# A holistic framework for Empowering SME's capacity to increase their energy efficiency

Project: **SMEmPower Efficiency**

Deliverable number: **3.2**

Deliverable Name: **Training handbook**

| Document Properties | |
|---|---|
| **Dissemination level** | Public |
| **Lead beneficiary** | Technical University of Cluj-Napoca (UTC) |
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| **Checked by WP leader** | Technical University of Cluj-Napoca (UTC)<br>30/07/2020 |
| **Approved by Project Coordinator** | 30/07/2020 |
| **Submission due date** | 31/07/2020 |
| **Actual submission date** | 31/07/2020 |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 847132.

## Document History

| Version | Date | Contributor(s) | Description |
|---|---|---|---|
| 1.0 | 15/06/2020 | UTC and UPV | Creation of the report |
| 2.0 | 03/07/2020 | Dan Micu, Andrei Ceclan, Elisa Penalvo Lopez | Check and approval of report |
| 3.0 | 04/07/2020 | OEB, ENERGIADA, AUTH, TEES, SGZ, adelphi, UPV, SERVELECT, UoWM | Document Review |
| 4.0 | 15/07/2020 | Denisa Stet, Levente Czumbil, Timea Farkas (UTC) | Improved draft based on the review |
| 5.0 | 22/07/2020 | OEB, ENERGIADA, AUTH, TEES, SGZ, adelphi, UPV, SERVELECT, UoWM | Document Review |
| 6.0 | 30/07/2020 | UTC | Final version based on partners' comments and suggestions |
| 7.0 | 30/07/2020 | Grigoris Papagiannis (AUTH) | Final version |

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# List of Acronyms

| Acronym | Meaning |
|---|---|
| **CBA** | Cost Benefit Analysis |
| **E&T** | Education & Training |
| **ECTS** | European Credit Transfer and Accumulation System |
| **EE** | Energy Efficiency |
| **EED** | Energy Efficiency Directive |
| **EPC** | Energy performance Contracts |
| **EQF** | European Qualification Framework |
| **ESCO** | Energy Service COmpany |
| **EU** | European Union |
| **FV** | Future Value |
| **GHG** | Greenhouse Gas Emissions |
| **HVAC** | Heating, Ventilation and Air Conditioning |
| **ICT** | Information and Communications Technology |
| **IPMVP** | International Performance Measurement and Verification Protocol |
| **IRR** | Internal Rate of Return |
| **LCA** | Life Cycle Assessment |
| **LCCA** | Life Cycle Cost Analysis |
| **LO** | Learning Outcomes |
| **LU** | Learning Units |
| **M&T** | Monitoring & Targeting |
| **M&V** | Measurement & Verification |
| **MARR** | Minimum Attractive Rate of Return |
| **NPV** | Net Present Value |
| **PV** | Present Value |
| **RES** | Renewable Energy Sources |
| **ROI** | Return on Investment |
| **WACC** | Weighted Average Cost of Capital |
| **WP** | Work Package |

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# Executive summary

This Report has been developed in the framework of the “SMEmPower Efficiency” project, funded by the Horizon 2020 under the Grant Agreement No. 847132/ 2019.

The SMEmPower Efficiency project is based on a holistic framework to “empower” SMEs to undergo energy audits and implement their proposals. An integrated Education & Training (E&T) program is going to support this objective, targeting energy related SME staff.

The Deliverable contains the Handbook and outlines the common E&T program by presenting the Learning Units and their content.

The report presents the purpose of the Handbook and the methodology used to design it. This is a first version of the specialized handbook which will be continuously reviewed and updated according to the feedback obtained from participants and trainers. The handbook will be available on the SMEmPower website in all the partner country languages.

The Handbook is structured in such a way that each Learning Unit (LU), each chapter of the handbook, is divided in the following four sections / subchapters: *Introduction*, which contains the aim, objectives, provided learning outcomes and the prerequisites of the LU, *Content of the Learning Unit*, *Remarks* and *References*.

Updated version of the Handbook will be delivered after the first two SMEmPower E&T sessions in project month 20 and 27. While the final version of the Handbook will be delivered at the end of the project in month 32.

# Introduction

The current report reflects on a first version of the **Training Handbook** developed by the consortium partners based on Deliverable 3.1, the **Program Design** of the Education & Training Program entitled **"Energy efficiency and sustainability for energy managers and energy professionals (in SMEs)"**.

## Purpose of the handbook

The aim of the Training Handbook is to provide a modern and easy to use training material for both SMEmPower E&T program trainers and attendees.

On the one hand the Handbook presents the **common curriculum** of the Learning Units (LU), that will be used by trainers as a guideline for the implementation of the corresponding training courses in each of the 8 SMEmPower partner countries as part of their Life-long learning programs. Figure 1 shows information flow diagram for SMEmPower training program, information flow that was used in the design and implementation process of the current Handbook:

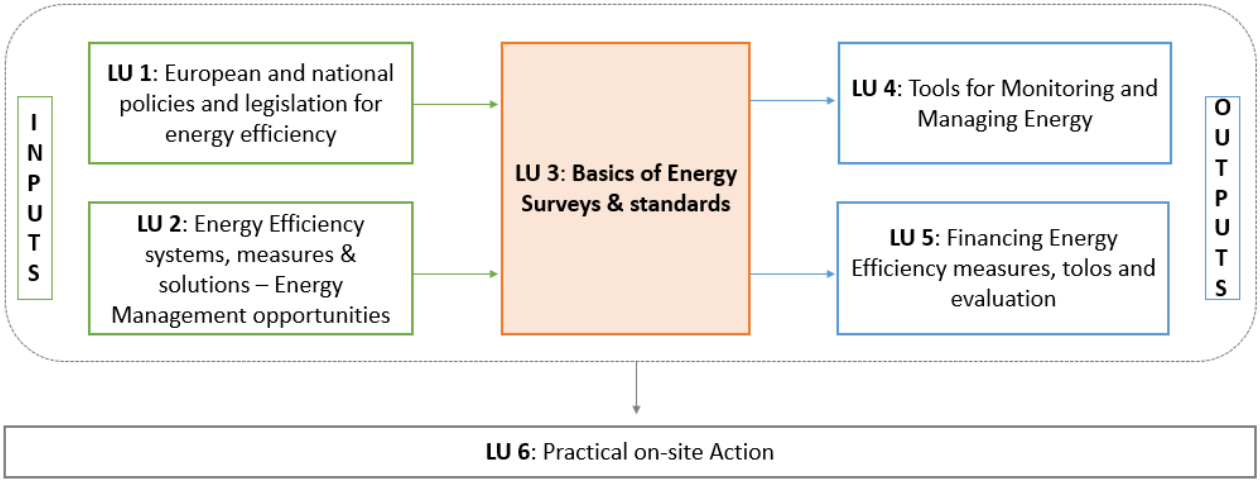


*Figure 1. Information flow diagram through the SMEmPower training program.*

The final training content will be adapted to the needs of SMEs and attendees from each country. However, the Handbook will ensure the common knowledge base in each partner country.

On the other hand, the Handbook is expected to provide a modern and easy to use training for the participants of the SMEmPower Education & Training Courses, to gain a better knowledge about the information that is presented during SMEmPower training program. Therefore, the handbook will be available for attendees and all the interested professionals as an open access document, during and after the end of the project, on SMEmPower website and on the training portal.

## Handbook development methodology

The presented Handbook as a deliverable and training support material was created through the joint effort of the all the contribution members, based on E&T Program structure agreed in Deliverable D3.1 and taking into account the recommendations and advices from future E&T program trainers. The content of each learning unit was developed especially by a team of two project partners (contribution of each partner is presented in Table 1). The improved versions of the Handbook will be even more consistent in content, as they will include materials provided by trainers from all project partner countries, including LU6 *Practical on-site Action* (according to D3.1.) which will contain some real case studies from SMEs from which the attendees are coming from.

*Table 1. Contribution of partners to the content of LUs*

| Contribution | Partner |
|---|---|
| **Delivering the Training Handbook** | UTC (as a WP leader) and UPV (as an assistant WP leader) |
| **LU1: European and national policies and legislation for energy efficiency** | adelphi and OEB |
| **LU2: Energy Efficiency systems, measures & solutions – Energy Management opportunities** | TEES and SGZ |
| **LU3: Basics of Energy Surveys & standards** | UPV and ENERGIADA |
| **LU4: Tools for Monitoring and Managing Energy** | SERVELECT and UTC |
| **LU5: Financing Energy Efficiency measures, tools and evaluation** | AUTH and UoWM |

The presented Handbook is an instrument for the trainers and also for the trainees. Firstly, the presented material will be useful for trainers as in each country an adapted version of the Learning Units will be presented during the Education & Training Courses, but without changing the common learning outcomes.

