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SEID

Sustainable & Efficient Industrial Development in Nepal & Bhutan

Project Funded by

switchasia

Austrian Development Cooperation

European Union, Switch Asia

Project Implemented by

GrAT Center for Appropriate Technology

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GRAT, ASSIST, FNCCI-EEC, BCCI, GIZ, AREC, STENUM Asia

1 Introduction

Foreword

The Agro- and Tourism sectors in Bhutan and Nepal serve as an important engine for poverty alleviation through obtaining foreign currencies and creating employment opportunities. However, these industries still rely on energy-intensive, outdated and polluting technologies and operating practices in delivering their products and services. Inefficiency in resource utilization has led to excessive waste generation as well as financial burden to small and medium-sized enterprises, not to mention micro cottages (MSMEs). Main reasons are a lack of awareness on up-to-date best practices and a systematic guidance to implement innovative technical solutions that can remarkably improve energy and resource efficiency and at the same time contribute to cost saving and improvement of work environment. There is a great demand for such appropriate technologies and practices.

To address these deep rooted challenges of Agro-and Tourism-based industries,the project "Sustainable and Efficient Industrial Development (SEID) in Bhutan and Nepal" has been active since February, 2012 through its forty months programme. With the funds from the European Union, and co-funds by the Austrian Development Corporation, SEID provides consulting services to MSMEs to help them tackle the problems through a holistic approach embracing improvement of resource and energy efficiency, chemical and waste management, and work environment. At the same time the program aims at generating economic savings and to be greener by various means such as reducing consumption, replacing old system and tools, and adopting alternative solutions.

Project Lead GrAT (Center for Appropriate Technology) and Partners– ASSIST (Asia Society for Social Improvement and Sustainable Transformation), FNCCI (Federation of Nepalese Chambers of Commerce and Industry), BCCI (Bhutan Chamber of Commerce & Industry), GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), AREC (Austria Recycling),and Stenum ASIA Sustainable Development Society -are pleased to present this handbook, which provides practical guidance for MSMEs.

The handbook starts with methods for measuring of the current level of resource and energy consumption,and suggests diverse measures to improve the business by reducing consumption and waste generation. It is encouraging to underscore the fact that many of the suggested improvement measures don't even require financial investments. The practical tips outlined in this handbook are based on international best practices, but have been adapted to local conditions of Nepal and Bhutan.

Hence, we hope that you will use this handbook extensively in order to help you not only to improve your business operations but also to reap the environmental and financial benefits. Good project design is necessary to manage resources and time, and to have milestones to check project progress against. The project design will dictate who does what and when within your business units. The SEID Team will be happy to support you with the design of your improvement project and monitor the progress. We are looking forward to receiving your feedback on implementations and we will be publishing success stories featuring your company's improvements.

We also take this opportunity to thank the SEID Frontier Group companies who provided the environment for the project team to practically adapt to the Bhutanese and Nepalese industrial context and conditions. We also thank our Associate members as well as Local Consultants for their invaluable time and contributions to the project.

On behalf of the Project Team,

Dr. Robert Wimmer

Lead Project Manager – SEID

Managing Director- GrAT(Center for Appropriate Technology)

Introduction

Tourism and Agro based Industries are fast growing sectors in both Nepal and Bhutan and contribute significantly to their GDP, employment generation, and foreign exchange earnings. However, the rise in tourists' arrivals has put extra pressure on developing additional infrastructure and has contributed directly to environmental degradation, waste generation and environmental pollution. Competitiveness of Agro based Industries are fast eroding as a result of outdated technology, lack of optimized process and unsustainable sourcing. In Nepal, demand for electricity increases by 10% every year whereas production remains constant and the 12 hours daily power cuts are a reality. While both Bhutan and Nepal have ample supply of water, the water tables in many famous tourist destinations and industrial zones are stressed. These are big challenges that need to be addressed.

The Project SEID is designed to directly address several issues faced by both the sectors and transfer best practices, technology and proven approaches on Sustainable Consumption and Production (SCP).

Both Bhutan and Nepal have a great potential of rapid industrial development. Thus, timely knowledge transfer and capacity building will ensure that existing and newly emerging industries are in line with the concepts of SCP.

Project brief

Title	Sustainable & Efficient Industrial Development (SEID) – Bhutan and Nepal
Project Duration	40 Months
Project starting date	Feb 2012
Project Location	Nepal & Bhutan
Target Sector	Tourism and Agro-based Industries

Primary target groups:

- Micro, Small and Medium Enterprises from the tourism and agro based industries.
- Local environmental and energy experts and service providers.
- Business associations, industry associations and academia.
- Public institutions, government authorities, industrial park management authorities and policy makers.
- Company Workers (especially women).

Objectives

The project shall contribute towards sustainable development of Nepal's and Bhutan's economy with a clear focus on the tourism and agro-based industries.

1. To reduce costs and pollution; improve health and safety performance in the target sectors.

2. To enhance the capacity of national anchor associations/service providers to collaborate and promote sustainable practices to their supply chain/members, providing technical support and input to MSMEs to improve the overall resource efficiency of their production processes from the life cycle perspective

3. To build strategic partnerships with on-going initiatives in the target sector, providing access to existing knowledge, Information Education Campaign material to address needs of MSMEs.

4. To facilitate dialoguing and networking amongst key stakeholders including government, financial institutions, industry associations, academia aimed at creating and enabling environment which propagates & promotes adoption of sustainable industrial practices.

Preface

Resource efficiency means using the limited natural resources in a sustainable manner while minimising impacts on the environment. It allows companies to create and deliver greater value with less input[1]. Increasing resource and energy efficiency can also save costs, because companiesdo not need to purchase new resources and to pay high utility fees. Proper organisation of work place also contributes to increasing resource efficiency through early identification of problems (e.g. water leakage) and prevention of accidents.

Resource & energy efficiency can be achieved through:

- Appropriate selection of raw materials and energy resources for required products and energy services;
- Minimization of waste, emissions, hazards and risks;
- Responsible management of material and energy flows during the production process;
- Attention to the use, recycling and disposal phases of the product life cycle; and
- Increase in renewable material and energy usage.

Benefits of resource & energy efficiency for companies include:

- Reduction in cost for materials, chemicals and energy;
- Reduction in cost for disposal of waste and treatment of emissions, as well as for compliance with laws governing waste, emissions and the use of chemicals;
- Improved productivity;
- Healthier and safer work environment;
- Improved competitiveness in the market;
- Over a long term, resource efficiency at large secures the supply of resources to all businesses; and
- Resource efficiency meets the growing customer demand for sustainable business practice.

The SEID Project aims to ensure resources; natural resources, minerals, chemicals, manpower and equipments, that are utilized to the optimum level in a sustainable way towards Sustainable and Efficient Industrial Development.

[1]European Commission, Online Resource Efficiency Platform. http://ec.europa.eu/environment/resource_efficiency/

Project funded by

SWITCH -Asia Program, initiative of the European Union, aims to promote Sustainable Consumption and Production (SCP) among Small and Medium sizes Enterprises and consumer groups in Asia. Sustainable Consumption and Production is an attempt to reconcile the increased demand for goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, in order not to jeopardize the needs of future generations. To achieve this objective, the programme works simultaneously on the ground with projects that target producers and consumers as well as with policy makers.

www.switch-asia.eu

Austrian Development Cooperation

Austrian Development Cooperation (ADC) supports countries in Africa, Asia and Central America as well as in South Eastern and Eastern Europe in their sustainable social, economic and democratic development. It aims at reducing poverty, conserving natural resources, promoting peace and human security in partner countries. The ultimate goal is to bring about a sustainable improvement in conditions in life.

www.mfa.at/adc ; www.ada.gv.at

Project implemented by

GrAT
Center for Appropriate Technology

Center for Appropriate Technology (GrAT) is a scientific association for research and development of Appropriate Technology. Since 1986, GrAT has been proactively responding to a wide range of relevant issues in sustainable development. The long-term vision/mission of the association is to establish systematically developed sustainable solutions.

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ASSIST 10 YEARS For a Sustainable & Inclusive Future

Asia Society for Social Improvement and Sustainable Transformation (ASSIST) is an international non-government organization focused on capacity building. It seeks to promote sustainable practices to address social problems in the developing world, with focus on Asia and Africa. ASSIST takes pride in its process-oriented approach to capacity building towards social improvement and sustainable transformation.

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FNCCI eec energy efficiency centre

The Federation of Nepalese Chambers of Commerce and Industry (FNCCI) is an umbrella organization of the Nepalese private sector. FNCCI plays a catalytic role in the business, industrial development and establish sound industrial relations in the country reinforcing business community's commitment to the society. It provides, inter alia, information, advisory, consultative, promotional and representative services to business and government and organizes training /workshop / seminar on a regular basis.

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Bhutan Chamber of Commerce & Industry (BCCI) was established under the Royal Command of His Majesty the fourth King in 1980. BCCI is a non-profit making private sector organization, comprising of business community members from all around the country. The BCCI provides linkage between the government and the privates and works closely with all the government agencies, autonomous organizations and international organizations and donor agencies towards facilitation and promotion of trade & industrial development.

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Austria Recycling (AREC) is working in sustainable industrial development at the interface between economy and environment, acting as a bridge between industry and environment. AREC supports enterprises and communities in particular in the process of the implementation of management systems, by technical and organizational consulting, empowerment of people and training for an eco-efficient, sustainable economic manner as well as in financial and social matters.

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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH offers services drawing on a wealth of regional and technical expertise and tried and tested management know-how. It offers demand-driven, tailor-made and effective services for sustainable development. To ensure the participation of all stakeholders, it applies a holistic approach based on the values and principles upheld in German society.

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Stenum Asia Sustainable Development Society is a training and consultancy organization registered in Gurgaon, India since 2007. Its objective is to promote sustainable development by supporting enterprises achieve higher resource efficiency (RE), minimise waste and enhance output. It has impacted more than 100 enterprises across sectors in India and helped them to save money while saving the environment. Benefitting from the optimum combination of training, consultancy and support for implementation and evaluation of the implemented solutions, participating enterprises achieved higher efficiency leading to lower cost of operations at no or low investments.

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1 Challenges in Nepal & Bhutan regarding resource efficiency

1 Challenges in Nepal and Bhutan regarding resource efficiency

The European Union attaches a very high priority in its "Strategy 2020" to the issue of resource efficiency. In the EU flagship initiative "A resource-efficient Europe" and the associated roadmap activities are presented to reach the strategic goal of resource efficiency. Through the optimization of processes and strategies as well as by technological innovation, resource consumption will be significantly reduced. This should largely reduce pollution caused by waste, wastewater and emissions. The optimized use of material resources also helps to reduce production costs and increase competitiveness.

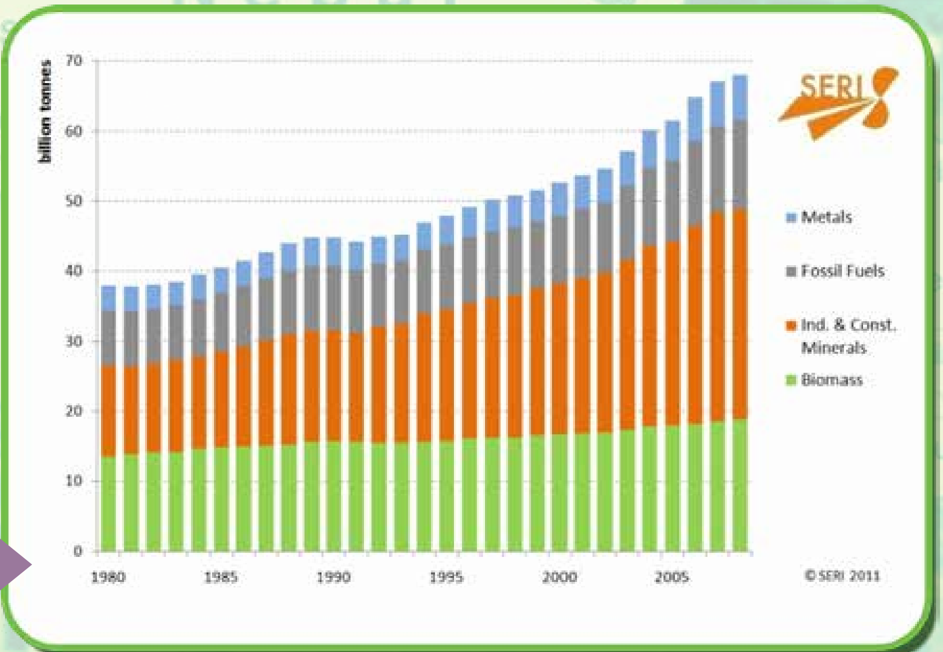


Figure 1: Development of global resource consumption

Source: http://www.worldresourcesforum.org/issue

For our economy various material resources are essential: these include metals, oil, gas, coal and various minerals, biomass and water. A good overview of the consumption growth was elaborated by SERI in 2011. Between 1980 and 2008, the resource consumption of metals, fossil fuels, minerals and biomass has doubled to nearly 70 billion tons worldwide (see Figure 1). Compared with the consumption of 1900 this means a tenfold increase. Already the next two generations will have to worry about a drying up of sources of oil and natural gas. The same is true for industrially important metals threat of depletion of zinc, copper and nickel.

The following table shows the estimated future availability of various resources.

Table 1: How long will material resources last?

Zinc, lead, cadmium, chromium, tin, silver, gold	Less than 25 years
Copper, manganese, molybdenum, mercury, nickel, tungsten, zirconium, talc, petroleum	Less than 50
Bismuth, chromium, niobium, selenium, tantalum, uranium, yttrium, gas	Less than 100
Iron, cobalt, beryllium, titanium, platinum, Lithium, rhodium, lignite, hard coal	Less than 200
Aluminium, potassium, magnesium, sodium, neodymium, rare earth, vanadium, limestone	More than 200

Wuppertal Institut (2011): Umweltrelevante metallische Rohstoffe

To ensure the availability of resources for future generations, a decoupling of resource use and economic growth is necessary. This target creates an apparent contradiction to the growth of the world population and increasing resource consumption in developed countries and emerging countries with rapid economic growth. Only a significant increase in efficiency can ensure the availability of natural resources.

In a survey in 2010 conducted by the Association of German Engineers (VDI) 85 % of executives interviewed stated that commodity and energy prices are important factors for their future economic situation.

In manufacturing, material costs make up the largest cost factor, they account on average for 42.9 % of the total gross value of production. In 1999 this number was 40%. In the same period the share of personnel costs of approximately 23.4 % in 1999 to 20.5 % in 2009. The material productivity increased 1960 to 2005 by a factor of 2, the labour productivity in the same period by a factor of 4 the established approaches to cost reduction had in the past the focus especially on staff costs.

The above said was derived for the economies in Europe. As salaries are generally lower in emerging countries, the share of material costs out of total production cost is even more significant in countries like Bhutan and Nepal.

Due to its geographical location, Bhutan is especially vulnerable to the adverse effects of climate change. Bhutan has been a strong advocate for environmental protection. In its National Adaptation Programme of Action, Bhutan has taken a number of measures to safeguard an environmentally sustainable development path and to mitigate the risk of natural hazards such as Glacier Lake Outburst Floods.

In its 10th FYP the government puts special emphasis on environment in the context of national spatial planning, focusing on issues relating to the protection of biodiversity habitats, forest conservation, watershed management, soil conservation and various other land use aspects. The government iis also committed to effectively mainstream environment into national development policies. This can be facilitated by resource efficient and preventive approaches.

Tourism development in the country is guided by the "high value–low volume" policy, in order to strike a balance between securing economic gains and the need to protect and preserve Bhutan's rich cultural, religious and natural heritage. The tourism sector has a high potential for Bhutan in terms of foreign revenue and providing employment and income opportunities in rural areas. Waste minimisation, efficient transport and a caring attitude towards the enviroment can support this strategy.

In Nepal, agriculture is the mainstay of the economy, providing a livelihood for three-fourths of the population and accounting for a little over one-third of GDP. Industrial activity mainly involves the processing of agricultural products, including pulses, jute, sugarcane, tobacco, and grain. Energy supply is limited and unreliable. Several studies showed that pollution is causing a deterioration of Nepal's environment, even though the industrial development of Nepal is occurring at a relatively slow rate and the average consumption of energy is very low when compared with usage pattern of most other countries in Asia.

