Sustainable Industrial Development in Uganda through Cleaner Production: Case Study of Sugar Corporation of Uganda Ltd (SCOUL)

BARBARA BATUMBYA NALUKOWE

Master of Science Thesis
Stockholm 2006
Barbara Batumbya Nalukowe

SUSTAINABLE INDUSTRIAL DEVELOPMENT IN UGANDA THROUGH CLEANER PRODUCTION:
Case Study of Sugar Corporation of Uganda Ltd (SCOUL)

Supervisor & Examiner:
LENNART NILSON

Master of Science Thesis
STOCKHOLM 2006

PRESENTED AT
INDUSTRIAL ECOLOGY
ROYAL INSTITUTE OF TECHNOLOGY
Abstract

The thesis provides an assessment of Cleaner Production (CP) implementation in Ugandan industries, using Sugar Corporation Of Uganda Limited (SCOUL) as a case study. The thesis covers the time the CP programme was implemented in 2004 to date. The study is primarily concerned with the sustainability of CP in Ugandan industries. Using the local Uganda Cleaner Production Centre (UCPC) Assessment Approach, both qualitative and quantitative research methods are used to explore the trend (progress) of environmental and economic performance of CP in SCOUL. Several indicators are used to gain better understanding of the raw materials, products and waste in SCOUL.

The thesis sets out to assess the environmental and economic performance of CP in Uganda, identify barriers to CP and make recommendations for Sustainable CP in Uganda.

The findings show that both the environmental and economic performance of SCOUL continues to improve, in line with raw material, products and waste reduction. This improvement can be attributed to the different CP options which were implemented. These options include reduction, reuse and recycling.

From the findings, it can also be argued that CP is a practical way towards sustainable industrial development as demonstrated in the progress made by SCOUL and that CP has good potential for application in other industries in Uganda. This is because CP is simple to implement and yet it has both economical and environmental performance benefits. As such, it can be argued that CP will lead to sustainable industrial development in Uganda.

The long term aim of this study is to contribute towards promotion of sustainable industrial development in Uganda by showing that the implementation of Cleaner Production is simple and yet it has both financial and environmental benefits.

Key Words: Cleaner Production, environmental performance, environmental indicator, end-of-pipe, Eco-Benefits Programme and sustainable industrial development.
Table of Contents

Abstract ............................................................................................................................................. i
Table of Contents .......................................................................................................................... ii
Preface ............................................................................................................................................... iv
Acknowledgment ............................................................................................................................ vi

CHAPTER ONE: Introduction ........................................................................................................ 1
1.1 General background .............................................................................................................. 1
1.2 Research Problem ............................................................................................................... 4
1.3 Aim and Objectives .............................................................................................................. 6
1.4 Delimitation of the Research Scope ..................................................................................... 6
1.5 Research methods .................................................................................................................. 7

CHAPTER TWO: CONTEXT AND LITERATURE REVIEW ..................................................... 9
2.1 Defining Cleaner Production ............................................................................................... 9
   2.1.1 Evolution of Cleaner Production .................................................................................. 9
   2.1.2 Benefits of Cleaner Production .................................................................................. 10
   2.1.3 Cleaner Production Indicators: A Theoretical Framework for CP Evaluation ......... 11
2.2 Regulatory Framework of Cleaner Production .................................................................... 13
   2.2.1 International Declaration on Cleaner Production ..................................................... 13
   2.2.2 Legal Framework for Environmental Management in Uganda ......................... 14
2.3 The Uganda Cleaner Production Centre (UCPC) ............................................................. 15
2.4 The Uganda Sugar Industry ............................................................................................... 18
   2.4.1 SCOUL’s Contribution to the Ugandan Economy .................................................. 19
   2.4.3 The Sugar Process ..................................................................................................... 19
2.5 Conducting CP Assessment in SCOUL ............................................................................. 21
2.5 The Eco-Benefits Programme ............................................................................................. 27
   2.6.1 Eco-Benefits III programme ...................................................................................... 29

CHAPTER THREE: Methodology ................................................................................................. 33
3.1 Introduction ......................................................................................................................... 33
3.2 Methodological Approach ................................................................................................. 33
3.3 The Case Study Approach ................................................................................................. 34

CHAPTER FOUR: Results and Discussion ............................................................................... 39
4.1 Benefits of Cleaner Production in SCOUL in 2004 ............................................................ 39
4.2 Benefits of Cleaner Production in SCOUL in 2005 ............................................................ 39
4.3 Implications of the results ................................................................. 41
  4.3.1 Increase in Recovery % Cane Indicator .............................................. 41
  4.3.2 Increase in Sugar (product) Indicator .................................................... 42
  4.3.3 Energy Consumption Indicator ............................................................ 44
  4.3.4 Reduction of Sugar Sample Indicator ................................................... 45
  4.3.5 Reduction in Volume of Effluent Indicator ........................................... 46
  4.3.6 Occupational Health and Safety (OHS) Indicator ............................... 47

CHAPTER FIVE: Conclusion ............................................................................ 49
  5.1 Evaluation of CP in SCOU ................................................................. 49
  5.2 Focus Areas for Improvement ............................................................... 49
    5.2.1 Regarding CP in SCOU ............................................................... 50
    5.2.2 Regarding Cleaner Production in Uganda ........................................... 50
  5.3 Recommendations for Further Study .................................................... 51

List Figures ........................................................................................................ 52
List of Tables ....................................................................................................... 53
List of Abbreviations .......................................................................................... 54
List of Abbreviations .......................................................................................... 54
References .......................................................................................................... 55
Preface

The quality of life, the economy and society at large is impacted by environmental problems. More so in developing countries which consume their environment and their renewable resources faster than the resources can be rebuilt by the environment, leading to environmental degradation. As such, there is need to use our environment in a more sustainable manner. To be able to sustain our fragile environment, there is need for more efficient, fair and responsible use of natural resources by the production sectors of the economy. There is also need for more sustainable patterns of consumption as well as more equitable use of resources by the entire world population if environmental degradation is to be slowed down (UNEP Geo Team, 1999).

Moreover it has become progressively clear that ‘end of pipe’ strategies alone cannot resolve complex environmental problems. This is because these ‘end-of-pipe’ strategies do not eliminate pollution, but often transfer it from one media to another. They also require expensive pollution treatment equipment and discourage technological innovation towards achieving environmental benefits beyond compliance. These strategies also hinder stakeholders’ dialogue (UCPC, 2004).

Today CP is currently implemented in over 60 enterprises in Uganda while over 170 CP consultants have been trained (UCPC, 2006). These consultants are trained to conduct CP training as well as implementation. Given the small number of industries that are implementing CP, there is need for the implementation of CP in all industries in Uganda, if the country is to achieve sustainable industrial development.

This is because CP is an overarching concept for flexible preventative strategies. It aims to prevent pollution from occurring and manage environmental impact of the whole production process, not just impacts of its output. CP addresses the root causes of environmental problems (rather than their effects), through an integrated package of improvements at all stages of a process and product life cycle. CP therefore eliminates or minimizes the very need for costly abatement, treatment and disposal systems- integral parts of conventional end of pipe environmental protection strategies. Moreover, it encourages innovation and stakeholder dialogue, eliminates trade-offs among environment and economic growth and ensures consumer and worker safety (UCPC, 2004).
This study assumes that the readers have some knowledge of CP. Nonetheless, it is hoped that the thesis will provide a better understanding of the concept of Cleaner Production. It is also hoped that this study will provide some basis and encouragement for more industries in Uganda to embrace and implement the CP. The author believes that many readers will find the study useful and inspirational, either as information for reference work for practicing professionals, or to conduct further studies in relation to the field of Cleaner Production.

**Barbara Batumbya Nalukowe**

**Stockholm, Sweden**
Acknowledgment

I wish to express my deepest and heartfelt gratitude to my supervisor, Lennart Nilson for his constant guidance, invaluable suggestions, positive criticisms and encouragement throughout this study. May God bless you. Many thanks are also extended to the Department of Architecture and Urban Infrastructure and to the staff of the same, for all the help given during this study.

This study would not have been possible with the invaluable help of SIDA (Swedish International Development Agency), the SI (Swedish Institute) and the Environmental Engineering and Sustainable Infrastructure (EESI) Programme. Thanks for providing me with the scholarship and the opportunity to pursue my Masters Degrees and to carry out this research.

I also wish to acknowledge the generous support given by SCOUL without which it would have been impossible to conduct my research in their premises. The information which I gathered proved invaluable to the attainment of my research goals. I also wish to extend my sincere appreciation to the executive director of UCPC, Dr Patrick Mwesigye, as well as the entire staff of UCPC (Uganda Cleaner Production Centre) for their valuable assistance throughout this study.

And to my family, thanks for the love, support and constant prayers. To my darling sisters Sara and Sheba, thanks for being excellent examples in pursuing your Masters studies and encouraging me to pursue my own. May God continue to bless all your endeavours.

And lastly, I would also like to thank my special Kista Alléväg friends: Hector, Aishu, Faisal, Charu, Daniel, Shaban, Ragu and (Katarina & Fumi – my roommates) for their help, comfort and friendship during my stay in Stockholm, Sweden. Special thanks are extended to my classmates Humberto, Shakila, Lu, Jianguo, Mary, Julien, Jiri and many others for their moral support and friendship throughout my studies in KTH.
CHAPTER ONE
Introduction

1.1 General background

Today there is an increased focus on sustainable development by individuals, governments, universities, the United Nations and several other world bodies. Sustainable development is a world wide concept that has become an important term within the environmental community. One of the most popular definitions of sustainable development is the one provided by the 1987 Brundtland Report, which states that “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Report, 1987).

Sustainable development should be translated into appropriate action at the global, regional, national, community and even village levels, regarding their specific situations. This study focuses on the national level where the sustainable development concept should be implicated by implementation of CP in Uganda, by all the industries. Moreover steady monitoring of those industries which have implemented CP should be carried out to ensure long term success.

Building a strong economy, while protecting our fragile environment is a challenge that the industrial sector faces everyday. CP responds to this challenge by helping to eliminate or reduce the industries’ impact on the environment. In general CP is an overarching concept for flexible preventative strategies which aims to prevent pollution and manage environmental impacts of the whole production process. It addresses the root causes of environmental problems rather than their effects, through an integrated package of improvements at all stages of a process and product life cycle. In principle CP is undertaken for the entire industrial processes though its implementation can be done for specific processes at a time depending on the need for environmental compliance and cost effectiveness of the CP options.

CP Evaluation is the process of discovering how far CP has enabled an industry regarding its efficiency, environmental and economic performance. The evaluation is done by using environmental indicators such as raw materials,
products, waste and energy consumption. The economic indicators may include money saved on implementation of the CP options.

Environmental Performance Indicators (EPIs) are excellent tools that are used to indicate an industry’s impacts on both living and non living natural systems including ecosystems. EPIs may help to identify the most significant environmental impacts, clarify and communicate industry’s environmental goals and progress to employees and other stakeholders. Environmental Indicators serve as powerful tools for performance evaluation, tracking environmental progress, supporting policy evaluation and informing the public (World Bank, 1997).

CP is one of the environmental concepts that use potential indicators and benchmarks in assessing the environment performance. In principle, instead of dealing with end-of-pipe impacts approach on the environment, CP deals with pollution reduction/prevention at the source. CP can also clearly show how the organisation is performing, and provide a firm basis for future targets and improvement. The long term purpose of CP in Uganda is to promote sustainable industrial development. CP has been studied, developed and adjusted to assess the performance of sustainability of industries. CP is not a new concept in the developed nations and it is implemented worldwide in very many industries, although it may be called differently. CP is however rather newly implemented for the greater African countries and other less developed countries in Latin America and Asia. In many of these countries where CP is being implemented, National Cleaner Production Centres (NCPCs) have been set up by the help of UNIDO and UNEP to assist in implementation (UCPC, 2004).

In Uganda, it is the Uganda Cleaner Production Centre (UCPC) that is spear heading the national CP activities. The detailed background and current activities of UCPC is presented in section 2.3.

Recognising the interconnectedness of sustainable production and consumption, UNIDO and UNEP have called upon NCPCs to expand their scope of activity to include sustainable consumption. In its Cleaner Production Global Status Report 2002, UNEP urged NCPCs to “focus now on the expanded vision of CP that links explicitly with sustainable consumption”. However, sustainable consumption issues have not yet been expanded into the activities of UCPC and as such only Cleaner Production activities have been considered in this study (UCPC, 2004).
This is a case study conducted in SCOUL where UCPC implemented CP with support from UNIDO and UNEP. The reason for selecting this case study is because SCOUL is one of the three sugar industries in Uganda which implemented CP, is easily accessible and was willing to be used in this research. Also, SCOUL has a big number of employees (over 5000) contributing greatly to the economic income of Uganda and therefore its sustainability would benefit not only its employees but the Ugandan economy as well.

The research problem which this study addresses is the sustainability of CP in SCOUL. The suggested indicators of Raw materials, Product (sugar), Energy, Sugar Samples, Wastes and Occupational Health and Safety (OHS) are used to evaluate the performance of CP in SCOUL.

