

SYLLABUS AND TEACHERS' REFERENCE



ENERGY AUDIT



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ENERGY AUDIT

Syllabus & Teacher's Reference for a 200-hours training course for engineers
2nd Edition • May 2017

Developed in pursuit of conformity with the Nigerian Competency Standards for Clean Energy | Release 2016 in the domain "Energy auditing in preparation for international certification"

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ABOUT

This document seeks to guide trainers on the delivery of the training course Energy Audit. The topics and subjects contained are a result of the needs expressed by the clean energy private sector in Nigeria conducted in 2014 and Competency Standards evolved together with industry in 2015 and 2016. This document is expected to be reviewed periodically to reflect changing needs of the Nigerian market.

Course objective	Enable engineers to undertake full-fledged energy audits for industries, hotels, hospitals and office complexes on energy saving opportunities while considering life-cycle costs – in conformity with the requirements of Nigerian Competency Standards for Clean Energy Release 2016 in the domain “Energy auditing in preparation for international certification”.
Target group	Engineers
Recommended entry criteria	Must possess HND or university degree in mechanical, electrical or industrial process engineering or comparable. Must have Minimum 5 years’ of relevant experience
Duration	200 hours recommended (equivalent to 25 days at 8 hours per day)
Classroom size	Up to 20 trainees recommended
Expected tasks and duties	<ul style="list-style-type: none"> ▪ Plan work ▪ Calculate processes ▪ Identify measures for reduction of energy consumption ▪ Perform audits ▪ Implement energy management systems
Teaching methods	<ul style="list-style-type: none"> ▪ Highly practical orientation ▪ Lectures (presentations and videos) ▪ Practical work ▪ Simulations ▪ Group work (homework, role play, presentation) ▪ Pop-quiz ▪ Hand outs ▪ Field trip and site visit ▪ Demonstration ▪ Discussion
Assessment methods	<ul style="list-style-type: none"> ▪ Written examination ▪ Practical examination ▪ Oral examination

1.1. USING THE SYLLABUS

The content of each course module is broken down to topical levels. Key information guides the trainer on the following:

- **Competency level** that the trainee is expected to attain at the end of the module. There are 4 levels of competency detailed in this document:

- Skills and competencies required by the trainee for knowledge purposes only are classified as “**To know**”. This is the simple most level.
- Skills and competencies required for explaining to third parties are classified as “**To understand**”.
- Skills and competencies required for day-to-day work on an as-is basis in respect of the handbook are classified as “**To use**”. Training on practical examples, for instance, is essential to attain this.
- Skills and competencies for day-to-day work which need to be adapted to practical contexts are classified as “**To apply**”. This level is the most demanding and requires application in areas beyond what has been learned.
- Appropriate **teaching techniques and methods** selected for effective delivery of contents.
- **Activities** to aid effective knowledge transfer.
- **Materials and equipment** required for training activities.
- **Key resources** for trainers to study to ensure the depth and breadth of their knowledge exceed that of the Course Handbook.

1.2. COURSE DURATIONS

The recommended contact hours for delivery of this course are **200 hours**. For a fulltime delivery of 8 hours per day over a 5-day week this translates into **5 weeks** of training.

For effective delivery, the course is designed in modules, each with recommended duration of delivery. The recommended amount of time to be spent by the trainees in specific learning environments is suggested in the following groups:

- **Classroom:** Duration suggested in a classroom setting where techniques such as discussions, role plays, and interactive sessions, exercises presentations are deployed to *engage* the trainees apart from traditional teaching.
- **Field trips:** Duration suggested for engaging in practical aspects. This could be field trips, site visits, laboratory experiments or any other form of engagement *practical* in nature.
- **Spare time:** Contingency kept aside to use at discretion of the trainer. The trainer decides what environment to use the spare time for based on the response of the class to course content.
- **Additional self-study:** Duration the trainee is expected to engage in self-study and research complementing classroom and practical time.

1.3. ACTIVITIES

Various activities are required for the successful delivery of the course. These include:

- **Demo:** Concepts or aspects are being demonstrated to trainees.
- **Exercise:** Activities that require the trainee to solve problems in the classroom.
- **Workshop:** The trainee engages in practical exercises meant to imitate real world conditions.
- **Interactive session:** Sessions where trainees are engaged in open discussions to share their views with the class, thus sparking intellectual debates.

- **Role play:** Trainees to perform roles they are expected to assume or encounter in the workplace.
- **Site visit:** Field trips that serve as a means of buttressing the point made in class by providing the trainees with tangible evidence/experience of concepts taught.
- **Video:** For introduction and support of concepts taught in class.

SPECIAL SYMBOLS

- ⌘ Indicates *material* available in softcopy in the package folder.
- ◆ Indicates *resources* available in softcopy in the package folder.

1.4. MATERIALS AND FACILITIES

To successfully deliver this training course – particularly in view of the skills acquisition, certain materials and equipment are required. A careful review of this section is warmly recommended well ahead of the delivery of the course to ascertain availability, verify operating status, initiate procurement or repairs and provide alternatives wherever the originally recommended item is unavailable. The success of this training course vitally depends on practice on such material and equipment encompassing:

- Multimeters for voltage, amps and temperature
- Voltage disturbance recorder
- Data loggers
- Stack gas analysis equipment
- RPM, illumination, air flow measurement equipment
- Energy meters
- Thermal imaging equipment

<i>Minimum requirements for a class of 20 trainees</i>	<i>Quantity</i>	<i>Estimated unit cost (NGN)</i>	<i>Estimated cost (NGN)</i>
Cardboard strips			
Pin board	2		
Laptop for trainer	1		
Projector	1		
Whiteboard	1		
Whiteboard markers	Lot		
Coloured pins	Lot		
Loud speaker	1		
<i>Multimeters for voltage, amps and temperature</i>			
Digital multimeter Testo 760-3	1	99,500	99,500
Clamp meter Testo 770-1	1	50,000	50,000
<i>Accessories:</i> Adapter for type K thermocouples	1	12,500	12,500
<i>Accessories:</i> Thermocouple with TC adapter, Type K	1	7,500	7,500