Secondly, it is a tool for trainees, as covers all the thematic units and it will be translated in all consortium languages (English, Greek, Romanian, Spanish, Italian, German, and Slovenian) and will be available from the web portal. It will include the necessary theoretical background, working examples, tutorials etc. The final version will include all instructor presentations and case studies group reports.

After each of the course edition, the content of the Handbook will be reviewed and updated, taking into account the feedback from the participants (based on the feedback tool proposed in D3.1), both trainers and trainees.

The first edition of the training handbook is incorporated in this report and will be available on the project website and the training platform in each of the partner country languages with the start of the first SMEmPower E&T program. Updated versions will follow the corresponding of D3.1 and will be delivered by M20, M27 and the final version by M32.

# Learning Unit 1: European and National policies and legislation for energy efficiency

## Introduction

| | |
|---|---|
| **AIM** | The learning unit will cover the most relevant EU policy regarding energy efficiency, in particular how it applied to SMEs. It will also look critically at how these directives are transposed in the national regulatory frameworks and what national regulations exist that differ from the directives. It will look at the regulatory barriers that SMEs face in their home countries and how these have been overcome. |
| **ECTs STRUCTURE** | **0.5 ECTS credits**<br>4 Practice hours in eco-design.<br>6 Lecture hours (including testing impact of self-study).<br>5 Self-Study hours.<br>**Total hours: 15** |
| **OBJECTIVES** | The LU will provide the SMEs with the knowledge to navigate the regulatory framework in their home country. It will also help them prepare for the upcoming changes under the amended energy efficiency directive (transposition deadline October 2020). SMEs will better understand the impacts of the regulatory framework on their operations, as well as being better at identifying opportunities to access support mechanisms and other ways to benefit from the regulatory environment. |
| **LEARTNING OUTCOMES** | • Learn about concepts and potentials of energy efficiency<br>• Learn about the EU policy for energy efficiency<br>• Learn about the special role of SMEs in implementing the EU energy efficiency plans<br>• Get to know the most common barriers in implementing energy efficiency measures in SMEs<br>• See how energy management systems can enable SMEs to overcome these |
| **PREREQUISITES** | Attendees should have an understanding of the national support schemes (if any) that their firm has benefitted from with regards to energy efficiency (technological enhancements to increase energy-efficiency, implementation of energy management systems). |

## Content of Learning Unit 1

# CONTENT OUTLINE of LU1

**1.1. ENERGY EFFICIENCY AND ITS BENEFITS**
**1.2. EU'S STATE OF AFFAIRS REGARDING EE**
**1.3. EU CLIMATE AND ENERGY GOALS**
**1.4. EU POLICY**

- **Energy Efficiency Directive 2012/27/EU - EED(2012/27/EU)**
- **EU policy framework**
- **Implementing EU policy into national law**

**1.5. IDENTIFICATION OF CURRENT ENERGY EFFICIENCY SITUATION IN SMEs**
**1.6. OVERVIEW OF SPECIFIC ENERGY MANAGEMENT SYSTEM OPTIONS FOR SMEs**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 1.1. Energy Efficiency and its benefits
## What is Energy Efficiency?

**Minimize Energy Input**
Electricity, Fuel, Heat, Compressed Air

**System, Process, Economy**

**Maximize Output/Benefit**
Products, Services, Revenue, GDP

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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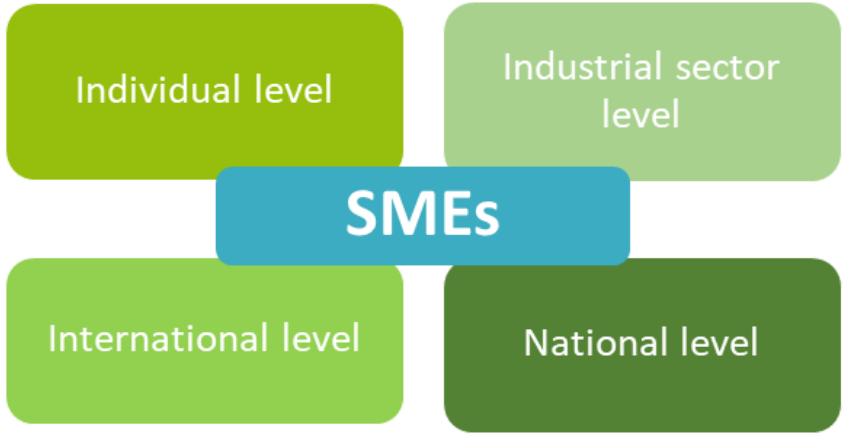
# 1.1. Energy Efficiency and its benefits
# Brainstorming Exercise – Benefits of Energy Efficiency

There are benefits of energy efficiency at various levels (e.g. environmental gains, greater energy security, lower energy bills etc.).

But what are the benefits resulting from energy efficiency for SMEs?




[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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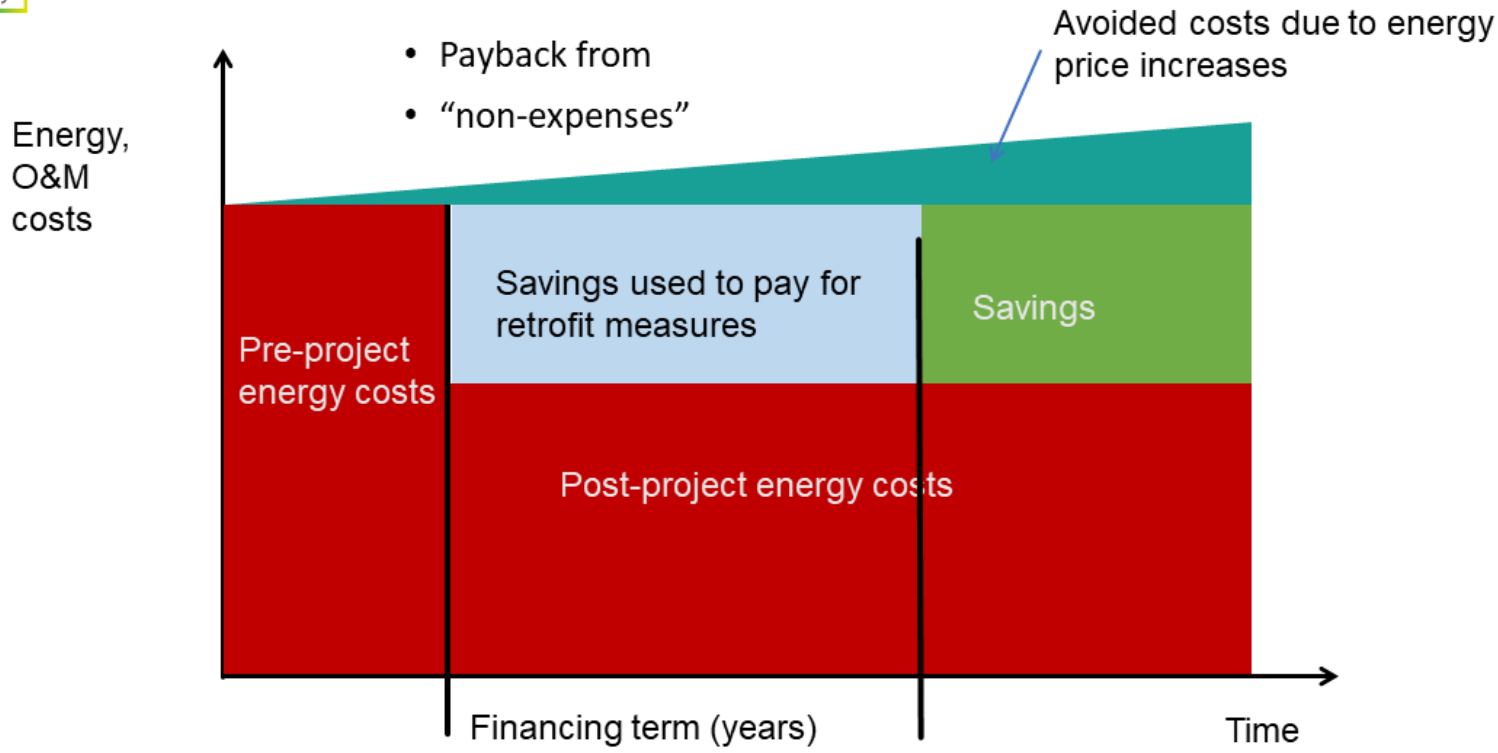
# 1.1. Energy Efficiency and its benefits
## Nature of Energy Efficiency Investments




