asea Brown Boveri (ABB)	”	Supplier of capacitor banks and electrical appliances/equipment
3.	Cartbrandy Ltd.	”	Capacitor supplies.
4.	Dekon Engineering Services	Accra	Electrical engineering and energy management – power factor correction, load management, etc.
5.	Deluxe Services Ltd.	”	Capacitor supplies.
6.	Environment Futures Ltd.	”	Distribution of Powerboss dynamic motor controllers
7.	Intertech. Services Ltd.	”	Boiler efficiency and retrofits, combustion systems, feed water treatment, energy management.
8.	K.E.M Ltd.	”	Electrical engineering and energy management – power factor correction, load management, etc.
9.	Multiplant Ltd.	”	HVAC systems, energy management.
10.	Semeq Gh. Ltd.	”	Steam systems, heat transfer systems, boiler systems, energy management,
11	Centre for Innovation and Enterprise Development	Kumasi	Technological innovation service including brokering of energy efficiency improvement projects
12	Technan Engineering Services	,,	Electrical engineering and energy management – power factor correction, load management, etc.

The experience of CIED is particularly relevant here. CIED struck an alliance with the IEAC with the view to picking up the IEAC's audit reports and arranging with the clients to implement the recommendations contained in the reports. Since CIED already had an on-going relationship with one of the sawmills in Kumasi, an audit was undertaken by a joint CIED-IEAC team. Unfortunately, close to one year after the audit was undertaken, the main recommendation to install capacitor banks has not been implemented. The main reason in this case is that CIED does not have the technical expertise to undertake installation of capacitor banks. Negotiations with various experienced engineers and technicians both in and outside Kumasi simply led nowhere as most found one capacitor not worth their while even though the sawmill in question was prepared to bear the full cost.

4.4.2 Finance

Financial Costs and Benefits of EE Measures

Energy efficiency options identified through energy audits of some timber companies together with a summary of their implementation cost and simple payback periods are presented in Appendices F and G. Typical costs of the total range of options for the companies considered range from about $6,200 to $100,000 and as shown in Table 24 these investments may be classified as Low or Medium Cost.

It is worthy to note that the paybacks for the complete options are quite short mostly within a year and in the case of the longest payback, 21 months. As shown in Table 25, even for the most expensive of the sets of recommendations made in the IEAC reports, the total implementation cost was US$ 100,000 with a payback of 12 months. One would think that a large creditworthy firm should be able to implement such a financially viable project but this project too has not been implemented, pointing to a complex mix of technical and institutional barriers.

Table 24: EE Options in a snapshot

Key EE Options	**Installation Cost**			**Range of Simple Payback (Months)**
	No/Low Cost	Medium Cost	High Cost	
EE Lamps Installation		✓		4 - 23
Skylight Installation		✓		14 - 73
Power factor Correction		✓		1.5 - 41
Switching Off Idle Machinery	✓			Immediate
Energy Efficient Motor		✓		11 - 26
Cogged V-belts Drives	✓			Immediate
Use of Synthetic Lubricants	✓			Immediate
Repair air Leaks	✓			9
Insulation of steam pipes	✓			3 - 7

Table 25: Summary of EE options and Cost Considerations

Company Name	No. of Options Recommended	Total Implementation Cost, $	Average Payback in Months
IEAC/002/99	7	100,613	12
IEAC/003/99	6	16,903	6
IEAC/004/99	6	10,595	9
IEAC/005/99	4	12,457	21
IEAC/006/99	4	9,642	8
IEAC/007/99	5	6,2625	12
IEAC/008/99	3	9,618	9

Sawmill Production Costs and Revenues

The present cost of electricity for sawmills is around 3 US Cents/kWh. The cost of electricity at the time the IEAC surveys were conducted was about 7 US Cents/kWh. From Table 12, therefore, it can be inferred that timber companies are spending between \$0.78 and \$3.8 at present (or \$2.0 and \$9.8/m^3 in 1999) per m3 of wood products. For 1999, Ghana Timber Millers' Organization (GTMO) quotes \$11/m^3, compared US\$ 3 – 4/ m^3 reported by Forestry Commission (DFID Study). The inconsistency is quite significant.

Nevertheless, a detailed analysis of the costs and revenues for wood-processing firms, presented in Appendix H, reveals that the percentage of total costs attributed to electricity by both FC/DFID and GTMO is quite similar. As shown in Figures 7 and 8, electricity (power) constitutes about 2 % in the FC/DFID data set for small sawmills while the GTMO dataset puts this at 3 % for all GTMO members (which includes small, medium and large sawmills as well as veneer and ply mills.) Interestingly, total costs range from 220 \$/m^3 for small sawmills to 440 \$/m^3 for small sliced veneer producers. GTMO's average for all its members is 320 \$/m^3, suggesting that the GTMO figures may not be quite as exaggerated as many would be inclined to think.

The key finding here is that electricity costs constitute a very small percentage of most sawmills' production costs and an even smaller percentage of their revenues. This explains, to quite a large extent, why timber firms have not been very keen on energy efficiency improvement measures. Further tightening up of the forestry policy regime and the expected increases in electricity tariffs, if sustained well into the future, could change the prevailing situation considerably.

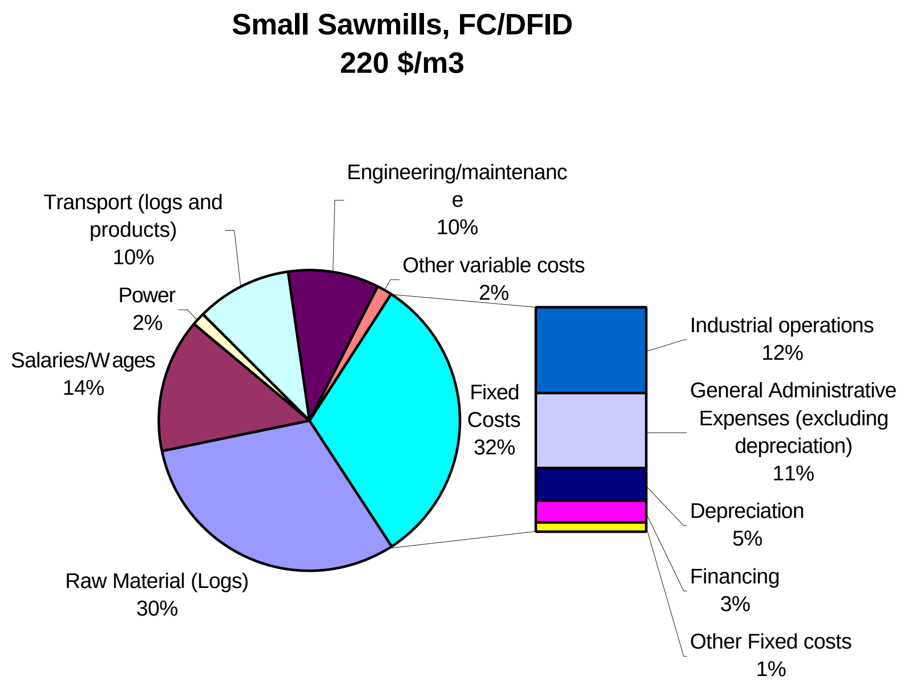

Figure 7: Cost Distribution for Small Sawmills based on Data from Forestry Commission (DFID Study)

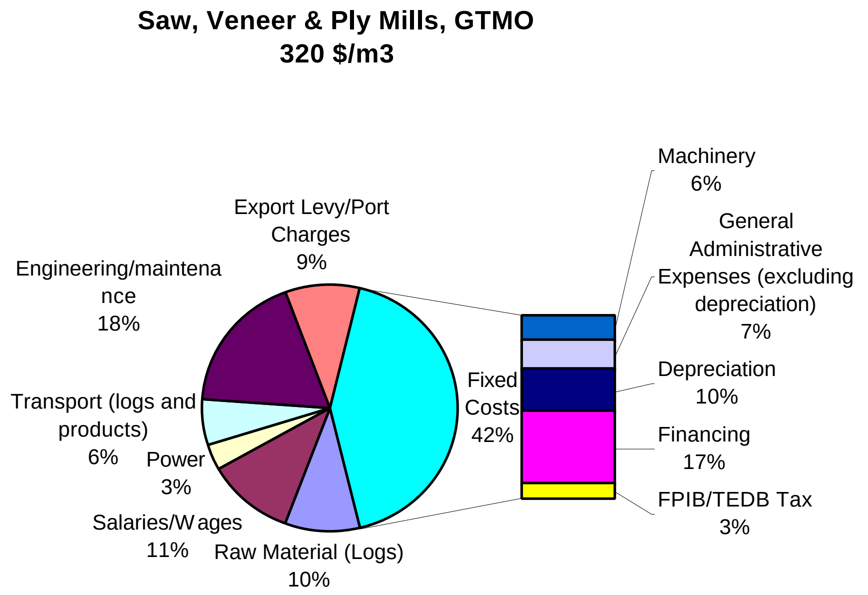

Figure 8: Cost Distribution for Small Sawmills based on Data from Forestry Commission (DFID Study)

4.4.3 Barrier Analysis

Barriers Specific to Particular Technical Measures

<u>Lighting</u>
. Average payback periods for installation of EE lamps were over 13 months, and for skylights about 34 months, in 1999 (see section 4.3.1). The quality of electricity supply was thought to be a barrier at the early stage of introduction of CFLs in the country (Brew-Hammond et. al., 1998). CFLs are now sold widely across the country and it is clear that the initial problems were more due to the quality of lamps than to the quality of electricity supply. The costs of CFLs and other EE lamps (e.g. T8) are still considered high.

<u>Electric Motors</u>
a) Power Factor
Many companies (about 50%) have made a go at power factor improvement through installation of capacitor banks and there have been mixed results. There is normally a general lack of technical and financial capacity within companies to carry out efficiency improvements and where outside capacity is brought in, sustaining the program could be a problem for many firms in the country.

The capacitor bank program shows that even when the rate of return is high, if the total amount of savings in electricity and in financial terms is small in magnitude or small in relation to the total expenditures, it is not attractive to the users. This is almost a "rational" response in that the users have many demands on their time and resources, and even if they are profit maximisers, they must do so within the constraints of time and resources. (Rath2000)

The popularity of capacitor banks, as compared to other electrical energy efficient measures, could be due to the following reasons:

- existence of a surcharge for power factors greater than 0.9, thus drawing attention to the issue;
- increases in electricity tariffs;
- the cost competitiveness of capacitor banks as compared to other energy efficient measures for electricity; and
- lack of knowledge amongst sawmill management of other energy efficient measures for electricity.

b) Switching off Motors
The effect of switching off equipment rapidly is not well known. Some companies assert that switching off too rapidly could lead to damaged equipment.

c) VSDs
There is in general limited exerience and very few suppliers of this equipment nationally.

d) Motor Maintenance, Repair and Replacement
There is little knowledge about EE motors, which are generally unavailable in Ghana, and there is a a preference for repair rather than replacement.

e)Synthetic lubricants
It is difficult to source synthetic lubricants on the local market and sawmills have little knowledge of the opportunities to be derived from using these lubricants. Many oil suppliers contacted have no idea what synthetic lubricants are..

<u>Diesel / Transport</u>
Cost of logs has traditionally been rather on the low side and many companies preferred to buy from commercial loggers rather than going into logging activities themselves. Generally, management of trucks within companies has not been very effective although a handful of companies have very well organized transport sections. Many of the trucks in use in the industry are very run down with poor maintenance schemes. A few barriers to proper management of transport include:

- ♦ Non-Adherence to general laws checking safety and controlling pollution levels of trucks in the country;
- ♦ Low priority attached by company managers to transport in the companies; and
- ♦ Lack of proper assessment of cost of logs (buying from loggers or logging for a company's own consumption).