Exploring this relatively new environmental concept of CP by using both quantitative and qualitative information together with descriptive and prescriptive approaches, this study has been conducted to assess the status, trends and challenges of CP in SCOUL. It also attempts to provide valuable information from the results of both environmental and economic improvement towards sustainable industrial development in Uganda.
1.2 Research Problem

Currently, nearly half of the world’s population lives in urban areas, causing significant pressures on the local environment. As urbanisation becomes more and more, so does industrialisation and the ever-increasing consumption rate of raw materials by the human population, creates enormous environmental problems. In the developing countries, inadequate waste management is the cause of serious urban pollution and health hazards (Ludwig et al, 2003).

Government of Uganda takes industrialization as a high priority development vehicle and advocates for poverty eradication through agricultural modernization, employment creation and industrialization (UACE, 2005). Consequently, industrial waste and pollution are some of the most serious problems that Uganda is experiencing (Alain Marcoux, 1998).

The National Environmental Management Authority (NEMA) has the direct responsibility of dealing with environmental management in Uganda. It has done a great job in promoting the abatement of waste and pollution, through establishing laws and regulations which industries are to comply with. However, it is sad that most of the industries are not compliant with these laws, regulations and standards and many may even be ignorant of what is required of them by NEMA. Therefore the challenge lies in the implementation of these laws, regulations and standards for the industries to meet the NEMA requirements and therefore achieve sustainable industrial development (UCPC, 2004).

Different industries have adopted different strategies for reaching their goals for example, by applying advanced environmental technologies, extending recycling and reuse, or by setting goals and targets for reducing the use of materials in their production. These strategies were made stronger by the establishment of the Uganda Cleaner Production Centre (UCPC) in 2001 whose main goal was to promote and implement the CP concept to industries. This was mainly done through the Eco-Benefits programme in which CP was promoted to industries as a preventative strategy to deal with current and future environmental problems as well as offering them better efficiency, economic and social benefits. As such industries were encouraged to join the Eco-Benefits programmes and implement CP. In this way the industries would comply with the NEMA requirements as they improved their environmental performance. Today the UCPC works alongside NEMA towards environmental sustainability of industries in Uganda (UCPC, 2004).
Cleaner Production, as a strategy for improving environmental performance while bringing economic and social benefits, is closely linked to the goals of international environmental governance via the key principles of sustainable development set out in the United Nations Rio Declaration on Environment and Development. Cleaner Production policies are also stressed as important means of achieving sustainable development in Agenda 21, adopted at the UN Conference on Environment and Development (1992).

The issue of linkage between environment and development can be more successfully resolved if CP becomes a core strategy for implementing Multilateral Environmental Agreements (MEAs). This is because CP fosters economic development while simultaneously improving environmental performance. More specifically CP aims to reduce the consumption of natural resources per unit of production, the amount of pollutants generated and their environmental impact, while making alternative products and processes financially and politically more attractive. As the European Environmental Agency states, “Cleaner Production is about the creation of a truly sustainable economy”. Cleaner Production brings economic benefits via increased resource efficiency, innovation and reduction of pollution control costs” (UCPC, 2004:8).

Increased use of CP-based strategies for implementing MEAs would provide national and local authorities with important, presently often missing, positive incentives to work toward MEAs goals. “Emphasising gains resulting from wiser resource management and the ways they might be shared”, instead of focusing on allocation of losses incurred through environmental regulations, would secure wider participation in MEAs and their implementation. Even developing countries would be more willing to join and implement MEAs, as they would see ways to meet environmental commitments without compromising their development objectives. Industry, encouraged to research profitable alternatives, could also take a more proactive approach in complying with MEAs (UCPC, 2004).

Despite the above benefits that industries would enjoy as a result of implementing CP, not all industries in Uganda have embraced the CP concept. However, SCOUL is one of the few industries which have undertaken and implemented a number of CP options in order to achieve ecological and economic benefits. This study seeks to investigate the benefits of CP as experienced by SCOUL, so that other industries will be encouraged to embrace and implement CP as a means of sustainable industrial development in Uganda.
1.3 Aim and Objectives

The long term aim of this study is to contribute more knowledge to the concept of Cleaner Production, especially concerning its contribution towards enhancing sustainable industrial development in Uganda if implemented in Ugandan industries.

The specific objectives are to:

- Undertake a study in SCOUL to assess the impacts of CP on the environmental and economic performance of this enterprise.
- Identify the challenges of CP implementation and its long term sustainability in SCOUL.
- Make recommendations for sustainable CP in SCOUL.
- Provide necessary CP information to be adopted in other industries for sustainable development.

Research questions

The main research questions are:

- How has SCOUL benefited from the implementation of Cleaner Production?
- Is there economic gain in SCOUL since the implementation of CP?
- Is the CP in SCOUL sustainable?
- Is CP a practical tool towards sustainable industrial development at SCOUL?

1.4 Delimitation of the Research Scope

This study sets out to assess the CP in SCOUL in relation to its environmental and economic performance since the implementation of the CP programme. The economic performance considered in this study is limited to the savings which were made by SCOUL as a direct result of the implemented CP options. It does not consider the entire economic performance of the factory. Due to limitation of time only those areas which were identified during the initial CP implementation were dealt with.

This study does not include the agricultural process of the factory (i.e. growth of sugarcane) due to time constraints. However it is recommended that further
studies be undertaken to complete the understanding of the whole process of sugar manufacture in SCOUL right from the growth of the sugarcane and how CP can be applied to this process.

Apart from some special instances, the data analysed in this study is limited to the years 2000 to 2005. See fact sheets in appendices A-F.

The CP assessment was carried out by only the researcher and not a team as is usually the practice. This was mainly due to the fact that this was an academic thesis which required that only the researcher undertakes the study.

1.5 Research methods

This study employs both qualitative and quantitative research methods. It specifically employs the case study approach to explore the benefits of CP to Ugandan industries. SCOUL was used as the case study.

Individual interviews were also used to obtain individual perceptions especially on the benefits that are difficult to quantify.
CHAPTER TWO
CONTEXT AND LITERATURE REVIEW

2.1 Defining Cleaner Production

Cleaner Production (CP) can be viewed as a widely recognised and proven strategy for increasing the efficiency of natural resources’ use as well as minimising wastes. In CP, pollution and risks to human health and safety are reduced at the source, rather than at the end of the production process, that is, the ‘end-of-pipe’ stage. CP typically involves improving maintenance practices, upgrading or introducing new technology, or changing production processes. It results in meeting consumers’ needs with more environmentally compatible, quality products and services. As well as reducing pollution, this strategy also generates tangible economic savings for a business enterprise by improving overall efficiency of production (UNEP, 2001).

Based on the above understanding of CP, this study adopts the United Nations Environment Programme (UNEP) definition of CP. According to UNEP, CP is “The continuous application of an integrated preventive environmental strategy to process, products, and services so as to increase efficiency and reduce risks on human and the environment” (UCPC, 2004).

2.1.1 Evolution of Cleaner Production

The concept of CP has its roots in the sustainable development discourse. In 1987, sustainable development was proposed as a way to steer the understanding of development. Sustainable development implies meeting the needs of the present generation, without compromising the needs of future generations (Brundtland report, 1987). The true challenge of sustainable development, however, is how to put the theory into practice. Cleaner production is one practical way to achieve sustainable development.

CP is neither a new concept nor a mere environmental initiative. In 1989, the UNEP-DTIE’s Cleaner Production Programme was launched. Its main aim was to create concept awareness, institutional capacity building and demonstrate its benefits to foster sustainable development. In 1992, Cleaner Production was adopted as one of the key strategies to achieve sustainable development. In Agenda 21, reference is made to CP as a blue print to
sustainable development. Agenda 21 also provided a basis for CP as a multi-stakeholder and multi-partnership matter. Today the CP emphasis is more action oriented and embodies the spirit of partnership through establishment of an enabling framework. Cleaner Production is now a global movement program of not just UNEP DTIE, but also of several organizations in the world that have adopted and adapted it. (Cleaner Production Global Status Report, 2002).

2.1.2 Benefits of Cleaner Production

According to UNEP (2004), the major benefits from a Cleaner Production program are: saving money, preventing pollution and complying with environmental legislation. These are discussed in more detail below.

**Saving Money**

Through Cleaner Production, companies save money from the better use of their valuable resources. This can include the recycling of wasted raw materials, maximum utilisation of water, as well as waste treatment and disposal (UNEP, 2004).

Cleaner Production strategies typically cost less than ‘end-of-pipe’ technologies. The CP strategies, such as housekeeping and process improvements, can be implemented at a low cost but can have immediate benefits. Changes to plant and equipment definitely requires capital but many Cleaner Production projects that have been undertaken show that they can easily become self-funding in less than one year. As such, companies can often perform better than their environmental requirements as an outcome of running a profitable and efficient business (UNEP, 2004).

**Preventing Pollution**

Business work practices and processes are reviewed throughout the entire operation to identify ways to reduce waste at the source rather than trying to control the pollution at the ‘end-of-the-pipe’. This will reduce the risk of causing environmental harm or nuisance (UNEP, 2004).

**Complying With Environmental Legislation**

There is assistance in maintaining or improving compliance with environmental legislation Cleaner Production. This may result in benefits such as reduced regulatory intervention, possible reduced licence fees and charges, and better control over the business. Regulations regarding the transport and disposal of wastes are becoming tougher (UNEP, 2004). In Uganda, The National
Environment (Waste Management) Regulations, 1999 require industries to adopt Cleaner Production methods so these issues are rapidly becoming a reality for industry.

It is worth noting that, although financial benefits in CP are usually very significant, this study emphasises the environmental benefits of CP.

2.1.3 Cleaner Production Indicators: A Theoretical Framework for CP Evaluation

This study employs CP indicators to assess the environmental performance of the SCOUL after the implementation of CP. The definition and selection of Environmental Performance Indicators (EPIs) is still young but the use of indicators is increasing, both for tracking of trends in pollution and other environmental issues at a large scale whether national or regional (World Bank, 1997).

The following guiding questions may be used to define indicators:

- Which figures show the goals (of my department) best?
- What shows best of why we do not meet these goals?
- How can we measure critical deviations best?
- What shows best, which is responsible for critical deviations?
- For which indicators can we get information easily and efficiently? (UCPC, 2003).

Hammond et al (1995) define an indicator as “something that provides a clue to a matter of larger significance or makes susceptible, a trend or phenomenon that is not immediately detectable”. An indicator’s main defining characteristics are that it quantifies and simplifies information in a way that promotes the understanding of environmental problems, to both decision-makers and the public. Above all, an indicator must be practical and realistic, given the many constraints faced by those implementing and monitoring projects (World Bank, 1997).

“EPIs can help quantify impacts and monitor progress. The goal is to assess how project activities affect the direction of change in environmental performance, and to measure the magnitude of that change. Indicators that allow a quantitative evaluation of project impacts are particularly useful, since they provide more information than just whether the project is improving or degrading the environment. Information on the magnitude of a benefit is
required to determine whether it is worth the resources being expended to achieve it. Similarly information on the magnitude of adverse impacts might indicate whether the harm is justified given other benefits of the activity/project in question” (World Bank, 1997).

CP indicators fall in two major categories namely, economic and environmental indicators. However, since it is difficult to measure economic indicators, this study will focus on environmental indicators to discuss whether SCOUL has benefited from CP and how it has benefited from CP.

Environmental indicators are important for assessing Cleaner Production opportunities and for comparing the environmental performance of one year and another as well as one processing-operation to that of another (UCPC, 2003).

Additionally indicators present data from the company in a concentrated way to give information about the company’s environmental performance:
- Relative (relation of parameters e.g. tons of waste per ton of product)
- Normalized (part in relation to the total e.g. relation of dangerous waste to waste)
- Indexed (relation to baseline e.g. tons of waste in relation to tons of waste in the past year (UCPC, 2003).

In this study it is the indexed indicators that have been used to evaluate CP in SCOUL.

It is an enormous challenge to choose appropriate EPIs because there is no universal set of indicators which can be applied to all cases. This is due to the diverse environmental problems and the contexts in which these problems arise to allow for universal solutions (World Bank, 1997).

“The process of selecting EPIs should be linked to project objectives and must start from a precise understanding of the environmental problems being addressed. Vague or broad objectives such as ‘reducing erosion’ or ‘protecting biodiversity’ are of little assistance in selecting EPIs (and may well indicate that the project is not well thought-out). Likewise, different EPIs will be best suited to each situation. Where the environmental consequence is not an explicit project objective but a by-product of project activities, Environmental Assessment (EA) process can help to understand the possible impacts and hence to select appropriate EPIs” (World Bank, 1997).
The fact sheets in appendices A-F present the CP indicators used in assessing the CP implementation at SCOUL. In brief, these indicators are: recovery % of cane indicator, sugar (product) indicator, energy loss indicator, sugar sample indicator, effluent indicator as well as Occupational Health and Safety (OHS) indicator. These indicators will also form the basis of discussion later on in Chapter 4.

2.2 Regulatory Framework of Cleaner Production

This section highlights the global and Ugandan regulatory framework of CP. It can be argued that the speed of growth of CP in Uganda was a result of the enabling environment in the country. This environment allowed for mainstreaming of CP within the laws and regulations. A CP bill that will be presented to Parliament is in the process of being drafted (UCPC, 2006). It is such moves that show that CP is well accepted and valued by the Ugandan government and will therefore be sustainable once it is passed as an Act in Parliament.

2.2.1 International Declaration on Cleaner Production

This International Declaration is a voluntary but public commitment to the strategy and practice of Cleaner Production. The Declaration outlines a set of principles, which when implemented will lead to increased awareness, understanding and ultimately, greater demand for Cleaner Production. For Cleaner production advocates, the Declaration is a tool to encourage more governments, companies and organizations to adopt and promote the strategy (UNEP, 2001).

