Gerlap Sida UNEP

Energy Efficiency Guide for Industry in Asia

United Nations Environment Programme
Division of Technology, Industry and Economics

FOREWORD

With its unprecedented rate of industrial growth, Asia is the main contributor to a growing global energy demand. By consequence, the region is also bearing the brunt of resulting negative economic, social and environmental impacts such as increased air and water pollution, waste disposal, floods, and climate change.

Governments across the region are formulating new policies to reduce the trend of increased energy consumption and the associated greenhouse gas emissions. They are introducing legislation to promote renewable energy use, and adopting measures to increase investments in energy efficient technologies.

But despite these worthy efforts, it is imperative that industry take concrete action now to prepare for a likely future of higher energy prices and emissions restrictions.

To help Asian industry improve energy efficiency, UNEP developed this Energy Efficiency Guide for Industry in Asia. The Guide includes a methodology to improve energy efficiency, case studies of more than 40 Asian companies in five industry sectors, technical information for different energy equipment, training materials, a contact and information database, and various other tools and information.

The Guide is the primary output of the Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific (GERIAP) project supporting Asian businesses to address climate change by becoming more energy efficient, and thereby reducing greenhouse gas emissions and costs. We encourage business leaders, policy makers, financiers and other stakeholders working with industry to use this Guide to take this effort forward.

Klaus Töpfer

Executive Director
United Nations Environment Programme

ACKNOWLEDGEMENTS

This Guide was prepared as part of the project *Greenhouse Gas Emission Reduction from Industry in Asia* (GERIAP).

Coordination and preparation

Sophie Punte, GERIAP Project Coordinator
Peter Repinski, GERIAP Project Officer
GERIAP Secretariat, United Nations Environment Programme (UNEP)
www.energyefficiencyasia.org

Special thanks to

The Swedish International Development Cooperation Agency (Sida) for the financial contribution that has made the development of this Guide possible.

The GERIAP National Focal Points for implementing the project in nine Asian countries:

Bangladesh – Institute of management Consultants Bangladesh (IMCB)
China – State Environmental Protection Administration (SEPA)
India – Indian National Cleaner Production Center (NCPC)
Indonesia – Ministry of Environment (MoE) and the Agency for the Assessment and Application of Technology (BPPT)
Mongolia – Ministry of Nature and Environment (MNE)
Philippines – Industrial Technology Development Institute (ITDI)
Sri Lanka – Small & Medium Enterprise Developers (SMED)
Thailand – Thailand Institute of Scientific and Technological Research (TISTR)
Vietnam – Vietnam Cleaner Production Center (VNCPC).

Companies that participated in the GERIAP project for testing the methodology and implementing case study options to improve energy efficiency (for list see appendix C).

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And everyone else who helped to make this project a success.

CONTENTS

Introduction to the Guide

Welcome to the Energy Efficiency Guide for Industry in Asia

This Guide has been developed for Asian companies who want to improve energy efficiency through Cleaner Production and for stakeholders who want to help them. It consists of a hard copy summary and a detailed CD-ROM version. The Guide is also available on: www.energyefficiencyasia.org.

This is the hard copy Guide summarizing what is included on the CD-ROM and website and indicates what parts have been translated into Bahasa Indonesia, Chinese, Sinhala, Thai and Vietnamese. The hard copy Guide is also available in these languages.

The Guide consists of five parts:

Where do you start?
Find out how to best use this Guide if you are a company manager, production staff, customer, supplier, government agency, financial institution, or other external organization who could facilitate energy efficiency in industry.
Part 1 is included in full in this hard copy Guide

How to become energy efficient?
A 6-step methodology to help Asian companies improve energy efficiency, reduce costs and reduce greenhouse gas emissions, based on the Cleaner Production methodology and *real practice* experience in more than 40 Asian companies.
Part 2 is included in full in this hard copy Guide

Industry sectors
Process information, energy efficiency options and company case studies for more than 40 companies in five industrial sectors: cement, chemicals, ceramics, iron & steel and pulp & paper.
This hard copy Guide gives a summary of what is included on the CD-ROM and website

Energy equipment
Technical information, energy efficiency options, case studies, and training materials for different energy equipments used by industry, such as boilers, fans and motors, and information on monitoring equipments.
This hard copy Guide gives a summary of what is included on the CD-ROM and website

Tools
Training materials, option checklists, worksheets, case studies, contact and information database and many more tools and resources to help companies improve energy efficiency. Here you can also find translated materials in Bahasa Indonesia, Chinese, Sinhala, Thai and Vietnamese
This hard copy Guide gives a summary of what is included on the CD-ROM and website

The Guide was developed as part of the GERIAP project, which is explained next.

The GERIAP project

Climate change is a serious risk facing industry in Asia and the Pacific. Every company will directly or indirectly be impacted by the Kyoto Protocol, rising fuel prices, energy shortages, extreme weather events and government energy policies.

There is one thing all companies can do to be prepared: improve energy efficiency now!

Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific (GERIAP) is a three-year project assisting Asian companies to become more energy and cost efficient through Cleaner Production (CP). CP is a strategy that prevents wastes and emissions and can assist companies to improve energy efficiency, reduce greenhouse gas (GHG) emissions and reduce costs.

More than 40 companies from the cement, chemicals, ceramics, iron & steel and pulp & paper sectors participate in the project in nine Asian countries: Bangladesh, China, India, Indonesia, Mongolia, Philippines, Sri Lanka, Thailand and Vietnam.

The project components included:

- Capacity building: National Focal Points (NFPs) and participating companies received training on how to apply CP to identify energy efficiency options for main energy uses in industry
- Demonstration of CP and energy efficiency: CP assessments to find ways to improve energy efficiency were carried out at the participating companies. Options that were technically feasibly, financially attractive and reduced energy and GHG emissions were implemented, resulting in sector specific case studies.
- Survey of barriers to energy efficiency: Why do some companies improve energy efficiency and others not? A survey assessed the financial, technical, cultural and other factors affecting businesses, resulting in proposed solutions to overcome the most important regional and national barriers in Asia.

This Guide is the main output of the GERIAP project.

GERIAP project partners

The project is coordinated by the GERIAP Secretariat of the United Nations Environment Programme (UNEP), funded by the Swedish International Development Cooperation Agency (Sida), and implemented in the nine countries through National Focal Points (NFPs). NFPs are institutions or government agencies with CP and energy efficiency experience. Their role is to implement the three project components in the nine GERIAP countries and provide input into the Guide.

Each of the project partners is briefly described below.

United Nations Environment Programme (UNEP)

UNEP is the environmental arm of the United Nations. Its headquarters are in Nairobi and regional offices exist in each continent. UNEP's mission is "To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."
UNEP comprises a number of divisions, including the Division for Technology, Industry and Economics (DTIE). The GERIAP project is coordinated through the DTIE division within the UNEP Regional Office for Asia and the Pacific (ROAP) in Bangkok. This includes training of NFPs, facilitating the implementation of the three project components in nine countries, and developing the Guide and coordinating the Guide's launch.

Contact:
GERIAP Secretariat
United Nations Environment Programme (UNEP)
UN Building, Rajadamnern Avenue
Bangkok 10200, Thailand
www.energyefficiencyasia.org

Sophie Punte
GERIAP Project Coordinator
Tel: +66 2 288 1898
Fax: +66 2 288 3829
punte@un.org

Peter Repinski
GERIAP Project Officer
peter.repinski@rona.unep.org

Swedish International Development Cooperation Agency (Sida)

Sida is the Swedish government agency for bilateral international development cooperation. Sida's overall goal is to raise the standard of living of poor people in the world. The Swedish Parliament has adopted the following six specific objectives to achieve this overall goal:

- Economic growth
- Economic and political independence
- Economic and social equality
- Democratic development in society
- The long-term sustainable use of natural resources and protection of the environment
- Equality between men and women

Sida is the main fund provider for the GERIAP project.

105 25 Stockholm
Sweden
Tel: +46 8 698 5000
Fax: +46 8 208 864
www.sida.se

Bangladesh - Institute of Management Consultants Bangladesh (IMCB)

The IMCB is a non-profit organization and recognized by the Ministry of Commerce, Government of the Peoples' Republic of Bangladesh as the sole professional body representing management consultants in Bangladesh. Its aim is to standardize management consultancy services in Bangladesh through its Code of Professional Conducts. IMCB is a member of the world apex body, International Council of Management Consulting Institutes (ICMCI) in the US, and it has Special Consultative Status with the United Nations Economic and Social Council (ECOSOC).

Contact:
Mr. M Saidul Haq
President, IMCB
396 New Eskaton Road
P .O. Box 7092, Dhaka 1000, Bangladesh
Tel: +880 2 935 1321
Fax: +880 2 935 1103/ 933 6478
E-mail: imcb@consultant.com
www.imcbangladesh.net

China – State Environmental Protection Administration (SEPA)

The State Environmental Protection Administration of China (SEPA) is the designated authority for environmental protection under the State Council of China. SEPA applies the principle of natural ecological conservation and environmental pollution prevention and has as main tasks: strengthening supervision on nuclear safety; enhancing environmental legislative enforcement, supervision and administration; applying people-oriented principles; safeguarding the environmental rights and benefits of the public, and promoting sustainable development of society, economy and the environment. SEPA is also responsible for the administrating and cooperation of international cooperation and exchange activities on the environment. The Department of International Cooperation (DIC/ SEPA), which is in charge of international environment cooperation, is China's focal point for the GERIAP project.

Contact:
Ms. Wang Qian
Deputy Director
Division of International Organizations
Department of International Cooperation
State Environmental Protection Administration (SEPA)
No. 115 Xizhimennei Nanxiaojie (4th floor),
Beijing 100035, The People's Republic of China
Tel: +86 10 6655 6518
Fax: +86 10 6655 6494/ 6655 6513
E-mail: wangqian@sepa.gov.cn
www.zhb.gov.cn/english/SEPA/

India - National Cleaner Production Center (NCPC)

UNIDO/UNEP selected the National Productivity Council of India to locate the National Cleaner Production Center (NCPC) in India. The NCPC's mission is to demonstrate the Cleaner Production concept in Indian industries, particularly small scale industries through

- Conducting Demonstration Projects
- Conducting training programmes/workshops
- Disseminating information on Cleaner Production
- Undertaking policy level intervention

Contact:
Dr. P.K. Gupta, Director NCPC
National Productivity Council (NPC)/ National Cleaner Production Center (NCPC)
5-6 Institutional Area, Lodi Road
New Delhi 110 003, India
Tel: +91 11 462 5013 / 461 1243
Fax: +91-11 462 5013
E-mail: ncpc@del2.vsnl.net.in
www.npcindia.org/cleaner.htm#establishment

Indonesia - Ministry of Environment (MoE)

The Ministry of Environment is a government institution responsible for promoting the protection of the environment in Indonesia. The Deputy Minister for Environmental Conservation is responsible for policy development and coordination of environmental conservation activities, and serves as the National Focal Point to the UNFCCC. In implementing the GERIAP project, the Ministry of Environment works in close cooperation with the Department of Energy and Mineral Resources, which has launched the Green Energy Policy. The Ministry is responsible for the overall coordination of GERIAP in Indonesia.

Contact:
Mr. Sudariyono, Deputy Minister for Environmental Conservation
State Ministry of Environment
Jalan Dl. Panjaitan, Kav 24
Kebon Nanas
Jakarta Timur 13410, Indonesia
Tel: +62 21 858 0111
Fax: +62 21 858 0112
E-mail: sudariyono@menlh.go.id
www.menlh.go.id/eng/

Indonesia - the Agency for the Assessment and Application of Technology (BPPT)

BPPT is a Non-Department Government Agency, which reports to the President of Indonesia. Within BPPT there is the Assessment and Application of Environmental Technology Center, which has a vision "to be a provider of environmental technology needed by the community in order to support a national sustainable development programme." To achieve this, the Center works on the assessment, application, coordination and preparation of national policies on technologies in the area of (1) environmental pollution control (2) environmental conservation and rehabilitation and (3) environmental design, simulation and standardization. The Center also provides monitoring and training services on environmental technologies to improve innovation, diffusion, dissemination, capacity building and transfer of technology. BPPT is responsible for the implementation of GERIAP in Indonesia.

Contact:
Dr. Ir. Tusy A. Adibroto, Msi, Director
BPPT Agency for the Assessment and Application of Technology
BPPT II Bld. 20nd Floor, JI.M.H. Thamrin No.8
Jakarta 10340, Indonesia
Tel: +62 21 316 9762
Fax: +62 21 316 9760
E-mail: tusyaa@ceo.bppt.go.id
www.bppt.go.id

Mongolia - Ministry of Nature and Environment (MNE)

The Ministry of Nature and Environment (MNE) of Mongolia is responsible for the formulation and promotion of environmental policies, laws, procedure, conventions etc. It has a high level sectoral mandate to ensure the environmental concerns are incorporated in all growth and development oriented projects and programmes in the country.

Contact:
Ms. Batsukh, Director
International Cooperation Department
Government Building 3
Baga Toiruu 44
Ulaanbaatar 11, Mongolia
Tel: +976 99 119 200
Fax: +976 11 321 401
E-mail: mne@magicnet.mn

Philippines - Industrial Technology Development Institute (ITDI)

The mission of ITDI is to support sustainable development in the Philippines by supporting cleaner and more efficient production technologies and techniques. Mandated to render a variety of services to local industries, ITDI is multidisciplinary with a unique blend of scientific disciplines linking the institute as an active partner in the country's industrialization programme. ITDI plays a vital role in providing tests and analytical services needed by government agencies and industries in the discharge of their functions and by industries for product and raw material evaluation/testing.

Contact:
Dr. Alice Herrera
Officer In Charge, Fuel & Energy Division
Industrial Technology Development Institute
DOST Compound, Bicutan, Taguig
Metro Manila, Philippines
Tel: +63 2 837 2071
Fax: +63 2 837 2071
E-mail: abherrera@pacific.net.ph, aherrera@dost.gov.ph
http://mis.dost.gov.ph/itdi/

Sri Lanka - Small & Medium Enterprise Developers (SMED)

SMED was established in 1989 as a joint collaboration project of the Federation of Chambers of Commerce and Industry of Sri Lanka (FCCISL) and Friedrich Naumann Stiftung (FNSt) of Germany to develop and promote the SME sector in Sri Lanka. SMED's mission is to assist businesses to be competitive, socially responsible and environmentally friendly by providing demand driven, effective and high standard professional services to achieve sustainable growth and development. SMED is concentrating heavily on issues related to Cleaner Production, environmental management, climate change and the "Triple Bottom Line". SMED works very closely with Sri Lanka's chambers of commerce, industry, government and non-governmental organizations, academia and relevant international organizations.

Contact:
Mr. Nihal Cooray
Manager, Environmental and Industrial Engineering
Small & Medium Enterprise Developers (SMED)
Level 4, No. 53, Vauxhall Lane
Colombo 02, Sri Lanka
Tel: +94 11 230 4287-89
Fax: +94 11 230 4291
E-mail: geriapsl@sltnet.lk
www.smed.lk

Thailand - Thailand Institute of Scientific and Technological Research (TISTR)

TISTR's mission is to conduct research and development programmes that help solve the problems of industries and rural communities, to transfer technology to small and medium enterprises and to render scientific and technological services to industries to help increase productivity and develop export potential. Cleaner Production, renewable energy, and efficient use of energy also the focus of environmental research & development programmes at TISTR.

Contact:
Ms. Peesamai Jenvanitpanjakul
Director of Environmental, Ecological and Energy Department
Thailand Institute of Scientific and Technological Research (TISTR)
196 Phahonyotin Road, Chatuchak
Bangkok 10900, Thailand
Tel: +66 2 579 6517
Fax: +66 2 561 4771
E-mail: peesamai@tistr.or.th
www.tistr.or.th

Vietnam - Vietnam Cleaner Production Center (VNCPC)

The Vietnam Cleaner Production Center (VNCPC) is a national focal point for the promotion and implementation of eco-efficient industrial production through Cleaner Production including Cleaner Technology. The VNCPC delivers mainly to service providers and to industries high quality services such as Cleaner Production assessments, financial engineering, technology advice, training and information. The objective of VNCPC is to contribute to sustainable industrial development in Vietnam.