[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 09. April, 2019]

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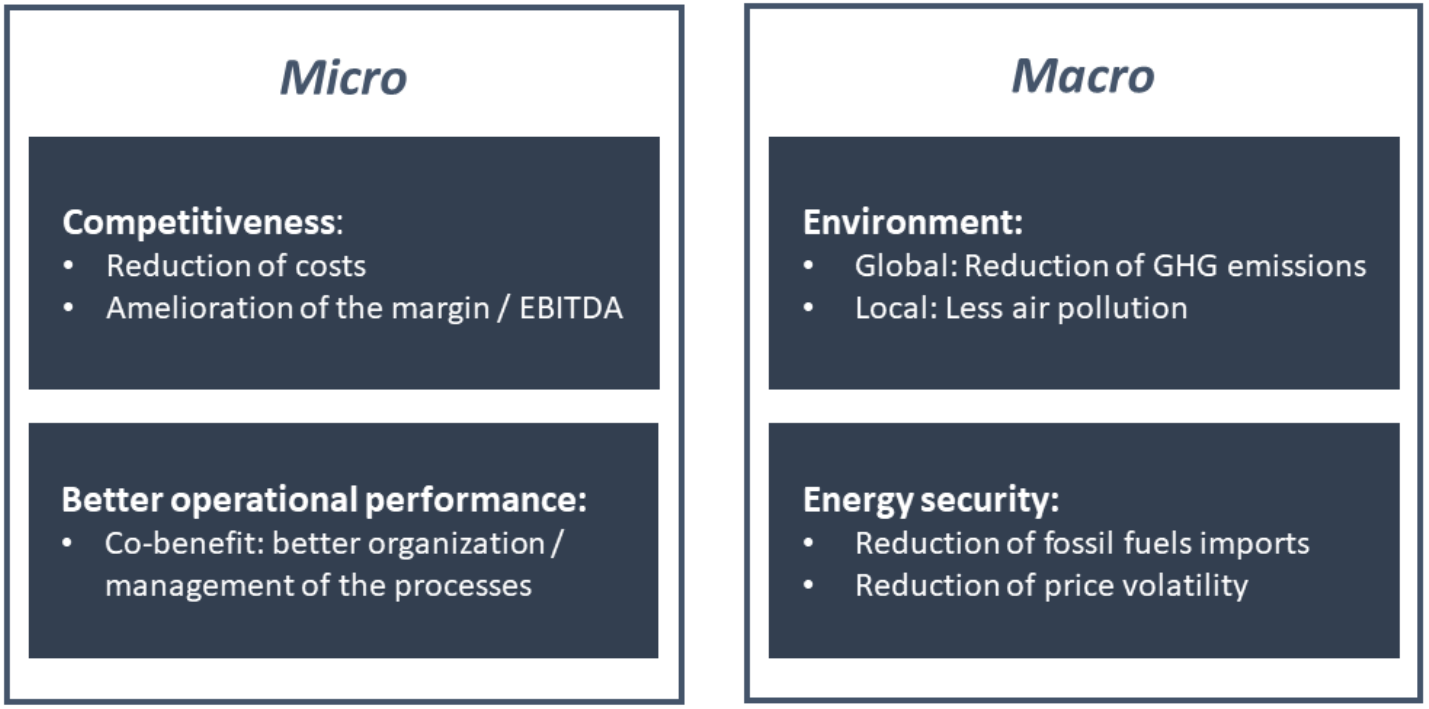
# 1.1. Energy Efficiency and its benefits
# The Multiple Advantages of Energy Efficiency




[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# Intermediate Summary

- There is not “one” kind of energy efficiency project
- Each energy efficiency project is specific
- Energy efficiency investments are different to “standard” investments:
  - technical complexity
  - special financing model (financing through avoided costs)
- Important to consider technical specifications, motivation and financing related factors (e.g. life time, energy savings per year, IRR)

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 09. April, 2019]

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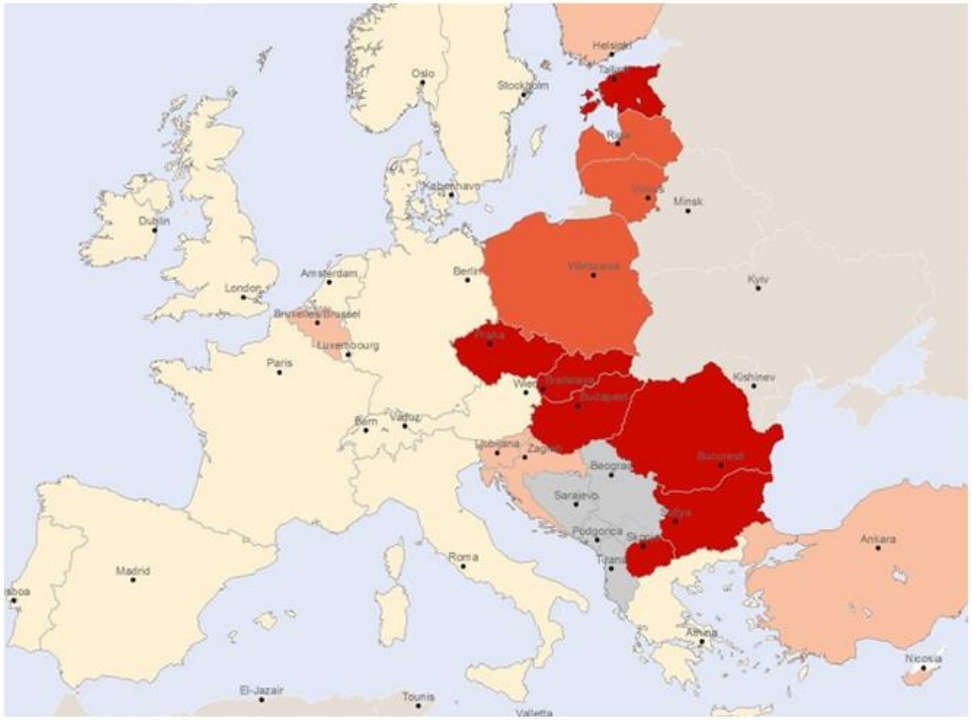
# 1.2. EU's state of affairs regarding EE
# Energy Intensity in EU




**Kilogram of oil equivalent per 1000 Euros, 2010.**

- < 200
- 200 - 300
- 300 - 400
- > 400
- No data (ESPON space)
- No data (No ESPON space)

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# 1.2. EU's state of affairs regarding EE Energy Savings Potential in the EU

According to the EU Energy Efficiency Plan 2011, in each of the following sectors the cost-effective energy savings potential until 2020 is*:

- 35% in Buildings
- 21% in Transport
- 13% in Industry, mostly in SMEs

PF4EE focuses on the two key sectors buildings & industry

→ If these potentials are tapped, up to 33% of emissions reduction across the EU economy can be achieved (E3G, 2012)

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# 1.3. EU Climate & Energy Goals

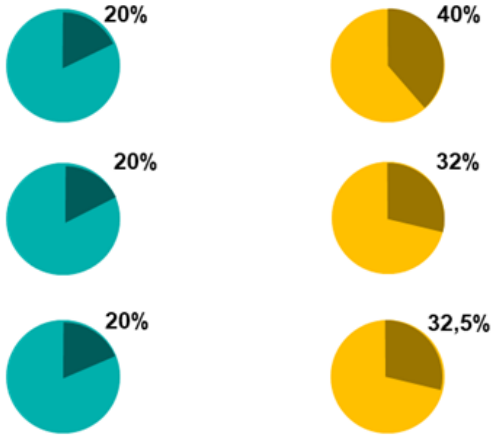
## EU Climate & Energy Targets

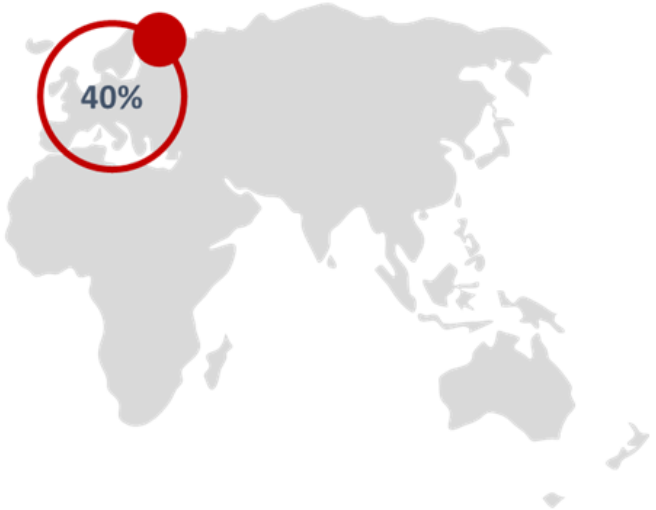
Reduction of GHG emission from 1990 levels

Share of renewables to the final energy consumption

Increase of energy efficiency/energy savings target

## EU 2020 Targets EU 2030 targets

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# 1.3. EU Climate & Energy Goals

**EU 2030 targets:**

The EU adopted the Climate and Energy Policy Framework for 2030 in October 2014

- At least 40% cuts in **greenhouse gas emissions** (from 1990 levels);

**EU 2050 targets:**

- At least 80-95% cuts in **greenhouse gas emissions** (from 1990 levels);

**European Green Deal**

- European Commission in December 2019, has adopted the European Green Deal which is a roadmap for **making the EU's economy sustainable.** The green deal will work through a framework of regulation and legislation setting clear targets to achieve a goal of net zero carbon emissions by 2050 at EU level; and a 50-55% cut in emissions by 2030 (compared with 1990 levels).