Studies show that chemicals from industrial effluents are increasingly contaminating Nepal's rivers. Air pollution is caused by dust and particulate emissions from cement factories, brick and tile factories, pulp and paper mills, distilleries, and textile mills. Most land pollution in Nepal stems from mismanagement of solid wastes, in both urban and rural settings, and the mishandling of pesticides and fertilizers in the agriculture sector. Similarly, indoor noise pollution is also a problem in some factories.

Source:
http://www.apo-tokyo.org/gp/e_publi/penang_symp/Penang_Symp_P149-158.pdf

2 Introduction to implementation of resource efficiency programmes

2 Introduction to implementation of resource efficiency programmes

2.1 Implementation of a material saving programme

Problems of waste and emission for a company arise at those points of production where materials are used, processed or treated. If a company wants to find a strategic solution to environmental problems, it is essential to capture the current material flows in a model to identify points of origin, volumes and causes of waste and emissions. Furthermore, in a material flow analysis the composition of the used substances is analysed, their economic value is estimated and possible future developments are forecasted. The introduction of an information system will enable management to retrace material flows within the company, to direct them and to guarantee that they are efficiently used.

Table 2: Steps for the implementation of a material saving programme

Steps	Description
Step 1: Draw a material flowchart	Identify all uses of materials by creating a flowchart for materials. • What materials are used in the company? • What quantities of materials are processed? • What is their economic value? • What quantities of waste and emissions are disposed of at the end of the production process? • How and where is the waste disposed and is there a possibility of using this waste to produce goods or energy?
Step 2: Create material balance	Get detailed information about what is going in and what is going out through the process. The data required for a material flow analysis can be obtained from different sources such as production data acquisition system, log books, routine measurements, individual measurements, information from the production and documentation of equipment, but also by calculating or estimating. Data on the input of raw and processed materials are available from the account- or the logistics-record. Data concerning process flows are available from the production planning and control, from the foremen or workshop masters themselves, from job planning or production records. If all these sources do not permit the collection of the necessary data on quantities and values you will have to carry out your own measurements or else rely on estimates.
Step 3: Consider options	Consider options from literature on other industries' experiences. Also undergo brainstorming sessions with your team. The following strategies can lead to an improved material utilization: • Good housekeeping in the sense of thoughtful use and handling of raw and processed materials (respecting product formulation, complete emptying of containers, sealing of leakages, etc.). • Substitution of hazardous raw and processed materials (e.g., raw materials containing formaldehyde, heavy metals or chloride, etc.). • Process modifications (automatic control, etc.) • Product modifications
Step 4: Evaluate option and implement programme	Evaluate option, compile and implement programme

2.2 Implementation of an energy saving programme

A successful energy efficiency programme should begin with a well-thought-out plan. Crucial to the development and use of this plan are management's commitment, sufficient technical staff and financial resources.

Table 3: Steps for the implementation of an energy saving programme

Steps	Description
Step 1: Collect data	Find background information on the factory's energy sources by collecting annual input data. Data on the annual consumption as well as costs have to be collected separately for each type of energy source. These data are available on energy bills (electricity) or from suppliers of heating oil or diesel as well as in records of the in-company petrol station or electricity plant, etc. Peak loads and power factor are additional relevant information that will have an impact on the electricity bill.
Step 2: Draw a list of equipment	Identify all uses of electricity. Draw a list of electricity and heat consuming equipment. The respective consumption data will show which equipment is responsible for what energy use. State condition of equipment and its accessories.
Step 3: Record data	Record data on a monthly basis, relate to production and analyse patterns. Based on specific energy consumption, the energy situation in a company can be analysed and controlled. In this case, the following points have to be considered: • Has specific energy consumption increased? – What could be the reason? Which areas have expanded? Has this expansion caused the higher specific energy consumption? Have energy sources been substituted? • If the specific energy consumption has decreased: – Is the decrease due to specific energy saving measures? Have the targets been met? Has the consumption decreased because energy sources were substituted? • Where can I find appropriate benchmarks? – Ask colleagues for data from a particular sector. – Ask plant manufacturers for data. – Search in literature. • Is the equipment placed at the right place (location of equipment)?
Step 4: Benchmark consumption	Monitor energy consumption.
Step 5: Record load profile and analyse	Record load profile and analyse. Connected load – the nameplate rating (in kW or kVA) of the apparatus installed at a consumer's premises. • Maximum demand – the maximum load that a energy-consuming equipment uses at any time. • Demand factor – the ratio of maximum demand to connected load. • Contact your power company to get a load curve. Implement peak load control and minimise base load consumption. • Identify power factor (reactive power).
Step 6: Consider options	Identify energy-efficiency options from the literature on other industries' experiences and/or recommendations from resource efficiency, Cleaner production & Safer Production service providers. Also, undergo brainstorming sessions with your team.
Step 7: Evaluate option & implement programme	Evaluate option, compile and implement programme.

2.3 Implementation of a water saving programme

A water efficiency programme starts with a bird's-eye view of water consumption. Draft a flowchart showing the water flows as suggested at the top of Table 4. Then take measurements to fill the flowchart with data. The benchmarking of water efficiency is done on the basis of specific water consumption per production unit. With this data on hand, options for reduction will become obvious. Selected options will be organised in the action plan.

Table 4: Steps for the implementation of a water saving programme

Steps	Description
Step 1: Draw a Water Flowchart	Identify all uses of water(on-site processes, machines, buildings & landscape irrigation to evaporation and wastewater discharge) by creating a water flowchart.
Step 2: Collect Data	Collect and measure consumption data using resources available and log it. Once all types of sources, uses and discharges of water have been identified, it is necessary to quantify all single mass flows. The following documents or tools are in most cases available: • Annual payment to provider or to disposal companies. • Water meter, water counter • Rotameter • Design specifications by manufactures of equipment. • Ultrasonic flow meter • The bucket method • Measuring wastewater e.g. by using the V-notch method.
Step 3: Benchmark Performance	Benchmark your consumption with best practice to determine improvement potential. The SEID team will provide you with the respective data.
Step 4 Consider Options	Consider options towards improving the plant's water efficiency from literature, other industries' experiences. Also undergo brainstorming sessions with your team.
Step 5: Evaluate Options and Implement Program	Evaluate options, compile & implement programme..

2.4 Implementation of a waste minimization programme

A good starting point for designing a waste management system is to determine the major problems/wastes associated with your particular process or industrial sector. Therefore all existing documentation and information regarding the process, the plant or the regional industrial sector should be collated and reviewed as a preliminary step.

Table 5: Steps for the implementation of a waste minimization programme

Steps	Description
Step 1: Draw a Flowchart	Identify all waste steams by creating a waste flowchart. • Is a site plan available? • Are any process flow diagrams available? • Have process wastes ever been monitored before? • Is there a map of the surrounding area indicating watercourses, hydrology and human settlements? • Are there other factories/plants in the area that may have similar processes? Important questions: • What are the obvious wastes associated with your process? • Where is water used in greatest volume? • Do you use chemicals that have special instructions for their use and handling? • Do you have waste treatment and disposal costs – what are they? • Where are your discharge points for liquid, solid & gaseous emissions? • Is the waste generated as a result of improper material handling?
Step 2: Create Material Balance	Get detailed information about what is going in and what is going out of the process. • Determine inputs • Measure current levels of waste reuse/recycling. • Quantify process inputs • Accounting for off-site waste • Assembling input and output information for unit operations. • Deriving a preliminary material balance for unit operation. • Evaluating the material balance. • Refining the material balance.
Step 3: Locate Source of Waste	Reduce, Reuse, Recycle Waste generation might be related to impurities in the raw materials, the production process itself (a chemical reaction might generate a certain quantity of by products; lubrication oils accumulate dirt over time and need to be replaced), the organisation of the process (start-up waste, shut down waste, expired chemicals), cleaning (cast-off materials cleaned out of machinery in between batches of different products), to quality control (off-spec products). Check for any leakages or exposed lines or valve controls. Location of equipments needs to be accessed too.
Step 4: Consider Options	Consider options from literature, other industries' experiences and/or recommendations from RE, CP and SP service providers. Also undergo brainstorming sessions with your team. Relate with other similar best industries and access the location of the machineries - have they been placed at the right place- having equipment based on their usage and material flow will reduce much of operational cost, e.g. water or steam pipelines should be preferably closer to its source to reduce losses due to travel distances.
Step 5: Evaluate Options and Implement Programme	Evaluate options, compile & implement programme.

2.5 Implementation of a chemical efficiency program

Table 6: Steps for the implementation of a chemical efficiency

Steps	Description
Step 1: Identify Substances	Identify all substances used in the work area, their sources and transportation to and from the plant. What do you need to know about the chemicals stored and used at your company? • Types of chemicals • Characteristics/properties • Place of use/storage • Type of containment/container • Average quantities This information is available from purchasing records, stock control records, inventories, suppliers product information, sales records, on the product label.
Step 2: Determine Hazardous Substances	Determine if substances are hazardous from labelling & MSDS. Sources are: • Safety data sheets of chemical substances • Labels attached to the chemicals packaging • Technical manuals of the equipment • Legal regulations and technical standards • Scientific and technical literature • Records of work accidents & occupational diseases • Interviews with workers.
Step 3: Draw a Flowchart	Create a chemical flowchart The objective is to clearly map the process flow to understand what the activities are and who is involved. This will help you understand where chemicals are used and located. Process flow means both the sequence of activities you undertake at your company, and the external activities that you can influence in your business, ranging from the products and services you procure, to the products and services that you provide.
Step 4: Identify Risks	Identity health, environmental, social and economic risks: • Create a risk assessment team. • Review hazard hotspots. • Identify risk-prone and vulnerable groups, areas & assets in case of an accident. • Identify potential accident scenarios related to the hazard hotspots you have identified. • Identify the severity of related health, environmental, social & economic impacts in an accident situation. • Estimate the likelihood of the identified accident taking place. • Assign a risk factor to each hazard hotspot. • Prioritize your hazards hotspots.
Step 5: Consider Options	Consider options from literature, other industries' experiences and/or recommendations from RE, CP and SP service providers. Undergo brainstorming session with your team.
Step 6: Evaluate Option and Implement Programme	Evaluate option, compile and implement programme.

3 Collection of data

3 Collection of data

3.1 Introduction

A flowchart is a graphic representation of a process: process steps are represented by boxes; material, water & energy flows by arrows. A flowchart helps to trace waste & emissions back to their respective sources & thus show starting points for potential improvement. According to the principles of maintaining mass and energy, every material entering a certain balance area has to leave this area again afterwards. The only exception is if the material is stored or converted. This means that all output (waste) was once an input (purchases or resources).

In a manufacturing company and hotels as well all materials and energies are tabulated at three stages:

1) When they enter the balance area; i.e. when being purchased.
2) When they are used according to specification; i.e. at the machine, plant.
3) When they leave the balance area; i.e. as product, emission, waste or thermal discharge. The quantities have to be the same at all three stages. If they do not match, this might indicate losses of optimisation potential.

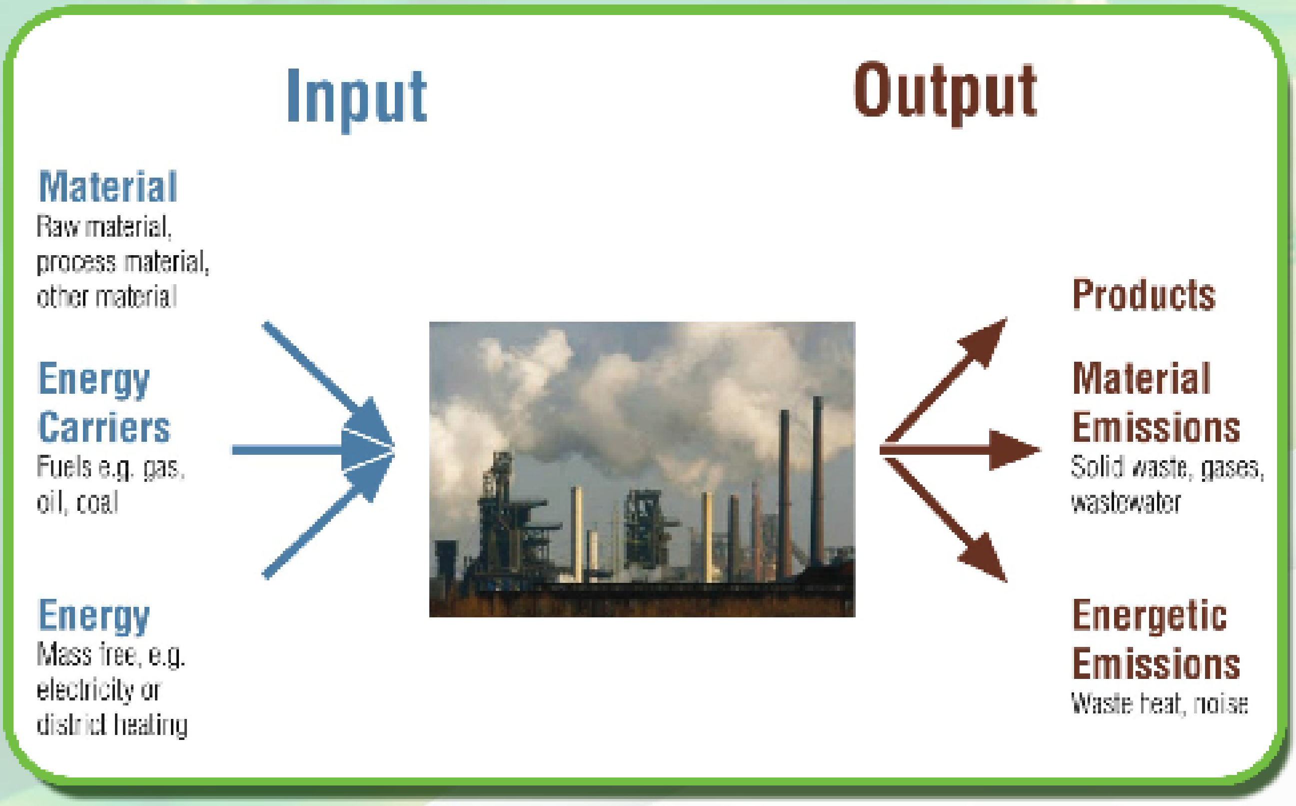


Figure 2: Principle of Input - Output analyses

3.2 Collecting of data

Frequent problem

Lack of data on volumes and costs.

Measuring methods

Check bills and accounts.	Read watt plates, and use instrument to measure consumption volume

Numbers for the enter, use and leave of resources can be extracted from various sources such as:

Entry:

- Documents for bookkeeping & cost accounting.
- Shipping documents.
- Information of suppliers concerning formulae.
- In-house data identification concerning packaging.

Use:

- Cost centre accounting.
- Measurements at plants and machine.s
- Information from staff concerning operating hours and change intervals.
- Receipts of materials purchased.
- Formulae
- Apparatus specifications

Exit:

- Product lists and formulae
- Records of waste and emissions, waybills.
- Settlement of accounts with disposal companies.
- Information about quantity and quality of wastewater (e.g. from measurements by the authorities or from the water association).

Data from the input/output analysis help to answer the following questions:

- How much raw and processed materials and energy is used?
- How big are waste and emission flows?
- From which process steps do waste and emission flows originate?
- Which waste is hazardous/requires monitoring, and why is it hazardous?
- Which part of raw or process material becomes waste?
- Which part of raw or process material is lost as volatile emissions?
- Which costs are created by the disposal of waste and the loss of purchased raw materials?

Frequent problem

Irregular electricity consumption

Measuring methods

Analyses of a peak load profile and apply peak load management.

The first step

Get accurate energy consumption data which can best be done through direct measurements with data loggers. The total electricity consumption of the company can be determined if it is possible to connect the loggers directly to the main breaker. The graph below shows the energy consumption of a day (24 hours) at a guestroom in tropicalregion. Energydemandfluctuatesalongthe time line, due to thechangeoftemperature (useof Air conditioners), use of hot water for shower, and lighting, etc.