Barriers at Policy and Macroeconomic Level
There have been many positive development at the level of institutions and programmes for energy efficiency improvement. However there are still a number of areas within the broader energy policy environment in Ghana where several barriers hinder the adoption of energy efficiency measures. The primary barriers at the policy level are:

- Low electricity tariffs;
- Poor co-operation and coordination among some key stakeholders (firms, ESCOs, utilities);
- Lack of codes, standards and guides on EE and EE equipment such that firms generally have very little information and there is no guidance on what to buy.
- Inadequacy of existing framework of financial arrangements to support energy efficiency investments;
- Limited number of suppliers for some specialized EE equipment like Variable Speed Drives and high efficiency motors; and small number and size of local Energy Service Companies.

From a macroeconomic perspective, Ghana's high inflation rates result in high cost of capital. Thus the range of EE options that are financially attractive is smaller than it may otherwise have been. The opportunities available are too small to interest local EE equipment and service providers, leading to a scarcity of well-equipped and experienced ESCOs[24]. The few well-equipped and experienced ESCOs therefore prefer to operate in the capital city (Accra) where there is a relatively larger market and, as much as possible, bundle many projects together in order to reduce transaction costs and attain better returns on their investment.

Barriers at Firm Management Level

There are a number of barriers to the adoption of energy efficient measures that have been found to exist at the management level within firms throughout Ghana. These are:

- Low level of awareness and capacity on the part of plant owners, managers and technical personnel about specific options to improve energy efficiency;
- Lack of sufficient financial incentive when EE investments are considered in terms of their impact on company profit margins;
- inappropriate or complete absence of electricity consumption records;

Barriers Specific to Sawmills

The following barriers were identified throughout the course of this study and are known to specifically (though not exclusively) affect sawmills. Some of these barriers overlap with those mentioned above; and may be summarized as follows:.

- electricity costs represent only a small percentage, of wood processing cost insignificant when compared to other expenses leading to low priority allocated to energy costs and associated energy efficiency by sawmill management;
- sawmill management are reluctant to invest in EE equipment and technologies that are yet to be "proven locally" (many managers actually stated they would only trust innovations that they know to have been successful in other competing mills);
- sawmillers expect high rates of return over short time periods;
- shortage of in-house technical resources to implement efficiency improvement recommendations;
- there is a general lack of knowledge in sawmills, about EE options;
- there is a general unwillingness to give medium term financing to sawmills (banks are usually more rigid when it comes to timber companies because of their traditional inclination to default on loans);
- and
- There is great concern about the security or longevity of the industry and many mill owners complain about the dwindling timber resource.

4.4.4 Key Constraints and Opportunities

A summary of the constraints and opportunities to energy efficiency in the Ghanaian Wood Processing Industry is presented in Table 26. The constraints include low electricity tariffs and inertia in introducing new policy instruments, at the policy level, as well as weak contractual arrangements and uncertainty over the future of the industry, at the institutional

[24] Brew-Hammond et. al., 1998.

level. With respect to opportunities, the growing number of ESCOs and possibility of increase in electricity tariffs during the next couple of weeks will be important for market development. Environment-related funds (like the GEF) and a special energy efficiency trust fund to be established by the Energy Foundation should also provide additional opportunities as far as finance is concerned.

With the PURC and electric utilities in Ghana trying to change the tariff regime to more economic levels, many industrial companies including the wood processing ones who previously enjoyed very low tariffs are envisaged to start investing in equipment that would ensure more efficient use of energy. The electricity generating and distribution utilities have advertised proposed tariff increases of the order of some 300%. These proposals if accepted are expected to have the effect of a surge in the demand for EE equipment as happened during the last upward adjustment in tariffs in the latter half of 1998. Most of the capacitor bank installations were done following the 1998 electricity tariff increases (Brew-Hammond et. al., 1998). Many energy efficiency firms also started to import and sell CFLs around the same time.

The present government has also indicated an intention to index utility tariffs to foreign exchange rates and that would mean the hard currency value of local tariffs should be more stable than it has been in recent years. This indexation is necessary mainly because the bulk of the equipment used in the electricity supply industry is imported. The indexation, if it is realized, would have a positive impact on EE in that companies who earn in foreign currency (like those in the wood processing industry) would have to face the pinch of increases in tariffs over a long time. The demand for EE would thus be sustained as energy cost would be quite significant over a long period of time and there would be responses from individuals and firms by way of efforts to reduce their energy consumption.

Whereas huge profits in timber mills were the situation in earlier years, this regime is fading out rapidly. This trend is partly due to the restructuring exercise in the forest sector in Ghana, which is aimed at making forests sustainable. One result of this has been the increases in the price of raw materials (logs). There is now the need to consider improvements and efficiency practices in wood processing activities. These improvements will be required if companies in the wood sector especially small ones are to remain competitive and survive the policy strengthening process which is aimed at ensuring better utilization of the forest resources. Also, companies are presently not paying the economic prices for the energy that they consume. The upward tariff adjustment in the latter part of 1998 that brought many companies to the realization that they need to use energy more efficiently was been derailed by the depreciation of the local currency. The current proposals to increase tariffs by some 300 % and also index the tariffs to foreign exchange rates, if approved, could cause companies to once again invest in energy efficiency options that have good prospects for reducing their production costs.

Table 26: Summary of Constraint and Opportunities for Energy Efficiency Practices in Timber Companies

Category	Constraints	Opportunities
Market Development	♦ Low market leading to high transaction costs to ESCOs for small firms' EE programmes ♦ Low level of Awareness of EE Options in firms ♦ Demonstration effect: wanting to see EE Option in implemented in another wood firm ♦ Lack of standards and codes ♦ EE not financially attractive enough to firms	♦ Growing number of ESCOs : The driving force has been donor funded training ♦ Possible increase in electricity tariffs ♦ Indexation of exchange rate
Training, Skills and Management	♦ Low/Lack of in-house-skills/knowledge on EE/management ♦ Lack of training for firm level ♦ Poor Records of energy use ♦ ESCO's - lack of capacity to overcome market barriers	♦ More Training now available for potential ESCOs and ESCO staff (Energy Foundation, Industrial Energy Assessment Centre)
Technology	♦ Lack of Availability of some technologies (e.g. Variable Speed Drives)	♦ Emergence of new suppliers (due to general growth of the private sector)
Policy Environment	♦ Low Electricity Tariffs ♦ Inertia in introducing new policy instruments (e.g. lobby for time of day tariffs, tax breaks)	♦ Clean development Mechanisms (CDM) Projects
Finance	♦ Firms tend to expect quick returns (<1 year) ♦ Banks unwilling to provide longer term finance	♦ Environment related funds (GEF) ♦ Energy Foundation is poised to set up an EE fund – revolving/trust fund
Legal & Institution Environment	• Performance Contracting • Weak Contractual arrangements • Lack of co-ordination between utilities – especially distributing companies • Uncertainty over the future of the industry which is a disincentive to investment • Existing EE intermediaries are biased towards large firms	♦ Energy Foundation now has the full backing of the government and the private sector

5.0 ADDING VALUE/MAXIMISING RECOVERY AND RESIDUE UTILISATION

5.1 Introduction

This chapter first presents baseline information on wood recovery rates across the whole spectrum from logging to saw/veneer milling. Various technologies for residues utilisation, adding value and increasing recovery rates are also reviewed. The chapter goes onto discuss the technical measures as well as various financial considerations relating to these activities within the Ghanaian context. The chapter concludes with a presentation on the analysis of constraints and opportunities as they emerged from the sub-sectoral analysis workshop undertaken as part of this study.

5.2 Baseline Data

5.2.1 Recovery Rates

It is estimated that as much as 45-55% of the wood volume of felled tree is left in the forest as residues. Table 27 gives the different types of logging residues and their potential uses. Lumber recovery in the mills is also put at 30-45% of the log input[25,26]. Thus, on average, about 80% (between 75% and just above 85%) of the standing tree in the forest ends up as residues (between the forest and the mill).

Table 28 gives the proportions of the main types of residue emanating from saw milling and the regional distribution of the mill residues. On the whole sawdust amounts to 25.7% of the residues and off-cuts come to 11.6%, whilst slabs and edgings constitute 62.7%.

Residues from the veneer mills include veneer strips and peeler cores and these are estimated at 8 – 20 % of the log volume. Log recovery in veneer mills is usually higher than that in sawmills. Industrialists often quote a conservative figure of 50% of the log input for the former.

5.2.2 Residue Utilization

Currently, big branches and tops of some wood species are extracted from the forest for furniture production. This has been possible through the operations of bush mills.

The sawmill residues with high energy content are mostly used as boiler fuel. Most of the companies also sell some of their residues as firewood to the local townsfolk. In a couple of companies, namely BMK (New Amanful - Takoradi, Western Region) and Novotex (Nkawkaw, Eastern Region) plant residues form the major raw materials for chipboard and particleboard production, respectively. A few companies have only recently begun to use finger jointers to join pieces of wood residue into exportable products.

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25 Okai asserts that the mean value yield of milling 'waste branch wood' of two species (Aningeria robusta and Terminalia ivorensis) is in the region of 20 – 25% as compared to 27 – 32% for conventionally sized logs.

26 The higher lumber recoveries are attainable in companies that have integrated forward into using more advanced equipment like the Finger Jointer.

Table 27: Summary of Types and Potential Uses of Logging Residues

RESIDUE TYPE	VOLUME %	LOCATION	CURRENT USES	POTENTIAL USES
Roots	Not Assessed	Stump site, underground	None, Inaccessible	None in the foreseeable future
Stumps	14.3	Stump site	None	Can be carbonised but usually uneconomic and inconvenient
Butt-end Off-cut	12.7	Stump site and also at primary landing	None	Carving and Sculpture. Charcoal production after size reduction
Defective Longs	Not Assessed	Stump site or at primary landing	Occasionall y for forest bridges	In situ processing into lumber, charcoal production, usually after size reduction.
Crown end Off-cuts And Crown wood	26.9	Close to stump site	Curls	In situ processing into small dimension items like flooring parquets and chips for pulp or chipboard. Also curls
Branch-wood	46.0	Close to Slump site	Little for fuelwood	Chips, small dimension products (e.g. Parquets, Fuelwood and Charcoal.
Twigs (below 10cm diameter)	Not Assessed	Close to Stump site	None	Fuelwood

Source: Nketiah (1992)

Table 28: 1995 Sawmill Residue Generation in m^3, solid wood equivalent (SWE)

Region	Sawdust	Slabs/Edging	Offcut	Total
Ashanti	107,886	264,284	49,280	421,450
Western	42,204	101,662	18,621	162,487
Brong Ahafo	26,148	61,071	17,063	104,284
Central	5,076	13,310	2,653	21,039
Eastern	16,829	43,694	8,630	69,153
Greater Accra	1,720	4,037	718	6,475
TOTAL	200,329	489,369	90,984	780,682
Total, %	25.7	62.7	11.6	100

Source: Authors' estimates based on data from TEDD

Some saw dust and veneer residues are used in firing burners to raise process steam, particularly for kiln drying at the mills (see Box 1). Some residual cores are also hogged for fuelling boilers. Peeler cores of diameters in the neighbourhood of 200 mm and lengths about 2,440 mm are resawn for lumber or used directly as fence posts.

5.2.3 Added Value

Many of the policies in the timber sub-sector have been directed at maximizing the recovery of useful products from wood harvests and to increase the contribution of the sub-sector to the national economy. All these are to be achieved without compromising the sustainability of the resource base. Specifically, as discussed in previous chapters, the policies have been aimed at encouraging increased local processing and adding value to the raw material as much as possible. These policies fall very much in line with the assertion that "Increasing wood scarcity would have the effect of raising the importance of obtaining value-added for wood products, carbonising wood residues efficiently and sawdust briquetting, and thereby raise the returns to these activities" (World Bank, 1988).

