The Regional Environmental Centre for the Caucasus is an independent, non-for-profit organization, established within the framework of the "Environment for Europe Process" by the governments of Azerbaijan, Armenia, Georgia and the European Union to assist in solving environmental problems as well as development of the civic society in the countries of the South Caucasus.

To achieve its mission the Centre encourages cooperation among the governments, non-governmental organizations, business, academic institutions, media and other stakeholders by supporting free exchange of information, offering advice and funding, promoting public participation in environmental decision-making in order to develop a free exchange of information, in line with principles, of the Aarhus Convention; offer assistance to all environmental NGO's and other stakeholders, and increase public participation in the decision-making process, thereby assisting the states of the South Caucasus in the further development of a democratic civil society.

REC Caucasus successfully implements its mission through various programmes and projects throughout the Caucasus region. One of the tasks of REC Caucasus is to be a "bridge" between the public and governments. As it was stated above the REC Caucasus's mission is to assist its stakeholders in capacity building through provision of information, advice and expertise and to encourage dialogue, cooperation and public participation in environmental decision-making. REC Caucasus plays an active role in interagency cooperation, too. The organization together with active environmental NGO's and the ministries of environment promotes the idea of environmental protection and sustainable development in the South Caucasus countries, demonstrating examples and arguments of direct links of environmental degradation and destruction with the growth of poverty, migration, economic recession, etc., i.e. other components (social and economic) of sustainable development.

Since its establishment the Regional Environmental Centre for the Caucasus has implemented about 60 medium and large scale projects in the region which have contributed to the policy development, capacity building, facilitation of dialogue and networking, information exchange on environmental issues and supporting the civil society in the South Caucasus states. Capacity building and trainings of various environmental stakeholders at regional, national and local levels has been one of the main focuses of almost all projects. Therefore, the organization has strong experience in providing trainings to different interest groups and deep knowledge on their needs, demands and constraints.

The Centre has proven to be a viable and independent organization providing services to governments, local authorities, non-governmental organizations, businesses, international organizations and other environmental stakeholders. The organization is best positioned in the region to assist various national and international organizations to tailor their activities of the region, countries and specific stakeholders.

Headquarter of REC Caucasus is located in Tbilisi, Georgia. The organization has national offices in Armenia and Azerbaijan.

Contents

Abbreviations

CP	Cleaner Production
BA	Best Assessment
BAT	Best Available Techniques
MaT	Monitoring and Targeting
IFI	International Financial Institutions

1. Introduction

The present manual is dedicated to the implementation of "Cleaner Production" technique in existing and operating enterprises. The definition of cleaner production was invented by the UNEP. In accordance to this definition:

"The Cleaner production means the continuous application of an integrated, preventive environmental strategy to processes and products to reduce risks to humans and the environment".

The definition is quite complex and difficult to understand, however we have set target to our Plain Language Guide to simplify the CP implementation process and to describe the CP implementation in reality. There are number of guidelines and reference materials describing the processes for the CP implementation, but often they are too scientific and complicated because they are designed for the enterprises with complex production technology, which needs detailed complex assessment of existing processes, waste generation, production parameters etc. The present document describes very basic approach to the CP implementation and is based on experience

gained during the CP activities implemented in the region and on cases common for the small and medium size enterprises in Caucasus region.

In real situation, we often face that technical personnel working in enterprises don't know processes in detail and usually they have not analyse their own technology from a perspective of minimisation of production costs or environmental indicators in order to improve their production and benefit from improvements made.

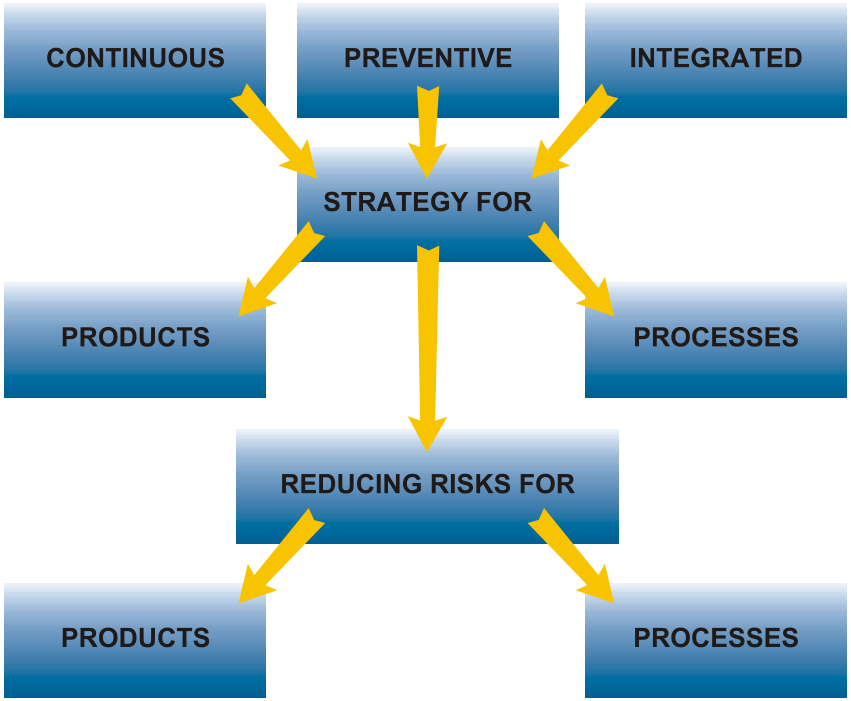

Figure 1.1 CP definition

While working on implementation of the CP in practice in Caucasus region, we have learned that in small and medium size enterprises the CP can be implemented, and the technology can improve significantly the operation of businesses even in the situation when

enforcement of environmental requirements to the enterprises is very poor and costs related with environmental issues are so small, that sometimes it is very difficult to quantify the benefits achieved from the improvements made.

