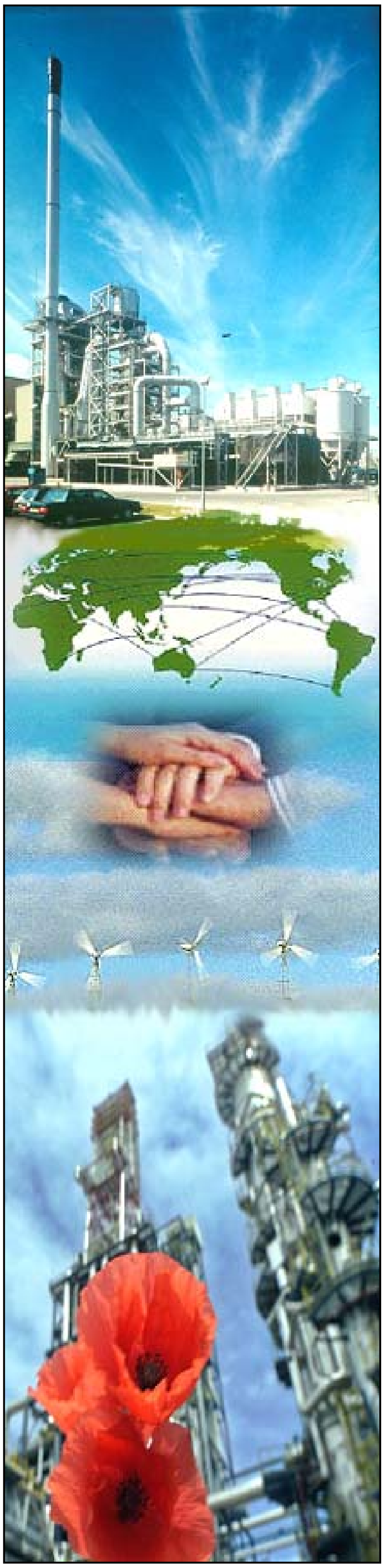

ECOPROFIT
Profits from Cleaner Production

Project Replication Guideline

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Foreword

Within the Europe Aid, Asia Invest Program of the European Community, Centric Austria International has successfully carried out a Cleaner Production Project for the Tianjin Foundry industry.

This sector specific project showed that the concept of cleaner production is applicable in China. The participating companies could demonstrate that they generated profits while reducing their environmental impacts. The project was designed to alert businesses to the potential for reducing costs and boosting productivity by integrating environmentally sustainable practices and processes into the everyday running of their businesses.

The success of this sector specific program encourages us to widespread our approach within China and also other countries. The project replication guide shall contribute to this intention as throughout this tool every committed institution or individual is able to initiate a Cleaner Production project. The guideline focuses on a general project approach and therefore the cleaner Production project becomes easy applicable in any industrial sector.

The replication guideline is a vital part of the project, as it contributes to the sustainability of the project. It outlines, in easy-to-understand terms, the minimum requirements for a CP project implementation. The guideline is published within our network and will be assessable to every interested party. We hope that we can contribute to a sustainable global development by presenting this guideline and to help enterprises to improve their environmental performance.

Coming from the conviction that consumers, suppliers, governments and the market at large are increasingly demanding environmental responsibility by the business community and the knowledge, that businesses ignoring this trend and rejecting the opportunity to improve their environmental performance and that they may find themselves left behind in the highly competitive global marketplace, we are happy to present this easy self learning tool.

Dr. Gerhard Weihs
Managing Director of CENTRIC Austria International

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1. Understanding Cleaner Production

1.1. The Concept of Cleaner Production

All businesses use resources of one kind or another to produce products and deliver services for meeting needs of other businesses and / or communities. In this process, some resources remain unspent, or unwanted products get produced as waste because 100% conversion or transfer of resources is seldom possible. This waste when discharged to the environment causes pollution.

Businesses have responded to pollution in four ways.

1. Firstly, by ignoring the problem. This always leads to maximum damage to the environment. This damage is not limited only to the local-scale or neighborhood; it can occur at the regional and in some cases even the global scales.

2. Secondly, by prescribing to the doctrine "the solution to pollution is dilution"; i.e. by diluting or dispersing pollution so that its effects are less harmful or apparent.

3. Thirdly, by trying to treat pollution through the so-called end-of-pipe approach.

4. Fourthly (and most recently), through the prevention of pollution and waste generation at the source itself.

We would like to recount here a case study to get an insight into the trend described. These case studied are selected to describe certain issues and not to have any kind of sector related approach many different sectors were chosen. The foundry sector is not mentioned on purpose, as many case studies can be found in the project web site and in the final report.

Case Study # 1[1]

Reactive Chemical Industries Corporation (RCIC) specializes in the production of additives for the processing of high polymer materials. Historically, RCIC had discharged around 500 m^3 of wastewater each day into a nearby river without any treatment. An incidence of fish kill downstream of the plant triggered monitoring and assessment of RCIC's wastewater stream. It was found that the wastewater had a Chemical Oxygen Demand[2] (COD) of 4,000 mg/L. Since the maximum stipulated COD discharge to the river at the time was 45 mg/L, RCIC built and commissioned a wastewater treatment plant (WWTP), at a capital investment of € 800.000 and an annual operating cost of € 60.000.

Subsequently, demands for better water quality by downstream users led to a tightening of COD discharge regulations to 20 mg/L. In keeping with the prevailing trend of "the solution to pollution is dilution", the Corporation decided to revamp the existing outfall by increasing its length and adding diffuser-port-riser

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[1] Case Study #1 has been adapted from a real case study, although the names and figures have been changed here.

[2] Chemical Oxygen Demand (COD) is a commonly used measure of industrial pollution that is determined by drawing a sample and conducting laboratory analyses. The greater the COD, the greater the severity of pollution. Domestic sewage typically has a COD of 250 mg/l whereas a textile effluent has a COD in the range of 600 to 1,000 mg/l.

mechanisms, at an investment of € 210.000 However, repeated negative impacts over time caused the river water quality to decline, thus resulting in a further tightening of discharge regulations. The Corporation found that additional investments in terms of upgrading the WWTP were extremely cost-prohibitive. Installation of a new WWTP was not feasible, given the substantial area requirement and escalating land prices.

Given this scenario, the Corporation decided to look at the problem of wastewater generation from a new angle. One idea was reducing the wastewater discharge at the source in the production processes where it was generated in the first place. An in-plant cleaner production assessment was conducted at RCIC to find such opportunities. Certain cleaner production options were identified and evaluated for technical and economical feasibility. Some of the cleaner production ideas that were implemented included improvements and expansions, improved housekeeping, direct recycling in the washing plant and certain process modifications (e.g. installation of a microprocessor-based system to control the quantity and rate of addition of raw materials, installation of vacuum pumps to allow the recovery of product previously lost with wastewater, etc.).

These options were implemented within a comparatively short time frame of 6 months, with an investment of € 50.000 and a payback period varying between 0.5 to 3 years. This helped the Corporation not only to meet the new stringent effluent discharge regulations easily, but also to increase its production by 15%, and save on raw materials and water. In fact, the effluent discharge to the WWTP was reduced to such an extent that approximately one-fourth of the existing WWTP was found to be redundant! RCIC therefore closed one of the batteries (125 m^3/day capacity) and decommissioned some of the equipment. The management at RCIC realized that *cleaner production* should have been the *first step* to manage the problem of pollution instead of dilution and end-of-pipe treatment. These simple but important discoveries made the Corporation scout out other such initiatives in coming years.

Conventional approaches to pollution management are generally after-the-event and reactive. It makes sound business sense to be proactive; i.e. employ anticipatory and preventive strategies.

Recounting this case study gets us thinking … we start to wonder about the extent of time, land, money and other resources that might have been saved if RCIC had not used a reactive approach to pollution management in the first place. We start to make some important realizations - that pollution management may not be a *liability* if businesses simply become proactive. Indeed, as the story of RCIC demonstrates, the pitfalls of being reactive are many. An effective way to manage pollution, then, is to set out a proactive strategy that looks for inimization of resource consumption and a reduction of wastes, by increasing conversion of resources to products.

The strategy that integrates the concepts of environmental protection and improvement of resource productivity is called Cleaner Production.

Let us broaden our understanding of the concept of cleaner production now by reviewing another case study. Here we will look at a business involved in packaging and learn how *product redesign* helped in reducing wastes and making profits.

Case study # 2

PAC Foods supplies food-packaging solutions to restaurants. For years PAC Foods operated on a 'business-as-usual' basis set out by Mr. George Sr. who founded the company three decades ago.

When George's son Mathew took over operations, the situation was starting to change. Solid waste was becoming an important regulatory issue with environmental and economic dimensions. Disposal fees escalated and the neighborhood started expressing its concerns, with some articles appearing in the local newspapers against PAC Foods. Indeed, the company's packaging operations were responsible for significant generation of solid wastes.

Mathew decided to reevaluate PAC Foods' system of packaging. He proposed a *LessWaste Initiative*, to identify and implement waste reduction options. The thrust of the initiative concentrated on materials substitutions and design alterations. The entire programme was implemented by forming a team and by hiring a consultant. Within the first six months, PAC Foods was able to eliminate almost 7,500 tons of superfluous packaging.

Innovative solutions that led to the decrease of food packaging material volumes included:

The cleaner production concept is not limited to technology alone; it includes redesign of products and packaging.

(a) Reducing raised designs on napkins: This simple action enabled 23% more napkins to fit into a shipping container, saving 294,000 kg of corrugated packaging and 150 truckload shipments.

(b) Redesigning drink shipment boxes to achieve a 4% reduction in corrugated packaging (i.e. saving 450,000 kg).

(c) Converting light-weight and non-greasy classified food containers from paperboard cartons to paper bags, thus saving 3 million kg worth of packaging.

PAC Foods also contributed to toxics use reduction by printing its packaging material with soy-based inks, as well as by introducing unbleached carryout paper bags. These steps were applauded by the local community.

The *LessWaste Initiative* led to a net savings of € 210.000 from the second year onwards, with an initial investment of € 63.000 Mathew proposed a special bonus to all the members of the *LessWaste Initiative*.

We need to understand here that the *LessWaste Initiative* at PAC Foods was not a regulation-driven programme; rather, PAC Foods actively anticipated the avoidance of waste as a proactive measure. This involved teamwork, and profits were shared as an incentive. But perhaps what mattered most was Mathew's strategy of change management and commitment.

The benefits of waste reduction were not limited to a reduction in the company's operating costs or its increase in profits. Decrease in packing paper translated into less trees being cut down. Less truckload shipments translated into savings in fuel, decreased gaseous emissions and better air quality. Toxics use reduction translates to significantly less environmental risks, and improved worker health and safety. Thus, PAC Foods in many ways contributed to planet's sustainability – albeit to a limited extent. The company's image in the community also received a boost.

Cleaner production involves commitment of top management, teamwork and a vision to understand the strategic advantages to business by being environmentally friendly.

Over the years, Mathew made PAC Foods stand out in the market as an environmentally sensitive company and that helped him secure new clients.

The concept of cleaner production is not limited to the manufacturing sector alone. The concept is equally applicable to other sectors such as services, infrastructure, natural resource management etc. Let us now discuss a case study from the hospitality sector, which illustrates how a medium-sized hotel used cleaner production as a strategy to increase competitiveness and establish a niche in the market.

Case study # 3

The Smiths operated a 40-room hotel called Relax at a holiday spot over a number of years. A number of new hotels had sprung up in the neighborhood and Relax was losing its competitiveness. Something had to be done to turn the business around; i.e. reduce operating costs, re-establish a foothold and create a niche for itself in the market. The Smiths were looking for a systematic process that would help them realize these objectives.

The Smiths used a water and energy audit as the starting guideline, as these two resources mattered most to Relax from the point of view of operating costs. They got a consultant in place and formed a team. The audit programme was operated over a month and included a number of measurements, record-keeping, analyses and brainstorming within the team. The following energy and water-saving measures were identified and subsequently adopted.

1 Existing lighting was replaced with lower wattage incandescent fluorescent lighting. The team anticipated savings of approximately 25% on electricity costs for lighting.

2 Flow restrictors were installed on all taps and showers, and this was estimated to save approximately 16,000 L of water per day. This worked out to annual savings of € 3.100.

3 The electric water heaters were replaced with gas operated units, which led to annual savings of approximately € 15.500.

4 For an initial investment of only € 210 the hotel could shut down its fountain pump system for five hours a night, thereby saving € 2.100. annually.

Cleaner production is implemented through a structured process. It involves identification of options and methods of a reasonable cost, the implementation of which can lead to economic and environmental gains.

The overall cost of investment worked out to be in the vicinity of € 49.000 with an annual monetary savings of € 22. greenhouse gas savings of 5.72 tons of CO_2 per year and electricity savings of 3.4 MWh.

The proprietors of the hotel were pleased that savings of such a magnitude could be had through such simple solutions. Publicizing their improved environmental performance helped the business earn the goodwill of existing clientele, attract new business (occupancy rates increased by 30% in the first quarter alone, directly as a consequence of effecting the changes) and increase profits. These measures also indirectly reduced previously high employee attrition rates. More importantly, the proprietors realized that there were further opportunities for improvement; other ideas in the pipeline include key-tag air-conditioning and lighting control in guest units and installation of dual-flush toilets during future refurbishment. Smiths decided to make water and energy audits an on-going process instead of a one-off initiative, and started developing data formats and work instructions to ensure that the process of tracking, evaluating and finding such options would be continuous.

Lessons from the Case Studies

Our three case studies show that cleaner production entails eliminating environmental problems at the source, to the maximum extent possible. Cleaner production is one of the most cost-effective methods of environmental protection because it reduces the need for construction of expensive end-of-pipe treatment and disposal facilities, and reduces long-term risks and liabilities associated with releases of wastes to the environment. The RCIC case study was an illustration that stressed this point.