In response to these policies and also as a result of the fact that the resource has severely dwindled, some 20–30% of the medium to large-scale companies have started going into down stream processing using internally generated wood residues which were hitherto sold to the small scale carpenters as 'waste'.

A few mills have also emerged going solely into downstream processing and producing profile boards (e.g. T & G), furniture parts, flooring parquets and finger-jointed materials. Increased down stream processing encourages and creates job opportunities and mitigates possible unemployment associated with reduced activities in mainstream processing. As pointed out in Chapter 3 of this report, earnings for most value added products (e.g. curls and furniture parts) have been increasing over the years.

A lot of material that comes out of the wood processing industries as 'waste' finds use in the local and regional market usually as carpentry and construction material or as wood fuel in either the raw or processed forms. Solid waste comprising of off-cuts, edgings, barks, and slabs are the type of waste that are suitable for the uses mentioned as well as for possible down stream processing. Wood processing waste in the form of shavings and sawdust usually have a negative value and their disposal often poses problems for the wood industry. In an effort to minimize the problems caused by these wastes some companies in the country have acquired boilers with furnaces that are fed on sawdust and shavings. Other areas where these kinds of waste could be put to use include particleboard manufacture, briquetting and cogeneration.

5.3 Improving Added Value and Log Recovery

5.3.1 Technical Measures

Specific processes used in adding value, increasing wood recovery and residues utilization include the following:

- optimal log positioning
- kiln drying
- finger jointing
- moulding
- ply milling
- thin blade technology
- circular saw tensioning
- residual cores utilization
- particle board manufacture
- sawdust briquetting
- residues utilization for heat and power

Optimal Log Positioning

Logs come in different shapes and sizes. Orientation of the log on the table has an effect on the magnitude of wastage at the head rig. In more advanced countries this is done by sophisticated equipment to put wastage at the barest minimum. In Ghana placing the log before cutting depends to a large extent on the expertise of the operator of the band saw. Some training on the orientation of the log on the saw table therefore helps to increase waste recovery.

Kiln Drying

This mainly involves the use of either a steam or hot water boiler to produce thermal energy to dry wood products kept in an enclosed chamber. Kiln drying is done to obtain a stronger material which is more resistant to biodegradation. Dried wood also machines better and takes finish better than the wet wood. Drying as indicated earlier, is a necessary step in any serious downstream processing.

Finger Jointing

A finger-jointing machine makes use of and turns into usable/exportable products, short and small pieces of wood that would have been termed and treated as waste in the industry. Where a timber processing company has a finger-jointing machine, lumber of shorter lengths than the required contract specifications are finger-jointed to get them into the contract specifications. Finger-jointing involves jugging, gluing and jointing.

Moulding

Moulding is one of the processes of adding value and making use of pieces of wood that would have been wasted and used otherwise in the wood industry. Log ends from band mills and cross-cutter rejects are resawn into smaller thicknesses by the resaw, prior to being moulded.

This is a very versatile operation in downstream processing. It is used in producing profile boards (e.g. T & G), skirting boards, broomsticks, furniture parts and flooring parquets.

Lumber for moulding is transported to the ripsaws which rip them into smaller thickness. After being bundled and kiln-dried, they are sent to various kinds of moulding machines depending upon the kinds of moulding desired. The boards obtained from this process are then sent to the edger and the crosscutter to be cut and trimmed respectively.

Putting specific designs (moulding) on lumber pieces has become a popular activity in many of the timber companies that have integrated forward into tertiary processes. Smaller versions of moulding machines are also in use in carpentry firms that are integrating further forward and these are usually used to put designs on wooden doors.

Ply milling

This is a product of the veneer mills. As stated earlier, log recovery from veneer production is usually higher than that for producing lumber with industrialists normally quoting a conservative figure of 50% of the log input for veneer milling. Production of plywood, which is usually integrated with veneer production, reduces the waste further by making use of otherwise unusable sliced ends. Sliced ends and other waste that result from the production of veneer are pressed and glued into the middle of two sliced veneer pieces to produce plywood.

In the production of plywood, veneer pieces (which cannot be sold on their own) can be used as feedstock. The bonding of the various plies is such that plywood is much stronger than the component wood. Plywood is used both domestically and internationally.

Thin Blade Technology

Various advancements in the areas of 'bandsaw blades' and 'sawtooth hardening' have led to the development of new sawtooth profiles. This has enabled thinner saw blades to be produced, which result in less waste than conventional blades. Product output has been found to increase by more than 32% in some cases (Krilov, 1988); cutting times are also reduced. As such, this technology saves energy considerably.

Although thin saws have been used successfully in sawmills in numerous industrialised countries, the technology is yet to be adopted in Ghana. Nevertheless, many firms agree that the adoption of thin blade technology would increase recovery rates and thus reduce wastes.

Circular Saw Tensioning

An increase in the operating speed of the circular saw results in higher quality cuts and higher feed rates, both of which are desirable outcomes for all wood processors. However, the circular saw cannot operate beyond a certain speed termed the 'critical speed'. As the circular saw approaches the critical speed, instability occurs and the saw begins to vibrate. This phenomenon is commonly referred to as 'snaking' in sawmills.

Saw tensioning, which takes place in Ghana via hammering and roll tensioning, raises the critical speed at which the circular saw can operate. Accurate tensioning of the saw requires a highly skilled and experienced technician so as to avoid saw breakage and dish instability. Inaccurate saw tensioning also leads to snaking which produces poor quality cuts, reducing the value of the product. More sophisticated and accurate saw tensioning methods are used in industrialised countries, however these have not been introduced in Ghana.

Residual Cores Utilisation

Some of the timber processing companies effectively utilise their wood residue by making use of gang saws which are used by just a few of the companies. The gang saw is a good way of converting residual rolls (or cores) resulting from rotary veneer production, into useful forms. For those rotary veneer producers who do not have such equipment, the residual roles become a huge pile of residue that is not used.

Particle/Chip Board Manufacture

It is possible to convert sawdust and shavings as well as solid residues, after passing these through a chipper/hogger, in particleboard or chipboard. The process consists essentially of the residues, in powdery/flaky form, being bonded and pressed into sheet form. Special equipment is normally required for this.

Sawdust Briquetting

Briquetting is the densification of loose granular material into compact and easily transportable fuel (AFREPREN, 1997). The principal aim of briquetting is to beneficiate the fuel by providing a resultant size that can be readily handled. The technology is an environment-friendly way of dealing with waste and producing useful fuel simultaneously. Sawdust and shavings that are posing environmental problems could get improved calorific values and reduced cost in transport to areas of usage. Although the price of briquettes is higher than that of charcoal and wood, they could be very economical if their development is integrated into waste disposal planning for wood and agro-industries.

Briquetting has not been very popular in Ghana. The project which advanced the most is a 2,200 tonnes/year capacity plant that was established in 1984. The plant, which was in operation for five years, closed down mainly because of management problems.

Residues Utilisation for Heat and Power

A large number of mills are already burning their solid wood residues in boilers to produce heat for their kiln dryers. Increasingly, a good number of mills are beginning to use the sawdust as well. Two case studies of such sawdust utilization in boilers are presented in Boxes 1 and 2. The objective of these case studies is to verify the profitability of investment in sawdust burning boilers as against that of boilers using the more conventional solid waste wood. It is the aim of the case studies to demonstrate that good energy management practices could improve competitiveness and have significant benefits for wood processing companies.

Box 1: Case Study of A Sawdust Burning Boiler at a Saw Mill

Background

Company X, a large wood processing company doing primary and secondary processing of wood into lumber, sliced veneer, rotary veneer as well as moulding (a tertiary product), was chosen for this case study.[27] It is worth noting that only a handful of wood processing companies have been identified to be using boilers fuelled on sawdust. Company X took

[27] For the purposes of the study, the identity of the company under consideration shall not be disclosed and would only be referred to as Company y.

over from an existing company (with another name) that operated from the same premises about a couple of years ago. Basically, the change was at the ownership and management level with some personnel of the old company still working for the new company. The new company bought and uses most of the equipment that was used by the former and in some cases some modifications on some of the old equipment has been done to suit particular processing activities.

Energy Requirement

For drying the products, Company X utilizes 5 boilers, 3 of which use sawdust. These 3 are not sawdust-only boilers and use other types of residues. The boilers were inherited from the previous company and there is no information on the year of installation. Information indicates that some of the boilers in use were originally manufactured to be fueled on coal and were modified for wood use. Information on the total installation cost of individual boilers is also not available.

The other types of waste utilized with sawdust include off cuts and residual rolls from veneer production. The residual rolls are cut up into smaller pieces with a chainsaw or an axe and these used to augment energy provided from sawdust.

The combination boilers (using both solid wood waste and sawdust) are fed by approximately 80% firewood and 20% sawdust in volume terms. Although the plant generates a lot of firewood and sawdust, much of the fuel resources that are utilized by the boilers are brought in from other wood processing companies in the area. It could be approximated that about 80% of all the wood used for drying comes from outside the company. Both sawdust and firewood are brought from outside.

A truckload of waste has an approximate volume $4m^3$ and each boiler utilizes about $60m^3$ solid wood equivalent of waste everyday. The total cost of a truckload of firewood including transportation costs is ten to twelve times that of sawdust.

Technical Problems with Sawdust Boilers

A large volume of sawdust is required as fuel and this means more transportation costs for Company X as opposed to bringing in other waste types. Wood processed in most sawmills is not well treated and the sawdust that results are usually not very efficient for use as fuel for process heat. Sawdust is again usually left to the mercy of rain and the sun and most sawdust used is too wet making it highly inefficient.

One technical hitch with the use of sawdust as fuel in boilers at Company X is that the dust particles block the tubes of the boiler. As charcoal and other soot which are the by-products of firewood settles at the bottom of the furnace, finer soot resulting from burning sawdust flies on the furnace bed and these block the tubes of the boiler constituting serious technical problems.

Conclusion

The information obtained from this plant has not been adequate to conduct a proper financial analysis to investigate the profitability or otherwise of using a sawdust burning boiler as opposed to a firewood burning one. The key technical person –Boiler Engineer- spoken to however iterated that management of the company is planning of adopting all the sawdust boilers to be fuelled on only firewood mainly because of the attendant technical problems with sawdust use.

It is worth noting that the problems associated with the boilers here might be largely due to the fact that the boilers were originally built to be fuelled on coal rather than wood or sawdust for that matter.

Box 2: Case Study of A Sawdust Burning Boiler at a Veneer Mill

Background

Company Y, owned and managed by foreigners (Italians)[28], is a rotary veneer processing company. This company may be termed medium-sized in the Ghanaian context.

Species processed for veneer tend to have poor heating characteristics and the wastes from these are usually of no use to veneer plants as fuel for producing heat. Wood processing companies which are solely into veneer production, have to bring in or buy a lot of residues to meet their high heat demand. Although heat demand in processing veneer is much higher than that required for lumber production in sawmills, recovery rates of the former are ironically very high.

Rationale Behind Investment in Sawdust Burning Boiler

Company Y does only rotary veneer using species that have comparatively low heating characteristics. A lot of the waste that goes through some drying and could have been used for producing heat to meet the process heat demand is processed further into plywood. Recovery rates are in excess of 80% and the only residues that are generated in large quantities are residual cores (residual rolls) that result from the initial peeling of the log. These were hitherto seen as having no heating value and disposal was a problem to management of the firm.

