



Mitigation Enabling Energy Transition in the MEDiterranean region
Together We Switch to Clean Energy

Training Package

ENERGY AUDITS IN INDUSTRIAL SMALL TO MEDIUM SIZED ENTERPRISES (SMEs)



meetMED is funded by the European Union



Regional Center for Renewable Energy and Energy Efficiency
المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

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The meetMED project is a two-year project funded by the EU and jointly carried out by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and by the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE). Its main goal is to reinforce regional cooperation aimed at fostering the energy transition in Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine and Tunisia under the umbrella of the UfM REEE platform.

The meetMED team in Brussels coordinates the project partners and experts in implementing the project activities, in the following areas of work: assessing EE and RES strategies and policies; advancing vocational training and public awareness; attracting sustainable RE and EE investments; supporting the UfM Renewable Energy and Energy Efficiency Platform.

The meetMED activities target and benefit a wide range of stakeholders, including policy makers, public authorities, investors and financial institutions as well as local communities and final customers. meetMED supports regional cooperation by building the technical capacity and raising the public awareness necessary to implement RE and EE projects and solutions, while creating synergies with other initiatives targeting energy transition in the Mediterranean region.



MEDENER is an international non-profit organization gathering agencies from the northern and southern Mediterranean countries in charge of implementing public policies on energy efficiency and the promotion of renewable energy sources, by implementing regional projects facilitating the sharing of know-how and best practices among its members and international partners, as well as accelerating the transfer of skills, methods and technologies in the field of energy efficiency and renewable energy.



RCREEE is an intergovernmental organization aiming at enabling the adoption of renewable energy and energy efficiency practices in the Arab region. **RCREEE** brings together regional governments and global organizations to initiate and lead clean energy policy dialogues, strategies, technologies and capacity development in order to increase Arab states' share of tomorrow's energy. Its key work areas are capacity development and learning, policies and regulations, research and statistics, and technical assistance.

Foreword



This meetMED publication contains the materials for a professional training on energy audits in industrial small to medium enterprises targeting public authorities, industrial sector, energy experts in charge of promoting EE in the industrial sector.

Technologies and processes for the rational use of energy in industrial production are the main tool to decouple industrial production from energy intensity – therefore contributing to the overall goal of transition to a low carbon and circular economy. In this respect, energy management contributes to assess and design the industrial processes that integrate energy savings and security as well as the competitiveness and sustainability of the industrial production.

This professional training on energy audits and energy management is a practical tool to strengthen the technical capacity to improve energy efficiency and profitability in the industrial sector and to optimize energy-intensive equipment and systems.

This meetMED training package is available for replication and to be used in future training activities addressed to the energy professionals in charge of energy systems in the industrial sector.

This meetMED training package on energy audits was designed by meetMED experts from RCREEE, ANME (Tunisia) and CRES (Greece).

The materials were drafted building on the existing national and EU practices and on the PA-CEMP project. Special thanks for their support and contribution go to SwitchMed and UNIDO.

The training materials were first used in a 5-day training held in Cairo in December 2019. The event was hosted by the RCREEE and delivered by meetMED experts from RCREEE, ANME (Tunisia) and CRES (Greece) with the support of the meetMED experts from AMEE (Morocco), APRUE (Algeria), ENEA (Italy), LCEC (Lebanon), and MEMR (Jordan).

The credits for this publication go entirely to the network of meetMED experts from the national energy agencies and ministries of the 13 meetMED countries, who prepared and tested the training materials - under the restless coordination of RCREEE, CRES (Greece) and ANME (Tunisia).

Matteo Barra

meetMED Project Manager

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About the Training Package

This training course is designed to provide energy experts with the necessary skills and knowledge to improve energy efficiency and profitability in the industrial sector as well as to gain required methodology for the completion of a thorough energy audit. Furthermore, the course includes the exchange of regional experiences among the meetMED targeted countries, in planning and implementing EE plans and related measures for industrial SMEs.

The training modules cover the general aspects of energy management and energy audit; electrical energy management; thermal energy management; energy auditing iso 50002; practical instruments and tools for energy auditing; energy performance assessment of equipment and SMEs; economic analysis and project financing; measurement and verification as well as demand side management programs.

The meetMED training course on Energy Audits in Industrial Small to Medium Enterprises (SMEs) took place on 08-12 December 2019 in Cairo, Egypt.

The meetMED training course was co-organized by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), the Greek Centre for Renewable Energy Sources and Saving (CRES) and the Tunisian National Agency for Energy Management (ANME), based on this training package they jointly developed.

Authors

Mina ADLY - Energy Expert, RCREEE



Mina Adly, graduated as an electrical engineer and is a certified European energy manager (EUREM) and PA CEMP. He joined RCREEE in 2015 as a local sustainable energy expert working on the sustainable energy financing facility for Egypt (Egypt SEFF) project, established by the European Bank of Reconstruction and Development, and its second phase, the Green economy financing facility in Egypt (GEFF Egypt). He is also participating in many different projects that focused mainly on resource efficiency and climate change topics as Financing Facility developed by GGF. This facility is dedicated to the implementation of EE and RE applications through Banque du Caire.

Hussam ALHERAFI – Technical Director, RCREEE



H. Alherafi holds a master's degree in Political Science, with a special focus on International Economic Relations. Currently, he is Senior Policy Specialist at RCREEE, where he has been working for the past six years. He has a strong experience in promoting RE and EE policies and projects in the Arab region. Furthermore, he has a solid expertise in market assessment and in designing, monitoring, evaluating and reporting cross-sectorial policies, regulatory frameworks, governance systems and governmental subsidies. He is currently involved in several regional projects and studies on sustainable energy, implemented in collaboration with national and international organizations (i.e. LAS, EU, WB, GIZ, UNDP).

