ENERGIZING CLEANER PRODUCTION

–A Guide for Trainers

Internationale Weiterbildung und Entwicklung gGmbH
Capacity Building International, Germany

UNEP

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A Guide for Trainers

United Nations Environment Programme

Division of Technology, Industry and Economics

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Foreword

Industrial production is at the heart of a growing US$ 60 trillion global economy, and industrial development is a key element to reducing poverty. The increasing demand for the energy to power industry, however, is also producing unwanted effects, including higher energy prices, increased air pollution and higher emissions of greenhouse gases linked to climate change.

To protect both economic growth and environmental values, we need to rapidly increase energy efficiency and deploy less carbon-intensive energy sources. Due to its size and importance, the industrial sector is a key player to achieving these goals.

But this change is often not easy, and can follow a steep learning curve. Cleaner Production Centres and research/academic institutes can help, as can industry associations and consultancies, but many of these organizations lack the resources to develop comprehensive training regimes and materials.

UNEP programmes are designed to fill such gaps. This guide *Energizing Cleaner Production – a Guide for Trainers*, includes a *Management Course* for company managers, which outlines an approach to improve energy efficiency, more effective national policies, mechanisms to finance projects, and the Clean Development Mechanism of the Kyoto Protocol. The Guide also includes a *Technical Course* providing company staff with more detailed knowledge about energy equipment, such as boilers and electric motors, and training to assess performance and identify cost-effective energy efficiency opportunities.

Energizing Cleaner Production – a Guide for Trainers was developed with support from InWEnt - Capacity Building International, Germany, and is based on materials from previous UNEP projects that apply the cleaner production approach to improve energy efficiency. Our experience from that work is that opportunities abound, and we encourage you to use and profit from this guide. UNEP and InWEnt also invite your feedback and comments, which can be sent to the organization addresses provided.

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Many of the training sessions were based on materials from the "Energy Efficiency Guide for Industry in Asia" (www.energyefficiencyasia.org) that was developed by UNEP as part of the Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific project and funded by the Swedish International Development Cooperation Agency (Sida).

UNEP, therefore, wants to thank InWEnt and Sida for their support to the training guide and course materials.

Contents

1. Introduction

1.1 Background

InWent works with the United Nations Environment Programme (UNEP) to build the capacity of cleaner production centers and similar organizations on a range of preventive environmental management topics. In 2006, InWEnt and UNEP developed an advanced training course and trainer's guide on energy efficiency (EE) in industry using the cleaner production (CP) approach.

The advanced training course and guide were prepared based on materials from previous UNEP projects that applied an approach integrating CP and EE. InWEnt and UNEP developed an initial awareness raising seminar for NCPCs and identified the methodology and how best to work with them. As a next effort, the GEF supported **CP-EE project** titled "Promoting Industrial Energy Efficiency through a Cleaner Production / Environmental Management System Framework" aimed to reduce industrial greenhouse gas emissions by improving energy management practices and identifying new CP-EE investments for small- and medium-sized companies (SMEs). The approach was taken one step further in Asia, by the project "Greenhouse gas Emission Reduction from Industry in Asia and the Pacific (**GERIAP**) which had a more sectoral focus, with the support of the Swedish International Development Cooperation Agency (Sida), and partner agencies such as country governments and UNIDO/UNEP National Cleaner Production Centres (NCPCs) in nine Asian countries. This project led to the publication "Energy Efficiency Guide for Industry in Asia" which was also in the form of a CD-ROM and on internet at www.energyefficiencyasia.org.

The advanced train-the-trainer course was held at the InWent Lake Starnberg International Conference Centre in Feldafing, Germany in July 2006. Fifteen representatives from cleaner production centres and similar organizations from South America, Africa and Eastern Europe participated. The final versions of the ***Management Course*** and ***Technical Course*** on energy efficiency were prepared based on the course experience and participant feedback.

Both courses are designed to be given by cleaner production centres, or similar organizations, to industry (company management and staff) and people working with industry such as industry associations, consultants, non-governmental organizations, government agencies, research institutes, or academic institutions.

1.2 Contents of this Guide

The purpose of this publication is to provide guidance to trainers who wish to deliver the ***Management Course*** (Section 2) and/or the ***Technical Course*** (Section 3). The guide explains:

- The objectives and target audience of each course;
- Course agenda;
- Trainer requirements;
- Each session and suggestions on how to best deliver the session and assess participants; and
- How to evaluate the course.

1.3 Contents of the CD-ROM

The publication is accompanied by a CD-ROM that can be (partially) copied or printed to disseminate to course participants. The CD-ROM consists of three parts:

- **Guide to Trainers:** which is the text of this publication.
- **Management Course:** which includes the agenda, evaluation form, and materials for the training sessions including PowerPoint presentations, background reports and tools, workshop exercises and quizzes.
- **Technical Course:** which includes the agenda, evaluation form and materials for the training sessions on energy equipment including PowerPoint presentations, background chapters, workshop exercises and quizzes.

A detailed table of contents of the CD-ROM is included in Appendix C.

About InWEnt

InWEnt - Internationale Weiterbildung and Entwicklung gGmbH, or, in English, InWEnt Capacity Building International, Germany, stands for the development of human resources and organizations within the framework of international cooperation. InWEnt's services cater to skilled and management staff as well as to decision makers from business, politics, administration and civil societies world-wide. InWEnt cooperates equally with partners from developing, transition and industrialized countries and gets through to approximately 55,000 participants yearly.

About UNEP

UNEP is the voice for the environment in the UN system. It is an advocate, educator, catalyst and facilitator, promoting the wise use of the planet's natural assets for sustainable development. The organization works with many partners, including UN entities, international organizations, national governments, non-governmental organizations, business, industry, the media and civil society.

UNEP's work includes: • Assessing global, regional and national environmental conditions and trends • Developing international and national environmental agreements and legal instruments • Strengthening institutions for the wise management of the environment • Integrating economic development and environmental protection • Facilitating the transfer of knowledge and technology for sustainable development • Encouraging new partnerships and approaches within civil society and the private sector

One of the aims of UNEP's Division of Technology, Industry and Economics (DTIE) is to assist industry in reducing their environmental impact through Cleaner Production and Energy Efficiency.

2. Management Course

This section explains the ***Management Course*** on energy efficiency.

2.1 Target Audience and Objectives

This course is aimed at senior management of companies and can be given to organizations that work closely with company management, such as cleaner production centres, government agencies, or industry associations.

The overall purpose of this course is to improve energy efficiency in industry. The specific objectives of the course are to enable participants to:

- Become aware of the importance of energy efficiency and its potential benefits for industry and the environment;
- Understand how to improve energy efficiency in industry in a systematic way and integrate continuous improvement into business processes;
- Obtain a basic understanding of the Clean Development Mechanism (CDM) under the Kyoto Protocol and be able to assess a particular project's eligibility and feasibility under CDM;
- Identify barriers to energy efficiency in industry and how to overcome them, including: an improved ability to measure energy use and greenhouse gas emissions, the potential role of government policies to facilitate energy efficiency, and of the available mechanisms to help finance energy efficiency projects; and to
- To be able to calculate GHG emissions of companies using the GHG Indicator.

2.2 Course Agenda

This course was designed for three days and the suggested course agenda is on the next page. The trainer may decide to increase or reduce the number of days or amend the agenda, depending on the audience, time available and the need to cover additional/different topics. For example, a one-day course could cover only the Energy Efficiency Methodology. Appendix C lists the training materials that are included on the CD-ROM that accompany the guide.

2.3 Trainer Requirements

To ensure the success of the training, some considerations for the selection of trainers are offered. One trainer can deliver the course because the lectures are followed by workshop exercises so the trainer does not need to deliver presentations all the time.

Ideally, a trainer should have experience with cleaner production assessments, preferably with energy efficiency. This increases credibility with the audience and the lectures can be illustrated with concrete examples taken from the trainer's experience. It is also important that the trainer has experience working with senior management in industrial companies, especially if company managers attend the course. Knowledge of environment, quality, or information management systems is essential as this course deals with energy efficiency at a management level rather than at a technical level.

Energizing Cleaner Production: Agenda of Management Course

	9.00 – 10.30	10.30 – 11.00	11.00 – 12.30	12.30 – 13.30	13.30 – 15.00	15.00 – 15.30	15.30 – 17.00
Day 1	**Introduction** – course and participants	BREAK	**EE Methodology** – steps 1 and 2 lecture and workshop exercise	LUNCH BREAK	**EE Methodology** – step 3 lecture and workshop exercise	BREAK	**EE Methodology** – steps 4, 5 and 6 lecture and workshop exercise
Day 2	**Kyoto Protocol and CDM** – lecture		**Kyoto Protocol and CDM** – workshop exercise		**Barriers to EE** - lecture		**Barriers to EE** – workshop exercise
Day 3	**Measuring GHG emissions** - lecture		**Policies for EE** – lecture and workshop exercise *OR* **Financial Feasibility Analysis** - lecture		**Financing EE Projects** - lecture		**Financial Feasibility Analysis / Financing EE Projects** – workshop exercise **Course evaluation**

Depending on the trainer's experience, it may be desirable to invite guest trainers to deliver specific sessions or a specialist to attend sessions to answer questions. For example, while it is possible to deliver the CDM and Kyoto Protocol sessions without in-depth knowledge, in practice, participants can ask quite detailed questions because it is a new and complex area. Similarly, the sessions on energy efficiency policies and financial mechanisms could have more credibility if a government policy maker or a banker could be present at the respective sessions. An alternative is to set up a panel of specialists on these topics to answer questions or take part in a facilitated discussion.

2.4 Session Guidance

Appendix A provides guidance for each session of the ***Management Course***, which should enable the trainer to deliver the session more effectively. The guidance includes:

- Title of the session
- Background
- Objective
- Minimum duration and approach
- Contents
- Assessment of participants
- Other comments

2.5 Course Evaluation

Determining Participant Expectations

It is important to evaluate the course at the end of the last session. But it is equally important to assess participant expectations at the outset of the training. This allows the trainer to emphasize information or discuss topics that participants have identified as important. The trainer can amend the agenda to accommodate participants' expectations if possible. For example, if participants know a lot about energy equipment, then more time can be spent on identifying areas for energy conservation, explaining case studies from other companies, or visiting a plant. In addition, determining expectations upfront makes it easier for the trainer and the participants to assess if expectations have been met or not.

Expectations can be determined by asking each participant to complete a short questionnaire prior to the course, or by asking everyone to introduce themselves and explain what they hope to learn during the introductory session. It is important that the trainer writes expectations down. This can be done on a whiteboard or flipchart or on a separate sheet in the following way:

Name participant	Organization / country	Expectations from the course
1.		
2.		
3.		
etc.		

Evaluation Discussion

During the last session, the trainer can ask participants to reflect on how the course met their expectations using three questions:

- What was useful about the course?
- What could be improved or what was missing?
- What will be done with what was learned?

Then participants can be asked one-by-one to verbally explain their answers. The advantage of this method is that people can react to and reflect on each other's comments before giving their own views. A trainer can get a good sense about the reaction to the course from the group as a whole. It is important to have written expectations from the beginning of the course at hand to be able to compare expectations with actual outcomes.

Evaluation Form

Suggested evaluation questions are given below, but the trainer can decide to remove/add questions as required.

Name:	
Organization:	
Date of course:	

1) Did the course meet your expectations?

Yes ☐ No ☐ Somewhat ☐

Comments:

2) Will this course help you carry out your job?

Yes ☐ No ☐ Somewhat ☐

Comments:

3) Were the course handouts adequate?

Yes ☐ No ☐ Somewhat ☐

Comments:

4) For each course session, please rate the quality of the session, if the topic was treated in sufficient detail and what was learned.

1 = Poor 2 = Moderate 3 = Satisfactory 4 = Good 5 = Excellent

Session title	**Quality of session**					**Treatment in depth**					**Knowledge gained**				
	1	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***
Introduction to energy efficiency (EE)															
Methodology to improve EE															
Kyoto Protocol and CDM															
Barriers to EE															
Measuring GHG emissions															
EE policies															
Financing EE															

5) What can be done to improve the course?

Please explain:

6) Would you recommend this course to others?

Yes □ No □ Maybe □

Comments:

Action Plan

The impact of the training course can be determined by monitoring what participants apply in practice. In some instances, donor agencies that fund a course may require such feedback to justify funding future courses. For this reason, an action plan template is useful. It can be used to find out how participants intend to use what they have learned. Applications include:

- CP audits in industry using the EE methodology
- Training
- Reviews or surveys
- Dissemination of information and/or materials
- Project proposals

After a certain period, for example three or six months, participants can be requested to provide feedback on the results of their planned actions. Results may include the number of companies audited, the energy / GHG options identified, potential or obtained financial and environmental savings or the number of people trained.

3. Technical Course

This section explains the ***Technical Course*** on energy efficiency.

3.1 Target Audience and Objectives

This course is aimed at the production staff in companies, and can also be given to staff from organizations that work closely with companies to improve energy efficiency, such as cleaner production centers, research institutes, academic institutions, consultancies or industry associations.

The overall purpose of the course is to enable participants to improve energy efficiency in industry. The specific objectives of the course are for participants to:

- Become aware of the importance of energy efficiency and benefits for industry and the environment;
- Obtain an understanding of energy and energy equipment that is used in industry, including types of equipment, how to assess their performance and the main areas for potential energy conservation; and/or to
- Be able to use different monitoring instruments to measure energy-related parameters (an additional day is needed for this).