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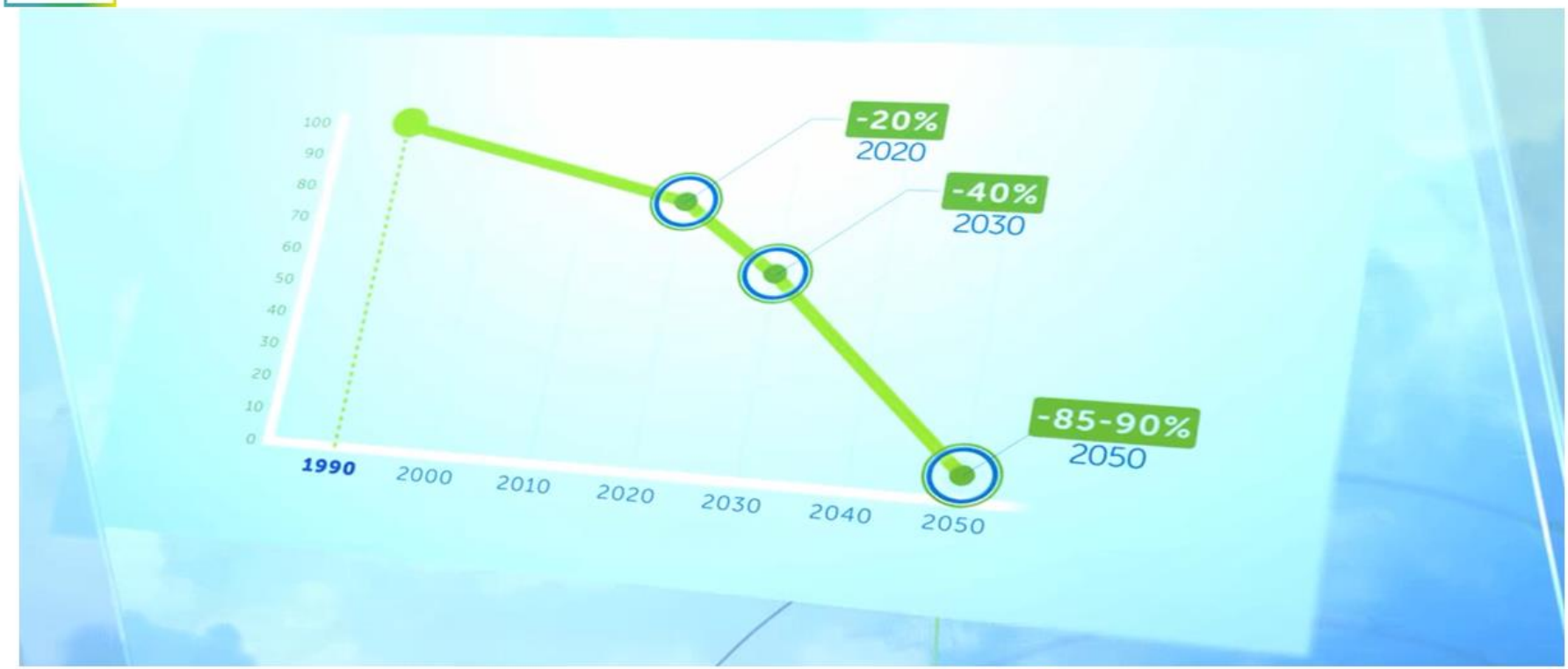
# 1.3. EU Climate & Energy Goals

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# 1.3. EU Climate & Energy Goals
# 2030 target - National Energy and Climate Elan (NECP)

To meet the EU's energy and climate targets for 2030, EU Member States need to establish a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030.

Introduced under the Regulation on the governance of the energy union and climate action (EU/2018/1999), the rules requires the final NECP to be submitted to the Commission by the end of 2019.

The national plans outline how the EU Member States intend to address

- energy efficiency
- renewables
- greenhouse gas
- emissions reductions
- interconnections
- research and innovation

The NECPs have the potential of turning the EU Green Deal into tangible actions, act as capital raising instruments and involve citizens and civil society in key issues of the climate transition

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# Overview of the objectives of 2030 among the participating countries in the SMEmPower project

| 2030 Targets | EU | Cyprus | Germany | Greece | Italy | Romania | Slovenia | Spain | UK |
|---|---|---|---|---|---|---|---|---|---|
| **Renewable Energy Sources (RES)** | | | | | | | | | |
| Total Share of energy from RES in the gross final consumption of energy | 32% | 23% | 30% | 35% | 30% | 30,7% | 27% | 42% | 27% |
| ○ RES – Heating and Cooling (indicative) | - | 39% | 27% | 43% | 33,9% | 33% | 30,5% | 31% | 50% |
| ○ RES – Electricity (indicative) | - | 26% | 65% | 61% | 55% | 49,4% | 47,4% | 74% | 47% |
| ○ RES – Transport (indicative) | - | - | - | - | - | - | - | - | - |
| RES – Road Transport (binding) | - | 14% | Not provided | 19% | 22% | 14,2% | 10,1% | 28% | 12,4% |
| **Energy Efficiency** | | | | | | | | | |
| Final Energy Consumption (Mtoe) | 956 | 2 | Not provided | 17,38 | 103,8 | 25,7 | Not provided | 79 | 154,1 |
| Primary Energy Consumption (Mtoe) | 1.273 | 2,4 | 240,4 | 20,55 | 125,1 | 32,3 | 7,1 | 104 | 185 |
| **Greenhouse Gas Emissions** | | | | | | | | | |
| Overall greenhouse gas emissions compared to 2005 | -40% (compared to 1990 levels) | -24% | -38% | -16% | -33% | -43,9% | -15% | -50% | -37% |

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# 1.4. EU Policy
# Energy Efficiency Directive 2012/27/EU

- It serves all EU member states as a common framework for measures to promote energy efficiency.
- Set of measures to reach EU's 20% energy efficiency target by 2020:
  - Suppliers and traders of energy are obliged to a saving target of at least 1.5% of annual energy sales per year
  - Obligatory implementation of energy audits for enterprises that are not SMEs*
  - National incentives for SMEs to undergo energy audits
- EU countries must draw up National Energy Efficiency Action Plans (NEEAPs) every three years stating:
  - estimated energy consumption
  - planned energy efficiency measures
  - the improvements countries expect to achieve

*As a SME does **not** count:

- who employs 250 or more persons, or
- who employs fewer than 250 persons but has an annual turnover exceeding EUR 50 million and an annual balance sheet total exceeding EUR 43 million.

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# 1.4. EU Policy
# Which aspects of the EED are the most relevant for SMEs

The EED also stresses the special role of SMEs, as the following two extracts show:

- "Most Union businesses are SMEs. They represent an **enormous energy saving potential** for the Union. To help them adopt energy efficiency measures, Member States should establish a favourable framework aimed at **providing SMEs with technical assistance and targeted information**."

- "Member States shall develop programmes **to encourage SMEs to undergo energy audits** and the **subsequent implementation of the recommendations** from these audits."