Matteo BARRA – meetMED Project Manager



Mr Barra is currently working as Project Manager for the meetMED Secretariat. His main responsibility is to lead the implementation of the meetMED Project by coordinating the work package leaders and monitoring the organisation of the activities in order to ensure that they will achieve the deliverables of the project. Matteo is also responsible for reporting to

the European Commission on the implementation of the project. In his former experiences, Matteo has worked as senior expert on investments at the Energy Charter Secretariat, acting mainly on ECT investment provisions and dispute settlement. Previously, he was associate with the international arbitration team of a large law firm in Geneva, where he acted in investment and commercial disputes concerning among others the electricity, gas and oil industry. Matteo holds a Ph.D. in International Economic Law (Bocconi) and an LL.M. in International Energy Law and Policy (CEPMLP).

Enrico BIELE – Energy Expert, ENEA



E. Biele works as Senior Expert of Energy Policy in the Italian Energy Agency (ENEA). He has previously worked for the Sustainable Energy Authority of Ireland and the Italian Federation for the Rational Use of Energy, first as Energy Efficiency Analyst and, then, as Principal Energy Policy Officer. He holds a Master in Business Administration (MBA) from the Frankfurt School of Finance and Management (DE) and a MSc+BSc in Energy Engineering from the University of Sannio (IT).

He has been speaking at 90 National and International Conferences, of which 10 held as Chairman and, he has been a lecturer in Energy efficiency policies and Incentives at University masters and national training courses, for an overall number of more than 2,000 specialists trained. He published for ECEEE and IEPPEC on the topic of energy efficiency obligation schemes and energy efficiency in industry. He is a Certified Measurement and Verification Professional under the IPMVP scheme.

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE



Dr. Elfarra has 30-year experience in the field of energy and environmental aspects. He participated in many national and international programs for Egypt, that served to enhance the performance of EE and RE technologies implementations in order to achieve GHG emissions reduction at the national level. He is currently working as general manager for the Engineering and Projects Department at the National Energy Corporation - Egypt (NECE) – TARSHEED. During his career in TARSHEED, Dr. Elfarra focused on business development venues for EE and RE in industrial, commercial, tourism, and buildings sectors in Egypt and the region. In addition, Dr. Elfarra has participated in many energy and strategic plans ac-

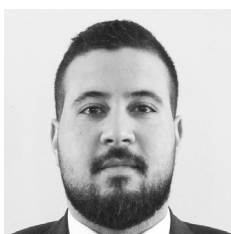
tivities considering the demand and the generation sides on national scale. Dr. Elfarra is the chair of Certified Energy Manager (CEM) seminar of the Association of Energy Engineers (AEE) in Egypt. In this regard, Dr. Elfarra has delivered the CEM courses and certified more than 800 engineers as CEM in Egypt, Saudi Arabia, Kuwait, and UAE since 2001. He is also a trainer for energy efficiency and renewable energy technologies in industry for the EUREM program in Egypt and the Pan Arab Certified Energy Management Professionals. He organized seminars and trained the trainers on energy conservation technologies, performance contracting and ESCO activities. He set environmental management programs carried out in some Egyptian governorates. As a former technical Manager assistant for Energy Conservation and Environment Projects (ECEP), funded by USAID, he was involved in techno-economic feasibility studies, capacity building, technologies implementation, and projects management.

Ayman EL ZAHABY – Technical Expert, UNIDO



A. El Zahaby is a technical expert specialized in the circular economy and resource efficiency for industry with a focus on the textile, food and beverage, cement, and chemical sectors. In his fifteen years of experience, he has been managing, co-managing and leading energy and resource efficiency projects as well as consulting assignments with a focus on Egypt and the Southern Mediterranean region. He has strong experience with technical assistance programmes. He is currently a regional coordinator for UNIDO's MEDTEST III in Egypt while supporting the implementation of MEDTEST III in Jordan. His career at UNIDO, started in 2014 when he developed an energy efficiency benchmark study for the Egyptian iron and steel sector. He also acted as a national expert for several energy efficiency related assignments within the UNIDO - Industrial Energy Efficiency project. Other than his experience with UNIDO, A. El Zahaby served as a senior expert in the African Development Bank for the IWEX project, and as energy efficiency advisor for the USAID - Trade Facilitation Project. Throughout his career, he has supported more than fifty enterprises on implementing and assessing environmental and economic benefits for sustainable energy and resource efficiency projects. With respect to Egypt, he has a full understanding of regulatory and policy frameworks governing the energy and industrial sectors. Over the years, he has built strong relations with the different stakeholders and active market players in the country. A. El Zahaby is an engineering graduate with mechanical power specialization from Cairo University and holds a master's degree in environmental engineering from the American University in Cairo.

Khalid SALMI – Senior Energy Management Specialist, RCREEE



K. Salmi, graduated as a mechanical engineer and holds a MSc degree in Renewable Energy engineering. He joined RCREEE in 2014 through the vocational internship program APSEY, and currently, he is actively managing the regional implementation and execution of RCREEE's standardization and certification programs, specifically SHAMCI (Solar Heating Arab Mark and Certification Initiative), which is the first certification scheme for solar thermal products and services in the Southern and Eastern Mediterranean countries, and PA-CEMP (Pan Arab Certified Energy Management Professional Program), which is the first standardized in-depth professional certification program for energy managers in MENA region.

By cooperating with regional governmental agencies and international development organizations, Mr. Salmi acquired a practical expertise about the important role of quality standardization and products/personnel certification as an effective instrument for the deployment of new clean energy practices.

Katerina SFAKIANAKI – Energy expert, CRES



K. Sfakianaki is a physicist, holding also a postgraduate Diploma in environmental physics from the Physics Dept. of the University of Athens. She worked as a research scientist in the Group of Building Environmental Studies of the University of Athens (2002-2010) and participated in a variety of European research and applied projects on energy conservation, integration of renewable energies in buildings, indoor air quality, thermal comfort and passive cooling.