3.2 Course Agenda

Three suggested course agendas are provided on the next pages:

- Option 1: A 5-day course based on the absolute minimum time required to cover the basics of each type of energy equipment in lectures and carry out workshop exercises.
- Option 2 (recommended): A 7-day course based on the optimum time required for energy equipment lectures and workshop exercises.
- Option 3: A 5-day course that covers a reduced number of types of energy equipment but based on the optimum time required for energy equipment lectures and workshop exercises.

The trainer can increase or reduce the number of days or amend the agenda, depending on the audience, time available or the need to cover additional/different topics. For example, the course could be extended to cover monitoring instruments and their practical demonstration during a plant visit. Plant visits to look at different types of equipment and assess their performance has been highly recommended by previous participants.

The course can be shortened by excluding types of energy equipment (as shown in Option 3) or workshop exercises. This may be useful if the audience is from a specific sector. Table 1 indicates which types of energy equipment are used in various sectors. For example, a cement plant generally does not have boilers or a steam distribution system. Therefore, if the ***Technical Course*** is given to production staff from cement plants, these two sessions can be removed. It is also possible to hold workshop exercises at the end of each session (especially for short sessions such as lighting) instead of combining workshop exercises for different equipment in one session.

Appendix C lists the training materials that are included on the CD-ROM accompanying the guide.

Energizing Cleaner Production:

Agenda of the Technical Course (option 1 – minimum time required)

	9.00 – 10.30	10.30 – 11.00	11.00 – 12.30	12.30 – 13.30	13.30 – 15.00	15.00 – 15.30	15.30 – 17.00
Day 1	Introduction – course and participants		Fuels and combustion		Boilers and thermic fluid heaters		Workshop exercises
Day 2	Steam distribution and utilization		Workshop exercises		Furnaces and refractories		Workshop exercises
Day 3	Waste heat recovery	BREAK	Cogeneration	LUNCH BREAK	Electricity	BREAK	Lighting
Day 4	Electric motors		Fans and blowers		Pumps and pumping systems		Workshop exercises
Day 5	Cooling towers		Refrigeration and air conditioning		Compressors and compressed air systems		Workshop exercises Course evaluation

Agenda of the Technical Course (option 2 – optimum time required)

	9.00 – 10.30	10.30 – 11.00	11.00 – 12.30	12.30 – 13.30	13.30 – 15.00	15.00 – 15.30	15.30 – 17.00
Day 1	Introduction – course and participants		Fuels and combustion		Boilers and thermic fluid heaters		Workshop exercises
Day 2	Steam distribution and utilization		Workshop exercises		Furnaces and refractories		Workshop exercises
Day 3	Waste heat recovery	BREAK	Cogeneration	LUNCH BREAK	Workshop exercises	BREAK	Electricity
Day 4	Electric motors		Workshop exercises		Fans and blowers		Workshop exercises
Day 5	Pumps and pumping systems		Workshop exercises		Cooling towers		Workshop exercises
Day 6	Refrigeration and air conditioning		Workshop exercises		Compressors and compressed air systems		Workshop exercises
Day 7	Lighting		Monitoring equipment		Workshop exercises		Course evaluation

Agenda of the Technical Course (option 3 – reduced energy equipment)

	9.00 – 10.30	10.30 – 11.00	11.00 – 12.30	12.30 – 13.30	13.30 – 15.00	15.00 – 15.30	15.30 – 17.00
Day 1	Introduction – course and participants	BREAK	Fuels and combustion	LUNCH BREAK	Boilers and thermic fluid heaters	BREAK	Workshop exercises
Day 2	Steam distribution and utilization		Workshop exercises		Furnaces and refractories		Workshop exercises
Day 3	Electricity		Electric motors		Fans and blowers		Workshop exercises
Day 4	Pumps and pumping systems		Workshop exercises		Cooling towers		Workshop exercises
Day 5	Refrigeration and air conditioning		Workshop exercises		Compressors and compressed air systems		Workshop exercises Course evaluation

Extra days for monitoring instruments and plant visits

Option A	Monitoring instruments		Plant visit		Plant visit		Evaluation plant visit

Option B	Plant visit		Plant visit		Plant visit		Evaluation plant visit

Option C	Monitoring instruments		Workshop exercises		Plant visit		Plant visit
	Plant visit		Plant visit		Plant visit		Evaluation plant visit

Table 1. Training sessions applicable to different industrial sectors depending on the type of fuel and equipment used

Session titles	Cement	Fertilizer	Pulp & paper	Steel	Ceramics	Textile	Food processing	Engineering
Electrical equipment								
Electricity	✓	✓	✓	✓	✓	✓	✓	✓
Electric motors	✓	✓	✓	✓	✓	✓	✓	✓
Fans and blowers	✓	✓	✓	✓	✓	✓	✓	✓
Pumps and pumping systems	✓	✓	✓	✓	✓	✓	✓	✓
Cooling towers	✓	✓	✓	✓	✓	✓	✓	✓
Air conditioning and refrigeration	✓	✓	✓	✓	✓	✓	✓	X
Compressors and compressed air	✓	✓	✓	✓	✓	✓	✓	✓
Lighting	✓	✓	✓	✓	✓	✓	✓	✓
Thermal equipment								
Fuels and combustion	✓	✓	✓	✓	✓	✓	✓	✓
Boilers and thermic fluid heaters	X	✓	✓	X	X	✓	✓	X
Steam distribution and utilization	X	✓	✓	X	X	✓	✓	X
Furnaces and refractories	✓	✓	X	✓	✓	X	X	✓
Cogeneration	✓	✓	✓	X	X	✓	X	X
Waste heat recovery	✓	✓	✓	✓	✓	✓	✓	✓

3.3 Trainer Requirements

To ensure the success of the training, some considerations for the selection of trainers are given.

It is possible for one trainer to deliver this course but this is not recommended because most of the equipment needs to be discussed in detail and the workshop exercises require a lot of supervision. Therefore, a minimum of two trainers is recommended. An alternative is to invite guest trainers for specific types of equipment or topics. For example, a monitoring instrument supplier could deliver the monitoring equipment session. However, this would require time management from the lead trainer.

The trainer should have experience in carrying out energy assessments and at least one of the trainers should have sufficient technical knowledge to be able to answer technical questions. This is especially important when participants are technical staff, because in many instances they may have detailed knowledge, but may not have not looked at the equipment from an energy efficiency perspective. They may have focused on increasing production rather than producing more efficiently. Trainers with technical knowledge are particularly important when a plant visit is included in the course.

In addition to technical know-how, it is also important for the trainers to be able to communicate with people who have limited knowledge about energy equipment. One concern is that a trainer might have an inaccurate understanding of the technical level of the participants. For this reason, a good solution is to have one trainer with basic technical knowledge and one trainer with more detailed technical knowledge in order to handle both types of participants.

3.4 Session Guidance

Appendix B includes guidance for each session of the ***Technical Course***, which should enable the trainer to deliver the session more effectively. The guidance includes:

- Title of the session
- Objective
- Minimum duration and approach
- Contents
- Assessment of participants
- Other comments

The different types of training materials available for each session are described below and include: a PowerPoint presentation, a textbook chapter, a quiz, a workshop exercise, and company case studies.

PowerPoint Presentation

A PowerPoint presentation is the main training resource used for each session. Each presentation starts with a title slide, followed by a training agenda that lists the main topics covered. The last slide includes the disclaimers and references and does not necessarily need to be shown.

Trainer notes are given underneath each slide to assist the trainer in delivering the session. It includes more detailed information for each bullet on the slide and mentions ***(Click once)*** to indicate where a click on the mouse is needed for the next bullet, figure, formula or arrow to appear. The notes also include suggested questions to participants, references to other sessions where applicable, and messages that should be emphasized. It is important to note that the information on the slides is the minimum that should be explained to the audience and that it is up to the trainer to decide to what level of detail he/she wants to go through the trainer notes.

Copies of presentation slides (e.g. 6 slides on one page) can be included in the course handouts, but it is not recommended to hand out the trainer notes. The trainer notes were written specifically for the trainer. The information relevant to the participants is included in more detail in the textbook chapter.

Textbook Chapter

All PowerPoint presentations are based on a textbook chapter. The presentation slides follow the chapter very closely. The trainer notes underneath each slide are 'copy-pasted' from the chapter but often have been reduced in length and presented in bullet format so that it is easier for the trainer to use.

The textbook chapter includes:

- More detailed information than the presentation slides
- Detailed examples of calculations (usually relating to the assessment of the equipment) whereas the presentation slides only list the formulae
- An option checklist that is not covered in the presentation
- Worksheets for most equipment that can be used, for example, to collect information on boiler performance
- A detailed reference list whereas the presentation only gives the author's name and the publication to reference the figures and tables

It is recommended to include the textbook chapter in the course handouts, or if copies of PowerPoint slides are already handed out, the textbook chapter can be included in a CD-ROM for participants.

Quiz

A quiz with 10 multiple-choice questions was developed for each session on energy equipment. A separate page that is not handed out to participants provides the answers. The quiz includes questions from across the chapter and contains 3 types of questions:

1. A question for which the correct answer has to be selected. For example:

   The largest heat loss from boilers is caused by

   ☐ **a.** Moisture in fuel

   ☐ **b.** Moisture in air

   ☐ **c.** Radiation and convection

   ☐ **d.** Dry flue gas

2. Four statements and 1 statement must be selected as true or false. For example:

   Which of the following is <u>not</u> correct?

   ☐ **a.** TEFC motors are more efficient than FPBC motors

   ☐ **b.** High speed motors are more efficient than low speed motors

   ☐ **c.** Rewinding of motors may increase or decrease their efficiency

   ☐ **d.** None of the above

3. A question that involves a calculation using a formula from the chapter/presentation. For example:

Reducing the RPM of a fan by 10 percent brings about the following change in power consumption

☐ **a.** Increase by 21% ☐ **c.** Decrease by 25%

☐ **b.** Increase by 33% ☐ **d.** None of the above

The quiz on Monitoring Equipment is an exception. It has 1 question in which 10 types of equipment must be matched with ten measured parameters (e.g., combustion analyzer measures carbon dioxide). In a second question participants are asked to indicate what type of monitoring instrument(s) are to be used to measure the performance of certain types of equipment (e.g., for a lighting survey one needs a lux meter and a power analyzer).

The quiz is meant to be completed immediately following the session, and should take between 10 to 15 minutes depending on how the quiz is completed. Different ways include:

- The trainer asks questions and lets the participants come up with the answers. This is an option when there is little time.
- Each participant completes the quiz on his/her own and is allowed to use the textbook chapter and the slides.
- Each participant completes the quiz on his/her own without the use of the textbook chapter or the slides. This option will take the most time.

Workshop Exercise

For most of the sessions there is a workshop exercise for participants to apply the formulae explained in the presentation. Workshop exercises are not available for the Refrigeration and Air Conditioning, Lighting or Monitoring Equipment sessions.

The first page of the exercise provides the question and data needed to complete the calculation. The worked out answer is provided on a separate page, which the trainer can hand out during the discussion of the exercise. Appendix B explains what each workshop exercise involves.

Depending on the session and the level of the participants, a workshop exercise can take between 20 and 45 minutes to complete and discuss. Participants need calculators. Please note that if there is insufficient time available, one option is to complete workshop exercises for only some types of equipment.

If the workshop exercise is to be completed during a session other than that of the PowerPoint presentation, it is recommended to explain the exercise before the break, so that participants can start when they want.

Company Case Studies

Feedback from previous training courses notes the usefulness of practical examples from what other companies have done to improve the energy efficiency of fans, motors, and cooling towers. This is recommended especially if a plant visit is not included in the course because it helps participants get an idea of the potential financial investments, savings and reductions in energy consumption and greenhouse gas emissions.

Several hundred case study options are available from the GERIAP project on www.energyefficiencyasia.org. These case studies were collected from 44 companies in the cement, chemicals, ceramics, steel and pulp and paper sectors from nine countries: Bangladesh, China, India, Indonesia, Mongolia, Philippines, Sri Lanka, Thailand and Vietnam. For all options, a summary of approximately 200 words is available, and for about 100 options, more detailed case studies are available. They include:

- Summary of the option
- Key words: country, sector, equipment, other keywords
- Observations: what was the problem or observation, e.g. high fuel consumption per unit of production in the furnace
- Options: what were the options proposed and/or implemented
- Results: financial results (investment costs, operating costs, annual savings, payback period), environmental (energy reductions, greenhouse gas emission reductions and other environmental savings like water or waste reductions) and other benefits (e.g. improved work environment, increased production, improved reputation)
- For more information: contact details of the company where the option was implemented and the organization that implemented the GERIAP project in this country.

In addition, the CD-ROM includes an overview of databases and websites with examples of implemented cleaner production and energy efficiency options from across the globe and covering a range of sectors. If a trainer decides to cover some examples of implemented options he/she can insert additional slides. Another possibility is to include case studies in the course handouts and to discuss them with participants.