[**Source**: DIRECTIVE 2012/27/EU, https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32012L0027&from=GA

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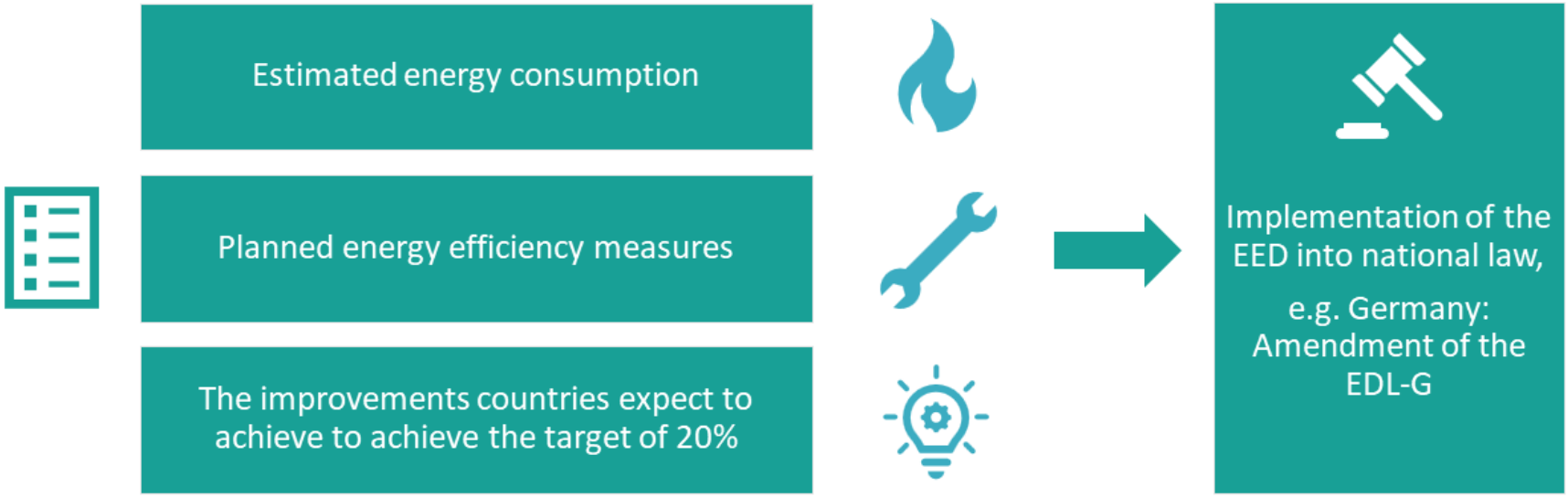
# 1.4. EU Policy
# Energy Efficiency Directive 2012/27/EU

- EU countries must draw up National Energy Efficiency Action Plans (NEEAPs) every three years stating:




[**Source**: DIRECTIVE 2012/27/EU, https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32012L0027&from=GA

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# 1.4. EU Policy
# The Revised Energy Efficiency Directive EU (2018/2002)

The EU has set new rules for energy efficiency, including an ambitious target of at least 32.5% by 2030 (no more than 1128 Mtoe of primary energy and no more than 846 Mtoe of final energy), following on from the existing 20% target by 2020

- Extending the energy saving obligation beyond 2020 sends a positive signal to investors and the energy market
- Encourages the uptake of innovative technologies, techniques and services which will stimulate the demand for energy efficiency improvement measures.
- EU countries will have to achieve new energy savings of 0.8% each year of final energy consumption for the 2021-2030 period.

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# 1.4. EU Policy
# The Revised Energy Efficiency Directive EU (2018/2002)

- Energy efficiency targets and energy labels encourage industry to innovate and invest.
- More energy efficient buildings can save energy, reduce bills, address health issues, lower air pollution, and improve people's quality of life.
- Energy savings are the easiest way of saving money and reducing greenhouse gas emissions.

If households, transport and industry across the EU become more energy efficient, the combined impact will make a major contribution to meeting our Paris Agreement climate goals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 1.4. EU Policy
# The Revised Energy Efficiency Directive EU (2018/2002)

The revised Directive will encourage using energy more efficiently and will lead to:

- Reduced energy foconsumptionr households and businesses – thereby lowering energy bills
- Lower consumption, making Europe less reliant on energy imports
- Incentives for producers/manufacturers to use new technologies and innovate
- More investment, for example in the building sector, thereby creating jobs
- Clearer information in household bill.

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# 1.4. EU Policy
# Possible role of SMEs in implementation of Energy Efficiency Directive (2012/27/EU)

**How to participate in general effort for an annual reduction of 1.5% in national energy sales: could be the art. 7 from EED (efficiency obligation schemes (EEOSs) an opportunity for SMEs. Aggregators (energy efficiency networks)** and energy companies on approaching small and medium sized enterprises (SMEs)

- programme to cooperate with companies primarily in the industry sector through industrial associations

→ **Case study 1: Voluntary Agreements**

- working on energy efficiency through the supply chain → **Case study 2: Demand Side management or Implementation of art7 EED**

**Case study 1 Voluntary Agreements (VA) - Concept:**
Contract between central authority and industrial association focused on reduction of energy consumption including tasks for both signatory parties
-medium-sized – and sometimes smaller – enterprises take part in VA
-it is required that VA companies practice process efficiency measures that are cost effective. In other words, the company can recoup the costs in less than five years
-VA participants practice systematic energy management in the company; companies remains consistently focused on their energy consumption.

**Case study 2 DSM or EED art 7 - Concept**:
**DSM**-traditionally seen as a means of reducing peak electricity demand so that utilities can delay building further capacity.
(DSM) programs consist of the planning, implementing, and monitoring activities of electric utilities which are designed to encourage consumers to modify their level and pattern of electricity usage.
**EED-option 1**:companies have to carry out measures which help final consumers improve energy efficiency.
**EED-option 2**: alternative measures – See EE Law no.121/2014 amended

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# 1.4. EU Policy

## The Potential of Smart Technologies and Micro-Generation in SMEs

- In UK, from the smart technology categories examined, fleet management, integrated building management systems and smart meters have the potential to offer the greatest energy savings to SMEs
- **Smart technologies** refer to the use of digital and communications technologies based on signals. They include a vast and growing array of technologies, such as smart appliances, smart lighting systems, integrated building energy management systems, smart meters, electric vehicles, Big Data in logistics and transportation, and fleet management.
  - the research finds that the application of **smart technologies within the SME market offers significant estimated annual energy savings potential** in the order of ~£8.6 billion against an estimated annual energy spend of ~£49.7 billion ( **simple payback-5.8 years** in UK)(representing ~17% savings potential on energy expenditures).
- **Micro-generation** refers to technologies that produce heat or electricity from a low carbon source and are <100 kW,(UK legislation), such as on-site solar photovoltaics (PV), heat pumps and biomass boilers.
  - **Feed-in tariffs** coupled with information campaigns have been the most commonly implemented policy for micro-generation globally.**T**he main barriers concentrate on three areas:
    - **Economic** - other investment priorities; payback periods for investments are less than two years;
    - **Information and - imperfect information** and a lack of technical skills to process the information
    - **Competing priorities** - pressure on the limited time, people and operational resources of SMEs.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

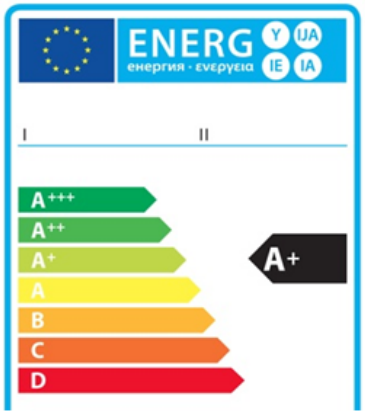
# 1.4. EU Policy
# Ecodesign and Energy Labelling

## The legal framework

- Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products
- Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU

## Ecodesign Directive

- provides consistent EU-wide rules for improving the environmental performance of products,
- sets out minimum mandatory requirements for the energy efficiency of these products.
- prevent creation of barriers to trade, improve product quality and environmental protection.




## Energy Labelling Directive

- Definition of *standards* for specific appliances
- Labelling for Energy-related Products
- Energy consumption of products presented by an efficiency scale (A → G & A+,A++,A+++)
- Indication of annual energy consumption and further product specific information

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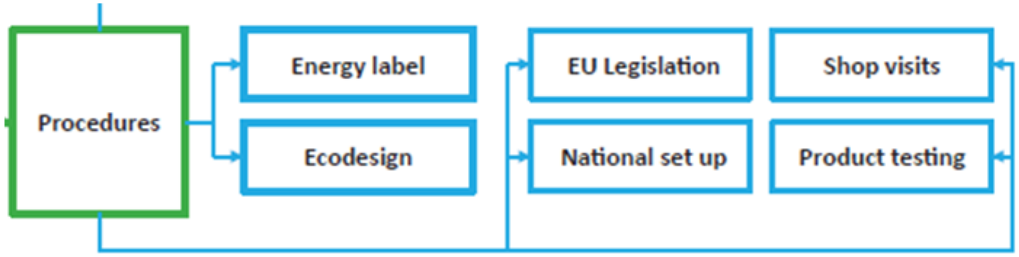
## Barriers and necessary support for SMEs for implementation of minimum energy efficiency standards and labelling for a variety of products such as boilers, fans, transformers, household appliances, lighting (EU regulations for energy label and eco-design).