2. What is Cleaner Production

Cleaner production is a cost-effective, preventive approach to pollution control that makes efficient use of energy and materials and reduces risks to health and safety. It is a "win-win" approach when entrepreneur running business gets benefit out of the reduction of operation costs, minimization of expenses related with environmental payments and penalties for pollution etc, on other hand community and country benefits out of minimized environmental pollution, better consumable products, improved living conditions. The many potential benefits to an industrial enterprise adopting the CP include:

- Cost savings
- Higher product yields and quality
- Maintenance or improvement of market share
- Reduced liabilities.

Worldwide experience shows that achieving these benefits through the CP requires real and sustained commitment of senior enterprise managers to the CP, otherwise the implementation of the CP technology has non continuous character, and after the pilot project implementation the CP stops.

In practice the CP can be defined as preventive, continuous process addressed to implementation of methodology to improve process efficiency and increase overall yield of final products. The CP should be oriented to reduction of environmental impact caused by production process. This can be reached by reduction of the pollutant and waste generation at several stages of production process and increase of overall environmental performance of the enterprises.

In addition to the methodology, the results of the CP measures implemented depend on specific project selected for the CP implementation. The project can be low cost, medium cost and high cost projects. Internationally the following is recognized and A type,

B type and C type the CP projects.

A – Low Cost (self-resourced)

B – Moderate Cost, Internal finance financed by specific funds inclusive revolving funds, specific grants addressed to specific issues etc

C – High Cost Needing Investment Finance.

For implementation of the CP actions different scale financial assessment is required.

- Simple pay-back method assessment for - A/B actions
- Return on investment (ROI) assessment for - B/C actions

2.1. Benefits

The CP is "win-win" type of the methodology, in which the benefits can be split between the entrepreneur and public. This makes the CP very attractive, as soon the entrepreneurs benefit should be the driving force for implementation of the technology in production processes, also this helps in dissemination via duplication of good practices by similar enterprises.

The benefits from entrepreneurs site are related mostly in financial benefits and reduction of enterprise risks related with environmental issues. The financial benefits can be reached by:

Minimisation of production related costs

efficient use of raw materials can be achieved through improved raw material handling and storage. Improved process management can lead to significant decrease of the quantities of wasted raw material and can generate savings from disposal of wasted raw materials,

increased yield of final product quantities and generation of extra income, minimisation of labour costs related with raw material handling.

Increased efficiency of specific processes leading to savings of operation costs at different operational stages like temporary storages semi products because of not synchronised production, minimization of buffer storage volumes, avoiding multiple heating/cooling processes etc. Ensuring better technology in order to avoid the semi product waste generation and spoiling. This can be caused because of unexpected stopping of technological lines often happened when technological equipment maintenance is not systematic and well managed. i.e. technological lines and equipment is repaired after it is damaged and not maintained proper.

Introduction of energy efficient technologies can be achieved via minimisation of electric energy loses because of bad synchronisation of equipment replacement of equipment with modern more energy efficient models, introduction of computerised power management systems, replacement lighting of internal lighting systems by better designed schemes with energy efficient lights. etc. Another way is to avoid thermal energy losses through installation of insulated systems, better boilers and heaters, recovery of extra energy from waste streams, minimisation of reheating of the materials because of inefficient operation etc.

Minimisation of waste water quantities, pollution level and treatment requirements can benefit in reduction of the costs for raw water and costs related with wastewater treatment inclusive both types of expenditure: investment and operation costs. Can be achieved by separation of different type wastewater streams, minimisation of pollution at sources and water recycling and introduction of recirculation streams.

Minimisation of solid waste generation can benefit in reduction of the costs for handling and disposal of the hazardous and non hazardous wastes. The introduction of new recycling schemes can lead to

financial benefits, which can help to improve financial sustainability of the business. The important is to prevent waste generation at sources and implementation of waste generation prevention techniques.

2.2. Why it is important to use Cleaner Production

The CP technologies enables reduction of environmental pollution caused by economic activities and therefore reduces impact associated with operation of small and medium size enterprises. The CP techniques includes minimization of the resource wastage and increases overall efficiency of resource utilization. It guides the community to more sustainable use of natural resources and increases the targets set in the specific sectors of the industry.

In addition the CP helps with more efficient production and allows to reduce the self price of produced goods, contributing to wider accessibility of community to better and cheaper products and services in the country.

In parallel the technology allows to develop step-by-step existing industrial sector, which usually is responsible significant contribution of environmental pollution from industrial sector. This is very important as soon small and medium size enterprises usually use old, outdated technologies and equipment. Usually those enterprises are experiencing problems with financial resources, and they are not able to upgrade their businesses to modern technology. The CP is recognized as a tool which helps to move through the transition stage before upgrading the technologies to the modern level.

3. Decision making regarding the Cleaner Production implementation

One of major problems in the CP implementation is recognized as willingness of top company managers in implementation of the CP technology in the enterprises. Without the commitment of Top managers, the CP usually becomes non effective and all the achievements have the temporary character.

The CP implementation process is schematically presented in Figure 3.1.Central to it is the "***interest and commitment of senior managers***". Unless they commit human and financial resources to the CP activity its results may be patchy and short-lived. Raising the awareness of enterprise managers on the CP issues is a key objective and activity of person or entity, trying to promote or implement the CP in the enterprises.

The present document assumes that senior enterprise managers are aware of many potential benefits to be gained from the CP, and have initiated an initial review of their current situation and areas of opportunity for improvement.