Second step

Link the peaks and valleys in the consumption data with energy consuming actions and to evaluate which energy services consume the most energy. As an example, at night the energy

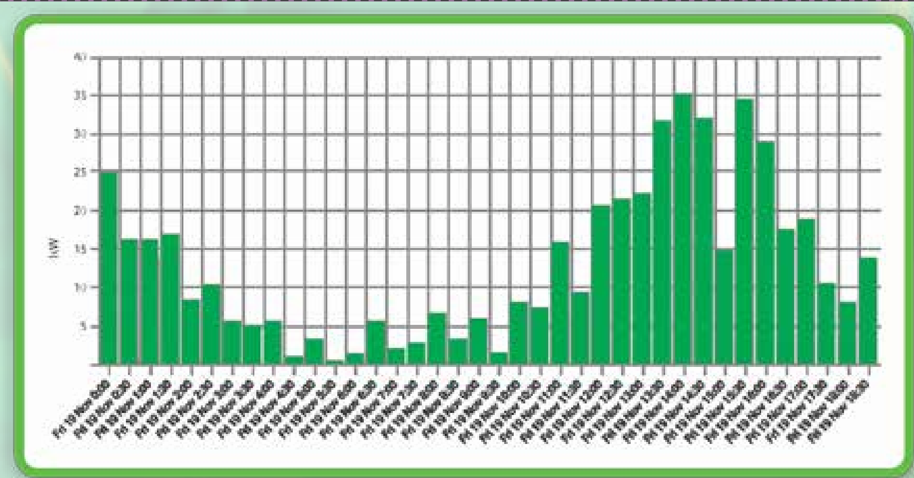


Figure 3: Load curve for a metal mechanic workshop

consumption is quite minimal as the only energy consuming devices that might be in operation are air conditioning equipment, cooling equipment (refrigerators and freezers) and small appliances plugged into the outlets such as guests' phone chargers. In the evening the energy consumption is significantly higher because many different energy services might be used, such as cooking appliances, TV sets and washing machines in addition to cooling and lighting devices.

Third step

Peak load management refers to the shifting of electrical loads to low-use periods. The goal of any load-management program is to maintain, as nearly as possible, a constant level of load, thereby allowing the system load factor to approach 100%. The important benefits of load management are reduction in maximum demand, reduction in power loss.

Better equipment utilization and saving through reduced maximum demand charges. Load shifting, one of the simplest methods of load management, is to reduce customer demand during the peak period by shifting the use of appliances and equipment to partial peak and peak periods. Here no loads are being switched, but only shifted or rescheduled, and hence the total production is not affected. A second important aspect is to identify parasitic loads, e. g. during the nights and weekends, when no production is on and to stop them. (http://dspace.library.iitb.ac.in/jspui/bitstream/10054/1389/1/5683.pdf)

Mostly, oversized DG sets (Diesel Generating sets) assure more than sufficient energy supply during peak loads. Thus, it is consuming more fuel than needed.

On the basis of the energy performance data logged by the measurement systems, peak load management-or basic environmental awareness workshops can be conducted regularly in attendance of managers and technicians.

3.3 Measuring equipment

3.3.1 Energy

Frequent problem

No data on temperature available, e.g. surfaces, pipes, solar plants.

Measuring methods

Measure the surface temperature easily with an infrared thermometer like shown in the picture. Another possibility is to measure the temperature with a thermal imaging camera. A thermal imaging camera records the intensity of radiation in the infrared part of the electromagnetic spectrum and converts it to a visible image.

Application area:

- Visualize energy losses.
- Detect missing or defective insulation.
- Source air leaks.
- Find moisture in insulation, in roofs and walls, both in the internal and the external structure.
- Detect mould and badly insulated areas.
- Locate thermal bridges.
- Locate water infiltration in flat roofs.
- Detect breaches in hot-water pipes.
- Detect construction failures.
- Monitor the drying of buildings.
- Find faults in supply lines and district heating.
- Detect electrical faults.

Infrared thermometer

'This equipment can be borrowed from the SEID offices.'

Frequent problem

No data on energy consumption.

Measuring methods

Measuring of the power consumption of plants such as electrical diveces with power clamps.

Measuring of the electric conumption of devices like refrigerators, computers, etc. with plug in meter.

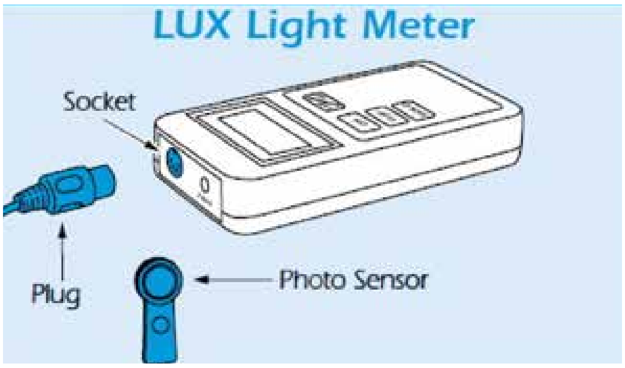
Electric Power plug-in meter

Frequent problem

No data on light intensity.

Measuring methods

Use a lux meter.



Ensure factories, offices and other buildings are providing sufficient working light with this hand held lux meter. Refer to the following table for proper illumination of different areas:

Lighting systems	Illuminance (lux)	
General lighting for rooms & areas used infrequently &/or casually or for simple visual tasks.	20	Minimum service illuminance in exterior.
	30	Outdoor stores and stockyards.
	50	Exterior walkways & platforms, indoor tasks, car parks.
	75	Docks and quays.
	100	Theatres & concert halls, hotel bedrooms, bathrooms & corridors.
	150	Circulation areas in industry, stores and stock rooms.
	200	Minimum service illuminance for a task (visual task not requiring any perception of detail).
	300	Rough bench and machine, motor vehicle assembly, printing machine rooms, general offices, shops and stores, retail sales areas.
	500	Medium bench and machine, motor vehicle assembly, printing machine rooms, general offices, shops and stores, retail sales areas.
	750	Proofreading, general drawing office, offices with business machines.
	1.000	Fine bench and machine work, office machine assembly, colour work and critical drawing tasks.
	1,500	Very fine bench and machine work, instrument & small precision mechanism assembly, electronic components gauging and inspection of small intricate parts; may be partly provided by local lighting.
	2,000	Minutely detailed and precise work, e.g. very small parts of instruments, watch making and engraving, operating area in operating theatres – 2,000 lux minimum.

Use energy-saving fluorescent T5 lamps instead of T12 lamps. One will need proper adapter/retrofit kits to fit the tube or replace the housing totally. T5 lamps have more LUX (international unit of illumination – one lumen per square meter) than T12 lamps with similar wattage thus fewer lamps are needed in a fixture. T5 retrofits don't need starters and some can bypass the ballasts.

- USE of LED tube lights can also be an option (they have the same size as T12s & T8s without using ballasts and starters). Ballasts consume 10-15% of the energy input. No mercury content, give more LUX with less wattage, last longer than other lamps, shatter proof and vibration resistant, and more expensive to purchase but cost less in the long run.
- Change old magnetic ballasts with more efficient electronic ballasts.
- Change incandescent lamps in exit signs with LED exit signs.
- Clean bulbs for maximum efficiency. Bulbs will produce more light after cleaning. This is especially true in workshops, storage areas and dusty areas.
- Use dimmer controls in meeting rooms, common areas and guest rooms. By using dimmer switches to control light output to the amount needed, energy consumption can be reduced. Make sure the lamps and ballasts installed were designed to be dimmed.
- Use timers or sensors to control outdoor lighting.
- Utilize white or light colored walls and ceilings. White or light colored walls and ceilings reflect the light better.

Table 7: Luminous efficiencies

LAMP TYPE	EFFICACY (Lumens per watt) 10 30 50 70 90 110 130 150	AVERAGE LIFE (Thousand hours) 2 6 10 14 18 22 26 30	COLOUR RENDERING
TUNGSTEN FILAMENT			EXCELLENT
TUNGSTEN HALOGEN			EXCELLENT
COMPACT FLUORESCENT			VERY GOOD/ EXCELLENT
TUBULAR FLUORESCENT (halophosphate)			POOR/ MODERATE
TUBULAR FLUORESCENT (triphosphor and multi-phosphor)			VERY GOOD/ EXCELLENT
HIGH PRESSURE SODIUM (SON/E and SON/T)			VERY POOR

Frequent problem

No data on air flow.

Measuring methods

Airflow meter

Airflow meter

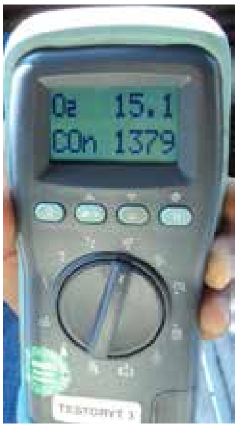
The air flow meter can be used to record, analyse and document all relevant climatic parameters, such as flow velocity and volume flow.

Frequent problem

No data on excess air or residual oxygen.

Measuring methods

Flue gas analyser
The flue gas properties are checked for efficiency by drilling a small hole in the chimney, turning on the boiler and inserting a flue gas analyser to measure residual oxygene. This was left in position and the air intake settings were adjusted to increase the efficiency (4% residual oxygene with fuel oil, 8% with wood or husk). The small test hole drilled in the metal flue was taped up with aluminium sticky tape. But this should only be done after the chimney has cooled to avoid burns.



Flue gas analyser

Frequent problem

No data on air losses.

Measuring methods

Ultrasonic detector

In a system with 6 bar air pressure and at an electricity price of 8 cents per kWh, a leak of 1mm will cause costs of more than 250 US Dollars for electricity. An audible sound in the headset indicates that a leak has been found. Leaks can be detected from a distance of 15–20 m.

Ultrasonic Detector

3.3.2 Water

Frequent problem

Water meters are not available to measure the consumption in single departments or at individual machines.

Measuring methods

The Bucket method

Use any bucket where you know the capacity or measure the capacity of the bucket before further steps (e.g. 10 litres or 2.5 gal). Take the bucket and fill the bucket with the hose where you want to know the flow. Count the time in seconds (e.g. 20 seconds) Divide the capacity by the time in seconds. You will get the water flow from the hose in litres per second or gallons per second.

Table 8: Water loss by drips per second

No. of Drips per second	Litre per minute
1	.023
2	.045
3	.068
4	.091
5	.114
5 drips per second is a steady steam	

Table 9: Relation between size of leaks and water loss

Hole size (mm)	Water loss (m^3/day)	Water loss (m^3/year)
0.5	0.4	140
1	1.2	430
2	3.7	1300
4	18	6400
6	47	17,000

Frequent problem

No data on water flow.

Measuring methods

Installation of a flow meter.

A simple water meter is installed inline at the water entry pipe. Readings should be taken e. g. Daily at the same time and documented. The consumption should be related to production. These indicators should be discussed regularly with the operators.

Water flow meter

Frequent problem

No data on waste water.

Measuring methods

A V-notch can be used to measure water flow in an open channel. You insert a steel sheet with a V and measure (e. g. with a ruler or dipstick) the height of water flow in the V. V-notches can measure discharge from 1 lit/sec to 120 lit/sec maximum. For low discharges, V-Notches are superior to Flumes because head over the crest is large and thus flow remains unaffected by surface tension and viscosity. V-Notches have their own limitation and not suitable for discharge measurements in field channels due to obstruction of silt.

The formula for the calculation of flow is:

The flow rate measurement in a rectangular weir is based on the Bernoulli Equation principles and can be expressed as:

$q = 2/3\ b\ (2\ g)^{1/2}\ h^{3/2}$

q = flow rate (m^3/s)

h = head on the weir (m)

b = width of the weir (m)

g = 9.81 (m/s^2) - gravity

Frequent problem

Water volume in a tank is not known.

Measuring methods

Use a Dipstick to measure the liquide level of a tank.

To get the volume of a vertical cylindrical tank, you need to multiply the height of liquid level by (πr2), with r the radius of the tank.
The base formula for volume in a cylinder is as follows:

$V = \pi * r^2 * h$

3.3.3 Waste

Frequent problem

- No detailed information about the waste categories and the amount of waste is produced in the company is available.
- No detailed information about what is going in and what is going out of the process is available.

Measuring methods

Install a proper waste management system

- Identify all waste streams and the waste collection points.
- Map the process flow to understand what type of & how much waste is generated from which process and why. Use a scale in case there are no data available.
- Measure current levels of waste reuse/recycling.
- Quantify process outputs.
- Outputs include primary product, by-products, wastewater, gaseous wastes, liquid & solid wastes that need to be stored or sent off-site for disposal and reusable or recyclable wastes.
- Accounting for off-site waste.

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3.3.4 Noise

Frequent problem

No data available on noise from electrical devises, diesel generators, process equipment.

Measuring methods

*

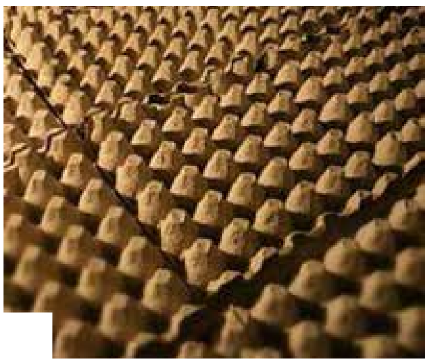
Measurment of the sound level with a sound level meter.
A sound level meter is an electronic instrument that provides a real-time reading of noise intensity (loudness) levels. The unit is dB (decibel).
The meters are usually hand-held devices equipped with a microphone, electronic-filter network, and a visual display unit. Sound level meters are typically used for surveying noise pollution in an area.

Table 10: Threshold limit values for noise recommended by WHO

	Duration per day	Sound Levels in dBA
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.5	103
	3.75	106
	1.88	109
	0.94	112
Seconds	28.12	115
	14.06	118
	7.03	121
	3.52	124
	1.76	127
	0.88	130
	0.44	133
	0.22	136
	0.11	139

*In reality the measuring device should be placed at a distance of 1 meter

The installation of soundproofing equipment can reduce the sound level.



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4 Specific problem solutions

4 Specific problem solutions

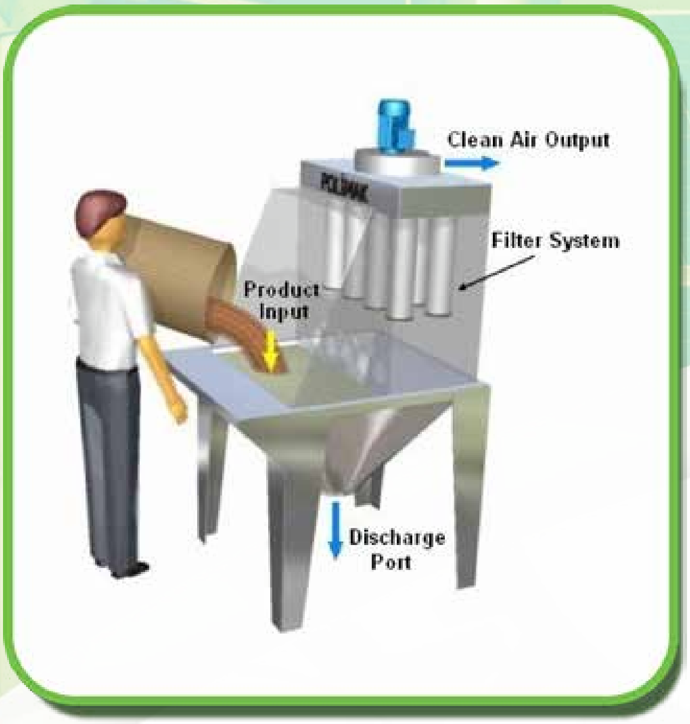
4.1 Materials

Frequent problem

Dust is generated when emptying bags and mixing solids: flour is spilled on the machine and the floor. This is not only a material loss but also a serious risk for fire and even explosion.

Suggestions for improvement

The picture shows a proper workplace for opening bags: Air is collected by a fan and cleaned by filters. The collected dust falls back into the cone and thus can be collected and used.



Frequent problem

Material losses to ground, spillage, dust.

Suction port at wood working machine

Duct to transfer dust to a silo

Fan working in a dust extraction system in a sawmill

Suggestions for improvement

- Install a proper extraction system with velocities of 20 m/s in suction port.
- Tight ducts
- Slide valves to shut off machines which are not used. Use frequency controlled fans.
- Collect the dust in bag filters.

Frequent problem

A survey revealed that people tend to use more water, resources (e.g. soaps, shampoo, towels, etc.), and electricity (e.g. lighting, air conditioning, TV, etc.) during their stays in commercial accommodation. The extravagant consumption behavior of guests results in generation of unnecessary waste.

Suggestions for improvement

Water saving faucet can be installed to lower the water flow.