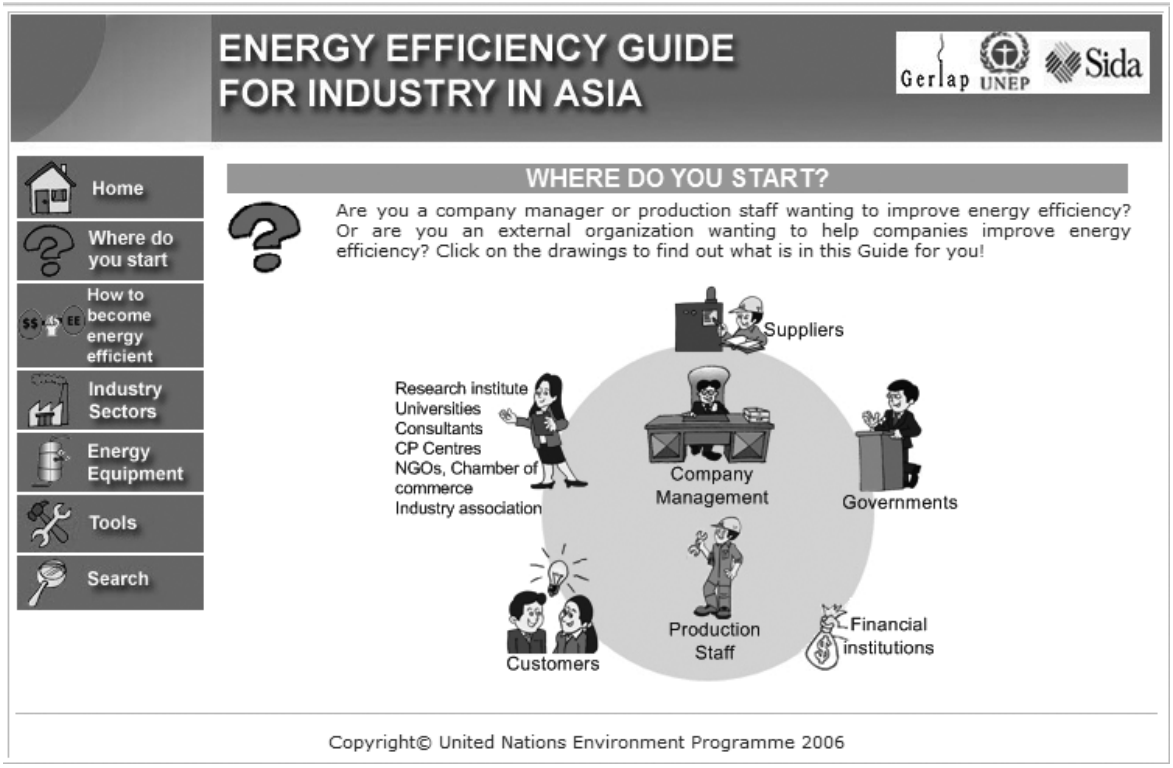
Contact:
Dr. Tran van Nahn
Director VNCPC
Vietnam Cleaner Production Center (VNCPC)
Hi-tech Building
Dai Co Viet Road
Hanoi, Vietnam
Tel: +84 4 868 1686-7
Fax: +84 4 868 1618
E-mail: VNCPC@vncpc.org
www.un.org.vn/vncpc/

PART 1
WHERE DO YOU START?

Part 1: Where do you start?

Are you a company manager or production staff wanting to improve energy efficiency? Or are you an external organization wanting to help companies improve energy efficiency? Find out below how to best use this Guide!

When you go to the "where do you start" part on the CD-ROM or website the following screen will appear:



Company management

As a company director, top manager or middle manager, you are always looking for ways to improve your company's performance.

Improved energy efficiency can help your company:

- Reduce energy and production costs
- Improve environmental performance and reduce greenhouse gas emissions
- Reduce exposure to rising energy prices and energy shortages
- Win new customers who consider environment as an important selection criteria

The most useful information in this Guide for you is:

- A *Company Energy Efficiency Methodology* that explains in six steps how to become more energyefficient (see part 2)
- Case studies of more than 40 other companies that have already benefited from energy efficiency initiatives (see part 5)

- A Contact Database with useful contacts of people and organizations who can help you improveenergy efficiency, such as suppliers, consultants, research institutions, CP centers, associations and government agencies (see www.energyefficiencyasia.org).

Where do you start?

- Organize a meeting between management and relevant staff to start an energy assessment of your company (see part 2, step 1 of the methodology)
- Start rewarding and recognizing staff for good ideas to improve energy efficiency
- Give this Guide to your production staff
- Add your contact details to the Contact Database (www.energyefficiencyasia.org)

Production staff

You can be a boiler operator, maintenance staff, mechanical or electrical engineer. As production staff you can do a lot to help your company improve energy efficiency. This will also help you to:

- Get recognized by management and strengthen your job security!
- Develop skills that are wanted by your company but also desirable by other companies
- Improve occupational health and safety conditions at your workplace

The most useful information in this Guide for you is:

- Technical information and training materials for energy equipment and your industry sector (see part 3 and 4)
- Case studies of energy options implemented by other companies for energy equipment you work with and for your industry sector (see part 5)
- Option checklists and worksheets for different energy equipments to help you identify options to improve your company's energy efficiency (see part 4)

Where do you start?

- Find out how much energy is used in your work area
- Talk with your manager and co-workers about energy efficiency opportunities in your work area
- Carry out a systematic search for energy saving options in your work area

Government

Many national, provincial or local government agencies responsible for industry, environment, energy or the economy, have an interest in energy conservation.

As a government agency, developing awareness and promoting energy efficiency in industry can:

- Improve the financial viability of your country's industry sectors because they spend less money on energy
- Reduce your dependence on foreign energy supply (especially oil), and reduce the burden on your country's GDP
- Reduce your country's greenhouse gas emissions as part of addressing climate change

The most useful information in this Guide for you is:
- An *Energy Efficiency Survey* with regional and national barriers to energy efficiency also recommending solutions that can be incorporated in government policies (see part 5)
- Energy efficiency case studies from various companies in the Asia and Pacific region (see part 5)
- An Information Database with information about the GERIAP project and other projects (see part 5)
- A Contact Database with contact details of organizations in your country who can help facilitate the implementation of government energy policies and projects

Where do you start?
- Facilitate the dissemination of this Guide among industry and organizations influencing industry
- Develop policies that encourage energy efficiency in industry with the message that energy efficiency is good for business as well as the environment
- Align energy policies with economic policies and environmental policies
- Add your contact details to the Contact Database (www.energyefficiencyasia.org)

Facilitators

Companies cannot improve energy efficiency on their own. Several types of organizations can act as facilitators to help companies, such as industry associations, research institutes, consultants, Cleaner Production Centers, universities, chambers of commerce and NGOs.

By helping companies to improve energy efficiency you can:
- Help industry reduce costs and exposure to rising energy prices
- Develop useful skills and experience within your organization and as an individual
- Contribute to an improved environment through reduced greenhouse gas emissions

This Guide gives you all the information you need to help facilitate energy efficiency in industry. The most useful information for you is:
- A *Company Energy Efficiency Methodology* that explains in six steps how to become more energy efficient (see part 2)
- Training materials (textbook chapters and presentation slides) covering the methodology, energy equipment, monitoring equipment and different industry sectors (see part 5)
- Other tools such as case studies from more than 40 companies, guidance on how to finance options, and a Contact and Information Database (see part 5)

Where do you start?
- Get to know the Guide and find out how to help industry improve energy efficiency
- Identify interested companies and organize a training course for industry using the training materials in the Guide
- Meet with company management to raise awareness about energy efficiency, get them interested in an energy assessment, and explain how you can assist them with this using the *Company Energy Efficiency Methodology*
- Get companies in touch with other organizations for areas where you are unable to help, such as financial institutions, suppliers, and chambers of commerce, using the Contact Database
- Add your contact details to the Contact Database (www.energyefficiencyasia.org)

Financial institutions

Companies often turn to financial institutions to help fund large projects, mostly commercial banks and sometimes Energy Service Companies (ESCOs) if these exist in the country. As a financial institution, by investing in companies to help improve energy efficiency you can:

- Help improve the financial viability and credit-worthiness of the companies who will continue to be your clients in the future
- Get greater returns on investment as energy projects, such a cogeneration, are often very profitable
- Expand your financial product portfolio and therefore expand your client base
- Improve your public image as a financial institution that also takes steps to protect the environment

The most useful information in this Guide for you is:

- An overview of tools for companies and investors regarding financing of energy efficiency and cleaner production projects (see part 5)
- Energy efficiency case studies from various companies in the Asia and Pacific region to see what type of projects exist, the investments required and returns (see part 5)
- A Contact Database with other financial institutions and other organizations (e.g. government agencies, suppliers) that finance energy projects (see part 5)

Where do you start?

- Get to know the tools and case studies in the Guide to determine the potential of investing in energy efficiency projects
- Inform companies about existing financing packages
- Assist companies to make proposals for energy efficiency projects bankable
- Expand investment evaluation criteria to include energy and environmental considerations
- Develop new financial products that consider energy, greenhouse gas emissions and the environment in general
- Add your contact details to the Contact Database (www.energyefficiencyasia.org)

Customers

Customers of industrial companies can be other manufacturers (e.g. car manufacturers buying steel), wholesalers (e.g. a wholesaler buying paper to sell to retailers), retailers (e.g. a household store buying ceramic products to sell in its stores) or end users (e.g. construction companies buying cement).

As a customer, by encouraging your suppliers to improve energy efficiency you can:

- Reduce purchase costs as energy cost savings can be incorporated in the price of the goods you buy
- Protect and improve your reputation through improved environmental management of your suppliers

The most useful information in this Guide for you is:

- A *Company Energy Efficiency Methodology* that can help your suppliers become more energy efficient (see part 2)
- Case studies for more than 40 other companies that have already benefited from energy efficiency initiatives (see part 5)
- A Contact Database with useful contacts of people and organizations who can help your suppliers improve energy efficiency, such as consultants, research institutions, CP centers, associations and government agencies (see part 5 and www.energyefficiencyasia.org)

Where do you start?

- Bring the Guide to the attention of the management of your suppliers
- Include environmental and energy considerations into your purchasing policy
- Ask your suppliers what component of price of their goods is energy costs, and what they are doing to be more energy efficient

Suppliers

Companies have many suppliers who provide them with various goods and services such as raw materials, energy, equipments, packaging materials, maintenance services, and transport. The GERIAP project found that poor quality goods and services are often the cause of high energy costs. Examples include poor quality coal, cheap but inefficient boilers and poor management of air compressors by contractors.

As a supplier, by helping your industrial customers to improve energy efficiency you:

- Are more likely to keep customers in the long term because you save them money
- Make it easier to promote yourself with new or potential customers
- Can ask higher prices for your products and services because your customers will earn the cost back through improved energy efficiency

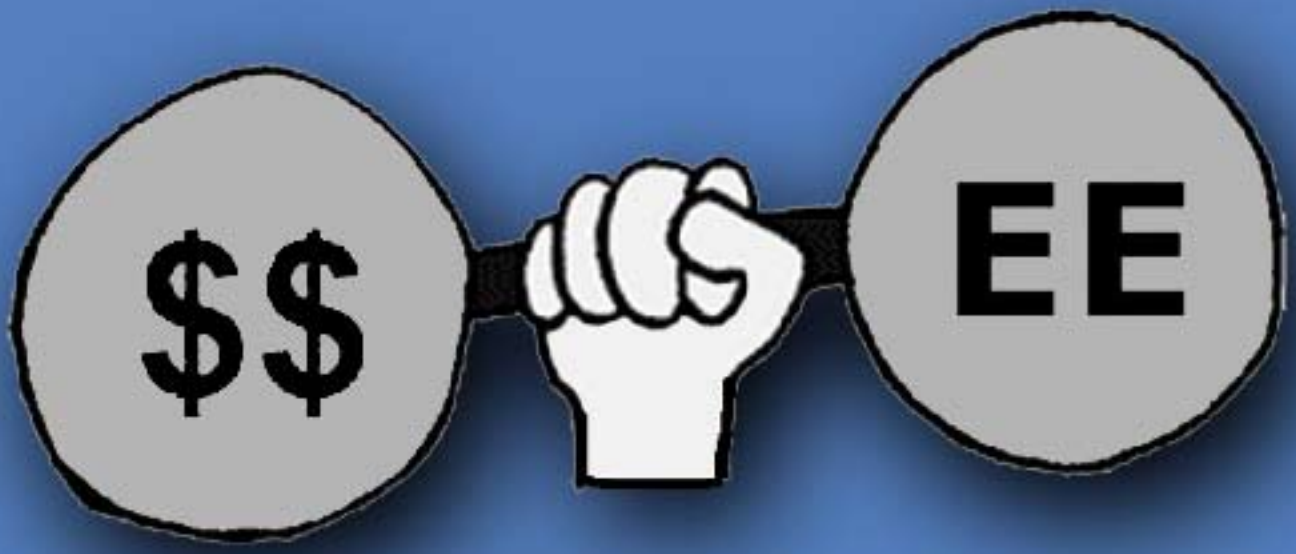
The most useful information in this Guide for you is:

- Technical information and training materials for energy equipment used by companies and for industry sectors (see part 3 and 4)
- Case studies for more than 40 companies, giving examples on how you can help your customers improve energy efficiency (see part 5)
- A Contact Database with contacts of companies and organizations who influence them (such as industry associations, consultants, research institutions, CP centers, and government agencies) who you can approach (see part 5 and www.energyefficiencyasia.org).

Where do you start?

- Add your contact details to the Contact Database (www.energyefficiencyasia.org)
- Bring the Guide to the attention of your customers and within your own organization
- Meet with company management to raise awareness about energy efficiency, and explain how you can help them to improve energy efficiency through your products and services

PART 2
HOW TO BECOME ENERGY EFFICIENT



Part 2: How to become energy efficient

This part provides a 6-step methodology to help Asian companies improve energy efficiency, reduce costs and reduce greenhouse gas emissions, based on *real practice* experience in more than 40 Asian companies.

Part 2 is included in full in this hard copy Guide

Introduction

The "Company Energy Efficiency Methodology" (Methodology) has been developed for ***Asian industrial companies*** to help them ***improve energy efficiency*** through Cleaner Production.

Energy efficiency can help companies to:
- Reduce energy and production costs
- Improve environmental performance and reduce greenhouse gas emissions
- Reduce exposure to rising energy prices and energy shortages
- Win new customers who consider environment as an important selection criteria
- Improve productivity and product quality
- Improve reputation with customers, government and public
- Improve staff health, safety and morale
- Improve compliance with legislation and ISO 14001 targets

This Methodology has been developed because it:
- Is tailored to energy-intensive industrial companies in developing Asian countries, which in many ways are different from companies in industrialized and Western countries
- Focuses on energy, which is less visible than waste, water and raw materials
- Explains not only what should be done in theory, but also how it is done in practice because all companies are different. A focus is therefore given on how to overcome barriers such as time limitations and lack of data, and on practical company examples

This Methodology is based on:
- The Cleaner Production (CP) strategy: prevention of waste, systematic approach, integrated into business processes and aimed at continuous improvement
- Several existing CP and energy audit methodologies
- ***Real practice*** experience from energy assessments carried out as part of the GERIAP project in more than 40 Asian industrial companies

How to use the Methodology

Companies can improve their energy efficiency through a ***6-step Cleaner Production approach*** (see Figure 1). On the CD-ROM and website, you can click on each step to see the purpose, output and estimated time required for the step. You can also download all steps as a pdf file or download training materials.

Under each step there are several ***tasks***. Each task describes what a company should do as a minimum. On the CD-ROM and website, arrows on the right provide more detailed information:
- Company examples that explain how the task was applied at different companies and lessons learnt (Appendix A)
- Worksheets to assist you in completing the task, and which are editable and printable (Appendix B) Remember: the ultimate purpose is to keep improving energy efficiency, and this methodology

can help companies do this. But the methodology should be applied flexibly and depending on the company's situation, because ***each company is different***: country, sector, size, organizational structure, production processes, existing energy management systems, and so on.

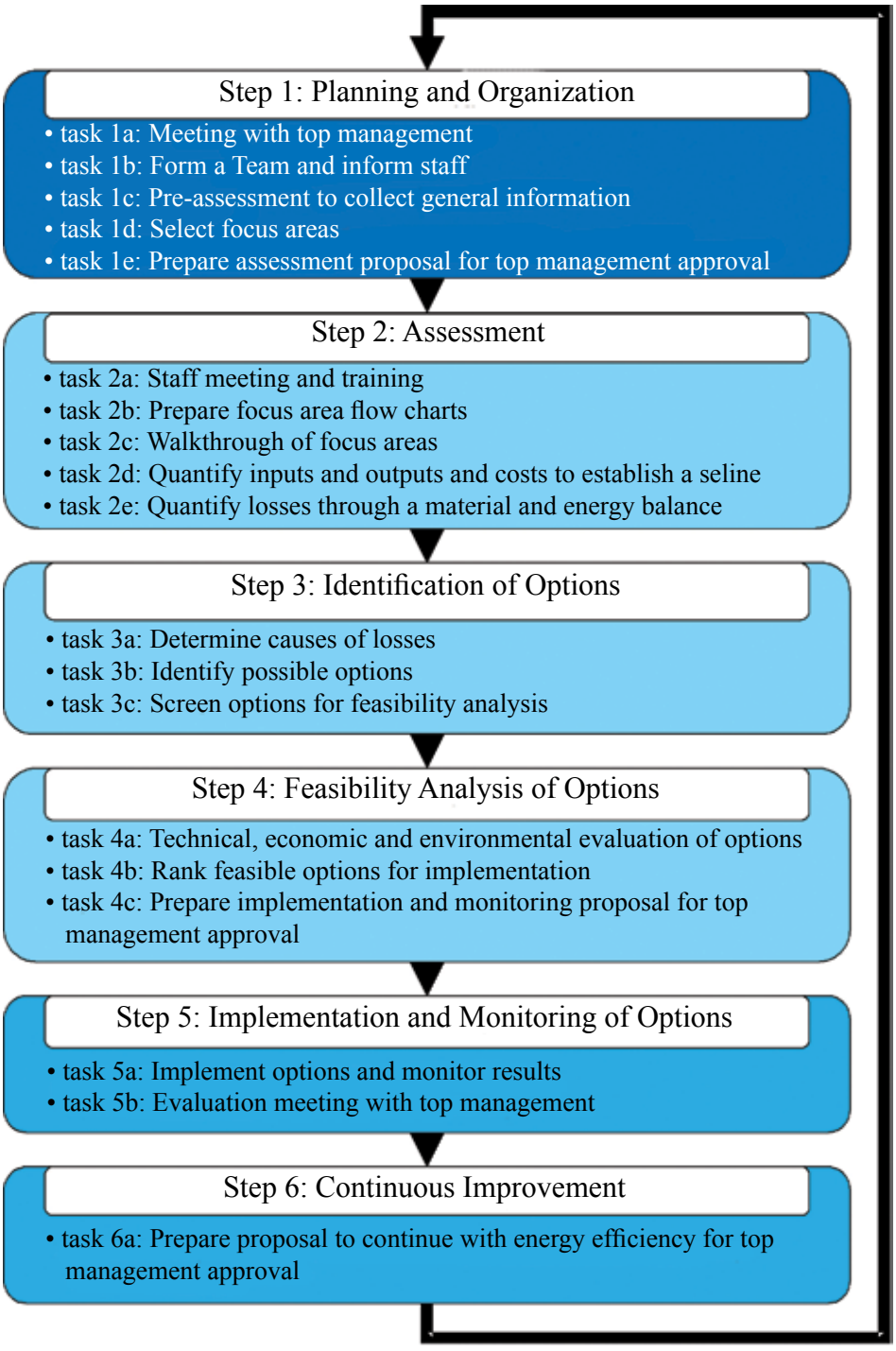


Figure 1: Company Energy Efficiency Methodology

Step 1 - Planning and Organization

The ***purpose*** of step 1 is to obtain top management commitment and plan and organize an energy assessment. Without an approved plan, there is no commitment!