The CP audit may identify a number of potential CP options – both low cost and higher cost measures. Managers should assign "***priorities***" for implementing low-cost measures and making "***project appraisals***" of higher cost measures. Whilst project appraisal might show that a higher cost measure is both technically and financially viable, "***investment finance***" must still be secured if the measure is to be "***implemented"***. An enterprise's retained funds and commercial loan are the likely sources of finance but, whatever source or sources of funding is used, a "***business case***" will need to be prepared to demonstrate an adequate financial return and justify the investment or loan to decision makers.

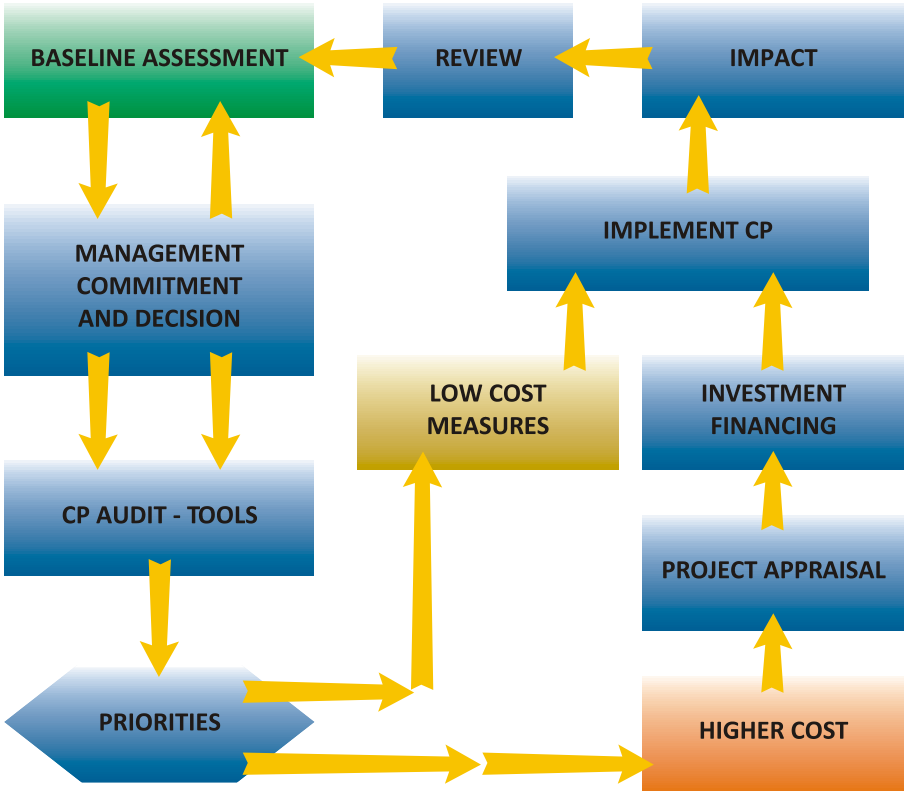

Figure 3.1 CP implementation process

3.1. Start up, project identification

Difficult process is start up of the CP implementation. As decision is made by the enterprise managers, the process should start. Initial meeting in the enterprise is very important tool to launch the CP in action. Usually the enterprise managers, technical personnel and staff working on site long time know about major environmental and technological problems causing the losses, or major environmental impacts of the enterprise operation.

The first action will be to list major environmental impacts caused by the enterprise operations. Usually the impacts caused by the

production process is very well known, however it is important also to list the impacts caused by support infrastructure and housekeeping. This kind of impacts are not usually discussed, and sometimes they are causing major problems.

After all impacts are listed, the processes should be assigned, to which major environmental impacts are associated. The process lists should be prepared and potential theoretical projects should be assigned to each issue with some indication of solution difficulty or approximate costs for the projects. At later stages, the assessment of existing documentation and information should be performed in order to identify if existing information is enough to make decision on implementation of projects and if it will provide enough information for the CP project results assessment (Table 3.1.1).

##	Description	Environmental effect
1.	Closing the system of water vacuum pumps sealing	Reduction of water use 96.000 m3/y, and discharge of waste water
2.	Increase of heat exchange in boiler	Reduction of natural gas consumption – 108.000 m3/y,
3.	Changing of the mixing system for paper pulp	Reduction of electrical energy use 120.000 kWh/y
4.	Increase steam condensate recovery and use water from heat exchanger to belt washing unit	Reduction of natural gas consumption – 14.500 m3/y, reduction of freshwater consumption – 3.200 m3/y

Table: 3.1.1 Project identification

3.2. Analysis of existing situation – baseline assessment

Once the interest and commitment of managers has been gained, then making the baseline assessment is an enterprise's first step towards identifying and implementing its CP opportunities. As far as possible, the baseline assessment should:

- Summarize quantitatively and succinctly

  (i) the resources used by workshops or departments in the enterprise and

  (ii) waste generation - emissions to air, wastewater discharges, solid and hazardous wastes

- Review the efficiencies of resources use and compare them with the achievements of other departments or enterprises in the sector ("benchmarking")
- Identify "best available techniques" (BAT) for waste prevention applicable in the enterprise's sector
- Assess true costs of waste and resource inefficiency and potential cost savings
- Establish priorities for subsequent activity to

  (i) identify the CP opportunities and

  (ii) monitor performance

- Prepare an action plan for subsequent implementation.

The baseline assessment provides an enterprise with a firm basis for its future CP activity. The BA helps to maximize the effectiveness and impact of an enterprise's CP efforts and provides an "internal benchmark" against which future changes in performance can be measured and judged.