The International Declaration on CP is a tool, which if used, can help to overcome barriers related to limited awareness and understanding of the implementation of CP. Cleaner Production is a proven strategy to achieve the goal of sustainable production and consumption of goods and services. Reorientation to more sustainable practices is required - The declaration considers the fact that each sector (public, private, non governmental, academic, etc) has a role to play. And as a framework for action, its six principles provide a general overview of activities for each sector to move towards the adoption of the Cleaner Production strategy. Commitment from political, public and private business leaders will reinforce the endorsement of a more diverse, intense and broader adoption of Cleaner Production worldwide (UNEP, 2001).
2.2.2 Legal Framework for Environmental Management in Uganda

Among the principal laws regulating the environment in Uganda is the National Environment Legislation. Industries and businesses in Uganda are required to comply with environmental standards as set out by the law. 

The 1995 National Environment Statute is the principal environmental protection law. The statute established the National Environment Management Authority (NEMA) which came into being in January 1996. NEMA is the principal regulatory agency for environmental matters. In order to direct environmental protection, NEMA has issued guidelines for environmental auditing and among these guidelines is Cleaner Production.

Part of the NEMA guidelines states that “A person who owns or controls a facility or premises which generate waste is required to minimise waste generated by adopting Cleaner Production methods” The National Environment (Waste Management) Regulations, 1999. It requires industries to adopt the following Cleaner Production methods:

- Improvement of production process through the conservation of raw materials, and the reduction of toxic emissions and waste;
- Monitoring the product cycle from the beginning to the end by identifying and eliminating potential negative impacts of the product, enabling the recovery and use of new products where possible and reclamation and recycling; and
- Incorporating environmental concerns in the design and disposal of products.

In light of the above, industries/businesses in Uganda should prioritise compliance with the environmental requirements. As such, industries should avoid as much as possible, business operations that are contrary to the established environmental standards and legal requirements. Non-compliance with the provisions of the 1995 National Environment Statute, and the various regulations can result in significant penalties. For example, the industry/business can be made to pay penalties and/or its activities that have an effect on the environment may be restricted or prohibited by a court. This prohibition could be in form of an injunction.

Moreover in Uganda, industries and businesses need to know that the Polluter-Pays- Principle (PPP) applies. Any person who pollutes the environment has to bear the cost of stopping, controlling or limiting such pollution. This, in most
cases, is an unforeseeable cost met by businesses and is additional to the
damage to the reputation, public perception and competitiveness of one’s
products and services (UCPC, 2004).

2.3 The Uganda Cleaner Production Centre (UCPC)

UNIDO and UNEP have joined forces to establish National Cleaner
Production Centres (NCPCs) in developing countries and countries with
economies in transition. One such centre is the Uganda Cleaner Production
Centre (UCPC). The role of NCPCs is to promote the Cleaner Production
strategy in enterprises and government policies, in harmony with local
conditions. This is in addition to developing local capacity to create and meet
Cleaner Production demand throughout the country. NCPCs aim primarily to
transfer know-how, and not just to transfer technology. The Centres and the
Cleaner Production assessors trained by them do not deliver ready-made
solutions. They train and advise their clients on how to find the best solutions
for their specific problems. Other activities undertaken by the centres typically
fall under the following categories: awareness raising, information exchange,
education and training, commitment and partnership building, policy advice
and development, technical assistance (UNEP, 2006).

The CP promotion strategies employed in Uganda are in relation to the basic
services provided by NCPCs as presented below.

• Raise awareness of the benefits and advantages of Cleaner Production: In
countries where there is little awareness of Cleaner Production.

• Demonstrate that Cleaner Production works through in-plant Cleaner
Production assessments and demonstration projects: Through in-plant
demonstrations, a NCPC can show that the concept of Cleaner
Production can be applied to any industrial sector and that waste
avoidance can be turned into profit.

• Train local experts and build local capacity for Cleaner Production:
Training in the Cleaner Production methodology is an essential NCPC
activity to build local expertise and capacity. Training may be 1) in-plant
training, as a part of in-plant demonstration projects; or 2) outside plant
training, conducted through workshops and seminars for specific target
groups.

• Help to obtain financing for Cleaner Production investments: The
Centres also create a core capacity in the promotion of Cleaner
Production investment projects to facilitate the transfer of Cleaner
Production technologies to developing countries. This activity is loosely
linked to the in-plant assessments and in each country a number of
national experts are being trained in identifying and formulating Cleaner Production investment projects.

- Disseminate technical information: One of the key advantages of being part of an established international network is greater access to the latest Cleaner Production information. NCPCs are thus able to obtain and share Cleaner Production information nationally and internationally.

- Provide policy advice to national and local governments: Governments, particularly in developing countries and economies in transition, play an important role in providing the overall policy and economic framework for a country's development. NCPCs thus have an important role in helping governments to identify and develop the policy tools and economic instruments suitable to their country's context which would encourage industry to favour Cleaner Production over end-of-pipe treatment (UCPC, 2006).

CP also works in full collaboration with the National Environment Management Authority (NEMA). Whereas NEMA is the “stick” they are the “carrot” in compliance with environment regulations.

2.3.1 Challenges of Cleaner Production in Uganda

From the perspective of industries considering adaptation of Cleaner Production, the challenges facing Cleaner Production investments in developing countries have been grouped into six main categories namely: Financial, Economic, Policy Related, Organisational, Technical and Conceptual (CP Issue Paper, 2000). These challenges discussed below are also faced by Ugandan industries.

**Financial Challenges**

- The high cost of external capital for investments in industry.
- Lack of funding mechanisms appropriate for CP investments.
- There is a perception that investments in CP present a high financial risk due to its supposedly innovative.
- CP is not properly valued by credit providers in their evaluation procedures (for lending, equity contribution etc.).
- Lack of knowledge in industry, especially among small and medium sized industries, on available funding channels.
- High transaction costs.
• The size of investments in the environmental field is often too low to interest bank loan or investment officers.
• Environmental investments are often evaluated by the environment department which is less influential in bank structure.
• CP investments are seldom hard assets.
• There is lack of confidence in non-biased expertise of environmental consultants.

Economic Challenges
• CP investments are not sufficiently cost effective (compared with other investment opportunities), given present resource prices.
• Immaturity of the company’s internal cost calculation and cost allocation practices.
• Immaturity of the company’s internal capital budgeting and capital allocation procedures.

Policy-Related Challenges
• There is insufficient focus on CP in environmental, technology, trade and industrial development policies and strategies.
• Immaturity of the environmental policy framework such as the lack of enforcement.

Organisational Challenges
• Lack of leadership for environmental affairs.
• The perceived management risk related to CP does not allow for incentives to managers to put their efforts into CP implementation.
• Immaturity of the environmental management functions in the company’s operations.
• General immaturity of the organisational structure of the company and its management and information systems.
• Limited experience with employees’ involvement and project work.

Technical Challenges
• There is absence of a sound operational basis such as well established production practices, maintenance schemes etc.
• Complexity of CP such as the need to undertake a comprehensive assessment of all production processes to identify appropriate CP opportunities.
There is limited access to equipment supportive to CP e.g. high quality process instrumentation devices.

Limited accessibility of reliable technical information tailored to the company’s needs and capacity to assimilate.

**Conceptual Challenges**

- There is indifference in perception regarding the industry’s own role in contributing to environmental improvement.
- The narrow interpretation or misunderstanding of the CP concept results in resistance to change (CP Issue Paper, 2000).

### 2.4 The Uganda Sugar Industry

The Sugar industry in Uganda is one of the oldest industries in the country with a history dating back to 1924. The first factory to be established in Uganda and the whole of East Africa was the Uganda Sugar Factory Limited, now the Sugar Corporation of Uganda Limited (SCOUL) – Lugazi. It was established by the late Naju Kalidas Mehta who came to Uganda in 1901 from India. The sugar sector in Uganda is regulated by the Ministry of Tourism, Trade and Industry (Lars, 2004).

The Ugandan Sugar Industry was a world leader in the 1950s and 1960s with production of more than 140,000 tonnes of sugar per year, most of which was for domestic consumption. At the same time, over 20,000 tonnes of sugar per year were exported to the United States of America and to neighbouring countries.

**Figure 2.1: Showing Background of Sugar Corporation Of Uganda Limited**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Sugar Corporation of Uganda Limited (SCOUL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location:</td>
<td>Lugazi - Uganda</td>
</tr>
<tr>
<td>Established:</td>
<td>1924</td>
</tr>
<tr>
<td>Contact Address:</td>
<td>P. O. Box 1, Lugazi, Uganda</td>
</tr>
<tr>
<td>Telephone:</td>
<td>+256-31-555500/ +256-41-448279</td>
</tr>
<tr>
<td>E-mail:</td>
<td><a href="mailto:scoul@mehtagroup.com">scoul@mehtagroup.com</a></td>
</tr>
<tr>
<td>Contact Person:</td>
<td>Mr. S.C. Khanna (Chief Executive)</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>5200 (the whole corporation)</td>
</tr>
<tr>
<td>Products:</td>
<td>Sugar and Alcohol</td>
</tr>
<tr>
<td>Production:</td>
<td>Sugar: 35,578 metric tons; Alcohol: 1,924,680 litres</td>
</tr>
<tr>
<td>Sector:</td>
<td>Sugar sector</td>
</tr>
<tr>
<td>Markets:</td>
<td>The Whole of Uganda</td>
</tr>
</tbody>
</table>

Source UCPC, 2004
2.4.1 SCOUL’s Contribution to the Ugandan Economy

SCOUL is one of the leading producers of quality sugar, which is an essential commodity and plays a key role in the development of the Ugandan economy. The corporation is among the largest employers not only in Uganda but in East Africa with a total of more than 7300 people. Occupying nearly 10,000 hectares at Lugazi, SCOUL is a totally integrated unit that grows sugarcane, manufactures white sugar, and converts the molasses by-product into ethanol. The ethanol distillery located at SCOUL, is the only one of its kind in Uganda. It operates at about 30 percent capacity and produces about 1.5 million litres of alcohol per annum, which is consumed locally by hospitals, colleges, laboratories, and other industries (Mehta Group, 2000.)

The company is involved in efforts to advance Uganda’s economic development through improving the productivity of the Lugazi sugar plant. This will help the country earn vital foreign exchange and meet the growing demand at home. These efforts such as CP are demonstrated in the company environmental policy and quality policy. However, the company is also involved in a variety of diversification moves such as the floriculture project which grows jasmines and tuberoses for the European and West Asian markets. SCOUL is also involved in horticulture - producing vanilla and essential oils for exports - as well as particle board manufacture, potable alcohol manufacture, seed farming, agribusiness and co-generation of power. (Mehta Group, 2000).

SCOUL- Lugazi Co-generation Project plans to install a 7 MW (4 MW surplus) at their Lugazi Sugar Mill. The proposal is for wheeling a large portion of the surplus power to other captive industries of the Mehta Group. The project at the SCOUL Sugar Mill will have a definite diesel displacement impact in its early years of operation, and will also make use of surplus bagasse that would otherwise be wasted. The more efficient operation of the SCOUL mill based on the improved reliability of the new energy system for both sugar making and surplus electricity production will realise both environmental (carbon offset and local emissions reduction) and economic (reduced sugar imports and more jobs) benefits (OCS APL PCD Form, 1998).

2.4.3 The Sugar Process

The raw sugar canes are transported from the fields to the factory where they enter the factory on a conveyor belt. The first processing step is the kicker, where the canes are cut down into smaller pieces by a series of rotating, cutting
knives. The canes are chopped further in the Fibrizer, where the canes are shred and the sugar containing cells are exposed. In the milling station rollers crush the cane and extract the juice. Maceration or imbition water is added to the crushed cane prior to the final crushing. That is to assist in extracting the cane juice. At this point the sugar content juice is already separated from the bagasse (Wardrobe Engineering, 2003).

The bagasse is the fiber from the canes, and the bagasse is transported to the boilers for combustion. The excess bagasse is transported out of the factory. See Figure 2.2 below. The bagasse has a moisture content of 50–55% water, and this is also the moisture content of the cane when it is fed into the boiler. None of the sugar factories in Uganda pre-dry the bagasse before it enters the boiler. The ash content varies from 2.5–6%, and the season of the year and techniques of harvesting are determining the ash content. If the harvesting is done in terms of mechanical loading, the ash content increases, and this is also happening in wet weather because more mud etc. is following the canes into the process (Polzin, 2004). The production volume at SCOUL was 36 000 tons of sugar cane processed in 2002. The bagasse content of 45% make this 16 200 tons of bagasse produced a year, and the excess bagasse produced is 7200 tons. The production of molasses is 1080 tons (Wardrobe Engineering, 2003).