The critical issue in the case of Hotel Relax was the management's decision to install a continuous process of improvement and not treat audits as a one-off activity. Cleaner production is therefore a *continuous preventive strategy*. Cleaner production is practiced through a structured process (e.g. water and energy audits in the case of Hotel Relax) and is not an ad hoc approach.

It should also be stressed that cleaner production is very much about attitudinal change, and it requires commitment of the top management and teamwork. That is what probably worked in the example of PAC Foods.

Cleaner production is not limited to manufacturing processes alone; it includes products in the context of their entire life cycle. The cleaner production concept is therefore not limited to individual facilities, but extends itself to products (like in the case of PAC Foods) and services (as in the case of Hotel Relax), including customers and communities.

The factors driving the concept of cleaner production are, therefore, several: customer / community pressures, resource availability and pricing, competition in business and need of image building, and increasingly stringent pollution control norms and their enforcement.

Adopting a cleaner production strategy is however not necessarily a complex procedure. Rather, we may look at such an exercise as a simple retrofit of previous business practices, or the ushering in of a new era of change management, with the added advantages of the ability to generate sizable cost savings, boost profit margins and earn enormous goodwill.

Cleaner production is not just an environmental tool. Just as importantly, it is a vehicle to enhance the productivity of a business enterprise. In essence, cleaner production is a strategy positioned at the interface of environmental protection and productivity. Each of the case studies cited in this section show how water and energy could be saved, or how raw material requirements could be reduced, or how the output or production could be increased. It may be useful therefore to examine the evolution of cleaner production from both these perspectives.

1.2. The Evolution of Cleaner Production

In the previous section, it is noted that cleaner production is closely intertwined with productivity. Therefore, it is important to understand the evolution of the concept of productivity in the context of cleaner production.

1.2.1. Milestones in the Field of Productivity and Environmental Management

Traditionally, productivity has been defined as the amount of output per unit of input used. An increase in productivity entails an increase in the amount of output and / or a decrease in the amount of input. Productivity is also impacted by the internal organization of a business; in other words, improving organizational effectiveness can be one way of improving productivity.

At first, productivity improvement focused on *quantity;* i.e. outputs. As the markets developed and competition increased, *cost effectiveness* became the key factor towards success. Therefore, a *cost reduction* approach was used to improve profitability or organizational effectiveness; viz. productivity.

Next, growing consumer preferences and competition ushered in the era of the *quality* drive. With its advent, productivity was measured not only in terms of the quantity produced, but also in terms of the percentage of production that met the required quality.

The *consistency* of delivering the utmost *quantity* of a product at the desired level of *quality* in a cost-effective manner became the third generation concept in the productivity movement. Consistency could be ensured only by influencing the internal organization of a business, and hence a number of management systems emerged - Total Quality Management (TQM), Total Preventive Maintenance (TPM) and subsequently, the international standard on Quality Systems viz. the ISO 9000 series.

While the productivity concept expanded, the field of environmental management also matured and broadened (see **Figure 1.1**).

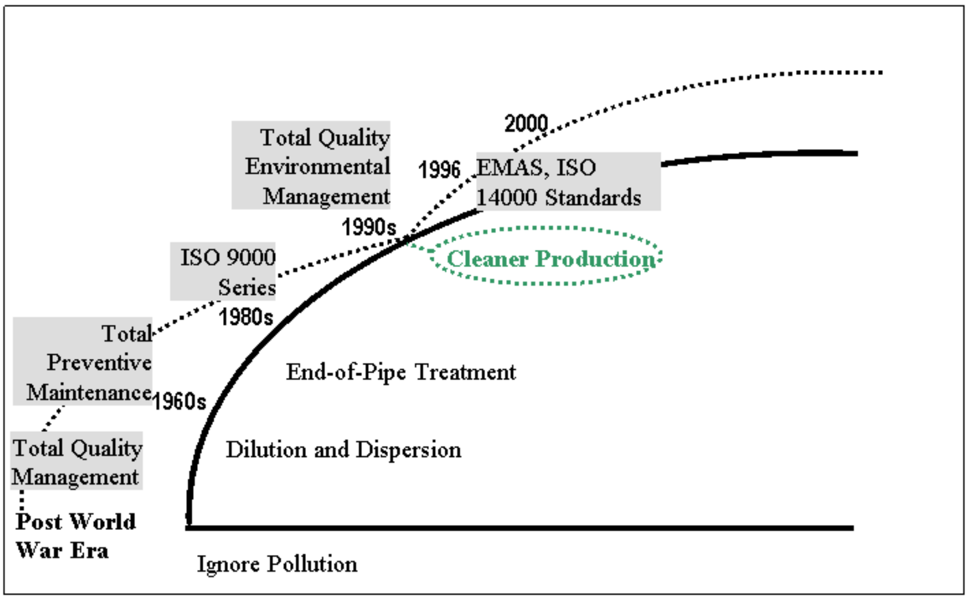

Figure 1.1: Tracking the Influence of Quality Programmes on Productivity

The earlier concepts of "ignore", "dilute" and "treat" pollution changed to "prevent pollution", "re-utilize wastes or generated by-products" and finally "treat" and "dispose of" residues in a secured manner. This change took place because of a variety of reasons listed below:

Pressures from the neighborhood and environmental non-governmental organizations (NGOs) increased dramatically. By ignoring or practicing dilution, businesses attracted legal suits, lost their reputation in the market and subsequently faced closure.

The standards on pollution control became stringent across multiple media; viz. air, water and solids. Enforcement became stricter, requiring significant investments in treatment and disposal facilities. This required substantial funds and the acquisition of extensive tracts of land. A radical turnaround was needed in thought processes for preventing pollution at the source itself, if the business was to survive and operate cost-effectively.

The emphasis on pollution prevention needed to have support from the internal organization of the business, with the commitment of its top management. This was promulgated by Environmental Management Systems (EMS) such as the ISO 14000. This led to ensuring consistency in environmental performance and establishing the strategic importance of environmental thinking in business.

Around this time, the environmental factor got integrated into productivity improvement programmes (e.g. TQM to TQEM). Here, the concepts of resource vulnerability, life cycle assessment, and waste as an economic burden, were brought to the fore through environmental management, thus reinforcing the need to internalize environmental issues in business.

The need to fundamentally change the approach to business by using natural resources efficiently, and taking a holistic life-cycle view of product generation was recognized in the 1990s. Efficient use of natural resources translates into environmental protection, and also results in the improvement of productivity.

Consequently, as Figure 1.2 shows, the conventionally held view of productivity grew steadily from the earliest 'quantity based' and 'cost reduction' approaches, to incorporate 'quality of the product' and finally, to respond to 'environmental' concerns.

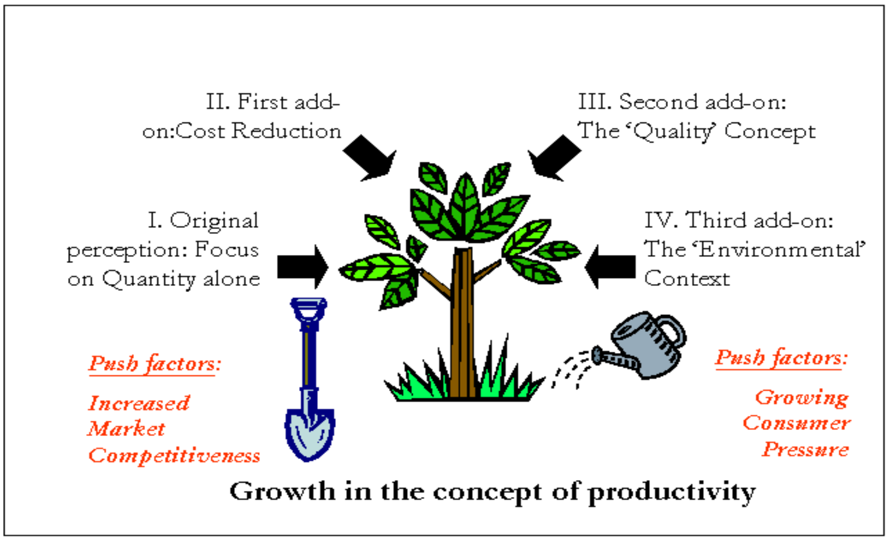

Figure 1.2: Major Milestones in the Field of Productivity

At this juncture, trends in productivity and environmental management intersected and influenced each other in developing a common strategy such as cleaner production.

1.3. The Definition of Cleaner Production

A formal definition of the term "cleaner production" will help to organize ideas at this point.

1.3.1. Definition of the Term "Cleaner Production"

Cleaner production is defined[3] as the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner production can be applied to the processes used in any industry, to products themselves and to various services provided in society.

For production processes, cleaner production results from one or a combination of the following - conserving raw materials and energy, substituting toxic/hazardous materials by more benign ones and reducing the quantity and/or toxicity of all emissions and wastes before they leave a production process.

For products, cleaner production focuses on the reduction of environmental impacts over the entire life cycle of a product, from raw material extraction to the ultimate disposal of the product, by appropriate design.

For services, cleaner production entails incorporating environmental concerns into the design and delivery of services. Figure 1.4 shows a representation of this definition.

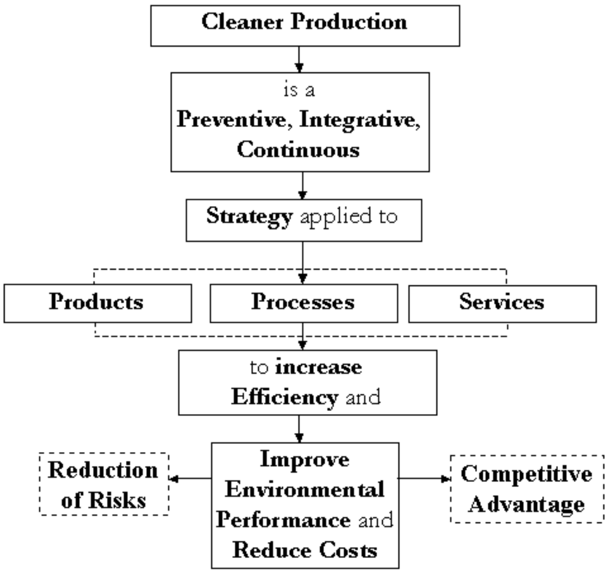

Figure 1.3: The Definition of Cleaner Production[4]

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[3] United Nations Environment Programme (UNEP) - Cleaner Production. Available at: http://www.uneptie.org/pc/cp/understanding_cp/home.htm

[4] Modified from Joseph Strahl, 1996. Available at: http://www.lu.se/IIIEE/general/cp.html

1.3.2. Extracting the Key Elements from this Definition of Cleaner Production

Extracting the key elements from this definition of cleaner production, the following points come to mind.

- Cleaner production entails a **continuous** process; it is not a one-time activity.
- Cleaner production is **not limited** to industries or businesses of a certain type and/or size.
- Cleaner production moves towards striking a **balance** between the availability and consumption of materials (including water) and energy. It does not deny growth, but does insist that it be **ecologically sustainable**.
- Cleaner production refers to the approach of producing goods and providing services with **a minimum of environmental impacts**, given the technological and economic limits at the current time. It is not merely limited to minimization of wastes; rather it employs a broader context, and uses the term "**impacts**" in the **life cycle**.
- In addition to life cycle impacts, cleaner production also addresses **health and safety** concerns and emphasizes **risk reduction**. In this perspective, cleaner production is a **holistic** environmental management strategy.
- Cleaner production is both **efficient** (in terms of increased *outputs* on an immediate basis) and **effective** (in terms of positive *outcomes* over the long-term).
- Cleaner production is a **'win-win-win'** strategy that protects the environment, communities (i.e. the health and safety of workers, consumers and the neighborhood) and business (i.e. its profitability and image). Therefore, cleaner production addresses economic, environmental as well as social concerns and should **not** be considered only as an environmental strategy.

1.4. Benefits and barriers to Cleaner Production

Cleaner Production carries great importance in the field of environmental policy and management. Environmentally, Cleaner Production approaches provide a concrete and long-term technique to eliminate and/or reduce such emissions as carbon dioxide and sulphur dioxide. Consequently, Cleaner Production plays an important role in addressing global environmental issues such as climate change, acid precipitation, and urban smog.

Economically, prior experiences with Cleaner Production programs have proven that further environmental damage can be averted in a cost-effective manner. In a majority of the cases, Cleaner Production programs have actually saved money. Finally, Cleaner Production as well as Pollution Prevention programs have been more successful than simple pollution control methods in providing social benefits for the public. A long-term, comprehensive restoration of the natural environment increases health and living standards, while creating a safer and more enjoyable habitat for all species.

The environmental benefits of Cleaner Production directly coincide with economic interests. More specifically, there are numerous benefits which result from Cleaner Production activities. First, Cleaner Production programs are beneficial because they reduce operating costs. For example, the costs involved with waste treatment, storage, and disposal are often reduced through Cleaner Production programs and the savings can be used to offset the development and implementation costs of the program.

Material, energy, and facility cleanup costs can also be reduced through Cleaner Production programs. Second, Cleaner Production programs reduce ecological damage from raw material extraction and refining operations, and the risk of emissions during the production process and during recycling, treatment, and disposal operations. Third, Cleaner Production programs improve company image. For example, employees are likely to feel more positive toward their company when they recognize that management is committed to providing a safe working environment. Finally, participation in Cleaner Production activities can reduce risk of both civil and criminal liability by minimizing the amount of waste generated. This benefit is particularly important if the waste products are hazardous or toxic in nature. Cleaner Production makes compliance with national, provincial, and local regulations easier. A Cleaner Production program can also lessen the exposure of employees to harmful substances, thus decreasing risk and saving money.

Despite the known benefits of Cleaner Production, there are still several barriers to successful development and implementation of Cleaner Production programs. For example, individuals are often hesitant to change an already established process or method. Also, many are under the impression that Cleaner Production programs will actually cost more than existing practices. In other cases, it is uncertain whether or not customers will accept the changes made in implementing a Cleaner Production program. Finally, in many situations, other projects may have a higher priority than Cleaner Production programs. It is important to recognize that the barriers to Cleaner Production can be overcome with certain actions, which should be incorporated into a Cleaner Production strategy. For example, environmental management systems identify environmental protection as a high priority within a company.