Company Y has to bring in about 90% of the fuel resource needed for producing the heat required for processing the veneer. Waste wood could be quite expensive depending on the type of waste and a tractor load with a volume of 4 m3 sells anywhere between ¢120,000 - ¢800,000 ($17 – 114). Waste wood used for meeting process heat demand is more on the

[28] For the purposes of the case study, the identity of the company under consideration shall not be disclosed and would only be referred to as Company P.

lower side of the scale. Sawdust is in abundance in a lot of sawmills located close to Company Y and there is in general a disposal problem associated with this type of waste.

In the face of rising cost and demand for wood waste from wood processing companies, Company Y decided to purchase a sawdust-burning boiler when it started operations in 1995. The boiler which was a conditioned one from Europe (Italy) was installed in the same year and has been performing well since. The company has invested in another boiler, a brand new one this time (in the last few months) and this is fuelled on both sawdust and firewood. The new boiler was acquired at DM 353,000 ($160,000).

Energy Requirement

For veneer processing, Company Y utilizes two boilers which use sawdust (brought from other companies) together with other waste (veneer waste and residual cores) from the company's own processing. Residual cores from all species milled were not previously utilized due to the general conception of poor heating characteristics. Apart from one species (Ceiba) that has been proven to be not satisfactory[29] for use as fuel, the residual rolls of other species processed for veneer are used in the boiler. These are cut up into smaller pieces with an adapted cutting equipment and used to augment energy provided from sawdust.

The first boiler is fed by approximately 90% sawdust and 10% other wastes in volume terms. The 'other wastes' here comes from the plant's own operations. The second boiler takes more firewood and residual rolls (70% by volume) than sawdust (30% by volume) for meeting the heat demand. All sawdust and more than 80% of the firewood used are brought in from other wood companies in the area.

A truckload of sawdust has an approximate volume of $4m^3$ and the first boiler utilizes about $20m^3$ of sawdust by volume everyday. Sawdust from companies in the area is not sold and the only cost incurred by company Y using this is the transportation and labour costs. Whereas the average total cost for a truckload of sawdust to reach the premises of Company Y is ¢ 10,000, ($2) that of firewood is ¢120,000 ($17). The newer boiler utilizes about one tractor load of sawdust and two tractor loads of firewood daily.

Technical Problems with Sawdust Boilers

Company Y has not had any technical problems with the use of sawdust boilers since it installed one about six years ago. Management has provided suppliers of the sawdust with the type and quality of the sawdust they would purchase and so far the sawdust supplied has been up to standard.

The problem of blockage of boilers tubes by the sawdust particles has not been experienced here. There is in the design a fan that provides high enough velocity to blow away any dust particles that might settle and cause blockage of the tubes.

[29] Company P started burning this specie and ascertained that assertions on their very poor heating characteristics are true. It was also certified that there are some liquid by-products that could be harmful to boilers.

Financial Analysis of using Sawdust as Fuel for Process Heat

This section tries to conduct a financial analysis to investigate the profitability or otherwise of using a sawdust burning boiler as opposed to a firewood burning one. Below is a summary of an analysis done on the cost Company Y incurs annually on using sawdust against that which would have occurred with the use of firewood.

The analysis is done based on Company Y's first boiler.

Two scenarios are presented for the sawdust boiler:

1. Only transportation and labour costs goes into bringing in sawdust (the prevailing situation)
2. A cost element (25% of the cost of firewood) is assumed for sawdust

Scenario 1

COST DESCRIPTION	**COST ($)**	
Sawdust Fuelled Boiler		
Total Cost of a tractor load of sawdust	1.4	
Cost of Sawdust Consumed daily	7.0	
Total Cost of Firewood Consumed annually (300 days of usage assumed)		2,100
Annual Depreciation of Boiler Cost[30]	25,000	
Total Cost incurred in meeting process heat demand	**27,100**	
Firewood Fuelled Boiler		
Total Cost of a tractor load of firewood	17.2	
Cost of Firewood Consumed daily	51.6	
Total Cost of Firewood Consumed annually (300 days of usage assumed)	15,480	
Annual Depreciation of Boiler Cost	17,000	
Total Cost incurred in meeting process heat demand	**32,480**	

Scenario 2

COST DESCRIPTION	**COST ($)**	
Sawdust Fuelled Boiler		
Total Cost of a tractor load of sawdust	4.3	
Cost of Sawdust Consumed daily	17.2	
Total Cost of Firewood Consumed annually (300 days of usage assumed)		5,160
Annual Depreciation of Boiler Cost	25,000	

[30] The boiler was acquired at the cost of $250,000 and is assumed to have a lifetime of 20 years.

Total Cost incurred in meeting process heat demand **30,160**

Firewood Fuelled Boiler

Total Cost of a tractor load of firewood	17.2
Cost of Firewood Consumed daily	51.6
Total Cost of Firewood Consumed annually (300 days of usage assumed)	15,480
Annual Depreciation of Boiler Cost[31]	17,000
Total Cost incurred in meeting process heat demand	**32,480**

Conclusion

The basic financial analysis done here has pointed to the fact that the use of sawdust could mean some financial benefits to management of wood processing companies. Company Y is one of a growing number of companies that have invested in sawdust boilers and this company's experience with this resource has been so positive that they have invested in yet another to meet increased demand in process heat.

Even in the case where some financial value was assumed for sawdust the basic analysis pointed to sawdust boilers providing a cheaper means of meeting the heat demand. The cost of firewood-fuelled boiler was assumed to be the same as that of sawdust burning ones although in actual sense the former is dearer. Technical personnel spoken to were also of the view that sawdust boilers could last as long as or even longer than firewood fuelled ones if proper maintenance is done on the plant.

Cogeneration is the process of producing heat and electricity simultaneously from a single thermodynamic machine which is usually fuelled by biomass or petroleum fuels (oil and gas). One option is where the machine produces steam, which then drives a turbine or steam engine to produce electricity; the machine also produces heat which can be used in various processes like kiln drying. Accordingly, cogeneration has many industrial applications.

This simultaneous production of heat and electricity is also highly efficient. Cogeneration also produces fewer air pollutants than other means of generating electricity, such as coal. Where cogeneration is tied to sustainable forestry or wood lots to generate the needed biomass, it is considered an 'emission neutral' technology. From the electricity generation viewpoint, cogeneration can circumvent the expensive undertaking of grid extension for remote and isolated firms.

In principle, cogeneration is particularly applicable to the case of sawmills. This is because most sawmills in Ghana have steam or hot-water operated kilns for drying their lumber, which are fuelled by their wood residues. Sawmills could thus generate electricity and also use their wood residues more efficiently, resulting in higher quality dried timber (due to the higher quality heat produced). The only caveat is that a large amount of wood residues are generally required.

[31] The lifetime of the boiler using firewood as fuel has been assumed as 15 years

A few sawmills in Ghana have undertaken cogeneration. For example, Samartex Timber & Plywood Products(a large sawmill located in Samreboi, a small town in the Western Region) was burning all its residues in four vintage locomotive-type boilers; this raised 3.5 t/hr of steam at 15 bars and the steam passed through 625 kVA and 437.5 kVA turbo-generators for electricity generation and the plant was also able to meet the all heat requirements of the sawmill. Samartex is still operating its cogeneration plant.

Some sawmills which were using cogeneration stopped doing so soon after they were connected to the national electricity grid. Some however continue to cogenerate. Specialised Timber Products, a large sawmill in Kumasi, undertook cogeneration even though it is connected to the grid. IEAC recommended cogeneration to a large sawmill as part of the energy audit. Their study revealed annual cost savings of $100,069 with an implementation cost of $860,215, giving a simple payback period of 8.6 years (which corresponds to an SROI of 12%). Increasing electricity tariffs and the unreliability of the power supply from the national grid are contributing to make cogeneration a more attractive option.

In 1999 KITE conducted a study on the feasibility of a 250 kW wood waste power plant for MOW, a large wood processing company in Kumasi. KITE has subsequently revised this study to investigate the feasibility of a 3 MW plant in Kumasi. This revised study show that for a cogeneration plant with a 15% efficiency on the electricity generation side, a total of more than 80,000 m3 of wood residues would be required. This amount of wood requirement would have to come from close to 10 sawmills including that from one of the largest in the country (where the proposed plant would be sited).

5.3.2 Financial Aspects

Summary of Technical Measures for Value Addition/Waste Minimisation

An overview of the key technical measures for added value/residue utilisation to maximise recovery and their financial implications is presented in Table 29 below.

Many of the options considered have been found to have relatively short payback period. The prospect of increase in recoveries and better utilization of residues is also very encouraging since this has implications for the financial bottom line as far as practically all sawmills are concerned. The profitability of these identified measures for improvement in value added/waste recovery is very site specific (;each option would be specific to particular wood processing companies and the necessary assessment would have to be made before investment in any of the measures is undertaken.

Table 29: Key Technical Measures for Added Value and Residue Utilisation

Description	**Scope for savings**	**Capital Cost**[32]	**Payback Time**[33]
1. Moulding machine 2. Finger Jointing machine 3. Kiln dryer	These 3 together get approx. 20% extra useful product from log (from STP)	1. $10,000 - $60,000 2. $10,000 - $40,000 3. $	6-12 years
Morticing machine (for furniture, doors, windows)	Mainly for small scale processors – doesn't save wood – saves labour	$ 700 - $ 40,000 depending on the complexity of the equipment	4 – 10 years
Training on better log positioning	2-5%	$100 - $2000	1 – 4 years
Use of appropriate saws (e.g. use of thinner blade saws)	1-5% max.	$1,000 - $2,000	1 – 2 years
Use of Woodmizer (to process branch wood, smaller diameter logs, residues)	Can make use of branch wood, equivalent to about 5-7.5% of log	$1,200 - $13,000	1-3 years
Sawdust burners for kiln dryers	2-3% on waste that could be finger-jointed	$160,000 - $ 400,000	5-8 years
Briquetting and particleboard	10-15% of log ends up as sawdust	For small-scale briquetting machine, $4,000 - $20,000 for 100kg/hr	2 – 7 years

5.4 Constraints And Opportunities

As stated earlier in this report, the prices of raw materials are going up and there is scarcity in the supply of logs. The higher costs of raw materials and the reduced supplies is driving many firms to seriously consider adding value to the products and increase in log recovery. Table 31 presents a summary of the constraints and opportunities for going into added value products and investing in equipment that would increase recovery and make better utilization of residues in the wood processing industry in Ghana.

Constraints to more activities on value added products and recovery maximization include:

- Lack of local technical skills;
- Improper formal strategic planning;

[32] Quotations here are mainly for reconditioned machines on the international market. One primary source has been Electro Motion UK (Export) Ltd.

[33] Payback depends on a lot of other factors such as other machinery and only approximate figures are given here.

- Poor display of business skills;
- Changing policy and institutional environment; and
- Poor electricity supply

Table 31: Summary of Opportunities and Constraints to Increased Added Value, Recovery and Better utilization of residues

Category	**Constraints**	**Opportunities**
Market/ Market development		• Improved economics of tertiary processing and added value • Use of lesser used species (promotions already ongoing) • Increase in local demand for wood products • Mindsets on material recovery are changing
Technology/ Product development	• Lack of local skills and technical back-up • Lack of packaged information on new technologies/ products	• Sawdust burners for kiln drying • Tertiary processing products and technologies • Use of woodmizers
Business Skills	• Lack of formal strategic planning in sawmills	
Policy	• Lack of supply of lumber to local market – affecting local tertiary and micro-sawmills • Changing policy and institutional environment	Generally very favourable – clear goals
Finance	• Related to business skills – bad relationship with banks • For small firms, kiln drying not economic	Some finance available for planting (e.g. PCF)
Operating Environment/ Infrastructure	• Poor electricity supply	

Opportunities identified range from those that arise from global concerns on environmental issues to prospects of using technologies that allow the utilization of wastes hitherto considered to be of no value in the industry. There are mechanisms of the Kyoto protocol which encourage creating carbon sinks through reforestation and afforestation programmes. Investment finance for such programmes could come from international financing schemes such as the Prototype Carbon Fund (PCF) instituted by the World Bank. Encouraging the use of less preferred species and the realization of the economic benefits of value added products are further making positive impacts on this stream of activities.