<i>Minimum requirements for a class of 20 trainees</i>	<i>Quantity</i>	<i>Estimated unit cost (NGN)</i>	<i>Estimated cost (NGN)</i>
<i>Accessories:</i> Clamp probe for pipes, diameter 15-25 mm, TC Type K	1	29,500	29,500
<i>Accessories:</i> Surface temperature probe -60 to +400°C	1	27,000	27,000
<i>Accessories:</i> Temperature probe with Velcro (TC Type K)	1	19,500	19,500
<i>Accessories:</i> Spare 10 A/1,000 V fuses (set of 5)	1	17,500	17,500
<i>Accessories:</i> Spare 630 mA/1,000 V fuses (set of 5)	1	7,500	7,500
<i>Accessories:</i> Probe extensions (angled), 1,000 V	1	9,500	9,500
<i>Accessories:</i> Probe extensions (straight), 1,000 V	1	9,500	9,500
<i>Speciality monitors and data loggers</i>			
Voltage disturbance recorder – ACR PowerWatch	1		302,500
Voltage disturbance recorder – PowerWatch software I/F package	1		52,500
Thermal imager Flir E4 (resolution. 60x80)	1	600,000	600,000
Data logger – EL-USB-2 Temperature + rH	1	50,000	50,000
Data logger – HOBO State Data Logger	1	46,000	46,000
<i>Accessories:</i> USB cable	1	5,000	5,000
<i>Accessories:</i> AC current switch	1	44,000	44,000
<i>Energy meters</i>			
Ansmann AES-1 Zero Watt Energy Saving Timer Plug (UK plug)	10	20,000	200,000
Energenie Power Meter (UK plug)	10	30,000	300,000
SourcingMap UK Plug Energy Meter (UK plug)	10	30,000	300,000
Beha-Amprobe 3-phase energy meter	1	750,000	750,000
<i>Equipment for stack gas analysis</i>			
Compact flue gas analyser – Testo 320 basic	1	310,000	310,000
<i>Accessories:</i> USB mains unit incl. cable	1	17,500	17,500
<i>Accessories:</i> Flue gas probe; 300 mm; Ø 6 mm; T _{max} 500°C	1	120,000	120,000
<i>Accessories:</i> Spare particle filter, compact probe (set of 10)	2	25,000	50,000
<i>Accessories:</i> Case for instrument, probes and accessories	1	42,000	42,000
<i>Equipment for RPM, illumination, air flow</i>			
Tachometer – Testo 465	1	94,500	94,500
Lux meter – Testo 540	1	58,000	58,000
Air flow meter – Testo 417	1	158,000	158,000
<i>Accessories:</i> 9V rechargeable battery	2	13,000	26,000
<i>Accessories:</i> Charger for 9V rechargeable battery	2	11,000	22,000
Vane anemometer set – Testo 417 Set 2	1	N/A	N/A
Differential pressure meter – Testo 512 (0...2 hPa)	1	188,500	188,500
<i>Accessories:</i> Pitot tube, 500 mm long	1	69,000	69,000
<i>Accessories:</i> Connection hose; silicone; 5 m long	1	18,500	18,500

Prices are as at December 2016

1.5. TRAINING COURSE OVERVIEW**Module 1. General aspects of energy management** **24 hours**

Content	1.1 Climate change and renewable energies 1.2 Energy efficiency definition 1.3 Energy Manager/energy management 1.4 Metrics of energy 1.5 Basics of financial and economic analysis of energy efficiency savings 1.6 Energy monitoring schedule 1.7 Software tools for energy management
Recommended time allocation	24 hours Classroom 0 hours Site visit 0 hours Spare time +4 hours Additional self-study
Learning outcomes	At the end of the module the learner is able to: <ul style="list-style-type: none"> ▪ Understand fossil fuels and their impact on climate change ▪ Appreciate the importance of the energy manager ▪ Differentiate the units for energy management ▪ Describe different energy conversion processes ▪ Carry out basic life cycle costing ▪ Plan an energy monitoring schedule

Module 2. Norms, codes and standards **20 hours**

Content	2.1 Introduction to ISO 50001 2.2 The PDCA cycle 2.3 The PDCA procedure
Recommended time allocation	20 hours Classroom 0 hours Site visit/field trip 0 hours Spare time +4 hours Additional self-study
Learning outcomes	At the end of the module the learner is able to: <ul style="list-style-type: none"> ▪ Explain the characteristics of a management system in general and the ISO 50001 management system in particular ▪ Explain the steps and contents for implementation of the ISO 50001 system ▪ Explain the management audit as the central element of the ISO 50001 system

Module 3. Energy efficiency in industries: Thermal processes **32 hours**

Content	3.1 Fuels and combustion 3.2 Boilers 3.3 Steam systems 3.4 Furnaces 3.5 Recuperation of heat 3.6 Heat exchangers
Recommended time allocation	24 hours Classroom 8 hours Site visit 0 hours Spare +4 hours Additional self-study

Learning outcomes	<p>At the end of the module the learner is able to:</p> <ul style="list-style-type: none"> ▪ Describe operational principles of common industrial thermal processes ▪ Use respective tools and instruments ▪ Calculate energy losses ▪ Conceive, analyse and recommend energy conservation measures ▪ Prepare, present and defend proposals ▪ Implement measures
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Module 4. Energy efficiency in industries: Electrical applications

32 hours

Content	<p>4.1 Lighting systems 4.2 Electric motors 4.3 Compressed air systems 4.4 VAC and refrigeration systems 4.5 Fans, blowers, pumps and pumping systems 4.6 Power generating equipment: Diesel, natural gas, CHP and solar PV</p>
Recommended time allocation	<p>16 hours Classroom 16 hours Field trip/visit of installation 0 hours Spare time +4 hours Additional self-study</p>
Learning outcomes	<p>At the end of the module the learner is able to:</p> <ul style="list-style-type: none"> ▪ Describe operational principles of common industrial electrical application ▪ Use respective tools and instruments ▪ Calculate energy losses ▪ Fathom the effects of fuel and load factor in power generating equipment ▪ Conceive, analyse and recommend energy conservation measures ▪ Prepare, present and defend proposals ▪ Implement measures