2. Developing Cleaner Production Project

2.1. Introduction

No Cleaner Production Project, i.e. an ECOPROFIT[5] project can be successfully established unless the lead is taken by institutions, corporations or individuals have a clear stake in establishing it as a part of their mission and business objectives.

The process of establishing a Cleaner Production Project can be described in terms of four milestones.

1. *Formulating the conceptual plan*: The project manager formulates the concept that is responsible for the genesis and operation of a Cleaner Production Project. The concept should clarify for instance what the Project Management should do and how. The plan will also identify the stakeholders supporting the projects

2. *Developing the basic design*: The stakeholders of the project together will need to formulate its mission, objectives and strategy, along with its organizational set-up. In addition, the stakeholders will also need to identify the basic resource requirements.

3. *Meeting the financial needs of the project*: Once the basic resource requirements of the project have been finalized, the next step will be securing funding to meet those requirements. Funding sources could include, 100% financing by the corporations participating in such a project and/or seed funds in cash and / or in kind from the stakeholders, as well as any identified funding from national and / or international donor agencies. The project participants should always contribute to the project costs to raise awareness for the projects.

Establishing the Project: recruiting the CP consultants/ Trainers, and preparing its physical facilities.

While the process on paper is laid out in four tidy milestones, with a series of steps, it is more than likely that in reality it will be a good deal less tidy. Often, the stakeholders will find that some steps need to be triggered earlier or undertaken simultaneously, and there could also be situations where the outcomes of one step could influence earlier steps in the form of a “feed-back loop”.

[5] See Part 3: Implementing a CP Project

2.2. Formulating the Conceptual Plan for the Project

- What should be the geographic location of the Project?
- What are the focal sectors that need to be addressed through the Project?
- Which stakeholders should be involved in the establishment and operation of the Project? What could be their roles and relationships?

At this point, the project management and the stakeholders together will work on the rest of the fundamental conceptual issues:

- What other cleaner production activities or resources exist in the country? What are the cleaner production-related needs that are still unmet?
- What type of project should the management focus on? Individual CP assessments, sector specific projects as a combination of Workshops and on-site CP consulting like the Ecoprofit project.

By answering these key questions, the project management and the other stakeholders can then:

- Identify the project with the best impact on environmental protection and industrial development.
- Develop a preliminary design for the project, i.e. the draft mission, objectives and strategies

2.2.1. Determining the location and Focal Sectors to be addressed

The project management must decide the location and the focal sectors this project will address.

When deciding what sectors a new CP project should focus on, it is useful to study each of the sectors in the context of the national economy, social indicators and environmental sensitivity. Some of the useful statistics that the Champion may consult would fall under the following sub-groups:

- Economic (percent contribution to the GDP, percent contribution to the exports, percent investments)
- Social (percent employment of the total)
- Environmental (percent consumption of natural resources, namely, materials, water and fuels)

Finally it is important to follow the stakeholder's plans; they want to promote certain sectors and regions and are willing to contribute to the project. In case of a 100% corporate financed project the case is clear.

2.2.2. Identifying Relevant Stakeholders for the Project

The project manager should not attempt to establish a project alone. It is important to bring together all relevant, equally interested or committed stakeholders. If these institutions are not involved upfront, there are risks such as non professional duplication, poor coordination, lack of support, especially in messaging and implementing cleaner production, and of course the stakeholders will contribute financially to the project.

For instance, if the project manager is trying to form a CP project focusing on certain industrial sectors, "natural" stakeholders are the relevant national associations of industries.

Some general guidance can be given about what types of institutions could be stakeholders in a centre. These can be listed as follows:

- Representatives of the focal sectors;
- Representatives of the government authorities that are involved in the management of production and consumption patterns of the focal sectors;
- Representatives of the financial institutions who are intimately connected with the focal sectors, to influence the decisions regarding investment in cleaner technologies;
- Representatives of institutions of higher learning and research that can work with the focal sectors to develop cleaner technologies;
- Representatives of those parts of civil society that are impacted by the activities of the focal sectors (e.g., resource depletion and degradation, health and safety related issues, etc.).

Representatives of the focal sectors

This is probably the most important class project stakeholders.

- They will help the centre to get to know and reach its "clients".
- They will be a source of sector-specific technical and economic knowledge that will allow to evolve more appropriate sector-specific cleaner production promotion strategies.
- After adequate training, they can also be a source of sector-specific cleaner production experts, who in alliance with the centre can offer cleaner production services to their members.
- Often, they are respected partners of governments - another important class of stakeholders - who use them not only to understand the needs of the sector, but also to transmit the government's policy decisions.

Industry or trade associations are a very common stakeholder, either as general industrial associations that cover numerous industry sectors or that cover specific industrial sectors (e.g. the Chinese Foundry Association is playing a substantial role in the EC financed CP project for the Chinese foundry industry). Chambers of Commerce have also been stakeholders in projects, as have Business Federations.

Representatives of government

Because cleaner production involves many public policy issues, government authorities should always be one of the important stakeholders in a CP project.

Since historically there have always been links between cleaner production and environmental protection Ministries, Commissions, National Authorities of Environment, Environmental Protection Agencies, Environmental Departments and so on, have generally been one of the stakeholders in CP projects.

Cleaner production has important links to industrial efficiency, innovation, productivity and competitiveness. Therefore, the Ministries, Commissions of Industry (or equivalents) are important stakeholders. If energy efficiency (one element of cleaner production) is considered an important part, then Ministries of Energy (or equivalents) - where they exist - could be stakeholders. The need to create an enabling framework for cleaner production-related investments suggests that the Ministries of Finance or Economy (or equivalents) could be important stakeholders. A focus on tourism could mean that the Ministry of Tourism (or equivalents) should be a stakeholder.

Representatives of financial institutions

It is being increasingly recognized that financial institutions have an important role to play in promoting cleaner production. Involving financial institutions as stakeholders can help in establishing a "virtuous circle" between project financiers and project seekers. The enterprises or institutions with a need to make investments in cleaner production-related projects could get connected to bankers who are looking for low-risk high-return projects.

Representatives of institutions of higher learning and research

These institutions can have a stake in cleaner production at two levels:

1. Cleaner production can often require basic or applied research to adapt existing technologies or develop new process technologies, or redesign products from the point of view of the environment (i.e. eco-design). Institutions that are involved in such research and development activity can be stakeholders in the activities undertaken.

2. Institutions of higher learning in engineering, business, finance (universities, vocational training schools, and so on) have a role to play in mainstreaming cleaner production, as they are involved in educating the younger generations. If the education programmes at these institutions provide an exposure to students on cleaner production concepts, tools and techniques, then it will be easier to develop the required pool of cleaner production professionals across multiple sectors.

Representatives of the civil society

Depending on the focus of the centre, NGOs can have a large stake in cleaner production. (UNIDO National Cleaner production Centers, International training providers and project developer as CENTRIC Austria international…)

By this point, the project manager should have identified the most relevant group of stakeholders. The project manger will then have to conduct one-on-one meetings with the identified stakeholders, so that each party can understand each others' concerns, obtain answers to any doubts and clarify their respective roles in the venture. These activities will be followed by a brainstorming session, which could require revisiting the proposed conceptual plan.

After this step, the project management and the stakeholders will have to continue the process of developing the design and implementation plan and obtain the necessary funding towards its establishment. It could well be that the PM (Project Manager) will have to continue to play a lead role; however the decisions from now on should follow a participatory or consultative mode as a group.

2.3. Identifying Ongoing Cleaner Production Activities and Cleaner Production Resources in the Country Region

During the process of establishing the project, it is important for the stakeholders to take stock of what cleaner production activities have already been undertaken in the country / region, or are underway especially to realize follow up projects.

> It is important that the PM and other stakeholders not use too narrow a definition of cleaner production in this review or stock-taking exercise. There are many activities that may not have the title of "cleaner production", but may actually have a very strong element of cleaner production (e.g., green productivity, eco-design and so on). Similarly there may be persons who do not list cleaner production as one of their areas of expertise, but who do actually have considerable expertise that is relevant to cleaner production. They are important consultants for each CP project.

2.4. Identifying Cleaner Production Needs

Once the group of stakeholders has been consolidated, and once all are in agreement about focus of the proposed project, the stakeholders will need to take part in a process that will help in moving ahead from the conceptual plan to the design and implementation plan.

There are a number of possible different needs in cleaner production, namely, awareness raising, training, cleaner production assessments, demonstration projects, networking, matchmaking, and knowledge management. This project replication Guideline refers to **ECOPROFIT** of similar CP projects which generally include all of these activities.

2.5. Creating the Basic Design for the Project

- Formulate the mission and objectives of the project;
- Develop the basic strategy to meet the objectives;
- Develop targets based on the objectives;
- Develop tasks which need to be carried out to meet those targets (who, what, when, where, how and how long);
- Identify the basic resource requirements of the centre.

2.6. Formulating the Mission and the Objectives

A mission statement is a means of committing to paper the basic premise / essence of each project. Thus, its formulation requires careful consideration. The best way to formulate a mission statement is to start with a brainstorming session between all the stakeholders, looking for those key phrases and words that best capture what the CP project will be about. Remember that the best mission statements are short and concise.

Once the stakeholders have agreed on the mission statement for the centre, they need to set its objectives. Little guidance can be given on what specific objectives must have, because they will be very situation-specific. However, some general guidance can be given:

- The objectives should derive from the mission statement.
- The objectives should be both short-term as well as long-term; i.e. the steps actual project must take at the present time to fulfill its mission and objectives to sustain the results of the project.

2.7. Developing a Strategy to Achieve the Objectives

Once the initial objectives have been set, the PM and stakeholders can lay down the project plan to follow to meet them.

In general, the work plan should be laid out in broad terms:

- The general set of activities the PM will undertake; this will follow naturally from the decisions the stakeholders made about the project; in case of this guideline the ECOPROFIT project
- The clients
- The working partnerships (national and international CP consultants, universities etc.)
- The resources (both personnel and non-personnel) that the project will require in order to provide this project in a manner in which it can meet the objectives; and finally
- The programme the PM should pursue to cover the costs of the resources it needs.

2.8. Developing Targets and Tasks

Once the strategy of project has been formulated, the stakeholders will need to decide on the targets to be achieved and the tasks to be executed, in line with the objectives and, hence, the mission of the project.

The targets will entail the accomplishment of short-term and long-term objectives. In this light, targets have a direct bearing on the resources the project would need. Targets need to be "**s-m-a-r-t**"; i.e. ***S****pecific*, ***M****easurable*, ***A****ttainable*, ***R****ealistic* and ***T****raceable over time*. Setting targets is also an adaptive process; long-term targets may need to be reviewed and revised depending on the achievements of short-term targets and / or changing economic and environmental situations.

After deciding the targets, the stakeholders will have to allocate tasks needed to meet a particular target. The tasks will entail answering the following questions - who, what, when, where, how and how long. In this context, the stakeholders will be faced with the following questions:

Human resource requirements for the projects: The number of people required, their skills, training needs (if any) stakeholders contributing to the project with a part of its human resource requirements.

Financial resource requirements: Governmental (local and national), non Governmental, private financing, seed funds etc..

2.9. Identifying the Basic Resource Requirements for a CP project

At this point, the stakeholders are in the position of being able to determine what the basic resource requirements.

The costs will be essentially broken up into either capital costs or operating costs.

Capital costs could include books, specialized periodicals, software, on-line cleaner production databases, equipment, office equipment (fax machines, phones, computers, photocopying machines, etc.), training equipment (overhead projectors, etc.), monitoring equipment (pH meters, volumetric flow meters, sampling equipment, other laboratory analysis equipment, etc.), vehicles for travel, and so on.

However, it may be prudent to keep capital costs as low as possible. The PM should look for opportunities to offload certain capital costs as operating costs. For example, stakeholder institutions (Commissions, Universities) could provide access to laboratory equipment and laboratory analytical facilities.

The main project cost will be the salaries of project team, reflecting the fact that a project's main resource requirement will be person-power. Other items under operating costs would include office utilities, office stationary, vehicles for travel, charges for using laboratory facilities, charges for using space for conducting seminars/ training sessions, costs associated with travelling on the field, costs of technical documentation, costs for printing promotional brochures, training materials etc., costs for establishment and upkeep of the project website, and so on.

2.10. Meeting the Financial Needs of the Project

At this point, the stakeholders will have formulated a detailed design of how the project will function, and how much funding will be required. It is now time to consider the issue of how to secure this funding. This is an issue that the stakeholders should devote considerable attention to. It makes little sense to go to all the trouble and expense of establishing a CP program only to see it collapse a short time later because the necessary funding was not secured properly.

The project should eventually be able to sustain itself financially, by providing services to its clients. However, when the awareness within the industries is not ready to pay for such a project, as there is no client base yet, additional funding may be necessary.

2.11. Securing Funds for the Project

Securing Contributions from the Stakeholders

Here, the stakeholders have to determine the contributions they can make for this project. These contributions can be either in cash or in kind. Monetary contributions would be preferred as they are easier to manage. Possible Contribution:

- Stakeholders finance the project – small contribution from the participants should be allocated

- Stakeholders can assist the project holder in its promotion activities. For instance, an industrial association can spend time and some costs (e.g., free advertising space in association magazines) to introduce the program its members. Stakeholders can also give the PM slots to promote its services in conferences or seminars they are organizing.

- Stakeholders having laboratory analytical facilities can offer to undertake for free analyses that PM needs done on its clients' i.e. waste streams.

2.12. Identifying Potential Sources to Meet the Shortfall in Funds

In the ideal case, the participating companies together can make sufficient contributions of funds in cash to cover the project needs. However, if their contributions are not enough, then the shortfall must be covered by other sources. As a benchmark, experience with the CP Programs, shows that an ECOPROFIT project costs between € 60.000 and € 120.000 per project year depending on the involvement of international consultants and on the number of participating companies.