While any example of an implemented option is better than no example at all, it is preferable to include examples from the country or industry most relevant to course participants. So, if a training course is held in Chile, a Chilean example is more useful than a Thai example. Similarly, if participants are from textile companies, examples from other textile companies will make more sense to them than examples from cement plants. One benefit of energy efficiency efforts is that many types of energy equipment are used across different sectors, i.e., all companies use lights and motors and many use boilers.

A plant visit under the guidance of an expert who can explain the different types of equipment and explain to energy efficiency opportunities is the most useful tool to visualize energy efficiency approaches to participants.

3.5 Course Evaluation

Determining Participants Expectations

It is important to evaluate the course at the end of the last session. But it is equally important at the outset to determine what participants expect to learn from the course. Expectations can be determined by asking each participant to complete a short questionnaire prior to the course, or by asking everyone during the introduction session to introduce themselves and to explain what they hope to learn. It is important that the trainer writes expectations down, for example on a whiteboard, flipchart or on a separate sheet as follows:

Name participant	Organization / country	Expectations from the course
1.		
2.		
3.		
etc.		

Evaluation Discussion

During the last session, the trainer asks all participants to reflect on how the course met their expectations using 3 questions:

- What was useful about the course?
- What could be improved or what was missing?
- What will be done with what was learned?

Then participants can be asked one-by-one to verbally explain their answers. The advantage of this method is that people can react to and reflect on each other's comments before giving their own views. A trainer gets a good sense about the reaction to the course from the group as a whole. It is important to have written expectations at the beginning of the course at hand to be able to compare expectations with actual outcomes.

Evaluation Form

Suggested evaluation questions are given below, but the trainer can decide to remove/add questions as required.

Name:	
Organization:	
Date of course:	

1) Did the course meet your expectations?

Yes □ No □ Somewhat □

Comments:

2) Will this course help you carry out your job?

Yes □ No □ Somewhat □

Comments:

3) Were the course handouts adequate?

Yes □ No □ Somewhat □

Comments:

4) For each course session, please rate the quality of the session, if the topic was treated in sufficient detail and what was learned.

1 = Poor *2 = Moderate* *3 = Satisfactory* *4 = Good* *5 = Excellent*

Trainer	***Quality of session***					***Treatment in depth***					***Knowledge gained***				
	1	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***
Introduction to energy efficiency															
Fuels and combustion															
Boilers and thermic fluid heaters															
Steam distribution and utilization															
Cogeneration															
Waste heat recovery															
Electricity															
Lighting															
Electric motors															
Fans and blowers															
Pumps and pumping systems															
Cooling towers															
Compressors and compressed air systems															
Refrigeration and air conditioning															
Monitoring equipment															

5) Did the plant visit help you to better understand energy equipment and energy efficiency in practice?

Yes □ No □ Don’t know □

Comments:

6) What can be done to improve the course?

Please explain:

7) Would you recommend this course to others?

Yes □ No □ Maybe □
Comments:

Action Plan

The impact of the training course can be determined by monitoring to what extent participants apply what they learned in practice. In some instances, donor agencies may require such feedback to justify funding future courses. For this reason, an action plan template is useful. It can be used to find out how participants intend to use what they have learned. Applications include:

- Cleaner production/energy efficiency audits in industry focusing on energy equipment
- Delivering training on energy equipment
- Dissemination of information and/or materials
- Project proposals
- Other

After a certain period, for example three or six months, participants can be requested to provide feedback on the results of their planned actions. Results may include the number of companies audited, the energy / GHG options identified, potential or obtained financial and environmental savings or the number of people trained.

A. Management Course: Session Summaries

This appendix gives a summary of the Introduction session, followed by summaries of the other sessions in alphabetical order:

- Barriers to energy efficiency
- Energy efficiency methodology
- Financial feasibility analysis
- Financing energy efficiency projects
- Kyoto Protocol and CDM
- Measuring greenhouse gas (GHG) emissions
- Policies for energy efficiency

The guidance for each session includes the following:

- Title of the session
- Objective
- Minimum duration and approach
- Contents
- Assessment of participants
- Other comments

Title	**INTRODUCTION**
Objective	▪ To introduce participants to course objectives, content and to each other ▪ To become aware of the importance of energy efficiency and the potential benefits for industry and the environment
Minimum duration and approach	▪ One session (1.5 hours) ▪ Recommended approach: take 5 minutes to introduce oneself as the trainer and spend 20 minutes to go through the PowerPoint presentation. Depending on the number of participants, allow about 30 minutes for participants to introduce themselves and describe their expectations of the course. This leaves about half an hour flexibility (see suggestions under "other comments") ▪ Presentation: 13 slides ▪ Introduction and agenda: 3 pages
Contents	▪ Importance of energy efficiency in industry ▪ Introduction to the course ▪ Introduction to the participants
Assessment of participants	▪ When participants are asked to introduce themselves, they can give their - Name and country - Organization and their position - Expectations of the course ▪ It can be useful for the trainer to assess the participants' previous knowledge and experience. For example, the trainer could ask participants: - Have they attended a similar course before? - Are there any topics on the agenda that they know a lot about already?
Other comments	▪ The PowerPoint presentation can be adapted depending on the course agenda. ▪ One session is allocated for the introduction but there is half an hour that could be allocated to the following: - In practice courses often start a little later than planned - The trainer may want to include an "ice-breaker" at the start of the course - Sometimes a short video is shown or presentation is given from the organizing / sponsoring organization or the program in which this course is given - Other practicalities need to be explained, such as a social program or reimbursement of expenses.

<table>
<tr><td>Title</td><td>BARRIERS TO ENERGY EFFICIENCY</td></tr>
<tr><td>Background</td><td>Companies are faced with a range of financial, cultural, technical and other barriers that affect their ability to adopt energy efficiency measures. Overcoming barriers requires the involvement of people from inside and outside the company. For this reason, UNEP carried out a review of barriers to energy efficiency to identify the barriers, solutions, and the role of stakeholder groups, particularly that of policy makers. The report from this review “Barriers to Energy Efficiency – Review and Policy Guidance” forms the basis of this session.</td></tr>
<tr><td>Objective</td><td>To identify and explain: barriers to improving energy efficiency in (the participants’) industry, how to overcome these, and what can participants do. This is important because understanding the energy efficiency methodology and technical information alone are not sufficient to achieving significant energy efficiency improvements.</td></tr>
<tr><td>Minimum duration and approach</td><td>▪ 2 sessions (3 hours) including a workshop exercise.
▪ Recommended approach: spend one hour to go through the PowerPoint slides. Explain the workshop exercise before the break and resume 45 minutes into the second session and have each group present the results to other participants.
▪ Background report “Barriers to Energy Efficiency – Review and Policy Guidance”: 109 pages (main report 15 pages)
▪ Presentation: 23 slides</td></tr>
<tr><td>Contents</td><td>▪ Review of barriers - approach
▪ Four main barriers and examples
▪ Guidance to policy makers
▪ Role of companies, cleaner production centers and others</td></tr>
<tr><td>Assessment of participants</td><td>▪ Pose questions during the session. For example, ask participants about examples from their experience.
▪ Carry out the workshop exercise. Participants can be asked the following:
Barriers to energy efficiency in industry can be classified into four groups:
- Lack of management awareness / commitment
- Limited availability of and access to knowledge and information
- Lack of financing for energy efficiency projects
- Limited policies and enforcement
These are described in the report “Barriers to Energy Efficiency in Industry in Asia – review and policy guidance”.
Please focus on the barriers that exist in your country (or the region) that prevent the improvement of energy efficiency in industry.
1. Rank the four barrier categories in order of importance.
2. Explain for each barrier category what could be your (organization’s) potential role to address them.
3. Based on the ranking of the barrier categories and the potential role of you/your organization, what would you do first?

Suggestions on how to run the workshop:
▪ Depending on the size of the group, split the group into smaller groups of 3-5 people. Try to place similar participants in the same group, by organization</td></tr>
</table>

	type (e.g., industry, cleaner production centers, or government) or by geographical location (e.g. by province, country or continent). This will make it easier for the groups to agree on the barriers and identify their roles. ▪ Ask participants to write their answers on a flipchart, which makes it easier to present them to the other participants ▪ Under question 2 it is important to understand that not all stakeholder groups can address all barriers. For example, a cleaner production center may not be able to influence government policies as well as to bring companies in touch with financial institutions who can help finance projects. In other words, participants should not be afraid to conclude that for some barriers they can do very little! ▪ When facilitating the presentation and discussion of results, make sure to point out that in order to overcome barriers, the cooperation of many stakeholders is needed. Industry cannot do this alone and neither can government, cleaner production centers or any other group.
Other comments	▪ The PowerPoint presentation gives examples of Asian companies and countries that participated in the GERIAP project. Please replace these examples with ones from the countries or sectors of the participants. ▪ The report "Barriers to Energy Efficiency – Review and Policy Guidance" consists of a main report (15 pages) that can be handed out to course participants. The appendices, however, give the detailed results of the survey and a breakdown by the nine Asian countries, and therefore will not be as relevant to the course participants.

Title	**ENERGY EFFICIENCY METHODOLOGY**
Background	In order to improve energy and resource efficiency on a continuous basis at a company, a systematic process is needed that looks at individual energy equipment or energy/resource use and puts it in a broader context. As part of the UNEP GERIAP project, a "Company Energy Efficiency Methodology" was developed that: ▪ Is tailored to energy-intensive industrial companies in developing Asian countries. Though they are different from companies in industrialized and Western countries they also have similarities with companies in other developing countries. ▪ Focuses on energy, which is less visible than waste, water and raw materials. ▪ Explains what should be done in theory and how it is done in practice because all companies are different. A focus is given on how to overcome barriers such as time limitations and lack of data, and on practical company examples. This methodology forms the basis of this training session.
Objective	To understand how to improve energy efficiency in a systematic way and integrate continuous improvement into business processes.
Minimum duration and approach	▪ Three sessions (4.5 hours), including 3 workshop exercises ▪ Recommended approach: - Session A (1.5 hours): spend up to 1 hour on the slides, then explain the workshop exercise and allow participants 30 minutes to complete it. If time is left, discuss the exercise before the break, if not, then discuss it at the start of Session B. - Session B (1.5 hours): spend up to 45 minutes on the PowerPoint slides. Explain the workshop exercise and give participants 30 minutes to complete it, followed by 15 minutes to go through the answers. - Session C (1.5 hours): spend up to 45 minutes on the PowerPoint slides. Explain the workshop exercise and give participants 30 minutes to complete it, followed by 15 minutes to go through the answers. ▪ Background report: "Company Energy Efficiency Methodology" ▪ Presentation: 72 slides (Session A: 43 slides; Session B: 10 slides; Session C: 19 slides.
Contents	▪ Introduction to the methodology ▪ Methodology step-by-step, and for each of the 6 steps the following is explained: - Purpose, outputs and tasks - Company examples: 3 examples from companies in Asia on how they implemented the task. - Worksheets: these will assist to collect and record information and data. - Energy focus: some steps require specific energy knowledge or input, these slides are highlighted by an orange arrow.
Assessment of participants	**Workshop exercise A** – Meeting with Top Management (Task 1a of the methodology) This workshop exercise is a role play. One person is the auditor and 1 person is the company's managing director. The auditor has to interview the managing director

	about energy management at the plant, and based on the answers complete an Energy Management Matrix ("Matrix"). The Matrix provides insights into the level of energy management by giving a score 0 (lowest) to 4 (highest) in five categories: policies and systems; organization; motivation; information systems; training and awareness; and investment. Pages 1 and 2 of the workshop exercise document explain the Matrix in more detail. The "Auditor" gets a sheet with the following instructions: *You are the auditor and have a meeting with the company's managing director. You have to determine how well the company manages energy by filling out the Energy Management Matrix.* *During the meeting, introduce yourself, and explain that you want to get an understanding of the company's systems and processes that are in place to manage energy before you start with the energy assessment.* *Then you have to ask questions for each Matrix category. Suggested questions are included below, but you can also make up your own questions. Based on the managing director's answers you can put a bullet in the matrix under each category and connect the bullets to draw a line.* *Suggested questions are: (three questions for each category follow)* The "Company's Managing Director" gets a sheet with the following instructions: *You are the company's Managing Director and have a meeting with an auditor who wants to carry out an energy assessment of your plant. You don't know what he will be asking, but your answers should be based on the information about your company provided below. (The following text provides clues about the company and its energy management practices.)* There is an instruction sheet for a managing director of a large multinational and for a managing director of a small- and medium-sized family business. The last page of the workshop exercise gives the Matrix with the scores of the multinational and family business based on the information provided for each business in the managing directors' instruction sheets. The main conclusions from the filled in Matrix for both companies are: ▪ The multinational company has many formal processes and systems in place (= high scores for policy/systems, organization, information systems and investment) but there appeared to be little ownership by the work floor staff (= low scores for training/awareness, which is mostly aimed only at senior staff, and motivation). ▪ The family-owned company has the opposite situation: informal processes and systems, but an incredibly high involvement and commitment from employees to help the company improve energy efficiency. Thanks to the Matrix scores, the Team knew it had to focus on involving work floor staff at the multinational company and on setting up formal committees, policies and systems at the family-owned company to make the project successful. These would be typical recommendations to include in the report to management with energy efficiency options after the assessment, because without a proper system, energy

efficiency efforts are less likely to continue in the future.