6.0 PROPOSED INTERVENTIONS

6.1 Introduction

This is the last chapter of the report. It draws on the key issues that have been raised in all the preceding chapters in order to propose interventions for addressing the main problems identified in the timber sub-sector in general, and sawmills in particular. Most of the interventions presented here were generated in the sub- sectoral analysis workshops and special meetings organized for this same purpose.

Interventions at the sub-sectoral level are presented first, followed by interventions for energy efficiency and interventions on added value/ recovery maximization/residues utilization. Some conclusions and recommendations are then made and finally a few ideas are put forward on the perceived gaps, as far as the body of knowledge presented in this report is concerned, and further work needed to address these gaps.

6.2 Interventions at Sub-Sectoral Level

The identification of interventions at the sub-sectoral level was done through an exercise which started with determination of the sources of leverage regarding the Ghana timber sub-sector map and the constraints and opportunities presented in Chapter 3. Suggestions were then made for interventions at points of convergence between sources of leverage on the one hand, and the constraints and opportunities. The sources of leverage for the Ghana timber sub-sector as a whole are listed below.

Nodes:

- Lumber traders
- Log traders
- Bush mills supply to local market

Clusters:
- Small-scale carpenters
- Sawmills (highly clustered geographically, as are the small-scale carpenters)

Policy:
- Chainsaw ban
- Annual allowable cut
- EIAs

The intervention matrix generated from the exercise described above is presented in Appendix I. The proposed interventions, with reference to small scale carpenters and furniture makers as well as small and medium sawmills, may be summarized as follows:

- backward integration to establish bush mills (i.e. need to get TUPs);
- technology development and transfer for using alternative materials/ lesser used species and also for greater residue processing;
- training/ re-skilling to use alternative materials/ lesser used species;
- empowerment and advocacy by donors, NGO's, etc;
- incentives for plantation development;
- group financing schemes and exploration of opportunities for group purchase of diesel gensets – and/or better transformers – for independant generation.

One intervention clearly identified was the need to get a system in place so that the local market is not stifled of lumber. At present sawmills are not inclined to supply the local market as exports earn them much more. The ban on chain sawn lumber if strictly enforced would mean that there would be limited lumber on the local market. TUPs granted to bushmills should thus be streamlined to make sure the local market has its fair supply of lumber.

Other interventions identified include:

- Requirement in TUC for replanting at replacement rate;
- General policy of encouraging plantation development – e.g. teak, eucalyptus (exotics), as well as indigenous species . mixed plantations are favoured; and
- Stimulating service providers to identify spare kiln drying capacity in larger firms and linking up with smaller firms to use the spare capacity.

6.3 Interventions for Energy Efficiency

Identification of interventions for energy efficiency was done through an exercise similar to the one described above for the sub-sector as a whole. In this case a problem tree, presented in Figure 9, was developed and used to bring out the key interventions.

The interventions listed in order of priority are:

1. Lobby and raise awareness of benefits of EE to policy makers (this is to be achieved indirectly through advocating economic levels in electricity tariffs and lobbying for greater attention to forests as well as environmental issues);

2a. Do case studies, training and awareness raising, and project development, using existing intermediaries (e.g. Energy Foundation);

2b. Advocate for a pilot project on performance contracting for low cost EE improvement for small sawmills (e.g. Power Factor Correction, Lighting);

3a. Assess the possibility of establishing a special fund for small sawmills;

3b. Consider pilot projects for EE options that have not been practiced in Ghana (e.g. VSDs, EE motors, cogged V-belts, synthetic lubricants, cogeneration); and

4. Support the establishment of an intermediary organization for EE in small firms or work with existing intermediaries or ESCOs to target small firms.

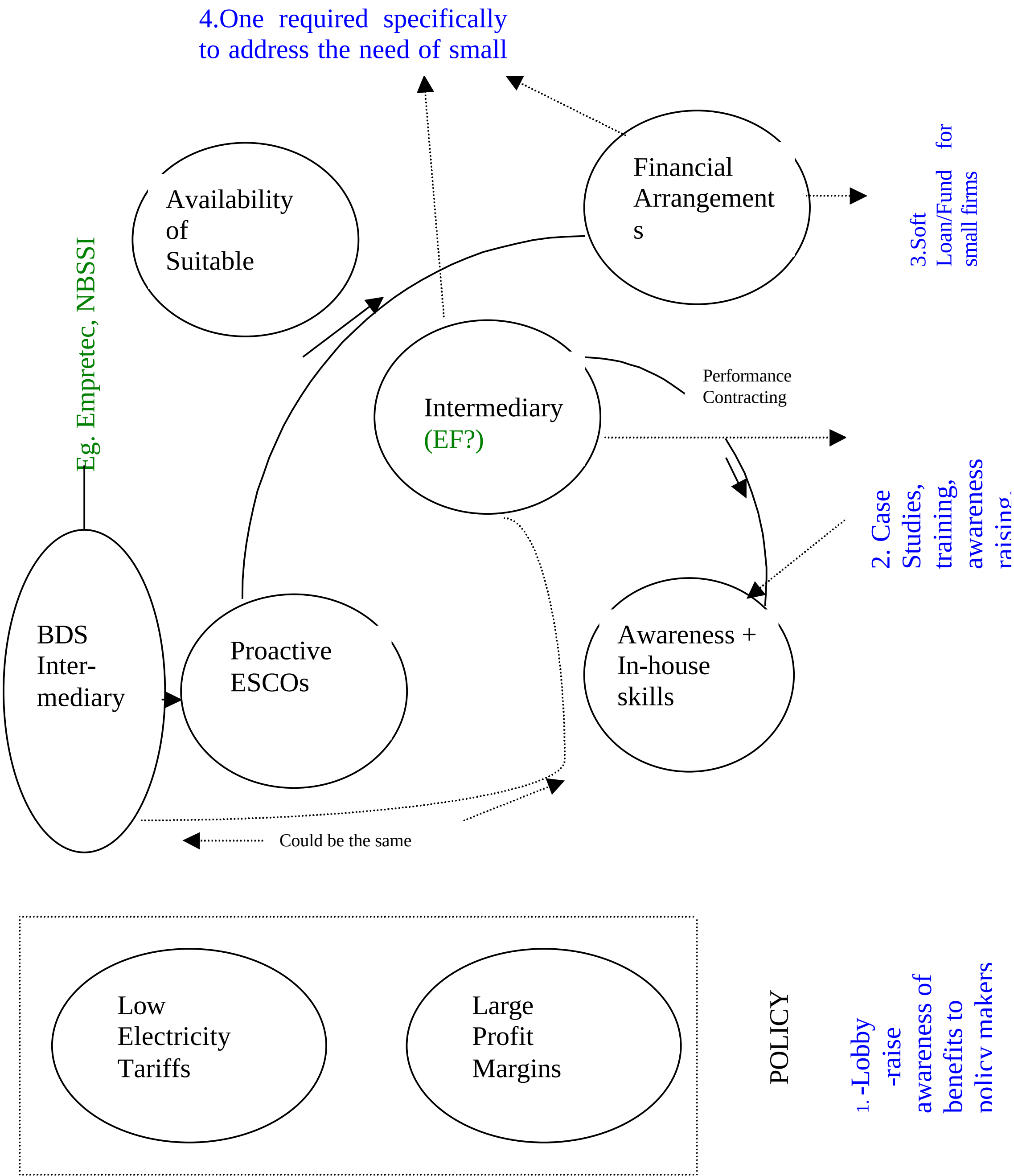

Figure 9: Problem Tree Used to Identify Interventions on Energy Efficiency

6.4 Added value, Recovery Maximization and Residue Utilisation

A summary of the interventions identified for increased added value products and waste minimization efforts is summarized in Table 30. A key intervention identified would be to improve dissemination of information and knowledge relating to new added value technologies, and information on TUCs and TUPs.

Training of trainers at some of the industry's training institutions could help improve the skills of technical and management personnel of the wood processing companies. An intervention here would be to identify possible ways of getting the trainers at the few information centers of the industry better equipped with knowledge on international best practice. Also, local wood entrepreneurs lack proper business skills and well designed training in strategic planning offered by institutions like WITC could be an intervention to see better practices in the industry.

Value addition/recovery maximisation and waste utilization could get a boost if more case studies of such activities (local and international experiences) are prepared and shared with entrepreneurs.

Table 30: Proposed Interventions for increased added value/ recovery maximisation/ residue utilisation

Category	**Proposed Intervention**
Technology/Product development	• Training of trainers – WITC; • Better dissemination of information • TIDD/WITC – more case studies of best practice, plus seminars on TUCs/TUPs
Business Skills	Training in business skills/ strategic planning – do this through WITC
Policy	Streamline TUP's for bushmills/ local market suppliers
Finance	Stimulate service providers to identify spare kiln drying capacity in larger firms and link up with smaller firms who don't have facility
Operating Environment/ Infrastructure	Co-generation for a cluster of small firms

Considering the flow of waste in the industry, another intervention would be to make good use of branch wood that is usually left in the forest to rot. Experience from sawmilling activities in the country reveal that around 50% of the tree volume is left in the forest in the form of branches and stumps. The diameters of a lot of the branch wood that is not milled at present are comparable to those of useful and whole logs milled in other less endowed countries. Use of less expensive equipment like woodmizers, which are currently employed to mill small diameter logs like teak could be employed and the recovery of felled log increased significantly. Also, residual rolls from rotary veneer companies must be collected and either sent or sold (if possible) to gang-saw-using mills as an additional income-generating venture for these companies.

6.5 Conclusions and Recommendations

One of the main achievements of this study has been the development of a sub-sector map for the wood-processing industry in Ghana. The map helps to focus attention on problem areas within the industry, particularly the squeeze on lumber supplies to the small-scale carpenters and furniture makers. The map also helps to reveal some of the gaps in information, as far as the structure and resource flows in the industry are concerned, and it highlights the critical role that bush mills are playing now to ease problems of log supply to the local market. As a policy tool, therefore, the timber sub-sector map developed in this project will need to be diffused as widely as possible and any effort to fill in the knowledge gaps thrown up by the map will be in the right direction.

Although there exists a broad scope to improve energy efficiency in the timber industry, activity in this area has rather been on the low side. Many sawmills (about 50% of those located in the cities) have made a go at power factor improvement through installation of capacitor banks but very little has happened with respect to other energy efficiency improvement options. This situation could be primarily attributed to large profit margins of milling operations in the country until recently. The changing policy regime (stumpage fees, export levies, etc.) and external issues like rising energy (fuel and power) costs are reversing this situation rapidly.

There is normally a general lack of technical and financial capacity within companies to carry out efficiency improvements. Other barriers to more energy and process efficiency-improvement activity in the sector have been identified to include lack of proper assessment to invest in improved and emerging technologies at the firm level and the high rate of returns that entrepreneurs, especially those in the timber industry, expect from investments. Experience in Ghana shows that serious efforts will be made at addressing these barriers only when entrepreneurs begin to feel the pinch. As far as energy efficiency is concerned, therefore, a top priority intervention proposed in this study is for NGOs like KITE and Energy Foundation to lobby and raise awareness of the benefits of EE with particular regard to policy makers. An indirect way of implementing this intervention would be to advocate economic levels in electricity tariffs and lobby for greater attention to forest as well as environmental issues.