- The project team must identify potential sources for these funds; and

- must prepare, submit and promote a formal request for the funds.

Normally, the PM will have two primary sources of funding to tap into - national funds (primarily from the government), and international funds.

If the national, regional or local government is a potential funding source, there is a good chance that it will already be a stakeholder in this project. Thus, its capability to cover the project costs has been explored already. However, it is possible that government authorities, which are not stakeholders, have certain funds that could be tapped into.

For instance, the World Bank and other regional Development Banks give countries technical and financial assistance for specific purposes. In such a case, the PM could attempt to tap into these funds.

The alternative is for the PM to try and secure the necessary funds from international donors.

2.13. Preparing and Submitting a Formal Request for Funds

Once a promising source of funding has been identified, the PM needs to prepare a formal request for funds. Each funding source normally has its own specific format for preparing funding requests, but in most cases they will follow the general format.

2.14. Implementing the project

Assuming the stakeholders have secured all the necessary funding, the final task to turn CP projects into reality.

Part 3 of the Guideline will describe as an example the implementation and the tasks of an ECOPROFIT Project for corporations as one possibility to deliver CP projects.

3. Replicate the ECOPROFIT Project

3.1. General Remarks

Several mechanisms can be employed in the delivery of Cleaner Production, and they could be used either singly or in combination, whichever gives the best results. Typical mechanisms are:

- Seminars / conferences;
- One-to-one meetings;
- Workshops;
- On-site CP Assessment ;
- Study Tours and Business Matchmaking activities
- Public events
- Involvement of Mass Media

Seminars / conferences and workshops are the most commonly used delivery mechanisms. While seminars and conferences focus on the concept and case studies, workshops are useful to deepen the concept in terms of methodologies and to gain experiences of putting the cleaner production concept into practice. Half-day seminars are particularly useful in influencing top management, whereas workshops focusing on themes such as energy efficiency, water conservation etc. are more suited (effective) for middle-level management.

Keep in mind while organizing such seminars / conferences, that the primary focus of awareness raising is retained. The focus should not diverge into skill-building or training at this stage.

One-to-one meetings serve as good follow-up mechanisms after a seminar for the top management moving them to the next intended step such sending their representatives to CP workshops and undertaking a cleaner production assessment or taking part in a demonstration project.

On-site visits are a necessary add-on to the workshops. The general input of the workshops needs to be implemented/ putting in to practice in each participating company. The CP consultants will assist the companies in their CP Assessments on-site.

Depending on the Clients and the Sectors – but in first case on the budget of the project there is the option to organize study tours for the participants. Here they will see cleaner production in practice and they have to opportunity to develop new business and contacts to environmental sound technologies.

A successful completion of a CP can be awarded in a public event by handing over a participation certificate as e.g. the ECOPROFIT certificate. Mass media should be invited to these ceremonies.

Beside this awareness for CP programs can be delivered throughout journals, papers etc and a project web-site.

3.2. The ECOPROFIT Project

The ECOPROFIT Project is a combination of these entire elements. The Project Manager, from governmental or non-governmental organization, a private training provider or a combination, invites up to 15 corporations to participate in one ECOPROFIT program. The duration of the project depends on the objectives of the individual project and on the resources of the provider and the participants. For the Guideline a two year layout for the program will be explained.

Any sector in any size can participate in this project. In case of different participating sectors the program will be general, as described in the guideline, in case of sector specific program; some of the program elements can be adapted to the needs and processes of this sector.

ECOPROFIT - short for Ecological Project for Integrated Environmental Technology - is a project aimed at economic strengthening of enterprises by preventive environmental protection; at the same time it strives toward a contribution to improve economic standing of a company. ECOPROFIT is designed in such a way that - based on environmental problems - production processes and other activities are assessed and checked as to their utilisation of material and energy in order to trigger in-house innovations. Against this background, products, technologies and material used are critically assessed in order to avoid emissions and waste and/or to ensure utilisation of the waste that cannot be avoided. ECOPROFIT is therefore not a solution for isolated individual problems but rather a tool for an overall corporate concept.

The term "eco" refers to three purposes:

- ecological benefit,
- economic benefit and
- in accordance with the original Greek term *oikos* (oikos, "the house, household") it underlines that a company-specific solution is to be found for companies.

The basic principle applies that nobody knows a company better than their own management and employees and that they have important and valuable expert knowledge. External know-how and knowledge from the project provider can and should only be used for providing ideas. So ECOPROFIT means therefore first and foremost **"self for self-help"**.

The concept was developed by the city of Graz, Austria in corporation with national experts to reduce the environmental impacts of the industry as one element of an eco-city plan for the 90^{th} of the last century. The successful program soon speeded in Austria improving the environmental performance of many companies and labelling them with the Ecoprofit label. To meet the requirements to archive the qualification for the label a standard procedure controlled by national authorities were developed.

In the last years the strategy spread in many countries initiated by Austrian institutions.

3.3. Organizing and Implementing the ECOPROFIT Project

The basic condition to develop this project is described in part 2 of the guideline.

3.3.1. Preparation for the Training Programme

Step 1: Acquisition of the Participants (See also Part 2)

Irrespectively if the PM carries out a sector specific or general approach the proper acquisition of the companies is vital for the whole project. The total number is up to the PM but should not exceed 15 as the individual work in the company's needs resources, more participating companies would possibly affect the quality of the service. The participating representatives (each company should send at least 2 representatives to ensure the redundancy principle) must have certain skills to follow up the program and the organizational power to implement the project in their company. The absolute commitment of the top management is mandatory.

For the acquisition purposes a half day conference or a seminar on the ECOPROFIT project for the leaders of the addresses corporations should be carried out by the stakeholders to gain awareness for the project. Follow up activities might be necessary as well.

All stakeholders shall be involved in this process.

Step 2: The Content of the training programme

The content of the training programme follows the programme steps of the ECOPROFIT steps. Due to the nature of the project the topics are somehow pretexted and listed in chapter 3.5. Nevertheless some lectures shall be adapted to the individual project. E.g. sector specific programs need to address the technology and cleaner production measures of the sector or country or region specific issues need to be considered as the legal requirements.

In general the content should preferably be in the language and style the clients are most familiar with. As a general principle the content should be easy to read and grasp and not overwhelming. It is important that the content of the training programme reflects the actual training needs and not the content that a trainer or its partner can easily provide (selection of training providers!). For international consultants it is important that if required they have to send their working material in advance to give the local partner time for translation. Interpreters shall be well briefed before.

The content of the ECOPROFIT training programme is based on four important components; viz. lecture notes, textbooks and worksheets, case studies and resources. These documents help the participant understand the overall contents of the programme; i.e. the concept, familiarity with the procedures and tools (e.g. material and energy balances, ecomaps, process flow diagrams, etc.), and their applications. Case studies induce a problem solving approach by the trainee. Resources can be used by the trainee at a later date as a reference material. Resources can typically include benchmarks, technology fact sheets, important formulae, etc. Such a basic structure of content helps in building the necessary competence of the trainee in the chosen training module.

Step 3: Planning the Delivery Mechanism

The core project includes the workshop series, the on-site implementation and the awarding process. A minimum number of workshop days and on-site consulting is required to succeed in the project. When and how the PM organizes/ splits the training events must be evaluated. The decision takes the project manager taking the needs of the clients into account. In chapter 3.5 we will outline one programme as example. This example should be considered as options to suit the convenience of the trainees. Long duration, discrete training events are best suited when operating a continuing education programme on cleaner production. A continuous training event; e.g. a hands-on training workshop over say 3 to 5 days, is useful to build focused skills in a relatively short time. At the end all necessary elements need to be implemented to get the ECOPROFIT award.

Step 4: Organizing the Workshop facilities

The PM is responsible for the WS execution. This steps needs to carried out in accordance with the budged, the stakeholders, the clients and the nature and culture of the WS location.

3.4. Conducting the Training Programme

General Remarks

Conducting the training refers to the logistics, sharing of responsibilities, preparation of the training materials, promotion of the event, and actual conduct of the event. Logistics include deciding on the venue, providing required training equipment, and deciding on the timing and duration of the training programme. The promotion and conduction of the training programme is generally the responsibility of the PM.

The training programme must be conducted in a disciplined and standardized manner. (see sample WS outline) All the persons involved in conducting the training programme should be provided with ECOPROFIT standardized templates to prepare lecture notes and overhead projections. Details such as type of font, size, and formatting should be specified to achieve uniformity in the training materials. All materials should be carefully proofread. Key portions of the text may require to be translated depending on the background of the trainees. Hence, the training materials should be prepared well in advance.

It is important that some of the principles of cleaner production be followed while conducting the training programme itself; e.g. photocopying should be done on both sides of the paper, plastic folders / files should be avoided, etc.

How should the training programme be organized?

It is desirable that the training programme includes the following items, apart from the conduct of the actual technical sessions:

- A short presentation on the purpose or objectives of the training programme;
- A self introduction of the participants and faculty;
- Time slotted for discussions/questions after each presentation or session;
- Adequate time for experience sharing by the participants;
- Time reserved at the beginning and close of each day for making any practical announcements;
- Sessions to assess the trainees (short quizzes, group work, etc.); and
- A closing session on evaluation of the training programme.

Who should be conducting the training programme?

The selection of the training faculty is a critical aspect. The faculty must have practical experience in cleaner production and / or allied areas. In addition, the training faculty must be excellent communicators; good communicators make good trainers, whereas technically proficient persons alone may not always be good trainers.

Training programmes run by a single faculty are not effective, however competent the training faculty may be. Hence, the PM should involve at least two to three lead faculty members in designing the content and implementing the training programme. Again, the faculty should be drawn from a mix of experience; e.g. from university, industry, local environmental law expert etc. This helps in widening the perspective.

3.5. Sample Outline of a ECOPROFIT Workshop Programme

The following table will state the main time frame, the WS topics, a short explanation to each topic and the related on-site activity. The on-site CP assessment sample follows in the Annex. The documentation, working materials and textbooks are not included in this guideline, but can be downloaded or ordered at e.g. CENTRIC Austria International www.centric.at. Other institutions like the UNIDO have as well sets of training materials including teacher's notes available.

Timeframe: 12 Month
Participants: 5-15 Companies of different sectors

The ECOPROFIIT Project

Implementation Schedule	Month	WS	Workshop Title	WS Duration	Content	Related Activities
	1	1a	Setting up an ECOPROFIT Project in the company Sustainable Entrepreneurship	1 Day	Introduction of the Program and Participants Introduction to CP Environmental team and Policy Structure and Responsibilities Awareness Rising exercises	After the Workshop: 1st Company Visit Formation of the CP Team Development of CP Policy
	1	1b	Get to know your Company The CP Assessment	1 Day	Input Output Analysis Material Flow Analysis and Exercise Energy Analysis and Exercise	Initial gap analysis by the CP expert Company specific data assessment
	1	1c	Waste – The non profit output Preparation for the on-site CP assessment	1 Day	Waste Management Waste Cost Evaluation Hazardous Materials	Waste streams analysis - tasks to be finished up to WS2
	3	2a	CP Measures Development	1 Day	Creativity and Project Management and Exercise Risk Analysis (e.g. FMEA) CP Options – Good Housekeeping is the key	2nd Company visit: Data evaluation CP option finding in the company
	3	2b	The Environmental Program	1 Day	CP Options Exercise CP Case Studies	CP Measures Implementation
	3	2c	Eco Controlling	1 Day	Development of Key Performance Indicators Indicator Exercise Environmental Accounting	Development of Action Plan
	6	3a	Technology Assessment	1 Day	Conducting and Technology Assessment Program Environmental Sound Technologies	In House Technology Assessment
	6	3b	Best Available Technology	2 Day	Per Participation Sector	- ongoing CP measures implementation
	9	4a	Environmental Management Systems	1 Day	EMAS, ISO 14001 Certification EMS Documentation Development	3rd Company visit: Evaluation of the CP projects
	9	4b	Preparation for the ECOPROFIT Audit	1 Day	ECOPROFIT audit guidelines Final Report preparation	Preparation Ecoprofit Audit

Implementation Schedule	Month	WS	Workshop Title	WS Duration	Content	Related Activities
	12		Ecoprofit Audit Sustain the Project	1 Day		4th Final Audit: Evaluation of CP projects Development of follow up activities
	12		Ecoprofit Awarding Ceremony	1 Day		
			OPTIONAL	**2nd Year**		
	14		Study Tour	1-2 Weeks	Business Mission	Business Matchmaking Activities
	16-22		ECOPROFIT Advanced Seminars	½ Day each	Additional topics relevant for the sectors Continuation of the CP Projects EMS Implementation Business Matchmaking Technology Transfer Eco-labeling Eco-Design	Business Matchmaking and Technology Transfer facilitating activities

4. The CP Assessment in the company

4.1. Introduction

This Chapter describes the practice of a full on-site CP assessment in a Company. The necessary knowledge of the participating companies will be transferred in the workshops. This guarantees that the main tasks can be done by the CP team in the company itself. The external CP consultant will guide the team.

The Cleaner Production Assessment (CPA) is perhaps the core part of the Ecoprofit Project. A good CPA helps the enterprise in many ways. The benefits of a CPA include:

- Identification, characterization and quantification of waste streams and thus environmental and economic assessments of loss of resources (material and energy)
- Identification of easy to implement and low-cost cleaner production options that enterprises can immediately implement; and
- Preparation of investment proposals to financing institutions for undertaking medium to high cost cleaner production measures that may require technology or equipment change.

Additional benefits of a CPA include:

- Building a "cleaner production culture" in the company, which is crucial for long-term sustainability;
- Generating local examples / case studies which could be effectively used in training and awareness-raising programmes;
- Helping in the estimation of the potential of cleaner production in the concerned sector and thus in the formation of the basis for sectoral policy reforms; and
- Helping in identifying the technology and skill development needs of the company and sector.