3.2.1. Planning the baseline assessment

The following four issues have to be considered while planning the BA:

- Scope – extent of assessment and its duration
- Sources of information
- Internal resources required – specific personnel
- Use of external consultants/advisors.

Scope: In deciding an appropriate scope enterprise first need to consider the number and diversity of its products and production departments. Enterprise might assess the whole site or focus it's the BA on one or two specific departments or workshops – detailed local knowledge will help to make decision. In a large enterprise, the experience gain in one department should be applied subsequently to the baseline assessment of other production departments.

Secondly, it should be considered how resource use and waste is recorded against the range of products made in selected department/s. If each product is regarded as a "cost-centre" - and relevant data are recorded on a product-specific basis – the BA may be made for each product. However in case if the enterprise doesn't adopt this precision in data collection, each production department should be assessed as a whole.

Thirdly, which resources or waste issues to address? Experience shows that enterprise should include all material and energy resource uses and wastes in the baseline assessment. Keep an open mind at this stage. The selection and prioritization of the CP issues is an output of the BA – don't prejudge the outcome by imposing pre-conceived ideas on the baseline assessment. It is a good idea to seek advice on this point from external consultants.

Depending on the specific situation, enterprise may also wish to make a site-level the BA of its enterprise's use of utilities – energy (fuels, steam, electricity), compressed air, cooling systems, water and wastewater. This will complement any departmental assessment/s make.

Sources of Information: Much of the data and information required to make the baseline assessment. However, enterprise may need to consult external sources for specific purposes:

- Benchmarking performance against other enterprises in the sector (domestic and international) – see later
- Searching checklists of BAT to identify potential the CP measures.

At this stage, i.e. while preparing the BA, enterprise should not expect to undertake monitoring investigations to collect additional data. Of course, it might include in the BA report a recommendation that further monitoring be undertaken to provide the data needed to properly evaluate potential the CP measures.

Internal Resources: If the BA is to be undertaken in-house, i.e. using r enterprise's staff, a small team of up to 4-5 people should be established. More important than their individual roles and positions in the enterprise's hierarchy, team members should have the following characteristics:

- All should be open-minded, able and willing to challenge old assumptions but in a positive way
- At least one member must be influential with senior managers and familiar with the management processes in practice – though it is neither necessary or desirable that he or she is a top-level manager – and have ready access to relevant cost data
- The team needs to include member/s that are
  - engaged in production duties
  - engaged with site issues regarding the provision of utility services
  - familiar with metering and recording of utility use and production data
  - engaged with environmental management
  - competent at (i) data analysis (ii) preparation of quantitative reports and (iii) presentation of key findings to senior management

Consultants and Advisors: Enterprise must seriously consider the option of hiring external consultants to prepare the baseline assessment. Consultants may be used to a greater or lesser extent – to lead or contribute specialist knowledge. Though an enterprise has to pay for their services, advantages for the enterprise in hiring a consultant are:

- A consultant should more easily provide a fresh perspective and challenge existing practices
- Consultants are likely to have relevant experience and access to information that may not be readily available to enterprise
- Though still having to contribute time and effort, managers and staff of r enterprise do not have the task of making the baseline assessment added on top of their normal, routine work duties. So completion of the assessment is likely to be more efficient and timely.

3.2.2. Information needs and sources

Internal: Range of data and information will be used while producing the baseline assessment. Most will be held already by enterprise, though perhaps kept in a number of offices or workshops. Later sections describe how the data and information are used in making the baseline assessment.

The following data and information may be particularly helpful:

- Site plans, process flow sheets, utility flow sheets or schematics/diagrams and data on operating conditions
- Material, water and energy balances
- Process yields
- Monthly production figures (e.g. tons, m^3 etc) for each month of most recent 24-month period – use "actual", not adjusted or standardized figures
- Monthly rates (%) of
  - Intermediate product rework (on-site recycle)
  - Product rejection (resulting from quality checks)
  - Product returns from distribution system and customers
- Monthly measured, bought-in resources consumed in each month of most recent 24-month period
  - Energy: electricity, fuel/s, steam, hot water
  - Freshwater – list separately if more than one source (quality and cost) of freshwater is used
  - Raw materials
  - Chemicals
  - Other material resources that may be significant in enterprise's operation, costs and environmental impact
- Measured quantities of waste generated and destined for recycling, treatment and or disposal – ideally, collect figures for each month of most recent 24-month period
  - Wastewater volume (m^3)

  - Solid and hazardous wastes - differentiated into significant components where possible (ton)
  - Substances emitted to air from process plant (kg)
- Analyses of wastewater before any on-site treatment
- Analyses of wastewater discharged to municipal sewerage system or river, and relevant discharge standards (norms) to be complied with
- Analyses of emissions to air from combustion (boilers etc) and process plant, and relevant discharge standards (norms) to be complied with
- Current and projected future unit costs and prices for
  - Products
  - Energy (fuels, electricity, steam, hot water)
  - Freshwater
  - Materials, chemicals etc
  - Wastewater and solid/hazardous wastes disposal

If one or several of listed items are not available, the activity to obtain missing data or information might be included in enterprise's future action plan.

External: Other information is more likely to be held externally:

- Benchmark resource use or waste generation in r sector
- BAT checklists

3.2.3. ite plans and process / utility flow sheets

It is recommended to prepare simple charts for the enterprise or specific processes, which is more appropriate. At first stage existing site plans should check that, process flow sheet/s and utility schematics are up-to-date. Formal note of differences between existing documentation and actual situation have to be developed.

Secondly, regardless current status of the documentations, simplified versions as block diagrams should be produced. This is particularly useful if enterprise is employing external consultants to assist with the baseline assessment but, more generally, helps company to focus attention on key issues rather than on process minutiae. It will also help company in communicating with senior management.