Module 5. Energy efficiency in buildings

26 hours

Content	<p>5.1 Elements of the building energy management process 5.2 Energy consumer groups 5.3 Tariff evaluation 5.4 Energy efficiency indicators 5.5 Energy efficiency measures for buildings 5.6 Building design 5.7 Retrofitting homes and public buildings 5.8 Reference standards (local and international)</p>
Recommended time allocation	<p>18 hours Classroom 8 hours Field trip/visit of installation 0 hours Spare time +24 hours Additional self-study</p>
Learning outcomes	<p>At the end of the module the learner is able to:</p> <ul style="list-style-type: none"> ▪ Describe the fundamentals of building energy management ▪ Appreciate the importance of building management systems (BMS) ▪ Identification of energy consumer groups in a building ▪ Collect and analyse data gathered ▪ Conceive, analyse and recommend energy conservation measures ▪ Prepare, present and defend proposals ▪ Implement measures

Module 6. Process performance assessment, monitoring and verification		50 hours
Content	6.1 Energy audits 6.2 Energy planning 6.3 Control systems 6.4 Energy measurement, verification and monitoring 6.5 Software tools for auditors 6.6 Tests and assessment	
Recommended time allocation	34 hours Classroom 16 hours Site visits 0 hours Spare time +24 hours Additional self-study	
Learning outcomes	At the end of the module the learner is able to: <ul style="list-style-type: none"> ▪ Explain the procedure of an energy audit ▪ Carry out an energy audit ▪ Develop an audit report with analysis of reduction of energy consumption and recommendations ▪ Understand the most common groups of industrial energy consuming equipment ▪ Appreciate the importance of monitoring and verification in an energy management plan. ▪ Include monitoring and verification in an energy management ▪ Roughly estimate the costs of an energy audit 	

Practice Test – In preparation of national certification		16 hours												
Purpose	At the end of the course, the aptitude of each trainee should be assessed through a practice test in preparation of National Certification. The test should be based on the same benchmark: Nigerian Competency Standards for Clean Energy Release 2016 in the domain "Energy auditing in preparation for international certification". Practical examination shall be based on student reporting and activities during site visits.													
Recommended duration and weightage	<table border="1"> <thead> <tr> <th>Duration</th> <th>Examination type</th> <th>Weightage</th> </tr> </thead> <tbody> <tr> <td>4 hours</td> <td>Written examination</td> <td>30%</td> </tr> <tr> <td>4 hours</td> <td>Oral examination</td> <td>30%</td> </tr> <tr> <td>8 hours</td> <td>Practical examination</td> <td>40%</td> </tr> </tbody> </table>	Duration	Examination type	Weightage	4 hours	Written examination	30%	4 hours	Oral examination	30%	8 hours	Practical examination	40%	
Duration	Examination type	Weightage												
4 hours	Written examination	30%												
4 hours	Oral examination	30%												
8 hours	Practical examination	40%												
Grading	A candidate is deemed to have completed the course successfully (passed) if candidates attains a cumulative average score of 70% or above.													
Recommended certificate	Certificate of participation													

MODULE 1: GENERAL ASPECTS OF ENERGY MANAGEMENT

Content	Topics	Methods & materials	Key resources
1.1. Climate change and renewable energies (2 hours classroom)		Competency level: To understand	
Classification of energy sources	<ul style="list-style-type: none"> - Nigeria's intended nationally determined contribution - Primary vs secondary - Renewable vs non-renewable 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Video 1.1-1</u>: At the beginning of the class, the teacher should show video on general problems related to carbon dioxide and global warming.</p> <p><u>Interactive session 1.1-1</u>: Teacher should encourage discourse in the class by asking trainees to give their opinions on the following topics:</p> <ol style="list-style-type: none"> 1. Carbon dioxide. 2. Global warming. 3. Dependency and economic impact of utilisation of fossil fuels. 4. Renewable energies. 	<ol style="list-style-type: none"> 1. ♦ <i>Renewable energy resources</i> • Tidwell and Weir 2. ♦ <i>World energy outlook 2016: Executive summary</i> • IEA 3. ♦ <i>Africa energy outlook 2014</i> • IEA 4. ♦ <i>Nigeria's intended nationally determined contribution</i> • UNFCCC 5. ♦ <i>Guidebooks Vol. 1 – 1. Energy scenario</i> • Bureau of Energy Efficiency (BEE), India 6. ♦ <i>Guidebooks Vol. 4 – 12. Application of non-conventional and RE sources</i> • BEE, India 7. ♦ <i>Guidebooks Vol. 1 – 9. Global environmental concerns</i> • BEE, India 8. ♦ <i>Adapting to climate change: An introduction for Canadian municipalities</i> • NRCan 9. ♦ <i>Climate change 2013 – The physical science basis</i> • IPCC 10. <i>Why the right climate target was agreed in Paris</i> • Schellnhuber, Rahmstorf, Winkelmann

Content	Topics	Methods & materials	Key resources
1.2. Energy efficiency definition (2 hours classroom)		Competency level: To know	
Energy efficiency and conversion	- Measuring and calculating energy	Methods Instruction, Discussion	1. ♦ <i>Guidebooks Vol. 1 – 3. Energy management and audit</i> • BEE, India 2. <i>Energy benchmarking hurdles (and how to get over them)</i> • Building: Smarter facility management (www.buildings.com/article-details/articleid/6208/title/8-energy-benchmarking-hurdles-and-how-to-get-over-them-)
Energy saving	- SANS 50010 definition of energy efficiency savings - Calculating energy efficiency savings - Incentives for the implementation of energy efficiency in sample countries	Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards	
Energy efficiency benchmarking	- Energy efficiency and national or international energy performance benchmarking	Activities <u>Interactive session 1.2-1:</u> Teacher invites trainees to give examples of energy conversion chains that they have encountered and to estimate the efficiency of these chains.	
1.3. Energy Manager/ energy management (4 hours classroom)		Competency level: To know	
Energy management system	- Dimensions of energy management systems - The energy audit - Organisational structure of an energy consuming system - Energy balance	Methods Instruction, Discussion	1. ♦ <i>Guidebooks Vol. 1 – 3. Energy management and audit</i> • BEE, India 2. ♦ <i>Energy management handbook, 6th edition</i> • Turner and Doty 3. ♦ <i>Guidebooks Vol. 1 – 4. Material and energy balance</i> • BEE, India
		Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards	
		Activities <u>Interactive session 1.3-1:</u> Teacher should encourage reflection by asking trainees to describe their actual role in their organisation and the role they are going to play in the future (after the course, in one year), using an organogram of their home organisation. <u>Interactive session 1.3-2:</u> Reading, discussion, and understanding of energy consuming system the trainee brought from their home organisation.	