Suggestion on how to run the workshop:

- Explain the Energy Management Matrix: its purpose and how to use it (5 min)
- Nominate an auditor and a managing director. There are three possibilities:
  - Two people get nominated and do the role-play in front of the others. All observing participants fill in the scores in the Matrix based on the interview.
  - The group gets split into 2 groups. The same happens as with the first option, except one group gets the instruction sheet of the multinational company and the other group the instruction sheet of the family business.
  - The group gets split into pairs and each pair consists of an auditor and managing director.
- At group level, compare the Matrix scores developed by participants with the Matrix scores given on the last page of the workshop exercise document.
- A good way to close the workshop exercise is to ask participants what they would recommend to management to improve the overall energy management to ensure continuation of energy efficiency in the future (i.e., more than implementing concrete options).

Tip: if there are senior managers from companies in the audience, then they can also take the role of Managing Director without using an instruction sheet, can base their answers on the real situation in their company.

Workshop exercise B - Identifying energy efficiency options (Tasks 3a and 3b of the methodology).

Participants are asked the following:

Crystal Cement is a medium-sized cement plant producing 400 tons of clinker per day (TPD) using the dry process. The Company Energy Efficiency Methodology was applied to this company:

- *Task 1d: the Kiln Area was selected as one of the focus areas.*
- *Task 2d: inputs, outputs and other parameters were measured as shown in the figure on the next page.*
- *Tasks 2d and 2e show:*
  - *Material losses of 2 TPD through the chimney.*
  - *The specific thermal energy consumption is 720.4 kCal per kg of clinker produced. The benchmark value is 675 kCal per kg of clinker.*
  - *During the last few months the fan power consumption has increased by 20%.*

Questions

1. *Task 2e: Identify the type of energy lost (thermal or electrical) from the clinker, kiln, preheater and ID fan.*
2. *Task 3a: Determine the possible causes of the energy losses.*
3. *Task 3b: List possible options.*

Areas of energy losses	Possible causes	Possible options
Clinker:		
Kiln:		
Preheater:		
ID Fan:		

If participants have difficulty getting started, try going through the "Clinker" area as an example:

- *Area of energy loss (first column): Thermal energy lost from clinker because temperature is 650 ^oC*
- *Possible causes of energy loss (second column): Clinker at 650 ^oC is left to cool in the open air*
- *Possible options (third column): Install a clinker cooler that allows you to recover waste heat (to be used for preheater or cogeneration)*

Workshop exercise C – Feasibility Analysis of an energy efficiency option (Task 4a of the methodology)

Participants are asked the following:

The first step in conducting a feasibility analysis is to identify what tasks must be completed for each option, i.e., what questions do you need to answer to decide if an option is feasible or not? Worksheet 16 of the methodology (attached separately) can be used to document the tasks and results of the feasibility analysis and the results after the option is implemented. Tasks are documented under the column "FEASIBILITY ANALYSIS TASKS (Task 4a)". An example of feasibility tasks for the option "waste heat recovery from hot flue gases leaving the gas-fired furnace to pre-heat the combustion air" is provided in the workshop exercise sheet of tasks for the technical, economic and environmental feasibility analysis.

Questions

1. *Using Worksheet 16, list the tasks under the column "FEASIBILITY ANALYSIS (Task 4b)" for **one** the following options:*
   - *Installation of a condensate recovery system from a steam distribution network in a food processing industry*
   - *Replacement of incandescent lamps with fluorescent lamps*
   - *Insulation of steam pipelines*
   - *Installation of variable speed drives (VSDs) on motors coupled to fans to reduce electricity consumption*
2. *For the chosen option, what could be barriers to implementation?*

	Suggestions on how to run the workshop: ▪ Hand out a copy of Worksheet 16 of the Methodology and explain it before going through the workshop exercise questions. ▪ Answers are provided only for the first option '*Installation of a condensate recovery system from a steam distribution network in a food processing industry'*. Therefore if the trainer has limited time to prepare for this session, it is recommended that all participants are asked to list feasibility tasks for this option. ▪ Suggest participants complete the exercise in pairs. In practice this is something people will do more likely as a group instead of on their own.
Other comments	▪ It is possible to hold a 1-day training on the methodology alone. ▪ Session B has only a few slides but requires relatively more explanation under each slide compared to the other sessions. ▪ It is possible to go through the entire presentation in one session, but only if company examples and workshop exercises are excluded and if worksheets are not explained in detail. This approach is not recommended because even though presented, participants may not have completely understood the methodology and may need additional help to apply it. ▪ The presentation slides give 3 examples from companies for each task that participated in the GERIAP project. If possible, replace these with examples from the trainer's experience and/or examples that are more relevant to the participants' country or sector. If this is not possible, the examples from the GERIAP countries will provide a good understanding of how the methodology works in practice.

Title	**FINANCIAL FEASIBILITY ANALYSIS**
Background	Often the feasibility analysis of options is carried out by company staff or consultants who have a sound technical knowledge but may be less familiar with finance. In addition, management of companies, especially small companies, may use the "Simple Payback" calculation to evaluate a proposed option. For options that require higher investments and have a longer payback period it can also be useful to determine the Net Present Value calculation to help in decision making. A session on how to carry out the financial feasibility analysis of options can therefore be useful to many course participants.
Objective	To obtain an understanding of how to determine the financial feasibility of options.
Minimum duration and approach	▪ One session (1.5 hours) ▪ Recommended approach: the workshop exercises are included in the PowerPoint presentation. Therefore spend - 20 minutes to go through slides 1 – 20 - 5 minutes to explain cash flow calculations in workshop exercise question 1 (It is suggested to go through the exercise as a group since there is not enough time to do this exercise individually) - 5 minutes on workshop exercise question 2 - 20 minutes on slides 21 – 35 - 30 minutes on workshop exercise questions 3 and 4, including the discussion of the answers - 10 minutes on slides 36 - 42 ▪ Presentation: 42 slides
Contents	▪ Introduction to financial feasibility step ▪ Cash flow ▪ Profitability indicators: Simple Payback, Return on Investment (ROI), Net Present Value (NPV) and Internal Rate of Return (IRR)
Assessment of participants	▪ Pose questions during the session. Ask participants which profitability indicators they have used in the past and why. There are also some slides with questions for participants. ▪ Carry out the workshop exercise. It is about the PLS Company, a medium-sized firm that produces rolls of printed, laminated film. The company bought a quality control (QC) camera system for the print line to detect printing errors earlier and thus reduce the scrap rate. The objective of this exercise is to conduct a profitability assessment for the project using two different profitability indicators. Participants are given background information about the company and the following four questions: <u>Question 1: Calculation of annual cash flows (15 minutes)</u> *You will first need to calculate the annual operating costs associated with the manufacturing inputs to the print step as well as waste management costs for the solid scrap waste from the print step. These costs need to be calculated both before installation of the QC camera ("business as usual"), and after installation of the QC camera. Then the annual savings, i.e., reduction in annual operating*

costs, can then be calculated. Use the materials balance information and the Cash Flow Worksheet given on the following page to calculate the "before" and "after" operating costs for the project. At the bottom of the worksheet, calculate the total annual operating costs "before" and "after" installation of the QC camera. Finally, calculate the total savings for the project, i.e., the total reduction in operating costs.

Question 2: Calculation of Simple Payback to evaluate profitability (5 minutes)

A Simple Payback calculation represents the number of years it will take for the cash inflows from an investment project to "pay back" the initial investment. It is calculated by dividing the total initial investment by the first-year savings from the project.

Simple Payback = initial investment / first year savings

The total initial investment cost for the QC camera system (for purchase, installation, and employee training, etc.) is US$ 105,000. Use the annual savings calculated in Question 1 above to calculate Simple Payback for this project.

PLS uses a simple payback hurdle rate of three years. In other words, if the simple payback for a project is less than three years, then PLS considers the project to be profitable. Based on the simple payback calculated, is the QC camera project profitable or not?

Question 3: Calculation of NPV to evaluate project profitability (15 minutes)

Question 2 asked for the calculation of the simple payback indicator to assess the profitability of the QC camera project. Net Present Value (NPV) is another profitability indicator that is a bit more complicated to calculate, but can be more reliable and accurate. Recall that the definition of NPV is: NPV_n *= the sum of the present values of all project cash flows over the first n years. For example:* NPV_3 *= the sum of the present values of all project cash flows over the first 3 years.*

Recall that if the NPV for a project is greater than zero, the project is considered to be profitable over the time period of interest. If NPV is less than zero, the project is considered NOT to be profitable over that time period. See the attached handout entitled "Performing Net Present Value (NPV) Calculations" for assistance in doing the NPV calculation.

The average discount rate for investment projects at the PLS company is 15%. Use this discount rate to calculate NPV_3 *for the QC camera project. Based on the NPV calculated, would you say that the QC camera project is profitable at the end of three years or not?*

Question 4: Compare simple payback and NPV (5 minutes)

You have now calculated both simple payback and NPV_3 *for the QC camera project. Record your results in the table below, and compare the results from the two indicators. What do you think about the relative values of simple payback and NPV as profitability indicators?*

	Suggestions on how to run the workshop: ▪ Explain the questions when the presentation slide comes up during the PowerPoint presentation. ▪ Completing the workshop exercises will probably go faster if participants work in pairs. ▪ Note that session planning does not include time for participants to answer question 1 by themselves. There is only 5 minutes allocated for an explanation by the trainer of cash flows without and with the QC camera system. Therefore it is recommended to include question 1 only if more time is available. ▪ Question 2 is relatively easy, but it is still recommended that participants have a few minutes to do the calculation themselves. The Simple Payback is used frequently.
Other comments	▪ This session is largely based on *from "Profiting from Cleaner Production", in Strategies and Mechanisms for Promoting Cleaner Production Investments in Developing Countries. UNEP.* ▪ Depending on the familiarity of the audience with profitability indicators, the trainer can decide whether to include this session in the course or not.

Title	**FINANCING ENERGY EFFICIENCY PROJECTS**
Background	Companies indicate that one of the main barriers to improve energy efficiency is a lack of financing. For this reason, a review was carried out of the financial mechanisms available to help pay for energy efficiency improvements or of the mechanisms that provide financial incentives to implement such improvements. The report of the review "Improving Energy Efficiency in Asia – a review of financial mechanisms" forms the basis of this training session.
Objective	To obtain an understanding of existing or potential financial mechanisms to facilitate energy efficiency improvements in industry.
Minimum duration and approach	▪ One session (1.5 hours) ▪ Recommended approach: spend 45 minutes to go through the PowerPoint slides, 30 minutes to do the workshop exercise and 15 minutes to discuss the findings. Depending on the audience, a different approach may be taken (see below). ▪ Presentation: 31 slides ▪ Report "Improving Energy Efficiency in Asia – A policy review": 39 pages (excluding appendices)
Contents	▪ The finance barrier: why is this a barrier and what are the causes ▪ Four financial mechanisms: taxes, subsidies, lending programs, ESCOs ▪ Conclusions ▪ Roles of policy makers, industry and financial sector
Assessment of participants	▪ Pose questions during the session. Ask participants to name the different types of policy instruments before or after they are explained. ▪ Workshop exercise. Participants are asked the following: *Lack of financing is often mentioned by industry as a reason for not implementing projects that can improve energy efficiency. Either the plant does not have money available to invest in options, or it is not available at the moment.* *The report "Improving Energy Efficiency in Asia – a review of financial mechanisms" explains the various financial mechanisms available: tax policies, subsidies, lending programs, and Energy Service Companies (ESCOs) performance contracts. It also describes the roles of government, industry and the financial sector.* *Based on your experience (industry) in your country:* *1. Is lack of financing a barrier, and if so, for whom? Does company size, type, or sector play a role?* *2. Why is lack of financing a barrier? (explain the causes / reasons)* *3. How can the lack of financing be solved? (explain what must be done and who should be involved)* Suggestions on how to run the workshop: ▪ Break up in small groups, preferably by country, so that financing barriers of specific countries can be discussed.

	▪ If time is limited, focus on question 3 only. ▪ Ask participants to write answers on a flipchart, which makes it easier to present them to the other participants.
Other comments	▪ It is recommended to hold this session after the "Financial Feasibility Analysis" session. ▪ The PowerPoint presentation gives an overview of the types of financial mechanisms, but provides no examples. It is more interesting to the audience if examples are added from their own country. ▪ The report "Improving Energy Efficiency – a review of financial mechanisms" is relevant for a general audience until Section 3 (21 pages) and can be handed out to course participants. Part 4 and the appendices provide more details on the financial mechanisms in the GERIAP countries, which can be relevant to audiences from these countries but less so for participants from elsewhere.

<table>
<tr><td>Title</td><td>KYOTO PROTOCOL AND CDM</td></tr>
<tr><td>Background</td><td>An energy barriers survey that was conducted amongst Asian companies and their stakeholders, found that companies are very interested in the Clean Development Mechanism (CDM) but lack information.

As part of the GERIAP project, a CDM Information Paper and a CDM Pre-screen Tool were developed. The information paper provides an introduction to the Kyoto Protocol and CDM - how it works, participants, project cycle, timelines, and transaction costs. The paper also explains an excel-based tool that can be used by companies in developing countries that are interested in participating in the CDM. It helps companies:
▪ Determine if their project is eligible for CDM;
▪ Calculate an initial emission baseline and potential reduction through CDM; and
▪ Calculate the payback period of costs of the CDM application procedure with CER revenues.