The extracted juice is pumped into a receiving tank. From this tank, the juice is pumped further to the primary juice heater, where the juice is heated to around 70 °C. The next step is a reaction tank where a lime solution is added. The lime solution prevents sucrose inversion because the pH is increasing from around 5.2 to 7. In the secondary heater the temperature increases further to 100–105 °C, before the juice is pumped to the clarifier, where the solids are allowed to settle out. The mud from the clarifier is transported to a filter, where the rest of the juice is extracted. The filtrate is transported back to the rest of the juice on the way to the evaporators, where the water content of the juice is gradually reduced until it becomes syrup. Sulphur dioxide is bubbled through the syrup. After the crystallization, the sugar is separated from the molasses in the centrifuge (Wardrobe Engineering, 2003).
2.5 Conducting CP Assessment in SCOUL

The Cleaner Production Methodology given below was used to systematically identify and evaluate the CP options and facilitate their implementation in SCOUL in 2003/2004. It was useful in organising the CP programme. Its application brought together a team of people who were involved in the development, evaluation and implementation of Cleaner Production Measures in SCOUL in 2003/2004. The key objectives for CP in SCOUL were:

- Conserve raw materials, energy and product
- Reduce the quantity of wastewater
- Improve quality of wastewater
- Prevent leakages/spillage of sugar containing materials
- Improve occupational Health and Safety of workers
- Improve Hygiene at the factory (UCPC, 2004)

The CP Assessment methodology involved the following steps. Some have already been implemented and currently the enterprise is at the stage of continuation of the Cleaner Production Programme.
Details of the CP Assessment Methodology

1. **CP quick scan, identifying/recognizing the need for Cleaner Production**

A quick scan was carried out by a team from the Uganda Cleaner Production Centre. The following areas were visited:

- Cane Yard /preparation
- Mill house
- Boiling House
- Bagging house
- Water use
- Hygiene and Sanitation
- Maintenance workshop

The issues that needed attention in these areas were those which are shown in Table 2.1 below.

**Table 2.1: Showing Problems and Priority Areas for CP in SCOUL**

<table>
<thead>
<tr>
<th>No.</th>
<th>Problems</th>
<th>Priority Areas</th>
</tr>
</thead>
</table>
| 1.  | Mishandling of raw materials | • Cane crushed at the yard  
• Staling of cane at the yard  
• Falling prepared cane from cane carriers |
| 2.  | Energy losses | • Lights left on 24 hours a day  
• Steam leakages  
• Old motors with low power factor  
• Poor/no insulation of some vessels and steam pipes |
| 3.  | Large quantity of samples used in the laboratory | • Juice sampling  
• Sugar sampling |
| 4.  | Large volume of effluent (over 2500m³/day) | • High volumes of cleaning water (for floor and equipment)  
• Leakages from pumps, pipes and tanks  
• Overflows from tanks  
• Water from filter station  
• Many drain valves out of order leading to continuous drainage of water  
• Mill bearings cooling water  
• Overflow from spray pond |
| 5.  | High Total Suspended and Dissolved Solids in mill effluent | • Spillage of cush-cush from inter-carriers  
• Spillage from mixed juice screen  
• Spillage from between the mill rollers |
| 6.  | Spillage/leakage of sugar containing materials in the factory leading to high-undetermined pol losses (on average 0.32%) | • Spillage/ leakages at the mls  
• Overflow at the juice weighing station  
• Leakages from pumps  
• Overflow from crystallizers, continuous meter, and molasses tanks  
• Leakages/spillage from centrifugals  
• Spillage of sugar from the hopper and bagging point |
| 7.  | Occupational Health and Safety | • High noise levels and High temperatures  
• High dust levels  
• Machine guards |
| 8.  | Poor sanitation and hygiene | • Changing cane at the yard  
• Unhygienic practices at the factory  
• Toilets dirty and in bad state of repair  
• No clean drinking water points |

Source: UCPC, 2004
2. **Planning and organization**

Planning and organization was very important for the successful start of the CP programme in SCOUL.

- The Chief Executive Officer of SCOUL committed himself to sending two people for the Eco-Benefits programme that began in June 2003 and ended in April 2004, (ten weeks). These constituted the core.

- Employees were involved as part of the extended CP team. These were drawn from all sections of the factory including planning, engineering, processing and maintenance.

- Every after the weekly Eco–Benefits training, an in-house training of the week’s topic was conducted for the extended team.

- Goals to address the above issues were set per topic addressed following the tasks in each unit.

3. **Assessment Procedure**

**Source identification**

Material flow diagram was made to identify sources of waste and waste generation

**Cause diagnosis**

Factors that influenced the volume and composition of the waste were investigated.

**Option generation**

Ways of how to eliminate or control each of the causes of waste and emission generation in option generation the following were considered.
Table 2.2: Showing CP Options in SCOUL and their Related Benefits

<table>
<thead>
<tr>
<th>Area</th>
<th>CP Options</th>
<th>Major benefits to be achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cane preparation</td>
<td>• Install conveyor to reclaim falling prepared cane</td>
<td>• Saving sugar loss</td>
</tr>
<tr>
<td></td>
<td>• Proper maintenance of cane-carriers</td>
<td>• Saving sugar loss and labour</td>
</tr>
<tr>
<td></td>
<td>• Seal all the openings in the cane carrier side plate.</td>
<td>• Saving on cane staling and crushing at the yard</td>
</tr>
<tr>
<td></td>
<td>• Increased mechanical off loading</td>
<td></td>
</tr>
<tr>
<td>Mill House</td>
<td>• Install steam injection pump to reclaim juice spillage/leakage from pumps</td>
<td>• Saving on sugar loss</td>
</tr>
<tr>
<td></td>
<td>• Replace the slates conveyors with rake elevator</td>
<td>• Good hygiene</td>
</tr>
<tr>
<td></td>
<td>• Use central lubrication system</td>
<td>• Reduced falling of cush-cush</td>
</tr>
<tr>
<td></td>
<td>• Replacing the dust conveyors with rake elevator</td>
<td>• Reduced use of lubrication oil</td>
</tr>
<tr>
<td>Boiling House</td>
<td>• Install level sensors to A-machine and crystallisers</td>
<td>• Eliminate spillage</td>
</tr>
<tr>
<td></td>
<td>• Replace the brushes in B and C machines</td>
<td>• Reduce leakages</td>
</tr>
<tr>
<td></td>
<td>• Interlock A-molasses pumps to the hopper</td>
<td>• Reduce spillages</td>
</tr>
<tr>
<td></td>
<td>• Use H₂O₂ instead of Sodium Hydrosulphide</td>
<td>• Eliminate the need for gas mask</td>
</tr>
<tr>
<td>Bagging House</td>
<td>• Connect the top screen at the sugar bin to the cyclone to suck sugar dust</td>
<td>• Better working environment due to reduced dust levels in the air</td>
</tr>
<tr>
<td></td>
<td>• Install a conveyor for rodi at the end of the end of the dryer</td>
<td>• Savings on sugar loss</td>
</tr>
<tr>
<td></td>
<td>• Enclose the A-melter to reclaim spillage</td>
<td>• Better hygiene</td>
</tr>
<tr>
<td></td>
<td>• Put angle to stop sugar falling from dryer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tile the floor of the bagging section</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provide the workers of the bagging section with hygienic wear.</td>
<td></td>
</tr>
<tr>
<td>Water Use</td>
<td>• Re-use the filter effluent and overflow from condensers cooling water for cane wash.</td>
<td>• Reduced water consumption and waste volume</td>
</tr>
<tr>
<td></td>
<td>• Monitoring and repair of condensate and water leaks</td>
<td>• Cleaner environment</td>
</tr>
<tr>
<td></td>
<td>• Give free to parties who can re-use</td>
<td></td>
</tr>
</tbody>
</table>

Source: UCPC, 2004
4. Evaluation of the CP options

The following evaluations were made for the CP options that were generated:

**Technical evaluation of the options**
- availability and reliability of the equipment
- expected maintenance
- operating and supervisory skills

**Economic evaluation of the options**
- Investments, operational costs and benefits
- The major evaluation criteria for the heavy investment option e.g. better maintenance of pumps was evaluated using the pay back period which was economically feasible.

**Environmental evaluation of the options**
- Leads to compliance of the NEMA environmental regulations and standards.

**Selection of the feasible options**
- All the options generated were technically, economically and environmentally feasible
- The maintenance of pumps had the highest financial investment but with a very short payback period (approx. 7 months).
- Some other options were low – medium cost options.
- The rest of the options were no cost options. (See options generated section 4.1).

5. Implementation and continuation of the CP programme in SCOUL

- The implementation of the CP options generated was made within the next six months of the Eco- Benefits programme up to April 2004. The Figure 2.2 below shows the options which have already been implemented:
2.5 The Eco-Benefits Programme

The Eco-Benefits Programme is one of the major activities of Uganda Cleaner Production Centre (UCPC). The Programme started in May 2002 and 40 enterprises from across Uganda have so far participated.

**The core objectives of the Eco-Benefits Programme**

- Strengthen the economic situation and competitiveness of companies in Uganda by introduce Cleaner Production
- Achieve sustainable industrial development and thus improve the ecological situation in Uganda
- Support an increasing number of companies of all sectors to become more efficient and hence remain competitive
- Provide selected company staff with comprehensive know-how and on the job training in CP
- Create awareness about Cleaner Production in relevant institutions and in the public by presenting convincing results.
PROCESS DESCRIPTION OF SUGAR PRODUCTION

**INPUTS**
- Cane from field
- Energy
- Weighed cane
- Energy
- Prepared cane
- Water (cooling)
- Energy (steam)
- Lubricants
- Chlorine(Cl₂)
- Sepran (flocculant)
- Mixed juice
- Lime
- Phosphoric acid
- Steam
- Electricity
- Bagacillo

**OUTPUTS**
- Weighed cane
- Waste cane (negligible)
- Prepared cane
- Wasted cane (negligible)
- Mixed juice spillages, Waste steam
- Bagasse, Waste oil
- Bagacillo, Effluent water
- Clear juice & waste juice
- Filter mud (muddy juice), Waste water & steam, Waste lime-waste steam, waste bagacillo

**Raw material**

**Cane Reception**

**Preparation**

**Juice Extraction**

**Clarification**

**Evaporation & Sulphitation**

**Pan Boiling & Crystallisation**

**Centrifugation**

**Drying**

**Packaging**

**Sugar**
Why companies participate in the Eco-Benefits Programme

- Cleaner Production leads to increased efficiency and minimisation of negative impacts on the environment through better use of materials, water and energy in companies.
- The Eco-Benefits Programme assists companies in achieving environmental compliance.
- Two staff members are trained to become in-house CP experts in each company. This enables the company to improve continuously through its own in-house capacities once the programme has been implemented.
- Companies that have successfully gone through the whole Eco-Benefits Programme obtain a certificate as well as special promotion through UCPC: A brochure about the Eco-Benefits of each company is produced and distributed widely.
- CP is a good basis for the implementation of an Environmental Management System and ISO 14000 series.
- Participating companies gain competitive advantages over those who have not undertaken the Eco-Benefits Programme.

Companies of all sectors, which have a keen interest in implementing improvements for more efficient and environmentally friendly production and services, can participate in the programme. Each participating company selects two staff members, e.g. production manager, quality manager, person responsible for environmental and waste management issues, to participate in the programme (UCPC, 2006).

2.6.1 Eco-Benefits III programme

The Eco-Benefits III programme of which SCOUL was a part started on the 25th June 2003. It took ten months from the start date and end on 16th April 2004 to complete the four phases of the Eco-Benefits programme. These phases constituted the programme as shown in Table 2.3 below:
### Table 2.3: Showing the Phase of the Eco-Benefits Programme

<table>
<thead>
<tr>
<th>Phase</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>The Guided Cleaner Production Phase. This leads to the presentation of the CP Assessment report for each company.</td>
</tr>
<tr>
<td>Phase B</td>
<td>Implementation of the generated CP options and energy efficiency measures</td>
</tr>
<tr>
<td>Phase C</td>
<td>Evaluation of the environmental and economic benefits that companies have achieved.</td>
</tr>
<tr>
<td>Phase D</td>
<td>CP certificate. UCPC presented CP certificates to successful companies and consultants. Their promotion will be continual throughout the country and internationally.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to CP</td>
</tr>
<tr>
<td>2</td>
<td>Environmental Legal Framework</td>
</tr>
<tr>
<td>3</td>
<td>Material Flow Analysis I (Waste Reduction Audit I)</td>
</tr>
<tr>
<td>4</td>
<td>Material Flow Analysis II (Waste Reduction Audit II)</td>
</tr>
<tr>
<td>5</td>
<td>Energy Management I &amp; II</td>
</tr>
<tr>
<td>7</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>8</td>
<td>Environmental &amp; Economic Interpretation and Evaluation of Data</td>
</tr>
<tr>
<td>9</td>
<td>Generation and Evaluation of CP-options, Preparation of CP Assessment Report</td>
</tr>
<tr>
<td>10</td>
<td>Discussion of CP Assessment Reports including the Proposals for CP Implementation</td>
</tr>
</tbody>
</table>

Source: UCPC, 2004

The lessons learnt at the workshops in Phase A were re-discussed in meetings at SCOUL. The meetings were attended by the CP core and extended team members as well as the CP consultants. See Table 2.4 below for the complete C team in SCOUL.
Table 2.4: Showing the CP team in SCOUL and their Responsibilities