Club Himalaya

Left-over soap bars can be reused to to wash laundry with stains. A soap saver can be utilized to aggregate the left-soaps so as to be re-used.

Frequent problem

Input for production (i.e. raw materials) is needlessly lost during the transport and preparation processes.

Especially the loss can become significant, if fruits and vegetables are purchased far from the production site and transported. Damaged materials may have to be discarded. Some companies use metal hooks when they lift the sacks of materials such as rice, flour, sugar, etc. Often the hook leaves holes in the sack, thus, material loss occurs. In beaten rice industry, the rice is kept in water for soaking for 10-12 hours. Once the process is over, the water from the pot is thrown away. There is some loss of rice during this process.

Suggestions for improvement

Minimise the distance of transport by purchasing raw materials from the nearest market. Avoid sharp tools which cause material loss in logistics.

Nets could be used around the outer circumference of the soaking pot while throwing out water from the pots and the material waste can be minimized.

4.2 Energy

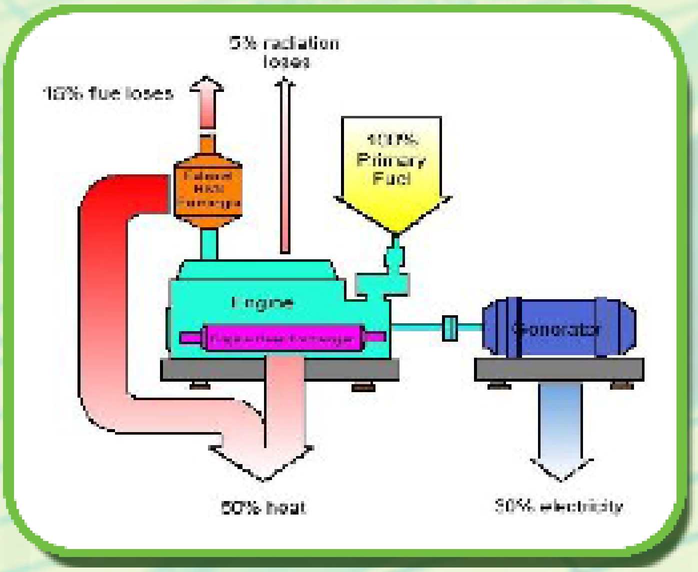
Frequent problem

Inefficient operation of the diesel generator & no waste heat recovery from generators.

Suggestions for improvement

Energy Saving Measures for Diesel Generator Systems

- Ensure steady load conditions on the DG set, & provide cold, dust free air at intake (use of air washers for large sets, in case of dry, hot weather can be considered).
- Improve air filtration.
- Ensure fuel oil storage, handling & preparation preparation as per manufacturers' guidelines /oil company data.
- Consider fuel oil additives in case they benefit fuel oil properties for DG set usage.
- Calibrate fuel injection pumps frequently.
- Ensure compliance with maintenance checklist.
- Avoiding fluctuations, imbalance in phases, & harmonic loads.
- In case of a base load operation, consider waste heat recovery system adoption for steam generation or refrigeration chiller unit incorporation. Even the Jacket Cooling Water is amenable for heat recovery, vapour absorption system adoption.



- In terms of fuel cost economy, consider partial use of biomass gas for generation. Ensure tar removal from the gas for improving availability of the engine in the long run.
- Consider parallel operation among the DG sets for improved loading and fuel economy thereof.
- Carry out regular field trials to monitor DG set performance, & maintenance planning as per requirements.

Frequent problem

Inefficient boiler because of:

- No return of condensate.
- High surface temperature.
- High flue gas temperature.
- No preheating of combustion air.
- No preheating of the boiler feed water.
- No sufficient softening of feed water.
- Excessive purging of water from the boiler to remove hardness.
- High fraction of oxygen in the exhaust gas.

Suggestions for improvement

Energy saving measures for boilers:

- Fireside surfaces, waterside surfaces, the burner assembly & the stack should be regularly maintained. This includes visual inspection, & cleaning, if necessary.
- Seals, feed water pumps & safety valves should be checked for leaks and repaired, if necessary.
- Minimise idle time at low fire. Try to operate one boiler at full load instead of two boilers at half load.
- Optimise blow down by measuring conductivity of the boiler water & automatically controlling blow down.
- Recover heat from flash steam (forming from blow down or returning condensate). The flash tank acts as a separator allowing the remaining liquid to separate from flash steam. The low-pressure steam can then be used for process applications.
- Use warmest air as combustion intake. As a rule of thumb, an increase in boiler efficiency of approximately 1 % is possible for each 20°C increase in intake combustion air temperature. Generally the area just below the roof will be warmer due to temperature stratification of air.
- Recover stack loss. The energy loss through the stack is a function of flue gas temperature & the excess air. Typically this contributes to about 15 % energy loss. Energy from stack can be recovered for preheating combustion intake air or preheating water.
- Install condensing economisers if you use natural gas as a fuel. By cooling the flue gas below the dew point, they recover both sensible heat from the flue gas & latent heat from the condensed moisture. Condensing economisers may reach efficiencies above 100 %, because of the recovery of the heat of condensation of the water vapour in the exhaust gas.

• Adjust air to fuel ratio. Best performance is obtained by the installation of an automatic air control system that will adjust the supplied air volume depending on the residual oxygen content in the exhaust gas.

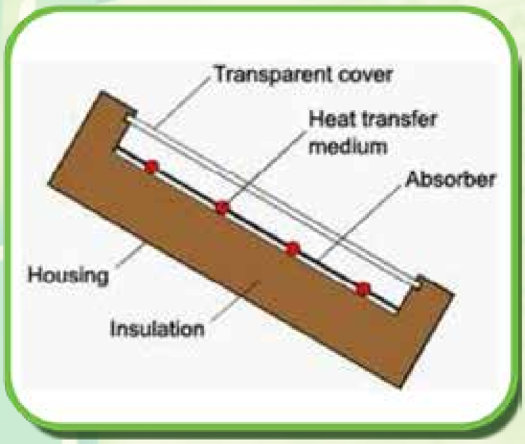
Energy saving measures for steam system:

• Eliminate steam leaks. Significant savings can be realised by locating and repairing leaks in live steam lines and in condensate return lines. Leaks in the steam lines allow steam to be wasted, resulting in higher steam production requirements from the boiler to meet the system needs. Additional feed water is required to make up for condensate losses and more energy is expended to heat the cooler feed water than to heat the warmer condensate. Water treatment would also increase as the top-up water quantity increased. Leaks most often occur at the fittings in the steam and condensate pipe systems. Savings for this measure depend on the boiler efficiency, the annual hours during which the leaks occur, the boiler operating pressure and the enthalpies of the steam and boiler feed water (where enthalpy is a measure of the energy content of the steam and feed water).

Frequent problem

- No use of solar plants for the hot water supply or for space heating.
- Discontinued use of solar plants.

The shadow cast on the panel of thermal solar of hotel holiday inn pokhara, FG from Pokhara Chapter.



Suggestions for improvement

Here are some suggested inspections of solar system components. Also read your owner's manual for suggested maintenance schedule and obtain a technical manual for your equipment and read it.

- **Collector shading**

Ensure that the collectors are fully exposed to radiation. Visually check for shading of the collectors during the day (mid-morning, noon, and mid-afternoon) on an annual basis. Shading can greatly affect the performance of solar collectors. Vegetation growth over time or new construction on your house or your neighbour's property may produce shading that wasn't there when the collectors were installed.

- **Collector soiling**

Dusty or soiled collectors will perform poorly. Periodic cleaning may be necessary in dry, dusty climates.

- **Collector glazing and seals**

Look for cracks in the collector glazing, and check to see if seals are in good condition. Plastic glazing, if excessively yellowed, may need to be replaced.

- **Plumbing, ductwork, and wiring connections**

Look for fluid leaks at pipe connections. Check duct connections and seals. Ducts should be sealed with a mastic compound. All wiring connections should be tight.

- **Piping, duct, and wiring insulation**

Look for damage or degradation of insulation covering pipes, ducts, and wiring.

- **Roof penetrations**

Flashing and sealant around roof penetrations should be in good condition.

- **Support structures**

Check all nuts and bolts attaching the collectors to any support structures for tightness.

- **Pressure relief valve (on liquid solar heating collectors)**

Make sure the valve is not stuck open or closed.

- **Dampers (in solar air heating systems)**

If possible, make sure the dampers open and close properly.

- **Pumps or blowers**

Verify that distribution pumps or blowers (fans) are operating. Listen to see if they come on when the sun is shining on the collectors after mid-morning. If you can't hear a pump or blower operating, then either the controller has malfunctioned or the pump or blower has.

- **Heat transfer fluids**

Antifreeze solutions in liquid (hydronic) solar heating collectors need to be replaced periodically. It's a task best left to a qualified technician. If water with a high mineral content (i.e., hard water) is circulated in the collectors, mineral buildup in the piping may need to be removed by adding a de-scaling or mild acidic solution to the water every few years. You can avoid scaling by using a water softener.

- **Storage systems**

Check storage tanks, etc., for cracks, leaks, rust, or other signs of corrosion.

• The solar system makes their owners less dependent on increases in energy prices.
• Thermal solar systems for the provision of hot water are technically mature and have a service life of about 20 years.
• A standard solar system covers between 50 % (in northern latitudes) and 90 % (in subtropical & tropical climates) of the yearly energy required for the provision of hot water. Even in northern latitudes, 90% of the energy demand between May and September can be covered.
• Solar systems for swimming pool water heating are economical to install, and their cost can be amortized over a very short period of time.
• Within the course of its life a solar system supplies about 13 times more energy than was used to make it.
• Solar systems require very little maintenance, & their energy is permanently available.
• By taking up solar technology the trade gains new areas of work, which are secure for the future.
• Solar technology creates lasting employment in production, installation and servicing

Flat Plate Solar Collectors

A flat-plate collector consists of an absorber, a transparent cover, a frame, and insulation. Usually an iron-poor solar safety glass issued as a transparent cover, as it transmits a great amount of the shortwave light spectrum.

Two major factors affecting the performance of properly sited and installed solar water heating systems include scaling (in liquid or hydronic-based systems) and corrosion (in hydronic and air systems). Domestic water that is high in mineral content (or "hard water") may cause the build-up or scaling of mineral (calcium) deposits in hydronic solar heating systems. Scale build-up reduces system performance in a number of ways. If your system uses water as the heat-transfer fluid, scaling can occur in the collector, distribution piping, and heat exchanger. In systems that use other types of heat-transfer fluids (such as glycol, an anti-freeze), scaling can occur on the surface of the heat exchanger that transfers heat from the solar collector to the domestic water. Scaling may also cause valve and pump failures on the potable water loop.

You can avoid scaling by using water softeners or by circulating a mild acidic solution (such as vinegar) through the collector or domestic hot water loop every 3–5 years, or as necessary depending on water conditions. You may need to carefully clean heat exchanger surfaces with medium-grain sandpaper. A "wrap-around" external heat exchanger is an alternative to a heat exchanger located inside a storage tank.

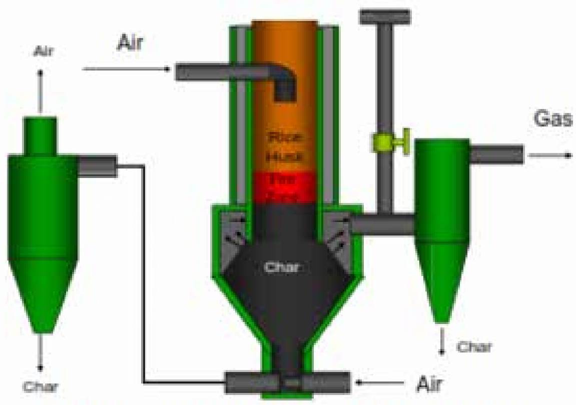
Most well-designed solar systems experience minimal corrosion. When they do, it is usually galvanic corrosion, an electrolytic process caused by two dissimilar metals coming into contact with each other. One metal has a stronger positive electrical charge and pulls electrons from the other, causing one of the metals to corrode. The heat-transfer fluid in some solar energy systems sometimes provides the bridge over which this exchange of electrons occurs.

Oxygen entering into an open loop hydronic solar system will cause rust in any iron or steel component. Such systems should have copper, bronze, brass, stainless steel, plastic, rubber components in the plumbing loop, and plastic or glass lined storage tanks.

Solar water heating systems, which use liquids as heat-transfer fluids, need protection from freezing in climates where temperatures fall below 42°F (6°C):
• Use an antifreeze solution as the heat-transfer fluid
• Drain the collector(s) and piping (collector loop); either manually or automatically, when there's a chance the temperature might drop below the liquid's freezing point

Frequent problem

Improper use of husk as fuel.



Cut-Away View of the Continuous Flow Rice Husk Gasifier

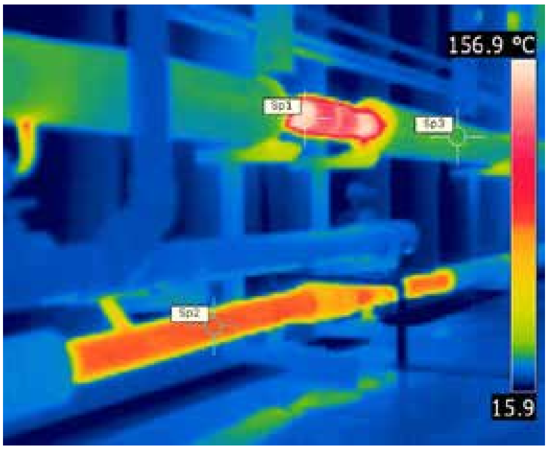
Suggestions for improvement

Continuous flow rice husk gasifier

Gasification of rice husks in this gasifier is accomplished in a downdraft mode. Rice husks are fed at the top of the reactor and are burned at its bottom. Air is introduced into the bed of rice husks from the top of the reactor and moves downward through the fire zone. Fire zone is maintained by gradually removing the char from the char chamber employing a jet-type pneumatic conveyor installed right beneath the reactor. The gas generated in the reactor during gasification is directed to the burner passing through the momentum separator. Char is separated from the gas by a 30-cm diameter cylindrical shape momentum separator. The gas produced is burned either in a jet-type, a gas pipe-type, or a drum-type burner. The air that is used to convey the char is also used to cool the reactor at the same time. At the end of the conveyor is a cyclone separator to separate the char from air. A water container is provided at the bottom of the cyclone to immediately cool the hot char that is leaving the reactor.

Frequent problem

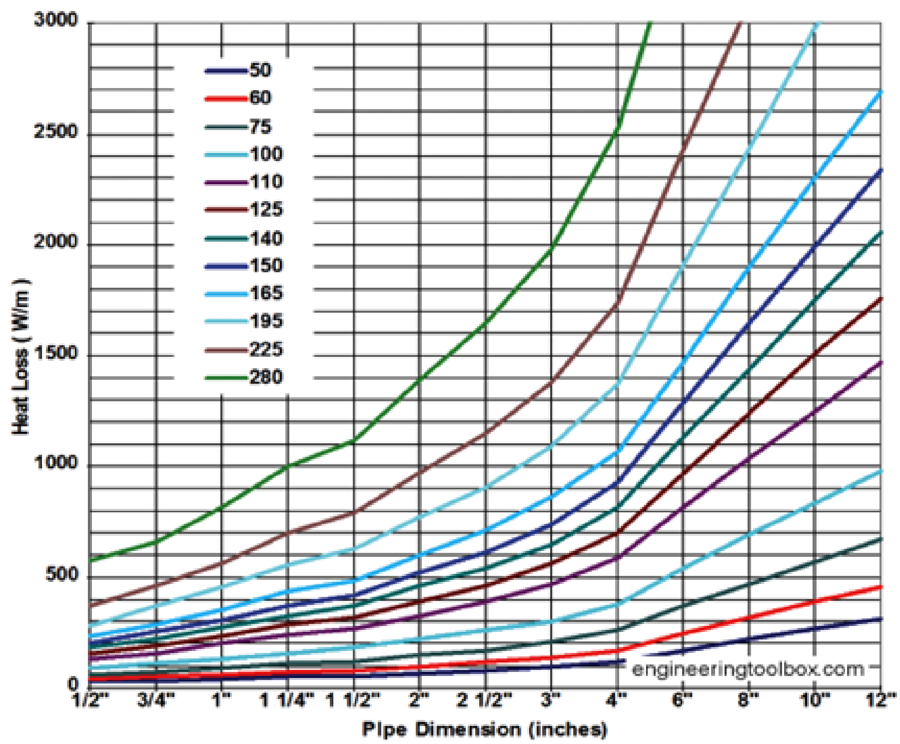
Loss of energy from hot surfaces, e.g. pipes because of improper insulation.