Currently, she is working as a building physicist at CRES, where she has participated in a variety of national projects contributing to the development and implementation of the legislative framework that adopts EU policy directives. Also, she has participated in a variety of European projects on energy saving in buildings, on enhancing the capacity of public administrations to improve the energy efficiency of their building stock, and on the development of technical tools for planning energy-upgrading interventions.

Training Package

0. The meetMED Project

Matteo Barra – meetMED Project Manager

Summary of the Presentation

meetMED project is a two-year project funded by the EU and jointly carried out by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and by the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE).

Its main goal is to reinforce regional cooperation aimed at fostering the energy transition in Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine and Tunisia under the umbrella of the UfM REEE platform.

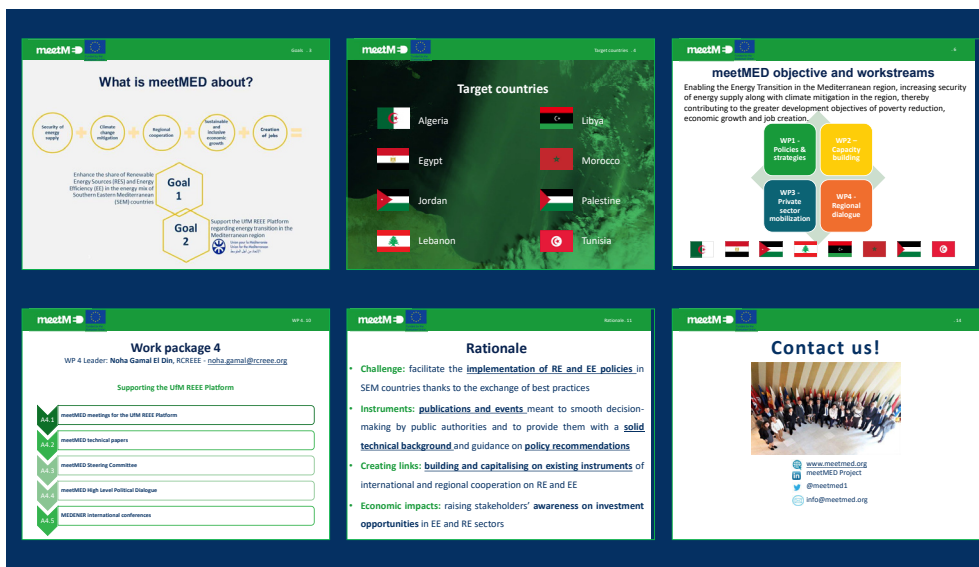
meetMED brings together more than 60 experts from national energy agencies and ministries, whose common goal is to exchange best practices, to train professionals and to raise public awareness on sustainable energy choices and investments. The meetMED activities target and benefit a wide range of stakeholders, including policy makers, public authorities, energy stakeholders, investors and financial institutions as well as local communities and final customers at large.

Due to the importance of the Mediterranean region as the key area where energy transition to clean and sustainable energy is possible in the next following years, meetMED supports regional cooperation in the field of RE and EE not only by facilitating the exchange of best practices between all its partners and by raising capacity building and public awareness, but also by creating synergies with other initiatives targeting the Mediterranean region, such as the ClimaMed, SwitchMed, MedStat and EuroMed Cities.

The meetMED team in Brussels coordinates the project partners in implementing the project activities, which concern mainly the following areas of work: assessing EE and RES strategies and policies; advancing vocational training and public awareness; attracting sustainable RE and EE investments in target countries; supporting the UfM Renewable Energy and Energy Efficiency Platform.

The Module's Contents

- Context
- Goals
- Target Countries
- Structure
- meetMED objective and workstreams
- Work Packages - 1 to 4
- Rationale
- Events 2018 / 2019
- Contacts



Preview of some of the slides. This Module has 14 Slides.

Download the full module [here](#)

0. Overview and achievements of the SwitchMed initiative

Ayman EL ZAHABY – Regional Coordinator, UNIDO

Summary of the Presentation

The session provided an overview of the SwitchMed program, which is an initiative jointly implemented by UNIDO, the UN Environment-MAP/SCP-RAC, and the UN Environment Economy Division, in close coordination with DG NEAR on behalf of the European Union, that supports and brings together stakeholders to scale-up social and eco innovations in the Mediterranean. The initiative aims to support and accelerate the transition of the Southern Mediterranean countries toward Sustainable Consumption and Production.

The project impacted positively on the development of the industrial sector in the region. The impacts included: productivity increase as well as operational and environmental compliance costs reduction; investments optimization and business risk minimization; compliance with international environmental standards; sustainability of long-term production supply; improved involvement and coordination of the main stakeholders.

Dr Aymen provided case studies and best practices in the Arab region, such as: (1) Coca Cola company Jordan that identified and integrated more than 30 measures into existing ISO14001 system and impacted cutting water use by 22%, energy by 44% and raw materials by 3% with total annual savings of 570k euro. (2) New Amico Tunisia (DEMCO group) company jean washing that realized 360k Euro savings with 46% of water savings reached, 26% of energy savings and 1% in chemicals. (3) SinkrotFood Company, where several energy efficiency measures led to a reduction by 60% of the total gas consumption at boilers and oven.

125 industries have benefited from SwitchMed Initiative and received full package technical assistance with a leverage of 87.6 Million Euro and 40% of investments envelope pipelined (approved) through national financing schemes.

The Module's Contents

- The context
- The TEST approach
- The business case: experience from MED
- TEST Programme
- Regional Results

Preview of some of the slides. This Module has 28 Slides.