In the case of maximising recovery rates and residue utilization/ value added, the current trend is for mills to go into downstream processing and a few have even been set solely for the production of profile boards (e.g. T & G), furniture parts, flooring parquets, etc. The main constraints here are the lack of local technical skills and knowledge as well as the rather unstable policy and institutional environment which increases the risk of new investments in the sub-sector. A key intervention identified here would be to improve dissemination of information and knowledge relating to new added value technologies, and information on TUCs and TUPs.

6.6 Gaps/Further Work Needed

As indicated above, one of the major problem areas within the industry at the moment is the squeeze on lumber supplies to the small scale carpenters and furniture makers. The squeeze is a result of the dwindling resource base which has led policy makers to tighten the regulations for timber harvesting and marketing. A controversial regulation in the whole policy framework is the ban on chain sawn lumber whose effects appear to be biased against the small scale enterprises. Furthermore, it is unclear whether the ban is achieving the primary purpose for which it was imposed, namely the reduction in timber harvesting from the forest in order to achieve the annual allowable cut. Further research in this area would therefore be needed to identify clearly the impacts of the ban and investigate the efficacy of alternative policy instruments. Further research on the **resource flows within the industry** would also be needed to address the knowledge gap associated with the timber sub-sector map developed in this study. Some refinement in the **quantitative aspects of the map** will be necessary and this would provide a solid platform for more innovative policy interventions in future.

The whole trend towards greater value-added processing/residue utilization in the sawmills and specialized tertiary product manufacturers will require attention. There is some evidence of firms going into value added as a result of recent policies in the timber sub-sector aimed at maximizing the contribution of the sub-sector to the national economy. However, this evidence is mostly anecdotal. A detailed study of this new trend (i.e. value addition) will therefore be necessary.

In particular, major gaps exist in the knowledge base in relation to the **actual revenues and expenditures within the industry**, and the **costs and benefits of value added/maximizing recovery and residue utilization options** within this economy. It had been hoped within this study that some relevant data would have been collected and analysed but doing so proved to be more difficult than had been anticipated. Fortunately, another study funded by the UK Department for International Development (DFID) is addressing this issue through the development of an econometric simulation model for the timber industry. The findings of this study will constitute an important step in addressing this knowledge gap and it may still be necessary to undertake a follow-up study whose methodological aspects are carefully designed to ensure that the relevant data is obtained.

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Appendix A: Sawmilling Technology and Environmental Impact

Sawmilling Technology

There are four major processes involved in the processing of lumber: log break-down, trimming, ripping, and drying. At the first stage, the logs are brought to the log yard where they are cut up to 'preferred lengths' using chain saws before being debarked usually by use of an axe. Next, they are lifted by overhead cranes to a band mill to be cut into desired or contract sizes. The logs are cut to the required widths by the edger before being transported to the cross-cutter which trims them into the required lengths of finished lumber. The lumber is either air-dried or kiln-dried depending on contract specification before packaging.

During log breakdown, the round logs are converted into boards, planks, or boules using the band mill. The band mill normally has solid teeth which are only on one side of the saw. The logs are held in carriages which run on double tracks, almost parallel to the plane of the saw blade. Slabs or boards are removed when the logs pass through the saw (Agyeman, 1998).

During ripping, any bark or rough edges are removed from the lumber. Ripping involves dimensioning of the plank or board to a desired width. Where ripping is done carefully, higher-grade lumber and also greater quantities of lumber can be obtained (Panshin et. al.1962).

Three basic operations carried out during trimming are squaring the ends of the board, cutting to desired lengths as well as defects removal. The trimmer is used for the trimming operation and varies in complexity and size.

Drying of the lumber product is carried out in the dryer. Dryers are normally hot-water operated, steam-operated or solar kilns. Drying is also done in the open air. Hot water or steam – operated kiln dryers are supplied with hot water or steam from a boiler which is normally fueled by wood residue. These hot water or steam-operated kilns are commonly used in Ghana, in conjunction with air drying. However, other methods of drying exist, such as: chemical seasoning, vapour drying, dehumidification, vacuum drying, solvent drying (Oppong, 1997).

The various processes described usually result in the production of wood residues; these residues are classified as either 'solids' or 'fines'. Solids consist of bark, slabs, edgings/trimmings, off-cuts, veneer wastes and cores; fines are sawdust, planes, shavings and sander dust. Most sawmills use some of their residue to fire their boilers for kiln-drying purposes, depending on the heating value of the residue. The remainder of the waste may be subject to downstream processing by the same firm, sold locally, or discarded. What happens to the wastes generated in the sawmilling process will be explored in more detail in Chapter 5.0.

The main machinery used in sawmills in Ghana is as follows:

Machinery	**Function**
Bandsaw	Cuts the logs into the desired size
Resaw	Saw the output of the bandsaw to contract size.
Edger	Cuts logs to required widths.
Cross-cutter	Cuts logs into desired lengths.
Kiln-dryer	Dries the lumber.
Peeler	Peels round log into sheets.
Press (automatic or manually operated)	Compresses wood residue between two other wood surfaces to required thickness such as in the case of producing plywood.
Clipper	Similar to a trimming machine.
Finger-jointer	Joins otherwise small pieces of wood together to get them to contract lengths.
Extraction unit	Extracts the sawdust from the plant.
Trimmer	Squaring the ends of the board, cutting to desired lengths, defects removal.
Overhead crane	Lifting and moving the logs.
Moulding Machine	A machine used to put designs on wood.

Environmental Impact

Main sources of environmental concerns in the timber industries are sawdust and dumpsites, smoke, dust and noise.

Noise

Sawmill operations often result in generation of a lot of noise, especially in the night and people in residential areas very close to sawmills have been known to complain to local law-enforcement authorities.

Sawdust and dumpsites

The Environmental Protection Agency (EPA) has been trying to solve the sawdust disposal problem by liaising with manufactures of chipboards who use the sawdust as their main raw material. In this direction, tertiary wood processing industries like the furniture manufacturers in the Ashanti Region are being moved to the wood village at Sokoban. The purpose of the re-location is to group the residues produced by these companies at one place for use by chipboard or briquette manufacturers. It is also envisaged that a kiln-drying company would be set up at the wood village to make use of the wood residues like off-cuts, trimmings, sawdust, etc. in firing the boilers.

Timber processing industries have not been given a clearly demarcated site for residues disposal. For this reason, the sawmills use their own dumpsites. However, EPA expects that:-

- The dumpsites should not be near building facilities or any other structures or installation (e.g. Electricity supply lines, phone lines and water pipelines. Also, waste dumps must be far away from rivers, lakes or any water body so as not to contaminate these sources of water.
- Timber companies engage in controlled burning and for this reason from EPA's inspections it is expected that timber industries would be advised to use incinerators.
- The dumpsites should not be near to drains. Even though waste dumps are waste disposal purposes, they must be kept very neat

Smoke and Dust

It is expected of timber industries to erect high enough chimneys so that smoke would rise very high into the atmosphere without polluting the immediate environment. Unfortunately, some companies have faulty chimneys so that other nearby manufacturing companies are polluted. The smoke produced also leads to reduced visibility that in turn causes accidents or makes plants to use electricity during the day thus incurring avoidable electrical energy costs.

Also, in transporting residues to disposal sites or dumpsites the trucks are not well covered and the wind blows the residues along the streets causing a nuisance to the public.

Appendix B: Timber products and their export destinations

	Product Manufactured	Export Destination
1	Lumber (kiln-dried)	U.S.A., Germany, France, U.K., Belgium, Hong Kong, Holland, Spain, South Africa, Saudi Arabia, Japan, Denmark, China, India, Lebanon, Australia and Israel.
2	Lumber (Air-dried)	Same as Above
3	Sliced veneer	Western Europe, U.S.A., South Africa, Egypt, Japan, Sweden, Malaysia, Lebanon, Venezuela, Denmark, Hong Kong, Norway, Peru and Portugal.
4	Rotary veneer	Western Europe, U.S.A., South Africa, Egypt, Syria, Malaysia, Lebanon, Venezuela, Denmark, Hong Kong, Norway, Peru, Portugal and Senegal.
5	Plywood	Western Europe, U.S.A., Australia, Senegal, Gambia, Liberia, Israel, Benin and Canary Islands.
6	Processed Lumber (Moulding)	Western Europe, Japan, Israel, Taiwan, Australia, South Africa, U.S.A., Finland, Lebanon and Taiwan.
7	Boules (Air-dried)	Germany, France, Italy, Holland, U.S.A. and Senegal
8	Boules (Kiln-dried)	Germany, Italy, Ireland and U.K.
9	Furniture parts	U.K., Italy, Denmark, Spain, Germany, Cyprus, Ireland and South Africa.
10	Curls veneer	France and Germany
11	Flooring parquets	Italy, France, U.K., Germany and Hong Kong.
12	Poles	Togo
13	Lumber (overland)	Togo, Burkina Faso, Niger, Mali and Gambia
14	Profile boards	Italy and Ireland
15	Layons (jointed veneer)	Australia, U.K., U.S.A., Germany and Belgium
16	Dowels	Malaysia, Italy, Norway, Spain, Germany, Holland, U.K. and France.
17	Broomsticks	Germany and Denmark.

Source: FPID Export Reports for August 1999.

Appendix C: Wood Flow Calculations

Demand

Estimating Total Wood Demand

a.	Local Demand		
		Estimated Housing Delivery	30,000 units
		Timber Content per Unit	46 m^3
	\	Total Timber in Housing	1,380 mil m^3
	Add 10% for other wood products, e.g. Furniture and construction, offices and schools		138,000m^3
	\ Total local wood Demand		1,518mil m^3
b.	Export Demand (For 1999)		433,100m^3
	Hence Total Wood Demand		1,951 mil m^3

Assuming an overall average
Conversion factor (recovery rate) of 60%

The total Wood Demand of Log volume 3.25mil m^3

Wood Supplies

a.	log Production by legal (licensed) loggers	1.102mil m^3
	Hence estimated production by illegal Producers	2.15mil m^3

WOOD FLOWS

a.	Production by licensed loggers	1.102mil m^3
	Equiv. Log Volume for Export Processing	918.510 m^3
c.	Overall Recovery Rate	47%
d.	Legal logs processed for local markets (mainly by Bush Mills)	183.490m^3
e.	Illegal logs processed for the local market	2.15mil m^3
f.	Hence total logs processed for local Mkt	2.33 mil m^3
g.	Export Market (Boules and Lumber)	271,758m^3
h.	Residues from Mills:	
	Sawdust (15% of 918,510)	137,777m^3

	(Useful Export products)	433,100m^3
	∴ Solid Residues (= 0.85 x 918510 – 433,100)	347,633m^3
	Residue available for reprocessing by Small Scale Carpenters (estimated to be 60% of Solid residues)	208,580m^3
i.	Local Construction	1,380,000m^3
j.	Local Furniture & Other Products	138,000m^3

Appendix D: Stumpage Fees (Effective February 1st 1999)