Suggestions for improvement

Thermal insulation

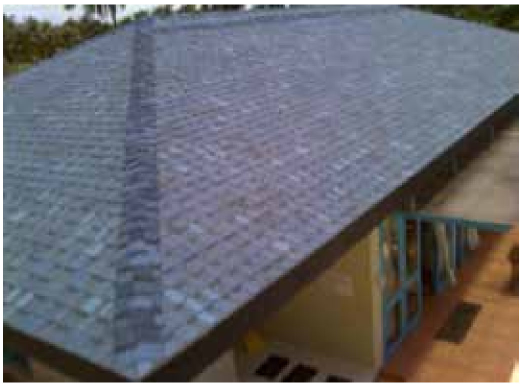
The need for efficient thermal insulation has become more important as both operating temperatures and energy costs have increased. The production, distribution and use of steam require thermal insulation to ensure that process requirements are satisfied. The first consideration is to ensure that steam generated at the boiler can be delivered to the point of use at the correct temperature and pressure. To ensure that energy loss remains within design tolerance it is essential to make the correct choice of thermal insulation. To ensure that losses are minimal the utility point can be closer from the point of production of steams.



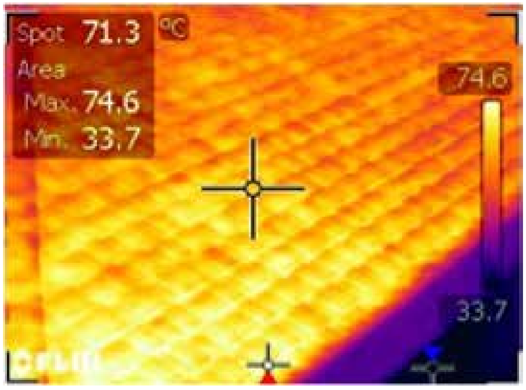
Heat losses from bare steel pipes

Frequent problem

- High surface temperatures on the roof/ceiling due to heat absorbing roofing materials.
- No sun buffers and shadings especially on the windows located at the west side.
- No insulation between the roof and the ceiling. High surface temperatures are caused by insufficient insulation.

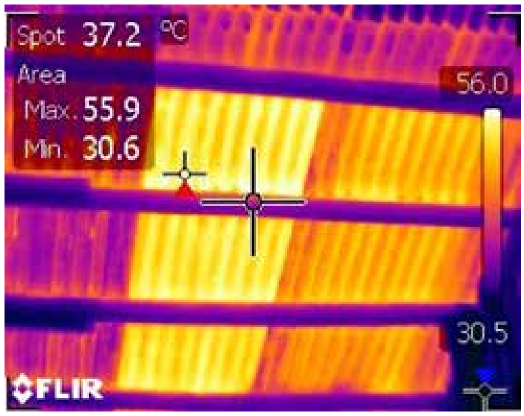


Tiled roof in the sun



Infrared pictures showing the surface temperature of the roof (maximum temperature 74 °C

Corrugated steel roof from inside the building



Infrared picture showing the temperature of the roof (maximum temperatur 56 °C)

Suggestions for improvement

- Choose roof materials with a low absorption rate and/or provide a good insulation additionally.
- Thatched roof is a good practice especially when the covering natural material is thick enough to properly insulate the roof structure.
- Provide sun buffers & louvers. Install green walls along the perimeter wall.
- Shading devices on the outside of the windows will block the heat and allow the light to pass. This is better than the use of curtains indoor.
- Add window film or tinting to windows and glass doors to reduce heat gain through windows.
- Install insulation materials. Solar heat gain through the roof can contribute a substantial amount to the cooling load of an air-conditioned building. Hence, roofs should be provided with adequate insulation in order to conserve energy. Insulation can be one of the most important factors in achieving energy efficiency in a building. It works primarily to slow the flow of heat through a building envelope.
- Insulation not only saves money by reducing cooling loads but is also a key factor in achieving comfortable living and working spaces.

Frequent problem

- Improper operation of cooling systems.
- High electricity demand for cooling systems .
- No heat recovery at cooling.

Suggestions for improvement

Recovery of heat from cooling equipment.

Energy saving measures for cooling systems:

- Keep doors of refrigeration chambers closed.
- Clean heat/cold exchanger regularly.
- Maintain appropriate temperature (not too cold) one degree warmer in the chamber saves up to 6% electricity.
- Clean, fix rubber insulation of the doors regularly.
- Defrost cold exchanger regularly.

Plate type desuperheater recovers heat from hot refrigerant to heat water

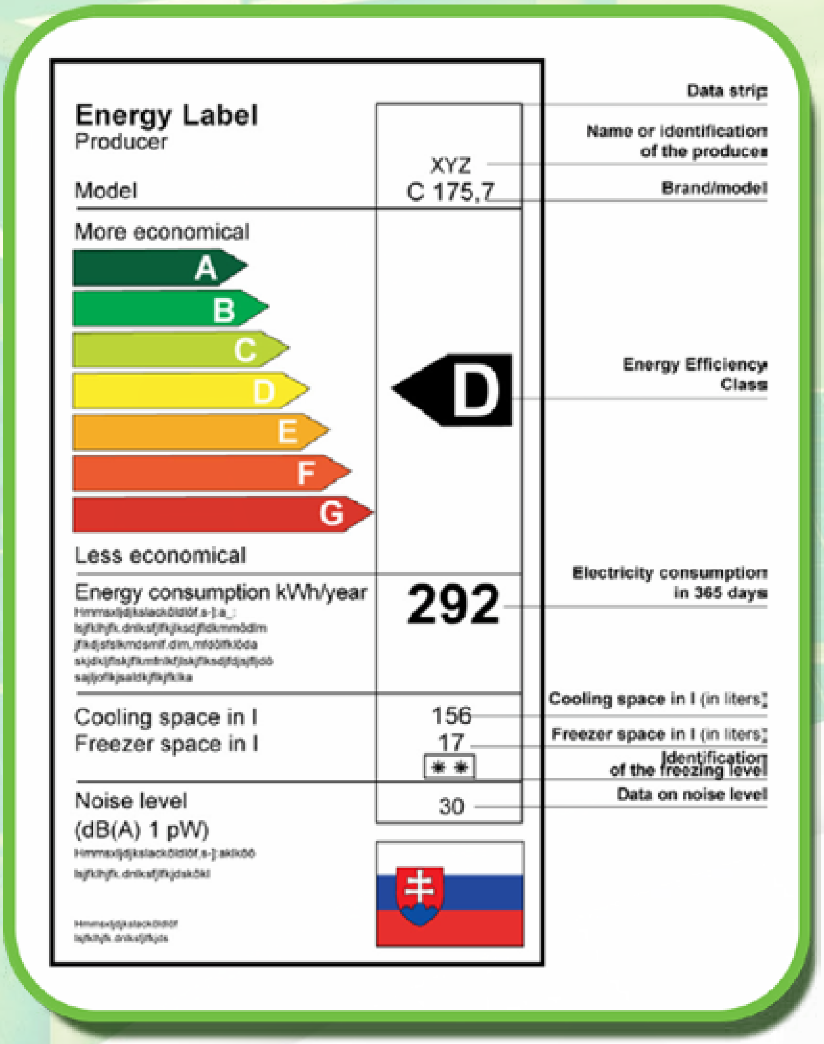
Thickness of ice deposit in deep freeze in Green Hill

Frequent problem

- High consumption of electricity for cooling.
- Placing Refrigerators close to the wall or inside cabinets increases the power consumption.
- Refrigerators in an air-conditioned room cool its contents but radiate the heat into the room and thus adds load for the A/C (air conditioner).

Suggestions for improvement

- Observe proper clearance of refrigerators to walls. Refrigerators should be located away from cooking stoves.
- Allow sufficient ventilation for refrigerators, don't enclose it.
- Turn off the refrigerators when not used for a longer time, e.g. when rooms are not occupied.
- Adjust refrigerator settings to the appropriate temperature & use a ref thermometer to monitor the temperature. Running a refrigerator at a lower temperature than needed will increase its energy consumption by 6-10% (per degree). Appropriate temperature settings are:
  - +8°C and below for all food in accordance with food safety legislation.
  - +6°C for salads and or vegetables
  - +4/+6°C for pastry items
  - +1/+4°C for dairy items.
  - –2/+2°C for meat products
  - -1/+1°C for fish
- Refrigerator clock savers can be installed to reduce energy consumption of the refrigerators that are always running, & to minimize the build up of ice.
- Consider ventilation options for the refrigerator´s condenser to directly exhaust heat to the outside (if the kitchen building allows).



Energy label showing the efficiency of a refrigerator

Frequent problem

Inefficient electrical device because of:

- Oversized and old motors.
- Bad control: a variable speed drive is not installed.
- Electrical devices are covered with dust.

Suggestions for improvement

- Size motors for efficient operation: motors should be sized to operate within a load window of between 65 % & 100 % of the rated load. The common practice of over sizing results in less efficient motor operation. For example, a motor operating at a 35 % load is less efficient than a smaller motor that is matched to the same load.
- Rewinding reduces the motor efficiency by 1 to 3 %. Therefore rewinding is not considered economical in the US and Europe.
- Select a new energy-efficient motor under any of the following conditions:
  – The motor is less than 40 hp.
  – An energy-efficient motor is recommended.
  – The cost of the rewind exceeds 65 % of the price of a new motor.
- Install Variable Frequency Drives (VFDs) on fans & pumps which have to operate over a range of operating conditions & are controlled by valves. An exact analysis of the economics can be done knowing the frequency of operating conditions. As a rule of thumb: supplying an air flow of 50 % with a VFD reduces electricity consumption by 70 % as compared to control with a valve.
- Use energy efficient V-belt. V-belts have a trapezoidal cross section to create a wedging action on pulleys to increase friction and power transfer capacity. V-belt drives can reach a nominal efficiency of 93 %. Regularly check the tension of the belts.

AC Variable Frequency Drives

V-belt drives

Frequent problem

- Bad practices in using firewood as heat source:
- big logs do not allow proper oxidation of the wood
- open burning chamber allows intake of false air
- no chimney to provide proper draft
- combustion air is not passed through the fuel
- Incomplete combustion.
- Heat losses because of hot surfaces.

Slight improvement in burning chambers firewood feeder section. The Net is installed for firewood and ash is collected below.

Suggestions for improvement

- **Air intake under the fire:** Improving the burning efficiency is assured by the air intake being below the fire and the reduction in the firewood sections. The mouthpiece has a shelf.
- **Smaller wood sections:** Smaller wood sections burn better than thick wood sections. The maximum section of the firewood pieces is 4-5cm thick (1½" - 2"). Lengthwise cutting (splitting) of firewood is easier than crosswise cutting. There is a trade-off between collecting large quantities of firewood or doing a little extra chopping.
- **Rocket or elbow principle:** The burning chamber is designed according to the "Rocket" or elbow principle which incorporates the above two points. The burning chamber needs to be as small as possible & product a vertical flame under the first pot.
- **Ashtray under elbow:** The amount of ashes will be greatly reduced by improved combustion. The ashtray can be made of thin metal. At the location of the ashtray, the burning chamber or stove does not need a bottom sheet.
- **Separate burning chamber:** The separation between the burning chamber and the rest of the stove allows these components to be made from different material qualities. The burning chamber can be made from chrome steel or stainless steel (light and durable) or 2.5mm (gauge).
- **Mild steel:** The sides can be made from 0.7mm sheets or galvanised steel sheet.
- **Insulating the burning chamber:** The airspace between the burning chamber & the outside of the stove is a good insulator, giving the outside of the stove a low temperature. This space can be filled up with wood ash during the summer when no heat radiation of the stove is required.
- **Draft regulation (air regulator and chimney draft):** The air regulator is fitted at the front of the mouthpiece of the elbow-shaped burning chamber and slides automatically down onto the wood sticking out of the opening. The air intake through the wood-feeding opening remains minimal. The chimney draft regulator needs to be manufactured in such a way that it can be easily positioned in a full range of positions. Because of the long chimney, opening the draft regulator increases the fire intensity.
- **Long chimney:** The chimney removes the smoke from the kitchen and creates the draft in the stove. A minimal 4 m long chimney assures sufficient draft at all times. The chimney should be from thin non-galvanised sheet metal (28-gauge=0.3 mm) to allow fast heating (less soot deposit), good heat radiation & low transport cost. Regular cleaning of the chimney is recommended Chimney sections are 120 cm long and need to be replaced when rusted through. For exterior chimney pipes, 28-gauge (0.3 mm) galvanised sheet steel is used.

Frequent problem

Improper tea drying: wet firewood, no control of hot air flow, low heat transfer from flue gas to hot air

Suggestions for improvement

Energy saving measures:

- Reducing the flue gas loss.
- Good insulation.
- Improve insulation of hot air ducts
- Reduce flue gas losses by cleaning heat exchanger pipes to reduce flue gas temperature
- control air to fuel ratio in combustion chamber
- Keep fire wood dry by storing under a shed
- Use a solar tea dryer as an alternative to wood fired tea driers
- Use heat pump driers
- Energy savings by storing fuel in closed space.
- Installation of new technologies: Heat pump tea dryer.

Installation of new technologies: Heat pump tea dryer.

- Heat pump dryer running cost just as 40 % of oil dryer, 50 % of coal burning boiler, 30 % of electric boiler;
- Max temp: 80 °C
- During drying, the material does not craze, distort, discolor, not oxidize, dry completely, with good rehydration, keep nutrient content.
- Energy saving and environmental protection.
- Dryer and dehumidifier all in one;
- Conventionally, materials are dried either in the field (sun drying) or using high temperature dryers (electric, gas fired, etc.). Successful outdoor drying depends upon good weather & indeterminate weather can render a product worthless. High temperature drying can damage the nutrient content & impart an unpleasant smell to the dried product.
- The SMER (specific moisture extraction rate) is used to characterise the efficiency of a dryer.

Frequent problem

- High reactive load.
- A power factor correction isn't installed.

Suggestions for improvement

Installation of a power factor correction. Reactive loads are ones which generally act on alternating current and have the effect of forcing the voltage wave and current wave to become out of phase with each other. This can have the real affect of increasing the power consumption of a reactive load even though the voltage and current is the same as they would be if the load was resistive. The additional factor to be considered is called the "Power Factor". This is often provided with large reactive loads like industrial AC electric motors.

Power factor correction

- An automatic power factor correction unit is a capacitor bank used to improve the power factor of an installation. The capacitors are switched on & off by a regulator that measures the power factor.
- Depending on the load & power factor of the network, the power factor controller will switch the necessary blocks of capacitors in steps to make sure the power factor stays above a selected value (usually demanded by the energy supplier).

4.3 Water

Frequent problem

High consumption of water by manual operations in hotel.

Suggestions for improvement

Taps:

- Adjust flow valves to the tap. Keep in mind this modification can also be easily changed by users.
- Check regularly for leaks.
- Use aerators for taps flow control. The design of the nozzle mixes air with the water under pressure. When the water exits the nozzle the air expands, increasing the apparent water flow. Water savings of 10 litres/min.
- Install flow restrictors. Flow restrictors can be installed in the hot & cold water feed lines to the tap Common flow rate designs include 2 to 6 litres per minute. Flow restrictors can be used where aerators cannot be used or where the tap is being abused. Water savings of up to 2,6 gpm or 10 litres/min.
- Install self-closing taps (push-down taps). To deliver flow, the user pushes down on the tap head. When the user removes their hand, the pressure generated inside forces the tap up and it automatically closes off the flow after a delay period (1 - 20 seconds, set at the time of installation).
- Install electronic tap with infrared sensor. The sensor is located on the underside of the tap head. The sensor is triggered when the user places their hands under the tap head.

Shower:

- Encourage users to take shorter showers (10 minute maximum).
- Check regularly for leaks.
- Install shower aerator or aerating showerhead. Water savings of up to 1.5 gpm or 6 litres/min.
- Install push button shower or a pull chain (mechanical timed flow control).

Guest information:

Inform your guests how they can help to reduce the water consumption.

Guest Information

Frequent problem

- Improper cleaning in food industry.
- High consumption of water by manual operations in food industry.