<table>
<thead>
<tr>
<th>No.</th>
<th>NAME</th>
<th>SECTION/RESPONSIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. Florence N.M Kasirye</td>
<td>Consultant (CP core team)</td>
</tr>
<tr>
<td>2</td>
<td>Ms Susan Atyang</td>
<td>Consultant (CP core team)</td>
</tr>
<tr>
<td>3</td>
<td>Mr. Apollo Lumala</td>
<td>Consultant (CP core team)</td>
</tr>
<tr>
<td>4</td>
<td>Mr. Lawrence Oboth</td>
<td>Deputy Manager Mill Sanitation; Head Hygiene and Sanitation Sub committee (CP core team)</td>
</tr>
<tr>
<td>5</td>
<td>Mr. Michael Kiiza</td>
<td>Ass. Manager Quality Assurance, CP Team Leader, Head Waste Management Sub Committee (CP core team).</td>
</tr>
<tr>
<td>6</td>
<td>Mr. S.C Khanna</td>
<td>Chief Executive</td>
</tr>
<tr>
<td>7</td>
<td>Mr. C.R Prassad</td>
<td>General Manager Works, Overall CP Coordinator</td>
</tr>
<tr>
<td>8</td>
<td>M.A.K Malik</td>
<td>Senior Manager Process, Implementing CP in Process House</td>
</tr>
<tr>
<td>9</td>
<td>Mr. W. Ziiwa</td>
<td>Asst. Manager Engineering, Head Maintenance Sub Committee</td>
</tr>
<tr>
<td>10</td>
<td>Mr. G. Muhangi</td>
<td>Asst. Manager Engineering, Cane Production</td>
</tr>
<tr>
<td>11</td>
<td>Mr. M. Ndiwalana</td>
<td>Asst. Manager Engineering, Boiling House Maintenance</td>
</tr>
<tr>
<td>12</td>
<td>Mr. J Katerega</td>
<td>Senior Manager Engineering, Head Cane yard Management Sub- Committee</td>
</tr>
<tr>
<td>13</td>
<td>Mr. N Rwangacharyulu</td>
<td>Manager Project &amp; Planning, Planning and Implementing CP Options</td>
</tr>
<tr>
<td>14</td>
<td>Mr. F. Mukomo</td>
<td>Asst. Manager Engineering; Head Mill Sub Committee</td>
</tr>
<tr>
<td>15</td>
<td>Mr. Pardha Saradhi</td>
<td>Deputy Manager Mill; Maintenance of the Mills</td>
</tr>
<tr>
<td>16</td>
<td>Mr. B.Okello</td>
<td>Deputy Manager Engineering; Head Steam Generation &amp; Distribution, Distillery Maintenance</td>
</tr>
<tr>
<td>17</td>
<td>Mr. Sirinivas</td>
<td>Deputy Manager Electrical, Head Energy Management Sub committee</td>
</tr>
<tr>
<td>18</td>
<td>Mr. N Tibata</td>
<td>Ass Manager Civil, Head Water Distribution and Consumption Sub Committee</td>
</tr>
<tr>
<td>19</td>
<td>Mr. D Agarwal</td>
<td>Manager Audit/ Management Information Systems</td>
</tr>
</tbody>
</table>

Source: UCPC, 2004
CHAPTER THREE

Methodology

3.1 Introduction

This chapter presents the processes and the research approach used to carry out the research. The study is based on both qualitative and quantitative information. It is noted that “researchers should not only consider which is the most appropriate method for the study of their chosen topic or problem but also what combination of research methods will produce a better understanding of it” (Hansen et al, 1998). In this sense the research drew on the case study methodology which uses a combination of methods to collect data.

3.2 Methodological Approach

As a qualified CP consultant in Uganda and a Masters student conducting her research in the area of CP, the key problem of data collection as far as access to industry was not encountered. It is acknowledged that this ease of access to the industry gave rise to easy obtaining of information.

To achieve the research goals, qualitative interviews of organisational staff was combined with an analysis of the relevant organizational documentation (Fielding, 1993). Documents analysed included archival material, annual reports and (where this does not breach corporate confidentiality) intra-company minutes, reports and correspondences (Deacon et al 1999).

The content analysis took place at two levels. It began with a quantitative account of the chosen indicators. The primary focus of this level was the measurement of the chosen indicators since “quantification gives researchers additional statistical tools to use that can aid in interpretation and analysis” (Wimmer and Dominick 1995:158). The quantitative information dealt with the available information from various sources including geographic area, temporal coverage, frequency coverage and data manipulation. See fact sheet in appendix A-F for detail).

The next level utilized these results to qualitatively analyze questions of diversity and compliance to CP and discuss their link to industrial sustainable development. The qualitative information focused on the data level in terms of
strength and weakness, reliability, accuracy robustness and certainty. These
details are represented in the fact sheets shown in the Appendices.

3.3 The Case Study Approach

This study employed the case study method because of its suitability in
attending to a wide spectrum of evidence such as documents and its
particularistic abilities in studying practical real-life problems such as
environmental issues at organizations (Wimmer and Dominick, 1991; Yin,
1984). A case study is useful in attending to documentary evidence as it is a
study of a bound system that emphasizes the unity and wholeness of that
system by confining attention to only those aspects that are relevant to the
research problem (Stake, 1994). This allowed the researcher to deal only with
issues arising out of the main concept of this study which is Cleaner Production
in SCOUL.

The case study method usually takes place within five distinct stages namely
design, pilot study, data collection, data analysis, and report writing (Wimmer
and Dominick, 1991).

In designing case studies, one should be concerned with what to analyse and what
exactly constitutes a case. A case, according to Wimmer and Dominick (1991)
and Yin (1984), might be a specific decision, a particular corporation at a
certain point in time, a programme, or some other discrete event. One way of
determining what to use as the unit of analysis is the available research
literature. In this study a particular corporation known as SCOUL was used as
the case study.

In the Pilot Study a study protocol is constructed before the pilot study is
conducted. The protocol included: procedures to be used in the study such as
data gathering instruments, procedures necessary for gaining access to SCOUL
and the method for accessing records; questions central to the inquiry and
possible sources of information to be tapped in answering these questions. The
schedule of data collection and addressed the problem of logistics such as
office space available for my research, availability of copy machine to duplicate
records and what would be needed in the way of supplies. The pilot study was
then conducted and was used to refine the research design and the field
procedures. The problem of logistic was also uncovered. The results of the
pilot study were then used to revise and polish the study protocol.
Data collection: Most case studies recommend using multiple sources of data thus affording triangulation of the phenomenon under study (Rubin, 1984). In addition multiple sources help the case study researcher improve the reliability and validity of the study. A study of the case study method found that the ones that used multiple sources of evidence were rated higher than those relying on a single source (Yin, Baterman, & Moore, 1993). The data collection stage may involve observation, interviews, survey research methods, and documents. For the purposes of this study, documents, interviews and observations were used to collect data on CP in SCOUL.

Data analysis: Yin’s (1989) suggested three broad analytical strategies which were used to analyze data in this study. These are pattern matching, explanation building and time series. Pattern matching involves comparing an empirically based predicted pattern with a predicted pattern or several alternative predicted patterns (Wimmer and Dominick, 1991: 152). In explanation building, the researcher constructs an explanation about the case by making statements about the cause or causes of the phenomenon under study whereas in time series, the investigator depends mainly on published documents such as annual reports to reach a conclusion for their study.

Report writing: Traditionally, the report can follow a format proceeding with problem, methods, findings and discussion. However, it can also follow a non-traditional format such as chronological arrangement in case the study is comparative in nature (Wimmer and Dominick, 1991). This case study report followed the traditional research study format of Problem, methods findings and discussion in the form of IMRAD i.e. Introduction, Methods, Results And Discussion.

The case study method is also considered useful for this study as it generates new perspectives, new meanings and fresh insights, which can be used in improving future policy processes (Wimmer and Dominick, 1991). This is because case studies are considered as a step into action. Their insights may be directly interpreted and put to use in democratising the decision-making process (Cohen and Manion, 1994:123).

3.3.1 Selection of the case study

The case study was selected according to the purposes set out by Patton (1990):

- Typical case sampling. The purpose of such a study is to illustrate or highlight the typical, normal or average.
• **Criterion sampling.** Cases that meet some criterion are selected.

• **Snowball or chain sampling.** This is often used within a case to select persons to interview. Each interviewee is asked to suggest who to interview next to gain more information.

• **Combination sampling.** Two or more principles of purposeful sampling are used in combination. This provides a kind of triangulation.

### 3.3.2 Document Analysis

Documents are considered an important source of information since they are most likely to reflect an authentic situation that occurred at some stage in the past (Lincoln and Guba, 1988). Documents are also important since they are less susceptible to alteration (Chikunkhuzeni, 1999). Documentation has the advantage of being: Stable it does not change and can be reviewed many times. Unobtrusive: documentation is not created as a result of the case study. Exact: names, places, times and other details are often exact. Broad in coverage: in a series of agendas from meetings, for instance a long time span is covered (Johansson, 2004).

The SCOUL policy process of documenting their information allows the departments to submit their results to management in order to report on the progress of the company. The corporation’s employees are clearly guided on what the company expects to receive in their daily, weekly, monthly and annual reports. The documents analysed in this data were widely available to me through permission from the Executive Director. Some of the general information however was obtained for the internet sources and the SCOUL website. For the documentation, the following are the main sources:

- CP Evaluation Report for SCOUL 2005
- Internet
- Reports from Uganda Cleaner Production Centre, UNIDO and UNEP

### Validating Evidence

The results of the case study were validated through triangulation. “Triangulation has been generally considered a process to clarify meaning by identifying different ways the phenomenon is being seen” (Stake, 1998). Triangulation means that one applies several- three or more-alternative approaches to each item. In connection with qualitative methods Data and Method Triangulation were used according to Patton (1987).
• Data triangulation: several sources from which to collect data about the same phenomenon.
• Method triangulation: several methods are used to gather data about the same phenomenon.
• Theory triangulation: the same data is analyzed using different principles. The analytical methods used were Time-Series Analysis, Explanation building and Pattern-Matching.
CHAPTER FOUR

Results and Discussion

The results and discussions for this study are based on the selected indicators:

- Recovery % of cane indicator
- Sugar (Product) indicator
- Energy loss indicator
- Sugar sample indicator
- Effluent indicator
- OHS indicator

The above indicators were chosen to assess the CP in SCOUL. Fact sheets for each indicator are found in appendices A-F.

4.1 Benefits of Cleaner Production in SCOUL in 2004

The Table 4.1 below is a summary of both the economic and environmental benefits which resulted from CP options implemented in 2004.

**Table 4.1: Showing a Summary of the CP Options in 2004 and Related Benefits**

<table>
<thead>
<tr>
<th>CP Options</th>
<th>Capital Investments US $ / year</th>
<th>Cost savings US $/year</th>
<th>Payback (years)</th>
<th>Environmental benefits</th>
<th>Economic benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous recovery of falling prepared cane</td>
<td>8,630</td>
<td>80,370</td>
<td>0.11</td>
<td>Less Suspended solids and BOD in run-off water</td>
<td>Increased yield/hectare</td>
</tr>
<tr>
<td>Switching off lights during (the day)</td>
<td>Nil</td>
<td>1,000</td>
<td>Immediately</td>
<td>Reduction in energy consumption and CO2 emissions</td>
<td>Reduced energy bills</td>
</tr>
<tr>
<td>Better maintenance of pumps</td>
<td>323,000</td>
<td>455,000</td>
<td>0.71</td>
<td>Less Suspended Solids and BOD in run-off water</td>
<td>Increased efficiency and productivity</td>
</tr>
<tr>
<td>Reduction in quantity of sugar sampled per day from 5kg to 1kg</td>
<td>Nil</td>
<td>595</td>
<td>Immediately</td>
<td>Conservation of resources</td>
<td>Increased overall yield of product</td>
</tr>
<tr>
<td>Reduce wet floor cleaning to twice a week</td>
<td>Nil</td>
<td>Nil</td>
<td>Immediately</td>
<td>Reduced effluent volume</td>
<td>Reduced water bills</td>
</tr>
<tr>
<td>Replaced horse pipe at the mill</td>
<td>335</td>
<td>1,500</td>
<td>0.22</td>
<td>Mill effluent rate reduced from 240 to 140(m³/day)</td>
<td>Clean working environment</td>
</tr>
</tbody>
</table>

Source: UCPC, 2004
**Additional benefits through Eco-Benefits**

- Workers were trained on CP leading to better awareness of Environmental Management Systems
- Improved relations with Environment stakeholders like NEMA and Directorate of Water Development
- Better public image

**4.2 Benefits of Cleaner Production in SCOUL in 2005**

The following are the continued benefits of the CP options in the year 2005.

**Raw material losses /Mishandling of raw material (cane)**

- Staling of cane at the yard reduced i.e. cane balance was less or equal to 200 tonnes most of the time because the principle of first-in-first out was applied
- Falling prepared cane from cane carriers was recovered regularly
- Timely shut downs are taken and proper maintenance is done
- Sling bar was put in place to reduce on cane trampling in the yard.

**Leakage of sugar containing material in factory**

- Many old pumps were replaced by new ones
- For any leakages of solid material, it is reclaimed immediately
- Undetermined pol losses were reduced from 0.33% in 2003 to 0.21% in 2004 and 0.07 in 2005.

**Energy Losses**

- Steam leakages were minimized through attending to them regularly
- Daily cost-cutting measure of power consumption was achieved through installing transparent sheets in some areas like mill house, boiling house, bagging and power house. Many of the bulbs are switched off during the day and only switched on at night.
- Many vessels and steam pipes were lagged to reduce heat loss.

**Large quantity of sugar samples use in the laboratory**

- Juice quantity was reduced to one litre per sample
- Sugar quantity was reduced to 500g for composite sample
**Large volume of effluent**
- Floor washing was reduced to twice a week to reduce on effluent
- Leakages from pumps, tanks, and valves are attended to regularly
- Overflows from spray pond are used for can washing
- Flow rates are monitored daily as against the target and standard. Effluents flow rates reduced from 107 m$^3$/hr in January 2006 to 52 m$^3$/hr in June 2006.