Content	Topics	Methods & materials	Key resources
1.4. Metrics of energy (4 hours classroom)			Competency level: To use
Physical units and conversion	<ul style="list-style-type: none"> - Definition - Forms of energy - Units of energy - Difference between energy and power - Demand and electrical energy - Energy conversion processes 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Exercise 1.4-1</u>: Students are given exercises out of a physics school book ('Physics for dummies') to train mathematical competencies.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 1 – 2. Basics of energy</i> • BEE, India 2. ♦ <i>Physics for dummies</i> • Holzner
1.5. Basics of financial and economic analysis of energy efficiency savings (EES) (4 hours classroom)			Competency level: To use
Economic evaluation	<ul style="list-style-type: none"> - Cost benefit analysis - Weighted average capital cost - Net present value - The project internal rate of return - Dynamic payback period - The cost of repayment of debt - Energy cost/ depreciation ratio - Least life cycle cost of EMOS 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Exercise 1.5-1</u>: Students are given financial calculations to make.</p>	<ol style="list-style-type: none"> 1. ♦ <i>A manual for the economic evaluation of energy efficiency and RE technologies</i> • Short, Packey and Holt 2. ♦ <i>Financing renewable energy in developing countries</i> • UNEP 3. ♦ <i>Developing model ESCO performance contracts (EPCs) for industrial projects</i> • Alliance for Energy Efficient Economy (AEEE)
General cost calculation	<ul style="list-style-type: none"> - Cost of electricity supplied versus cost of electricity saved 		
Energy service contracts	<ul style="list-style-type: none"> - Energy service contract models 		
1.6. Energy monitoring schedule (6 hours classroom)			Competency level: To apply
Energy monitoring	<ul style="list-style-type: none"> - Data sources - Historical data analysis - Load factor and utilisation factor - Tabulation of fuel consumption data - Tabulation of other data 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<ol style="list-style-type: none"> 1. <i>Handbook of energy audit</i> • Albert Thumann 2. ♦ <i>CIPEC Energy efficiency planning and management guide</i> • NRCan 3. <i>The handbook of sustainability literacy – skills for a changing world</i> • Stibbe

Content	Topics	Methods & materials	Key resources	
	<ul style="list-style-type: none"> - Comparative analysis - Energy monitoring - Targeting targets 	<p>Activities</p> <p><u>Role play 1.6-1:</u> Trainees are given a scenario – a challenge, background information and some guidelines on how they should approach the problem – similar to, but abstracted from a real-world case. Each participant is assigned the role of a particular stakeholder. They are assigned roles different than those they normally fill so that they can gain insights into other's perspectives. Exercises are always followed by debrief conversations to facilitate reflection and shared learning.</p> <p><u>Interactive session 1.6-1:</u> Each trainee elaborates a plan for the project: Implementation of an energy monitoring in my organisation; or to elaborate a plan for a given project.</p> <p>⌘ <u>Interactive session 1.6-2:</u> Trainer discusses a sample energy audit procurement tender issued by a power plant.</p>		
Procurement of energy audit				
Defining the energy audit from preliminary to detailed audit	<ul style="list-style-type: none"> - Practical auditing method - Final steps 			
1.7. Software tools for energy management (2 hours classroom)			Competency level: To apply	
Common energy management software tools	<ul style="list-style-type: none"> - RETScreen - Unit calculator - SinaSave - Loan payback calculator - The levelised cost of energy (LCOE) calculator - Advanced manufacturing office (AMO) software tools - Schneider Distant Learning Energy University 	<p>Methods</p> <p>Instruction, Discussion</p> <p>Materials</p> <p>Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>		

MODULE 2: NORMS, CODES AND STANDARDS

Content	Topics	Methods & materials	Key resources
2.1. Introduction to ISO 50001 (4 hours classroom)		Competency level: To understand	
About ISO		<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Video 2.1-1</u>: Getting started - ISO 50001 energy management. ⌘ <u>Video 2.1-2</u>: Important terms - ISO 50001 energy management. ⌘ <u>Video 2.1-3</u>: Measuring performance - ISO 50001 energy management. ⌘ <u>Video 2.1-4</u>: Top 10 tips - ISO 50001 energy management.</p> <p><u>Interactive session 2.1-1</u>: Trainees are asked about their experiences with ISO 50001 in their places of work and discuss it with the teacher.</p> <p><u>Interactive session 2.1-2</u>: Trainees study the ISO 50001 standard focussed on interpretation during a class discussion.</p>	<ol style="list-style-type: none"> 1. ISO 50001 standard • ISO 2. ♦ <i>Video: Getting started - ISO 50001 energy management</i> 3. ♦ <i>Video: Important terms - ISO 50001 energy management</i> 4. ♦ <i>Video: Measuring performance - ISO 50001 energy management</i> 5. ♦ <i>Video: Top 10 tips - ISO 50001 energy management</i>
2.2. The PDCA cycle (2 hours classroom)		Competency level: To understand	
Steps of the plan-do-check-act system	<ul style="list-style-type: none"> - Energy policy - Energy plan 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<ol style="list-style-type: none"> 1. ISO 50001 standard • ISO 2. ISO 50002 standard • ISO 3. ♦ <i>Guide book for energy auditing in industry</i> • UNDP 4. ♦ <i>Industrial energy manager training handbook</i> • GIZ NESP, Nigeria