The ***output*** of step 1 is therefore a written proposal with selected steps and tasks to improve the company's energy efficiency that is approved by top management. An approved plan will make steps 2 to 6 a lot easier!

Step 1 should take about 3 – 6 days. Tasks under step 1 and the estimated time needed include:*

- Task 1a: Meeting with top management (1-2 hours)
- Task 1b: Form a Team and inform staff (0.5-1 day)
- Task 1c: Pre-assessment to collect general information (1-3 days)
- Task 1d: Select focus areas (0.5-1 day)
- Task 1e: Prepare assessment proposal for top management approval (2-3 days)

*Note: the amount of time depends on, for example, the size of the plant, the number of people involved and the amount of information available.

How you start depends on who you are. If you are:

- ***Top management*** of a company interested in improving energy efficiency, then you should identify which managers and staff members are needed to get a project started, and ask them to attend a first meeting with you. You can also ask an external facilitator to attend the meeting
- ***Middle management*** (e.g. Production Manager, Environment Manager) and not part of top management, then you should request top management for a meeting and invite other managers and staff who are needed to get a project started to attend. You can also ask an external facilitator to attend the meeting
- ***An external facilitator*** (e.g. consultant, CP Centre, research institute) with an interest in getting the company to improve its energy efficiency, then you should request top management for a meeting (or ask a company manager to organize a meeting for you). You can also ask for company managers who are needed to get a project started to attend the meeting

1a. Meeting with top management

If you are top management, then the purpose of this first meeting is to get the commitment of company middle managers, staff and/or external facilitators to carry out a pre-assessment and write a proposal for a detailed energy assessment.

If you are a company middle manager or external facilitator then the purpose of this first meeting is to get top management's approval for a pre-assessment and writing of a proposal for a detailed energy assessment.

At this 1-2 hour meeting discuss the following:

- If and/or why top management is interested in improving the company's energy efficiency (see Worksheet 1 for a list of possible reasons)
- Any energy areas of interest or concern
- Where the company is right now with energy management (fill out the Energy Management Matrix in Worksheet 2)
- Other factors that will influence the approach to improving energy efficiency (see Worksheet 3)
- The amount of time needed to conduct a pre-assessment (normally 1-3 days) and write a proposal (normally 2-3 days) and deadlines
- Who should be in the Team and who from top management will be the main contact for the Team (see task 1b)

- How staff will be informed to ensure their assistance during the pre-assessment (see task 1b)

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the meeting with top management.
- Worksheets (Worksheet 1, 2 and 3, See Appendix B)

1b. Form a Team and inform staff

A Team of 4 - 6 people should be formed. In practice, the Team is often formed at the meeting with top management.

The Team normally includes (but can be expanded when the focus areas have been selected):
- Someone who knows the main energy uses and environmental impacts of the company, e.g. the Environment Manager or Energy Manager
- Someone who knows the production process, e.g. the Head of Production
- Someone with access to general company information and energy cost data, e.g. the company's Accountant or Finance Manager
- A communications or training person, especially if management have identified staff training as one of their objectives
- A top management representative who normally is not part of the Team's day-to-day work

The company may decide to also include an external facilitator (consultant or service provider) in the Team for the pre-assessment and writing of the proposal, especially if he/she/they are needed for the assessment later.

The Team holds a half-day first meeting to agree on each member's roles (see Worksheet 4) how and when to carry out the pre-assessment (task 1c), select focus areas (task 1d), and write a proposal for management (task 1e).

In addition, the Team should inform staff about the pre-assessment, for example through a letter by top management, regular staff meetings or notice boards.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the Team formation and informing staff.
- Worksheets (Worksheet 4, See Appendix B)

1c. Pre-assessment to collect general information

The Team now carries out a pre-assessment at company level to collect and review general information, which normally takes between 1-3 days. The main purpose of the pre-assessment is to identify where the biggest areas for energy savings are (= potential focus areas in task 1d!) and writing a realistic proposal to top management (task 1e).

This information can be obtained through existing documentation and computer systems, interviews with staff, a walkthrough of the plant, and simple monitoring. Because staff were informed about the pre-assessment, they are more likely to cooperate!
Information collected should include:
- General company details, such as address, number of staff, working hours and production capacity (see Worksheet 5)
- Organization chart with the different departments and main functions
- General production flow chart for the whole company with the main inputs and outputs for each

production step (see Worksheet 6)
- Production data for the past 3 years, preferably for each month (see Worksheet 7)
- Energy and other resource consumption data and costs for the past 3 years, preferably for each month and for each production step or department (see Worksheet 7)
- An inventory of major equipment, such as boilers, air compressors, motors (see Worksheet 8)
- Overview of information collected for each process step / for each department (see Worksheet 9)
- Company greenhouse gas (GHG) emissions (see GHG Indicator)

Note: the amount and quality of information available is most important for task 2d (quantifying inputs and outputs and costs for focus areas). If only limited information is available, then task 2d can only be carried out in less detail or more time is needed to measure and collect data.

See "Company examples" for examples of companies that participated in the GERIAP project on how they did the pre-assessment.

Information on the CD-ROM and website:
- Company examples (Appendix A)
- Worksheets (Worksheet 5, 6, 7, 8, 9, See Appendix B)
- GHG Indicator

1d. Select focus areas

Now it is time to select focus areas. A focus area can be:
- The entire plant
- A department, production line, or process step, such as the kiln or the packaging plant
- Specific (energy) equipment or resources, such as steam, compressed air, motors, or fans

The Team meets for a 1-4 hour brainstorm session to prepare a list of possible focus areas, and to choose focus areas based on for example (see Worksheet 10):
- Size of the plant
- Management's areas of interest or concern
- High energy / resource consumption or costs
- Areas for which energy efficiency audits or project have not yet been carried out
- Expertise and knowledge of staff about a certain area
- Plans for construction or upgrading
- Available information for a certain area

Note: this information has already been collected as part of the management meeting and the pre-assessment!

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the selection of focus areas.
- Worksheets (Worksheet 10, See Appendix B)

1e. Prepare assessment proposal for top management approval

It is important to obtain top management commitment because an energy assessment costs money and staff time and can interrupt the production process. This can only be achieved if there is a clear proposal for the energy assessment (step 2, 3 and 4 of the approach).

This proposal can be prepared within the company (e.g. the production manager, energy manager or an internal Team or committee) or by an external facilitator who has been involved in tasks 1a – 1d (e.g. by a consultant, a Cleaner Production Centre or other service provider).

The assessment proposal should include (see Worksheet 11):
- Objectives (i.e. agreed in the meeting with management)
- Scope (i.e. focus areas)
- Outputs (i.e. an proposal for implementation of feasible options to improve energy efficiency)
- Approach (i.e. the steps 2, 3 and 4 of the Methodology – how detailed each step and task should be depends on the company, because each company is different!)
- Team (i.e. who will take part in the assessment and the roles and responsibilities of each Team member)
- Time planning (i.e. how much time / man days is needed for each step and task, a timeframe with deadlines)
- Budget (i.e. how much money is needed for the assessment)

The proposal is then sent or presented to top management for comments and approval. In case of an external facilitator, consultant or service provider a contract is signed for assistance with the energy assessment.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the assessment proposal to top management.
- Worksheets (Worksheet 11, See Appendix B)

Step 2 - Assessment

The ***purpose*** of step 2 is to assess where energy is lost/wasted for the focus area(s).

The ***output*** of step 2 is an overview of how much energy is lost and how much money this costs for the focus area(s). Then it becomes easier to identify options to improve energy efficiency in step 3!

Tasks under step 2 and the estimated minimum time needed include:*
- Task 2a: Staff meeting and training (minimum 0.5 day for staff meeting only)
- Task 2b: Prepare focus area flow charts (minimum 2 hours per focus area)
- Task 2c: Walkthrough of focus areas (depending on the focus area, but minimum 0.5 day per focus area, excluding collection of detailed data for task 2d)
- Task 2d: Quantify inputs and outputs and costs to establish a baseline (time required depends on data available as determined during the pre-assessment, task 1c)
- Task 2e: Quantify losses through a material and energy balance (0.5 – 1 day per focus area provided that data were collected under task 2d)

* Note: the selection of tasks, time needed and who does what should already be included in the energy assessment proposal to top management that was prepared under task 1e. Although task 2b, 2d and 2e are described as separate tasks, it is possible to combine these, which will avoid repetition and save the Team time!

2a. Staff meeting and training

As a minimum the Team should organize a staff meeting to inform staff about the assessment and their roles and to get their support. Staff from the focus areas should attend this meeting, but preferably everyone from top management to production staff throughout the plant should get an introduction. Production staff are important because they are the ones who work in the focus area every day and understand the production processes best!

It is recommended that the Team and staff working in the focus areas receive training on CP and energy efficiency, how to carry out an assessment, and technical training on energy equipment, depending on whether

- The Team has sufficient knowledge and experience to carry out the energy assessment
- An objective of the energy assessment is to increase staff's knowledge and experience so that they can continue with energy assessments in the future (as indicated by top management under task 1a) or only to find quick energy efficiency options
- The company's Team or external consultants carry out the energy assessment

See Worksheet 12 for suggested training. ***Note that this Guide includes training material for company staff!***

Other possible activities include hanging up posters, starting a slogan campaign, explanation at section/ department meetings, and announcements through a letter from top management to staff or through a company newsletter.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the staff meeting and training.
- Worksheets (Worksheet 12, See Appendix B)

2b. Prepare focus area flow charts

The Team should prepare a focus area flow chart for each of the selected focus areas as follows (see Worksheet 13):
- List the different steps of the focus area and draw a box around each step
- List the most important inputs (resources) for each step on the left, such as energy (electricity, fuels), water, raw materials and chemicals
- List the most important outputs for each step on the right, such as solid wastes, heat, emissions, noise and wastewater
- List the intermediate and final products between the steps, such as clinker and cement

Add any information on units of measurement for inputs and outputs and quantities and costs that is already available. Otherwise this information can be gathered as part of the next tasks.

The focus area flow chart will look differently for a department or process step (e.g. kiln, boiler house) compared to specific energy uses (e.g. steam system, motors, fans).

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of flow charts of focus areas for companies that participated in the GERIAP project.
- Worksheets (Worksheet 13, See Appendix B)

2c. Walkthrough of focus areas

The Team now conducts a detailed walkthrough of the focus areas, usually starting at the first step of the process flow chart and finishing at the last step. The purpose of the walkthrough is to:
- Better understand the focus area
- Get feedback from production staff about problems they have with procedures and operating equipment, and possible losses of energy and other materials
- Write down any visible losses of energy and materials such as steam and water leaks, damaged valves and pipelines, excess blow-down from the boiler, etc (see Worksheet 14 for more examples)
- Obtain information about quantities and costs for the inputs and outputs of each focus area step through interviews with staff, metering reports, or taking measurements (needed for task 2d)

The first walkthrough is done thoroughly. But in practice, the Team will visit the focus area several times to meet with production staff and gather more information on inputs and outputs (task 2d) and later to identify and investigate energy efficiency options (step 3 and step 4).

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they addressed the walkthrough of focus areas.
- Worksheets (Worksheet 14, See Appendix B)

2d. Quantify inputs and outputs and costs to establish a baseline

A baseline is important because you can measure improvements after implementing options, and management will only be convinced to continue if you can show how much resources and money was saved.

To establish a baseline, for each input and output in the process flow chart collect the following information (see Worksheet 13):
- Quantities (e.g. tons of coal per day)
- Costs (e.g. $ per ton of coal)
- Other characteristics (e.g. temperature of water going in and out of the boiler, pressure)

Ideally, you want quantity and cost information for 3 years, 12 months within one year, and the days within one month, so that you can observe trends.

The information can come from interviews with staff, readings of online meters, monitoring records, and by taking measurements with monitoring equipment (especially to verify data records!)

However, in practice it is not always possible to do all this because:
- Not all companies have this information readily available. For example, a company may only have electricity bills and an electricity meter for the plant but no breakdown for each equipment or department that uses electricity
- Monitoring equipment is not available at the plant
- There is limited time available to complete this task

The level of detail and how much time is needed to measure and collect data under this task should already be identified during the pre-assessment (task 1c). Possible solutions should also have been included in the proposal to management (task 1e).

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they established a baseline.
- Worksheets (Worksheet 13, See Appendix B)

2e. Quantify losses through a material and energy balance

What goes into a process must come out somewhere else. Based on the process flow chart and quantified inputs and outputs prepared in the previous tasks, try to “balance” the inputs and outputs side.

Any inputs that do not come out as useful outputs (e.g. product, steam) are considered “losses”. These can include losses of energy (e.g. through heat, blow-down, flue gases, un-burnt materials), and losses of products and materials (e.g. water, chemicals, product rejects and off cuts).

Using the cost information (task 2d), calculate the costs of the losses. This will allow you to focus on options from a cost and resource point of view.

Completing a full and detailed material and energy balance could take a long time, especially if there is little data on inputs and outputs at the company. It is also more difficult to determine energy losses because energy is not as tangible as raw materials and wastes.

It is important to be practical and focus on quantifying at least the biggest and most expensive losses, because this will form the basis of identifying options for improvement.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples of companies that participated in the GERIAP project on how they prepared a useful material and energy balance.
- Worksheets (Worksheet 13, See Appendix B)

Step 3 - Identification of Options

The ***purpose*** of step 3 is to identify opportunities to improve energy efficiency for the selected focus areas.

The ***output*** is a list of options that will be investigated on their feasibility in step 4.

Tasks under step 3 and the estimated time needed include:*
- Task 3a: Determine causes of losses (estimated 0.5 day per focus area)
- Task 3b: Identify possible options (estimated 0.5 day per focus area)
- Task 3c: Screen options for feasibility analysis (estimated 0.5 day)

* Note: the time needed and who does what should already be included in the proposal prepared under task 1e. Step 3 can take between 1 – 3 days depending on the number of focus areas, the number and type of losses and causes, the time available, the technical expertise of the Team members and if tasks 3a – 3c are carried out separately or together. For example a one-day workshop can be held where the Team first looks at the causes of losses, then identifies possible options and finally screens options for feasibility analysis.

3a. Determine causes of losses

Once we have identified the losses, it is important to answer the question: Why are these losses occurring?

The best way to analyze the causes is through a brainstorm session, which is a meeting with the Team and other staff from the focus areas to discuss the losses. One person can act as facilitator and make notes on a whiteboard so that everyone can follow the discussion.

It is important to continue asking "why" until you have found the real cause or "root cause" of the problem. A common problem with boilers is un-burnt ashes. Why? Because the air supply to the boiler is too low. Why? Because the meter gives a wrong reading of air supplied. Why? Because the meter has not been maintained properly. Why? Because boiler operators nor maintenance staff maintain the boiler. Why? Because the maintenance procedures do not specify who should maintain the boiler and how often. This is the root cause of your loss. And only now it is possible to come up with options to solve this problem permanently. In our example, increasing the air supply is a temporary solution (saving little energy in the short term), whereas changing maintenance procedures is a permanent solution (saving a lot of energy in the long term).

Worksheet 15, the Fishbone Diagram tool, and Company examples from companies that participated in the GERIAP project can help you find the causes for losses at your selected focus areas.

Information on the CD-ROM and website:
- Company examples (See Appendix A)
- Worksheets (Worksheet 15, (Appendix B))
- Fishbone Diagram

3b. Identify possible options

Once we know why losses occur, we can move to the next question: What can we do to solve it?

A brainstorm session with the Team and other staff from the focus areas is the best way to come up with possible options. Options can fall in the following categories:

- Good housekeeping
- Improved process management
- Production process / equipment modification
- New technology / equipment
- Input material substitution
- On-site reuse / recovery
- Production of useful by-product.
- Product modification

Click on "Option categories" for an explanation and examples for each category. You can also use Worksheet 15 to write down possible options.

There is no such thing as a "bad idea" so everyone should be encouraged to come up with as many possible options as possible! Sometimes hundreds of possible options are generated for one focus area alone.

Another source of possible options are the notes from the walkthrough of focus areas under task 2c (Worksheet 14) and the notes from the discussion with top management about energy management in the company under task 1a (Worksheet 2).

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they identified possible options.
- Worksheets (Worksheet 15, See Appendix B)
- Option categories

3c. Screen options for feasibility analysis

The Team now needs to decide which possible options to investigate for feasibility. The easiest way to do the screening of options is by putting them in one of these categories:

- Options that can be implemented directly. They are technically simple and need little or no money to implement. For example, repairing leaks, changing an operating procedure, reducing excess air from the boiler.
- Options that require further analysis. These options are technically more complex or require a financial investment. For example, replacing a compressor, recovering heat from boiler blow-down, or replacing lime with alternative materials in cement production.
- Options that can be considered at a later stage. These options are probably difficult to investigate and implement, for example, because the costs are too high, they take too much time to investigate, or a plant upgrade is planned that will cover this option already.