- **Energy labels and minimum energy performance standards** are recognized among the most important ways to influence the market and ensure that the operation of products using energy does not result in this consumption being unnecessary high.
  - https://eur-lex.europa.eu/legal-content/RO/TXT/PDF/?uri=CELEX:32009L0125&qid=1589527990997&from=EN
  - The Energy Labelling system, with first attempts in Europe in place since 1979, is in generally considered a very efficient tool to raise the energy efficiency of products (appliances).
- Market surveillance is the **tool enabling the verification of individual claims** displayed on the label,ensuring the proper format and content.
- EU projects: **ATLETE, ATLETE II, Come On Labels, and Ecopliant**, are summarizing their overview of market surveillance in the EU and the recommendations and improvement opportunities identified. **INTAS – eco-design for industrial equipment(**Ecodesign requirements for large industrial products, specifically **transformers and fans. )**
- **SEMs can have specific responsibilities for both type of equipment: household appliances and industrial equipment**

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# 1.4. EU Policy
# Ecodesign and Energy Labelling

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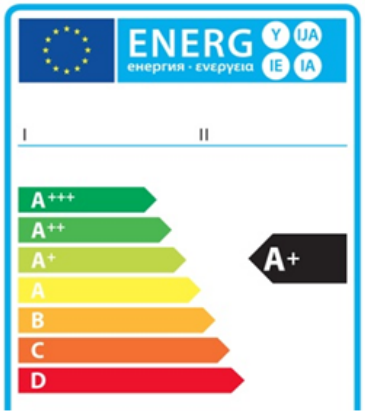


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# 1.4. EU Policy
# Ecodesign and Energy Labelling

## Market surveillance

- National market surveillance authorities verify whether products sold in the EU follow the requirements laid out in ecodesign and energy labelling regulations.
- National contact points in charge of market surveillance under the ecodesign directive
  - Implementation contact points
  - Market surveillance contact points

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# 1.4. EU Policy
# European Product Database for Energy Labelling (EPREL)

- As of 1 January 2019, suppliers (manufacturers, importers or authorised representatives) need to register their appliances, which require an energy label in the EPREL, before selling them on the European market.
- The product information that suppliers need to enter in the database relates to the energy label, technical documentation and compliance monitoring.
- For products placed on the EU market:
  - from 1 January 2019, their registration must be completed before placing any product on the European market
  - between 1 August 2017 and 31 December 2018, their registration had to be completed until 30 June 2019
  - before 1 August 2017 and which are no longer marketed after this date, their registration is on a voluntary basis (at any time)

Register a product in EPREL

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# 1.4. EU Policy
# EU funding programs examples

| | DESCRIPTION | TERM | BUDGET |
|---|---|---|---|
| **European Energy Efficiency Fund** | investing in energy saving, energy efficiency and renewable energy projects, particularly in urban settings, finances both project development and investments | Since 2011 | EUR 265 mio |
| **PF4EE** | increase the availability of debt financing to eligible EE investments, targets projects which support the implementation of NEEAP | 2014-2017 | EUR 1 bn |

**Other relevant funds and programmes:**
EU Horizon 2020, European Regional Development Fund, Cohesion Fund

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# 1.4. EU Policy
# EU Policy Framework

## Carrots and Sticks

### The Sticks

EU Directives, eg.:

Energy Efficiency Directive 2012/27/EU

Renewable energy directive 2018/2001/EU

Energy Performance of Buildings Directive 2010/31/EU (EPBD)

### The Carrots

Investment Incentives

## … and the Tambourine

### The Tambourine

- Information Provision
- Campaigns

[**Source**: Rainer Agster, adelphi, *Financing Energy Efficiency in Cyprus*, Workshop – Nicosia, 10. April, 2019]

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# 1.4. EU Policy
## Challenges of designing and delivering effective SME energy policy

**1. SMEs (small and medium enterprises) are widely acknowledged as a difficult target for energy policy.**

- they operate in every sector, in all property types and vary from one person operations with no business premises, to manufacturers with up to 250 employees
- their energy use is poorly understood: evidence on where, why and how much energy they use is incomplete.
- **Three categories of options available to policy makers are described:**

(1) designing 'universal' policy ;(2) developing organizational policy designed with minimum obligation thresholds, and (3) deploying measures specifically targeted at SMEs.

2. SMEs are considered to have **limited capacity for economies of scale**, to suffer from **lack of information**, time or **expertise to deal with regulations** or administrative rules, and to find it more **difficult or expensive to access capital** than larger organizations.

-A recent survey found that more **than 60 % of SME owners do not regard energy efficiency as a key priority**, (Scottish Power, 2016).

-the **majority of policy designed with SMEs at the centre takes an incentive based approach**,with a large proportion of 'business support' taking the form of grants, loans or face-to-face advice - Despite the significant provision of incentive-based policy for SMEs, **little effort is made to quantify and aggregate emissions and energy savings**

**Conclusion:It is clear that there are a number of challenges to designing and implementing effective energy policy for SMEs, but addressing this group as a whole may not offer the best solutions.**

[**Source**: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/1-foundations-of-future-energy-policy/challenges-of-designing-and-delivering-effective-sme-energy-policy/EU Policy Framework]

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# 1.4. EU Policy
# Policy Framework in Germany

## Obligatory execution of an energy audit for non-SMEs

No duty for SMEs

## Support through

- 500 sponsored Energy Efficiency Networks (see notes)
- funding schemes for energy efficiency measures
- funding schemes for energy audits
  → Up to 80% of the costs or 6,000.- €

- funding the creation of a company-specific energy saving concept by an external energy consultant
- low interest loans for the implementation of energy efficiency measures by the KfW

| Instrument | Large enterprises | SME | Energy audits | Management system | Exchange mechanisms | Regulatory instruments | Voluntary agreements | Financial instruments | Information instruments |
|---|---|---|---|---|---|---|---|---|---|
| Mandatory energy audit | • | | • | | | • | | | |
| SME Energy Consulting Programme | | • | • | | | | | • | |
| Eco tax cap for manufacturing industry | • | • | •[1] | • | | | | • | |
| Special equalization scheme | • | • | •[2] | • | | | | • | |
| BAFA support programme for energy management systems | • | • | | • | | | | • | |
| BAFA support programme for cross-cutting technologies | • | • | • | | | | | • | |
| Energy efficiency networks | • | • | • | | • | | | | • |

[1] only refers to SMEs
[2] only refers to companies with an electricity consumption of less than 5 GWh

[**Source:** *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems*, European Union, April 2016]

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# 1.4. EU Policy
# Policy Framework in Germany

## Information instruments

by the government sponsored campaigns to promote the funding for Energy Efficiency

- Promotion of Energy Efficiency Networks Scheme
- Various German industrial associations run sponsored campaigns (e.g. business associations, chamber of commerce)
- other governmental and non-governmental organizations addressing energy efficiency in industry (e.g. German DENEFF, dena)

→ **For SMEs Germany provides subsidies and incentives as well as information instruments, but no regulatory instruments.**

[**Source**: *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems*, European Union, April 2016]

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# 1.4. EU Policy
# Transposition of the Energy Efficiency Directive 2012/27/EU in Cyprus Legislation

*The following programmes and measures have been implemented as a transposition of the Energy Efficiency Directive (EED) into Cypriot legislation*

- **4th National Energy Efficiency Action Plan** (2017)
- **Legislative actions** – Amendment of law for Energy efficiency in End-Use and Energy Services, law for the Promotion of Combined Heat and Power Generation and law regulating the Electricity Market
- **Energy audit obligation for large companies** (No duty for SMEs)
- **Obligations for the public sector to act as the front-runner in energy efficiency (public purchasing)**

[**Source**: Anthi Charalambous, Panayiotis Kastanias, PF4EE Training – Nicosia, 07 March 2018]

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# 1.4. EU Policy
# Transposition of the Energy Efficiency Directive 2012/27/EU in Cyprus Legislation

## *4th National Energy Efficiency Action Plan (2017)*

- **Outline of measures and programmes for implementation of EED**
- **Projections for final energy consumption up to year 2020 by sectors** for business-as-usual scenario, and with implementation of energy saving measures
- **Final energy saving measures and programmes** – households, services, industry (non-ETS), transport (road and air), agriculture
- **Achieved final energy savings**, and targets up to 2020 by sectors and sources of financing
  - 272.317 toe by 2016, of energy end-use consumption (131% of the target)
  - the national indicative target for primary energy consumption for 2020 is 2.2 Mtoe.
  - The national indicative target for primary energy savings is 375,000 toe by 2020. The achieved energy savings from the measures implemented in 2010-2016 amount to 121,815 toe (32.5% of the 2020 target)