**Effluent Quality**
- The High Total Suspended Solids in mill house has somewhat been reduced since rake elevators are used instead of inter carriers to reduce cushion-cush spillages.
- Some effluent parameters are being determined like pH, COD, BOD, TDS and EC.

**Occupational Health and Safety**
- Noise levels are being monitored and measures are put in place to reduce it e.g. silencers, working on steam leakages, provision of PPE to workers.
- High temperatures in the house are reduced by lagging steam pipes and vessels.
- Machine guards are put on most of the machines.

**Fire Risk**
- Hydrant points are paced in strategic points inclusive of other fighting equipment like CO$_2$ fire extinguishers and sandbags all over the factory.
4.3 Implications of the results

This section discusses the findings in light of the indicators used in implementation of the CP options in SCOUL. The section discusses the recovery % cane first, followed by sugar indicator, energy consumption indicator and sugar sample indicator. It also discusses the wastewater indicators regarding volume and quality of the effluent. Lastly it discusses the Occupational Health and Safety indicator. The indictors reflect the impact of CP in SCOUL.

4.3.1 Increase in Recovery % Cane Indicator

*Figure 4.1 : Showing Increase in Recovery % Cane Indicator*

![Graph showing increase in recovery % cane from 2000 to 2005.](image)

The Recovery % cane is the relation between the sugarcane that was crushed to that which was bagged. According to SCOUL, the target recovery % cane is 9.20. This target has not yet been achieved so far. However, Figure 4.1 shows that a significant increase in the recovery % cane occurred after the implementation of CP in 2004. Unfortunately this figures dropped slightly in 2005 due to a number of reasons.

One of the reasons was the significant shutdown time experienced in this year. The factory experienced a total of over 600 hours shutdown time in 2005 compared to an average of 400 hours shutdown in the previous years. Shutdown time is usually due to machine breakdown which requires that new machines are installed and/or ones replaced. *(See the appendix for details of hours of*
The frequent plant shutdowns and stoppages meant that the sugarcanes were left stalled for long hours before being processed. As such their moisture content was reduced leading to less juice and sugar extracted than is usually the case. According to the environmental staff, this contributed to the lower recovery % of cane.

Secondly, according to the SCOUL environmental staff, it was suspected that the sugar cane harvested in 2005 was not mature enough and thus had a low pol% cane. There is a direct relationship between the sugar/sucrose content of cane, which may be referred to as pol% cane or recovery% cane. The likelihood of extracting more sugar from cane increases with pol % cane. But there are other process factors which affect recovery such as microbial inversion of sucrose, formation of dextran (which is the reverse of microbial inversion), performance of the sugar mills, maceration at the mills, evaporator efficiency, spillages, et cetera. Moreover the recovery % cane is directly related to the maturity age of the sugarcane. Current research in SCOUL in 2006 revealed that: Young sugarcane (before 11 months) gives low recovery because it has very low pol % content. Sugarcane between 11-15 months has pol % cane between 6-7.5. Mature cane (between 19-21 months) has pol % cane between 10-12. Very mature sugarcane beyond 21 months also has a low pol % because at some point, the sugar cane begins to use up the sucrose in its stem. So, the time of harvesting matters; not too young and not too old. Unfortunately there was no supportive data for 2005 for the above argument. However through CP, SCOUL is now in the process of researching to find out the optimum maturity age for harvesting the sugar so that the targeted recovery % cane of 9.2 is achieved.

4.3.2 Increase in Sugar (product) Indicator

Figure 4.2: Showing Increase in Sugar (product) Indicator
The amount of sugar bagged increased from 2001 to 2004 as seen from Figure 4.2. However, there was a significant drop in 2005. This drop in sugar bagged was attributed to frequent plant shutdown for many hours as discussed in the previous section. This therefore did not yield the increase expected when CP options are implemented.

Less sugar bagged in 2005 may also be due to losses of sugar during bagging or a few processes before bagging. This may be due to loss of sugar-containing material in the factory. The Total Loss is composed of Pol in (Bagasse + Filter Cake + Molasses + Undetermined lost pol). See fact sheet for the specific details of sugar bagged and Total loss.

The significant loss of sugar in 2005 is demonstrated in the Figure 4.3 below. It can be argued that the loss of sugar signifies a slackening of the implementation of some particular CP options in 2005 compared to 2004.

*Figure 4.3: Showing Total Loss in SCOUL form 2000 to 2005*

The Undetermined Pol loss decreased significantly between 2003 and 2005. The Undetermined pol loss is the pol loss that is not measured directly but rather obtained by subtracting the pol in (Bagasse + Filter Cake + Molasses) from the total losses. These undetermined losses are mostly due to leakage of juice and sugar spillages. It can be observed from the Figure 4.4 below that the undetermined pol losses greatly reduced from 2003 to 2005. This reduction in undetermined pol could be attributed to the related CP options which were
implemented in this period. These CP Options included the replacement of many old pumps with new ones as well as immediate reclaiming of solid sugar-containing material. See fact sheet in Appendix B for details of undetermined loss.

*Figure 4.4: Showing Undetermined Pol Loss from 2000 to 2005*

![Undetermined Pol Loss (%)](chart_4_4)

4.3.3 Energy Consumption Indicator

*Figure 4.5: Showing Annual Power Consumption in SCOUL*

![Annual Power Consumption (MWH)](chart_4_5)

The energy consumption indicator is mainly concerned about the annual consumption of power in SCOUL. It was divided into three parts namely: Turbine Alternator Source, State Power Source and Factory usage as shown in above Figure 4.5.
There was an increase in the amount of power consumed from 2003 to 2005. Moreover, one may notice the increased use of Turbine Alternator Source power from 2003 to 2004 after implementation of CP options. The Turbine Alternator Source Power is that power that is produced from steam after burning bagasse at the boilers, while the State power is the power supplied by Uganda Electricity Distribution Company Limited (UEDCL). CP encouraged the factory to rely more on their own power source thus reducing the total amount of State power use. In fact the long term plan is to stop using State Power source and rely completely on the Turbine Alternator Source Power.

In 2005 however, there was a decrease in the Turbine Alternator Source Power and an increase in the State Power Source as well as increased factory usage of power in that year. This was possibly due to the frequent shutdown of the factory during this period resulting in less power produced by the factory and thus dependence on the State Power instead. Also there were many machine installations and testing of these machines during 2005 which consumed a lot of the State Power. This resulted in the general increase of factory usage of power. See Appendix C for fact sheet with details of Annual Power Consumption.

According to the environmental staff in SCOUL, lights were switched off during the day which led to reduction in power consumption and CO_{2} emissions. However, due to its insignificant amount compared to power consumed by the machines, the reduction in power consumption, as a result of switching off lights during the day, was not reflected in the overall picture of the power consumption of SCOUL.

**4.3.4 Reduction of Sugar Sample Indicator**

The quantity of sugar sampled per day for laboratory use was reduced from 5kg to 1kg in 2004. This led to an increased overall yield of sugar product in 2004 as seen in Figure 4.2 above.

Until 2004, an old technology saccharimeter was being used to measure pol in sugar. This saccharimeter needed to be used in a dark room and required large quantities of sugar to be sampled. However with the implementation of CP in SCOUL, a newer technology saccharimeter was introduced which is easier to use and requires less quantities of sugar to be sampled. The quantity of sugar sampled was further reduced to 500g in 2005 up to date.
4.3.5 Reduction in Volume of Effluent Indicator

Figure 4.6: Showing Monthly Average Flow Rates (m$^3$/hr) in 2006

The above Figure 4.6 shows that the volume of effluent is continuously reducing and is soon getting to the target of 40m$^3$/hr as indicated in the month of July 2006. The data obtained for the volume of effluent in SCOUL was only for January to July 2006. This is because no continuous monitoring was being done in the earlier years. The volume of effluent was mostly reduced directly by reducing wet floor cleaning to only twice a week as compared to everyday cleaning. Also leakages from pumps, tanks, and valves are attended to regularly; overflows from spray pond are used for cane washing.

The reduction in effluent was also due to recycling of all cooling water from: Sulphur burner air compressor, Centrifugal Pumps, Boiler air compressors Boiler feed water pumps, Power turbine bearings, mill bearings, Fibrisor and Cooling glands of all vacuum pumps of filters.

Construction of the reservoir tank at the spray pond also contributed to the reduction in flow rates. However mill bearings are still leaking; if worked on, there will be a further reduction in the flow rates. See fact sheet in Appendix E for data of average flow rate of 2006. Regarding the quality of effluent, an oil separator plant was constructed which deals with separating oil and bagasse from the effluent. This has greatly reduced the quality of the effluent ending up in River Musamya though it is still not up to the required standard of NEMA. See fact sheet in Appendix E for details of quality of effluent. The data of quality of effluent used in this study was the monthly quality of effluent produced by SCOUL in June 2006. There was no data collected for the earlier years. The parameters
measured for the quality of effluent produced are BOD, COD, TDS, EC and pH. See fact sheet in Appendix E for the quantities of these parameters.

4.3.6 Occupational Health and Safety (OHS) Indicator

In this thesis study the OHS Indicator only concentrated on the Personal Protective Equipment (PPE) distributed to the employees in SCOUL. There was a significant increase in the number of PPE issued to employees working in unfriendly environments in 2005 and 2006. See Table 4.2 below. The Group Personal Accident Policy (GPA) was also revised making it more favourable for the employees. However, fly ash from boilers is still a big problem with ash entering into people’s eyes. Measures suggested to mitigate this fly ash include: installing Cyclones, Bag houses, Electrostatics precipitators, Absorption equipment and Wet scrubbers.

Also, noise pollution has persisted from the following equipment:

- Main Steam Header = 101.15db (max),
- Mill turbine No.3 = 112db (max),
- PRD Station =112.20 db (max).

This equipment is giving residual noise to the surrounding places. Some ear plugs and ear muffs were supplied to some people in these sections as shown in the above table but some sections still need to be dealt with concerning the noise pollution.
Table 4.2: Showing Personal Protective Equipment (PPE) issued in 2005 and 2006

<table>
<thead>
<tr>
<th>No.</th>
<th>Protective Wear</th>
<th>Quantity</th>
<th>Section</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Over Coats</td>
<td>09</td>
<td>Quality Assurance</td>
<td>March</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72</td>
<td>G Shift</td>
<td>April</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52</td>
<td>Managers</td>
<td>April</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>Managers Trainees</td>
<td>November</td>
</tr>
<tr>
<td>2</td>
<td>Overalls</td>
<td>106</td>
<td>Shift + G. Shift</td>
<td>April</td>
</tr>
<tr>
<td>3</td>
<td>Leather Gloves</td>
<td>10</td>
<td>Workshop</td>
<td>March</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>Mills</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>08</td>
<td>Pumping</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>01</td>
<td>Clarification</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>01</td>
<td>Turbines</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>02</td>
<td>Boilers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>06</td>
<td>Boiling House</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>03</td>
<td>Electrical</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>03</td>
<td>Welfare</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rubber Gloves</td>
<td>17</td>
<td>Quality Assurance</td>
<td>March</td>
</tr>
<tr>
<td>5</td>
<td>Rain Coats</td>
<td>10</td>
<td>Quality Assurance</td>
<td>March</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Cane Analysis)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>White Over Coats</td>
<td>10</td>
<td>Bagging</td>
<td>March</td>
</tr>
<tr>
<td>7</td>
<td>Nosal Masks</td>
<td>09</td>
<td>Process Civil</td>
<td>March</td>
</tr>
<tr>
<td></td>
<td></td>
<td>08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Goggles</td>
<td>06</td>
<td>Mill House</td>
<td>March</td>
</tr>
<tr>
<td></td>
<td></td>
<td>01</td>
<td>Boilers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>02</td>
<td>Boiling House</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>07</td>
<td>W/House</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>31</td>
<td>Boilers</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Ear plugs</td>
<td>21</td>
<td>Boilers</td>
<td>December</td>
</tr>
<tr>
<td>10</td>
<td>Ear Muffs</td>
<td>10</td>
<td>Managers and Supervisors - Boilers</td>
<td>December</td>
</tr>
<tr>
<td>11</td>
<td>Gas Mask</td>
<td>04</td>
<td>Clarification</td>
<td>December</td>
</tr>
<tr>
<td>12</td>
<td>Hard Hats</td>
<td>100</td>
<td>Cane Yard (02)</td>
<td>February (2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mills (29), Eng (08)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boilers (28), Process (02)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Boiling House (22)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Electrical (04)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Workshop (05)</td>
<td></td>
</tr>
</tbody>
</table>

**Major Lessons Learnt from CP**

- CP options substantially reduce the size of environmental investments because they are easy to implement and are sustainable with good financial paybacks.
- CP options can be best implemented with the involvement of shop floor workers, industry technicians and management. Process technologists developed the most effective solutions, after the identification of environmental problems by the CP team.
- Best tools for identifying the areas of CP options implementation are material balances and water balances.
- Much as CP options are not a replacement to end-of-pipe treatment systems in all cases; they have the potential to reduce the size of end-of-pipe treatment and resource optimization.
- There is a need for continuous improvement in CP and research for new and modern techniques of CP options.
- Partners of CP options dissemination are industry associations (UNIDO, 1997).
CHAPTER FIVE

Conclusion

This chapter makes some recommendations arising from the whole study and presents concluding remarks. The chapter also identifies areas for further research.