This information paper and tool form the basis of this session. The session also used materials from the project “Applying Cleaner production to Multilateral Environmental Agreements” (ACME) that is funded by the Swedish International Development Cooperation Agency (Sida).</td></tr>
<tr><td>Objective</td><td>To obtain a basic understanding of the CDM under the Kyoto Protocol and be able to assess a particular project’s eligibility and feasibility under the CDM.</td></tr>
<tr><td>Minimum duration and approach</td><td>▪ Two sessions (3 hours), including a workshop exercise
▪ Recommended approach: spend one session (1.5 hours) on the PowerPoint presentation. Take 10 minutes before the break to explain the workshop exercise. Allow the participants a maximum of one hour to complete the workshop exercise and use the last 30 minutes to go through the answers.
▪ Presentation: 50 slides
▪ Report “CDM Information Paper for Industry in Developing Countries”: 18 pages
▪ Tool (excel-based) “CDM Pre-screen Tool for Industry in Developing Countries”</td></tr>
<tr><td>Contents</td><td>▪ Introduction
▪ The Kyoto Protocol and CDM at a glance
▪ How the CDM works
▪ The CDM Pre-screen Tool for Industry</td></tr>
<tr><td>Assessment of participants</td><td>▪ Questions during the session. The presentation includes several slides with questions for participants to answer at the completion of each sub-topic, facilitated by the trainer.
▪ Workshop exercise, where participants are asked the following:

You have been carrying out a CP assessment in a medium-sized paper mill in Thailand. You have identified a number of opportunities for energy savings, four of which could be potential CDM projects. Each of these projects is described below.</td></tr>
</table>

	Based on the eleven questions of the "CDM Pre-screen Tool for Industry in Developing Countries", determine which of these projects are eligible as CDM projects. Explain why/why not. Suggestions on how to run the workshop: ▪ Provide participants with a copy of the information paper prior to the workshop. ▪ Ask people to work in pairs so they can discuss reasons why or why not a project is eligible under the CDM.
Other comments	▪ This session could also be given as a stand-alone session, for example, as part of a seminar. ▪ It is recommended to have a CDM expert or consultant present at this session to answer questions. ▪ The excel-based "CDM Pre-screen Tool" does not work properly on some computers because of the security settings. This can be solved as follows - Select the **Tools** menu option and then select **Macro** and **Security**. In the resulting **Security** dialog, set the security level to Medium by clicking the **Medium** radio button. - Close the file and any other instances of the application currently running on the computer. - Open the file again and click the **Enable** button when prompted to allow for the unsigned macro to run ***Be sure to reset the security settings at "maximum" after the demonstration!***

Title	**MEASURING GREENHOUSE GAS (GHG) EMISSIONS**
Background	Many companies monitor their energy consumption, although fewer companies will have a comprehensive monitoring system that collects energy use and cost data for individual divisions or processes, sets targets and quantifies savings from implemented options. Even fewer companies calculate their greenhouse gas emissions (GHG) arising from fuel combustion, electricity use, transport and industrial processes that release such emissions. However, with the rising importance of climate change in international and national policies, companies are under pressure to reduce their emissions. Other companies are seeing an opportunity to participate in emissions trading, Joint Implementation or the Clean Development Mechanism under the Kyoto Protocol. For whatever reason, knowing measurements of GHG emissions are emitted each year is of growing importance to companies. This session is based on 2 initiatives that can help companies measure their GHG emissions: ▪ The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Business and Non-Commercial Organizations ▪ The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard, revised edition
Objective	To be able to calculate GHG emissions of companies using the GHG Indicator.
Minimum duration and approach	▪ One session (1.5 hours), including a demonstration of the GHG Indicator and a quiz ▪ Recommended approach: ▪ Presentation: 32 slides ▪ The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Business and Non-Commercial Organisations: 1 page flyer ▪ The GHG Indicator version 2, 2002: excel based tool (included on the CD-ROM) ▪ The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard, revised edition: 116 pages. It is suggested to print out the first 11 pages, until the end of Chapter 1.
Contents	▪ GHG types and sources ▪ GHG Indicator to calculate emissions (explanation and demonstration) ▪ GHG accounting and reporting
Assessment of participants	▪ Pose questions during the session. Ask participants what type of GHG emissions they know about before the presentation. ▪ Quiz about the GHG Indicator to be handed out at the end of the GHG Indicator part (slide 17). ▪ Questions for each of the five reporting and accounting principles are included on the slides and should be answered through a group discussion: - *Relevance: A multinational operates a plant but owns only 60% of shares. Do you count 100% or 60% of emissions?* - *Completeness: Sometimes companies do not include all emission sources /*

	activities. Can you think of reasons why? - *Consistency: Why is it important that GHG emissions be compared between different years?* - *Transparency: Who makes use of the "audit trail" of data?* - *Accuracy: What can companies do to improve data accuracy?*
Other comments	▪ The demonstration of the GHG Indicator requires a laptop or computer. The trainer can show how the tool works "live" during the training session. It is preferable if the participants can work with the tool on computers themselves. This depends on the training facilities available. ▪ The GHG Indicator excel-based tool does not work properly on some computers because of the security settings. This can be solved as follows - Select the **Tools** menu option and then select **Macro** and **Security**. In the resulting **Security** dialog, set the security level to Medium by clicking the **Medium** radio button. - Close the file and any other instances of the application currently running on the computer. - Open the file again and click the **Enable** button when prompted to allow for the unsigned macro to run ***Be sure to reset the security settings at "maximum" after the demonstration!***

Title	**POLICIES FOR ENERGY EFFICIENCY**
Background	One of the main barriers to improving energy efficiency in industry is limiting policies and/or limited implementation and enforcement of existing policies. For this reason, a review of the different types of policy instruments was conducted. For each instrument, examples of implemented policies were analyzed. The report of the review "Improving Energy Efficiency in Asia – a policy review" aims to assist governments improve energy efficiency in industry. This report forms the basis of this training session.
Objective	To obtain an understanding of different types of government policies to facilitate energy efficiency in industry.
Minimum duration and approach	▪ One session (1.5 hours) ▪ Recommended approach: spend 45 minutes to go through the PowerPoint slides, 30 minutes to do the workshop exercise and 15 minutes to discuss the findings. Depending on the audience, a different approach may be taken (see below). ▪ Presentation: 24 slides ▪ Report "Improving Energy Efficiency in Asia – a policy review": 46 pages
Contents	▪ Types of policy instruments (legislative, economic, voluntary) ▪ Definitions and international examples of each policy instrument category ▪ Evaluation of policy instruments (environmental effectiveness, economic efficiency, budgetary impact, ability to implement and enforce, support from stakeholders)
Assessment of participants	▪ Pose questions during the session. Ask participants to name the different types of policy instruments before or after they are explained. ▪ Carry out the workshop exercise. Participants are asked the following: *Policy instruments to improve energy efficiency can be classified into three groups: legislative (energy conservation laws and standards), economic (taxes and subsidies) and voluntary (voluntary agreements, programs, labeling and research and development). These are described in the report "Improving Energy Efficiency in Industry in Asia – a policy review".* . *Different policies exist in different countries depending on the local situation, needs and the level of policy development. Please focus on the policies in your country (or region) that target the improvement of energy efficiency in industry.* *1. What policies are you aware of for your country?* *2. What are the overall main strengths and weaknesses of the policies?* *3. If there are 3 things government could do to, what would you recommend?* Suggestions on how to run the workshop: ▪ Break up in small groups, preferably by country, so that the policies of specific countries can be discussed. ▪ If time is limited, focus on question 3 only. ▪ Ask participants to write their answers on a flipchart, which makes it easier to present them to the other participants.

Other comments	▪ This topic is relevant to policy makers and to some extent to organizations that work with governments, such as cleaner production centers. If the policy session is less relevant to the audience, then it is suggested to expand the Financing Energy Efficiency topic over 3 sessions (in the suggested agenda there are only 2 sessions). ▪ A different approach can be taken for different audiences: - Policy makers: This is an important topic for them, it can be stretched out over 2 sessions. For example, spend 45 minutes for the presentation, 1 hour for the workshop exercise and 30-45 minutes to present and discuss the results. - Cleaner production centers and other facilitating organizations: The topic may be relevant but including it in the training would depend on participant expectations and the time available to cover other topics. - Company managers: The topic is less relevant. If the topic remains in the training agenda then it can be made more interesting to company managers by giving an overview of energy efficiency policies that are available in their country that are relevant to their company/industry. It is also suggested to only ask them to complete question 3. If the topic is removed, then question 3 can be incorporated in the workshop on Barriers to Energy Efficiency. - If the audience is a mix of different organizations, then the session can be included in the training course. It may be possible to mix the stakeholder types in the workshop groups so that the policy maker can explain what is available and the company manager and cleaner production center can provide feedback on what else is needed. ▪ The PowerPoint presentation gives examples of policies in Asia and other countries, and can be used as a standard presentation. Of course it is more interesting to the audience if examples are from their own country. ▪ The report "Improving Energy Efficiency – a policy review" consists of a main report (31 pages) that can be handed out to course participants. Appendix B includes an overview of energy efficiency policies in Asia, which is relevant to Asian audiences but possibly less so for participants from other continents.

B. Technical Course: Session Summaries

This appendix gives summaries of the Introduction session, followed by the other sessions in alphabetical order:

- Boilers and thermic fluid heaters
- Cogeneration
- Compressors and compressed air systems
- Cooling towers
- Electricity
- Electric motors
- Fans and blowers
- Fuel and combustion
- Furnaces
- Lighting
- Monitoring equipment
- Pumps and pumping systems
- Refrigeration and air conditioning
- Steam generation and utilization
- Waste heat recovery

The guidance for each session includes the following:

- Title of the session
- Objective
- Minimum duration and approach
- Contents
- Assessment of participants
- Other comments

Title	**INTRODUCTION**
Objective	▪ To introduce participants to the course objectives, content and to each other ▪ To become aware of the importance of energy efficiency and the benefits for industry and the environment.
Minimum duration and approach	▪ One session (1.5 hours) ▪ Recommended approach: take 5 minutes to introduce the trainer and spend 20 minutes to go through the PowerPoint presentation. Depending on the number of participants, allow about 30 minutes for participants to introduce themselves and describe their expectations of the course. This leaves about half an hour flexibility (see suggestions under “other comments”). ▪ Presentation: 13 slides ▪ Introduction and agenda: 3 pages
Contents	▪ Importance of energy efficiency in industry ▪ Introduction to the course ▪ Introduction to the participants
Assessment of participants	▪ When participants are asked to introduce themselves, they can give their - Name and country - Organization and their position - Expectations of the course ▪ It can be useful for the trainer to assess the participants’ previous knowledge and experience. For example, the trainer could ask participants: - Have they attended a similar course before? - Are there any topics on the agenda that they know a lot about already?
Other comments	▪ The PowerPoint presentation can be adapted depending on the course agenda. ▪ One session is allocated for the introduction but there is half an hour allocated to the following: - In practice courses often start a little later than planned - The trainer may want to include an “ice-breaker” at the start of the course - Sometimes a short video is shown or presentation is given from the organizing / sponsoring organization or the program in which this course is given - Other practicalities need to be explained, such as a social program, or reimbursement of expenses.

Title	**BOILERS AND THERMIC FLUID HEATERS**
Objective	To obtain an understanding of boilers and thermic fluid heaters, including types of boilers, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1.5 sessions (2 hours), including the quiz and workshop exercise ▪ Recommended approach: spend 1 session (1.5 hours) on the PowerPoint presentation. It is unlikely that much time is left at the end of this session, therefore it is recommended to go through the quiz as a group (10 minutes). Participants should spend 30 minutes on completing the workshop exercise and it takes about 15 minutes to go through the solution. In the agenda the workshop exercise for fuels and combustion is placed in the same session as the boilers workshop exercise. ▪ Presentation: 54 slides ▪ Textbook chapter: 42 pages
Contents	▪ Introduction ▪ Types of boilers ▪ Assessment of boiler ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide, for example "What type of boilers do you know" should be asked before the types of boilers are explained. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: *A company is considering replacing an oil-fired boiler of 10 tons per hour with a coal-fired boiler of the same capacity. With the help of the data provided, calculate the following:* *1. Annual oil consumption in tons per year* *2. Annual coal consumption in tons per year* *3. Annual fuel cost savings in million US$* *The following data is given:* - *Heat content of steam 660 kCal/kg* - *Feed water inlet temperature 600 C* - *Daily operating hours 24* - *Number of days / year 300* - *Efficiency of oil-fired boiler 82%* - *Efficiency of coal-fired boiler 72%* - *Cost of oil US$ 300/ton* - *Cost of coal US$ 45/ton* - *GCV of oil 10,000 kCal/kg* - *GCV of coal 4,200 kCal/kg* If participants have difficulties completing the exercise, it may be helpful to give them the four calculations they should make to determine the annual oil and coal consumption:

	a. Boiler operation hours *b. Annual steam production* *c. Energy (Q) required to produce the amount of steam calculated under (b)* *d. Amount of coal or oil required by multiplying the energy Q by the GCV of coal or oil* Participants should not have difficulties to calculate the annual fuel cost savings so there is no need to give them formulae for question 3.
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources can be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ If the workshop exercise for fuel and combustion is not combined with the boiler workshop exercise, then there will be time left at the end of the second session. There are several possibilities to use the remaining time: - Explain the monitoring instruments that typically are used in determining boiler performance: combustion analyzer, thermocouple and infrared thermometer. See the session “Monitoring Equipment” for more details. This option may be particularly useful if the course does not include a specific session on monitoring equipment. - Explain cogeneration under “Energy Efficiency Opportunities” during the boiler session, as cogeneration is based on combined heat (steam) and power generation. This is especially useful if the course does not include the cogeneration session. See the session on “Cogeneration” for more details.