Content	Topics	Methods & materials	Key resources
		<p>Activities</p> <p><u>Group work 2.2-1:</u></p> <ol style="list-style-type: none"> 1. Trainees analyse the contents of the p/d/c/a-cycle and present it in groups. 2. Trainees compare roughly ISO 50001 and 50002 in group work and present the elaboration by Metaplan cards and discuss it. 3. Trainees define stakeholders and their positions in the framework of ISO 50001 and use a roleplay to develop the respective points of view. 	
2.3. The PDCA procedure (14 hours classroom)		Competency level: To understand	
Plan	<ul style="list-style-type: none"> - Energy plan, - Energy review aspects - Energy baseline - Energy performance indicators - Energy objectives and targets - Energy performance indicators - Documentation - Action plan 	<p>Methods</p> <p>Instruction, Discussion</p> <p>Materials</p> <p>Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities</p> <p><u>Group work 2.3-1:</u> Trainees elaborate an energy policy for different industries given by the trainer.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Industrial energy manager training handbook</i> • GIZ NESP, Nigeria 2. ♦ <i>Guide book for energy auditing in industry</i> • UNDP 3. ♦ <i>Industrial energy audit guidebook: Guidelines for conducting an energy audit in industrial facilities</i> • Hasanbeigi and Price
Do	<ul style="list-style-type: none"> - Legal requirements - Responsibilities of the top management - Energy Manager - Energy management team - Awareness building - Documentation and monitoring the EnMs 	<p><u>Group work 2.3-2:</u> The trainer provides information about an industry of his choice and trainees look for possible performance indicators and present them with Metaplan.</p> <p><u>Group work 2.3-3:</u> Trainees develop an awareness building plan for a factory given by the trainer.</p>	
Check and act	<ul style="list-style-type: none"> - Monitoring and measurement of results - Internal audit - Introduction to energy audit 	<p><u>Group work 2.3-4:</u> Trainees explain the difference between energy audit and energy management audit and present it in groups.</p>	

<i>Content</i>	<i>Topics</i>	<i>Methods & materials</i>	<i>Key resources</i>
	<ul style="list-style-type: none"> - Procedure of the management audit - Corrective actions - Control of records - Management review - Certification, assessment and external communication 	<p><u>Internet research 2.3-1:</u> Trainees research the internet for possible legal requirements in their country and present and interpret it.</p>	
<p>Energy performance auditing vs. Energy management systems</p>			

MODULE 3: ENERGY EFFICIENCY IN INDUSTRIES: THERMAL PROCESSES

Content	Topics	Methods & materials	Key resources
3.1. Fuels and combustion (4 hours classroom)			Competency level: To apply
Sources of fuels focus wood	- Wood as renewable fuel	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 3.1-1:</u> Before lessons begin, trainees discuss what they know about different fuel types.</p> <p>⌘ <u>Exercise 3.1.-1:</u> The trainees work in groups to solve given calculations about fuels and combustion.</p>	1. ♦ <i>Guidebooks Vol. 2 – 1. Fuels and combustion</i> • Bureau of Energy Efficiency (BEE), India
3.2. Boilers (4 hours classroom)			Competency level: To apply
Boilers and heating systems for small and medium sized companies.	- Boiler efficiency - Boiler blowdown - Economisers - Different kinds of boilers - Heat distribution systems - Boiler annual fuel utilisation efficiency	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 3.2.-1:</u> Before lessons begin, trainees discuss what they know about boilers, how to operate, losses etc.</p> <p>⌘ <u>Exercise 3.2.-1:</u> The trainees work in groups to solve given calculations about boilers.</p>	2. ♦ <i>Guidebooks Vol. 2 – 2. Boilers</i> • BEE, India 3. ♦ <i>Guidebooks Vol. 4 – 1. Energy performance assessment boilers</i> • BEE, India
Energy performance quality vs. energy management of boiler systems	- Listing the system performance parameters and associated sensors		
3.3. Steam systems (4 hours classroom)			Competency level: To apply
Optimising steam and condensate systems	- Excerpt from steam tables - Flash steam recovery	<p>Methods Instruction, Discussion</p>	1. ♦ <i>Guidebooks Vol. 1 – 2. Basics of energy</i> • BEE, India

Content	Topics	Methods & materials	Key resources
		<p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 3.3.-1:</u> Before lessons begin, trainees discuss their knowledge of steam systems.</p> <p>⌘ <u>Exercise 3.3.-1:</u> Trainees work in groups to solve given calculations about pressure, temperature, etc. Trainees then discuss solutions with rest of class.</p>	2. ♦ <i>Guidebooks Vol. 2 – 3. Steam systems</i> • BEE, India
3.4. Furnaces (4 hours classroom + 8 hours visit of installation)			Competency level: To apply
Types, characteristics and performance assessment	<ul style="list-style-type: none"> - Heat balance of a furnace - Performance terms and definitions - Furnace efficiency testing methods (direct / indirect) - Measurement parameters - Heat loss - Factors affecting furnace performance 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Exercise 3.4.-1:</u> The trainees work in groups to solve given calculations about performance of furnaces, measurements, heat loss, etc.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 2 – 4. Furnaces</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 4 – 2. Energy performance assessment furnaces</i> • BEE, India
Useful data	<ul style="list-style-type: none"> - Radiation heat transfer - Furnace utilisation factor - Standby losses - Furnace draft control - Theoretical heat 		

Content	Topics	Methods & materials	Key resources
3.5. Recuperation of heat (4 hours classroom)			Competency level: To apply
Waste energy streams and potential uses	<ul style="list-style-type: none"> - Practical recuperation rate - Direct heat recovery methods - Indirect heat recovery methods 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Exercise 3.5.-1</u>: The trainees work in groups to solve given calculations about recuperation of heat, heat exchangers, efficiency, temperature profiles, etc.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 2 – 8. Waste heat recovery</i> • BEE, India
3.6. Heat exchangers (4 hours classroom)			Competency level: To apply
Design, operation and maintenance	<ul style="list-style-type: none"> - Overall heat transfer coefficient - Heat exchanger terminology 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities ⌘ <u>Exercise 3.6-1</u>: The trainees work in groups to solve given calculations about heat exchangers, thermal parameters, efficiency, etc.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 2 – 9. Heat exchangers</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 4 – 4. Energy performance assessment heat exchangers</i> • BEE, India