Scientific Name	Trade/Local Name	Stumpage Fee (¢/cubic metres)
High Demand		
Aningeria	Asanfina	73,500.00
Entandophragma utile	Efuobrodedwo/Utile	93,100.00
Entandophragma candollei	Omu/Candollie	66,640.00
Guibourtia ehie	Hyeduanini	40,180.00
Khaya spp.	Dubin/Mahogany	68,600.00
Milicia excelsa/regia	Odum/Iroko	58,800.00
Nauclea diderrichii	Kusia/Opepe	49,000.00
Tieghemella heckelii	Baku/Makore	78,400.00
Entandophragma cylindricum	Penkwa/Sapele	72,912.00
Lovoa trichiloides	African Walnut	57,820.00
Pericopsis elata	Kokrodua	117,600.00
Moderate Demand		
Afzelia	Papao	41,160.00
Albizzia ferruginea	Awiemfosamina/Okro	19,600.00
Antrocaryon micraster	Aprokuma	19,600.00
Canarium	Bediwenua	19,600.00
Ceiba pentandra	Onyina	19,110.00
Chrysophlleum albidum	Akasa	36,750.00
Daniella spp.	Shedua	20,090.00
Dist. Benthamianus	Bonsamdua/Anyan	25,235.00
Entandophragma angolense	Ediam	26,950.00
Guarea spp.	Kwabohoro	29,400.00
Heritiera utilis	Nyankom/Niangon	41,160.00
Lophira alata	Kaku/Ekki	26,950.00
Mansonia altissima	Oprono	39,200.00
Pterygota macrocarpa	Kyere/Koto	34,300.00
Rhodognaphalon	Onyinakoben/Bombax	14,700.00
Terminalia ivorensis	Emire	33,320.00
Terminalia superba	Ofram	24,500.00
Trplochiton sceroxylon	Wawa	19,600.00
Turreanthus africanus	Apapaye/Avodire	32,732.00
Low Demand		
Celtis spp.	Esa	13,475.00
Neosogordonia papaverifera	Danta	14,700.00
Pycnanths angolensis	Otie	11,025.00
Erythronphleum guineese	Potrodum	11,025.00
Cylicodiscus gabonensis	Denya	13,475.00
Sterculia rhinopetala	Wawabima	11,025.00
Morus mesozygis	Wonton	7,350.00
Antiaris africana	Chenchen	9,800.00

Piptadeniastrum africanum	Dahoma	11,025.00
Other species		7,350.00

Source: Timber Resource Management Regulation – LI 1649

Appendix E: Output of timber products for 1996 - 1999

Type of Product	1996 Volume Export (m3)	1996 Export Value (US$)	1997 Volume Export (m3)	1997 Export Value (US$)	1998 Volume Export (m3)	1998 Export Value (US$)	1999 Volume Export (m3)	1999 Export Value (US$)
Lumber (Air-dried)	140,297.36	48,897,593.21	142,391.55	51,947,719.63	118,622.91	44,584,731.07	117,137.28	42,548,315.93
Lumber (Kiln-Dried)	84,918.66	30,289,972.45	127,398.47	41,804,825.28	129,244.85	45,898,530.20	124,239.85	45,870,170.30
Sliced veneer	27,881.51	24,853,552	30,861.86	26,072,798.89	33,932.50	30,295,503.96	33,197.52	29,589,600.99
Boules	35,771.98	10,513,468.13	47,456.86	12,936,842.03	42,023.11	11,164,800.94	30,382.40	12,790,265.68
Rotary veneer	25,524.47	7,420,540.04	34,458.05	9,866,085.87	49,286.41	14,251,383.48	67,367.53	18,535,912.34
Furniture parts	1,471.60	3,036,601.04	3,015.48	6,533,896.36	3,425.05	7,736,323.56	2,719.88	7,143,809.87
Moulding	9,609.50	5,547,642.50	12,983.92	6,193,652.28	14,663.93	6,457,765.10	17,225.49	7,631,459.22
Poles	1,086.93	749,037.19	391.16	308,571.00	912.714	719,999.00	1,297.66	850,338.96
Plywood	18,887.95	7,256,191.13	25,549.80	9,040,322.41	11,663.11	3,917,739.12	25,001.63	7,495,247.21
Flooring	3,413.09	2,891,263.23	3,607.77	2,438,258.46	3,006.64	2,139,371.39	2,097.85	1,779,062.37
Profile boards	178.29	133,827.27	936.51	523,733.44	1,220.00	740,277.18	1,884.16	1,171,830.85
Lumber (overland)	13,387.15	1,144,050.45	9,326.34	828,273.02	4,800.59	433,112.85	8,526.14	915,735.66
Dowels	1,227.32	777,514.98	1,260.57	773,644.22	1,743.45	1,079,694.17	1,100.15	628,000.15
Curls	186.24	214,487.94	140.25	162,497.24	404.161	994,996.01	251.65	360,597.50
Doors	0	-	192.26	93,333.86	128.846	85,010.22	16.11	15,705.00
Sleepers	192.22	54,704.84	1,113.48	259,071.89	-	-	58.38	16,200.00
Broomsticks	232.23	120,326.73	268.92	122,036.44	331.901	170,157.25	263.06	126,523.29
Blackboards	184.43	37,288.34	189.03	35,856.77	-	-	-	

Layons	0	-	535.94	581,286.68	290.594	327,469.82	280.12	309,030.00
TOTALS	364,450.93	143,938,061.77	442,078.22	170,522,705.78	415,700.75	170,996,865.32	433,046.85	177,777,805.32

Appendix F: Results from Energy Efficiency Survey

REGION	Total No. of Companies	No. of Companies Served with Questionnaire	No. of Companies responding	Companies using boilers	Electric motors	Standard v-belt drives	Cogged v-belt drives	Incandescent lights	Fluorescent lights	Mercury vapour lamps	High pressure sodium lamps	Skylights	Other kinds of lights	PF>0.9	PF<0.9	Capacitor bank exists	Capacitor bank does not exist	Prepared for energy audit	Not prepared for energy audit	Previous energy audit done	No previous energy audit done	Number of employees	steam dryers	kiln dryers
ASHANTI	85	30	24	19	24	20	1	5	20	20	4	3	0	10	12	13	9	8	2	12	8	20,236	6	11
BRONG-AHAFO	15	11	9	2	9	9	0	2	7	6	0	0	2	1[a]	0	1	8	9	0	0	9	1,810	2	0
EASTERN	18	11	8	2	6	6	0	0	5	3	0	1	0	1	5	3	3	6	0	0	6	1,946	1	6
WESTERN	24	19	15	13	15	15	0	0	15	14	1	4	0	7[b]	6	10	3	12	0	4	9	6,667	3	12
OTHERS	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-
TOTALS	154	71	56	36	54	50	1	7	47	43	5	8	2	19	23	27	53	35	2	16	32	30,659	12	29

[a] All the companies here use the Low Voltage Tariff structure of the Northern Electricity Department (NED) of the Volta River Authority (VRA) which has no PF readings

[b] 2 companies here use the non-residential tariff structure of the Electricity Company of Ghana (ECG) which has no PF readings

Appendix G: Summary of Energy Audit Results for Some Timber Firms

Sawmill Name, Date of Survey	Assessment Recommendations	Implementation Cost & Payback in Months
1. IEAC/002/99	Correct Power Factor Install Energy Efficient Motors Install Skylights Install Energy Efficient Lamps Use Synthetic Lubricants	$ 30,480 25 months $ 24,242 10 months $ 3,204 16 months $ 4,699 7 months - Immediate
2. IEAC/002/99	Correct Power Factor Install Energy Efficient Lamps Install Skylights Turn off lights at Production area during breaks and Lunch Install Energy Efficient Motors Use Cogged V - Belts Use Synthetic Lubricants	$ 18,480 13 months $ 20,186 23 months $ 20,912 32 months Immediate $ 41,035 14 months Immediate Immediate
3. IEAC/006/99	Correct Power Factor Use Energy Efficient Motors Install Energy Efficient Lamps Stop emptying compressor receiver	$ 4,242 16 months $ 5,483 26 months $ 2,687 28 months $ 45 2 months
4. IEAC/004/99, 10/2/99	Correct Power Factor Use Energy Efficient Motors Install Energy Efficient Lamps Use Cogged V - Belts Install Skylights Use Synthetic Lubricants	$ 8,365 7 months $ 7,000 11 months $ 870 7 months Immediate $ 667 14 months Immediate
5. IEAC/008/99, 5/2/99	Correct Power Factor Use Energy Efficient Motors Use Cogged V - Belts	$ 5,499 8 months $ 4,119 16 months Immediate
6. IEAC/005/99, 14/5/99	Correct Power Factor Insulate Steam Pipes Use Energy Efficient Motors	$ 4,664 8 months $ 1,111 7 months $ 3,694 16 months

	Use Cogged V – Belts Use Synthetic Lubricants Install Energy Efficient Lamps	 Immediate Immediate $ 1,125 14 months
7. IEAC/007/99, 8/2/99	Install Energy Efficient Lamps Use Energy Efficient Motors Install Cogged V – Belts Use Synthetic Lubricants	$ 536 4 months $ 9106 17 months Immediate Immediate
8[34]. CIED/IEAC/00, 15/2/2000	Correct Power Factor Install Energy Efficient Lamps Use Energy Efficient Motors	$ 7,568 11 months $ 1,709 17 months $5,793 22 months

Source: IEAC.

[34] This audit was done together with Centre for Innovation and Enterprise Development (CIED)

Appendix H: Financial Analysis for the Wood Processing Industry

This appendix gives an overview of the costs and benefits, and hence profit margins, of firms operating in the wood processing industry. This is done in order to throw more light on the relevance to firms of the increases in returns offered by investments in energy efficiency options discussed in the main report. Data was obtained from three sources: FPIB, GTMO and interviews/discussions held with sawmill personnel by KITE, ITC and PRI.

Forestry Commission Data

Table H1 below contains the export price in $\$/m^3$ for selected saw and veneer mill products for 1993 (which is prior to the imposition of export ban for round logs and 1999.

Table H1: Summary of Export Revenues on Selected Products

Product	$\$/m^3$ of product		% Change
	1993	1999[35]	
Lumber (Overland)	128	106	-17
Rotary Veneer	310	276	-11
Plywood	353	300	-15
Lumber (Air-Dried)	302	366	21
Lumber (Kiln-Dried)	337	369	9

Source: FPID Reports

There is a downward trend in export revenues for three products (overland lumber, rotary veneer and plywood) while the opposite (i.e. an upward trend) is true for air-dried and kiln-dried lumber. The relatively low price of overland lumber is noticeable; this lumber (which is usually all chainsawn lumber, in spite of the ban,) is exported to neighouring countries such as Burkina Faso and Ivory Coast and it is cheap because of its poor quality and, although a ban has now been imposed on this.

Table H2: Export Revenues for a few popular wood species

Lumber (Kiln Dried)	**$\$/m^3$**		**% Change**
	1993	**1999[1]**	
Wawa	222	289	30
Mahogany	382	524	37
Koto/Kyere	501	546	9
Asanfina	416	585	41
Teak	532	588	11
Odum	624	623	-0.2

Source: FPID Reports

[35] Data for 1999 is for January – November inclusive; data for December was not yet available.