Title	**COGENERATION**
Objective	To obtain an understanding of cogeneration, including the types of cogeneration systems used in industry, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz and workshop exercise. ▪ Recommended approach: spend 45 minutes on the PowerPoint presentation, go through the quiz questions as a group, and leave 35 minutes to do workshop exercise because is requires several calculations. ▪ Presentation: 25 slides ▪ Textbook chapter: 19 pages
Contents	▪ Introduction ▪ Types of cogeneration systems ▪ Assessment of cogeneration systems ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following:

A process industry has decided to install cogeneration plant. The process requirements are:

- *The plant requires 4.5 MW of electrical power*
- *The boiler has a maximum steam generating capacity of 31.25 TPH at 63 kg/cm2 pressure and a temperature of 486 °C*
- *The table below gives the process steam requirements*

	Process steam flow (TPH)	*Pressure (kg/cm^2)*	*Temperature (^oC)*	*Enthalpy (kCal/kg)*
Boiler	*31.25*	*63*	*486*	*808*
Process #1	*3.25*	*21*	*310*	*669*
Process #2	*8.0*	*8.0*	*174*	*662*
Process #3	*20.0*	*5.0*	*160*	*659*

1. *Determine the total power that could be generated by a single turbine that meets the process steam requirements.*
2. *Calculate the additional amount of power to be purchased from the grid.*
3. *Calculate the heat to power ratio of the cogeneration plant.*

The following data are given:

- *Alternator efficiency: 95%*
- *Transmission efficiency: 95%*

	- *Thermal efficiency of turbine: 80%* - *1 kW electricity: 860 kCal* Participants may have difficulties to get started on question 1. In this case it may be helpful to give them the 4 calculation steps: - *Calculate the enthalpy of the steam produced by the boiler (in kCal per hour)* - *Calculate the enthalpy of the steam taken by the three processes (in kCal per hour)* - *Calculate the amount of heat remaining after the three processes have taken their steam (in kCal per hour)* - *Calculate the total amount of power generated from the remaining heat (in MW), taking into account the efficiencies of the turbine, generator and transmission* Once the answer to question 1 is known, participants should have difficulties in solving questions 2 and 3.
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as an illustration of how other companies are reducing energy consumption and costs. ▪ If there are time limitations not all energy equipment sessions need be covered, It is possible to remove the cogeneration session and explain it as an energy efficiency opportunity during the session “Boilers and Thermic Fluid Heaters”. In this case, the quiz and workshop would also be removed.

<table>
<tr><td>Title</td><td>COMPRESSORS AND COMPRESSED AIR SYSTEMS</td></tr>
<tr><td>Objective</td><td>To obtain an understanding of compressors and compressed air systems, including the types of compressors, how to assess their performance and the main areas for energy conservation.</td></tr>
<tr><td>Minimum duration and approach</td><td>▪ 1.5 session (2 hours), including the quiz and workshop exercise.
▪ Recommended approach: spend up to 1 hour and 20 minutes on the PowerPoint presentation. Explain the quiz and workshop exercise and resume 30 minutes in the second session and spend about 30 minutes to go through the answers.
▪ Presentation: 35 slides
▪ Textbook chapter: 24 pages</td></tr>
<tr><td>Contents</td><td>▪ Introduction
▪ Types of compressors
▪ Assessment of compressors
▪ Energy efficiency opportunities</td></tr>
<tr><td>Assessment of participants</td><td>▪ Pose questions during the presentation.
▪ Take the quiz with 10 multiple choice questions.
▪ Carry out the workshop exercise. Participants can be asked the following:

A Free Air Delivery test and leakage tests were conducted in an automobile industry for a 1000 cfm compressor by operating the compressors with out equipment that use compressed air.

The results of the Free Air Delivery test showed that the compressor delivers 90% output of the rated capacity.

The results of the leakage test were:
- Compressor was on load for 8 minutes
- Compressor was unloaded for 48 minutes
- Compressor was consuming 144 kW

Calculate the following:
1. Free air delivery or the output of the compressor
2. Specific power consumption
3. % leakage in the compressed air system
4. Quantity of compressed air leakage
5. Power lost due to leakage

If participants have difficulties completing the workshop exercise, or if time is running out, then it may be helpful to give them the formulae that they should use. In this exercise these are:
- Free air delivery: % of rated capacity X cfm
- Specific power consumption: actual output / actual consumption
- % leakage in compressed air system: [T / (T =t)] X 100
- Quantity of compressed air leakage: % leakage X actual output
- Power lost due to leakage: leakage quantity / specific energy</td></tr>
</table>

Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ Note that the agenda assumes that the quiz for the Refrigeration and Air Conditioning session is combined with the quiz/workshop session for compressors.

Title	**COOLING TOWERS**
Objective	To obtain an understanding of cooling towers, including the types of cooling towers, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend up to 1 hour on the PowerPoint presentation, and then ask participants to do the quiz and workshop exercise individually or in pairs in about 20 minutes (they can be combined because the workshop exercise is very short). Leave 10 minutes for going through the answers. ▪ Presentation: 38 slides ▪ Textbook chapter: 17 pages
Contents	▪ Introduction ▪ Types of cooling towers ▪ Assessment of cooling towers ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Ask participants to explain the difference between natural draft and mechanical draft cooling towers at the end of the "types of cooling towers" part. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Ask the participants the following: *Calculate the cooling tower (CT) capacity in tons of refrigeration (TR) using the following data:* - *Water flow rate through CT: 120 m3/h* - *Specific heat of water: 1 kCal/kg °C* - *Inlet water temperature: 37 °C* - *Outlet water temperature: 32 °C* - *Ambient wet bulb temperature (WBT): 29 °C* If participants have difficulties completing the workshop exercise, then it may be helpful to give them the formula they should use: *Cooling tower capacity = (flow rate x density x specific heat x temperature difference) / 3024*
Other comments	▪ Cooling towers use motors, fans and pumps. For this reason it is recommended to have this session after the sessions "electric motors", "fans and blowers", and "compressors and compressed air systems." ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session to illustrate how other companies reduce energy consumption and costs.

Title	**ELECTRICITY**
Objective	To obtain an understanding of electricity, including electricity generation and transmission, characteristics of electricity, and the main areas for electricity conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend up to 1 hour on the PowerPoint presentation, and then ask participants to do the quiz and workshop exercise individually or in pairs for about 20 minutes. They can be combined because the workshop exercise is short. Leave 10 minutes for going through the answers. ▪ Presentation: 29 slides ▪ Textbook chapter: 15 pages
Contents	▪ Future electricity scenario ▪ Generation and distribution ▪ Phase of electricity ▪ Active and reactive power ▪ Power factor correction ▪ Electrical load management ▪ Electrical billing mechanisms ▪ Transformers
Assessment of participants	▪ Pose questions during the presentation. Ask participants what the Power Factor is before explaining the term. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise, where participants are asked the following: *During April 2003, a plant recorded a maximum demand of 600 kVA and average power factor (PF) of 0.82. The electricity utility requires a minimum PF of 0.92. For every 1 percent below this PF, a penalty of US$ 250 per month has to be paid. The plant installed a 100 kVAr capacitor at the end of April 2003.* *1. Calculate the improvement in PF for May 2003* *2. Calculate the penalty to be paid during May 2003* If participants have difficulties completing the workshop exercise, or if time is limited, it may be helpful to give them the steps to determine the PF improvement: - *Operating kW* - *kVAr required at 0.82 PF* - *New kVAr after capacitor installation* - *New kW* - *New power factor*
Other comments	▪ It is important to give this session before the sessions on electrical equipment (electric motors, fans and blowers, lighting, pumps and pumping systems, cooling towers, compressors and compressed air systems, and refrigeration and air conditioning) because many of the terms and definitions explained here are in

	other sessions. ▪ If participants are reasonably technical and already possess the basic knowledge on electricity (e.g., electrical engineers) then this session can be shortened. ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs.

Title	**ELECTRIC MOTORS**
Objective	To obtain an understanding of electric motors, including the types of electric motors, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend up to 1 hour on the PowerPoint presentation. Because the presentation is relatively long, the quiz can be completed as a group (rather than individually) in about 10 minutes. The workshop exercise takes about 10 minutes, especially if the calculation formulae are given. Ten minutes left to go through the answers. ▪ Presentation: 49 slides ▪ Textbook chapter: 24 pages
Contents	▪ Introduction ▪ Types of electric motors ▪ Assessment of electric motors ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Ask participants the following: *A motor with a 45kW rated capacity is drawing 30 kW of power at a given point of time. Calculate the motor loading at full load if the efficiency of the motor is 90%.* This workshop exercise is relatively easy to complete. But if there is limited time to complete the exercise, then the formulae can be given in advance: - *Efficiency motor % = (Rated output at full load ÷ Rated input at full load) x 100* - *Motor loading (%) = (Measured kW ÷ Rated input kW) x 100*
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ This is a very important session because electric motors are used widely in industry and account for a large part of electricity use. It is not possible to include all sessions in the training course, it is recommended to remove other sessions rather than the electric motors session. ▪ If it is not possible to go through the quiz during the session, this can be done during a workshop exercise session at the end of the training day.

Title	**FANS AND BLOWERS**
Objective	To obtain an understanding of fans and blowers, including their types, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1.5 session (2 – 2.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend up to 1 session (1.5 hours) on the PowerPoint presentation. There are a number of complex terms and definitions which take time to explain. If time is left, go through the quiz as a group (10 - 15 minutes, including a simple calculation). The workshop exercise is relatively long and should therefore be completed (30 minutes) and discussed (15 minutes) in a separate session. ▪ Presentation: 51 slides ▪ Textbook chapter: 21 pages
Contents	▪ Introduction ▪ Types of fans and blowers ▪ Assessment of fans and blowers ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: *An induced draft industrial fan is used to draw air through a bag filter. The following information is given for the fan:* - *Flow rate is 90 m3/s at a static pressure of 80 mm water column (WC)* - *65 mm WC is the static pressure across the bag filter* - *Motor power drawn is 120 kW* - *Motor efficiency is 86%* - *Impeller diameter is 70 mm* - *RPM is 1000* *The company decided to replace the bag filter with an electrostatic precipitator (ESP). After installation of the ESP:* *1. Static pressure across the ESP is 20 mm WC* *2. Flow rate increased by 20%* *3. The flow rate can be brought back to 90 m3/s by two options: (a) Impeller trimming and (b) Reduced pulley diameter to reduce the RPM* *Calculate the following:* *1. Fan static efficiency before installation of the ESP* *2. The new impeller diameter if the impeller is trimmed, that would result in a reduction in fan efficiency of 5%* *3. The new RPM that would result in a fan efficiency of 60%* *4. Which of the two options is more energy efficient* Participants may have difficulties completing the exercise because it involves so

	many calculations. In this case it may be useful to give out the formulae to be used, but leave it up to them to determine which one is used for each question. The formulae are: - *Power input at fan shaft = power drawn by motor x motor efficiency* - *Fan static efficiency = (Flow x Pressure developed across fan) / (102 x Power required at fan shaft)* - *New static pressure across the fan = total static pressure – static pressure across bag filter + static pressure across ESP* - *New flow rate Q = original flow rate x increase* - *$(Q1 / Q2) = (H1/H2)^2$, where Q = flow rate, H = static pressure or head* - *$(D1 / D2) = (kW1 / kW2)^{1/3}$, where D = impeller diameter, kW = power input* - *$(N1 / N2) = (kW1 / kW2)^{1/3}$, where N = RPM, kW = power input*
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ Fans use motors and therefore it is recommended to place this session on the agenda after the session on electric motors. ▪ In the agenda, one session is allocated for completing the workshop exercise for fans and blowers and for pumps and pumping systems.