MODULE 4: ENERGY EFFICIENCY IN INDUSTRIES: ELECTRICAL APPLICATIONS

Content	Topics	Methods & materials	Key resources
4.1. Lighting systems (2 hours classroom)			Competency level: To apply
Lights and lighting	<ul style="list-style-type: none"> - Lighting costs - Energy efficiency - Energy efficiency measures in lighting system 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Exercise 4.1.-1:</u> The trainees undertake a survey around the training facility and list the type of lighting systems they find.</p> <p><u>Interactive session 4.1-1:</u> Trainees attempt to describe the illumination comfort of surveyed venue in Exercise 4.1-1.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 3 – 8. Lighting systems</i> • Bureau of Energy Efficiency (BEE), India 2. ♦ <i>Guidebooks Vol. 4 – 10. Energy performance assessment lighting systems</i> • BEE, India
4.2. Electric motors (2 hours classroom)			Competency level: To apply
Electric motors and applications	<ul style="list-style-type: none"> - Determining motor load - Energy efficiency measures in electric motors - Power factor Improvement at motor terminals - Variable speed drives (VSD) 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards.</p> <p>Activities <u>Interactive session 4.2.-1:</u> The trainees list the types of electrical motors, their purpose and their function during a visit at any production unit (if possible).</p> <p>⌘ <u>Exercise 4.2-1:</u> The trainees work in groups to solve given calculations about electric motors.</p>	<ol style="list-style-type: none"> 1. ♦ Video: How to read a motor nameplate 2. ♦ <i>Guidebooks Vol. 3 – 2. Electric motors</i> • BEE, India 3. ♦ <i>Guidebooks Vol. 4 – 5. Energy performance assessment electric motors</i> • BEE, India

Content	Topics	Methods & materials	Key resources
4.3. Compressed air systems (2 hours classroom)			Competency level: To apply
Operation and cost of compressed air systems	<ul style="list-style-type: none"> - Energy efficiency measures in compressed air systems - Cost of compressed air leaks - Simplified air leakage test - Low, no cost and higher cost actions 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 4.3.-1:</u> The trainees list the types of compressed air systems, their purpose and their function during a visit at any production unit (if possible).</p> <p>⌘ <u>Exercise 4.3-1:</u> The trainees work in groups to solve given calculations about air compressors.</p> <p>⌘ <u>Exercise 4.3-2:</u> Trainees work in groups solving calculations concerning pumps.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 3 – 3. Compressed air systems</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 4 – 8. Energy performance assessment compressors</i> • BEE, India
4.4. Ventilation, air conditioning and refrigeration systems (2 hours classroom)			Competency level: To apply
Efficient operation of cooling systems	<ul style="list-style-type: none"> - Ventilation systems - Ventilation rates - Components and efficiency 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 4.4.-1:</u> The trainees list the types of ventilation systems, their purpose and their function during a visit at any production unit (if possible).</p> <p>⌘ <u>Exercise 4.4-1:</u> The trainees work in groups to solve given calculations about ventilation and HVAC systems.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 3 – 4. HVAC and refrigeration systems</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 4 – 9. Energy performance assessment HVAC and refrigeration systems</i> • BEE, India

Content	Topics	Methods & materials	Key resources
4.5. Fans, blowers, pumps and pumping systems (2 hours classroom)			Competency level: To apply
Types, characteristics and performance assessment	<ul style="list-style-type: none"> - Affinity law - Assessment of fans and pumps - Selected savings opportunities 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 4.5-1:</u> The trainees list the types of fans, blowers or pumps, their purpose and their function during a visit at any production unit (if possible).</p> <p>⌘ <u>Exercise 4.5-1:</u> The trainees work in groups to solve given calculations about fans.</p> <p><u>Exercise 4.5-2:</u> The trainees work in groups to solve given calculations about pumps.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 3 – 5. Fans and blowers</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 4 – 6. Energy performance assessment fans and blowers</i> • BEE, India 3. ♦ <i>Guidebooks Vol. 3 – 6. Pumps and pumping systems</i> • BEE, India 4. ♦ <i>Guidebooks Vol. 4 – 7. Energy performance water pumps</i> • BEE, India
4.6. Power generating equipment: Diesel, natural gas and solar photovoltaics (6 hours classroom)			Competency level: To apply
Types, characteristics and performance assessment	<ul style="list-style-type: none"> - Diesel engine generators – industrial applications - Energy saving opportunities - Conducting energy performance assessment of DG set 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 4.6.-1:</u> The trainees perform a literature – or internet study – about diesel generators and PV-systems, work out their characteristics and compare the systems focusing on costs, possibilities of implementation, general acceptance, political acceptance, etc.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 3 – 9. DG sets</i> • BEE, India 2. ♦ <i>Guidebooks Vol. 3 – 1. Electrical systems</i> • BEE, India

Content	Topics	Methods & materials	Key resources
Natural gas generators	<ul style="list-style-type: none"> - Steam generation units - Centralised gas turbines - Combined cycle units - Distributed generation - Industrial natural gas fired turbines - Natural gas-fired reciprocating engines 	<p>⌘ <u>Exercise 4.6-1</u>: The trainees work in groups to solve given calculations about diesel generators.</p> <p>⌘ <u>Exercise 4.6-2</u>: The trainees work in groups to solve given calculations about cogeneration.</p>	
Photovoltaics	<ul style="list-style-type: none"> - Solar photovoltaics (PV) - Efficiency - PV panels and systems - Rooftop and building integrated systems - Prospects for use in rural areas - Facade systems - Major components of a PV system - Sizing and energy output - Conditions for installation - Power grid connection 		

Across 4.1. – 4.6.: Additional hours to be spent on site visits: 16 hours

MODULE 5: ENERGY EFFICIENCY IN BUILDINGS

Content	Topics	Methods & materials	Key resources
5.1. Elements of the building energy management process (2 hours classroom)		Competency level: To apply	
Building energy management systems	<ul style="list-style-type: none"> - Residential sector - Energy management system (EnMS) - EnMS within company /municipality - EnMS documentation - Energy management manual - Document control - Communication - Structure of an energy report 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 5.1.-1:</u> General discussion about energy policy in the country, general acceptance of energy managements plans.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 1 – 3. Energy management and audit</i> • Bureau of Energy Efficiency (BEE), India 2. ♦ <i>Energy efficiency in buildings (Module 18): Sustainable energy regulation and policymaking training manual</i> • UNIDO 3. ♦ <i>Final energy audit report ECOWAS HQ Abuja</i> • ECREEE
5.2. Energy consumer groups (2 hour classroom)		Competency level: To know	
Consumer groups and consumption	<ul style="list-style-type: none"> - Electricity and consumption - Human behaviour and wastage - Largest saving potential: Hot water heating, cooling and lighting 	<p>Methods Instruction</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<ol style="list-style-type: none"> 1. ♦ <i>Energy efficiency in buildings (Module 6)</i> • GIZ, South Africa 2. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA
5.3. Tariff evaluation (2 hours classroom)		Competency level: To use	
Energy costs	<ul style="list-style-type: none"> - Off-grid electricity prices - Grid electricity prices 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Interactive session 5.3.-1:</u> Trainees present tariff examples and discuss experiences with charges levied.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 1 – 3. Energy management and audit</i> • BEE, India 2. ♦ <i>Energy consumption data analysis</i> • GIZ, South Africa 3. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA

Content	Topics	Methods & materials	Key resources
		<u>Exercise 5.3-1</u> : Trainees analyse the MYTO II giving their thoughts and opinions.	
5.4. Energy efficiency indicators (2 hours classroom)			Competency level: To apply
Energy performance of buildings	<ul style="list-style-type: none"> - Energy efficiency: Costs, certifying and consumption - Energy intensity - Natural energy gains - Delivered energy - Exported energy - System losses - Determining a building's energy performance 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<ol style="list-style-type: none"> 1. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA 2. ♦ <i>Energy efficiency indicators: Essentials for policy making</i> • IEA
5.5. Energy efficiency measures for buildings (2 hour classroom)			Competency level: To apply
Reducing energy consumption	<ul style="list-style-type: none"> - Reducing cooling demand - Avoiding excessive glazing - Use of shading - Solar control glass - Selecting equipment with reduced heat output - Separating high heat load processes from general accommodation - Making use of thermal mass and night ventilation to reduce peak temperatures - Reducing heat gains from lighting - Predicting the impact of passive cooling strategies - Reducing the energy requirements for ventilation - Use of cool roof 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<ol style="list-style-type: none"> 1. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA 2. ♦ <i>Energy adviser training material</i> • Johannes Fechner, CER

Content	Topics	Methods & materials	Key resources
5.6 Building design (4 hour classroom)			Competency level: To apply
Passive architecture	<ul style="list-style-type: none"> - Reducing energy consumption with improved ventilation, windows design, lighting - Reducing energy for water heating - Reducing consumption of appliances - Good housekeeping and people solutions - Investment in energy efficiency in buildings 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<p>1. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA</p>
5.7. Retrofitting homes and public buildings (2 hour classroom)			Competency level: To apply
	<ul style="list-style-type: none"> - Lighting - Refrigeration - Landscaping - Providing incentives - Use of renewable energy - Energy Star equipment and appliance labelling 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p>	<p>1. ♦ <i>Energy adviser training material</i> • Johannes Fechner, CER</p>
5.8. Reference standards (local and international) (2 hours classroom)			Competency level: To apply
Energy efficiency standards, standards and labels (S&L)	<ul style="list-style-type: none"> - Policy tools to promote building efficiency - Codes, standards and labels - Retail price of efficient appliances - Energy efficient S&L programmes - Residential and non-residential buildings - Incentives - Certification and labelling - Minimum energy performance standards - The Energy Star label - Energy Benchmark Pool Frankfurt in commercial buildings 	<p>Methods Instruction, Discussion, Exercise</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards</p> <p>Activities <u>Group work 5.8.-1:</u> Literature and Internet research. Trainees undertake a research for national – and international codes and standards and compare them.</p>	<p>1. ♦ <i>Energy efficiency requirements in building codes, energy efficiency policies for new buildings</i> • Jens Laustsen, IEA</p> <p>2. ♦ <i>Performance assessment of buildings and commercial establishments</i> • BEE, India</p>
Across 5.1. – 5.8.: Additional hours to be spent on site visits: 8 hours			

MODULE 6: PROCESS PERFORMANCE ASSESSMENT, MONITORING AND VERIFICATION

Content	Topics	Methods & materials	Key resources
6.1. Introduction to ISO 50002 and energy audits (6 hours classroom)		Competency level: To apply	
Introduction to ISO 50002 and energy audits	<ul style="list-style-type: none"> - Energy audit as defined by ISO 50002 - Types of energy audit - Levels of energy audits - Definitions of scope, boundaries 	<p>Methods Instruction, Discussion, Brainstorming</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pinboards</p> <p>Activities <u>Interactive session 6.1-1:</u> Trainees to share experiences that they have had in audit activities.</p> <p><u>Interactive session 6.1-2:</u> Teacher discusses difference between ISO 50001 and 50002.</p> <p><u>Interactive session 6.1-3:</u> The class discusses what they know about audit levels and what levels of audit are known by the trainees.</p> <p><u>Interactive session 6.1-4:</u> Teacher explains the different levels, discusses the differences and possibilities of application, referring to small- medium- and large scale industries (best on the base of previously visited industries).</p> <p><u>Interactive session 6.1-5:</u> Trainees are asked to develop ideas where scope and boundaries could be defined at the sample industries to be visited during the course.</p>	<ol style="list-style-type: none"> 1. ISO 50002 standard • ISO 2. ♦ <i>Industrial energy auditor training guidebook</i> • CBLA 3. ♦ <i>Energy audit report</i> • Darson Industries (Pvt) Limited 4. ♦ <i>Energy audit report</i> • Muhammed Shafi Tanneries (Pvt) Limited 5. ♦ <i>WTEA guide and checklist ISO 50002</i> • Andreas Karner and Peter Weldingh 6. ♦ <i>Guidebook for energy auditing in industry</i> • UNDP
Audit scope boundaries	<ul style="list-style-type: none"> - Definition - Phases of every audit - Audit plan - Site assessment or condition survey 		
Finding opportunities	<ul style="list-style-type: none"> - Preliminary review of utility data - Compiling data of energy use - Data analysis - The cost analysis - Benchmarking - Internal comparison - Profile energy use Patterns - Demand profile - Finding opportunities - Assess the costs and benefits 		
Energy audit reports	<ul style="list-style-type: none"> - Energy audit reports - Energy audit costs 		