In fact, conducting the CPA is an excellent method of building competence of the staff at the centre, as well as the staff in the participating company.

A CPA should be conducted in a systematic form and not on an ad-hoc basis. A structured approach is necessary to get the best results. Such an approach ensures that the outcomes of CPA are consistent with those identified in the organization's broader planning process.

4.2. The Generic CPA Process

A generic CPA process consists of the following steps:

- Planning and organization;
- Pre-assessment;
- Assessment;
- Feasibility analysis;
- Implementation; and
- Monitoring.

Figure 4.1 shows these steps and the related tasks of a typical CPA process.

This section will give a guideline for the CP experts involved in the ECOPROFIT project:

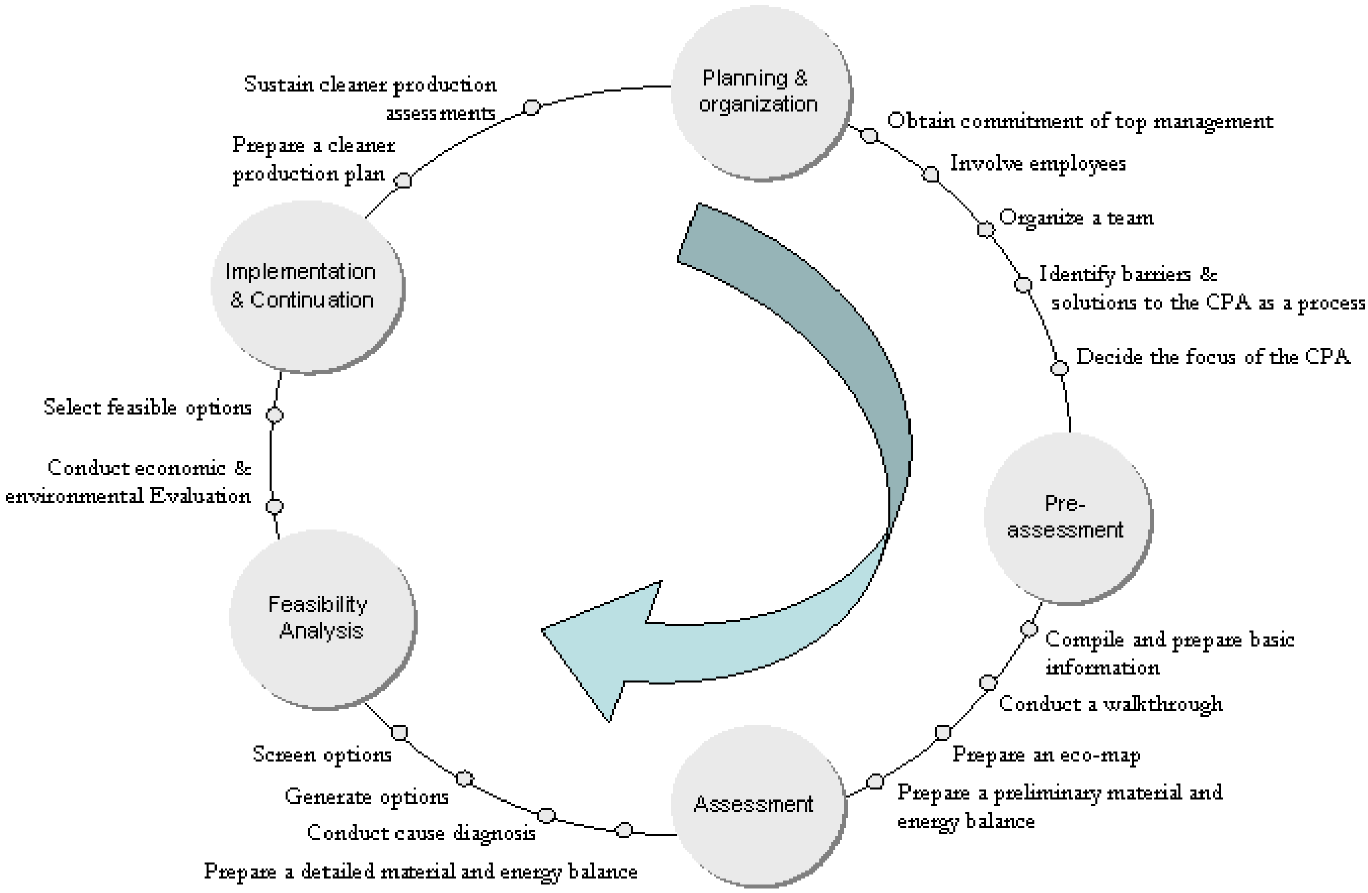

Figure 4-1: Steps and Tasks in the Generic CPA Process

4.3. Planning and Organization

The Management and the CP gets prepared in the preliminary seminar and in the ECOPROFIT workshops.

Experience shows that the following elements are important for the successful start of a CPA:

- Obtain commitment of top management;
- Involve employees;
- Organize a cleaner production team;
- Identify impediments and solutions to the CPA *as a process*; and
- Decide the focus of the CPA.

Planning can begin after the first ECOPROFIT Workshop.

Obtain commitment of top management

The management of an enterprise has to set the stage for the CPA, in order to ensure cooperation and participation of the staff members, especially to be willing to provide all necessary data.

Involve employees

The success of a CPA also depends on the collaboration of the staff. It is important to remember that successful CPAs are not carried out by persons external to the enterprise, such as the ECOPROFIT consultants, but by the staff of the enterprise itself, supported if and where necessary by external persons. The staff includes not only the senior management but also the staff on the shop-floor, involved in everyday operations and maintenance. The staff on the shop-floor often has a better understanding of the process and is able to come up with suggestions for improvement. Again, the staff involvement should not be limited to technical or production staff. There can be a considerable role for other departments such as purchasing, marketing, accounts and administration. These staff members provide useful data, especially on “inputs” and “outputs”; assist in the assessment of the economic and financial feasibility of cleaner production options; provide information on alternative raw materials; or, provide market feedback when redesign of products is envisaged.

Organize a cleaner production team

CPAs are best performed by teams, so the formation of one or more teams is an important part of the planning of a CPA. The teams should consist of staff of the enterprise, supported and assisted where necessary by the ECOPROFIT consultants. Efforts should be made to gel the members of the team by holding frequent meetings. Getting the right mix of team members is crucial, otherwise it is possible that the team may face hindrances from within as well as outside (e.g. from the staff and the workers of the enterprise).

For large organizations, a team could consist of a core team (formed with representatives from different departments) and a few sub-teams for specific tasks. For small and medium scale units, on the other hand, the team could just have the owner or proprietor and a supervisor or manager who looks after the day-to-day operations. This team should initiate, co-ordinate and supervise the CPA activity. In order to be effective, the team should have, on a collective basis, enough knowledge to analyze and review the present production practices. They should have the creativity to explore, develop and evaluate modifications in the production practices. Finally, they must have the competence to implement the economically feasible interventions.

Identify impediments and solutions to the CPA as a process

In order to develop workable solutions, the cleaner production team should identify impediments in the CPA process for a particular enterprise. For instance, there could be impediments in obtaining information from some of the departments. The team should highlight such difficulties right away so that adequate directives can be issued by the management to resolve the issue before the start of the CPA itself. Other impediments could include lack of awareness and / or skills amongst the workers and staff of the enterprise on cleaner production. Solutions to such impediments would typically include performing in-plant awareness-raising sessions, conducting associated training activities, providing and explaining relevant case studies and so on.

4.4. Pre-assessment

The first step the cleaner production team will execute is a pre-assessment. This consists of four important tasks:

- Compiling and preparing the basic information;
- Conducting a walkthrough;
- Carrying out preliminary material and energy balances.

In Accordance to Ecoprofit WS 1

Compile and prepare basic information

In this step, the cleaner production team generates two important outputs:

1. A Process Flow Diagram (PFD; and

2. Basic Data Acquisition

Content of the Ecoprofit WS:

4.4.1. Preparation of Process Flow Diagram

The preparation of a PFD is an important step in the CPA. To construct a PFD, it is best for the cleaner production team to start by listing the important unit operations right from receipt of raw materials to the storage / dispatch of final products. Next, each of the unit operations can be shown in a block diagram indicating detailed steps with relevant inputs and outputs. By connecting the block diagrams of individual unit operations, a PFD can be constructed. Sometimes, the best way to create and firm up a PFD is to conduct a number of walkthroughs (see next section).

While preparing a PFD the team should keep the following points in mind:

- Use blocks to denote the operations. For each block, write the name of the operation and any special operating conditions that need to be highlighted; e.g. for a dyeing operation, it may be pertinent to indicate 90° C and 1.2 atmospheric pressure.

- Show points of inspection or quality control in the PFD. Indicate what happens if the material quality is not according to standards. You may need to show whether the materials are rejected or whether they are reprocessed with and without certain additions. This can be done by developing separate flow charts of the rejection scenario.

- Show all inputs and outputs at each block, indicating major raw materials, intermediate and final products, water and steam as applicable; wastewater, air and solid waste emissions. If quantitative records are available, then these could be shown either on the PFD in the form of tables or referred to as attachments to the PFD.

- The PFD should use various symbols to add more information about the process. For instance, indicate clearly whether the operations are batch or continuous. Also, solid and dotted lines can be used to show continuous or intermittent release of emissions, respectively. Colour codes may also be used; e.g. green lines to indicate recycled streams and red lines to indicate release of wastes, etc. All these symbols need to be reflected in a key to the PFD. It is also useful to show the time required for each operation as a typical range; e.g. "2 to 4 hours", to improve understanding of the process.

- Due attention should be paid to capture start up, shut down and maintenance related activities; seasonal product or production related changes etc. This is best done by preparing a flowchart that indicates how a process or unit operation is operated for a special situation.

Figure 4.2 shows an illustration of a PFD for a wet-textile processing factory.

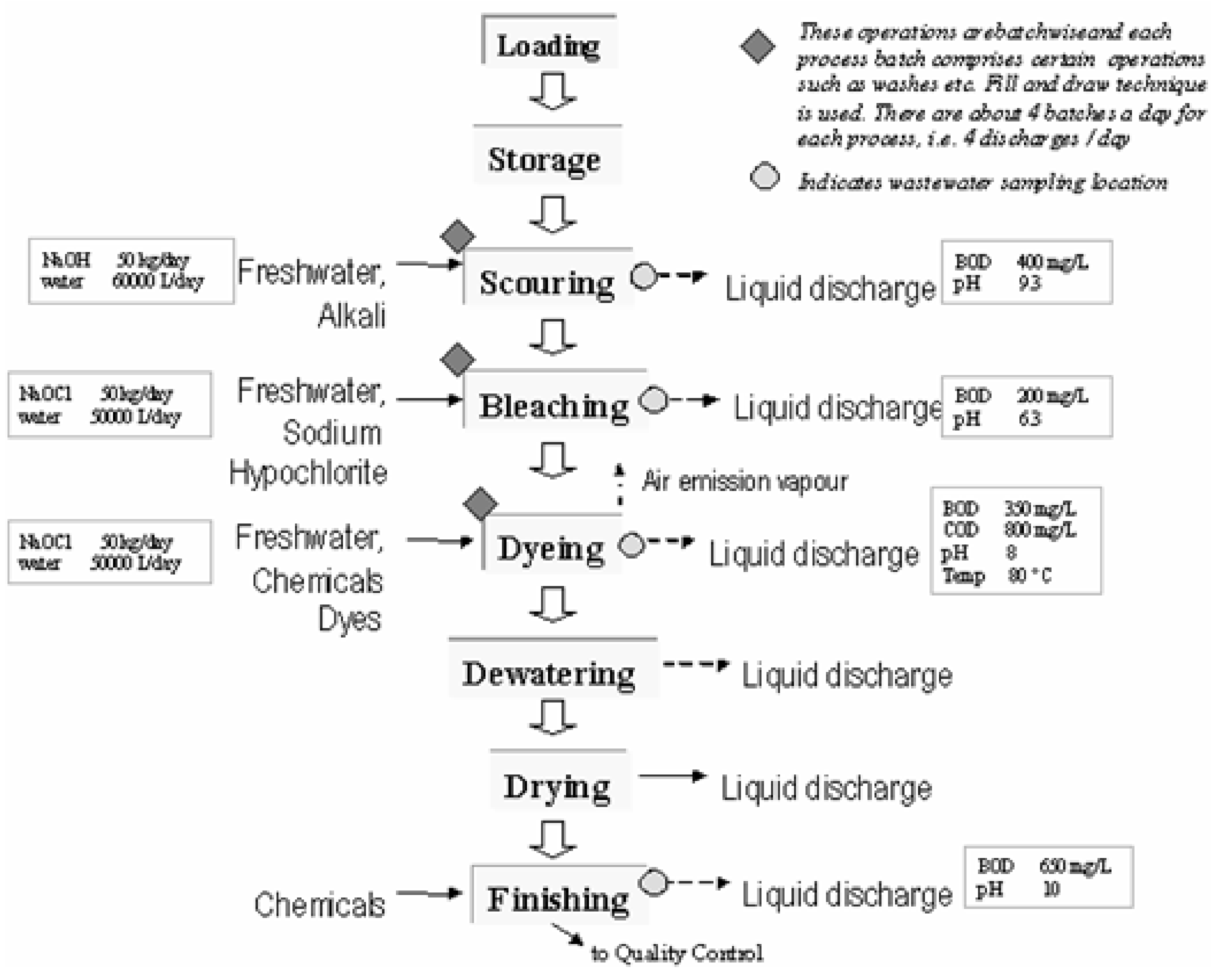

Figure 4-2: A PFD for a Wet-textile Processing Factory

Figure 4.3 provides a flowchart showing decision points for special situations within it; i.e. whether bleaching and scouring is required, whether the material needs to be dyed.