Site plans should be approximately to scale – in sufficient detail that the position and proximity of different departmental work areas can be easily seen, see e.g. Figure 3.2.3.1, which shows a partial lat of a processing plant.

Simplified process flow sheets such as in Figure 3.2.3.2 should show principal connections between process plant, material/energy flows between process plant and waste streams. Where possible, include measured or estimated process/waste mass or volume flow rates.

Use flow sheets while communicating with external consultants on manufacturing processes.

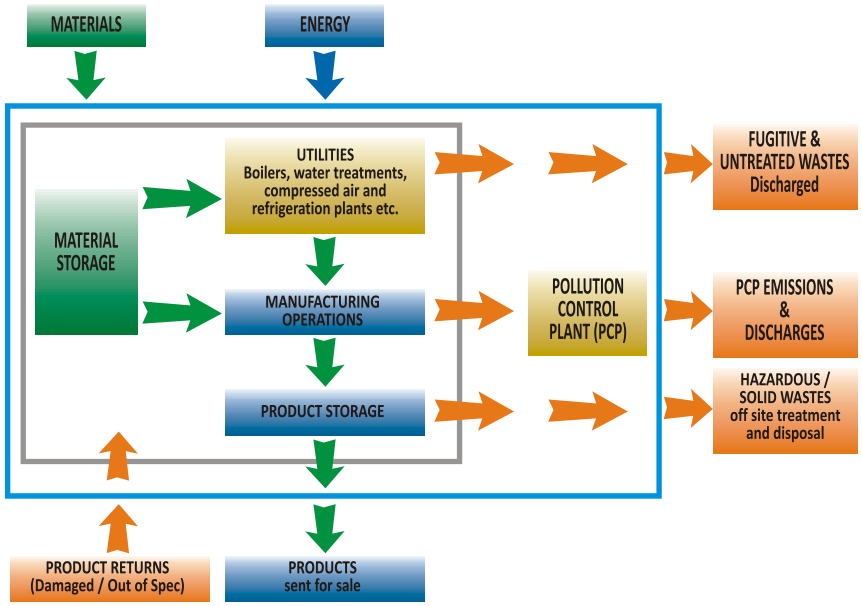

Figure 1.1.1.1 Fragmet of a Simple Site Plan

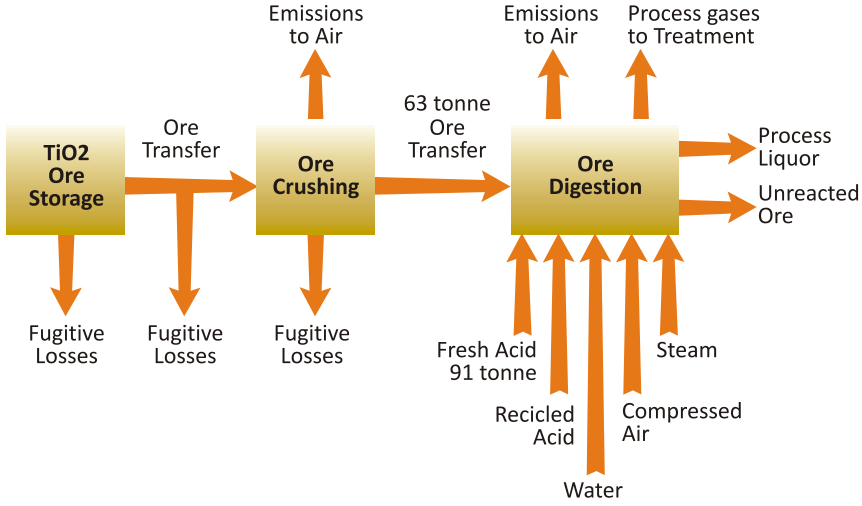

Figure 3.2.3.2 Simplified process diagram

While assessing enterprise's utility use at a site-level, similar flows sheets have to be papered for the distribution and use/disposal of water, steam, compressed air or heat-exchange fluids. Electricity distribution and its use have to be displayed in a schematic diagram.

3.3. Quick audit

Walk-through auditing is a tool to help identify (i) visually "obvious" waste and its causes and (ii) low-medium cost measures to prevent or minimize wastes generation. Conducted objective, on-site observation of actual situation will be helpful to identify cost-effective improvements.

Preparatory work in the BA will provide many clues to help enterprise to select priority operational areas, resources and wastes for preliminary walk-through auditing. If the audit forms part of the BA, therefore, enterprise should first complete:

- Review of site plans, process and utility flow sheets
- Assessment of material, water and energy balances, and generated wastes
- Assessment of process yields, wastes generation and specific resource consumption against benchmarks
- Assessment of relationships between resources consumed and production

However, if the BA has been made, then its action plan will identify the priorities and scope for further, detailed walk-through audits in enterprise.

Note: if external consultants have been engaged they will almost certainly want a "guided tour" initially to help familiarize themselves with the site. A "guided tour" is not the same as a walk-through audit.

Methodology: Audit may comprise several sessions, each lasting for up to 3 hours or so – though a single session might be as short as 20-30 minutes for a defined area. Sessions lasting longer than 3 hours tends to be counterproductive as concentration will lapse. It is good practice to develop noted observations into a precise record-report as soon as possible after completing an audit session – and before starting a new session.