Download the full module [here](#)

0. Introduction to AFEX EE

Hussam ALHERAFI – Technical Director, RCREEE

Summary of the Presentation

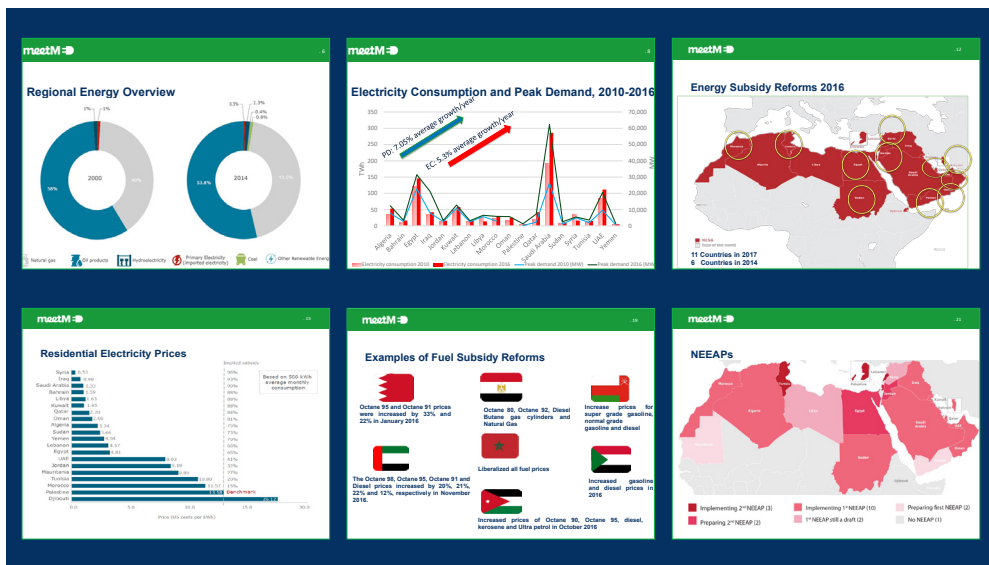
This presentation focused on Arab countries' efforts made and progress achieved in developing their energy efficiency markets in various sectors. Countries are ranked under more than 20 indicators that illustrate key energy market aspects, including energy pricing, policy framework, institutional capacity, and utility.

AFEX analysis provides a comprehensive overview of the progress achieved by 20 Arab countries with respect to the transition towards an EE market after recent plunges in oil prices and economic turmoil in the region. Moreover, it highlights the great opportunity for Arab countries to learn from each other's achievements and success stories in implementing energy efficiency measures, policies and technologies. Main key points highlighted by the presentation are:

- The region witnessed an unprecedented wave of energy subsidy reforms.
- 15 out of 20 Arab states have developed national energy efficiency action plans (NEEAPs), while others are preparing their first NEEAPs.
- Arab countries still need to further develop and implement energy efficiency regulations, initiatives, and programs to reduce energy consumption in the transport sector.
- UAE is leading the ESCO market in the region as Etihad super ESCO is playing a major role in regulating and enabling the EPC market. Etihad ESCO has set the ambitious goal of retrofitting 30,000 buildings in Dubai by 2030 achieving an annual saving of 1.7 TWh of electricity by 2030.

The Module's Contents

- About AFEX
- Regional Energy Overview
- Energy Pricing
- Policy Framework
- Institutional Capacity
- Final Scores



Preview of some of the slides. This Module has 27 Slides.

Download the full module [here](#)

0. Regional Policies and Legal Framework

Khalid SALMI – Senior Energy Management Specialist, RCREEE

Summary of the Presentation

The presentation provides an overview on Arab electricity consumption pattern as well as the Arab Guidelines for improving EE and rationalizing its end use consumption, as approved by the Arab Ministerial Council of Electricity. Main figures in the Arab Region are:

- 12 Countries fixed EE National Targets (Jordan, Bahrain, Egypt, Tunisia, Sudan, Syria, Iraq, Palestine, Lebanon, Libya, Qatar, Kuwait).
- 17 countries have national assigned EE entities (Jordan, Bahrain, Algeria, Egypt, Tunisia, Sudan, Syria, Iraq, KSA, Palestine, Lebanon, Libya, Qatar, Kuwait, Morocco, Djibouti, Yemen).
- 19 NEEAPs are developed at different stages (Jordan, Bahrain, Algeria, Egypt, Tunisia, Sudan, Syria, Iraq, KSA, Palestine, Lebanon, Libya, Qatar, Kuwait, Morocco, Djibouti, Mauritania, Yemen).
- 8 Countries implemented EE measures for the public sector, including governmental building, street lighting, efficient lighting systems, energy audits, and water pumping systems.
- 17 Countries issued more than 34 EE laws and regulations.
- 8 Countries implemented dedicated EE awareness and media campaigns.

The presentation gives also a general description of the Pan Arab Certified Energy Management Professional Program that represents a standardized professional certification for Energy Managers for the Arab Region endorsed by the Executive Bureau of the Arab Ministerial Council of Electricity since 2017 and clarifies its eligibility criteria and content.

The Module's Contents

- Background
- Context: The Arab Guidelines for Improving Electricity Efficiency and Rationalizing its End Use Consumption
- EE aspects at a glimpse
- PA-CEMP - Pan Arab Certified Energy Management Professional Program
- Conclusions

Preview of some of the slides. This Module has 21 Slides.

Download the full module [here](#)

I. Overview on energy Conservation and Energy Efficiency

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

The presentation provides an overview of the basics on energy efficiency, renewable energy, and mitigation measures for the energy resources management. In addition, the opportunities of energy efficiency and renewable energy were presented too.

The Module's Contents

- Energy and its forms
- Potential and kinetic energy
- Energy Resources Categorization
- Energy Outlook 2019
- Energy Conservation and Efficiency
- Systems to apply EE Opportunities
- EE and RE barriers to implementation

Preview of some of the slides. This Module has 13 Slides.

Download the full module [here](#)

II. General Aspects of Energy Management and Energy Audit

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

The presentation focuses on the approach to setup an Energy Management System, explained in a very simplified way for beginners. Energy Auditing is also key to set the baseline data and the outcome in terms of objectives and targets of the EnM System.

The Module's Contents

- General Aspects
- Energy Management System (EnMS) – Design Aspects/Considerations
- EnMS Definitions and Approaches
- EnMS Bottom Up Approach
- Auditing Aspects

Preview of some of the slides. This Module has 7 Slides.