5.1 Evaluation of CP in SCOUL

Based on the findings of this study, SCOUL is very much concerned about its environmental issues. This is well articulated in their environmental policy in which environmental management is one of the key issues.

Before implementation of CP in SCOUL, considerations were being given to ‘end-of-pipe’ approach which required a lot of money. CP approach has offered SCOUL a more practical and economic solution to many of its environmental problems. In fact SCOUL had adopted some CP practices (notably leakage control and the upgrading of turbo alternator to increase power generated locally) prior to joining the Eco-Benefits programme which made the suggestions from CP more readily acceptable.

From this study it can be concluded that CP is a practical tool towards sustainable industrial development since it leads to improvement in both environmental and economic performance of the industry as demonstrated in the results and discussion of SCOUL. It can therefore be concluded that CP will also lead to sustainable industrial development of other Ugandan industries.

5.2 Focus Areas for Improvement

Whereas many CP options have been implemented in SCOUL, there is a lot more that still needs be done in the company as a partner in sustainable development. For example there is no formal CP team in place; hence no meetings for effective follow up of CP options. Furthermore, there is no formal budget for CP activities and implementation of options. The sustainability of CP in SCOUL is therefore still questionable because it is observed that there is a decline in some of the indicators which were assessed in 2005. These include recovery% cane, sugar bagged and energy consumption
indicators. This may be explained by the fact that CP in SCOUL lacks regular monitoring and therefore has been slackening in its performance.

5.2.1 Regarding CP in SCOUL

- The portion of the oil separator plant which deals with separating bagasse from the effluent and oil needs to be improved so that it can perform its intended purpose.

- To achieve the targeted recovery % cane, sugarcane to be crushed (even cane bought from out growers) should be that of the optimum maturity age which will soon be disclosed by the current research in SCOUL.

- Fly ash needs to be trapped more efficiently.

- Mill bearings which are still leaking should be worked on there for further reduction in the flow rates.

- Routine maintenance of machines needs to be done to prevent frequent plant breakdown.

- All the workers need to be supplied with Personal Protective Equipment.

- Noise needs to be reduced to the required factory standards (85 db) especially noise coming from the Main Steam Header and Mill turbine No.3 equipment as mentioned in section 4.3.6

5.2.2 Regarding Cleaner Production in Uganda

Currently a large potential of CP remains untapped due to a lack of awareness by many industries in Uganda. In order to change the situation, and ensure that the potential of CP is adequately utilized in Uganda’s environmental protection and sustainable development efforts, it is necessary for UCPC to apply a strategic approach to promoting implementation of CP in all Ugandan industries. The strategy should elaborate various actions that the different stakeholders could take. It should provide a basis for formulating a concrete plan of action on how implementation of CP in Ugandan industries will lead to sustainable development.
5.3 Recommendations for Further Study

The following are the possible suggestions for further studies of CP in SCOUL as well as other industries in Uganda.

Not only has CP caused greater environmental and economic performance but it has also made the industry more efficient. It is recommended that a study be done to find out to what extent SCOUL has become more efficient since the implementation of CP.

It is recommended that further studies be undertaken to include the agricultural process of sugar (i.e. growth of sugarcane) manufacture in SCOUL and how CP can be applied to this process.

It is also recommended that CP assessments be made in the other industries which implemented CP to evaluate their current status and recommendations made for the sustainability of CP in these industries.

Given all the benefits of CP, it is surprising that not all industries have willingly embraced this concept. A study should be made on why many industries in Uganda have not yet implemented CP.
List Figures

Figure 2.1: Showing Background of Sugar Corporation Of Uganda Limited..............18

Figure 2.2: Showing a Heap of Baggase.........................................................................21

Figure 2.3: Showing CP Assessment Methodology..........................................................22

Figure 2.4: Showing the CP Options Implemented in SCOUL.......................................27

Figure 4.1 : Showing Increase in Recovery % Cane Indicator........................................41

Figure 4.2: Showing Increase in Sugar (product) Indicator.............................................42

Figure 4.3: Showing Total Loss in SCOUL form 200 to 2005.......................................43

Figure 4.4: Showing Undetermined Pol Loss from 2000 to 2005....................................44

Figure 4.5: Showing Annual Power Consumption in SCOUL..........................................44

Figure 4.6: Showing Monthly Average Flow Rates (m³/ hr) in 2006...............................46
List of Tables

Table 2.1: Showing Problems and Priority Areas for CP in SCOUL............................23
Table 2.2: Showing CP Options in SCOUL and their Related Benefits...........................25
Table 2.3: Showing the Phase of the Eco-Benefits Programme...........................................30
Table 2.4: Showing the CP team in SCOUL and their Responsibilities.........................31
Table 4.1: Showing a Summary of the CP Options in 2004 and Related Benefits..............39
Table 4.2: Showing Personal Protective Equipment (PPE) issued in 2005 and 2006 ......47
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>Cleaner Production</td>
</tr>
<tr>
<td>SCoufl</td>
<td>Sugar Corporation Of Uganda Limited</td>
</tr>
<tr>
<td>UCPC</td>
<td>Uganda Cleaner Production Centre</td>
</tr>
<tr>
<td>SIDA</td>
<td>Swedish International Development Agency</td>
</tr>
<tr>
<td>SI</td>
<td>Swedish Institute</td>
</tr>
<tr>
<td>EESI</td>
<td>Environmental Engineering and Sustainable Infrastructure</td>
</tr>
<tr>
<td>NCPCs</td>
<td>National Cleaner Production Centres</td>
</tr>
<tr>
<td>UNIDO</td>
<td>United Nations Industrial Development Organisation</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>EPIs</td>
<td>Environmental Performance Indicators</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Environmental Management Authority</td>
</tr>
<tr>
<td>MEAs</td>
<td>Multilateral Environmental Agreements</td>
</tr>
<tr>
<td>UNEP-DTIE’s</td>
<td>United Nations Environment Programme - Division of Technology, Industry and Economics.</td>
</tr>
<tr>
<td>EA</td>
<td>Environmental Assessment</td>
</tr>
<tr>
<td>OHS</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>PPP</td>
<td>Polluter-Pays- Principle</td>
</tr>
<tr>
<td>IMRAD</td>
<td>Introduction, Methods, Results And Discussion</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
</tr>
<tr>
<td>BOD</td>
<td>Biodegradable Oxygen Demand</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
<tr>
<td>EC</td>
<td>Electrical Conductivity</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>UEDCL</td>
<td>Uganda Electricity Distribution Limited</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
</tbody>
</table>
References

• UNEP’s Proposal for a Work Programme on Promoting Sustainable Consumption and Production Patterns (August 2002).
Appendices

- Appendix A: Indicator Evaluation Fact Sheet for Recovery % Cane Indicator.
- Appendix B: Indicator Evaluation Fact Sheet for Sugar/Product Indicator
- Appendix C: Indicator Evaluation Fact Sheet for Energy Consumption Indicator.
- Appendix D: Indicator Evaluation Fact Sheet Sugar Sample Indicator
- Appendix E: Indicator Evaluation Fact Sheet Effluent Indicator
- Appendix F: Indicator Evaluation Fact Sheet Occupational Health and Safety Indicator
- Appendix G: Map of Africa Showing Uganda and SCOUL
# Appendix A

## INDICATOR EVALUATION FACT SHEET FOR RECOVERY % CANE INDICATOR

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator Name</strong></td>
</tr>
<tr>
<td><strong>Year of Assessment</strong></td>
</tr>
<tr>
<td><strong>Type of Indicator</strong></td>
</tr>
<tr>
<td><strong>Frequently Asked Question</strong></td>
</tr>
<tr>
<td><strong>Priority Concern</strong></td>
</tr>
<tr>
<td><strong>Geographic Area</strong></td>
</tr>
<tr>
<td><strong>Magnitude and trend</strong></td>
</tr>
<tr>
<td><strong>Key Message</strong></td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition

Percentage of sugar recovered from the crushed cane in SCOUL is indicated as an annual recovery percentage (%) cane from 2000 – 2005.

2. Data Source

Data on recovery % cane is obtained from:
- Sugar Corporation Of Uganda Limited Yearly Manufacturing Report and
- Sugar Corporation Of Uganda Limited Monthly Manufacturing Report

Prepared by SCOUL Assistant Quality Assurance, Manager Quality Assurance, Sr. Manager Process and acknowledged by Dy General Manager Works.

3. Geographic area/Industrial coverage

Data on recovery % cane is covered only for SCOUL. The map showing SCOUL is in Appendix G.

4. Temporal Coverage

The recovery % cane is assessed from 2000 to 2005.

5. Methodology and Frequency of Coverage

The recovery % cane is collected monthly by SCOUL for 12 months and then the average is calculated to obtain the yearly recovery % cane for that year.

6. Methodology and Data Manipulation

Data recovery % cane is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)

The data on recovery % cane in SCOUL comprises the exact figures that were collected by SCOUL and presented in their Yearly Manufacturing Report.
2. Reliability, Accuracy, Robustness, Uncertainty (data level)

The Quality Assurance and the Process Departments are responsible units for the data in SCOUL.

SUPPORTING DATA

*Table showing Recovery % Cane during 2000-2005*

<table>
<thead>
<tr>
<th>CANE CRUSHED</th>
<th>318,750</th>
<th>312,987</th>
<th>441,929</th>
<th>451,907</th>
<th>544,151</th>
<th>520,733</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUGAR BAGGED</td>
<td>28,093</td>
<td>24,528</td>
<td>32,786</td>
<td>35,578</td>
<td>46,819</td>
<td>44,137</td>
</tr>
<tr>
<td>RECOVERY % CANE</td>
<td>8.82</td>
<td>7.82</td>
<td>7.47</td>
<td>7.85</td>
<td>8.6</td>
<td>8.47</td>
</tr>
<tr>
<td>TOTAL LOSS</td>
<td>2.31</td>
<td>2.41</td>
<td>2.69</td>
<td>2.43</td>
<td>2.44</td>
<td>2.61</td>
</tr>
<tr>
<td>YEAR</td>
<td>2000</td>
<td>2001</td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
</tr>
</tbody>
</table>

Summary

1. Policy Reference

1.1 Purpose

The recovery % cane is aimed at assessing how much sugar has been recovered from the crushed cane. It is obtained from the percentage amount of sugar bagged divided by the cane crushed per year.

1.2 Relevance to Cleaner Production

The concept of Cleaner Production embraces the best guarantee for protecting the environment from hazards associated with wastes is to prevent generation of wastes and emissions in the first place, rather than regulate their disposal and require clean up efforts and measures. The higher the recovery % cane the lower the sugar losses. The recovery % cane is therefore an indirect indication of how much sugar has been lost from the cane crushed. A high recovery % cane means that we have less waste (losses) to deal with, and this is directly supported by the CP concept of “prevention is better than cure”.

1.3 Targets

SCOUL aims for a Recovery % cane of 9.2%. This target has not yet been met by SCOUL.
# Appendix B

## INDICATOR EVALUATION FACT SHEET FOR SUGAR/PRODUCT INDICATOR

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator Name</strong></td>
</tr>
<tr>
<td><strong>Year of Assessment</strong></td>
</tr>
<tr>
<td><strong>Type of Indicator</strong></td>
</tr>
<tr>
<td><strong>Frequently Asked Question</strong></td>
</tr>
<tr>
<td><strong>Priority Concern</strong></td>
</tr>
<tr>
<td><strong>Geographic Area</strong></td>
</tr>
<tr>
<td><strong>Magnitude and trend</strong></td>
</tr>
<tr>
<td><strong>Key Message</strong></td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition
Amount of sugar bagged from the crushed cane in SCOUL is indicated as tones per year from 2000 – 2005.

2. Data Source
Data on amount of sugar bagged is obtained from:
- Sugar Corporation Of Uganda Limited Yearly Manufacturing Report and
- Sugar Corporation Of Uganda Limited Monthly Manufacturing Report
  Prepared by SCOUL Assistant Quality Assurance, Manager Quality Assurance, Sr. Manager Process and acknowledged by Dy General Manager Works.

3. Geographic area/Industrial coverage
Data on amount of sugar bagged is only for SCOUL. The map showing SCOUL is in Appendix G.

4. Temporal Coverage
The amount of sugar bagged is assessed from 2000 to 2005.

5. Methodology and Frequency of Coverage
The amount of sugar bagged is collected monthly by SCOUL for 12 months and then the average is calculated to obtain the yearly amount of sugar bagged for that year.

6. Methodology and Data Manipulation
Data on amount of sugar bagged is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)
The data on amount of sugar bagged in SCOUL comprises the exact figures that were collected by SCOUL and presented in their Yearly Manufacturing Report.