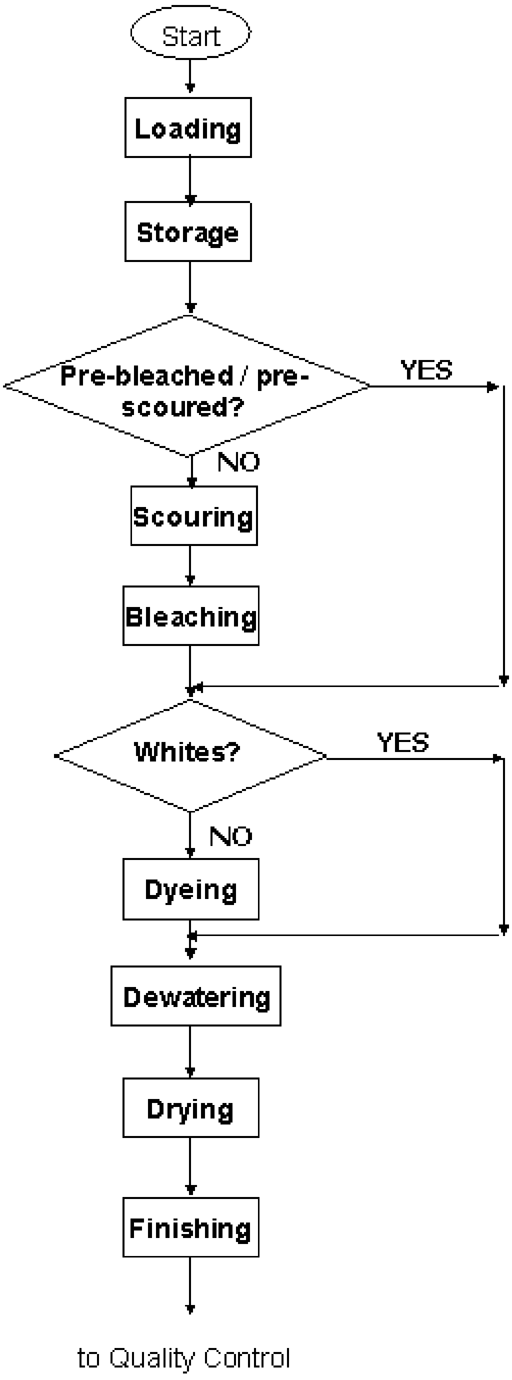

Figure 4-3: A Flowchart Indicating a Process Operation in a Wet-textile Processing Unit for Special Situations

4.4.2. Conducting a walkthrough

A walkthrough is the single most effective technique for getting first-hand information about a production operation in a short time. The cleaner production team, guided by the external CP consultant should not carry out a walkthrough when the operations are closed (e.g. on the weekend, or during low production cycles, or night shifts). The team should begin every walkthrough from the raw materials receiving area and end it at the department concerned with the finished product. A walkthrough thus essentially follows the PFD.

The walkthrough should also cover all the support utilities such as boilers, power generators, fuel storage tanks, pump-houses, refrigeration plants, raw water treatment plants, wastewater treatment facilities, etc.

The following box provides a checklist of recommended questions while conducting the walkthrough. These questions provide leads for discussions and, importantly, to get an insight on cleaner production options.

Checklist of Questions to be Asked During the Walkthrough

Work floor or shop floor -
- Is the floor dirty or ponded?
- Can the workers move about easily? Is there unnecessary piling of raw materials and stocks?
- Is the layout optimum; i.e. can the workflow be improved to minimize movement of materials and walking time?

Storage areas -
- Is the storage system FIFO (i.e. first in first out; raw material is utilized based on the date of procurement, giving preference to old stock) or LIFO (last in first out; fresh raw material is utilized first, while the old stock of raw material remains unutilized)?
- How are the received raw materials checked for quality?
- Are there frequent instances of receiving raw materials that do not meet the required specifications? What happens to the rejects?

Equipment and process -
- Is the process operated as per the Standard Operating Practice laid down by the equipment/technology provider? What are the reasons if there are any variations?
- Is the equipment upkeep regularly conducted? What are the operating efficiencies of the equipment? Are machine breakdowns or problems recorded and their causes corrected regularly?
- Are quality assurance / quality control done for the finished and intermediate products? How frequently? What are the current results?

Boiler and steam distribution system -
- Are there any leaking joints, glands, valves, safety valves?
- Is the condensate being returned to the maximum extent possible?
- Are the condensate return lines and feed tanks jacketed or lagged?
- Are steam traps of correct types being used for each process?
- What is the fuel used? Is it of a consistent quality and composition?

- What is the source of water? Is the raw water treated before use?
- What is the type of boiler (e.g. single pass / double pass, etc.)? How frequently does the boiler blow down?

Waste and emissions -

- Is the waste properly collected, segregated and transported?
- Is the waste generation continuous? Or in spurts?
- Are any measurements made of waste generated or emissions emitted?
- Are any valuable raw materials or products wasted as part of the emissions? Is it possible to reuse or recycle them if recovered?

4.4.3. Preparation of a preliminary material and energy balance

A material and energy (M&E) balance is a basic inventory tool, which allows for the quantitative recording of material and energy inputs and outputs. The basis of the material balance is the PFD. An essential step in the M&E balance is to check that "what goes in must come out somewhere." All inputs should thus have related outputs.

Material balances are typically carried out to make an inventory of the material flows (raw materials, chemicals, water, energy etc.) entering and leaving a manufacturing / service company. Energy balances are useful to find options to minimize the use of energy or to recover the energy lost in the system.
The first task for the team here is to conduct a preliminary M&E balance at processes or departments that have been identified in the planning stage as the focus.

A material balance normally requires a tie compound, which forms the basis for measuring the efficiency of the processes. The selection of the tie compound is a function of several possible parameters; it could be:

- *An expensive resource*
- *A toxic or hazardous compound*
- *A resource common to most of the processes*
- *A parameter which is easy to measure / record*

Preliminary M&E balances are normally prepared using secondary data, supported by the information recorded during the walkthrough. Water and energy bills paid give some idea of their consumption levels. On the output side, production figures or orders serviced over a certain period of time can give an estimate of average production. Obtaining figures on wastes and emissions is generally more difficult. Sometimes, concentration data for water and air pollutants exist, which can be estimated back to mass emissions, while data on mass or volumes of solid waste are sometimes available. Often, approximate calculations will need to be used, based on "typical" values given in the literature.

An energy balance is generally carried out through the following steps:

1. For each type of fuel used (e.g. electricity, gas, diesel, fuel oil, etc.), write down the amount consumed over a given period, along with the per unit cost and the total cost for the period, show which of the fuels is used in each area of operations, and show energy flows between the areas.

2. Estimate the proportion of each fuel used in each area of the operations. To do this, the cleaner production team should prepare a list of the rated energy consumption of the equipment, number of equipments and the type of the fuel used. Once done for each of the areas, the percentage usage of each fuel in each area can be calculated.

Generally, M&E balances at this level are best set by examining three months of data and computing monthly averages. Care should be taken to ensure that all quantification is expressed in the right units (preferably SI units), that they are uniform, and that the associated costs are provided.

4.5. Assessment

4.5.1. Preparation of detailed material & energy balance

It is probable that the cleaner production team finds substantial discrepancies in the preliminary M&E balance. This may require rediscussing the assumptions behind the numbers, conducting measurements, and making whatever revisions are necessary to the data used for inputs and outputs. Hence, the next task for the team is to prepare detailed material and energy balances around certain parts of the PFD. Developing a detailed material balance for each operation is neither practical nor relevant. The critical operations are generally chosen based on:

- The focus of the CPA and results of the preliminary M&E balance arrived at in the earlier steps; and
- The types of materials and processes used; i.e. operations are selected where hazardous materials are used or where materials used are expensive or where materials are used in quantities exceeding the benchmarks. Detailed M&E balances are often performed when the processes have long operational sequences.

Before concluding the M&E balance it could be extremely useful to assign costs to the materials lost or the waste streams that have been identified in the balance. Experience has shown that this could be the single most important information in convincing the management of an enterprise, of the value of cleaner production and securing their commitment for the next steps. While assigning a monetary value to the materials or waste streams, the team should consider the following:

- The cost of raw materials / intermediate products / final products lost in the waste streams (e.g., the costs of unexhausted dye in waste dye liquor);
- The cost of energy in waste streams, in terms of the energy consumed to heat or chill them;
- The cost of treatment / handling / disposal of waste streams, including tipping or discharge fees if any;
- The costs incurred, if any, in protecting the workers and maintaining safe working conditions (e.g., shop floor exhaust systems);
- The potential liability costs from a possible accidental spill, discharge, or leakage.

These costs should be determined at least for each major waste stream. Specific costs (i.e., costs per unit mass / volume of a waste stream) should also be determined so as to be able to compute the savings by reducing or avoiding waste streams. Obviously, the high-cost waste streams would be the most interesting ones to focus on from an economic point of view.
Thus a detailed M&E balance provides the team clues to identify the cause of waste generation or low productivity.

Figure 4.4 presents an example of a detailed material balance in a wet-textile processing unit.
Figure 4.5 shows a detailed energy balance in the same processing unit.

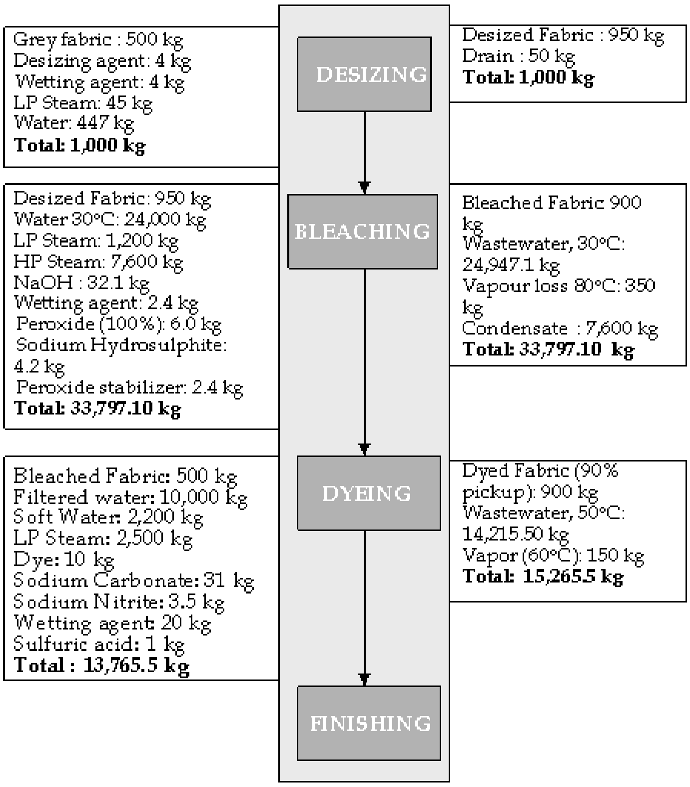

Figure 4-4: A Detailed Material Balance in a Wet-textile Processing Unit

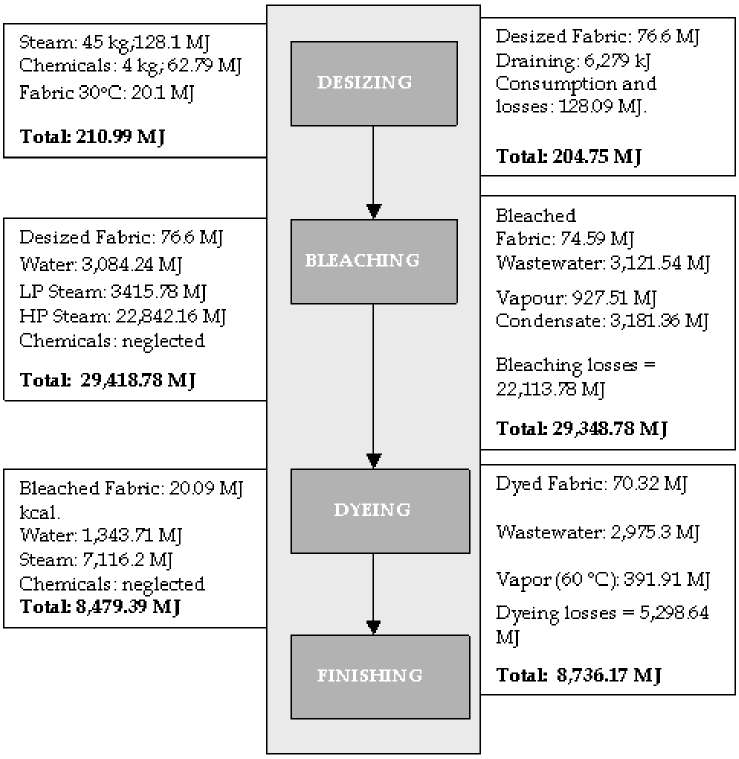

Figure 4-5: A Detailed Energy Balance in a Wet-textile Processing Unit

4.5.2. Cause diagnosis through the fishbone diagram

The cleaner production team now needs to start generating cleaner production options. This will be possible through conducting what is known as a cause diagnosis. As the name suggests, the cause diagnosis exercise involves asking the question **"why?"; i.e. "why did such a problem or outcome occur?"**. It is essentially an exercise to hypothesize over the root causes of any problem.

The team can more effectively conduct a cause diagnosis by using a tool known as the **fishbone diagram**. The fishbone diagram is an excellent tool for cause diagnosis in **complex situations where a number of factors are likely to be involved**. Once such a diagram has been prepared, the team can effectively use it for the generation of cleaner production options (explained in more detail in the following sub-sections).

The technique used in preparing a fishbone diagram is given below. We will use the textile dyeing process as an example. Let us assume that a winch is used as the dyeing equipment.[6] Refer to **Figure 4.6** below.

1. Identify the **principal problem** that is to be diagnosed and write it next to the head of the fish. For instance, one of the common problems in textile dyeing is that the shade of the dyed fabric does not match with the shade specified by the client. This is referred to as "low Right First Time (RFT)". This causes excessive product reject, thus lowering productivity and generating waste (improperly dyed cloth).