Title	**FUELS AND COMBUSTION**
Objective	To obtain an understanding of fuels and combustion, including the types of fuels and their characteristics, how to assess efficiency of fuel combustion and the main areas for energy conservation.
Minimum duration and approach	▪ 1.5 session (2 hours), including the quiz and workshop exercise ▪ Recommended approach: spend a maximum of 1 hour and 15 minutes on the PowerPoint presentation. If more than 20 minutes are left, participants can complete the quiz themselves first before discussing the answers. If little time is left, go through the quiz as a group (10 minutes). The workshop exercise is relatively long and should therefore be completed (30 minutes) and discussed (15 minutes) in a separate session. In the agenda, the workshop exercise for fuels and combustion is placed in the same session as the boilers workshop exercise. ▪ Presentation: 47 slides ▪ Textbook chapter: 24 pages
Contents	▪ Introduction ▪ Types of fuels ▪ Assessment of fuel combustion ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise, where participants are asked the following: *Calculate the stoichiometric (kg) amount of air required for the complete combustion of 1 kg liquid fuel with the following properties:* - *Carbon (C) 85.9% by weight* - *Hydrogen (H): 12%* - *Oxygen (O2): 0.7%* - *Nitrogen (N): 0.5%* - *Sulphur (S): 0.5%* - *Moisture (H2O): 0.35%* - *Ash: 0.05%* - *Total: 100%* *The gross calorific value (GCV) of the liquid fuel is 10200 kCal/kg.* Participants can make use of the example of stoichometric air calculations (section 3.2 in the textbook) to solve this question. If participants have difficulties getting started, it may be helpful to provide them the needed steps: - *Write down what you already know and assumptions* - *Write the combustion reactions based on 100 kg of fuel* - *Calculate the O2 required for complete combustion of 100 kg of fuel using combustion reactions (1), (2) and (3)* - *Calculate the air required to provide the additional O_2 for complete*

	combustion of 1 kg fuel
Other comments	▪ It is important to present this session before the sessions on thermal equipment (boilers, steam, furnaces, cogeneration, and waste heat recovery) because many of the terms and definitions explained here will be used later. ▪ The most important part of fuels and combustion is “Assessment of fuel combustion”. The best way for participants to understand this is by carrying out a calculation. It is strongly recommended to include the workshop exercise for fuels and combustion. ▪ If time is limited, it is recommended to spend less time on the types of fuels section (e.g. by going through the fuel properties only briefly or by explaining fuel properties for liquid fuels, but skip the explanation for solid fuels (coal)). ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs.

Title	**FURNACES AND REFRACTORIES**
Objective	To obtain an understanding of furnaces and refractories, including the types of furnaces and refractories, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 2 sessions (3 hrs), including the quiz and workshop exercise ▪ Recommended approach: spend 1 session (1.5 hrs) on the PowerPoint presentation. Explain the quiz and workshop exercise before the break and resume after 1 hour into the second session to go through the answers. ▪ Presentation: 56 slides ▪ Textbook chapter: 36 pages
Contents	▪ Introduction ▪ Types of furnaces, refractories and insulation ▪ Assessment of furnaces and refractories ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: *A steel billet preheating furnace operates between 7 am to 8 pm. The output of the furnace is 14 TPH and the last batch of the stock is removed from the furnace at 8 pm. In the first hour, 0.25 kL of furnace oil is fed to the furnace to raise the furnace temperature. It is assumed that the same amount of heat is also lost during the cooling of the furnace after 8 pm.* *Operating parameters after furnace stabilization following the first hour are given below.* - *Average surface temperature of heating and soaking zone (area = 78 m2): 120 0C* - *Average surface temperature of areas other then heating And soaking zone (area = 12 m2): 85 0C* - *Furnace wall thickness on the billet extraction outlet side: 460 mm* - *Opening on the billet extraction side: 1 m x 1m* - *The outlet is opened: 12 times/d for 15 min* - *Emissivity of furnace wall: 0.8* - *Operating temperature of the soaking zone: 1340 0C* - *Average flue gas temperature after air preheater: 750 0C* - *Specific heat Cp of flue gas: 0.24 kCal/kg per oC* - *Average O2 %: 10%* - *Ambient temperature: 30 0C* - *Theoretical air requirement of furnace oil: 14 kg air / kg fuel oil* - *GCV of fuel oil: 10000 kCal/kg* - *Average fuel oil consumption: 600 l/hr* - *Specific gravity of furnace oil: 0.92* - *H2 in furnace oil: 12%*

	- *Moisture in furnace oil: 0.25%* - *Radiation factor for D/X ratio of 2.17 (from graphs): 0.71* - *Black body radiation at 1340 0C (from graphs): 36 kCal/kg/m2/hr* - *Heat loss at 1200C through roofs and side walls: 1250 kCal/m2/hr* - *Heat loss at 85 0C through other areas: 777 kCal/m2/hr* *Calculate the operational efficiency of the furnace. The heat loss in the initial hour can be neglected.* Participants should make use of the formulae and example provided in the textbook chapter (Section 3.3). It is important to note that the example in the textbook calculates the percentage losses, and in the workshop exercise the actual heat loss in kCal is calculated for each source of heat loss!
Other comments	▪ There many slides and it takes time to go through each one so the session will require the full 1.5 hours available. If the quiz and workshop exercise are also completed, 2 full sessions are needed. ▪ If time is limited an alternative is to talk through the example calculation of combustion efficiency in the textbook chapter (Section 3.3) instead of doing the workshop exercise. ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as an illustration of how other companies reduce energy consumption and costs.

Title	**LIGHTING**
Objective	To obtain an understanding of lighting, including the types of lights, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz ▪ Recommended approach: spend up to 1.5 hours to go through the PowerPoint presentation. Depending on how much time is left, either go through the quiz as a group or ask participants to complete the quiz on their own before discussing the answers. ▪ Presentation: 47 slides ▪ Textbook chapter: 40 pages
Contents	▪ Introduction ▪ Types of lighting systems ▪ Assessment of lighting systems ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide. For example, ask participants what types of lamps they know before listing them. ▪ Take the quiz with 10 multiple choice questions. ▪ There is no workshop exercise for lighting.
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ If there is no separate session in the course on Monitoring Equipment, it is recommended to discuss what a Lux meter is and how it works in the session. See Monitoring and Equipment session for further details.

<table>
<tr><td>Title</td><td>MONITORING EQUIPMENT</td></tr>
<tr><td>Objective</td><td>To obtain an understanding of monitoring instruments used in industry, including the main types, what they measure, and how to operate them.</td></tr>
<tr><td>Minimum duration and approach</td><td>A1 session (1.5 hours), including the quiz
Recommended approach: spend up to 1.5 hours to go through the PowerPoint presentation. Depending on how much time is left, either go through the quiz as a group or ask participants to complete the quiz on their own before going through the answers.
Presentation: 67 slides
Textbook chapter: 26 pages</td></tr>
<tr><td>Contents</td><td>Electrical measuring instruments
Combustion analyzer
Manometers
Thermometers
Water flow meters
Speed measurement
Leak detectors
Lux meters</td></tr>
<tr><td>Assessment of participants</td><td>Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide.
Quiz 1: Match the monitoring equipment with the parameters measured
Name of the equipment
1) Clamp on power tester
2) Combustion Analyzer
3) Manometers
4) Thermocouple and Infra red thermometers
5) Ultrasonic Flow meters
6) Stroboscope
7) Ultrasonic leak detector
8) Lux Meters
Parameters measured
a) RPM
b) Illumination Levels
c) Liquid flow in pipes
d) Voltage and Current
e) Compressed air leakages
f) Pressure head
g) Carbon dioxide
h) Temperature
Quiz 2: Name at least one monitoring equipment you would need to conduct an assessment of the following equipments/area:
- Cooling tower
- Motor load survey</td></tr>
</table>

	- *Boiler* - *Furnaces* - *Insulation Survey* - *Compressed air system* - *Lighting Survey* - *Air conditioning plant* ▪ There is no workshop exercise for this session.
Other comments	▪ This session does not cover a specific type of energy equipment but explains the different monitoring instruments that can be used to measure a range of parameters, which are needed to assess the performance of energy equipment and the energy savings after options have been implemented. ▪ Monitoring instruments are best explained when demonstrated. ▪ If due to time limitations it is not possible to allocate a full session to monitoring equipment, it is possible to explain monitoring instruments as part of the energy equipment sessions as follows (slides will need to be moved to the respective energy equipment sessions) - Combustion analyzer: boilers session, furnaces session, or fuels and combustion session - Manometers, ultrasonic leak detector: steam session or compressed air session - Thermocouple and infra red thermometers, clamp on power tester: electricity session - Ultrasonic flow meters: cooling towers session - Stroboscope: electric motors session - Lux meters: lighting session

<table>
<tr><td>Title</td><td>PUMPS AND PUMPING SYSTEMS</td></tr>
<tr><td>Objective</td><td>To obtain an understanding of pumps and pumping systems, including the types of pumps, how to assess their performance and the main areas for energy conservation.</td></tr>
<tr><td>Minimum duration and approach</td><td>
1.5 session (2 hours), including the quiz and workshop exercise
Recommended approach: spend about an hour on the PowerPoint presentation. Depending on time left, either go through the quiz as a group (10 minutes), or ask each participant to do the quiz on their own and discuss the answers as a group (20 minutes). The workshop exercise takes 20 minutes to complete and 10 minutes to discuss. This will most likely need to be done in a separate session. In the agenda, the workshop exercise for pumps is combined with the workshop exercise for fans in one session.
Presentation: 40 slides
Textbook chapter: 19 pages
</td></tr>
<tr><td>Contents</td><td>
Introduction
Types of pumps
Assessment of pumps
Energy efficiency opportunities
</td></tr>
<tr><td>Assessment of participants</td><td>
Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide.
Take the quiz with 10 multiple choice questions.
Carry out the workshop exercise. Participants can be asked the following:

In a large paper plant the design and measured operating parameters for a clear water pump are the following:
<table>
<tr><th>Parameter</th><th>Design</th><th>Operating</th></tr>
<tr><td>Flow Q (m3/hr)</td><td>800</td><td>550</td></tr>
<tr><td>Head H (m WC)</td><td>55</td><td>24</td></tr>
<tr><td>Power P (kW)</td><td>160</td><td>124</td></tr>
<tr><td>RPM</td><td>1485</td><td>1485</td></tr>
</table>
The required water flow rate varies from 500 m^3/h to 700 m^3/h. For this reason, the pump flow rate has been reduced by partially closing the delivery valve. Motor efficiency is 93%.
Calculate the following:

Calculate the operating efficiency.
Explain what would be the best option to obtain the required flow rate variation.
Calculate the power savings if the options suggested under question 2 would reduce the flow rate of the pump is 550 m^3/h.
</td></tr>
</table>

	If participants have difficulties completing the exercise, or if time is limited, give them the formulae to be used in the calculations: - *Efficiency of the pump = Q x H x g* *According to affinity laws:* - *Relationship flow rate Q and RPM: Q1/Q2 = N1/N2* - *Relationship head H and RPM: H1/H2 = (N1/N2)2* - *Relationship power P and RPM: P1/P2 = (N1/N2)3*
Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ Fans use motors. Therefore it is recommended to place this session on the agenda after the session on electric motors. ▪ In the agenda, one session is allocated for completing the workshop exercise for fans and blowers and for pumps and pumping systems.

Title	**REFRIGERATION AND AIR CONDITIONING**
Objective	To obtain an understanding of refrigeration and air conditioning, including the types of related equipment, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1.5 session (2 hours), including the quiz ▪ Recommended approach: spend the full session (1.5 hours) on the PowerPoint presentation. As there is no workshop exercise for this equipment, ask participants to complete the quiz on their own, and discuss the results after the break in a separate session. ▪ Presentation: 50 slides ▪ Textbook chapter: 21 pages
Contents	▪ Introduction ▪ Types of refrigeration and air conditioning ▪ Assessment of refrigeration and air conditioning ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. For example, ask participants to name the five loops of heat transfer at the end of the introduction. ▪ Take the quiz with 10 multiple choice questions. ▪ There is no workshop exercise for this session.
Other comments	▪ As refrigeration and air conditioning differ so much from the other equipment, it takes more time to go through the session. In addition, there are a lot of energy efficiency opportunities that require more time to explain. ▪ If time is limited then the quiz questions can be answered as a group at the end of the session. ▪ Note that the agenda assumes that the quiz for the Refrigeration and Air Conditioning session is combined with the quiz/workshop session for Compressors and Compressed Air Systems. ▪ Unfortunately there are not case study options from the GERIAP project. Case study options from other sources (an overview of databases and websites of cleaner production and energy efficiency options is available on www.energyefficiencyasia.org and can be included in this session as illustrations of how to find other companies that reduce energy consumption and costs.

<table>
<tr><td>Title</td><td>STEAM DISTRIBUTION AND UTILIZATION</td></tr>
<tr><td>Objective</td><td>To obtain an understanding of steam distribution and utilization, including characteristics of steam, the components of a steam distribution system, how to assess the performance of steam distribution systems and the main areas for energy conservation.</td></tr>
<tr><td>Minimum duration and approach</td><td>▪ 2 session (3 hrs), including the quiz and workshop exercise
▪ Recommended approach: spend the first session to go through the introduction and explanation of steam distribution and components. Spend the first 45 minutes of the second session on the assessment of steam systems and energy efficiency opportunities. Give participants 30 minutes to complete the quiz and workshop exercise, and leave 15 minutes to go through the answers.
▪ Presentation: 79 slides
▪ Textbook chapter: 68 pages</td></tr>
<tr><td>Contents</td><td>▪ Introduction
▪ Steam distribution system
▪ Assessment of the steam distribution system
▪ Energy efficiency opportunities</td></tr>
<tr><td>Assessment of participants</td><td>▪ Pose questions during the presentation. Some suggested questions are included in the trainer notes underneath each slide.
▪ Take the quiz with 10 multiple choice questions.
▪ Carry out the workshop exercise, where participants are asked the following:

A paper plant has an extensive steam network. The steam is generated at a pressure of 10 bar and the condensate is not recovered. The plant management is planning to generate flash steam (from the condensate) for use as low pressure process steam and to recover as much steam condensate as practical.