Use of water via hose pipe without flow controller which causes wastage of water.

Suggestions for improvement

- Establish clear procedures
- Promote dry clean-up: dry clean-up means using brooms, brushes, vacuums, squeegees, scrapers, microfiber rags & other utensils to clean material before water is used. By collecting the majority of wastes, residues or contaminants in a dry form, large volumes of water & wastewater can be eliminated. The bulk of solid materials can be more efficiently removed in dry form before water is introduced for secondary washing.
- Many floor surfaces (i.e., warehouses, offices, automotive garages, non-critical processing areas, facility support operations, etc.) do not need to be washed with water. If necessary, use dry absorbents & sweep or vacuum these areas. Find and eliminate the source of spills and leaks that may be the sole reason why water wash-downs are needed.
- Use floor mats, 'clean-zones' and other means to reduce the tracking of waste & dirt residuals throughout a facility.
- Turn off running water when not in use.
- Do not use a hose as a broom.
- Use efficient spray nozzles with automatic shutoffs on the end of hoses.
- Consider high-pressure washers to clean more quickly and efficiently.
- Consider pressurized air-assisted spray nozzles to provide more cleaning force with less water.
- Use flow restrictors in water lines that supply hoses and pressure washers.
- In-house training of employees.

Spray nozzle

SEID Sustainable & Efficient Industrial Development in Nepal & Bhutan

Frequent problem

High water demand in hotels.

Suggestions for improvement

How hotels can reduce the water demand:

Taps and showers

- Control flow rates from taps and showers with flow regulators.
- Flow regulators give constant flow regardless of pressure fluctuations at 1 bar and above. Prevent starvation at end appliances. Reduce water use.
- Specify automatically controlled taps with spray heads in public wash basins (or regulated to 2 - 4 litres/min).
- Specify flow regulators for taps in hotels combined with aerated heads.
- Use flow regulators and aerated heads for showers. 8 – 10 litres/min is a good flow rate for showers even in hotels.

Use in kitchens

- Efficient dishwashers can use between 10 -50 litres per 12 place setting.

Underground leakage

- Longer the branch pipe, more potential for leaks.
- Can be more than one supply for larger hotels.
- Meters only need to be read once every two years, so leaks can remain undetected for a long time.
- Leakage can increase as mains in road replaced.

Swimming pools

- Prevent evaporation. A 25 by 12m pool can lose 7cm of surface water to evaporation a week, wasting 10,000 litres of water a week, 500m3 a year.
- Upgrade back flush mechanism.

Rainwater harvesting

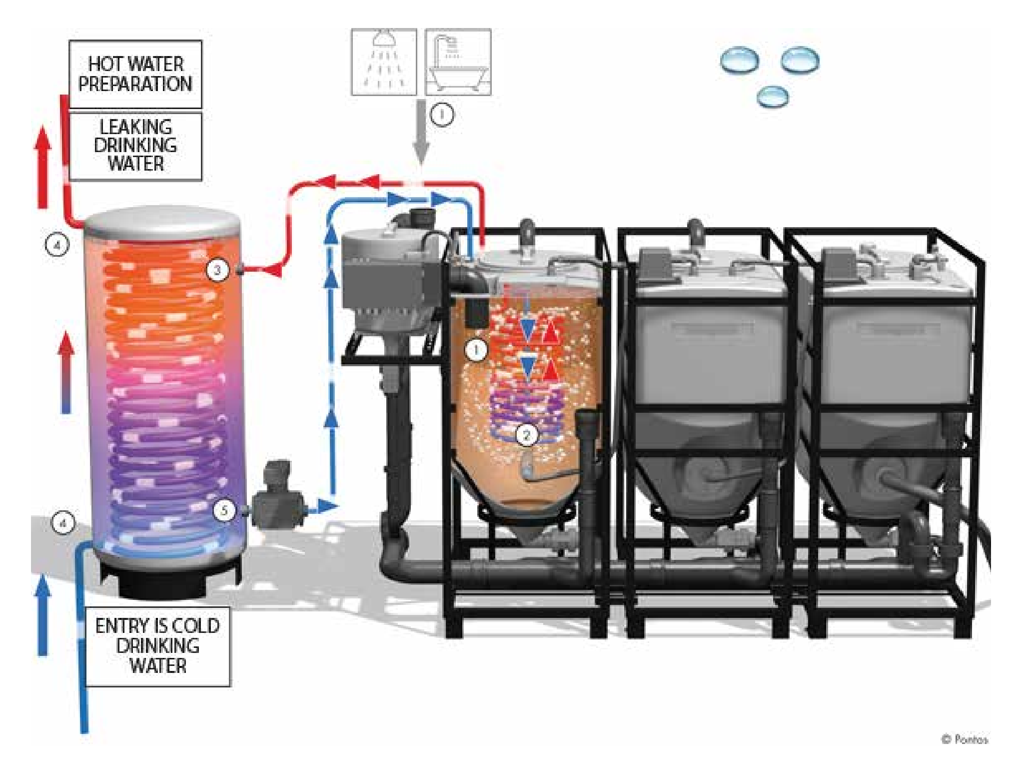
- Collect from roof areas and feed WCs, urinals, washing machines or for outside use.
- Rainwater harvesting usually requires a major retrofit to be undertaken.
- Using outside the building results in a simpler system.

Water flow speed regulator

Rainwater harvesting from a shed roof via a pipe into a water tank

Grey water recycling

- Hotels produce large amounts of grey water (showers) with a corresponding high requirement for the recycled grey water (WC flush).
- Systems such as PontosAquaCycle can be installed in hotels. For example, the 900 model provides 640 liters of grey water a day.
- Can have a higher carbon load than using mains water.



PontosAquaCycle

Frequent problem

Bad groundwater quality, high contents in iron, or ammonia.

Suggestions for improvement

Water treatment for iron

Red-water iron can be removed in small quantities by a sediment filter, carbon filter, or water softener, but the treatment system will very quickly plug up. A more common treatment for red-water iron and clear-water iron in concentrations up to 10 or 15 mg/l is a manganese greensand filter, often referred to as an "iron filter." Aeration (injecting air) or chemical oxidation (usually adding chlorine in the form of calcium or sodium hypochlorite) followed by filtration are options if iron levels exceed 10 mg/l.

Aeration "fountain"

Ammonia

Treatment technologies and strategies to remove ammonia in drinking water include biological treatment (controlled nitrification) and physicochemical processes such as breakpoint chlorination, ion exchange, membrane filtration and air stripping.

The selection of an appropriate treatment process for a specific water supply will depend on many factors, including the characteristics of the raw water supply, the source and the concentration of ammonia, the operational conditions of the specific treatment method and the utility's treatment goal.

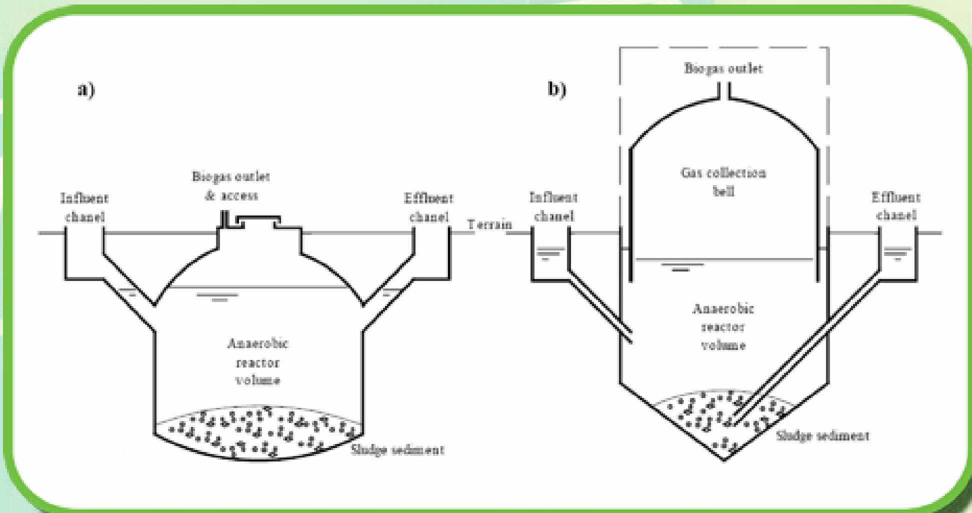
Frequent problem

High, concentrated BOD/COD in waste water.

Suggestions for improvement

Installation of anaerobic digesters to produce biogas. Biogas can be used instead of LPG.

Anaerobic digester is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.

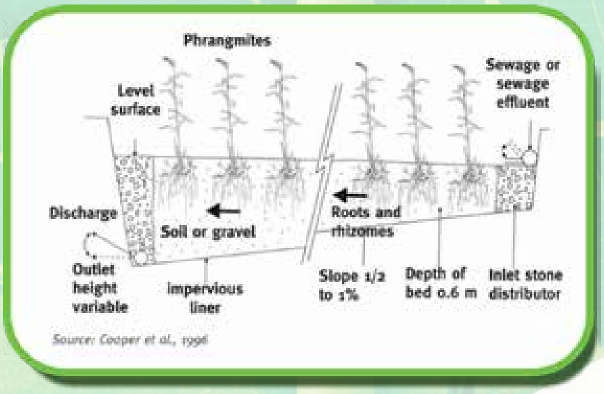


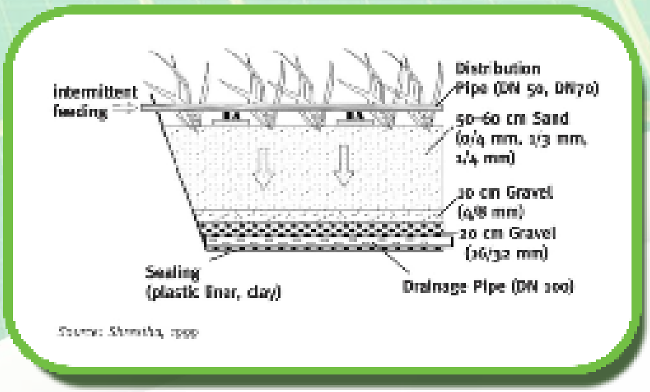
The plant in the picture is a subsidized ARTI Model biogas plant which costs 15000 NRs., can handle 3 kg waste per day.

Wetlands

Constructed Wetlands (CW) is a biological wastewater treatment technology designed to mimic processes found in natural wetland ecosystems. These systems use wetland plants, soils & their associated microorganisms to remove contaminants from wastewater.

Horizontal and vertical flow constructed wetland





The major advantages are:

- use of natural processes
  simple construction (can be constructed with local materials).
- simple operation and maintenance.
- cost-effectiveness (low construction & operation costs).
- process stability

4.4. Waste

Frequent problem

- Waste is not properly segregated or recycled & burned openly.
- Organic waste is landfilled.

Suggestions for improvement

- Place reminders/signage for guests and staff to segregate waste properly.
- Implement a solid waste management program
- Provide sufficient and appropriate containers & label them accordingly.
- Compost food wastes. You may use old pots or plastic containers or drums as composting pits.
- Consider installation of Bio-digesters to produce methane gas for cooking and fertilizer for gardening.

Frequent problem

No labelling of chemicals.

Suggestions for improvement

A Material Safety Data Sheets (MSDS) of a chemical substance contains details of the hazards associated with this specific substance and gives information on its safe use. Your chemical supplier should always include this information when delivering the chemical.

An MSDS:

- Helps you determine the effect of the chemical on end products (e.g. intended characteristics, quality, etc.).
- Allows you to determine chemical compatibility and do proper mixing.
- Gives information about proper storage and handling (e.g. ventilation).
- Enables you to prevent losses from the expiry of materials.
- Indicates appropriate security precautions and needed controls, including the use of personal protection equipment.
- Spells out emergency procedures in case of spills, fire and explosion.
- Indicates steps for first-aid.
- Specifies the hazard level, which gives clues about the possible effects on water, soil, human health
- Specifies the flashpoint (the lowest temperature at which a chemical releases flammable vapour); the lower the flashpoint, the more hazardous the chemical is as a source of fuel for fire or explosion
- Specifies the boiling point, which is used to determine volatility; the lower the boiling point, the higher the volatility 89.

- Provide information about the classification of chemicals by types of hazard and propose harmonised hazard communication elements to all employees (including maintenance workers and contractors) who may be exposed to the substances should be provided with
- GHS information and instruction chemical identification. The information should be provided in their language and make provision for employees who cannot read.

Table 11: Explanation of GHS pictograms

		
Explosives Selfreactives Organic peroxides	Flammables Selfreactives Pyrophorics Selfheating Emission of flammable gases	Oxidizers Organic peroxides
		
Gases under pressure	Corrosives	Acute toxicity (severe)
		Environment
		
Irritant Dermal sensitizer Acute toxicity (harmful)	Carcinogen Respiratory sensitizer Reproductive Target organ toxicity Mutagenicity	Environmental toxicity

Storage of chemicals in cupboard without labelling

Storage of paints and chemicals without any labelling

Frequent problem

Improper storage of chemicals

Suggestions for improvement

Safe storage of chemicals:

Proper chemical storage with strong shelves, proper separation, and drip tray

The quantities of hazardous chemicals should be kept to a minimum, commensurate with their usage & shelf life. Some chemicals degrade in storage & can become more hazardous, e.g. chloroform can produce phosgene from prolonged storage. Such chemicals should be identified and managed appropriately. Schools are encouraged to develop centralised chemical purchasing policies & monitoring systems to minimise stockholding.

Ensure chemical containers and their seals or stoppers are appropriate for the type and quantity of chemical stored. As far as is practicable, chemicals should be stored in the containers in which they are supplied.

If you repack chemicals make sure the new containers are labelled properly. All packages in storage should be labelled to allow unmistakable identification of the contents & all labels should comply with the relevant regulations. Labels should be reattached or replaced, as necessary, to clearly identify the contents of the package.

Containers that have held hazardous chemicals should be treated as full, unless the receptacle or package has been rendered free from hazardous chemicals. Do not give away empty containers to workers, neighbours, etc. If you are in doubt whether containers might leak to the outside, crush them and make them unusable.

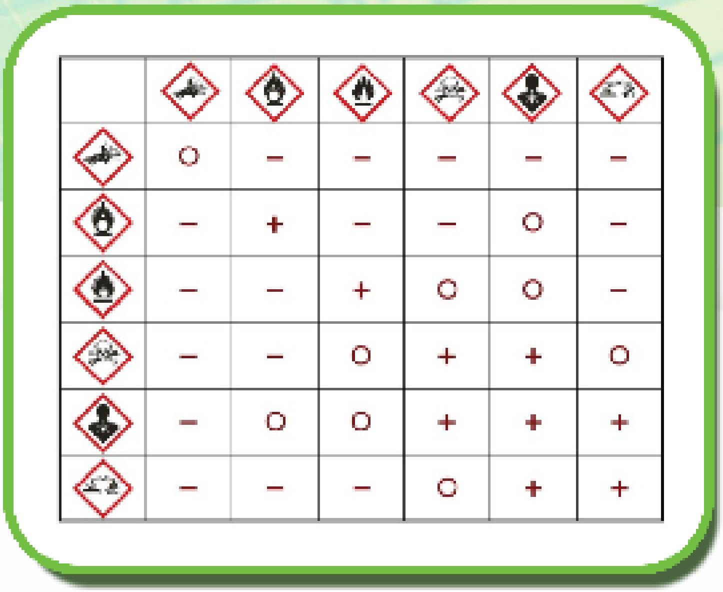
Storage of chemicals, including wastes, should be based on the properties and mutual reactivities of the chemicals. Incompatible chemicals should be kept segregated from one another, e.g. by fire isolation in a chemical storage cabinet or segregated by space. A separate spill catchment should be provided for each incompatible liquid.

Opening of packages, transferring of contents, dispensing of chemicals or sampling should not be conducted in or on top of a cabinet or a cupboard for storing chemicals unless it is specifically designed for this purpose and appropriate procedures & equipment are used.

Packages should be inspected regularly to ensure their integrity. Leaking or damaged packages should be removed to a safe area for repacking or disposal. Where flammable vapours or combustible dusts may be present as part of normal or abnormal operations, the areas should be classified properly. The relevant requirements concerning avoidance of ignition sources should be complied with in situations other than those where the ignition source is controlled and is necessary for experimental purposes, such as the use of a Bunsen burner. Electrical equipment should comply with appropriate standards. Arrange a hazard zone assessment.