2. Identify the **primary causes** of the problem. Primary causes are typically categorized **generically** as **Man, Method, Material** and **Machine**. To illustrate further, primary causes to the principal problem of low RFT could be:

   (a) "Lack of supervision" (Category = **Man**);

   (b) "Dyeing operation not properly carried out" (Category = **Method**);

   (c) "Poor quality of input materials" (Category = **Material**); and

   (d) "Uneven pulling of fabric in the dye liquor" (Category = **Machine**).

   These primary causes are to be listed on the "primary fish bones", as shown in **Figure 4.6**.

3. Every primary cause is the outcome of one or more **secondary causes**. Consequently, this step involves identifying the secondary cause(s) attributable to **each** primary cause. To carry the illustration further from point (2b) noted above, the dyeing operation may not have been properly carried out due to:

[6] A winch is an open-top machine with a tub-like structure where the fabric in a "rope" form is pulled through a dye liquor for a number of hours. It is one of the cheapest pieces of equipment used for dyeing, and is therefore extensively used by small and medium sized enterprises.

(a) Excessive use of salt in the dyeing operation;

(b) Incorrect procedure followed while dosing the chemicals.

Similarly, for point (2c) noted above, the poor quality of input materials may have been the result of:

(c) Impurities in the dyes used for the dyeing operation;

(d) Auxiliaries for the dyeing operation having exceeded their shelf-life;

(e) Improper storage of fabric used in the dyeing operation; and

(f) Poor quality of water used in the dyeing operation.

These secondary causes are to be listed on the "secondary fish bones", as shown in **Figure 4.6**

Important

Note that the technique of identifying the possible primary / secondary causes of any problem involves asking the question **"why?"; i.e. "why did such a problem or outcome occur?"**

Interestingly, certain causes appear several times in the diagnosis of primary (or perhaps even secondary) causes. Common examples in this case include “poor water quality used in the dyeing operation” and “lack of clear and concise work instructions”. This allows us to identify common causes, which when corrected could resolve several productivity and environment related issues. Options that address correction of the common causes thus become priority options in drawing the implementation plan.

The fishbone diagram is complete at this point. Primary and secondary causes may be colour-coded for the sake of clarity, although this is not a must. **Figure 4.6** shows the completed fishbone diagram for the preceding example.

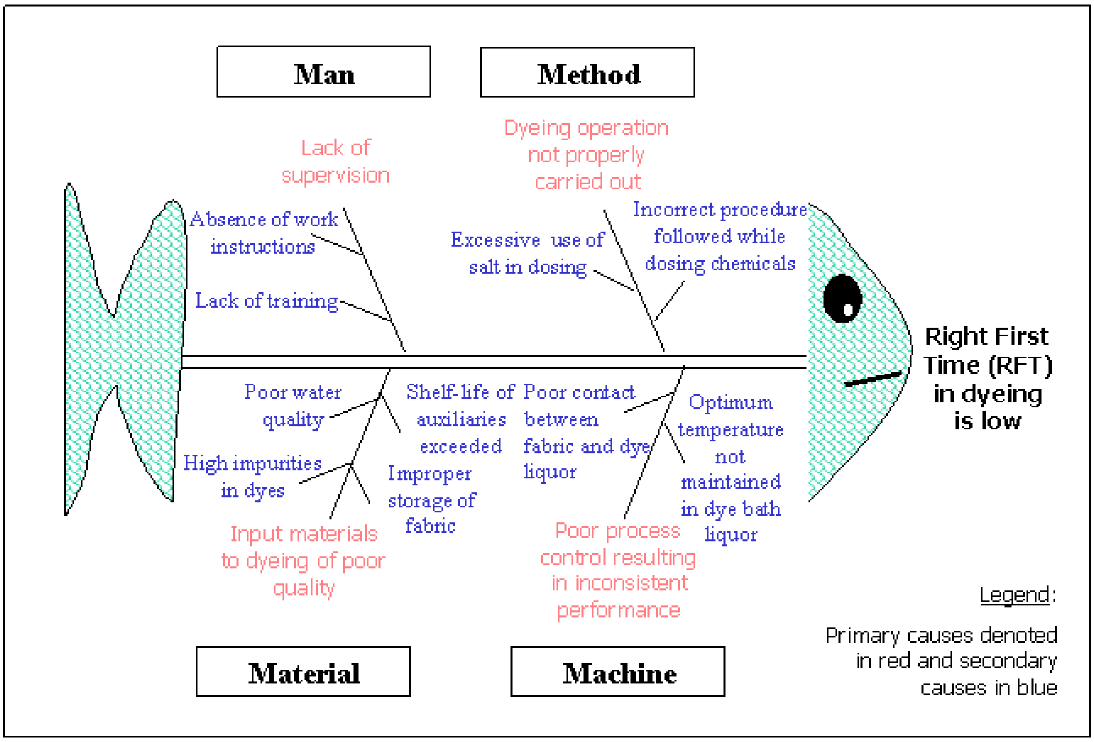

Figure 4-6: Illustration of a Fishbone Diagram to Facilitate Cause Diagnosis in the Dyeing Process

4.5.3. Allotting priorities to the causes identified in the fishbone diagram

The causes identified in the fishbone diagram are only "probable" causes. Thus, the next step is to calculate **the extent to which each particular cause contributes to the principal problem**. The cleaner production team needs to analyse the **extent** to which each of these probable causes contributes to the dyeing operation not being carried out satisfactorily. Such an analysis is possible through observations, record keeping, and setting up well-planned controlled experiments designed to isolate a specific secondary cause.

These efforts can assist the team in **validating** the primary and secondary causes and prioritizing cause elimination.

Tools such as Pareto analysis[7] may be used if a number of primary and secondary causes are to be analysed. The Pareto analysis is used to separate the most important causes of a problem from the many trivial ones, and thereby identify the most important problems for the team to concentrate on.

[7] Sometimes also called the 80/20 rule. This means that 80% of the problems are caused by 20% of the activities, and it is this important 20% that should be concentrated on. Source: Kanji G. and Asher M. (1996) "100 Methods for Total Quality Management."

Many cleaner production teams stumble at this juncture, since estimating the relative importance of each probable cause seems a wearisome task. **It cannot be stressed too much that teams should be strongly encouraged to push through with this step completely, since it can avoid significant wastage of time (and money) later on in the CPA.**

4.6. CP option generation through brainstorming

Once the points of action and priorities are understood and listed, the cleaner production team should move on to the logical next phase; i.e. option generation.

Option generation is a creative process, and is best performed, as in the case of the cause diagnosis, by the team as well as the enterprise personnel. Including the enterprise personnel in this activity would lead them to have a sense of ownership of the generated options and a deeper sense of understanding as to why a certain option is finally recommended for implementation. The option generation exercise is conducted through **brainstorming**, a commonly used tool for generating ideas. Given a particular item which needs to be resolved, the team and the enterprise personnel have to deliberate on the ways and means of obtaining a solution to it. In this sense, the cause diagnosis described in the earlier section provides a starting framework for the brainstorming exercise.

In a typical brainstorming session, an idea may be proposed by a person, which may be supported and / or extended by other persons. Further discussions yields other new, transformed, opposing and / or supporting ideas, **thus paving the way for the generation of cleaner production options**. The principle question to be asked during the brainstorming session is **"how?"; i.e. "how does one solve this particular problem effectively?"**

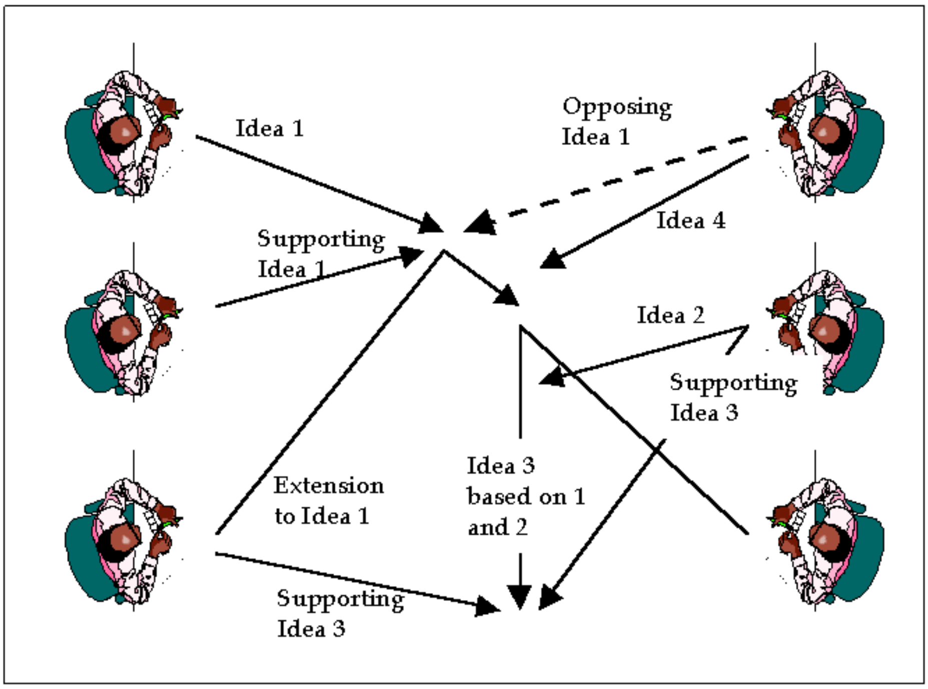

Figure 4-7: Generating Options through Brainstorming

Cleaner production options could fall under one of the following categories:

Housekeeping – Improvements to work practices and methods, proper maintenance of equipment etc., fall under this category. Efficient housekeeping can provide significant benefits in terms of saving resources. These options are typically low cost and provide low to moderate benefits[8].

A simple example of good housekeeping in a dyeing operation is to clean the floors and machines of dirt, grease, rust, etc. regularly, which will reduce the possibility of accidentally soiling the fabric, and thus minimize the need for extra washing.

Management and personnel practices – Management and personnel practices include effective supervision, employee training, enhancing operator skills, and the provision of incentives and bonuses to encourage employees to conscientiously strive to reduce waste and emissions. These options are typically low cost and can provide moderate to high benefits.

Process optimization – Process optimization involves rationalization of the process sequence, combining or modifying process operations to save on resources and time, and improve process efficiency. For instance, certain washing operations may not be required due to changes in raw materials or product specifications.

[8] For more information on housekeeping, refer to the "Good Housekeeping Guide for Small and Medium-sized Enterprises". Available as: www.getf.org/file/toolmanager/O16F15343.pdf

Raw material substitution – Primary / auxiliary raw materials can be substituted if better options exist in terms of costs, process efficiency, and reduced health and safety related hazards. Such an approach may be necessary if the materials already in use are difficult to source, or become expensive, or come under the purview of new environmental or health and safety regulations. In all cases of material substitution, it is crucial to test the suitability of the new material in terms of environmental and economic benefits, optimum concentration, product quality, productivity, and improved working conditions.

For instance, sodium sulphide and acidified dichromate tend to be used as auxiliary agents in the sulphur black textile dyeing process[9]. However, both these agents are toxic and hazardous to handle. Their usage may leave harmful residues in the finished fabric and generate effluents that are difficult to treat and damage the environment. Both these agents may be safely substituted without a decline in fabric quality, thus eliminating adverse health and environmental impacts. Sodium sulphide may be replaced with glucose or dextrose, whereas acidified dichromate may be substituted with sodium perborate or ammonium persulphate. The substitution of chemical dyes with natural dyes may also be cited as an example of raw material substitution.

New technology – Adopting and transferring new technologies can often reduce resource consumption, minimize wastes, as well as increase the throughput or the productivity. These options are often capital intensive, but can lead to potentially high benefits. Modifications in equipment design can be another option, which tends to be slightly less or equally capital intensive as the option for new technology, and can lead to potentially high benefits.

New product design – Changing the product design can cause impacts on both the "upstream" as well as "downstream" side of the product life-cycle. Product re-design for instance, can reduce the quantity or toxicity of materials in a product, or reduce the use of energy, water and other materials during use, or reduce packaging requirements, or increase the "recyclability" of used components. This can lead to benefits such as reduced consumption of natural resources, increased productivity, and reduced environmental risks. Often, this helps in both establishing as well as widening the market. Product re-design is, however, a major business strategy and may require feasibility studies and market surveys, especially if the supply-chain around the product is already established and is complex.

Recovery of useful byproducts / resources – This cleaner production option entails the recovery of wastes as byproducts / resources, which may have useful applications within the industry itself or outside it. This type of options essentially leads to the reuse / recycle, and thus minimization, of waste as well as to cost savings.

[9] Sulphur black dyes are generally used to produce a jet black colour in cotton fibres. Sulphur dyes are insoluble and must first be converted to a water soluble form by adding an agent – traditionally sodium sulphide – so that the dyes can be absorbed by the fibre. After dyeing the fabric, the dye is converted back to insoluble form with the addition of another agent, often acidified dichromates.

A common example of recovery from a waste stream for many industries is heat recovery through the use of heat exchangers. Such options are typically medium cost and can provide moderate to high benefits.

Onsite recycling and reuse – Onsite recycling and reuse involves the return of a waste material either to the originating process or to another process as a substitute for an input material.

For instance, in the case of a textile dyeing unit, instead of draining off the last cold washes, they can be collected in an underground tank, adjusted for pH[10], and then filtered prior to reuse in subsequent washing operations. These options are typically low to medium cost and can provide moderate to high benefits.

The team should always be made to remember that in general it is better to not generate a waste in the first place, rather than generate it and later recycle or recover / reuse it. **Therefore, the team should only consider the latter type of options once all the others that could prevent waste generation have been examined.**

In reality, many of the options a team will identify result as a combination of the above categories so as to produce cost-effective and sustainable results. For instance, any option of new technology should be preceded and followed by improvements in management and training. In addition, many a time, the option of new technology also requires substitution of raw materials.

It is important to bear in mind that some of the chosen options may require major changes in the processes or equipment or product. Often, these will dramatically reduce waste generation or increase productivity, but they also often imply considerable investments.