Effective walk-through auditing requires adoption of systematic, structured approach. There are no firm rules but a number of "tried and tested" practical options exist. The audit sessions focus on:

- Individual workshops or processes - for all or several resource/waste issues or just one
- All unit operations/processes for a given raw material i.e. "following the process lines" from material reception on site to its incorporation into product – repeating this for other significant raw materials
- Utilities generation/production, distribution and use i.e. "following the utility lines". Examples include freshwater, boilers and steam / hot water, refrigeration plant and coolant, water cooling systems including cooling towers, compressors and compressed air.

Note: The audit relies on visual observations. In practice therefore audit findings may be limited, if production facilities consist of enclosed process plant – especially if the vessels/pipework are pressurized and the materials are hazardous gases/liquids. It is not possible to see physically the pipe work in most cases.

3.4. Material, energy and water balances

These balances are practical expression of the laws of conservation of mass and energy, which essentially say that, "what is used in the processes must come out".

Put more formally, a mass balance for example states that:

Mass In - Mass Out - Mass Accumulation = 0

This very simple rule forms the basis of a powerful diagnostic tool that enterprise can use in the baseline assessment (and after) to help estimate and assess waste generations. Information yielded by such balances helps enterprise to identify waste minimization priorities and further actions. Figure 3.4.1. shows an example material balance for TiO_2 around the TiO_2 liquor-refining processes (downstream of ore digestion and liquor concentration) at an enterprise producing white, pigment grade TiO_2 powder.

A more detailed explanation of how to use this tool effectively is given in a separate guide, but the basic idea is to:

- Define a physical system boundary
- Define an appropriate time period for the analysis. For the baseline assessment this could be from several months to 1 year depending on production pattern
  - If production is batch-wise, not continuous, select a period that includes the completion of multiple batches
- Identify all input and output streams for the chosen material or energy across the selected boundary

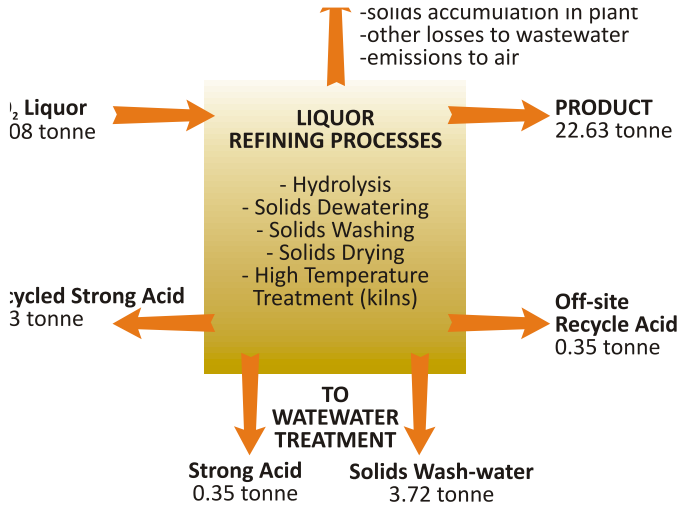

Figure 3.4.1 Example Material Balance for TiO2 Across Refining Processes

- Quantify each input and output over defined time period – ideally from direct measurements or, if that is not possible, by estimate
- Quantify changes in "stock levels" (i.e. determine the accumulation) over the defined time period
- Put all values into balance equation and review what this says about waste and loss levels from production.

Ideally, enterprise should look for a balance that comes close to "perfection", i.e. a formal balance sum that equals zero, but in practice an error of several percentage points must be expected. An error in excess of 10% of input suggests that other, unaccounted for losses are also present – or that the monitoring data are insufficiently accurate.

Often, as in Figure 3.4.1. for example, one or more of the waste streams cannot be quantified from available data. If this is the case, calculate the sum of the unknowns "by difference" assuming perfect

balance. Note, however, that a waste stream "estimated" by this method includes all errors associated with other quantities. For the ore processing plant example, Figure 3.4.1. highlights substantial losses of TiO_2 in wash water passed to wastewater treatment – stimulating a search for improved operating practices and solids recovery system. Figure 3.4.1.5 also suggested that a closer look be taken at minimizing the unaccounted for "other" losses in future.

Enterprise may find that the value of its existing balances, or its preparation of a balance, is limited by inadequate or insufficient monitoring data. If so, it highlights enterprise's need to pay more attention in future to monitoring the flow and composition of its process and waste streams.

4. Verification of identified projects

As it was mentioned in previous chapters several technique can be used for identification of potential CP projects. As usually the question is from what should the CP team start. The first and most effective tools are collection of information from technical staff working in the enterprise regarding main environmental and technical problems which are important, and identification of proposals for their solution or minimization of environmental impacts, however it is also very important to identify the spots or technological stages, where most of the wastes and pollutants are generated. After such spots are identified and potential issues listed, for each of listed projects probable solution should be identified.

Several technique can be used for verification of identified projects inclusive the methods described in Previous chapters. One of the most valuable tools during this process is mass and energy balances prepared for whole enterprise or specific parts of production process. Once the project is identified verification should be made using different methodology. The first would be review of process monitoring data if such is available. In most cases, monitoring

systems are so week and not consistent to reality and most enterprises are facing problems while evaluating monitoring data. In mentioned cases the tools like quick audit, walk through audit, material, water and energy balances can be very useful, as soon they help to identify at least semi quantitatively the spots where CP activities can be applied. The balancing method in parallel with preparation of the production facility plans and schemes can help in identification of the boundaries of specific process and estimation of losses, waste generation or inefficient production processes.

In the process of project verification, we can also use important tool which consists potential indicators in specific measurement. For not-continuous processes, when material is processed in batches, it is very important to measure real losses, waste generation and energy use. In such cases we can apply specific measurement of some indicators and then discuss obtained data. The mentioned technique is very useful in valuation of water losses, waste generations, and fugitive emissions from operation cycles.