The meeting with management under task 1a should also give you an indication of what screening criteria to apply!

Worksheet 15 can be used to categorize options, and look under "Company examples" to see what other companies have done.

Options that require further analysis will be investigated for their technical, financial and environmental feasibility as part of step 4. Options that can be implemented directly do not require a feasibility analysis, however, the technical, financial and environmental details will still need to be recorded.

Information on the CD-ROM and website:
- Company examples (See Appendix A)
- Worksheets (Worksheet 15, (Appendix B))

Step 4 - Feasibility analysis of options

The ***purpose*** of step 4 is to determine which options are technically, financially and environmentally feasible and in what order feasible options should be implemented.

The ***output*** of step 4 is a proposal that is approved by top management, with recommended options for implementation and how to do this, plus a list of options that require further investigation or which are not feasible.

Tasks under step 4 and the estimated time needed include:
- Task 4a: Technical, economic and environmental evaluation of options (time depends on the number and complexity of options investigated)*
- Task 4b: Rank feasible options for implementation (0.5-1 day)
- Task 4c: Prepare implementation and monitoring proposal for top management approval (2-3 days)

*If top management has given a maximum amount of time for the feasibility analysis, then the number and type of options selected for feasibility analysis should be adjusted accordingly.

4a. Technical, economic and environmental evaluation of options

The Team can now investigate which options are technically, economically and environmentally feasible. How this is done is described below. You can use Worksheet 16 to write down the results.

First of all, you must decide what tasks should be done for each option, i.e. what do you need to find out to know if an option is feasible? This should include (see "Feasibility analysis tools" for more details and examples):
- Technical feasibility: need for new equipment, space availability, impact on product quality, staff time required
- Economic feasibility: one-off investment costs, annual operating/ongoing costs, annual cost savings, payback period
- Environmental feasibility: impact on energy consumption and greenhouse gas emissions, but also look at water use, raw material use, solid waste, wastewater, other air emissions, noise, odours and dust.

Second, you need to identify other possible reasons for implementing the option. For example, if company emission levels are higher than legal limits then this may be a reason to implement an option even if the option is expensive.

Third, you need to think of possible barriers to implementing the option. For example, an option may have large savings and a short payback period, but investment capital is not available in the company. Lack of monitoring equipment may make monitoring of results difficult. Try to think of possible solutions too!

Also consider comments from top management on the reasons for energy efficiency, the current energy management practices and other factors of influence on improving energy efficiency (see Worksheet 1, 2 and 3). More

Information on the CD-ROM and website:
- Company examples (See Appendix A) for more examples of other reasons and barriers.
- Worksheets (Worksheet 16, See appendix B)

4b. Rank feasible options for implementation

Now that we know which options are feasible we want to know: which options should be implemented first, second, third, etc. Organize another Team meeting to give each option a rank:
- 1 - Options to be implemented in the short term, e.g. within one year
- 2 - Options recommended for implementation but in the longer term
- 3 - Option recommended for further investigation, or to be considered at a later stage
- Unfeasible options

The results of the technical, economical and environmental feasibility analysis and the other reasons and barriers are used as a basis to rank the options. In practice an open discussion amongst Team members is enough to compare and rank the options. However, you could also start by giving a "low", "medium" or "high" score for the technical, economical and environmental feasibility and other reasons, and then decide on the ranking (see Worksheet 17).

For options recommended for implementation in the short term (rank 1), you should now decide (and include in Worksheet 16):
- What are the implementation and monitoring tasks
- Who will be responsible for coordinating and carrying out these tasks (including internal staff, and external suppliers and consultants)
- Completion dates
- How much staff time is required
- Other comments

This will help with preparing an implementation proposal.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they ranked feasible options for implementation.
- Worksheets (Worksheet 16, 17)

4c. Prepare implementation and monitoring proposal for top management approval

Top management's support is again needed for the implementation and monitoring of feasible options in the short term. The Team should prepare a proposal for an Implementation and Monitoring Plan to top management (see Worksheet 18):
- An introduction
- Number of options identified, options investigated for feasibility, feasible options, options requiring further investigation, and unfeasible options
- Options recommended for implementation in the short term:

- Total estimated investment required, annual ongoing costs, annual savings and payback period
- Total estimated environmental benefits (energy, GHG emissions and resources/wastes)
- Most important other reasons for implementation
- Most persistent and difficult barriers and proposed solutions
- Table with list of options including technical, economical, environmental, reasons and barriers for each individual option

- Team (who will carry out the implementation and monitoring, including external facilitators/ consultants)
- Communication of results to top management and staff
- Appendices with
  - Worksheets 16 for options recommended for implementation in the short term
  - Worksheet 17 with details and ranking of all options investigated

The proposal is then sent to top management for comments and approval. If an external facilitator, consultant or service provider is needed for the implementation and monitoring, a contract is signed.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they prepared this proposal to top management.
- Worksheets (Worksheet 18)

Step 5 - Implementation and monitoring of options

The ***purpose*** of step 5 is to implement feasible options in order of priority and monitor results and discuss findings with top management.

The ***output*** of step 5 is improved energy efficiency, reduced costs and reduced GHG emissions from implemented options, and agreement with top management about the next steps.

Tasks under step 5 and include:
- Task 5a: Implement options and monitor results*
- Task 5b: Evaluation meeting with top management (0.5 day)

*How much time this task takes depends on the number and complexity of options to be implemented. This decision will have been made when top management approved the Implementation and Monitoring Plan.

5a. Implement options and monitor results

The Team should carry out the Implementation and Monitoring Plan approved by top management.

Use Worksheet 16 to record the monitored results for each option. These should at least include:
- Economic results: one-off investment costs, annual operating/ongoing costs, annual cost savings, and payback period
- Environmental results: energy consumption and greenhouse gas emissions, and other environmental results (depends on each option, such as water use, raw material use, solid waste, wastewater, other air emissions, noise, odors and dust)
- Other results: e.g. any other benefits from the option (e.g. improved legal compliance, reduced injuries) and barriers encountered

In practice, the monitored results will often be slightly different from the feasibility analysis data.

Without monitoring it will be very difficult to convince management that energy efficiency projects are beneficial to the company. You need to proof especially the financial benefits of implemented options to get their support for future projects.

It is also important to communicate (interim) results throughout this phase to management and staff to:
- Show management that energy efficiency is good for business and gain their support for future projects
- Reward staff for their efforts in improving energy efficiency and encourage them to come up with new options

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they implemented options and monitored results.
- Worksheets (Worksheet 16, See Appendix B)

5b. Evaluation meeting with top management

An evaluation meeting between the Team and top management is necessary to formally close the first round of energy efficiency projects. But a second purpose is to gain their commitment to continue with energy efficiency.

At this 2-4 hour meeting discuss the following:
- Results of the implemented options and how to communicate these internally and externally (see "Company examples" on how to do this)
- How to continue to improve the company's energy efficiency by agreeing with top management
  - Additional options for implementation (ranked 2 under task 3b)
  - Additional options for further investigation (ranked 3 under task 3b)
  - New focus areas to carry out more assessments (e.g. based on the list of possible focus areas from task 1d)
- How to integrate energy management throughout the company's systems by agreeing with top management actions needed under the six categories of the Energy Management Matrix (see Worksheet 3)
  - Policy and systems
  - Organization
  - Motivation
  - Information systems
  - Training and awareness
  - Investment

Therefore this evaluation meeting could also be used as a first meeting with top management (task 1a) as part of a new cycle.

Information on the CD-ROM and website:
- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they managed the evaluation meeting with top management.
- Worksheets (Worksheet 3, See Appendix B)

Step 6 - Continuous improvement

The ***purpose*** of step 6 is to ensure that the company *continues* with improving energy efficiency in a *systematic* way that is *integrated* in company processes (these are the key components of Cleaner Production)

The ***output*** of step 6 is continuation of implementing energy efficiency options and integration of energy management into company processes

Step 6 has only one task:

- Task 6a: Prepare a proposal to continue with energy efficiency for top management approval (2-3 days)

6a. Prepare a proposal to continue with energy efficiency for top management approval

The Team should now write a proposal based on what was agreed with top management at the evaluation meeting and seek top management approval.

Write this proposal by making use of

- Worksheet 11 - Assessment proposal (for the assessment of new selected focus areas and the feasibility analysis of the additional options selected for further investigation)
- Worksheet 18 - Implementation and monitoring proposal (for additional options selected for implementation and energy management improvement options)

Therefore writing this proposal is in fact a combination of preparing and assessment proposal (task 1e) and an implementation and monitoring proposal (task 3c) as part of a new cycle.

Energy management has been integrated into the Methodology, for example:

- The quality of the pre-assessment (task 1c) and assessment (step 2) depend largely on the quality of energy management systems
- Some of the identified options were aimed at improving energy management (task 3b)
- Many of the barriers for options are energy management barriers (task 4a)

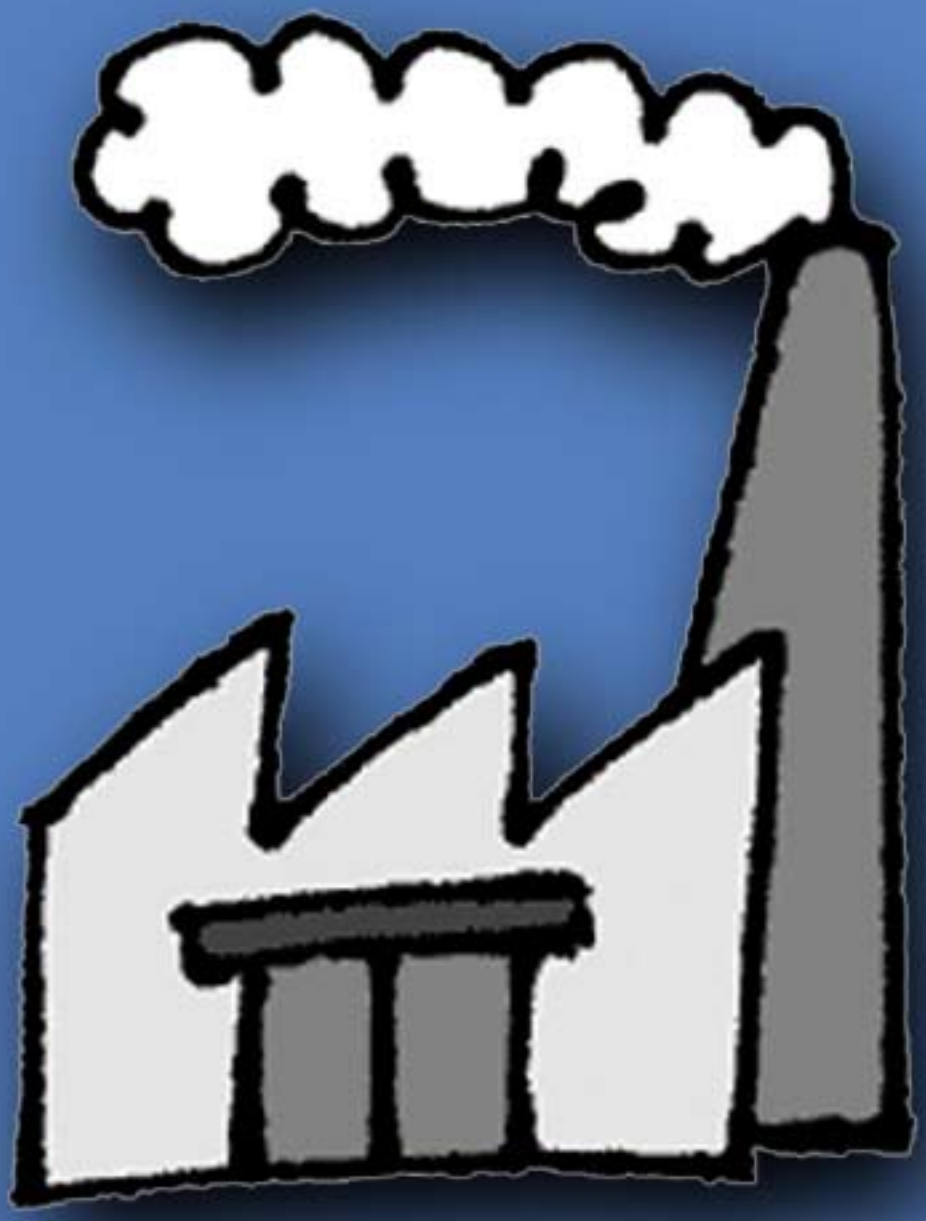
For this reason, continuous improvement can only be achieved by effective energy management and integration of energy management into other company processes and systems (see the Energy Management Matrix in Worksheet 3). For example, energy management should be integrated into the same management system for environment, health and safety, quality, and risks.

With the experience the Team now has, they can focus even more on improving energy management in a second cycle of the Methodology.

Information on the CD-ROM

- Company examples (See Appendix A) for examples from companies that participated in the GERIAP project on how they work for a continuous improvement.
- Worksheets (Worksheet 3, 11 and 18, See Appendix B)

PART 3
INDUSTRY SECTORS

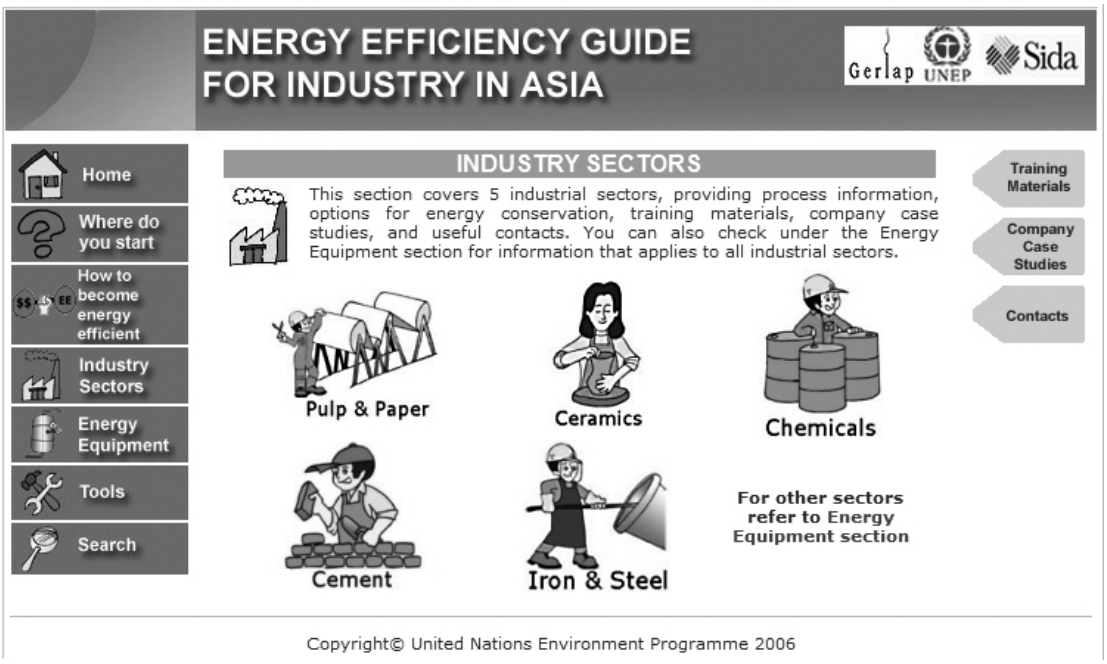


Part 3: Industry sectors

This part gives process information, energy efficiency options and company case studies for more than 40 companies in five industrial sectors: cement, chemicals, ceramics, iron & steel and pulp & paper.

This hard copy Guide gives a summary of what is included on the CD-ROM and website

When you go to the Industry sectors part on the CD-ROM or website, the following screen will appear:



Description of each industry sector

GERIAP covers the following five industry sectors

- Cement: producers of different types of cement, mostly covering the entire process from mining, production of clinker to the production of cement. Some companies only produce lime or purchase clinker from elsewhere to produce cement. The Guide covers the entire process.
- Chemicals: this is the most diverse sector and includes producers of fertilizers, rubber products, plastics, distilleries (for Mongolia), drugs, and paints. Because it is not possible to prepare sector descriptions, option checklists etc for all chemical companies combined, the chemicals chapter in the Guide only focuses on fertilizer production.
- Ceramics: producers of tiles, ceramic products (cups, bowls, vases etc). Because processes are diverse for different ceramics products, the ceramics chapter in the Guide focuses specifically on tiles manufacturing.
- Iron & steel: primary and secondary steel producers have been included, but the Guide focuses particularly on secondary steel production, which represents the majority of participating companies in the GERIAP project
- Pulp & paper: producers of pulp and paper and manufacturers of paper only. The Guide covers both pulp and paper manufacturing.