[**Source**: Anthi Charalambous, Panayiotis Kastanias, PF4EE Training – Nicosia, 07 March 2018]

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# 1.4. EU Policy
# Transposition of the Energy Efficiency Directive 2012/27/EU in Cyprus Legislation

## *Energy audit obligation for large companies*

- Definition (considered large company if any criteria fulfilled)
  - ≥ 250 employees
  - ≥ Turnover of EUR50m
- Criteria does not correspond 1:1 with definition of the EC
- Around 100 companies in Cyprus fulfil the criteria
- Exemption of ISO 50001 energy management system-certified companies
- Energy audit has to be carried out by an independent accredited auditor
- First energy audit to be carried out by 5 December 2015, and then repeat it every 4 years; fines up to EUR30k for non-compliance

[**Source**: Anthi Charalambous, Panayiotis Kastanias, PF4EE Training – Nicosia, 07 March 2018]

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# 1.4. EU Policy
# RES & Energy Efficiency Support for SMEs in Cyprus

| Type | Target Group | Description |
|---|---|---|
| **Support mechanism** | Households, SMEs | Net-metering for PV systems up to 10 kW |
| **Support mechanism** | SMEs | Net-billing for PV and Biomass systems up to 10 MW |
| **Support mechanism** | Public buildings, SMEs | Net-billing for CHP units ups to 5MW |
| **Support mechanism** | Households, SMEs | Stand-alone PV systems |
| **Support Scheme** | SMEs | Rural development programme 2014-2020 of the Ministry of Agriculture, Rural Development and Environment.<br>Subsidy is granted under the scheme for actions that involve purchasing and installing PV systems used to generate energy for own use in agricultural holdings/enterprises. |
| **Grant scheme** | SMEs | Energy Audits for SMEs (30% subsidy or up to €2.000) |
| **Grant scheme** | SMEs | Eco-Management and Audit Scheme (EMAS) for enterprises and public & private organizations |
| **Support instrument** | All buildings (Households, SMEs) | Building factor incentive<br>If a building is energy class A in the EPC and 25% of its energy consumption comes from RES, an additional 5% building factor can be provided. |

[**Sources:** D.2.2. *Report on current and potentially improved funding mechanisms and best practises for energy efficiency in SMEs*, H2020 SMEmPower efficiency project, April 2020]

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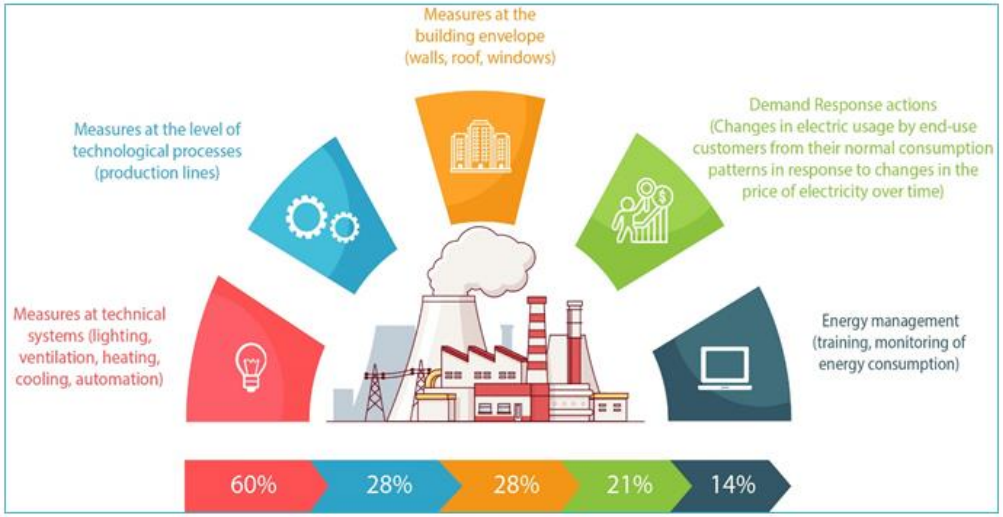
# 1.4. EU Policy
## Energy efficiency measures implemented in SMEs

213 SMEs participated in a survey from the 8 countries in the EU.

60% of SMEs prefer to implement measures to increase energy efficiency in technical systems, e.g.

- lighting,
- heating,
- cooling and
- ventilation.

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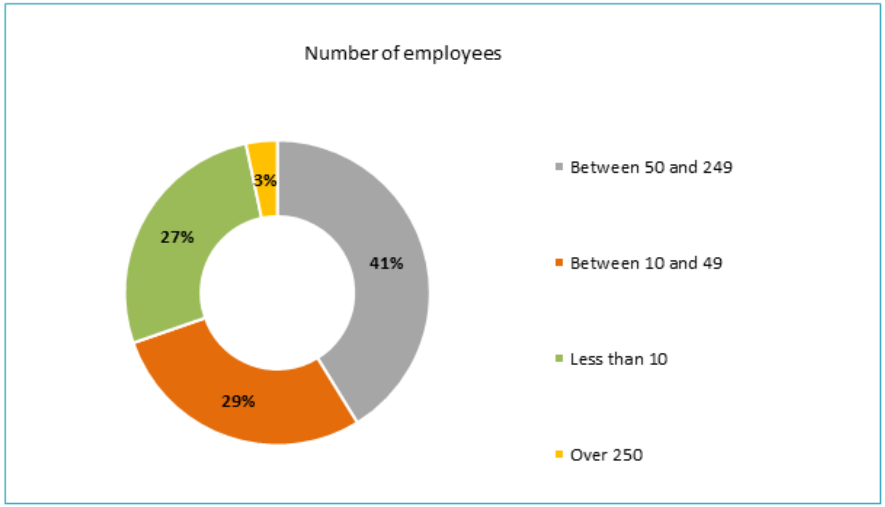
# 1.5. Identification of current energy efficiency situation in SMEs

## The SMEs sample

The aim of the survey was to identify barriers that influence the further promotion of energy audits/energy management and the implementation of energy efficiency measures.

The biggest group of the participating SMEs employs more than 50 people.

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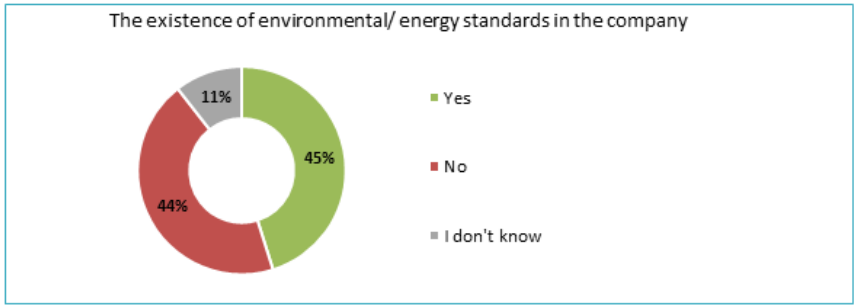
# 1.5. Identification of current energy efficiency situationin SMEs

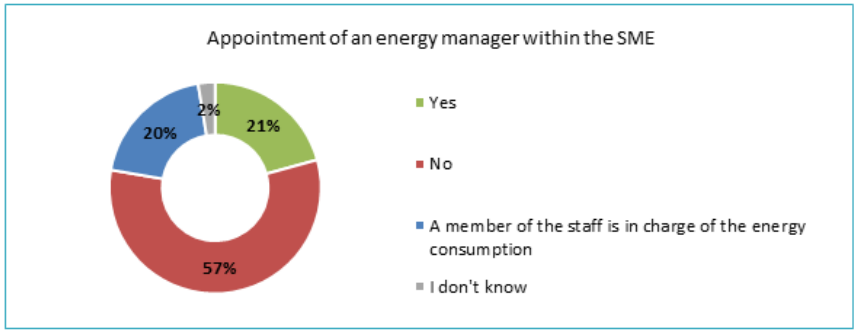
## Environmental/energy standards implemented in SMEs

45% of the SMEs have environmental/energy standards like EMAS or ISO 50001 implemented.




## The current level of energy management/energy efficiency within SMEs

And most of them have a person responsible for energy efficiency.