[Download the full module here](#)

III. Electrical Energy Management

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation introduces the basics for calculating the performance of the different electrical systems. It also tackles the opportunities to improve the efficiency of energy performance in terms of the proven technologies that are present in the energy efficiency market. The calculation tools setting the anticipated revenues related to the saved energy in the electrical systems were presented to the trainees.

The Module’s Contents

- Electrical Systems
 - Energy Basics Knowledge
 - Electrical Basics
 - Motors and Drives
 - EE opportunities in Motors
- Applications
 - Electric Fans
 - Pumps/Fans Controls
 - Compressed Air Systems
 - Lighting Systems

The image displays six preview slides from the module. The slides are arranged in a 2x3 grid. Each slide has a green header with the 'meetM' logo and a red footer with 'RCREEE'.

- Slide 1: Motors and Drives** - States that motors consume 55-65% of industrial electrical energy. Includes a diagram of a motor with labels for Pumps, Fans, Machining, Compressors, and Air Conditioning.
- Slide 2: Pump Operation and Design Consideration** - Shows graphs for Pump Curve, System Curve, and Pump Operating Point.
- Slide 3: Compressed Air Systems** - Lists measures to consider: Distribution system Modifications (pipe selection, parallel piping, filters, coolers, dryers, fittings) and Compressor Efficiency (relocate inlet, replace standard motors, replace filters, choose right air dryer).
- Slide 4: Lighting Systems** - Shows a pie chart of Global Energy Consumption of Lighting per Sector: Residential (35%), Commercial (40%), Industrial (17%), and Outdoor lighting (8%).
- Slide 5: Typical Lifespan Of Various Light Source Technologies** - A bar chart showing burning hours for technologies like Incandescent (750-1,000), CFL (8,000-10,000), LED (50,000-100,000), and High Power LEDs (40,000-55,000).
- Slide 6: Efficacy of Light Source Technologies** - A bar chart showing efficacy (lm/w) for various technologies, with LED being the most efficient.

Preview of some of the slides. This Module has 25 Slides.

Download the full module [here](#)

IV. Thermal Energy Management

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation introduces the basics for calculating the performance of the different Thermal energy system. The thermal energy systems are the systems by which the thermal heating/cooling loads are generated. It also tackles the opportunities to improve the efficiency of energy performance in terms of the proven technologies that are present in the energy efficiency market. The calculation tools that will support in setting the anticipated revenues related to the saved energy in the thermal systems were also presented to the trainees. The most verified technologies were also illustrated, such as the process controls and automation, the Cogeneration/Tri-Generation, the Building Automation Systems (BAS), the steam processes and the generation tools in efficient ways.

The Module's Contents

- Thermal systems
- Energy flows
- HVAC systems
- Boilers and Steam Systems
- Waste Heat Recovery Systems
- Control and Automation of Energy Systems

The Heat Flow

- The heat flow is processed through heat transfer that takes place by three modes;
 - Conduction (proportional to ΔT)
 - Convection (approx. prop. to ΔT^2)
 - Radiation (approx. prop. to ΔT^4)
- Heat Transfer by Conduction;
 - Heat is lost and gained through the building shell.

Boilers and Steam Systems

- System Components:

Waste Heat Resources and Recovery Potential

Process	Waste Heat Resource	Temperature (°C)	Flow Rate (kg/h)	Heat Recovery Potential (kW)	Notes
Boiler	Boiler exhaust air	150-200	10000	1000	Preheat combustion air
	Boiler condensate	100-120	5000	500	Preheat feed water
	Boiler blowdown	150-200	1000	100	Preheat feed water
	Boiler cooling water	30-40	10000	1000	Preheat feed water
Compressor	Compressor exhaust air	100-150	5000	500	Preheat feed water
	Compressor cooling water	30-40	10000	1000	Preheat feed water
	Compressor lubricating oil	50-60	1000	100	Preheat feed water
	Compressor discharge air	100-150	5000	500	Preheat feed water
Motor	Motor exhaust air	100-150	5000	500	Preheat feed water
	Motor cooling water	30-40	10000	1000	Preheat feed water
	Motor lubricating oil	50-60	1000	100	Preheat feed water
	Motor discharge air	100-150	5000	500	Preheat feed water
Furnace	Furnace exhaust air	150-200	10000	1000	Preheat combustion air
	Furnace cooling water	30-40	10000	1000	Preheat feed water
	Furnace lubricating oil	50-60	1000	100	Preheat feed water
	Furnace discharge air	100-150	5000	500	Preheat feed water

Control and Automation of Energy Systems

- Energy effective systems require energy effective controls (manual or automatic)
- Energy effective controls means that first we need to understand how the equipment SHOULD be operated and controlled, and then put such systems in place
- Requires that the system is properly installed, operational and commissioned.

Control System Hierarchy

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    graph TD
        A[Data Processing and Control Algorithm/Controller] <--> B[Input/Output Carrier Modules]
        B <--> C[Field Devices (Sensors, Actuators, etc)]
        C --> D[Control Actions]
        D --> E[Working Station]
        E --> A
    