For each sector the following information is given:

- Sector description
- Process flow
- Main process equipment: a general description of the equipment used in different processes and

comparing the energy efficiency between each of them

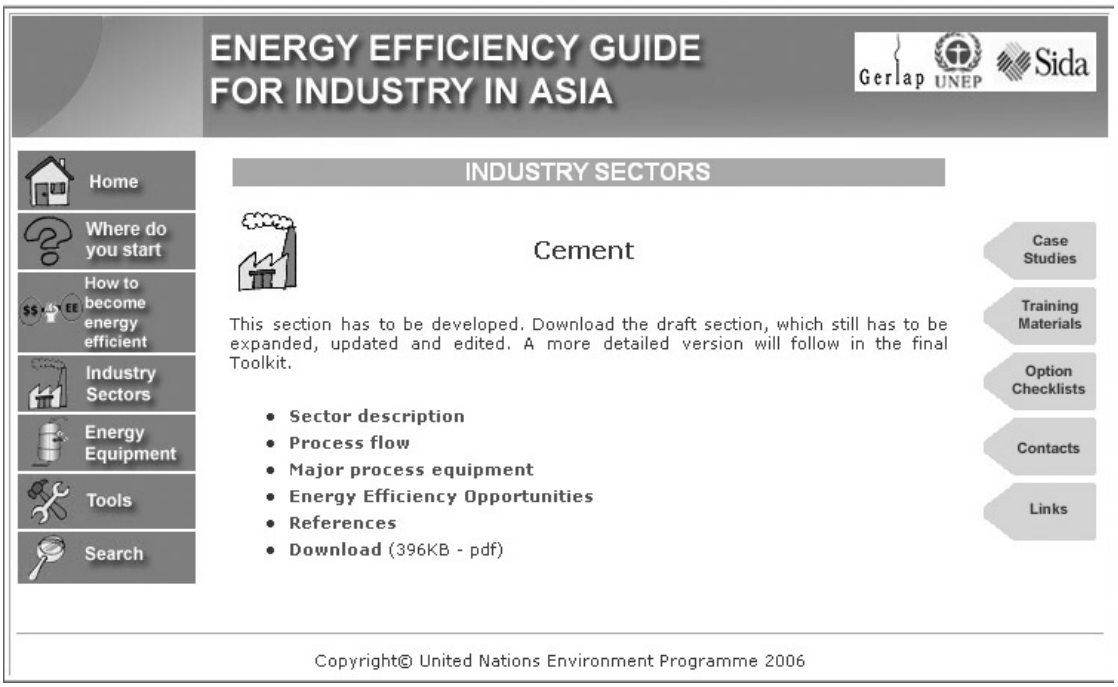
- Energy efficiency opportunities (including option checklists)
- References

An example of what information is included under each heading is given for the "Cement" chapter.

Example of industry sector chapter: cement

To give an idea of what information you can find on the CD-ROM and website for each industry sector, an example is given for the cement chapter.

When you click on "Cement" in the Industry Sector part on the CD-ROM or website, you will see the screen below.



The arrows on the right are links to training materials, case studies, option checklists and contacts relevant to the cement sector. These arrows are described in Part 5.

Sector description

This section briefly describes the cement sector and gives a short introduction to the main features of the sector.

Process flow

This section gives a process flow of the cement production process, describes each process step and the main inputs and outputs.

The basic process of Cement production as shown in figure 1 involves:

1. Acquisition of raw materials

2. Preparation of the raw materials for pyroprocessing
3. Pyroprocessing of the raw materials to form Portland cement clinker, and,
4. Grinding the clinker to Portland Cement

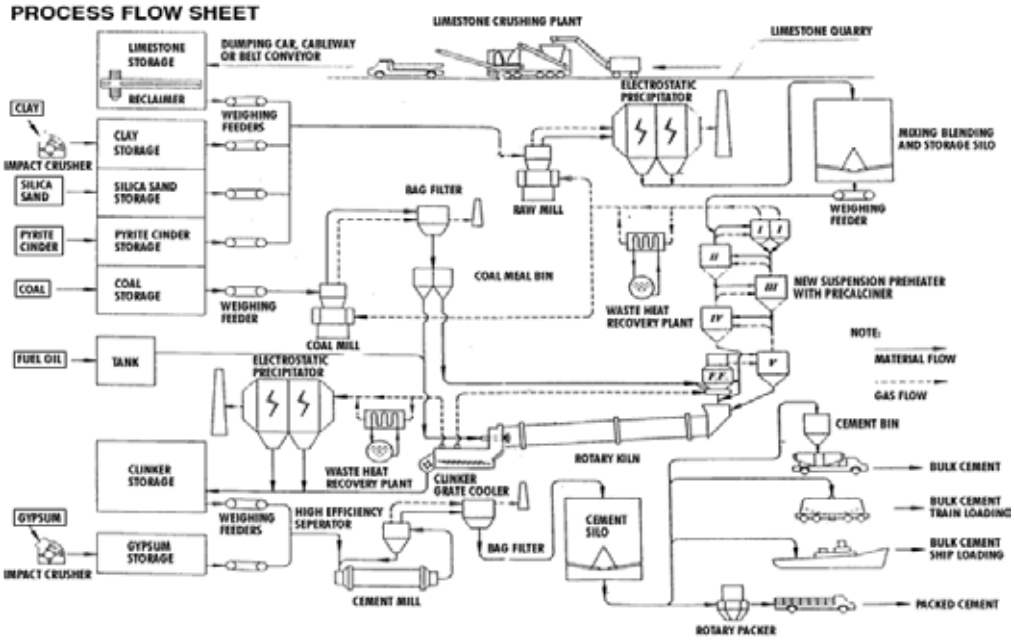


Figure 1: Cement Production Process. ***Reference: http://www.acclimited.com***

Mining: Limestone, the key raw material is mined in the quarries with compressed air drilling and subsequently blasting with explosives. The mined limestone is transported through dumpers or ropeways to the plant. Surface mining is gradually gaining ground because of its eco friendliness.

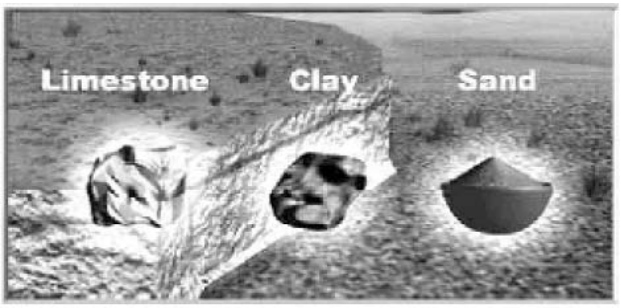


Figure 2: Raw Material. ***Reference: http://www.cement.org***

Crushing: The limestone as mined is fed to a primary and secondary crusher, where the size is reduced to 25 mm. More recently, tertiary crushers are used to further reduce the inlet size to the mill. The crushed limestone is stored in the stockpile through stacker conveyors. The crushed limestone, bauxite and ferrite are stored in feed hoppers from where they are fed to the raw mill via weigh feeders in the required proportion.

Figure 3: Crushing
Reference: http://www.cement.org

Other process steps are described on the CD-ROM and website.

Major process equipment

This section includes a general description of the equipment used in different process steps of cement production, and compares the energy efficiency between different equipment that are used for the same process step.

Energy efficiency opportunities

Energy efficiency options will reduce energy consumption and greenhouse gas emissions. However, the cement sector is also a main producer of greenhouse gas emissions because when limestone is burnt large quantities of CO_2 emissions are released. Options to reduce greenhouse gas emissions can therefore also focus on reducing the percentage of lime in the clinker, for example by partially replacing it with other materials.

Energy efficiency opportunities for cement production can be grouped as follows:

- Capacity utilization
- Fine tuning of equipment
- Technology upgrading
- Energy efficient technologies

Capacity utilization

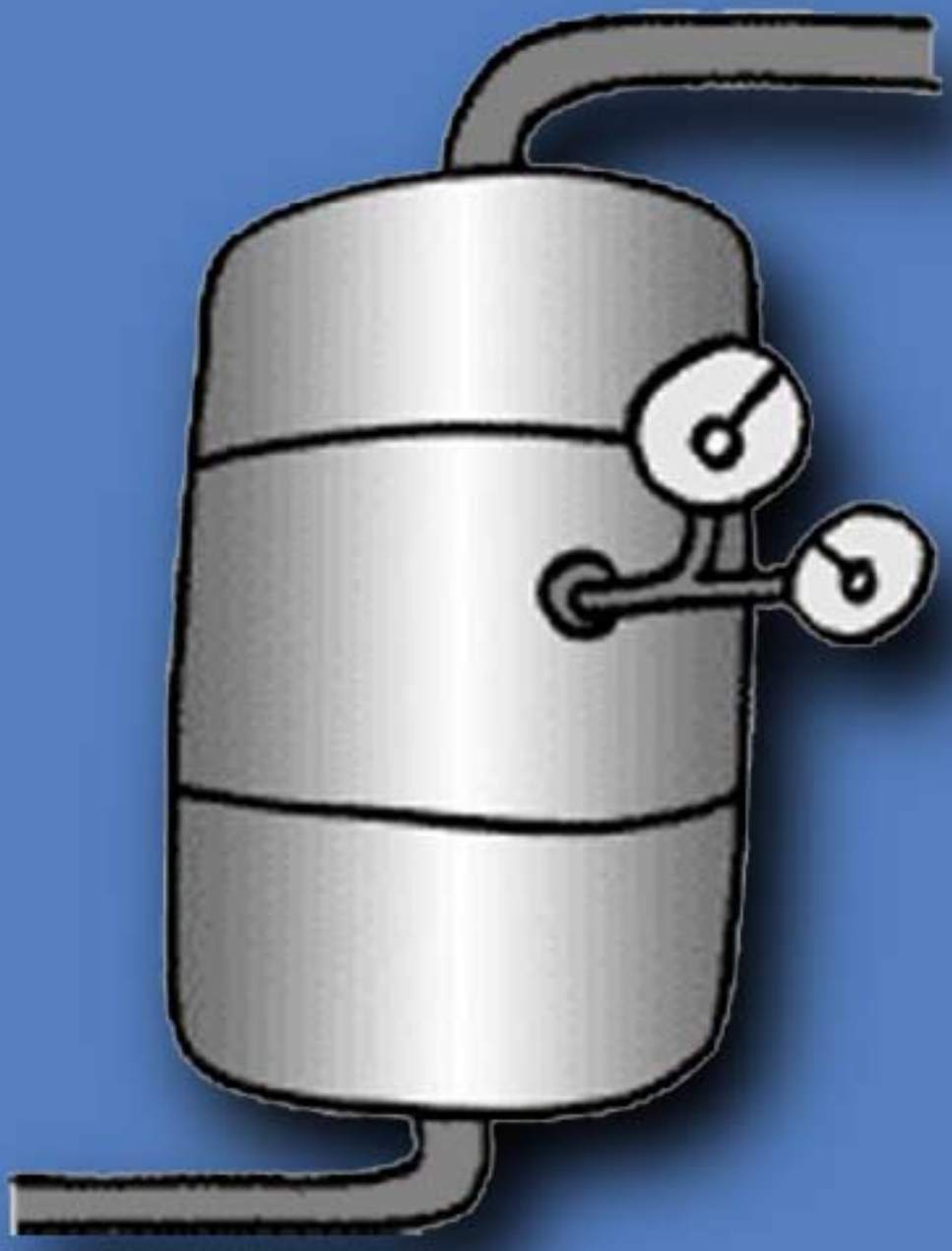
High capacity utilization is very essential for achieving energy efficiency. This brings down the fixed energy loss component of the specific energy consumption. Survey of excellent energy efficient companies show that 80 percent of the companies attribute capacity utilization as one of the foremost reason for a major drop in specific energy consumption. At least 90 per cent capacity utilization is to be ensured for achieving low specific energy consumption. Also achieving high capacity utilization is under the control of plant personnel. Hence the first and foremost step for an aspiring energy efficient unit should be on increasing capacity utilization and reduce the specific energy consumption.

Opportunities for the other areas are included in the CD-ROM and website version of the Guide.

References

1. National Productivity Council- Energy Audit reports in Cement Industries.
2. Reports from Lawrence Berkley Laboratory
3. Web Sites: India Cements Ltd, Australian Cement Institute

PART 4
ENERGY EQUIPMENT

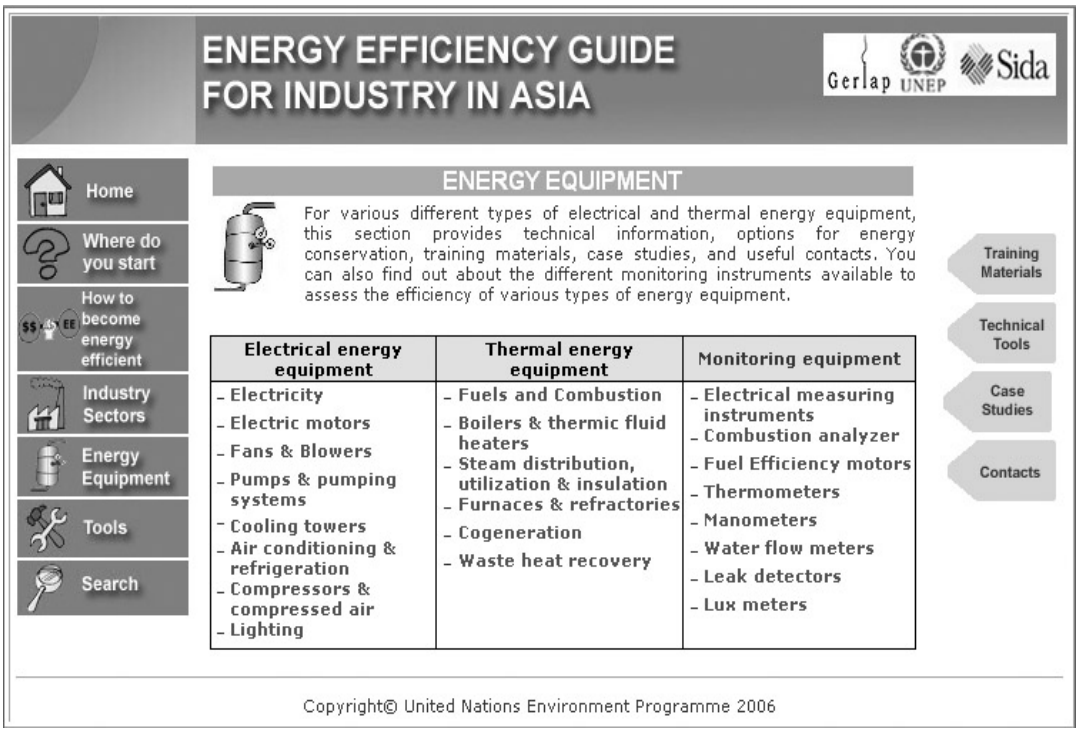


Part 4: Energy equipment

When you go to the Energy Equipment part on the CD-ROM and website you will see the screen below. For different types of electrical and thermal energy equipments, such as boilers, fans and motors, this part provides technical information, options for energy conservation, training materials, case studies, and useful contacts. You can also find out about the different monitoring equipment available to assess the efficiency of various types of energy equipment. Information can be read as html or can be downloaded as pdf files as well.

The arrows on the right are links to various tools and resources (training materials, technical tools, case studies, contacts), which are described in Part 5.

This hard copy Guide gives a summary of what is included on the CD-ROM and website



Electrical energy equipment

Before different types of electrical energy equipment are described it is important to understand the basics of electricity. The electricity chapter gives the following information:

- General information about electricity such as basic formulas, phase of electricity, and generation and distribution of electricity
- Electricity billing mechanisms
- Electrical load management
- Active and reactive power (capacitors/power factor controllers)
- Transformers

Chapters are included for different electrical energy equipments:

- Electric motors
- Fans and blowers
- Pumps and pumping systems
- Cooling towers
- Air conditioning and Refrigeration
- Compressors and compressed air system

Each of these chapters follows the same structure as the thermal energy equipment chapters:
- What is the equipment
- Types of the equipment
- Assessment of the equipment
- Energy efficiency opportunities
- Option checklist
- Worksheets and other tools
- References

An example of what information is included under each heading is given for the "Boilers & thermic fluid heaters" Part4 on page 45.

Thermal energy equipment

Before different types of thermal energy equipment are described, the first chapter "Fuels & combustion" gives the basics of fuels (oil, gas and coal) and combustion processes.

Next, chapters are included for different thermal energy equipments:
- Boilers and thermic fluid heaters
- Steam distribution and utilization
- Furnaces and refractories
- Waste heat recovery
- Cogeneration

Each of these chapters (including the Fuels & combustion chapter) follows the same structure:
- What is the equipment
- Types of the equipment
- Assessment of the equipment
- Energy efficiency opportunities
- Option checklist
- Worksheets and other tools
- References

An example of what information is included under each heading is given for the "Boilers & thermic fluid heaters" Part4 on page 45.

Monitoring equipment

Monitoring equipment can be useful to measure the actual operating parameters of various energy equipment and compare them with the design parameters to determine if energy efficiency can be improved. Or monitoring equipment can be used to identify measure steam or compressed air leaks. Parameters that are often monitored during an energy assessment are:
- Basic electrical parameters in AC & DC systems: voltage (V), current (I), power factor, active power (kW), maximum demand (kVA), reactive power (kVAr), energy consumption (kWh), frequency (Hz), harmonics, etc.
- Other non-electrical parameters: temperature and heat flow, radiation, air and gas flow, liquid flow, revolutions per minute (RPM), air velocity, noise and vibration, dust concentration, total dissolved solids (TDS), pH, moisture content, relative humidity, flue gas analysis (CO_2, O_2, CO, SO_x, NO_x), combustion efficiency, etc.