Procedures should be established to deal with clean up & safe disposal of spillages. Supplies & materials needed to control the spillages should be readily accessible.

Substances that are unstable at ambient temperature should be kept in a controlled temperature environment set to maintain an appropriate temperature range. Reliable alternative safety measures should be provided for situations when utilities, such as power, fail. Substances that can present additional hazards on heating should be clearly identified. Sunlight can affect some plastic containers or the chemical contents. Containers or chemicals that can be affected should not be stored in a laboratory where they can be exposed to direct sunlight.



	O	–	–	–	–	–
	–	+	–	–	O	–
	–	–	+	O	O	–
	–	–	O	+	+	O
	–	O	O	+	+	+
	–	–	–	O	+	+

Figure 4: Safe storage key (+ Can be stored together, - Cannot be stored together, 0 Can be stored together if specific precautions are taken)

Frequent problem

Improper transport of chemicals

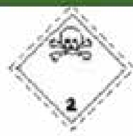
Suggestions for improvement

Transport labelling:

For transport labelling two systems exist: labelling according to the GHS and labelling according to the transport regulations. The classification criteria of the GHS are based on the UN "Recommendations on the Transport of Dangerous Goods".

Within the UN classification system for the transport of dangerous goods, products (including mixtures and solutions) and articles subject to these regulations are assigned to one of nine classes according to the hazard or the most predominant of the hazards they present. Some of these classes are subdivided into divisions.

Table 12: Transportation symbols

Explosives			
			
Class 1 Division 1.1	Class 1 Division 4	Class 1 Division 5	Class 1 Division 6
			
Flammable gases		Non-flammable non-toxic gases	Toxic gases
Class 2 Division 2.1		Class 2 Division 2.2	Class 2 Division 2.3
			
Flammable liquids		Flammable solids	Spontaneous combustion
Class 3		Class 4 Division 4.1	Class 4 Division 4.2
			
Emits flammable gases in contact with water		Oxidizing substances	Organic peroxides
Class 4 Division 4.3		Class 5 Division 5.1	Class 5 Division 5.2
			
Toxic substances	Corrosive substances		

Toxic Chemicals

Explosive Chemicals

Oxidizing and Organic Chemicals

Frequent problem

Use of toxic materials

The chemicals used in Nepali Hand made paper company

Suggestions for improvement

Substitution involves using a safer product or process. This includes exchanging the substance for one that is less harmful; using the same substance in a less hazardous form; or using the same substance in a less hazardous process.

- Safer substance: use detergent instead of chlorinated solvent for cleaning; use water-based chemicals instead of solvent-based chemicals where compatible.
- Safer form or process: paint with a brush instead of spraying; purchase a substance in a safer form (e.g. use less concentrated liquids in ready-to-use form instead of concentrates that require decanting or mixing; use pellets instead of powder that reduces the amount of dust formed).

Table 13: Replacements for commonly used toxic industrial chemicals

Chemical	Application	Replacement
Chromium VI	Decorative surfaces, corrosion protection	Chromium III, Cobalt
Lead	Soldering	Tin/silver/copper alloy
Lead	Stabiliser in plastic manufacturing	Calcium/zinc systems
Solvent based paints	Corrosion protection & decoration of surfaces	Water-based paints
Solvent degreaser	Degreasing of metal surfaces	Aqueous alkaline degreaser
R 22	Refrigerant	R 404 a, R 417 a, R 134 a
TCE	Degreasing	Modified alcohols

Frequent problem

- Improper dosage of chemicals
- High demand of chemicals

Suggestions for improvement

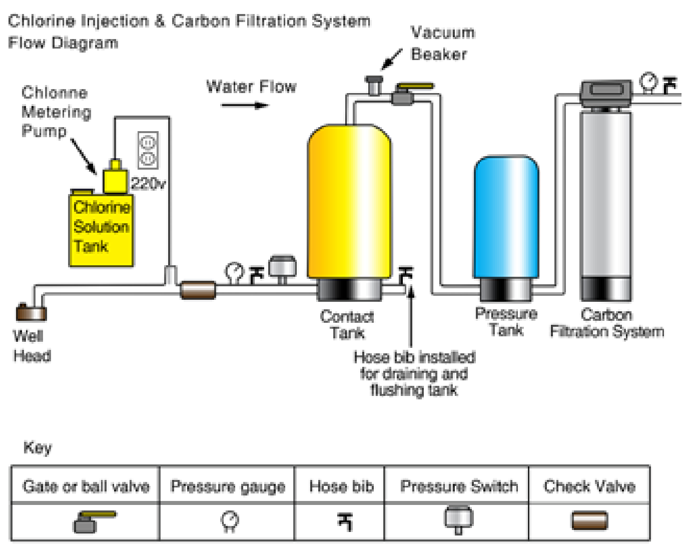
Automatic dosing system

Automatic dispensing system for cleaning soaps

Automatic dispenser for soaps for laundry machines

Advantages of an automatic dosing system:

- Eliminates detergent waste, over-soaping & theft.
- Cost savings - chemical detergents are cheaper over time compared to powders.
- Remove the need for staff to handle any chemicals or powders.
- Prevent spillage, making for a cleaner and safer environment.
- Dispense the right product at the right time
- Control of costs.



On-line chlorine dosing system for Raw Water Treatment Plant

Frequent problem

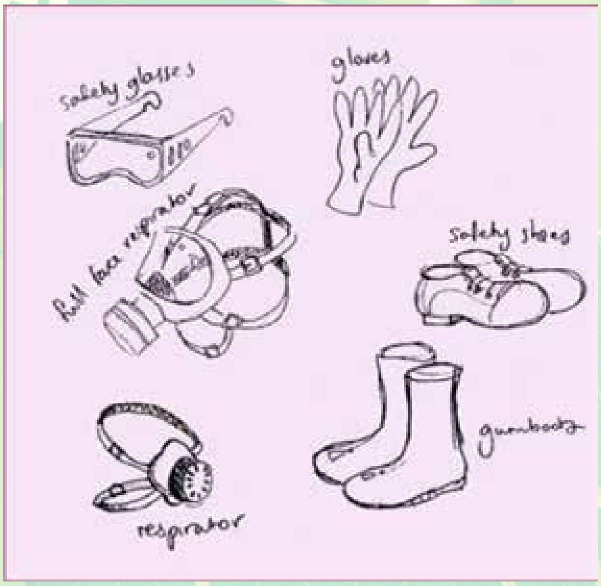
Working place hazards

Harm that can be caused to human health by chemicals includes, for example, skin irritation, respiratory problems or even cancer. In the environment, chemicals can harm animal population and disturb the natural functions of ecosystem. The risks of all kind of chemical are not assessed, information is not available and safety measures are not implemented.

Suggestions for improvement

Using pellets instead of powders and using water-based paint instead of oil-based.

Provide protective clothing and equipment for employees, supervisors and visitors. This measure should only be used if it is not practicable to use other measures, or when other measures do not adequately control exposure.



Training and information for the employees

Employees need to know how to use and store substances safely. The regulations require employers to provide information, instruction and training to employees on the hazards and risks associated with hazardous substances and dangerous goods that they use or may be exposed to. Where dangerous goods are stored or handled, other persons on site such as contractors, maintenance workers, administrative staff and visitors may also need to be given information, instruction and training on associated risks and precautions to be taken.

Frequent problem

All the dairy utensils after use contain some milk which after drying forms a thin film which encourages the bacterial growth. This film or dried milk is difficult to clean and remove in order to produce milk with low bacterial content and high keeping quality, it is absolutely necessary to clean and sterilize the utensils.

Clean and sterilize utensils used in production of milk

Suggestions for improvement

Solution: Proper cleaning in dairies

Milk readily absorbs taints from vessels which are not properly cleaned and sterilized. Unclean surface also causes biological fermentation which lowers the quality of milk. Milk often develops metallic taste from can surfaces which are not kept clean or are not coated properly with tin. Unclean cans cause unnecessary financial loss by reducing the keeping quality of milk.

The proper procedure for cleaning and sanitizing of dairy utensils is as follows:

1. Remove any residual loose milk or other solid material by rinsing the utensils with cold or lukewarm water to remove as much milk residue and other material as possible.
2. After being rinsed and drained, the utensils should be brushed with a hot detergent solution (120 0 F) to remove any remaining from lids.
3. Rinse again with hot water to remove traces of detergents and any loose material.
4. Sanitize the utensils before use either by steam or chemicals to destroy all pathogens and almost all non-pathogenic organisms.
5. Drain the utensils to prevent further bacterial growth.
6. Dry the utensils by keeping it in inverted position.
7. Do not use a cloth or towel for drying.

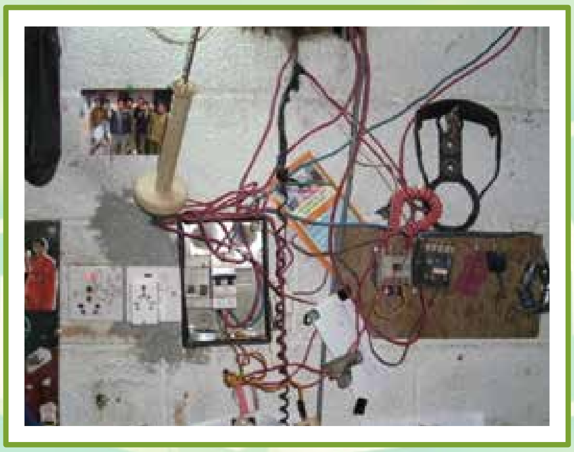
Solution: lower temperature on cooling side of pasteurization unit

Normally, the pasteurized milk must maintain temperature of 3-4 degrees centigrade but in practice upto 10 degrees centrigrade was found. Though correcting this problem increases cooling load and power consumption, it will enhance the processed milk quality.

4.6 Occupational health and safety

Frequent problem

- Improper electric installations, accidents at work involving electric shock or burns.
- Disorganized electric wiring systems which can lead to faulty wirings and accidents.
- Many if not all old structures or buildings have no available electrical plans.
- Undersized electrical wires.
- Contact with live parts, faults which could cause fires and fire or explosion where electricity was the source of ignition in a potentially flammable or explosive atmosphere.
- Damaged wires



Bad practise in electric insulation

Wire with damaged insulation can cause electric shock

Suggestions for improvement

Ensure that the electrical installation is safe:
A licensed Electrical Engineer should be consulted for line tracing & detailed electrical plan and computations. This is very significant for environmental as well as safety reasons.

- Install new electrical systems to a suitable standard and then maintain them in a safe condition.
- Existing installation should also be properly maintained.
- Provide enough socket-outlets - overloading socket-outlets by using adaptors can cause fires.
- Avoid:
  - in wet surroundings - unsuitable equipment can easily become live and can make its surroundings live.
  - out of doors - equipment may not only become wet but may be at greater risk of damage.
  - in cramped spaces with a lot of earthed metalwork, such as inside a tank or bin - if an electrical fault developed it could be very difficult to avoid a shock.

Bhutan Electrical Engineers

Frequent problem

Improper fuel storage:

- LPG (liquefied petroleum gas) cylinder tanks are often placed on the ground. LPG tanks are not fully utilized when placed lower and corrosion usually occurs on the tanks, which is dangerous.
- Fuel barrels and used oil containers are also directly placed on the soil/ground, which contaminates the ground water.

Improper fuel storage.

Suggestions for improvement

- Avoid direct contact of LPG tanks with the ground, elevate the LPG cylinders, put some under sheet/ base like plywood, plastic sheeting, etc.
- LPG should be placed outside the building or in a well ventilation area so that gaseous vapour will not accumulate.
- Ensure that the storage area is dry to avoid corrosion of the containers.
- Install bund walls around storage area of liquid chemicals, e.g. fuels, used oil, etc.

Proper storage of gas cyclinders secured to a wall or inside a metal cage

4.7 Hotels

Frequent problem

- High water consumption in Hotels because of drippy taps.
- Switched on lights in guest rooms.
- High amount of towels, bedclothes which are changed every day.

Suggestions for improvement

Use guest information like shown in the box.

Examples for guest information

5 Identification of options to increase the resource efficiency

5 Identification of option to increase the resource efficiency

5.1 Development of an action plan

There are different strategies to identify options:

- Use of manuals and checklists
- Ask equipment suppliers
- Use the creativity of the Resource Efficiency team

Resource Efficiency options can also be derived from information from suppliers who will be glad to give you information on the specific performance data for material and energy consumption of their equipment. It is valuable to divide the process of creative problem solving into four stages as shown in Figure 5:

- Problem analysis
- Idea finding
- Evaluation
- Realisation

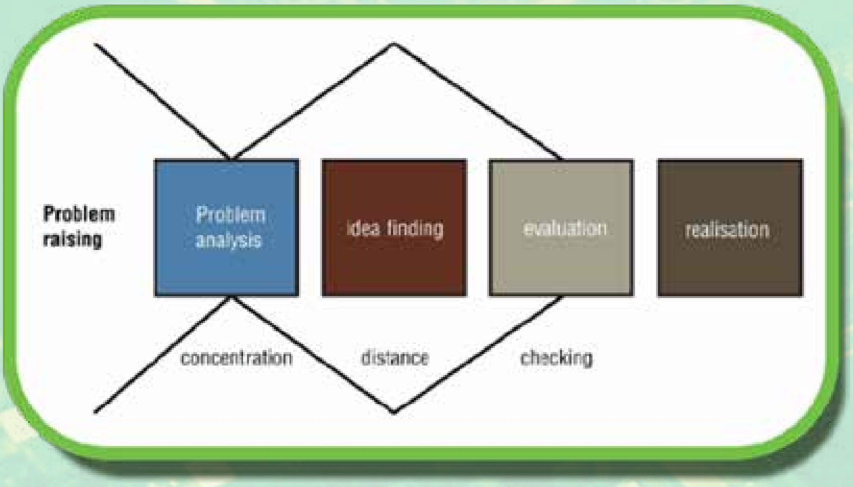


Figure 5: A Problem solving process scheme.

Figure 5: A problem solving process scheme used to direct focus during the analysis phase on setting priorities, opening the space for potential solutions during brainstorming and completing the feasibility analysis before implementing selected options.

Problem analysis

The point of this phase is to arrive at a clear description of the problem. It is here that the focus should be drawn to the actual problem; for example, what is the source of our waste and emissions? Document the boundary conditions of the problem and document the history of the problem; for example, what has been done in the past to solve the problem, what has worked, what has not worked?

Idea finding

The point of this phase is to take a step back from the problem and look at it from a bird's-eye view. Idea finding is done on an abstract level and should build on all available information. In this phase there is absolutely no criticism. The goal is to end up with as many creative ideas as possible. Idea finding is also known as brainstorming.

Evaluation

In the evaluation phase, ideas from the previous phase are evaluated one-by-one on the merits of their technical feasibility, their economic payback time and their ecological impact. After a strict evaluation, the most promising options are selected.

Realisation

In this phase, ideas selected from the process are implemented. For each activity, a team member will be assigned to follow up the process of implementation. Implementation can be straightforward, if the identified activity is, for example: to change set points or recipes, it can involve the definition of working procedures and training; it can involve the design of revamps or the selection of suppliers, a bidding procedure or the supervision of the supply.