Finally, it is equally important to bear in mind that certain chosen options will require thorough laboratory / bench scale / pilot studies to ensure that the product quality does not degrade as a result of their application, and that it is acceptable to the market.

[10] "pH" is a term used universally to express the intensity of an acidic or alkaline solution.

To round off this section, let us now combine our example of the cause diagnosis through the fishbone diagram with the identification of possible options for cleaner production in the form of the following table.

Table: Matching the Problems Diagnosed using the Fishbone Diagram with Possible Cleaner Production Options

Generic categories as per the Fishbone Diagram	Primary causes	Secondary causes	Possible cleaner production options	Category of cleaner production option
Man	Lack of supervision	Absence of clear work instructions	Develop work instructions as Standard Operating Practices (SOPs). Get the SOPs reviewed by external experts. Closely monitor improvements or identify problems faced, if any, in the implementation of the SOPs. Build a record keeping system to monitor SOP related compliance.	Management and personnel practices
		Lack of training	Organize shop floor based training programmes for the workers and supervisors.	Management and personnel practices
Method	Dyeing operation not properly carried out	Excessive use of salt in dosing	Improve worker instruction and supervision. Redesign the dyeing recipe by changing composition and materials e.g. use of low salt dyes.	Management and personnel practices, Process optimization, Raw material substitution
		Incorrect procedure followed while dosing chemicals	Improve worker instruction and supervision.	Management and personnel practices
Material	Input materials are of poor quality	High impurities in dyes	Get the dye purity checked by independent institutions over a number of samples and across commonly used shades, change the supplier if necessary	Raw material substitution
		Shelf-life of auxiliaries exceeded	Improve the inspection at the receiving unit. Check the container labelling, storage and supply systems.	Management and personnel practices
		Improper storage of fabric	Ensure proper storage of scoured/bleached materials e.g. on wooden blocks, wrapping to avoid soiling	Management and personnel practices, housekeeping

Generic categories as per the Fishbone Diagram	Primary causes	Secondary causes	Possible cleaner production options	Category of cleaner production option
		Poor water quality	Analyse the water for constituents such as hardness, total dissolved solids, pH and iron / manganese content, and compare the measured levels with recommended standards. Treat water to ensure that the constituents are within the recommended standards.	Raw material substitution
Machinery	Poor process control resulting in inconsistent performance	Optimum temperature not maintained in the dye bath liquor	Check the steam inlet position and steam pressure to ensure that heating is optimum. Take readings of temperature of the liquor before and after requisite modifications	Process optimization, New technology
		Poor contact between fabric and dye liquor	Explore changing from a winch to a jet dyeing machine that is enclosed, operates under pressure and imparts better contact between fabric and dye liquor.	New equipment

4.7. Feasibility Analysis

4.7.1. Preliminary screening of options

Once the options are identified through brainstorming, it is important to check whether all causes identified are adequately addressed by the options or whether additional options are required to resolve any causes that still remain outstanding.

The cleaner production team then needs to undertake a preliminary, rapid screening of the cleaner production options developed so as to decide on implementation priorities. In such a screening exercise, the options could be categorized into two classes:

Directly implementable options: Those simple options that are obvious and can be implemented straightaway. Generally, options related to housekeeping (e.g., plugging leaks and avoiding spills) or simple process optimization (e.g., control of excess air in combustion systems) fall into this category. For these options no further detailed feasibility analysis is required. Furthermore, their immediate implementation gives management real, tangible benefits in a short period, which makes them more comfortable with the cleaner production assessment.

Options requiring further analysis: Those options that are technically and/or economically more complex. Most of the options related to management improvement, raw material substitution, and equipment / technology change, would fall into this category. Some of these options could even be put into a sub-category: those that require much more information collection or are difficult to implement (due to reasons such as very high costs, lack of technology, requiring major changes, etc.). These can be left pending for later consideration.

4.7.2. Detailed screening of options

The team can now undertake a detailed screening of the options in the category requiring further analysis in order to determine which of the options are technically feasible, and ascertain both the economic and the environmental benefits of implementing these options. Each of these aspects is described below.

4.7.3. Technical evaluation

The technical evaluation should cover the following aspects:

Materials and energy consumption – For each option, it is important to establish material and energy balances for conditions before and after implementation to quantify the materials and energy savings that will result.

Product / byproduct quality – Assess the product / by product quality before and after the implementation of the option.

Right First Time – Provide estimates on the possible improvement of the RFT corresponding to before and after option implementation.

It is also important to examine the following aspects from the point of view of implementation.

Human resources required – whether the option can be implemented by in-house staff, or whether external expertise or collaboration with partner organization is required.

Risks in implementing the option - Some options may not be fully proven and may require laboratory scale experiments or pilot studies to assess the outcomes before a full-scale implementation is carried out. Some options may affect the key production process or product features, so the potential impact on the business if the option does not work as planned is very high.

Ease of implementation – The technical ease with which an option can be implemented will depend on such things as the layout of the production processes and of the auxiliary services such as steam lines, water lines, inert gas lines, etc., the physical space available, the maintenance requirements, the training requirements, etc. Also, if options require working on key production processes, the timing of the options' implementation becomes critical. If the option requires major changes in, or interruptions to, production patterns, any loss in production needs to be factored into the economic analysis of the option.

Time required for implementation – Time required if equipment or material needs to be procured, installed or commissioned including consideration of shut-down time for affecting the implementation of the option.

Cross-linkages with other options – Whether a particular option is linked to implementation of other options and / or whether the option is best implemented stand-alone or in consideration with other options.

4.7.4. Technical evaluation

The environmental evaluation of an option should ideally take into account its impacts on the entire lifecycle of a product or a service, wherever practically possible. In practical situations, however, the evaluation is often restricted to on-site and off-site (neighbourhood) environmental improvements.

The environmental evaluation should include estimation of following benefits that each option can bring about:

- Likely reduction in the quantity of waste/emission released (expressed on a mass basis);

- Likely reduction in the release of hazardous, toxic, or non-biodegradable wastes/emissions (expressed on a mass basis);

Likely reduction in the consumption of renewable natural resources (expressed on a mass basis);

- Likely reduction in consumption of non-renewable natural resources, e.g. fossil fuels consumed (expressed on a mass basis);

- Likely reduction in noise levels;

- Likely reduction in odour nuisance (due to elimination of an odorous compound);

- Likely reduction in the on-site risk levels (from the point of process safety);

- Likely reduction in the release of globally important pollutants, viz. ozone depleting substances, greenhouse gas emissions.

4.7.5. Economic evaluation

The team must now evaluate the economic benefits of all the reductions in waste generation and resource consumption that each option can bring about. It must estimate the immediately obvious savings in the purchase costs of materials and fuels, the treatment and disposal costs avoided as well as the material and waste stream costs (identified during the M&E balance earlier). However, it must also estimate less obvious financial benefits such reduced sick days for workers or generally higher worker productivity, lower personnel costs from reducing the burden of special management and reporting of hazardous materials, wastes and pollution, reduced worker and environmental liability, potential profits from sale of waste as by-product, from carbon dioxide credits, etc. Experience has shown that such an *expanded* financial assessment often helps in considerably improving the economic feasibility of an option.

The team must also estimate the economic costs of each option, in the form of investments in new technology or equipment, but also in terms of training and other costs ancillary to the implementation of the option.

These benefits and costs are then analyzed and computed using various evaluation criteria [e.g. pay back period, Net Present Value (NPV), Internal Rate of Return (IRR), etc.].

A simple **payback period** is evaluated based on a comparison of the annual savings and the initial investment. It simply indicates the time period to return the initial investment.

It is calculated as,

Payback Period in years = (Capital Investment/Annual Savings)

The payback period should be generally considered only as a ballpark assessment as it ignores depreciation of the investment made and the time value of money. Usually, investment decisions can only be made on the basis of payback period alone if the investment required is low and / or the returns are high so that the payback period is less than two years.

If these conditions are not met, a better approach is to use the concepts of NPV or IRR. These concepts consider the time value of cash inflows and outflows during the useful life of the investment made. This kind of economic evaluation requires information on:

- The capital costs associated with any investments required;
- Net revenue, which is computed as a difference between total revenue (that could be higher than the base case) and the operating costs (that are typically lower in the changed scenario); and
- Rates of interest and depreciation to enable computation of the Present Value.

The following are the equations that can be used for computation of NPV:

$$NPV = -(CF_0) + \sum_{i=0}^{i=n} \frac{Net\,Cashflow_i}{(1+r)^i}$$

CF_o = Cash outflow in the first year (capital investment)
r = opportunity cost of capital (i.e. for a rate of 10% 'r' would be 0.1)
n = useful life of the investment in years

For an investment to be financially viable NPV must be greater than zero.

Another indicator commonly used along with NPV is the **Profitability Index (PI)**. PI is computed as the ratio of the present value of the total cash inflows to the present value of the total cash outflows. For an investment to be financially viable, PI must be greater than 1.

IRR is essentially that rate of return on an investment that ensures that during the investment's lifetime the net cash inflows (i.e. inflows – outflows) are equal to zero, i.e., IRR is the value of r that gives zero as the value of NPV:

$$NPV = -(CF_0) + \sum_{i=0}^{i=n} \frac{Net\,Cashflow_i}{(1+r)^i} = 0$$

This problem is solved by assuming r and then following an interpolation procedure. The IRR is then compared with the rate of interest of the borrowings that may be needed from the market. Typically, if the IRR is lower than the market borrowing rate, then the investment is not considered to be financially viable.

It is useful to carry out a sensitivity analysis to understand the "ruggedness" of an option. This can be done by varying the expected efficiencies or yields, prices that the by-products may fetch in the market, or the capital costs of new equipment, and see how much of an effect these have on the outcome. This can help in building both optimistic and pessimistic scenarios to test how sensitive the IRR or NPV are to the data assumed in the economic analysis.

4.8. Implementation of Cleaner Production Options

The three evaluations help to eliminate options that are not viable. The remaining options may be considered in the preparation of a cleaner production implementation plan.

4.8.1. Prioritization of cleaner production options

In most cases, after conducting the feasibility analysis, it will emerge that different options have differing levels of technical feasibility, economic viability, and environmental performance. Since it is not desirable to implement all the options at the same time it will be necessary for the team to prioritize the cleaner production options. To assist the process of prioritization, a common evaluation framework will be necessary. A weighted-sum method could be considered for this purpose.

In this method, the team will assign weights to each of the three aspects of the feasibility analysis (technical feasibility, economical viability, environmental performance). These weights could be decided through a brainstorming session and involving the top management. The weights will vary from enterprise to enterprise, depending on their technical competence, financial conditions, environmental sensitivity etc. For example, a financially healthy small-scale enterprise facing considerable environmental pressures may decide to give the highest weightage to environmental performance (say, 50%), less to technical feasibility (say, 30%) and least to financial viability (the remaining 20%). This indicates that the enterprise is most keen to reduce pollution load but does not have high levels of capability to undertake technically involved options.

Once weights are assigned, simple indicators such as "scores" can be developed to assess the relative performance of each option. For example, economic viability could be assessed based on the payback period / NPV / IRR. Environmental performance could be assessed based on percent pollutant load reduction. Technical feasibility could be assessed based on technical complexity, requirements for new equipment / technology, requirement of additional technical skills, etc. Each option is then evaluated on a subjective basis and scores assigned to each of the three aspects. Scores could have a range such as 0 to 10 where lower scores will imply poor attainment of the performance etc. For example, two options may have IRR of 15%

and 33% respectively and hence may be assigned scores of 8 and 5 on the aspect of economic viability.

The weighted sum of the scores will give an index for each option, on the basis of which priorities may be assigned. It should be noted that the intention is not to prioritize each option individually but to group them into categories such as "top priority", "medium priority", and "low priority". This exercise would then be the basis for preparing the implementation plan.

The Table below presents an illustration of such analysis for prioritizing the cleaner production options.

Table : Deciding Priorities for Implementation Among Cleaner Production Options

Weights and cleaner production options	Technical Feasibility	Economic viability	Environmental performance	Total weighted index
Weights (%)	**30**	**45**	**25**	**100**
Scores for Option One	6	6	7	**6.25**
Scores for Option Two	7	9	6	**7.65**
Scores for Option Three	3	4	8	**4.70**
Scores for Option Four	5	8	3	**5.85**
Scores for Option Five	9	9	7	**8.50**

Based on above, Option Five may be considered as high priority, followed by Options One and Two as medium priority, followed by Options Three and Four. Such a method of prioritization helps in the development of an implementation plan.

4.8.2. Preparing a cleaner production implementation plan

An implementation plan consists of the organization of the projects required to implement the options, the mobilization of the necessary funds and human resources, and logistics. Training, monitoring and establishment of a management system such as EMS are also often important components of an implementation plan.

The implementation plan should clearly define the timing, tasks and responsibilities. This involves:

- Prioritizing implementation of options depending on available resources;
- Preparing the required technical specifications, site preparation, preparing bidding documentation, short-listing submissions, etc.; and
- Allocating responsibilities and setting up monitoring/review schedules.

The cleaner production team should give first priority to implementing options that are low in cost, easy to implement and / or are a pre-requisite for the implementation of other options. This should be followed by options that require more investment, laboratory or pilot trials, or interruption in production schedules.

Many a time, options are implemented during or immediately after the CPAs at enterprises. The very conduct of a CPA in this form becomes a demonstration for others to follow.

4.9. Sustaining cleaner production assessment

The application of CPA and implementation of cleaner production options will often require changes in the organization and management system of the enterprise.

The key areas of changes are: integration of new technical knowledge; understanding new operating practices, laying down revised purchasing procedures, installing and operating new equipment, or changing the packaging and marketing of the products / by-products. These changes will include modified preventive maintenance schedules, waste segregation and recycling practices, etc.

It is important, therefore, to ensure that the CPA is implemented as an on-going activity, by integrating the concept of cleaner production into the enterprise's management system.

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