The main aim for verification is to check whether the proposed the CP action will have effect in reality and will not cause other additional problems or difficulties.

4.1. Analysis of potential effects

The analysis of potential the CP effect can be carried out practically in all instances. The analysis should be performed in the way to express final effect in money and time. Moneywise analysis should be dependent on savings generated from the CP project implementation. In this regard we should remember about real costs of raw materials or semi products in production process, as the price of materials is often much higher, than it is expected by the personnel. For example real price of waste is not only the price of raw materials used for generation of waste, but also the costs of raw material processing to the waste generation point. This includes warehousing, handling and

processing costs, also costs for the utilities used to reach the waste generation point. At this stage some energy, water and other resources are used. Besides, costs related to waste disposal, accumulation and other actions required to handle the wastes should be attributed to the cost of the waste. The costs for environmental damage related with waste generation is often very difficult to estimate, however this kind of adverse environmental impact practically always exist.

During potential effect analysis for A type projects requiring small investments and having the payback period less than six month, economical effect can be calculated by direct calculation methods, i.e. simple calculations of the value without taking into account financial changes during the time, however for large projects it is important to take into account value of money in time. This will give us more competency regarding the CP real effect.

During the analysis of potential projects it is important to have a complex look on the effects. This can be a complex look on overall operation of facility and simplification of support processes logistics, etc.

4.2. Ranking tools

Ranking of identified and evaluated potential the CP projects is very important, because it allows us to prioritize the CP projects identified during previous stages of the CP implementation. The first principle for ranking is to select the project having maximum effect with minimum of investing requirements. Also ranking can be accomplished in accordance to urgent needs for the facility; i.e. if facility is facing problems with wastewater treatment, this should be taken into account in ranking process, even if improvement of wastewater treatment needs more funds and financial effect is less than in case of other projects.

The ranking also depends on rate of return period: the facility

might select strategy, first to implement small projects having less environmental effect than others, but with very short period of return. This allows facility to use available internal resources in efficient way.

In general the CP implementation process should be linked with financial planning for facility operation. In this terms the commitment of top management is very important, otherwise the staff will not be able to make effort for implementation of the CP projects.

After the ranking process is finished, the facility will have clear plan for implementation of the CP projects in practice.

5. Monitoring and reporting

The chapter is dedicated to the issues related with monitoring of the CP actions. The two main parts of the monitoring includes preparation of specific monitoring plans addressed specifically to measure and quantify the effects of the CP projects planned and implemented. The second and most important part of the monitoring is analysis of monitoring information, identification of character and trends observed during the project implementation phases.

The monitoring and analysis of monitored data is one of the most crucial parts of the CP implementation, as it helps to valuate our efforts towards increase of efficiency of existing processes and generation of the savings.

5.1. Monitoring plans

One of the most important tools to assess the efficiency of the CP projects is effective monitoring of the effects after implementation of the CP.

The monitoring plans should be focusing on implemented CP projects. The main tip for monitoring is to use same boundaries of

the project which was used in the process assessment and definition of the project boundaries. The monitoring plans for the assessment of the CP projects can be integrated with process monitoring plan, however the frequency and monitoring parameters should be similar to the parameters used during the baseline assessment.

In most cases, monitoring plans are focusing on assessment of the process yield, quantification of the generated emissions, wastewater and solid waste quantities. The monitoring parameter should be used similar to ones used during the baseline assessment. The frequency of monitoring activities can vary in accordance to the project needs and expected effects. The frequency can vary from intensive monitoring systems, like measuring the parameter in time, to the monitoring of the waste generation during one month of production. It is possible to modify the monitoring parameters in the way, that collected monitoring information should be easily understandable to the enterprise management.

One of the most important issues in the monitoring system is correct identification of sampling points and the methodology for sampling. There are no uniform rules for sampling, however it should be stated, that samples and sample processing should be financially acceptable for the assessment needs. Monitoring can be undertaken using instrumental methods for measurements or even by semi quantitative methods. In last case, it is not possible to quantify the CP effect in financial terms, but this kind of monitoring can be indicative and can prove, that as the result of the CP action was specific improvement. This is important issue for small and medium size enterprises, as such enterprises have limited resources which can be spent for the monitoring purposes.

5.2. Analysis of collected information

Raw materials and utilities (electricity, fuel gas, steam, compressed air, water, heating and cooling etc) are major cost items for most enterprises. Excessive consumption and waste imposes environmental burdens such as emissions to air, wastewater discharges, solid and hazardous wastes.

Improving resource efficiency is thus a "win-win" objective. Many enterprises worldwide have found that adopting a systematic approach (CP) has helped them achieve substantial cost-effective gains in resource efficiency. In many cases they have been able to reduce utilities use by up to 20% - 40%: even more in some cases. M&T is one of the CP tools that enterprise can use to achieve savings.

M&T comprises a number of techniques that help analyze enterprise's use of resources and stimulate such savings. This "statistical process control" (SPC) tool is based on using functional relationships normally found between resources consumption and its "driver" – usually a suitable measure of production activity.

The techniques are practical to use and, with the help of this guide and its examples, do not depend on having a detailed, prior knowledge of statistics. However, their use does demand that both resource consumption and its "driver" are measured.

Also, though M&T can be practiced using a handheld calculator, paper and pen, access to an electronic computer with standard spreadsheet capability (e.g. Excel) is desirable – for speed and ease of use.