The CD-ROM and website of the Guide provide information for various monitoring equipment that are often used during energy assessments in industry:
- Electrical measuring instruments
- Combustion analyzer

- Thermometers
- Manometers
- Water flow meter
- Speed measurement
- Leak detectors
- Lux meters

There is one chapter for all monitoring equipments combined, and for each type of monitoring equipment the following information is given:

- What the monitoring equipment does
- Where the monitoring equipment is used
- How to operate the monitoring equipment
- Precautions and safety measures necessary for the monitoring equipment
- References

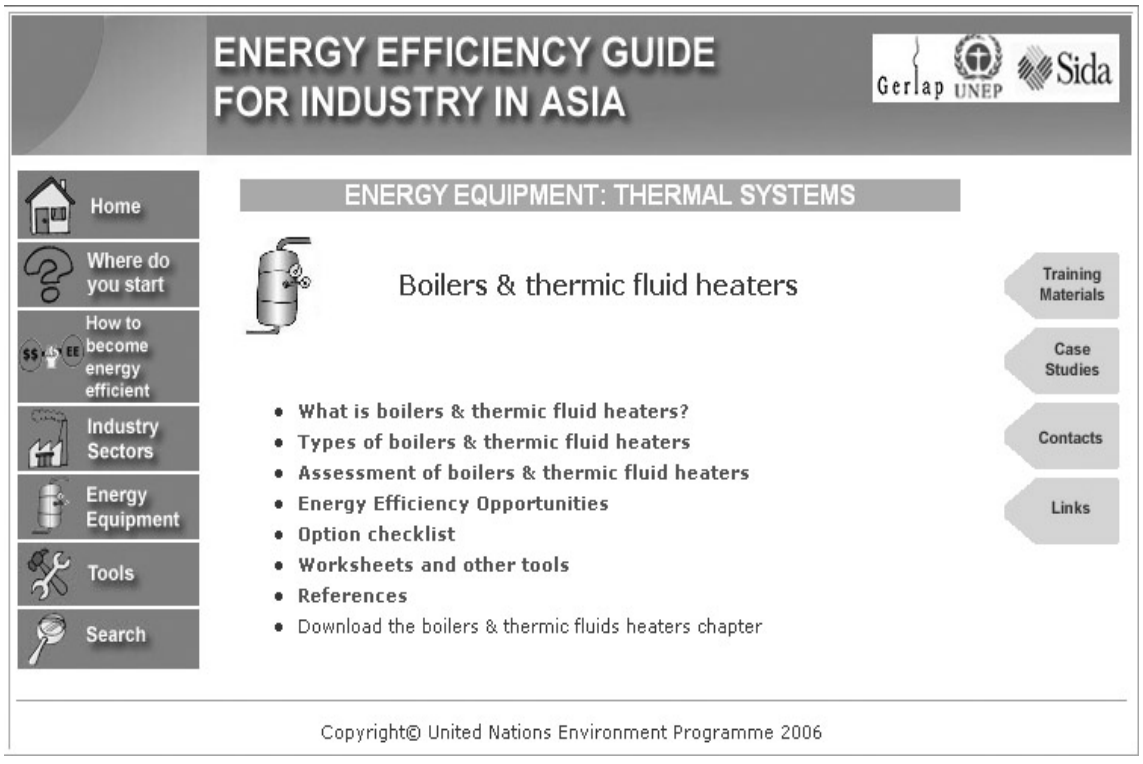
An example of what information is included under each heading is given for a combustion analyzer on page 45..

Example of the energy equipment chapter: Boilers & thermic fluid heaters

To give an idea of what information you can find on the CD-ROM and website for each type of electrical and thermal energy equipment, an example is given in the chapter for boilers & thermic fluid heaters.

When you click on the "Boilers & thermic fluid heaters" in the Energy Equipment part on the CD-ROM and website, you will see the screen below.

The arrows on the right are links to training materials, case studies, contacts and links relevant to boilers and thermal fluid heaters. These arrows are described in Part 5.



What is a boiler

This section briefly describes the Boiler and various auxiliaries in the Boiler Room.

A boiler is an enclosed vessel that provides a means for combustion heat to be transferred into water until it becomes heated water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process. Water is a useful and inexpensive medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be an extremely dangerous piece of equipment that must be treated with utmost care.

The boiler system comprises of: a feed water system, steam system and fuel system. The ***feed water system*** provides water to the boiler and regulates it automatically to meet the steam demand. Various valves provide access for maintenance and repair. The ***steam system*** collects and controls the steam produced in the boiler. Steam is directed through a piping system to the point of use. Throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges. The ***fuel system*** includes all equipment used to provide fuel to generate the necessary heat. The equipment required in the fuel system depends on the type of fuel used in the system.

The water supplied to the boiler that is converted into steam is called ***feed water***. The two sources of feed water are: (1) ***Condensate*** or condensed steam returned from the processes and (2) ***Makeup water*** (treated raw water) which must come from outside the boiler room and plant processes. For higher boiler efficiencies, an economizer preheats the feed water using the waste heat in the flue gas.

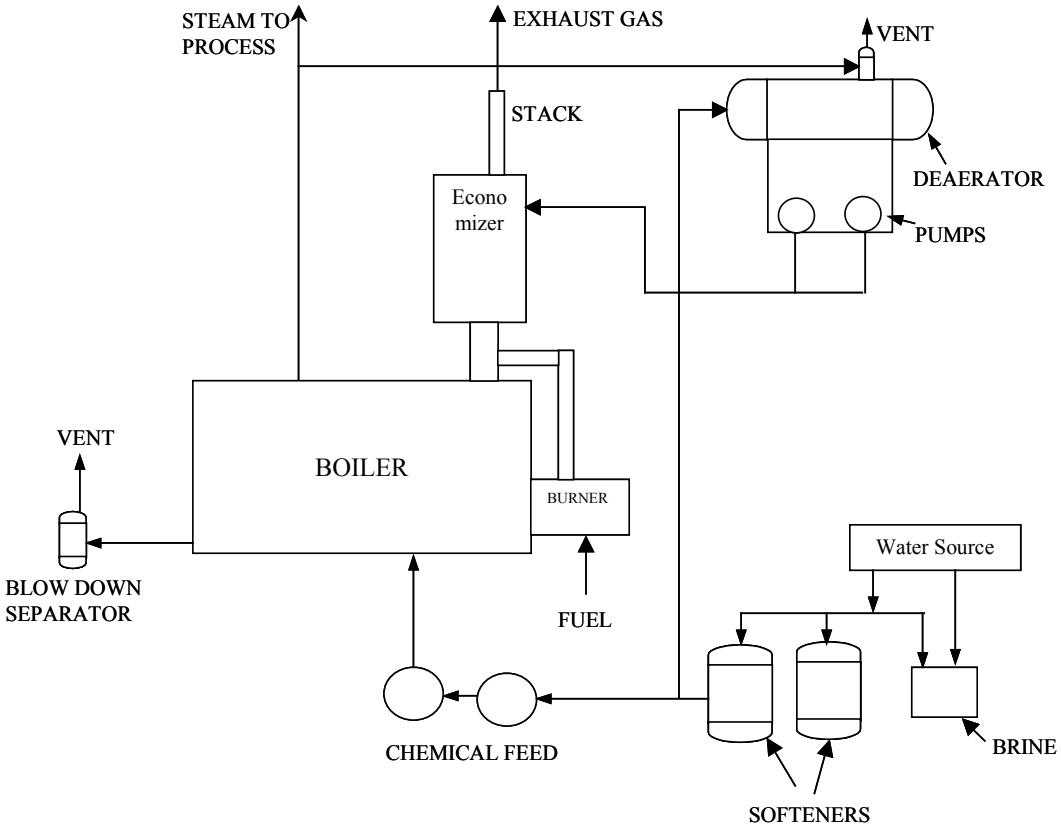


Figure: A typical schematic of a boiler room

Reference: National Productivity Council

Types of boilers

This section describes the various types of boilers: fire tube boiler, water tube boiler, packaged boiler, fluidized bed combustion boiler, atmospheric fluidized bed combustion boiler, pressurized fluidized bed combustion boiler, circulating fluidized bed combustion boiler, stoker fired boiler, pulverized fuel boiler, waste heat boiler and thermic fluid heater.

Fire Tube Boiler

In a fire tube boiler, hot gases pass through the tubes and boiler feed water in the shell side is converted into steam. Fire tube boilers are generally used for relatively small steam capacities and low to medium steam pressures. As a guideline, fire tube boilers are competitive for steam rates up to 12,000 kg/hour and pressures up to 18 kg/cm^2. Fire tube boilers are available for operation with oil, gas or solid fuels. For economic reasons, most fire tube boilers are of "packaged" construction (i.e. manufacturer erected) for all fuels.

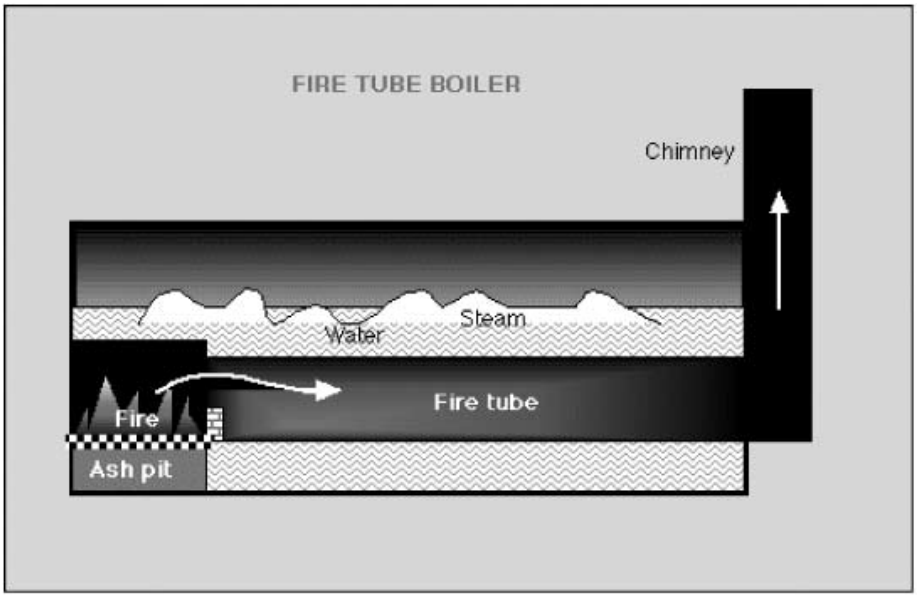


Figure: Sectional view of a fire tube boiler
Reference: http://www.bathtram.org/tfb/tT111.htm

Other types of boilers are described on the CD-ROM and website.

Assessment of boilers

This section describes the performance evaluation of boilers (through the direct & indirect method including examples for efficiency calculations), boiler blow-down and boiler water treatment.

Performance Evaluation of a Boiler

The performance parameters of a boiler, like efficiency and evaporation ratio, reduces with time due to poor combustion, heat transfer surface fouling and poor operation and maintenance. Even for a new boiler, reasons such as deteriorating fuel quality and water quality can result in poor boiler performance. A heat balance helps us to identify avoidable and unavoidable heat losses. Boiler efficiency tests help us to find out the deviation of boiler efficiency from the best efficiency and target problem area for corrective action.

Heat balance

The combustion process in a boiler can be described in the form of an energy flow diagram. This shows graphically how the input energy from the fuel is transformed into the various useful energy flows and into heat and energy loss flows. The thickness of the arrows indicates the amount of energy contained in the respective flows.

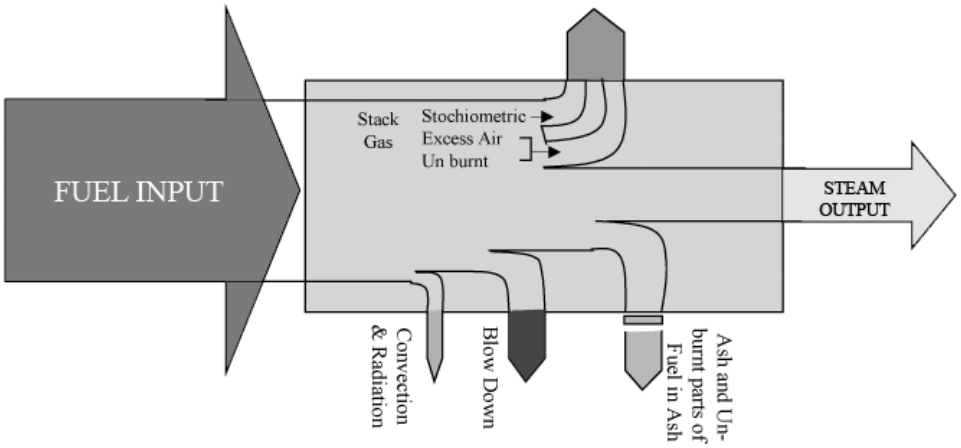


Figure: Energy balance diagram of a boiler

Reference: National Productivity Council, Field Experience

A heat balance is an attempt to balance the total energy entering a boiler against that leaving the boiler in different forms. The following figure illustrates the different losses occurring for generating steam.

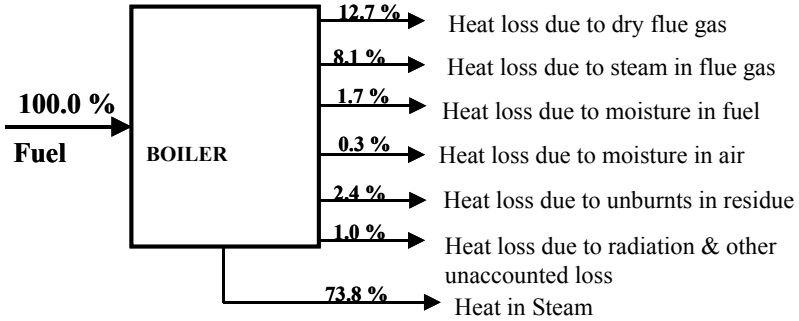


Figure: Typical losses from a coal fired boiler

Reference: National Productivity Council, Field Experience

The energy losses can be divided in unavoidable and avoidable losses. The goal of a cleaner production and/or energy assessment must be to reduce the avoidable losses, i.e. to improve energy efficiency. The following losses can be avoided or reduced:

- Stack gas losses:
  - Excess air (reduce to the necessary minimum which depends from burner technology, operation, operation (i.e. control) and maintenance)
  - Stack gas temperature (reduce by optimizing maintenance (cleaning), load; better burner and boiler technology)
- Losses by un-burnt fuel in stack and ash (optimize operation and maintenance; better technology of burner)
- Blow-down losses (treat fresh feed water, recycle condensate)
- Condensate losses (recover the largest possible amount of condensate)
- Convection and radiation losses (reduced by better insulation of the boiler)

The rest of this section is included on the CD-ROM and website.

Energy efficiency opportunities

This section includes energy efficiency opportunities related to combustion, heat transfer, avoidable losses, auxiliary power consumption, water quality and blow-down.

Energy losses and therefore energy efficiency opportunities in boilers can be related to combustion, heat transfer, avoidable losses, high auxiliary power consumption, water quality and blow-down.

The various energy efficiency opportunities in a boiler system can be related to:

- Stack temperature control
- Feed water preheating using economizers
- Combustion air pre-heating
- Incomplete combustion minimization
- Excess air control
- Radiation and convection heat loss avoidance
- Reduction of scaling and soot losses
- Reduction of boiler steam pressure
- Variable speed control for fans, blowers and pumps
- Controlling boiler loading
- Proper boiler scheduling
- Boiler replacement

Stack Temperature Control

The stack temperature should be as low as possible. However, it should not be so low that water vapor in the exhaust condenses on the stack walls. This is important in fuels containing significant sulphur as low temperature can lead to sulphur dew point corrosion. Stack temperatures greater than 200°C indicates potential for recovery of waste heat. It also indicates the scaling of heat transfer/recovery equipment and hence the urgency of taking an early shut down for water / flue side cleaning.

Energy efficiency opportunities for the other areas are included on the CD-ROM and website.

Option checklist

This section includes the most common options for improving the energy efficiency of a boiler.

Periodic tasks and checks outside of the boiler

- All access doors and plate work should be maintained air tight with effective gaskets.
- Flue systems should have all joints sealed effectively and be insulated where appropriate.
- Boiler shells and sections should be effectively insulated. Is existing insulation adequate? If insulation was applied to boilers, pipes and hot water cylinders several years ago, it is almost certainly too thin even if it appears in good condition. Remember, it was installed when fuel costs were much lower. Increased thickness may well be justified.
- At the end of the heating season, boilers should be sealed thoroughly, internal surfaces either ventilated naturally during the summer or very thoroughly sealed with tray of desiccant inserted. (Only applicable to boilers that will stand idle between heating seasons).

A longer checklist of options for boilers is included on the CD-ROM and website.

Worksheets and other tools

This section includes worksheets (boiler performance; data collection sheet; fuel analysis sheet) and other tools (boiler performance checklist; general rules (rules of thumb); Do's and Don'ts).

WORKSHEET BOILER: BOILER PERFORMANCE

No	Parameter reference	Units	Readings
1	Ultimate Analysis		
	Carbon	per cent	
	Hydrogen	per cent	
	Oxygen	per cent	
	Sulphur	per cent	
	Nitrogen	per cent	
	Moisture	per cent	
	Ash	per cent	
2	GCV of Fuel	KCal/kg	
3	Oxygen in Flue Gas	per cent	
4	Flue Gas Temperature (T_f)	^{0}C	
5	Ambient Temperature (T_a)	^{0}C	
6	Humidity in Air	Kg/kg of dry air	
7	Combustible in Ash	per cent	
8	GCV of Ash	KCal/kg	
9	Excess Air Supplied (EA): $(O_2 \times 100)/(21 - O_2)$	per cent	
10	Theoretical air requirement (TAR) $[11 \times C + \{34.5 \times (H_2 - O_2/8)\} + 4.32 \times S]/100$	kg/kg of fuel	
11	Actual mass of air supplied {1 + EA/100} x theoretical air	kg/kg of fuel	
12	Percentage heat loss due to dry flue gas $\{k \times (T_f - T_a)\}$ / per centCO2 Where, k (Seigert const.) = 0.65 for Coal = 0.56 for Oil = 0.40 for NG	per cent	
13	Percentage heat loss due to evaporation of water formed due to H_2 in fuel: $[9 \times H2 \{584 + 0.45(T_f - T_a)\}]$/ GCV of Fuel	per cent	
14	Percentage heat loss due to evaporation of moisture present in fuel: $[M \times \{584 + 0.45 \times (T_f - T_a)\}]$ / GCV of Fuel	per cent	
15	Percentage heat loss due to moisture present in air $\{AAS \times Humidity \times 0.45 (T_f - T_a) \times 100\}$ / GCV of Fuel	per cent	
16	Percentage heat loss due to combustibles in ash {Ash x (100 – Comb. In Ash) x GCV of Ash x 100} / GCV of Fuel	per cent	
17	Total Losses	per cent	
18	Efficiency	per cent	

Other worksheets and tools are included on the CD-ROM and website.