Table H3: Saw and Veneer Mill Costs in Ghana for 1999 (Source: DFID Ghana Wood Industry And Log Export Ban Study Project, Forestry Commission)

	Saw Mill			Rotary		Sliced		Plywood		Other Tertiary		
	Small	Medium	Large	Small	Large	Small	Large	Small	Large	Small	Medium	
VARIABLE COSTS, dollars per m3 of product (green font indicates corrected to Baseline 99)											Local	Export
Raw Material (Logs)	67.73	82.21	76.21	137.94	135.00	280.73	192.39	53.04	53.04	158.87	193.92	307.81
Salaries/Wages	31.59	23.82	10.83	20.00	17.39	20.00	17.39	23.77	20.87	3.90	23.48	68.64
Consumables, saws, chemicals, other mate	0.28	1.53	2.48	7.94	7.94	7.94	7.94	27.54	27.54	0.30	75.95	20.02
Power	3.33	3.65	4.20	3.88	4.46	3.88	4.46	3.88	4.46	2.42	6.89	12.82
Other utilities	0.17	0.17	0.43	1.16	1.16	1.16	1.16	1.16	1.16		0.17	0.17
Fuel and lubricants	1.20	1.20	1.20	2.41	2.41	2.41	2.41	2.41	2.41	0.02	12.78	12.78
Production expenses	2.13	2.13	2.13	1.50	1.50	1.50	1.50	1.50	1.50	0.02	1.74	1.01
Transport (logs and products)	22.28	22.28	22.28	21.02	21.02	20.32	20.32	18.41	18.41			23.02
Engineering/maintenance	21.26	19.65	34.68	40.58	24.05	40.58	40.58	17.39	11.59	2.41	22.72	27.00
Bush Expenses (10%)												
Compensation (logging only)												
Forest Service Charges												
Concession rent (for Logging)												
Informal Payments												
Sub-total Direct Variable Cost	149.99	156.65	154.45	236.44	214.94	378.53	288.16	149.11	140.99	167.94	337.64	473.28
Average FIXED COSTS, $/m3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial operations	27.39	25.19	18.26	19.13	17.97	19.13	17.97	0.00	0.00	0.30	1.74	25.19
Insurance	0.60	0.43	0.64	1.53	1.53	1.53	0.77	0.00	0.00	0.00	0.35	1.06
Fixed Transaction Cost (for Logging)	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.00
General Administrative Expenses (excluding depreciation)	23.19	0.00	9.47	13.91	13.04	16.89	11.16	0.00	0.00	23.94	25.15	16.54
Others	1.51	1.13	0.84	1.10	0.83	1.10	0.83	1.10	0.83	0.08	2.55	0.61
DEPRECIATION, $	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plant and machinery	7.51	5.32	13.54	4.99	4.99	5.01	5.01	4.35	4.35	0.16	7.51	7.51
Mobile equipment	0.51	0.38	0.38	0.51	0.38	0.51	0.38	0.00	0.00		0.87	0.87
Depreciation (Administration)	2.08	2.08	4.40	1.45	1.45	1.45	2.90	0.00	0.00	0.00	1.45	1.45
FINANCING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Servicing of Loans (For Fixed Capital Acc	0.70	0.52	0.44	3.83	3.83	3.83	3.83	3.83	3.83	0.00	4.71	9.42
Servicing of Loans (In respect of Working	6.03	5.29	5.29	5.54	2.90	11.59	8.70	2.03	2.03	0.00	7.40	21.21
Average Fixed Cost $/m3	69.51	40.34	53.26	51.99	46.92	61.04	51.54	11.30	11.03	24.49	51.72	83.86
'99 product volume '000m3	28.04	36.07	67.48	8.33	28.81	6.48	13.91	3.83	20.12	51.59	32.87	0.99
Total fixed costs in '99 ($'000)	6,723.16	5,020.13	12,399.08	1,493.80	4,663.70	1,365.23	2,473.36	149.18	765.74	4,358.65	5,864.92	285.11
Average Fixed Cost/Operation	146.16	152.13	495.96	186.73	358.75	341.31	247.34	18.65	63.81	2.69	195.50	57.02

Table H2 presents the revenue per cubic metre of kiln-dried lumber for some popular wood species. 3 of the species (Wawa, Mahogany and Asanfina) show high rates of increases of between 30 and 41 %, in their export prices. 2 of them (Koto/Kyere and Teak) show rather moderate increases of around 10 %. Odum is the only one that shows a negative change in export price over the period under consideration; this change, though, is very small.

Table H3 shows 1999 disaggregated costs of production for various categories of wood processing firms (saw and veneer mills as well as plywood and other tertiary products – small , medium and large, and local/export in the case of other tertiary products). The cost of raw material(logs and lumber) ranges from just under $70 per cubic metre of product for small sawmills to a little over $300 medium exporting tertiary products manufacturers. The cost of power (electricity) lies in the range $2 - 13 per cubic metre of product, for small and medium exporting tertiary products manufacturers. For sawmills in particular, the cost of electricity ranges from $3 to $4 per cubic meter of product, which is less than 2 % of the total (direct variable plus fixed) costs.

GTMO's Analysis

Table H4 presents data compiled by GTMO on the "trends in revenue and expenditure situation of the timber industry"[36] based on GTMO members' operational records. The GTMO report itself highlights the drop in net revenue between 1995 and 1999 of approximately 89%. The report similarly draws attention to the fall in net revenue before tax as a percentage of total costs, per cubic meter of processed timber, from 44.6% in 1995 to 3.3% in 1999. The report stated that in 1998 "most companies recorded negative net income"[37] and in 1999 a "good number" of timber companies had "negative net revenue"[38]. GTMO attributes the trend of falling net revenue to the increasing costs of production in the industry and falling export prices. The latter, as shown earlier in Tables A1 and A2, may be true for some products/species but not for all. The real reason for the falling revenues is likely to be the decreasing trend in average revenue which (judging from the Forestry Commission data presented earlier) would be due more to company performance than to market prices.

The data shows that costs have increased almost twofold in two areas: (1) logging and (2) marketing and finance. With respect to the former, stumpage costs have increased more than fivefold; social responsibility and plantation expenses (which were previously non-existent) have also emerged. Costs of depreciation of machinery for logging activities) have increased by 46% over the period 1995-1999, from $\$13/m^3$ to $\$20/m^3$; transport costs have also increased by 43%. With respect to the marketing and finance expenses, the main increase has been associated with export levies. It would seem that this levy would be the levy imposed on air-dried lumber, since this levy was initiated in 1997 and export levies first appear in the

36 GTMO, 1999, The Fate of the Timber Processing Industry Under the Current Ghana Forest Sector Reform Program.

37 GTMO, 1999, The Fate of the Timber Processing Industry Under the Current Ghana Forest Sector Reform Program.

38 GTMO, 1999, The Fate of the Timber Processing Industry Under the Current Ghana Forest Sector Reform Program.

GTMO data in 1997, however this could not be confirmed. Interest rates and bank charges have also increased substantially over the period for unclear reasons.

Table H4: Trends in Revenue and Expenditure Situation of the Timber Industry

Year	1995[39]	1996	1997	1998	1999
Average Revenue, $ per m3 of all products	$385	$353	$348	$372	$330
Cost, $/m3					
LOGGING					
Machinery[40]	13.44	12.59	16.95	19.09	19.66
Labour	4.48	3.84	3.37	3.79	3.70
Transport	8.51	8.22	9.33	11.73	12.21
Concession Expenses	5.97	5.12	4.50	5.05	4.93
Royalty/Stumpage	4.04	3.70	3.65	3.91	22.04
Social Responsibility	--	--	--	--	1.10
Plantation	--	--	--	--	2.29
Sub – Total	36.44	33.47	37.80	43.57	65.93
MILLING					
Labour	38.39	32.87	28.92	32.51	31.74
Electricity (Power)	3.84	3.69	3.18	8.24	10.78
Maintenance	63.98	63.64	56.26	63.10	58.56
Administration	22.80	22.36	19.91	23.10	21.16
Depreciation	38.39	36.90	31.82	34.65	31.22
Sub – Total	167.41	159.46	140.09	161.6	153.46
MARKETING & FINANCE					
Haulage	7.76	7.45	6.64	7.70	6.86
FPIB/TEDB Tax	11.53	10.58	10.43	11.16	9.89
Export Levy	--	--	27.85	29.79	26.41
Port Charges	4.26	3.66	3.21	3.61	3.53
Interest Rates and Bank Charges	38.48	58.09	57.27	62.36	52.81
Sub – total	62.03	79.78	105.4	114.62	99.5
GRAND TOTAL	265.88	272.71	283.29	319.79	318.89
NET REVENUE	119.12	80.29	64.71	52.21	11.11

Source: GTMO data (values have been converted from DM to $).

[39] Exchange rates used are: $1 = DM 1.48 (1995), $1 = DM 1.54 (1996), $1 = DM 1.79 (1997)
$1 = DM 1.64 (1998), $1 = DM 1.82 (1999)
These rates are the end of year figures recorded by FPIB in their annual reports at the time.

[40] Figures in this row could be referring to allowance for depreciation.

In contrast to logging expenses, and marketing and finance expenses, milling expenses have decreased by 8%. Milling however consistently represents the largest proportion of costs, on average 54%. Over the 5 year period there was a 17% decrease in (milling) labour costs and an 18% decrease in depreciation costs. Maintenance expenses fell by 8% whilst administration expenses fell only slightly.

Electricity expenses tripled over the 5-year period. There was an average 300% upward adjustment in electricity tariffs in the latter part of 1998, and the effect was felt mostly in 1999. Most of this upward adjustment was subsequently eroded by depreciation of the local currency, bringing tariffs down to about a third of their early 1999 levels by the end of the year 2000.

GTMO reports electricity costs of US$11/cubic metre of product compared US$ 3 – 4/cubic metre of product reported by Forestry Commission (DFID Study). There is a significant inconsistency between the two sets of data which could be investigated in future research.

Table H5: Average Revenues for Timber Products

Year	**1996**	**1997**	**1998**	**1999**
Forestry Commission (FPIB)	389	386	411	549
GTMO	353	348	377	330

Table H5 compares Forestry Commission and GTMO data on average revenues for timber products. The GTMO data consistently falls slightly below the FPIB data.

KITE – ITC – PRI Surveys

Surveys and interviews conducted by KITE, ITC and PRI personnel in May 2000 as part of the study revealed that the most popular species are Wawa, Ofram, Odum and Mahogany. Table H6 presents the data obtained on cost and sales prices for Wawa and Mahogany.

The KITE-ITC-PRI survey of sawmillers established that kiln dried 'Wawa' lumber sells at $210 (year 2000) while FPIB reports give an average of $289 for the same product. Similarly, for mahogany, the survey yielded $315 while FPIB gives $524. There is quite a major discrepancy here which tends to suggest either some gross under-reporting by the sawmillers or the inclusion of additional factors in the FPIB data (such as transporters' margins/overheads) not taken into account by the sawmillers interviewed.

Table H6: Costs and Revenues for Selected Timber Species

Species	Cost price of log input, $/ m^3$ of lumber sold	Sales price of lumber, $/m^3$	Margin (Difference between cost and sales prices), $/ m^3$of lumber products
Wawa	90	210	120
Mahogany	180	315	135

Appendix I: Intervention Matrix for Timber Sub-Sector in Ghana

Category	Constraint	Opportunity	Trade Group	Proposed Intervention (to support small enterprises in sub-ector)
Raw material/ Inputs	• Decrease in number of trees • Decrease in log supply • Increase in price of logs • Lack of capacity (of forestry staff to enforce regulations – TUPs and chainsaw ban)	Bushmills – can get TUPs if agree to supply 100% to local market	Small scale carpenters and FM	Backward Integration into bushmills (i.e. , need to get TUPs)
Market/ Market development	Local market for lumber competes unfavourably with export demand	• Improved economics of tertiary processing and added value • Opportunity for use of alternative materials		
Technology/Product development		• Bushmills – use of mobile sawmills/ woodmizers • Make more use of residues	Small-scale carpenters and FM Sawmills	• Possible technology development and transfer for using alternative materials/ lesser used species

				• Technology development/ demonstration for greater residue processing
Business Skills	Poor management and skills – especially among small-scale actors in local market. This constrains more added value, tertiary processing and efficiency		Small scale carpenters and FM	Training/ re-skilling to use alternative materials/ lesser used species
Policy	• Environmental lobby • Requirements for EIA • Policy instability • Interest of small-scale operators not adequately catered for		Small scale carpenters and FM	• Advocacy on behalf, by donors, NGO's, etc. • Empowerment • Incentives for plantation development
Finance	• Cost of capital for tertiary/ added value equipment is high		Small scale carpenters and FM	Group financing schemes

Operating Environment/ Infrastructure	Poor electricity supply – affects small scale carpenters in particular, because don't have generators		Small scale carpenters and FM	Explore opportunities for group purchase of diesel genset, or better transformers – plus independent generation?