5.3. Planning of future CP actions

Main definition of Cleaner production states, that the CP action should be continuous, and preventive. It is very important to plan CP actions in continuous way, i.e. one should ensure, that the activities related with improvements have continuous character. This can be achieved by better management on site. The CP team should have scheduled meeting, where internal staff or consultants will be discussing possibilities for the process improvement. In most cases, technical staff of the enterprise is overloaded with direct responsibilities to ensure that the production process is ongoing and technical or any other reasons will not stop the production. The mentioned staff usually cannot think on technological process improvements from the perspective of environmental impacts or risks, and accordingly is not willing to spend energy and time for such improvements.

If the activities of the CP team is correctly planned, it should be ensured, that some time of technical personnel is spent for identification of potential technical and technological improvements of the enterprise operation. It is expected, that in time, the CP projects proposed, will be more complicated and more expensive and difficult to implement in parallel; meantime the value of expected savings will be decreasing. Beside of this, must remember, that in any enterprise, inclusive very modern ones, the significant results with CP implementation can be achieved.

It is recommended to organize the CP team meetings at least quarterly and review of the CP activities at top management board at least annually, to show the overall effect from CP implementation.

5.4. Reporting needs

The reporting needs depend on the purpose of reports and on the system, how this reports will be used in the future. The main issue in preparation of the CP reports is to show the effect reached during the CP implementation. Usually the reports include multiple CP actions, projects of Type A, B and sometimes C, however it should be stated, that type C reports usually need complicated financial analysis inclusive the investment description, cash flows during the project implementation, internal rate of return etc.

The CP reports can be split on internal reports dedicated to the company management and used as documented results of the CP practice implementation. It is advised to use the CP project reporting matrix (Table 5.4.1.)

Table 5.4.1 Example of CP internal reporting table
CP Actions Type A; Paper Factory:

Lp.	Description	Environmental effectcological effect	Economical effect [USD]		
			Investment [USD]	Savings [USD/year]	PB Payback [year]
1.	Closing the system of water vacuum pumps sealing	Reduction of water use 96.000 m3/y, and discharge of waste water	1,500	119,040	1 month
2.	Increase of heat exchange in boiler	Reduction of natural gas consumption – 108.000 m3/y,	8,500	27,000	0.3
3.	Changing of the mixing system for paper pulp	Reduction of electrical energy use 120.000 kWh/y	low cost	15,360	0

4.	Increase steam condensate recovery and use water from heat exchanger to belt washing unit	Reduction of natural gas consumption – 14.500 m3/y, reduction of freshwater consumption – 3.200 m3/y	5,400	7,465	0.7
		Total:	15,400	168,865	1,2
Description of CP Action type B (during implementation phase)					
1.	Reconditioning of paper machine – changing all belts, and most important bearings; reuse the synthetic drying cloths for Paper Machine	Reduction of paper pulp losses, improvement quality of paper – reduction quantity of non quality product) Minimization of steam quantity used for 1 T of product, Minimization of CO2 and dust emission from boiler house, Reduction of electric energy use,Increase of the production cycle effectiveness, Decrease the quantities of paper which needs re-processing	Investment: 68,000	~16,500 (2)	4.1 years(2)
(2) - Estimated value, more exact calculations needs more information during the monitoring period					
Description of CP Action type C (During Business Plan preparation)					
1.	C/business plan	Install of cogeneration unit with heat recovery, enables uses of Natural gas for power generation + heat recovery	Improvement of energy efficiency	Investment: ~700,000	Payback period ~8 years

The CP implementation matrix can use some estimated values for the payment period calculations as well as saving calculations. It is recommended to support summary tables with calculations showing the process of the expected results estimation. Since usually estimations are based on assumption due to lack of information.

The external reports are usually prepared for different funding agencies. The main aim of the report is to show to potential donor, that the company already has experience in at least small scale CP implementation and some results has been already achieved in past. Those types of reports should include detailed information regarding proposed project. Special chapter should be dedicated to existing problem from environmental impacts perspective, describing the problem in details. It is recommended to use some (in better case extensive) clarification of the problem solution, like benchmark information for the sector, description of achievements from other similar enterprises etc. This will help decision maker to make decision on supporting the project. The documentation should include detailed description of savings accumulation process and also follow up process to CP implementation.

At the end we want to state, the CP implementation reports should be short, easy to understand and should not be overloaded with scientific and technical data. It is better to present such information in additional documents, annexes to the report etc. This should indicate, that the calculations have been in professional way and data presented is reliable enough to make decisions on projects.

Usually the report provided to the financial institutions should include, but not limited:

- Project and enterprise viability
- Economic and financial appraisal required by IFIs
- Financial appraisal required by commercial lenders
- Minimum commitment of funds by borrower
- Date at which repayment begins – “grace” period
- Repayment period and dates of payment
- Interest rate
- Minimum CP and EE benefits
- Proportion of project savings paid to lender
- Covenants -A promise to undertake stated actions as a condition of receiving the loan – monitored by the lender

The reporting becomes much more complicated when environmental effect is not direct and is related with reduced production risk or minimization of environmental liabilities. As an example operation of the wastewater treatment system can be used. If we assume, that the wastewater treatment plant operation is not reliable and there is a risk of discharging not treated water to the surface water body in rainy days, because some part of storm water flows in the system. There is a risk that the enterprise can be penalized by official structures because of surface water body pollution. In this example it is not possible to estimate how often described situation can happen and what can be a value of penalties and fines for the pollution, is a risk, that factory or enterprise can be closed down because of the non compliance with requirements. In such cases it is very difficult to estimate real risk of losses the enterprise can face.

Usually, when described situation exists, the CP specialists just use best estimates of the penalty or expected loss values. Preparation of the risk valuations is usually very difficult and is out of the scope of CP implementation, however such risks can be indicated in the report as one of the arguments during the ranking of potential CP projects.