```

Preview of some of the slides. This Module has 23 Slides.

Download the full module [here](#)

V. Energy Auditing ISO 50002

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation covered all requirements to the energy auditing procedures and the tools required to auditing the facility. The auditing process was explained starting from the planning phase until the final audit report operational procedures. Different related codes and standards have been introduced in comparison with the auditing under ISO 50002.

The Module's Contents

- Energy Audit : Objectives, Process, Guides and Standards
- Types of Energy Audits
- Audits Key Governances to Assign Audit Level
- Energy Audit Cycle Costs
- Energy Audit Steps

Preview of some of the slides. This Module has 18 Slides.

[Download the full module here](#)

VI. Instruments and Tools for Energy Auditing

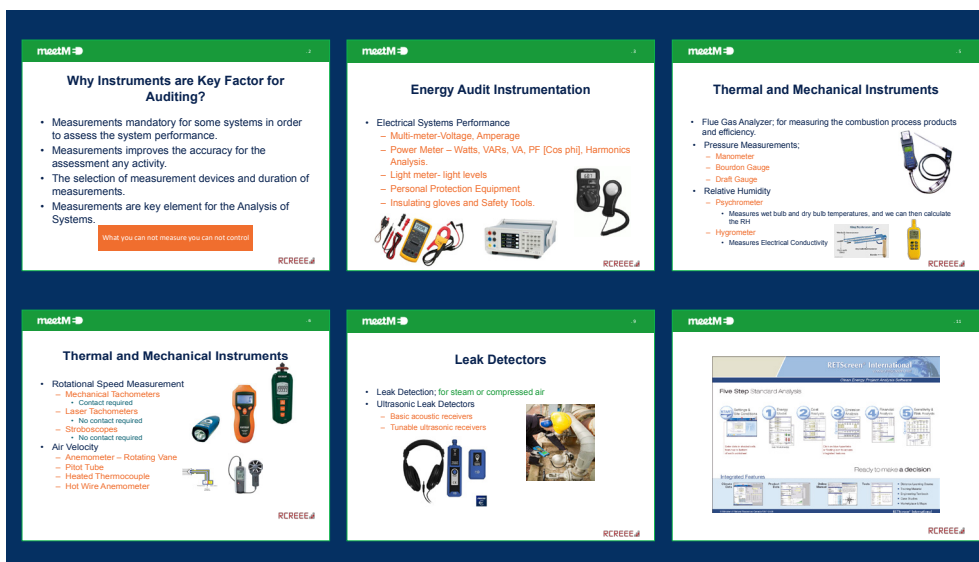
Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation focuses on the instruments and tools required for the energy flows measurements during the audit. All devices were introduced to cover both the electrical and thermal systems within any facility. Moreover, the calculation tools and software are commonly used to calculate energy efficiency and renewable energy opportunities with simple case studies/examples.

The Module's Contents

- Energy Audit Instrumentation
- Instruments Utilization
- Thermal and Mechanical Instruments
- Standalone Data Loggers
- Leak Detectors
- Tools and Software for Energy Audit Analysis



Preview of some of the slides. This Module has 12 Slides.

Download the full module [here](#)

VII. Energy Performance Assessment of Equipment and SMEs

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation tackles the categorization of different systems inside an anticipated auditing to the facility. The energy and mass balance are major issues to be conducted. Moreover, the concept of system performance in terms of energy consumption and efficiency was also introduced to the trainees.

The Module’s Contents

- How to Measure Facility Performance?
- Equipment in SMEs to Measure the Performance
- Systems Way of Measure

The thumbnails show the following content:

- Slide 1:** Title slide for 'Energy Performance Assessment of Equipment and SMEs' by Dr. Khaled ELFARRA.
- Slide 2:** 'How to Measure Facility Performance?' with bullet points on efficiency and productivity.
- Slide 3:** 'Equipment in SMEs to Measure the Performance' with a list of equipment types.
- Slide 4:** 'Systems Way of Measure' diagram for Chiller (Vapor Compression Cycle and Absorption Cycle).
- Slide 5:** 'Systems Way of Measure' diagram for Electric Motor and Compressed Air System.
- Slide 6:** 'Systems Way of Measure' diagram for Lighting System and Boiler.

Preview of some of the slides. This Module has 6 Slides.

Download the full module [here](#)

VIII. Economic Analysis and Project Financing

Mina ADLY - Energy Expert, RCREEE

Summary of the Presentation

The presentation focused on the basics for the financial analysis, the capital structure available for projects on EE in the industrial sector as well as on the most important types of budgeting techniques that are commonly used in most of the feasibility studies.

The participants gained in-depth knowledge on the following topics: Economic and financial aspects of EE projects; Project life cycle cost concept and basics of dynamic economics calculation for comprehensive EE investment projects; calculating own energy performance/energy supply contracting projects and business evaluation models of EE programs and project returns and risks. Gained this knowledge and skills other than practicing real examples and case studies made possible to explain how to calculate annual energy output, costs and revenues of EE programs for industrial SMEs.

Main conclusions are:

- Solvency ratios measure the ability of the industry to meet long-term obligations. Main ratios include debt and coverage indicators.
- Profitability ratios measure the aptitude of the industry to generate profits from revenue and assets. This includes profitability and return on investment indicators.
- Ratios are combined in general to better understand the project profitability and efficiency.
- The outputs of financial analysis provide valuable inputs into forecasts of future profitability and EE measures efficiency.

The Module's Contents

- Main pillar of calculations
 - Inflation rate
 - Time value of money
 - Future value
 - Present Value
- Interest rate
 - Simple interest rate
 - Compound interest rate
- Capital Structure & Cost of Capital
- Capital Budgeting Techniques

The thumbnails show the following content:

- Slide 1: Types of Interest** - A tree diagram showing Interest Rate branching into Simple and Compounded. A table shows values for years 0-6.
- Slide 2: Time Value of Money** - Definition of Present Value (PV), Equation: $PV = FV / (1+i)^n$, and a list of variables.
- Slide 3: Mixed Stream - Investment case** - A table with Year (0-5) and Cash Flows (-100,000, 20,000, 35,000, 55,000, 40,000, 30,000). Includes a calculation for Discounted Present Value.
- Slide 4: Capital Structure & Cost of Capital** - Definitions of Capital Structure and Cost of Capital. A tree diagram for Cost of Capital (Debt to Equity) showing Loan, Bonds, and Equity (Preferred, Common).
- Slide 5: Capital Budgeting Techniques** - A list of six techniques: 1. Payback Period, 2. Return on Investment, 3. Discounted Payback Period, 4. Net Present Value, 5. Internal Rate of Return, 6. Profitability Index.
- Slide 6: Capital Budgeting Techniques** - A table with Year (0-5) and Cash Flows (-200,000, 60,000, 90,000, 110,000, 75,000, 85,000). Includes NPV calculations for each year and a Total NPV of 21,260.

Preview of some of the slides. This Module has 20 Slides.

Download the full module [here](#)

IX. Measurement and Verification (M&V)

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

This presentation covered in a very simple approach the projects financing, the Energy Service Companies (ESCOs), the Independent Service Providers (ISP) to energy efficiency and renewable energy technologies. Furthermore, the different contractual issues related to the energy-based projects were presented.

The Energy based Projects from the contractual perspective need the Measurement and Verification (M&V) protocols. This M&V was presented in detail to the trainees to get the knowledge about the procedures required in order to prove the anticipated energy savings post the implementation of any energy saving opportunity.