References

1. Considine, Douglas M., *Energy Technology Handbook*, McGraw Hill Inc, New York, 1977.
2. Jackson, J. James, *Steam Boiler Operation*, Prentice-Hall Inc., New Jersey, 1980.
3. Pincus, Leo I., *Practical Boiler Water Treatment,* McGraw Hill Inc., New York, 1962.
4. Shields, Carl D., *Boilers*, McGraw Hill Book Company, U.S, 1961.
5. Elonka, Jackson M., and Alex Higgins, *Steam Boiler Room Questions & Answers,* Third Edition
6. Gunn, David., and Robert Horton, *Industrial Boilers*, Longman Scientific & Technical, New York
7. India Energy Bus Project, *Industrial Heat Generation and Distribution* -NIFES Training Manual Issued For CEC
8. Technical Papers, Boiler Congress-2000 Seminar, 11 & 12 January 2000
9. Fluidised Bed Coal-Fired Boilers – Department of Coal Publications, Government of India
10. Fluidised Combustion of Coal – A National Coal Board Report, London
11. Steam Generation, Distribution and Utilisation by TERI, GTZ and EMC
12. Efficient Operation of Boilers by National Productivity Council

www.eren.doe.gov
www.oit.doe.gov/bestpractices
www.pcra.org
www.energy-efficiency.gov.uk
www.actionenergy.org.uk
www.cia.org.uk
www.altenergy.com

Example of monitoring equipment information: combustion analyzer

To give an idea of what information you can find on the CD-ROM and website for each monitoring type of equipment, and example is given for the combustion analyzer section in the monitoring equipment chapter.

What a combustion analyzer does

The combustion analyzer is an instrument that measures the composition of the flue gases after the combustion has taken place. Depending on the requirement at the site these can ordered to match the requirement. Basically all combustion analyzers measure the percentage oxygen or carbon dioxide in the flue gases and then using an in-built programme to calculate the efficiency if required. The various types of combustion analyzers are given below:

Fuel Efficiency Monitor:

This monitor measures Oxygen and temperature of the flue gas. Calorific values of common fuels are fed into the microprocessor which calculates the combustion efficiency**.**

Fyrite:

A hand bellow pump draws the flue gas sample into the solution inside the fyrite. A chemical reaction changes the liquid volume revealing the amount of gas. The percentage oxygen or carbon dioxide can be read from the scale.

Gas analyzer:

This instrument has in-built chemical cells which measure various gases such as CO_2, CO, NO_X, SO_X etc.

Where the combustion analyzer is used

These instruments are used to determine the composition of the flue gases in the duct. The duct is the large piping arrangement of rectangular configuration and is used to flush out the combusted gases to the chimney. The value obtained of the different composition of the flue gases are by volume basis. Mostly these instruments measure the percentage carbon dioxide or oxygen and the temperature of the flue gas. During energy audit studies the composition of the flue gases is desirable to be known to assess the combustion conditions and also the in leakages of the atmospheric air into the system.

How to operate a combustion analyzer

The different types of the combustion analyzers are operated differently. In all the instruments the probe is inserted into the duct through a small hole made in the duct for monitoring purposes. In case of a fyrite, which is manually operated, the flue gas from the duct is sucked out using a manual pumping device whereas in most of the other analyzers the flue gases are pumped out of the ducts using a suction pump. The sucked gases react with the chemical/cells and give the reading of percentage oxygen or carbon dioxide.

Precautions and safety measures necessary for the combustion analyzer

Some of the safety precautions to be undertaken while using the instrument are:

- Always calibrate the instrument in open (fresh) air before taking a set of measurements.
- Check for any clogging of the air filters of the instrument
- During measurements, ensure that the rubber tubing carrying the gases from the duct to the instrument is not bended.
- After insertion of the probe into the duct, care should be taken to wrap the opening space left by cotton rags to ensure that there is no, infiltration or ex-filtration of air
- Thick cotton hand gloves, goggles, safety helmet etc. should be worn before taking the readings. Remember the gases you are handling are very hot.
- More detailed safety and precautions should be consulted from the operation manual of the instrument before using the equipment

References

http://www.energymanagertraining.com/energy_audit_instruments/new_energy_audit_equipment.htm

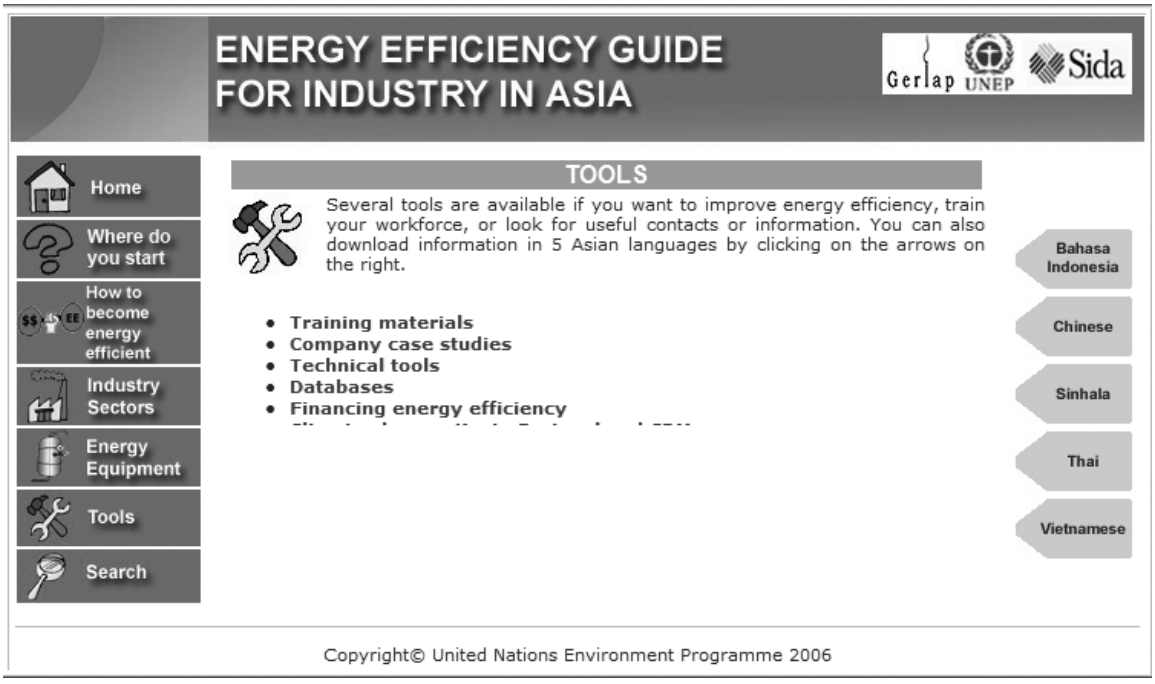
PART 5
TOOLS

Part 5: Tools

Part 5 offers training materials, option checklists, worksheets, a contact and information database and many more tools and resources to help companies improve energy efficiency. Here you can also download materials that have been translated into Bahasa Indonesia, Chinese, Sinhala, Thai and Vietnamese.

This hard copy Guide gives a summary of what is included on the CD-ROM and website

When you go to the Tools part of the Guide the following screen will appear:



Training materials

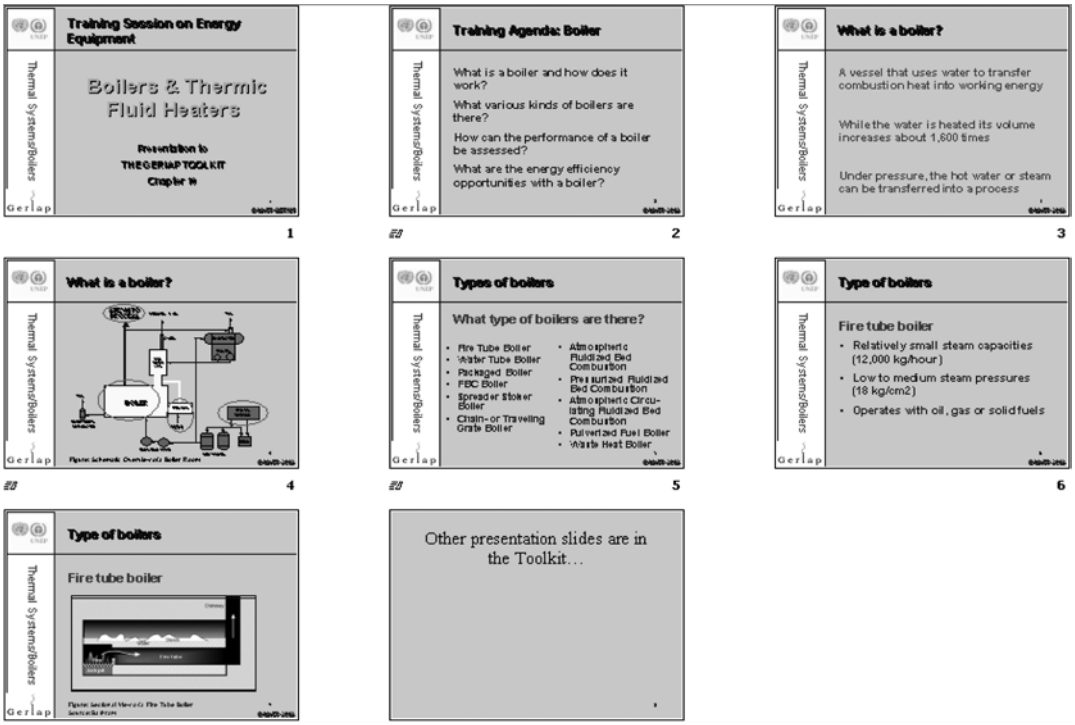
Training of company management and production staff is important because this allows the company to identify and implement energy efficiency options by themselves. The training materials in this Guide can be used by external organizations to train facilitators or company staff, but it is also possible to go through the training materials on your own.

Training materials in the Guide are described in the table below. As new training materials are developed in the future, these will be made available on the website version of the Guide (www.energyefficiencyasia.org).

Table: Training materials included in the Guide

Topic	Type of materials	Contents and duration of presentation	Translated into 5Asian languages
Company Energy Efficiency Methodology	Textbook Presentation slides	A six step methodology for companies to become more energy efficient	Yes
Energy equipment	Textbook chapters (see Part 3 of Guide) Presentation slides and speaker notes	Electrical energy equipments: ▪ Electricity (1 hr) ▪ Electric motors (1.5 hrs) ▪ Fans and blowers (1.5 hrs) ▪ Pumps and pumping systems (1.5 hrs) ▪ Cooling towers (1.5 hrs) ▪ Air conditioning and refrigeration (1.5 hrs) ▪ Compressors and compressed air system (1.5 hrs)	No
	Textbook chapters (see Part 3 of Guide) Presentation slides and speaker notes	Thermal energy equipments: ▪ Fuels and combustion (1.5 hrs) ▪ Boilers and thermic fluid heaters (2.5 hrs) ▪ Steam distribution and utilization (1.5 hrs) ▪ Furnaces and refractories (2.5 hrs) ▪ Waste heat recovery (1 hr) ▪ Cogeneration (1 hr)	No
	Textbook chapter (see Part 3 of Guide Presentation slides and speaker notes	Monitoring equipments (1.5 hrs)	No
Industry sectors	Textbook chapters (see Part 4 of Guide) Presentation slides and speaker notes	Cement (1 hr) Chemicals (fertilizer production only) (1 hr) Ceramics (tiles manufacturing only) (1 hr) Pulp and paper (1 hr) Iron and steel (secondary steel only) (1 hr)	No
Other	Presentation slides	Climate change (1 hr)	No
	Presentation slides	Greenhouse Calculator (1 hr)	No
	Presentation slides and workshop exercises	Financing Cleaner Production and energy efficiency options (4 hrs)	No

An example of presentation slides is given for Boilers and Thermic Fluid Heaters.



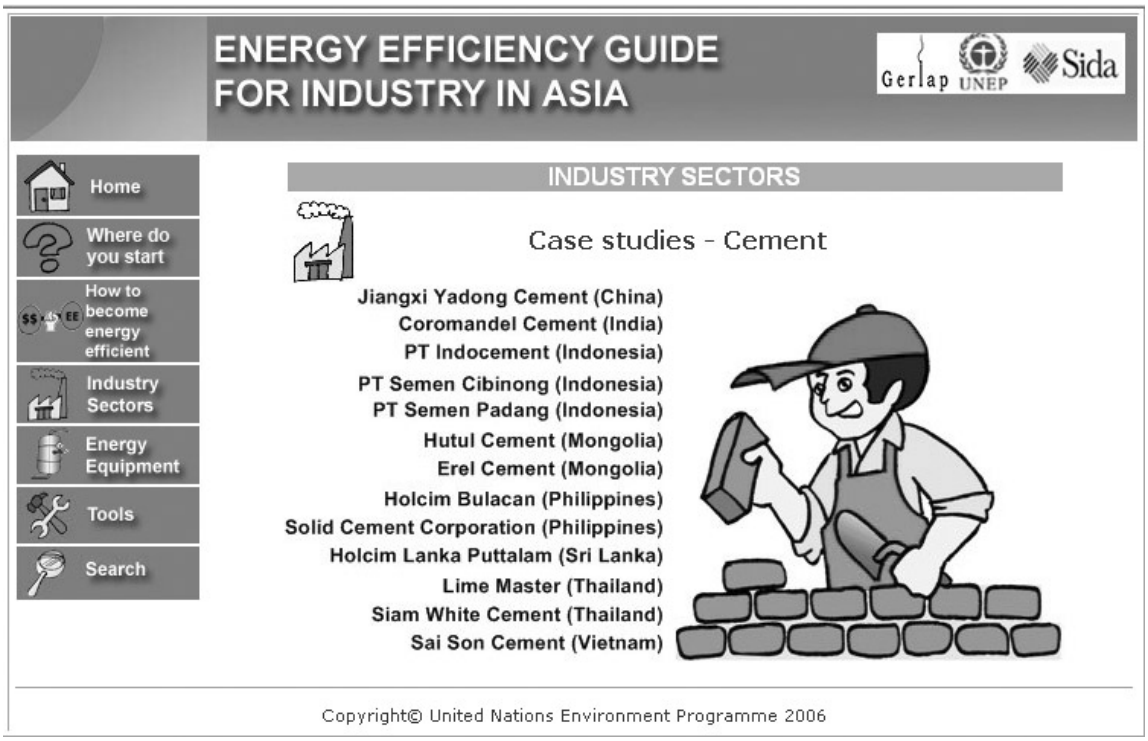
Company case studies

Case studies were written for more than 40 companies that participated in the GERIAP project.

Users of the Guide may want to search for different types of case studies. For this reason, case studies can be searched by:

- Country: Bangladesh, China, India, Indonesia, Mongolia, Philippines, Sri Lanka, Thailand and Vietnam
- Industry sector: cement, chemicals, ceramics, iron and steel, pulp & paper
- Energy equipment:
  - Electrical energy equipments (electric motors, fans and blowers, pumps and pumping systems, cooling towers, air conditioning and refrigeration, compressors and compressed air system)
  - Thermal energy equipments (boilers and thermic fluid heaters, steam distribution and utilization insulation, furnaces and refractories, waste heat recovery, cogeneration)

For example, if you click on “Industry sector” and then “Cement” the screen below will appear. Then you can select one of the 15 cement companies and download that company’s case study materials.



For each company, case study materials include a "company case study summary" and "case study options". Appendix C gives a list of all case study options and the relevant country, industry sector, energy equipment and other keywords.

Information included in the Company Case Study Summary
An example for a cement company is included in Appendix D

Company description: general information about the company such as name company, location, year of establishment, ownership (family/state /private national/private multinational), number of staff, products, annual production or production capacity, reason for participating in GERIAP, and any other information of interest

Process description: description of the main process steps at the company

Methodology application: examples of how the Company Energy Efficiency Methodology was applied in practice at the company, due that the methodology steps had to be adjusted depending on the company's individual needs, noting that each company is different. See also part 3 and appendix A of the Guide.