Content	Topics	Methods & materials	Key resources
		<p><u>Interactive session 6.1-6:</u> Trainees develop an audit strategy and planning matrix for an upcoming audit at sample industries through group work. Different groups focus different technologies.</p> <p><u>Interactive session 6.1-7:</u> Trainees develop questionnaires and checklists (Word & Excel) for the audit and present and discuss them with the others.</p> <p><u>Interactive session 6.1-8:</u> Trainees analyse existing audit reports (a few chapters per group) for coherence with requirements of ISO 50002 and its quality.</p> <p><u>Interactive session 6.1-9:</u> Trainees discuss commercial offers (days, rates, etc.) for such an energy audit.</p>	
6.2. Energy planning (8 hours classroom)		Competency level: To use	
Process	<ul style="list-style-type: none"> - EMO prioritisation - Methods to retrieve information - Benchmarking - Calculate EE improvement potential - Prioritising opportunities - Parameter for prioritisation - Prioritisation techniques - Targets and action plans - Action plans - Energy goals, targets and strategies 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pinboards</p> <p>Activities <u>Interactive session 6.2-1:</u> Participants do internet research for benchmarks for different industrial sectors, based on latest technologies, or for the sample industries to be visited during the course.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Energy efficiency adviser</i> • Pakistan TVET Reform Programme 2. ♦ <i>Energy management systems in practice: Guide for companies and organisations</i> • Umweltbundesamt (UBA), Germany 3. ♦ <i>Industrial energy auditor training guidebook</i> • CBLA 4. ♦ <i>Guides Vol. 1 – 5. Energy action planning</i> • Bureau of Energy Efficiency (BEE), India

Content	Topics	Methods & materials	Key resources
		<p><u>Interactive session 6.2-2:</u> Trainees have to develop an energy strategy (goals, EnPI, priority) for the sample industries to be visited during the course based on the data delivered by them or based on the exemplary energy data and measures.</p>	
6.3. Control systems (2 hours classroom)		Competency level: To apply	
Control systems and strategies as source for energy performance improvements	<ul style="list-style-type: none"> - Introduction - Technology classification - Control system complexity - Symbols in control engineering - Control modes 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pinboards</p> <p>Activities <u>Interactive session 6.3-1:</u> Discuss the case study of improving the controls of a central HVAC unit.</p>	<ol style="list-style-type: none"> 1. <i>Technical documents</i> • Samson (www.samsoncontrols.com/technical-documents) 2. <i>Building automation/HVAC technology</i> • Siemens (www.buildingtechnologies.siemens.com/bt/global/en/building-knowledge/pages/building-automation-hvac.aspx)
Input/output devices	<ul style="list-style-type: none"> - Transducers - Switches - Sensors - Transmitters - Addressable smart devices 		
6.4. Instrumentation and tools (8 hours classroom)		Competency level: To apply	
Measurement & Verification	<ul style="list-style-type: none"> - Concepts of M&V - Calculating and reporting savings - Energy measurement plan 	<p>Methods Instruction, Discussion</p> <p>Materials Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pinboards</p> <p><u>Interactive session 6.4-1:</u> Try to use all the tools available in the class room and discuss their use and limitations.</p> <p><u>Interactive session 6.4-2:</u> Discuss possibilities for process monitoring on the base of sample industries (previously visited).</p>	<ol style="list-style-type: none"> 1. <i>M&V protocol development</i> • Efficiency valuation organisation (http://evoworld.org/en/) 2. <i>Measurement and evaluation operational guide</i> • Office of environment and heritage (www.environment.nsw.gov.au/energyefficiencyindustry/confirm-energy-savings.htm) 3. <i>The certified Measurement and Verification Professional (CMVP) program</i> • Association of Energy Engineers (www.aeecenter.org/i4a/pages/index.cfm?pageid=3356)
Temporary measurement equipment	<ul style="list-style-type: none"> - Temporary measurement equipment 		
Continuous measurement (monitoring)	<ul style="list-style-type: none"> - Introduction - Equipment & hardware - Energy data software - Implementation 		

Content	Topics	Methods & materials	Key resources
		<u>Exercise 6.4-1</u> : Trainees are divided into 2-3 groups depending on the number of sample industries or buildings available. The sub groups form specialised teams which discuss individual parts of the audit, report it and present it at the end at the plenum.	4. Equipment and prices • Lesman (www.lesman.com/catupdates.html)
6.5. Software tools for auditing (2 hours classroom)		Competency level: To apply	
Auditing software tools	<ul style="list-style-type: none"> - Degree days - Mini web tool (WACC calculator) - TLV tool box - 3E plus - SinaSave - E3 calculator - CHP calculator - eQuest - Energy calculators - Boiler performance calculators 	<p>Methods</p> <p>Instruction, reports on experience, Discussion</p> <p>Materials</p> <p>Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards, Flip chart</p>	
6.6. Tests and assessment (8 hours classroom + 16 hours site visit)		Competency level: To apply	
<p><i>Note: The tests and assessment section is deliberately not covered by the handbook. It is designed to be carried out with data of the local context.</i></p>			
Conducting internal audits	<ul style="list-style-type: none"> - Codes and standards for energy performance testing - Performance evaluation of common energy consumers - Electric motors & variable speed drives - Efficiency testing - Determining motor loading 	<p>Methods</p> <p>Instruction, reports on experience, Discussion</p> <p>Materials</p> <p>Laptop, Projector, Loud speakers, Whiteboard, Whiteboard markers, Metaplan cards, Metaplan pin boards, Flip chart</p> <p>Activities</p> <p><u>Site visit 6.6-1</u>: Field trip to suitable manufacturers. The trainees act as auditors, ask questions to understand the processes with the aim to identify improvements of the energy performance of the visited companies.</p>	<ol style="list-style-type: none"> 1. ♦ <i>Guidebooks Vol. 1 – 3. Energy management and audit</i> • BEE, India 2. <i>Energy efficiency improvement and cost saving opportunities for the textile industry</i> • Energy Star, U.S. Environmental Protection Agency 3. <i>Energy efficiency and CO₂ emissions: Prospective scenarios for the cement industry</i> • SETIS, European Commission <p>♦ <i>Energy audit reporting, instruments and case studies</i> • K.K. Chakarvati</p>