The Module's Contents

- How to Finance EE/RE Projects?
- Guaranteed Saving
- Shared Savings Contract
- Comparing Guaranteed vs. Shared Savings
- Chauffage Contracts
- Measurements and Verification (M&V)
- International Performance Measurement and Verification Protocol (IPMVP)
- Concepts and Methodology for M&V
- M&V Formula Adjustment Factors
- M&V Costs

M&V Approach	Typical Costs (% of ECM Costs)
Option A, Spot Measurement: Energy performance indicators (e.g., specific energy or carbon efficiency) are determined with spot measurements (e.g., metering, submetering, submetering) during operating time.	1 - 5%
Option B, Continuous Measurement: Energy performance indicators (e.g., specific energy or carbon efficiency) are determined with continuous measurements (e.g., metering, submetering, submetering) during operating time.	3 - 10%
Option C, Utility Bill Comparison: Energy performance indicators (e.g., specific energy or carbon efficiency) are determined with utility bills.	1 - 10%
Option D, Calibrated Simulation: Energy performance indicators (e.g., specific energy or carbon efficiency) are determined with calibrated simulation.	3 - 15%

Preview of some of the slides. This Module has 26 Slides.

Download the full module [here](#)

X. Demand Side Management Programs

Khaled A. EL FARRA – PhD, GM Senior EE expert, RCREEE

Summary of the Presentation

The Demand Side Management is a program that is being initiated on the national level of the country. The main objective is to maintain the electrical power system at a certain peak demand in accordance with the national planning to meet the growth in demand. Also, at the consumer level, if the tariff is applied against the demand charge besides the energy charges, it is highly important to reduce the peak demand inside the facility.

The different approaches regarding the demand management were discussed in detail, by providing examples for the demand side management programs worldwide.

The Module's Contents

- Why Demand Side Management?
- Demand Profile
- Ways to reduce Peak Demand
- Common Approaches for DSM
- Steps to Design DSM Programs
- Utilities Driven Programs

Preview of some of the slides. This Module has 8 Slides.

Download the full module [here](#)

XI. Experience exchange and best practices on promoting EE in the industrial sector

Enrico BIELE – Energy Expert, ENEA

Summary of the Presentation

The presentation illustrated ENEA strategy in promoting EE and Italian government's policies and priorities for the industrial sector related to strengthening and streamlining the white certificates scheme and promoting EE of SMEs by renewing schemes for co-funding energy audits and EMS.

The presentation highlights main challenges linked to EE promotion including:

- Monitoring, verification, control and compliance
- Interaction and possible overlapping with other policies
- Industry is hard to manage but contains a huge cost/effective potential
- Provide and allocate an adequate budget for training and dissemination activities, market analysis.
- Encourage the use of ISO 50001 Energy management systems and incentivize the participation of certified ESCOS and professionals.

The session presents detailed energy auditing phases and reporting as well as guidelines for monitoring and evaluation systems.

The Module's Contents

- Energy Policy for Industries and Enterprises
- Energy Audits policy implementation

Energy Efficiency Obligation Schemes: White Certificates in Italy

Obligation for electricity and gas distributors with more than 50,000 end users to generate each year a certain amount of savings or, alternatively, to purchase an equivalent amount of certificates from non-obliged parties (such ESCOs or ISO 50001 certified parties).

Source: ENEC

Industrial plant energy framework (tree shape)

Source: ENEC

Building up industry KPIs

- Finding a relation between parameters in the scattered graph: energy consumption and output (linear relation in first approach)
- Evaluate acceptance criteria

Linear regression: $y = ax + b$

Source: ENEC

Level of monitoring coverage for industrial sector

Energy consumption to the reference year (tce/year)	Main Activities	Auxiliary systems	General activities
> 10,000	85%	85%	20%
1000	80%	75%	20%
100	75%	70%	20%
10	65%	60%	20%
1	55%	50%	20%
0.1	45%	40%	20%
0.01	35%	30%	20%
0.001	25%	20%	20%
0.0001	15%	10%	20%
0.00001	5%	5%	20%

Source: ENEC

Energy audits policy implementation results

Activity	Number of audits	Energy savings (tce)	Potential savings (tce)
1. Energy audits	100	100	100
2. Energy audits	100	100	100
3. Energy audits	100	100	100
4. Energy audits	100	100	100
5. Energy audits	100	100	100
6. Energy audits	100	100	100
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96. Energy audits	100	100	100
97. Energy audits	100	100	100
98. Energy audits	100	100	100
99. Energy audits	100	100	100
100. Energy audits	100	100	100

Source: ENEC (2017)

Energy audits policy implementation results

- Sectoral breakdown: almost 40% of them was performed on site in the manufacturing branch and more than 15% in trade, where energy consumption of Retail Channel has a relevant share.
- The potential saving may be roughly 1.5 Mtoe, more than 1.1 Mtoe of which could be achieved by around 14,000 interventions associated to investments with payback time equal or lower than 5 years.

Source: ENEC (2017)

Preview of some of the slides. This Module has 32 Slides.

Download the full module [here](#)

Katerina SFAKIANAKI – Energy expert, CRES

Summary of the Presentation

The session presents The STEAM UP Project a Case Studies from SME Industries in Greece that aims to promote EE measures in steam system of industries. Main projects activities are:

- Development of comprehensive guidelines for the implementation of energy audits in steam systems (based on EN 16247).
- Compilation and elaboration of training material concerning energy efficiency measures in steam systems.
- A capacity building program that includes training and coaching-on-the-job of over 500 energy auditors, ESCOs, internal energy managers and energy management training providers.
- Implementation of 75 energy audits in industries in Austria, Czech Republic, Denmark, Germany, Greece, Italy, Netherlands and Spain.

Main findings of Steam-up project are:

- Due to the lengthy and sustained recession, most of the SME's are understaffed and the process engineers have an extremely heavy workload. As a result of this, day-to-day management is of primary importance whilst energy efficiency is of a fairly low priority.
- Routine maintenance is regularly performed on the more crucial productive machinery whilst only non-routine maintenance is usually performed for the steam systems.
- The steam systems have a significant energy saving potential with the implementation of low-cost measures.
- None of the industries had energy management systems (e.g. EN ISO 50001).

The Module's Contents

- Scope of the project
- Main project activities
- Energy audits in 10 SME industries in Greece
- General Findings
 - Leaks
 - Insulation
 - Steam Traps
 - Steam Boilers
 - Flue Gas Economizers
 - Boiler Blow-Down
 - Deaeration of Make-Up Water
 - Steam Condensate Tank
 - Steam Accumulator

INSULATION

60% of the inspected plants had numerous surfaces that were not properly insulated.

Uninsulated steam boiler (back-end)
Uninsulated piping
Uninsulated collector and valves
Uninsulated tanks

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STEAM BOILERS

80 % of the steam boilers inspected using a flue gas analyzer were inadequately maintained, resulting in relatively low efficiencies and relatively high flue gas temperatures.

Example 1

Analyzer installed, high burner efficiency, excessive O₂ adjustment, reasonable flue gas temperature

Fuel	Natural Gas
Boiler Efficiency	83.2%
Excess air	2.6%
O ₂	0.3%
CO ₂	11.59%
CO	835 ppm
Flue gas temperature	215 °C

Example 2

Low burner efficiency, high excess air, high flue gas temperature (?)

Fuel	LPG
Boiler Efficiency	63.7%
Excess air	100%
O ₂	10.7%
CO ₂	6.7%
CO	0 ppm
Flue gas temperature	268 °C

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FLUE GAS ECONOMIZERS

• Even though many of the steam boilers had relatively high flue gas temperatures whose heat could be recovered, only 10% of the inspected steam boilers had installed flue gas economizers (heat exchangers used to either pre-heat the make-up water of the steam boiler or used directly in the plant processes).

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Example of poorly maintained and old steam distribution systems (i.e. galvanized steel piping) resulting in the deposition of flings. As a result of this inspection, one of the inspected plants commenced the gradual replacement of the pipes with stainless steel pipes.

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Example of the heat content of rejected condensate not being used. The condensate resulting from the use of steam in the expansion of Polystyrene in moulding machines is rejected due to the chemical impurities contained within.

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DEAERATION OF MAKE-UP WATER

Only in 10% of the inspected plants is flash steam from boiler blowdown and condensate return used to de-aerate the make-up water using flash condensing deaerator heads.

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Preview of some of the slides. This Module has 34 Slides.

Download the full module [here](#)

Countries presentation: Algeria, Jordan, Lebanon, Morocco and Tunisia

The course included regional experience exchange between meetMED targeted countries, in planning and implementing EE plans and related measures for industrial SMEs and delivers proven best practices for optimizing energy-intensive equipment and systems. It also presented different financial schemes and funds implemented in meetMED countries to promote sustainable energy deployment and boost energy efficiency in industrial sector.

Algeria covered:

- The National Program for Energy Management “PNME”
- The objectives expected from the implementation of energy audits
- The Indirect approach of energy audits
- Voluntary agreements for energy audits
- The ISO 50001 System
- The support actions and capacity building

Jordan covered:

- The REEE II TA support in the industrial sector
- The SMEs projects supported by JREEEF
- The main points of the Jordanian case study
- MED test II in Jordan (Video on Switch-med’s support in the industrial sector in Jordan)

Lebanon covered:

- The National Renewable Energy Action Plan
- The National Energy Efficiency Action Plan
- NEEREA Initiative
- The Development of ESCOs

Morocco covered:

- The Moroccan Agency for energy efficiency role and initiatives
- The Energy in the Industrial context
- The EE Regulatory framework
- The RE-EE financing facility (MORSEFF)
- The EE Actions of AMEE in industrial sector

Tunisia covered:

- The National Energy Policies context
- The National Energy Management Policy
- The Financial and Incentive Framework of ME
- 30|30 strategy
- The context of the energy audits in Tunisia

This publication is a product of the meetMED (Mitigation Enabling Energy Transition in the Mediterranean region) project which is funded by the European Union and jointly implemented by the Mediterranean Association of the National Agencies for Energy Management (MEDENER) and the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE). The conclusions of this report result from the analysis of the Country Policy Papers prepared by the meetMED Regional Expert Network (REN) – a network composed by experts coming from 13 Mediterranean countries – the aim of which is to support national governments in the implementation of EE and RE policies enhancing national programmes and frameworks in the region. Since 2012, the eight target countries (Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine and Tunisia) have improved their energy efficiency and renewable energy sectors, having put in place long-term national energy strategies that set ambitious targets for energy savings and renewable energy penetration. Nevertheless, several challenges still hinder the development of EE and RE, particularly related to governmental, technical or information aspects. This report identifies a set of recommendations that can be implemented to promote the development of both sectors. Awareness of the population for EE and RE benefits should be one of the main objectives of the countries since the lack of knowledge is a clear barrier to the dissemination of good practices. Regional cooperation should be encouraged to facilitate the energy transition in the Southern and Eastern Mediterranean Countries (SEMCs) – cooperation will accelerate the implementation of common measures and help overcome shared barriers.



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