Options:

- The focus areas selected for the project (e.g. boiler house, kiln, fans)
- Total options (1) identified (2) implemented (3) still to be implemented (4) requiring further analysis (5) found unfeasible / not to be implemented
- For the options implemented, the total investment costs, annual savings, and payback period
- For the options implemented, the total energy reductions, greenhouse gas reductions, and other environmental benefits
- The total greenhouse gas reductions (in tons CO_2) at the plant between the start of the project in 2003 and the end of the project in 2005.
- A table summarizing the results of each individual implemented option, including
  - Focus area and option title
  - Type of option: good housekeeping, improved process management, production process/ equipment modification, new technology / equipment, input materials substitution, production of useful byproduct, product modification (see Part 3, Company Energy Efficiency Methodology for definitions)
  - Financial results: investment costs, annual savings, and payback period
  - Environmental results: energy reductions, greenhouse gas reductions, and other environmental benefits
  - Comments (e.g. other benefits, barriers encountered)

For more information: Contact details of the company and the country's National Focal Point for the GERIAP project

Information included in the Case Study Options
An example is included in Appendix E

Title of option:

Summary of the option: mentioning the company name, location and products produced, and describing in short what was observed, what option(s) were implemented, and the main results

Keywords: country, industry sector, energy equipment, and other keywords

Observations: an explanation of what was observed during the energy assessment (e.g. a high CO level in the exit flue gas of the boiler, which indicates incomplete combustion), and what caused this (e.g. too low air supply or too large lumps of coal)

Options: a detailed description of the options to solve the problem and improve energy efficiency and drawings or photos to illustrate what was done

Results:
- Financial results: investment costs, operating costs, annual savings, payback period
- Environmental results: energy reductions, greenhouse gas reductions, and other environmental benefits
- Other results (e.g. improved workers conditions, better product quality)
- Charts, graphs or tables to illustrate the savings

For more information: Contact details of the company and the country's National Focal Point for the GERIAP project

Note: for several simple and no/low cost options only a summary was written

Technical tools

Several technical tools can assist a company to carry out an energy assessment, identify and implement energy efficiency options and monitor results. The table below describes the technical tools included in the CD-ROM and website Guide. More technical tools may be added to the website in the future, so please frequently visit www.energyefficiencyasia.org.

Table: Technical tools included in the Energy Efficiency Guide for Industry in Asia

Technical tool	Contents	Format	Translated into 5 Asian languages
Worksheets	Company Energy Efficiency Methodology: ▪ Worksheet 1. Reasons for energy efficiency ▪ Worksheet 2. Energy Management Matrix ▪ Worksheet 3. Factors of influence on improving energy efficiency ▪ Worksheet 4. Team members and roles ▪ Worksheet 5. General company details ▪ Worksheet 6. General production flow chart ▪ Worksheet 7. Production, energy and resource data ▪ Worksheet 8. Inventory of major equipment ▪ Worksheet 9. Information collected / available for each process step ▪ Worksheet 10. Criteria for selecting focus areas ▪ Worksheet 11. Energy Assessment Proposal to top management ▪ Worksheet 12. List of training courses ▪ Worksheet 13. Process flow chart for focus areas ▪ Worksheet 14. Walkthrough observations ▪ Worksheet 15. Causes, options and screening ▪ Worksheet 16. Options feasibility, implementation and monitoring ▪ Worksheet 17. Ranking of options ▪ Worksheet 18. Implementation proposal to top management	Word doc	Yes
	Electrical energy equipments: ▪ Electric motors ▪ Fans and blowers ▪ Pumps and pumping systems ▪ Cooling towers ▪ Air conditioning and refrigeration ▪ Compressors and compressed air systems	Word doc	No
	Thermal energy equipments: ▪ Fuels and combustion ▪ Boilers and thermic fluid heaters ▪ Steam distribution and utilization ▪ Furnaces and refractories ▪ Waste heat recovery ▪ Cogeneration	Word doc	No
Option checklists	Electrical energy equipments: ▪ Electric motors ▪ Fans and blowers ▪ Pumps and pumping systems ▪ Cooling towers ▪ Air conditioning and refrigeration ▪ Compressors and compressed air system	Pdf	Yes
	Thermal energy equipments: ▪ Fuels and combustion ▪ Boilers and thermic fluid heaters ▪ Steam distribution & utilization ▪ Furnaces and refractories ▪ Waste heat recovery ▪ Cogeneration	Pdf	Yes

	Industry sectors ▪ Cement ▪ Chemicals (fertilizer production only) ▪ Ceramics (tiles manufacturing only) ▪ Pulp and paper ▪ Iron and steel (secondary steel only)	Pdf	Yes
Calculation tables	▪ Table of density ▪ Specific heat ▪ Conductivity ▪ Steam table ▪ Psychometric chart ▪ Calorific value of different fuels	Pdf	No
Technical terms	A list of technical terms and abbreviations used for electrical and thermal energy equipments	Pdf	No

Database

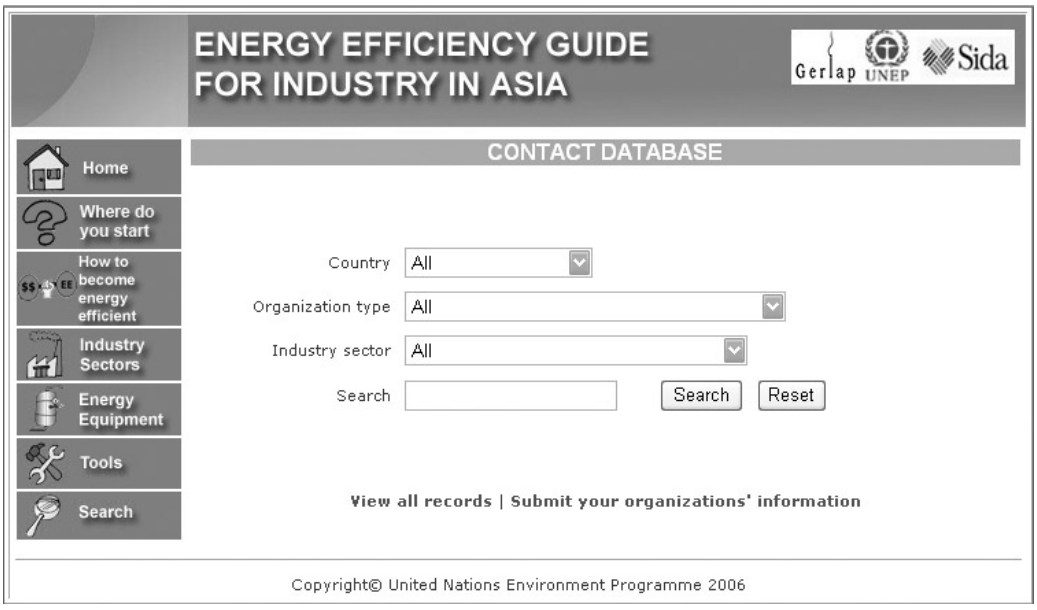
Several databases are available to provide contacts, information, events, projects/programs and training courses.

Contact database

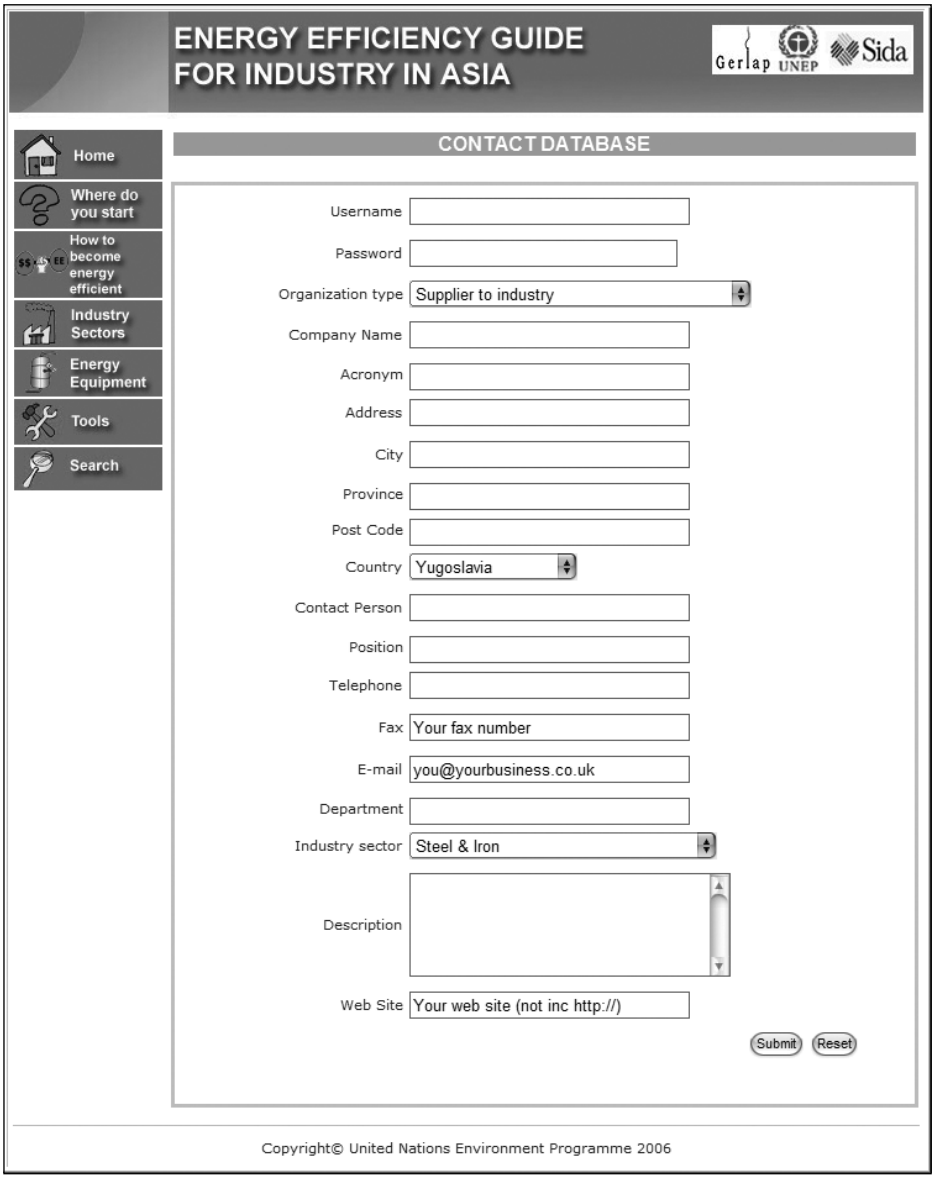
The website Guide includes a Contact Database especially for the nine GERIAP countries (although contacts from other countries are also included). When you go to the database, the screen below appears. You can search for contacts by:

- Country: the nine GERIAP countries but also other countries)
- Organization type: National Government; Province / Local government; Industry association / Chamber of commerce; Financial institution; Academic / Research; Consultant / service provider; International organization; NGO; Media; Supplier to industry; Other
- Industry sector: cement, chemicals, ceramics, iron & steel, pulp & paper, or other

For example, if you are an Indonesian cement producer wanting to start an energy assessment, you can search the database for consultants / service providers in Indonesia who may be able to help you.



If you are not yet in the database, you can also add your information into the database so that others can locate you. When you click on "Submit your organization's information" you can fill in and submit the following form:



Information database

The website Guide includes an Information Database on energy efficiency and Cleaner Production. When you go to the database, you can search for information by:

- Search: you will need to type in relevant keywords such as the author, country, topic, industry sector, etc.
- Information type: All, Case studies, Course/Event, Policy/Legislation, Project/Programme, Publication
- Information format: documents, website, CD-ROM
- Country

Most of the publications produced during the GERIAP project are included on this database (newsletters, surveys, training materials, company case studies), and the database has been supplemented with external information.

For example, you may want to find out about other case studies outside the GERIAP project, or a training course on energy efficiency to attend.

You can also add new information to the database by clicking on "submit new information" and providing the following details:

- Title
- Information type, with the following options: Case studies, Course/Event, Policy/Legislation, Project /Programme, Publication, Other
- Date: this can be the date a report was published or the dates of a training course
- Contact/Author (if applicable): e.g. the author of an industry survey report and contact details
- Organization: name of the organization who the information belongs to, e.g. the organization giving the training course or the ministry responsible for a certain energy policy
- Short description: describe in maximum 200 words the information content or give other details
- Attach: provide the link to the website where this information can be found, an email address of where the information can be ordered, or attach the document for uploading onto the Guide website

Financing energy efficiency

Financing energy efficiency projects is often a problem for many companies, especially when it concerns large projects such as cogeneration. For this reason, the Guide provides the following information:

- Contacts: a list of financial institutions and ESCOs included in the Contact Database
- Training materials: "Financing Cleaner Production" presentation and workshop exercises
- Links to useful websites on financing, in particular UNEP's CP Financing website (see below)

United Nations Environment Programme Division of Technology Industry and Economics

Financing Cleaner Production

In 1999 UNEP started a four-year project aiming at increasing investments in cleaner production in developing countries. The project demonstrates how such investments can be stimulated by helping financial institutions understand the importance of cleaner production and helping cleaner production experts develop creditworthy investment proposals**.**

The Web Site will offer you:

- Information: Providing and encouraging world wide exchange of information and knowledge on the challenges and opportunities, as well as on the main actors in financing cleaner production investments.
- Links: Forging alliances with financial institutions, organisations and research institutions promoting cleaner production investments.
- Investment Window: Featuring success stories and investment opportunities
- Training and Tools: Enhancing skills and knowledge with the support of top-level international expert partners

http://www.financingcp.org/

Climate change, Kyoto Protocol and CDM

Climate change is an emerging risk facing the industry sector in Asia and the Pacific. Every business will be impacted directly or indirectly and must understand available options to manage risks and maximise opportunities.

Briefing paper on climate change

An 8-page briefing paper "*Climate Change – What Every Asia and Pacific Company Must Know"* explains the following:

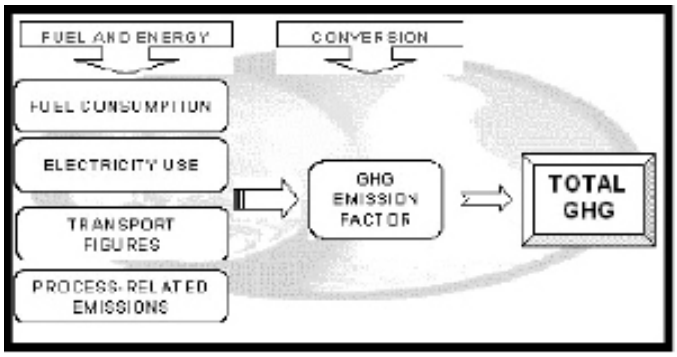
- Understanding climate change policies and responses: explanation of what causes climate change, the different policy responses by national governments, and the Kyoto Protocol
- Risks and opportunities to Asia and Pacific industry: explanation of how every company will be affected by climate change, and examples of risks and opportunities for four GERIAP industry sectors (cement, chemicals, pulp and paper, iron and steel)
- How companies should respond to climate change: what companies should include in their strategy to respond to climate change, which then should be implemented and evaluated regularly
- What is the Clean Development Mechanism (CDM): an explanation of what CDM is, criteria for CDM projects, eligible projects, the CDM project cycle
- Case studies of CDM in the Asia and Pacific region: four examples of projects that are eligible for CDM
- Further information about climate change, the Kyoto Protocol and CDM: important organizations, publications and newsletters

GHG Indicator

The *GHG Indicator* is a tool that can be used to calculate greenhouse gas (GHG) emissions for a company and can be found at: www.uneptie.org/energy/act/ef/ghgin/.

The "The *GHG Indicator*: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organisations" explains how the indicator works.

The GHG Indicator itself is an excel-based programme and GHG emissions are calculated as shown in the figure below. Data are collected for fuel and energy (fuel consumption, electricity use, transport) and for process-related emissions in separate spreadsheets. These data are then multiplied by company specific or standard emission factors. The total GHG emissions for a company are calculated in a summary spreadsheet.



As part of the GERIAP project a simplified spreadsheet was developed to allow companies to quickly calculate their emissions.

The World Business Council for Sustainable Development (WBCSD) has developed updates and sector specific calculation tools under the "*GHG Protocol*" initiative. This is an internationally accepted GHG accounting and reporting standard consisting of standards, practical guidance and calculation tools for different industry sectors. Sectors relevant to GERIAP include iron & steel, chemicals (nitric acid, ammonia, adipic acid), cement , pulp & paper. The calculations tools are electronic Excel spreadsheets with accompanying step-by-step guidance. Found at: www.ghgprotocol.org/standard/tools.htm

Translated materials into 5 Asian languages

The following information has been translated into Bahasa, Chinese, Sinhala, Thai and Vietnamese and can be downloaded as pdf or word documents from the CD-ROM and website Guide.

Translated material	Description
Part 1: Where do you start	
Where do you start	Explanation of how to best use this Guide if you are a company manager, production staff, customer, supplier, government agency, financial institution, or other external organization who could facilitate energy efficiency in industry
Part 2: How to become energy efficient	
Company Energy Efficiency Methodology	A 6-step methodology to assist companies to become more energy efficient
Company examples of methodology	Examples of how the methodology was applied in practice at more than 40 companies that participated in the GERIAP project
Part 3: Industry sectors	
Option checklists	Checklists with common options to improve energy efficiency for the five GERIAP industry sectors ▪ Cement ▪ Chemicals (fertilizer production only) ▪ Ceramics (tiles manufacturing only) ▪ Pulp & paper ▪ Iron & steel (secondary steel only)
Company case studies	For more than 40 companies that participated in the GERIAP project: ▪ Company case study summaries: an description of the company, the production process, examples of how the methodology was applied in practice, summary of options and results from implementation ▪ Case study options: observation what was observed, what option(s) was implemented, the main results, and contact details for more information
Part 4: Energy equipment	
Option checklists	Checklists with common options to improve energy efficiency for: ▪ Electrical energy equipments (electric motors, fans and blowers, pumps and pumping systems, cooling towers, air conditioning and refrigeration, compressors and compressed air systems) ▪ Thermal energy equipments (boilers and thermic fluid heaters, steam distribution & utilization, furnaces and refractories, Waste heat recovery, cogeneration)
Part 5: Tools *(note: translated tools are already mentioned in part 1 – 4)*	
GERIAP project	Description of the GERIAP project and the project partners
Guide brochure	
Guide publication	