2. Reliability, Accuracy, Robustness, Uncertainty (data level)
The Quality Assurance and the Process Departments are responsible units for the data in SCOUL.
**SUPPORTING DATA**

*Table showing Sugar Bagged during 2000 -2005*

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANE CRUSHED</td>
<td>318,750</td>
<td>312,987</td>
<td>441,929</td>
<td>451,907</td>
<td>544,151</td>
<td>520,733</td>
</tr>
<tr>
<td>SUGAR BAGGED</td>
<td>28,093</td>
<td>24,528</td>
<td>32,786</td>
<td>35,578</td>
<td>46,819</td>
<td>44,137</td>
</tr>
<tr>
<td>RECOVERY % CANE</td>
<td>8.82</td>
<td>7.82</td>
<td>7.47</td>
<td>7.85</td>
<td>8.6</td>
<td>8.47</td>
</tr>
<tr>
<td>UNDETERMINED POL. LOSS</td>
<td>0.38</td>
<td>0.16</td>
<td>0.34</td>
<td>0.33</td>
<td>0.21</td>
<td>0.07</td>
</tr>
<tr>
<td>TOTAL LOSS</td>
<td>2.31</td>
<td>2.41</td>
<td>2.69</td>
<td>2.43</td>
<td>2.44</td>
<td>2.61</td>
</tr>
</tbody>
</table>

**Summary**

1. **Policy Reference**

1.1 **Purpose**

The sugar bagged is aimed at assessing how much sugar has been produced from the crushed cane and also shows the performance of the industry. It is obtained from the amount of sugar that is actually put into bags and is ready for sale. The more sugar that is bagged, the more sales will be made and consequently the more profits the industry will make.

1.2 **Relevance to Cleaner Production**

The concept of Cleaner Production embraces economic gain through improved efficiency and reduction of wastes. The higher the amount of sugar bagged the more the sales and therefore the more the economic gain for the industry and for the country at large. Its relevance to CP is in the reduction of wastes from the source. The less the Total losses incurred during sugar production, the higher the amount of sugar bagged and this is part of what the CP concept is about.; reduction of pollution from the source.

CP is also about minimize losses so as to get maximum output out of raw materials. In other words CP encourages us to maximally utilize raw materials so as to get the most out of them. In SCOUL, the amount of sugar bagged is directly proportional to the amount of cane crushed. The more cane that is crushed, the more sugar is bagged. However, Cleaner Production does not require that we crush more cane in order to get more sugar bagged, but we
should minimize the losses so as to get the maximum output out of the cane that is crushed.

1.3 Targets

SCOUL’s target for the amount of sugar bagged is different for each year depending on the anticipated amount of cane crushed each year.

1.4 International Environment Treaties

Using Cleaner Production can facilitate attaining the objectives of most if not all MEAs e.g. the precautionary and preventative approach of CP is also stressed in Agenda 21 to enable economic growth in an environmentally sound and cost effective manner (UCPC, 2004).
## Appendix C

**INDICATOR EVALUATION FACT SHEET FOR ENERGY INDICATOR**

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator Name</strong></td>
</tr>
<tr>
<td><strong>Year of Assessment</strong></td>
</tr>
<tr>
<td><strong>Type of Indicator</strong></td>
</tr>
<tr>
<td><strong>Frequently Asked Question</strong></td>
</tr>
<tr>
<td><strong>Priority Concern</strong></td>
</tr>
<tr>
<td><strong>Geographic Area</strong></td>
</tr>
<tr>
<td><strong>Magnitude and trend</strong></td>
</tr>
<tr>
<td><strong>Key Message</strong></td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition
Amount of energy consumed annually in SCOUL is indicated as Yearly Power Consumption measured in Mega Watts (MW) per year from 2000 – 2005.

2. Data Source
Data on yearly power consumption is obtained from:
- Sugar Corporation Of Uganda Limited Yearly Manufacturing Report and
- Sugar Corporation Of Uganda Limited Monthly Manufacturing Report
Prepared by SCOUL Assistant Quality Assurance, Manager Quality Assurance, Sr. Manager Process and acknowledged by Dy General Manager Works.

3. Geographic area/Industrial coverage
Data on amount of power consumption is only for SCOUL. The map showing SCOUL is in Appendix G.

4. Temporal Coverage
The amount of power consumed is assessed from 2000 to 2005.

5. Methodology and Frequency of Coverage
The amount of power consumed is collected monthly by SCOUL for 12 months and then the average is calculated to obtain the yearly amount of energy consumed for that year.

6. Methodology and Data Manipulation
Data on amount of power consumed is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)
The data on amount of power consumed in SCOUL comprises the exact figures that were collected by SCOUL and presented in their Yearly Manufacturing Report.

2. Reliability, Accuracy, Robustness, Uncertainty (data level)
The Quality Assurance and the Process Departments are responsible units for the data in SCOUL.
SUPPORTING DATA

Table showing Yearly Power Consumption (MW) during 2000 -2005

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine Alternator Source</td>
<td>3.7532</td>
<td>8.6871</td>
<td>5.7276</td>
<td>2.4627</td>
<td>1.4427</td>
<td>2.0259</td>
</tr>
</tbody>
</table>

Summary

1. Policy Reference

1.1 Purpose

The energy consumption indicator is aimed at assessing how much sugar has been recovered from the crushed cane. It is obtained from the percentage amount of sugar bagged divided by the cane crushed per year.

1.2 Relevance to Cleaner Production

The concept of Cleaner Production embraces the best guarantee for protecting the environment from hazards associated with wastes is to prevent generation of wastes and emissions in the first place, rather than regulate their disposal and require clean up efforts and measures. The higher the recovery % cane the lower the sugar losses. The recovery % cane is therefore an indirect indication of how much sugar has been lost from the cane crushed. A high recovery % cane means that we have less waste (losses) to deal with, and this is directly supported by the CP concept of “prevention is better than cure”.

1.3 Targets

SCOUL’s target is to switch from using State Power from Uganda Electricity Distribution Company Ltd. (UEDCL) to using Turbine Alternator Source Power produced from the bagasse.
## Appendix D

**INDICATOR EVALUATION FACT SHEET FOR SUGAR SAMPLE INDICATOR**

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator Name</td>
</tr>
<tr>
<td>Year of Assessment</td>
</tr>
<tr>
<td>Type of Indicator</td>
</tr>
<tr>
<td>Frequently Asked Question</td>
</tr>
<tr>
<td>Priority Concern</td>
</tr>
<tr>
<td>Geographic Area</td>
</tr>
<tr>
<td>Magnitude and trend</td>
</tr>
<tr>
<td>Key Message</td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition
Amount of sugar sampled annually in SCOUL is indicated as kilograms (Kg) per year.

2. Data Source
Data on amount of sugar sampled was obtained from:
- Sugar Corporation Of Uganda Limited Environmental report 2005 prepared by the Assistant Manager Environment.

3. Geographic area/Industrial coverage
Data on amount of sugar sampled is only for SCOUL. The map showing SCOUL is in Appendix G.

4. Temporal Coverage
The amount of sugar sampled is assessed from 2000 to 2006.

5. Methodology and Frequency of Coverage
The amount of sugar sampled is collected from the monthly environment report of SCOUL.

6. Methodology and Data Manipulation
Data on amount of sugar sampled is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)
The data on amount of sugar sampled comprises the exact figures that were collected by SCOUL and presented in their environment report.

2. Reliability, Accuracy, Robustness, Uncertainty (data level)
The Assistant Manager Environment is responsible units for the data in the environment report of SCOUL.
Appendix E

INDICATOR EVALUATION FACT SHEET FOR EFFLUENT INDICATOR

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicator Name</td>
</tr>
<tr>
<td>Year of Assessment</td>
</tr>
<tr>
<td>Type of Indicator</td>
</tr>
<tr>
<td>Frequently Asked Question</td>
</tr>
<tr>
<td>Priority Concern</td>
</tr>
<tr>
<td>Geographic Area</td>
</tr>
<tr>
<td>Magnitude and trend</td>
</tr>
<tr>
<td>Key Message</td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition

Volume of effluent produced monthly in SCOUL is indicated as cubic meters per hour (m³/hr) for the year 2006.

2. Data Source

Data on volume of effluent produced is obtained from: Sugar Corporation Of Uganda Limited Monthly Average Flow rate Report

3. Geographic area/Industrial coverage

Data on volume of effluent produced is only for SCOUL. The map showing SCOUL is in Appendix G

4. Temporal Coverage

The volume of effluent produced is assessed for year 2006.

5. Methodology and Frequency of Coverage

The volume of effluent produced daily by SCOUL for 30 days and then the average is calculated to obtain the monthly volume of effluent produced.

6. Methodology and Data Manipulation

Data on a volume of effluent produced is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)

The data on volume of effluent produced in SCOUL comprises the exact figures that were collected by SCOUL and presented in their Monthly average flow rate report.

2. Reliability, Accuracy, Robustness, Uncertainty (data level)

The Quality Assurance and the Process Departments are responsible units for the data in SCOUL.
**SUPPORTING DATA**

*Table showing Effluent Parameters at SCOUL*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mill House</th>
<th>Boiling House</th>
<th>Factory</th>
<th>Distillery</th>
<th>Factory + Distillery</th>
<th>River Musamya</th>
<th>National Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD mg/l</td>
<td>4850</td>
<td>6530</td>
<td>5800</td>
<td>33400</td>
<td>9415</td>
<td>925</td>
<td>50</td>
</tr>
<tr>
<td>BOD mg/l</td>
<td>2500</td>
<td>3200</td>
<td>2890</td>
<td>7500</td>
<td>2350</td>
<td>410</td>
<td>100</td>
</tr>
<tr>
<td>TDS mg/l</td>
<td>302</td>
<td>833</td>
<td>475</td>
<td>11640</td>
<td>1900</td>
<td>1300</td>
<td>1200</td>
</tr>
<tr>
<td>EC µs/cm</td>
<td>544</td>
<td>1336</td>
<td>792</td>
<td>4420</td>
<td>800</td>
<td>740</td>
<td>1000</td>
</tr>
<tr>
<td>pH</td>
<td>4.36</td>
<td>6.81</td>
<td>5.67</td>
<td>3.48</td>
<td>4.89</td>
<td>5.89</td>
<td>6.0-8.0</td>
</tr>
</tbody>
</table>

COD – Chemical Oxygen Demand  
BOD – Biological Oxygen Demand  
TDS – Total Dissolved Solids  
EC – Electrical Conductivity
## Appendix F

### INDICATOR EVALUATION FACT SHEET FOR OCCUPATIONAL HEALTH AND SAFETY (OHS) INDICATOR

<table>
<thead>
<tr>
<th>DATABASE INFORMATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator Name</strong></td>
<td>Amount of PPE distributed to employees</td>
</tr>
<tr>
<td><strong>Year of Assessment</strong></td>
<td>2006</td>
</tr>
<tr>
<td><strong>Type of Indicator</strong></td>
<td>OHS Indicator</td>
</tr>
<tr>
<td><strong>Frequently Asked Question</strong></td>
<td>How many PPEs were distributed?</td>
</tr>
<tr>
<td><strong>Priority Concern</strong></td>
<td>Cleaner Production</td>
</tr>
<tr>
<td><strong>Geographic Area</strong></td>
<td>Lugazi, Uganda</td>
</tr>
<tr>
<td><strong>Magnitude and trend</strong></td>
<td>Relatively good</td>
</tr>
<tr>
<td><strong>Key Message</strong></td>
<td>The amount of PPEs distributed to employees was increased in 2005 after CP implementation.</td>
</tr>
</tbody>
</table>
TECHNICAL INFORMATION

1. Definition

The OHS annually in SCOUL is indicated as the amount of PPEs distributed to employees per year from 2005 – 2006.

2. Data Source

Data on the amount of PPEs distributed to employees is obtained from Sugar Corporation Of Uganda Limited OHS Report.

3. Geographic area/Industrial coverage

Data on amount of PPEs distributed to employees of SCOUL. The map showing SCOUL is in Appendix G.

4. Temporal Coverage

The amount of PPEs distributed to employees is assessed from 2005 to 2006.

5. Methodology and Frequency of Coverage

The amount of PPEs distributed to employees is collected monthly by SCOUL during those months when it is distributed.

6. Methodology and Data Manipulation

Data on amount of PPEs distributed to employees is directly extracted from the sources mentioned above in 2.0

QUALITATIVE INFORMATION

1. Strength and weakness (data level)

The data on amount of PPEs distributed to employees n SCOUL comprises the exact figures that were collected by SCOUL and presented in the OHS Report.

2. Reliability, Accuracy, Robustness, Uncertainty (data level)

The Quality Assurance and the Process Departments are responsible units for the data in SCOUL.
Summary

1. Policy Reference

1.1 Purpose
The OHS indicator is aimed at assessing to what extent the employees of SCOUL have been distributed with PPE at work. It is obtained from the number of PPEs that have been distributed monthly to the employees during 2005 and 2006. In fact CSOUL has a new OHS policy that is in place as shown above that is meant to minimize accidents and improve working environments.

1.2 Relevance to Cleaner Production
The concept of Cleaner Production embraces a safe working environment leading to reduced accident incidents, reduced medical care, increased productivity and reduced noise levels. The higher the number of PPE supplied to the employees who need it the lower the number of accidents to be dealt with.

1.3 Targets
The Factories Act 1964 requires that all industry employees should be provided with a safe working environment enhanced with the proper and adequate PPEs for all. In otherwords PPEs should be 100% distributed to all employees who need them.

1.4 Laws and regulations
According to the Factories Act 1964, it is a legal requirement for SCOUL to supply their employees with PPE. It is a requirement from NEMA to provide a safe, clean and healthy working environment for their workers.
Appendix G

Map of Africa showing Uganda and SCOUL
LOCATION OF SUGAR CORPORATION OF UGANDA LIMITED (SCOUL)

source: www.media.maps.com and www.booksforafrica.org