With the help of the data provided, calculate the following:
1. Quantity of flash steam generated (kg)
2. Annual savings from flash steam recovery in US$/year
3. Annual savings from flash steam recovery and condensate recovery in US$/year

The following data is provided:
- Total enthalpy of steam at 10 bars: 672 kCal/kg
- Condensate quantity: 1000 kg/hr
- Condensate pressure: 10 bar
- Cost of steam: US$ 25/ton
- Annual operating hours: 8000
- Low pressure process steam pressure: 2 bar (Flash steam pressure)
- Sensible heat of condensate at 10 bar: 187.1 kCal/kg
- Sensible heat of condensate at 2 bar: 134.4 kCal/kg
- Latent heat of steam at 2 bar: 517.5 kCal/kg
- Boiler efficiency: 82%
- Fuel used in boiler : Furnace oil
- GCV of Furnace oil: 10,200 kCal/kg</td></tr>
</table>

	- *Specific gravity of furnace oil: 0.92* - *Condensate temp. when recovered: 950C* - *Make-up water temperature: 350C* - *Cost of furnace oil : US$ 350/kiloliter* *The following equation is given:* *Flash steam generation potential condensate (%) = (S1-S2/L) X 100* *Where,* *S1 = Sensible heat of condensate at high pressure* *S2 = Sensible heat of condensate at low pressure* *L = latent heat of steam at low pressure* Participants should not have difficulties in completing this workshop exercise as both the formula and the steps are provided in advance.
Other comments	▪ This is the longest but also one of the most important sessions, as steam generation, distribution and use is one of the highest costs for companies. It also has the greatest potential for savings through energy efficiency. It is strongly recommended to spend two full sessions on this topic. ▪ It is important to take a break after the explanation of the steam distribution system and its components because it covers a lot of information. Without a break, there is a risk that participants will not take in the information on how to improve the energy efficiency of steam systems. ▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs.

Title	**WASTE HEAT RECOVERY**
Objective	To obtain an understanding of waste heat recovery, including the types of waste heat recovery equipment, how to assess their performance and the main areas for energy conservation.
Minimum duration and approach	▪ 1 session (1.5 hours), including the quiz and workshop exercise ▪ Recommended approach: spend maximum 50 minutes on the PowerPoint presentation, and then go through the quiz as group in 10 minutes. Give participants 20 minutes to complete the workshop exercise and leave 10 minutes to go through the answers. ▪ Presentation: 32 slides ▪ Textbook chapter: 18 pages
Contents	▪ Introduction ▪ Types of waste heat recovery equipment ▪ Assessment of waste heat recovery ▪ Energy efficiency opportunities
Assessment of participants	▪ Pose questions during the presentation. ▪ Take the quiz with 10 multiple choice questions. ▪ Carry out the workshop exercise. Participants can be asked the following: *A reheating furnace has two burners that use furnace oil (FO). Combustion air is supplied directly at ambient temperature of 350C. The company plans to install a recuperator to recover waste heat from the flue gases to preheat the combustion air to 3000C.* *Calculate the annual furnace oil savings using the following data:* - *% O2 in flue gas: 6 %* - *Density of furnace oil (FO): 0.9 kg/liter* - *Annual FO consumption: 750 tons* - *Specific heat of air(@ 300 0C): 0.246 kCal/kg 0C* - *Stoichiometric air to Fuel ratio: 14 kg air /kg of furnace oil (theoretical air requirement)* - *Furnace efficiency: 20 %* - *GCV of furnace oil: 10200 kCal/kg* - *Cost of furnace oil US$ 350/ton* If participants have difficulties completing this exercise, provide the steps and/or formulae they may need to carry out calculations. - *Percentage excess air (EA) = [% O2 / (21 - %O2)] x 100* - *Actual air requirement = (1 + excess air / 100) x theoretical air requirement* - *Heat recovery = (Actual air x Cp x Temperature difference)/ Furnace efficiency* - *Annual FO savings = (Heat recovery x annual FO consumption) / GCV of fuel* - *Annual monetary savings*

Other comments	▪ Case study options from www.energyefficiencyasia.org or other sources could be included in this session as illustrations of how other companies reduce energy consumption and costs. ▪ If there is limited time, it is possible to leave out the waste heat recovery session, because it is also covered in the other thermal equipment sessions as an energy efficiency opportunity. In that case, also remove the quiz and workshop.

C. Contents of the CD-ROM

Guide for Trainers

FOLDER NAME on CD-ROM	FILE NAME
Guide for Trainers	▪ Energizing CP – Guide for Trainers

Management Course

FOLDER NAME on CD-ROM	FILE NAME
Introduction and Evaluation	▪ Management Course - Introduction and agenda ▪ Management Course - Introduction presentation ▪ Management Course - Evaluation form ▪ Management Course – Action plan template
Barriers to EE	▪ Barriers to EE – Background report ▪ Barriers to EE – Presentation ▪ Barriers to EE – Workshop exercise
EE Methodology	▪ EE Methodology – Textbook chapter ▪ EE Methodology – Presentation ▪ EE Methodology – Workshop exercise A ▪ EE Methodology – Workshop exercise B ▪ EE Methodology – Workshop exercise C
Financial Feasibility Analysis	▪ Financial Feasibility Analysis – Presentation ▪ Financial Feasibility Analysis – Workshop exercise
Financing EE Projects	▪ Financing EE Projects – Background report ▪ Financing EE Projects – Presentation ▪ Financing EE Projects – Workshop exercise
Kyoto Protocol and CDM	▪ Kyoto Protocol and CDM – Presentation ▪ CDM Information Paper for Industry ▪ CDM Pre-screen Tool for Industry
Measuring GHG Emissions	▪ Measuring GHG Emissions – Presentation ▪ GHG Indicator - Quiz ▪ GHG Indicator - Flyer ▪ The GHG Indicator version 2, 2002: excel based tool (folder) ▪ GHG Indicator – completed company example ▪ GHG Protocol – revised
Policies for EE	▪ Policies for EE – Background report ▪ Policies for EE – Presentation ▪ Policies for EE – Workshop exercise

Technical Course

FOLDER NAME on CD-ROM	FILE NAME
Introduction and Evaluation	▪ Technical Course - Introduction and agenda ▪ Technical Course - Introduction presentation ▪ Technical Course - Evaluation form ▪ Technical Course – Action plan template
Boilers and thermic fluid heaters	▪ Chapter – Boilers and thermic fluid heaters ▪ Presentation – Boilers and thermic fluid heaters ▪ Quiz – Boilers and thermic fluid heaters ▪ Workshop exercise – Boilers and thermic fluid heaters
Cogeneration	▪ Chapter – Cogeneration ▪ Presentation – Cogeneration ▪ Quiz – Cogeneration ▪ Workshop exercise – Cogeneration
Compressors	▪ Chapter – Compressors and compressed air systems ▪ Presentation – Compressors and compressed air systems ▪ Quiz – Compressors and compressed air systems ▪ Workshop exercise – Compressors and compressed air systems
Cooling towers	▪ Chapter – Cooling towers ▪ Presentation – Cooling towers ▪ Quiz – Cooling towers ▪ Workshop exercise – Cooling towers
Electric motors	▪ Chapter – Electric motors ▪ Presentation – Electric motors ▪ Quiz – Electric motors ▪ Workshop exercise – Electric motors
Electricity	▪ Chapter – Electricity ▪ Presentation – Electricity ▪ Quiz – Electricity ▪ Workshop exercise – Electricity
Fans and blowers	▪ Chapter – Fans and blowers ▪ Presentation – Fans and blowers ▪ Quiz – Fans and blowers ▪ Workshop exercise – Fans and blowers
Fuels and combustion	▪ Chapter – Fuels and combustion ▪ Presentation – Fuels and combustion ▪ Quiz – Fuels and combustion ▪ Workshop exercise – Fuels and combustion
Furnaces and refractories	▪ Chapter – Furnaces and refractories ▪ Presentation – Furnaces and refractories ▪ Quiz – Furnaces and refractories ▪ Workshop exercise – Furnaces and refractories

FOLDER NAME on CD-ROM	**FILE NAME**
Lighting	▪ Chapter – Lighting ▪ Presentation – Lighting ▪ Quiz – Lighting
Monitoring equipment	▪ Chapter – Monitoring equipment ▪ Presentation – Monitoring equipment ▪ Quiz – Monitoring equipment
Pumps	▪ Chapter – Pumps and pumping systems ▪ Presentation – Pumps and pumping systems ▪ Quiz – Pumps and pumping systems ▪ Workshop exercise – Pumps and pumping systems
Refrigeration and AC	▪ Chapter – Refrigeration and AC ▪ Presentation – Refrigeration and AC ▪ Quiz – Refrigeration and AC
Steam	▪ Chapter – Steam distribution and utilization ▪ Presentation – Steam distribution and utilization ▪ Quiz – Steam distribution and utilization ▪ Workshop exercise – Steam distribution and utilization
Waste heat recovery	▪ Chapter – Waste heat recovery ▪ Presentation – Waste heat recovery ▪ Quiz – Waste heat recovery ▪ Workshop exercise – Waste heat recovery

D. Further Reading

Please note that this is not an exhaustive list.

Energy Systems

Boilers and thermic fluid heaters: www.energyefficiencyasia.org,

Cogeneration: www.energyefficiencyasia.org

Compressors and compressed air systems: www.energyefficiencyasia.org, http://www.oit.doe.gov/bestpractices/compressed_air/, http://www.productiveenergy.com/comp/comp.asp

Commercial energy systems http://cipco.apogee.net/ces

Cooling towers: www.energyefficiencyasia.org

Electricity: www.energyefficiencyasia.org, http://cipco.apogee.net/foe

Electric motors: www.energyefficiencyasia.org, http://www.oit.doe.gov/bestpractices/motors/, http://www.productiveenergy.com/motor/motor.asp

Fans and blowers: www.energyefficiencyasia.org, http://www.productiveenergy.com/fan/fan.asp, http://www.productiveenergy.com/blow/blow.asp

Fuel and combustion: www.energyefficiencyasia.org

Furnaces: www.energyefficiencyasia.org

Lighting: www.energyefficiencyasia.org

Monitoring equipment: www.energyefficiencyasia.org

Process heat: http://www.oit.doe.gov/bestpractices/process_heat/

Pumps and pumping systems: www.energyefficiencyasia.org, http://www.productiveenergy.com/pump/pump.asp

Refrigeration and air conditioning: www.energyefficiencyasia.org,

Steam generation and utilization: www.energyefficiencyasia.org, www.spiraxsarco.com/learn, http://www.oit.doe.gov/bestpractices/steam/efficiency.shtml

Waste heat recovery: www.energyefficiencyasia.org

Financing cleaner production and energy efficiency

Financing Sustainable Energy Directory (Online Database) http://www.fse-directory.net

Improving Energy Efficiency in Industry in Asia – a review of financial mechanisms http://www.energyefficiencyasia.org

International Finance Cooperation (IFC) http://www.ifc.org/enviro/EFG/EEfficiency/eefficiency.htm

Promotion of Energy Efficiency in Industry and Financing of Related Public and Private Investments http://www.unescap.org/enrd/energy/publications/finance/annex3.html

International Utility Efficiency Partnerships http://www.ji.org/index_eng.htm

Profiting from Cleaner Production http://www.financingcp.org/training/training.html

UNEP Sustainable Energy Finance Initiative http://sefi.unep.org

Sector information on cleaner production and energy efficiency

Energy Efficiency Technologies http://www.oit.doe.gov/industries.shtml

Textile: Smart Guide http://www.emcentre.com/unepweb/tec_case/textile_17/house/casename.shtml

US EPA Sector Notebooks
http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/

European Integrated Pollution Prevention and Control Bureau
http://www.jrc.es/pub/english.cgi/0/733169

Australian National Pollutant Inventory Industry Handbooks
http://www.npi.gov.au/handbooks/approved_handbooks/index.html

Energy Efficiency Technologies http://www.oit.doe.gov/industries.shtml

Online collection of pollution prevention http://wrrc.p2pays.org/industry/indsector.htm

Cleaner Production and Energy Savings Data Search
http://nett21.unep.or.jp/GECweb/asp-bin/en_DataSearch.asp

Software and Tools

Converter Center
http://www.wateronline.com/content/partner/home.asp?page=http://www.convertit.com/go/wateronline

Electrical Engineering Calculators http://www.ifigure.com/engineer/electric/electric.htm

Energy Data and Analysis Database (Asia Pacific)
http://www.ieej.or.jp/egeda/database/database-top.html

Engineering Online Calculators http://members.aol.com/engware/calcs.htm

FireCAD http://www.firecad.net/

Free Online Calculators http://members.aol.com/engware/calcs.htm

Material Safety Data Sheets (Database) http://www.msds.com/

Mechanical Engineering Calculators http://www.ifigure.com/engineer/mechanic/mechanic.htm

Motor Selector http://www.isr.gov.au/motors/motor/motorsoftware.html

Motor Solutions Online Self Assessment Tool http://www.peak.co.nz/ausat/

Online Calculators and Formulas for Power System Analysis http://www.nepsi.com/formulas.htm

Online Engineering Calculators http://www-sci.lib.uci.edu/HSG/RefCalculators4.html

Process Ace Software http://www.processacesoftware.com/

The GHG Indicator www.uneptie.org/energy/tools/ghgin/index.htm