Target/Detailed goal	Measure	Data	Deadline
Waste			
Sinter plant: Reduction of hazardous wastes from the Meros plant	Change of adsorption agent from lime hydrate to sodium hydrogen carbonate	Reduction of hazardous waste > 30%	30 Nov. 2011
Refractory engineering: Reduction in breakout material	Reduction of breakout material in torpedo ladles by lining through mouth	Reduction of breakout volume by appr. 143 tons/year	31 May 2009
Air-borne emissions			
Sinter plant: Reduction of NOx emissions	Installation of DeNOx plant	Clarification in the course of EIP2, 1/3 savings of NOx	31 Dec. 2012
Power plant: Reduction of NOx emissions	Replacement of block 06 (future standby unit) with block 07	NOx savings approx. 75 tons/year	30 June 2010 Deadline postponed because of delayed startup of block 07
Blast furnace: Reduced diffuse dust emissions	Installation of new top charging system on BF5 with significantly reduced emissions	Reduction of dust emissions by 25 tons/year	31 March 2012
Sinter plant: Reduction of NOx emissions	Installation of DeNOx trial plant	Clarification of industrial-scale plant functionality	31 Aug. 2009
Water/waste water			
Pickling tandem: Reduced waste water volume (DS water indirectly introduced to waste water cleaning plant in Asten)	Prevention of overflow of DS water in compens. tank of cooling water circulation station in cold-rolling mill 2	Reduction of waste water volume by 10 m^3/day	31 Dec. 2010
Automated monitoring of limit values for waste and cooling water	Development of a suitable IT tool	Automated reporting of entities responsible for derivation	30 June 2010 Postponed because of economic situation
Energy requirement and efficiency			
Hot-strip production: Reduced energy consumption per produced ton of hot strip	Installation of a walking beam furnace	Energy savings of 5% (based on 2006 business year)	31 Jan. 2011 Postponed by delay of walking beam furnace optimization
Power plant: Reduced energy consumption	Partial recovery of pump energy for cooling water condensation in block 07 through tubular turbine	Power recovery of 6,300 MWh/year	30 June 2010 Postponed for delay of startup of block 07
Technical utilities: Reduced electrical consumption	Power saving by supply of 8m blast furnace with low-pressure oxygen instead of oxygen with 15 bars through installation of an additional line and startup of air separation unit 10	Reduced power consumption by 8,000 MWh/year	31 Dec. 2010

Figure 6: Example for an environmental program form voestalpine Stahl GmbH.

Bottles cleaning at the Pickle Industry.

Owner with waterwaste collection tank at underground kitchen at a hotel.

5.2 Feasibility study

The feasibility studies have to prove whether each of the (non-obviously feasible) options is technically and economically feasible and whether it contributes to the environmental improvement.

Steps of a feasibility study

1st Step: preliminary evaluation

The options are ranked in order to identify additional evaluation needs. Managerial options do not always require a technical evaluation, while equipment-based options do. Similarly, simple options normally do not require an environmental evaluation, while complex options do. Finally, cheap options do not require a detailed economic evaluation, while expensive options may.

2nd Step: technical evaluation

The technical evaluation consists of two interrelated parts. First, it should be evaluated whether the options can be put in practice. This requires a check on the availability and reliability of equipment, the effect on product quality and productivity, the expected maintenance and utility requirements and the necessary operating and supervising skills. Second, the changes in the technical specifications can be converted into a projected materials balance, reflecting the input and output material flows and energy requirements after implementation of the Resource Efficient and Cleaner Production option. The options that do not need capital expenditure, e.g. housekeeping measures, can often be implemented quickly. It is a typical fast-track approach. If capital investment is needed for the chosen option, it is advisable to appoint an ad-hoc group of experts, to make a technical evaluation based on selected evaluation criteria. Raw material, equipment or process changes are expensive and may effect changes in production line or product quality. Therefore, technical evaluation of such option requires more complex investigation.

3rd Step: economic evaluation

The economic evaluation consists at least of data collection (regarding investments and operational costs, and benefits), choice between evaluation criteria and feasibility calculations. The economic data collection builds upon the results of the technical evaluation. In order to properly incorporate the long term economic advantages of Resource Efficient and Cleaner Production, it is highly recommendable to apply Total Cost Assessment principles to the economic evaluation (especially for high cost options).

4th Step: environmental evaluation

The objective of environmental evaluation is to determine the positive and negative impacts of the option for the environment. An environmental evaluation must take into account the whole life-cycle of a product or service. There are essentially two types of life-cycle analyses: quantitative and qualitative. The quantitative method involves developing a set of criteria against which the environmental impact of a product can be measured and then actually measuring it against these criteria. Criteria may be developed using parameters such as: the cost of disposal or clean-up of the wastes generated at all stages in the life-cycle; the amount or cost of energy used at all stages in the life cycle; etc. The other, qualitative approach is more useful for this assessment. It involves drawing up a matrix of environmental issues vs. life cycle stages.

5th Step: selection of feasible options

First, the technically non-feasible options and the options without a significant environmental benefit can be eliminated. All remaining options can in principle be implemented. However, a selection is required in case of competing options or in case of limited funds.

Implementation and continuation

In the last phase, the feasible prevention measures are implemented and provisions taken to ensure the on-going application of Resource Efficient and Cleaner Production. The development of such an on-going programme requires monitoring and evaluation of the results achieved by the implementation of the first group of prevention measures.

The expected result of this phase is threefold:

- Implementation of the feasible Cleaner Production measures.
- Monitoring and evaluation of the progress achieved by the implementation of the feasible options.
- Initiation of on-going resource efficient and Cleaner Production activities.

5.3 Payback time calculation

Payback period is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment. It is one of the simplest investment appraisal techniques.
The formula to calculate payback period of a project depends on whether the cash flow per period from the project is even or uneven. In case they are even, the formula to calculate payback period is:

$$\text{Payback Period} = \frac{\text{Initial Investment}}{\text{Cash Inflow per Period}}$$

Investment cost to consider

- Machine
- Installation
- Piping
- Control
- On site preparation
- Training
- Permitting

To consider in determining cash flow per period:

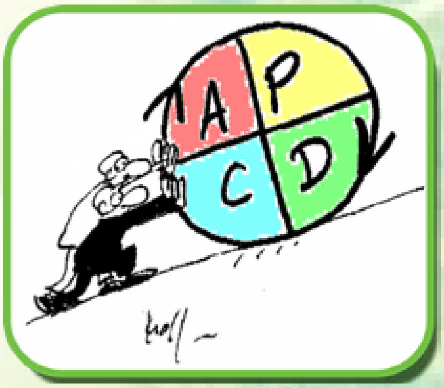
- Savings from saving water, energy, chemicals, other materials
- Maintenance costs
- Additional cost for auxiliary materials
- Spare parts
- Additional cost for energy for operation of the new installation
- Additional cleaning cost

6 Environmental Controlling

6 Environmental controlling

6.1 Plan-Do-Check-Act (PDCA)

The implementation of the Plan-Do-Check-Act (PDCA) cycle is essential for a continuous improvement of the resource efficiency of a company.



PLAN	Establish the objectives and processes necessary to deliver results in accordance with the goal or ideal state.
DO	Implement the new processes; start small if possible.
CHECK	Measure the new processes and compare the actual results against the expected results to ascertain any differences.
ACT	Analyse the differences to de termine their cause. Each will be part of either one or more of the P-D-C-A steps. Determine where to apply changes that will include improvement. When a pass through these four steps does not result in the need to improve, refine the scope to which PDCA is applied until there is a plan that involves improvement.

Figure 7: The Deming Cycle - Plan-Do-Check-Act (PDCA).

The PDCA cycle should be implemented in repeated spirals. Each cycle should converge closer to the objectives than the previous. This approach is based on the theorem that our knowledge of a system always will be limited, but will be improved through learning. It is better to start a process even with limited knowledge, start from an initial analysis and improve it stepwise by developing a hypothesis, test it and proceed according to the results of the testing.

6.2 Indicators

Indicators help to condense relevant data to provide exact and useful information about the efforts of management, the environmental impact of a company's activities or the state of the environment. Indicators are chosen as a means to present quantity or quality data or information in an understandable and useful form. This information can be provided in the form of absolute or relative, normalised or indicated information.

In most companies, indicators are already part of the planning process. Indicators can also be used in a similar way for an environmental information system to compile company data in a clearly structured way so that it is easy to interpret.

The following types of indicators can be used for controlling Resource Efficiency:

Absolute figures

Basic data: annual consumption.

Related figures

Relative figures: Consumption of energy, raw material per production unit.

Examples:

• Hotel:

- Consumption of electricity per overnight stay.
- Water consumption per overnight stay.

• Dairy:

- Consumption of energy (electricity & fuel) per litre of fresh milk.
- Volume of wastewater per kilogram of butter.

• Brewery:

- Water consumption per litre of beer produced (an example is shown in **Figure 8).**

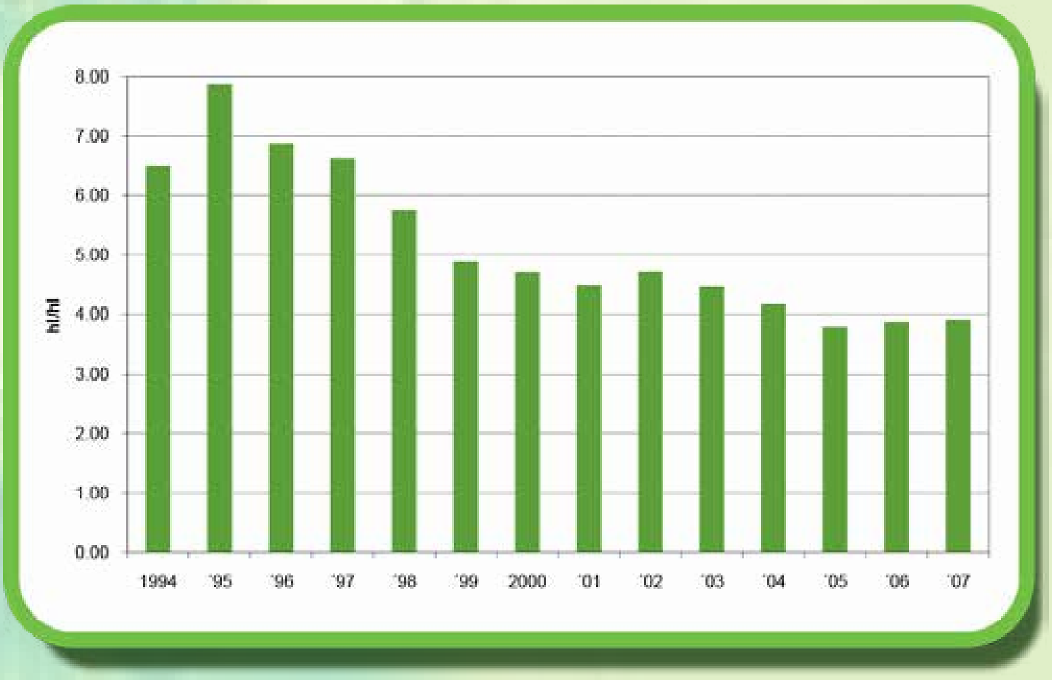


Figure 8: Specific water consumption of a brewery.

Development of indicators

For the development of specific indicators the basic data are:

• Consumption of water, raw materials, energy, chemicals, etc. in a defined period. E.g. water consumption in m³ per month.

• The amount of chemicals used in processes

• The amount of waste including all waste fractions like solid waste, glass, paper, chemicals, etc.

• Product or service in a defined period

The objective is to implement a set of indicators to guaranty the continuous improvement of the environmental performance of a company or a hotel and to monitor the effectiveness of the implemented measures, because with the measure a defined target should be reached.

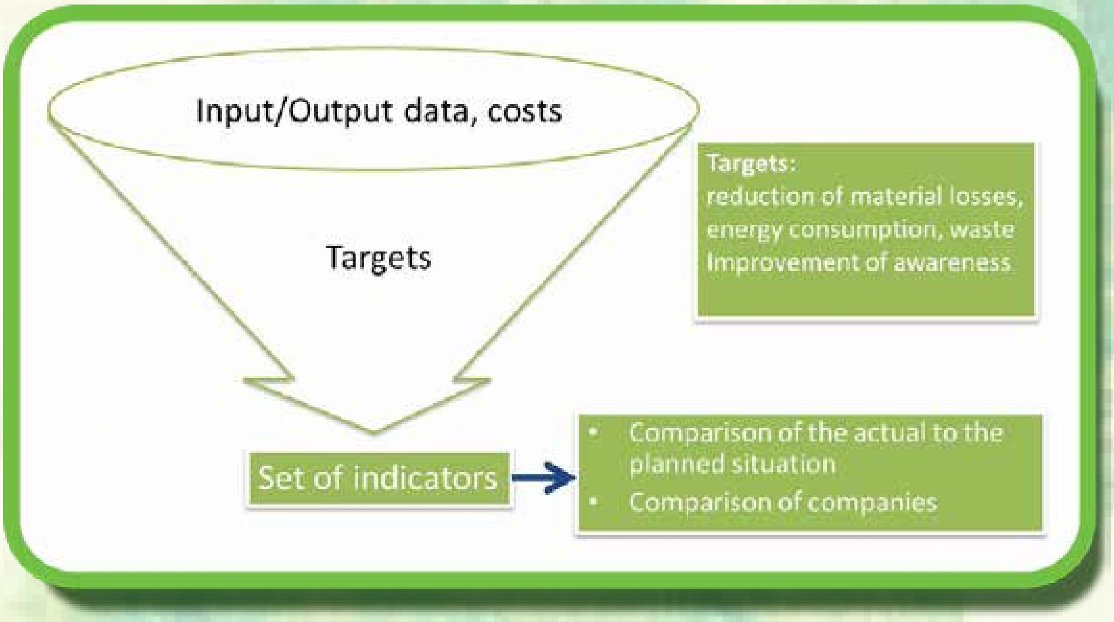
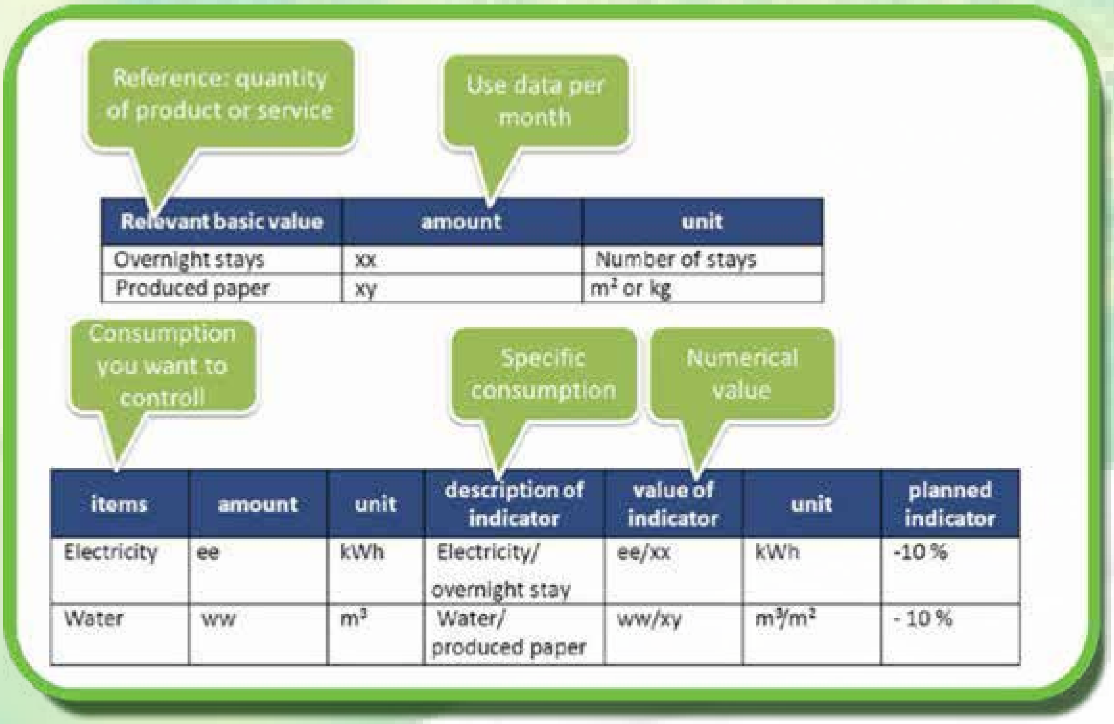


Figure 9: Development of indicators.

The indicators should be recorded and controlled regularly.



Relevant basic value	amount	unit
Overnight stays	xx	Number of stays
Produced paper	xy	m^2 or kg

items	amount	unit	description of indicator	value of indicator	unit	planned indicator
Electricity	ee	kWh	Electricity/ overnight stay	ee/xx	kWh	-10 %
Water	ww	m^3	Water/ produced paper	ww/xy	m^3/m^2	- 10 %

Figure 10: Example for a template to record indicators.

6.3 Benchmarking

Definition of benchmarking:

- A management technique to improve business performances.
- Used to compare performance between different organizations or different units within a single organizations undertaking similar processes on a continuous basis.
- Aim to document and measure a key process and then compare the resulting data with those relating to similar process in other organizations.

Benefits of benchmarking:

- Improved understanding of work flows, processes and procedures.
- Continuous improvement in work flows, processes and procedures.
- New ideas leading to continues improvement and breakthrough change.
- A view of work flows, procedures and processes in other organizations.
- Breakdown of traditional barriers between branches and management & staff.
- Improved productivity.

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