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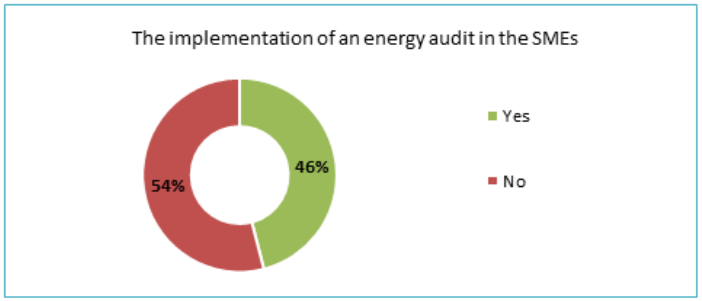
# 1.5. Identification of current energy efficiency situation in SMEs

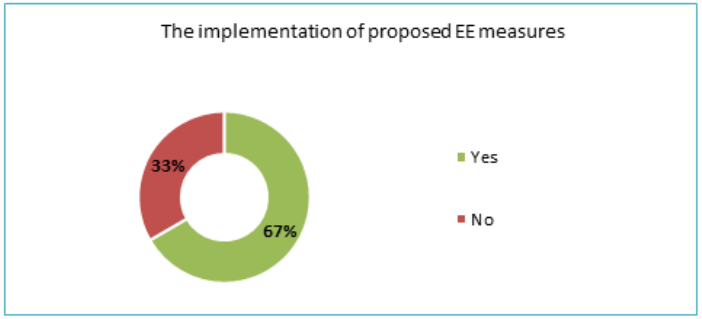
## Implementation of an energy audit

Just as many have carried out an audit




## Implementation of EE measures

67% of the SMEs have implemented EE measures which were proposed in the energy audits.

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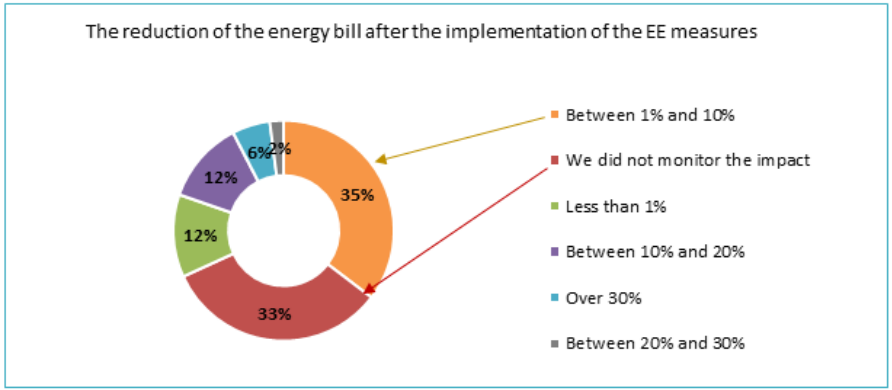
# 1.5. Identification of current energy efficiency situation in SMEs

## The impact of the implemented EE measures in the SMEs energy bill

The most energy efficiency measures reduced the energy bill by 1% - 10%, but one third didn't even monitor the impact.

This might be because mainly smaller investments were made for energy efficiency measures.

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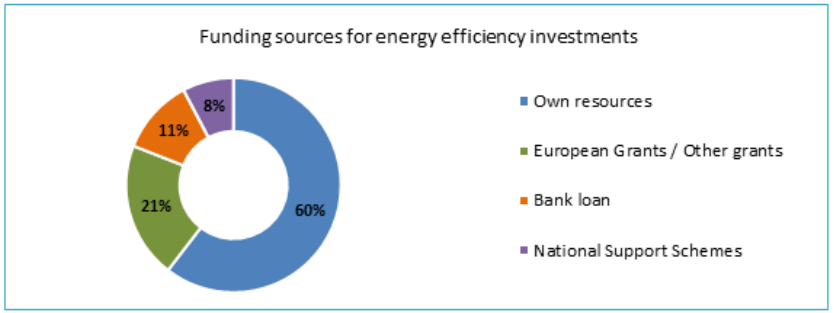
# 1.5. Identification of current energy efficiency situation in SMEs

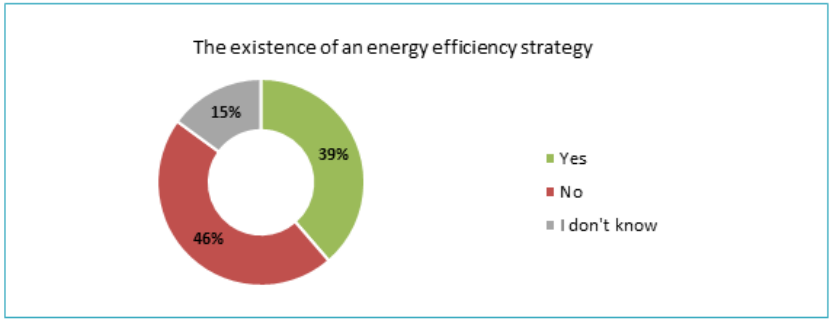
## Funding sources for energy efficiency investments

Most SMEs use own resources to finance EE measures.




## Existence of energy strategy in SMEs

More than a third is following an energy efficiency strategy for the future.

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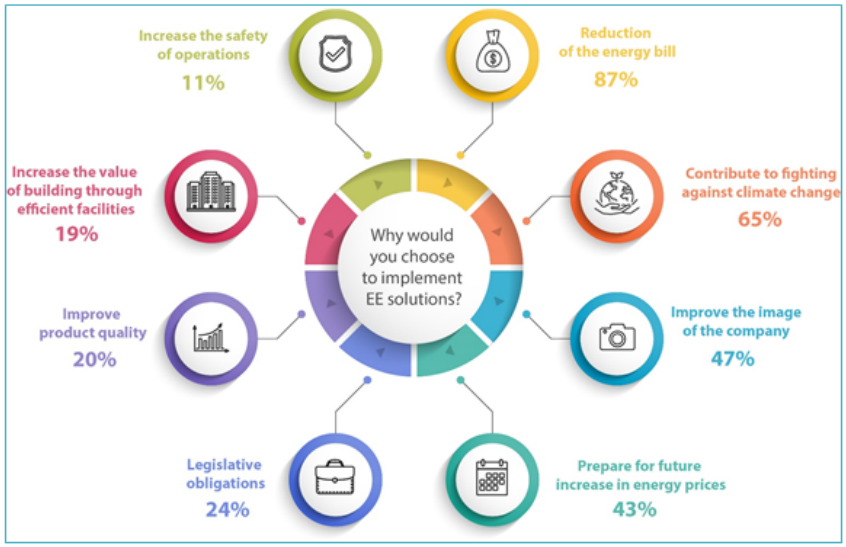
# 1.5. Identification of current energy efficiency situation in SMEs

## The reasons to implement EE measures within SMEs

- he main driver to implement energy efficiency measures in SMEs is to cut energy cost
- there's strong interest among SMEs to contribute to the fight against climate change
- 47% would implement energy efficiency measures in order to improve the reputation of the company

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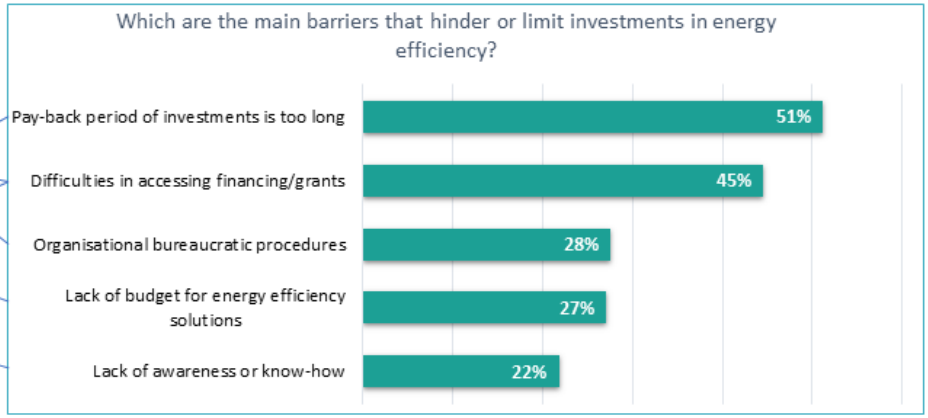
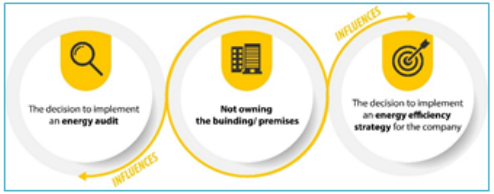
# SMEs common barriers in implementing energy efficiency measures

- Relevance of energy demand in SMEs / EE is not a priority
- Limited organisational capacity of SMEs
- Lack of trust in efficiency measures
- Industry and technology dynamics
- Financial capacity of SMEs / budget construction
- Organisational decision-making in SMEs
- Ownership of the property

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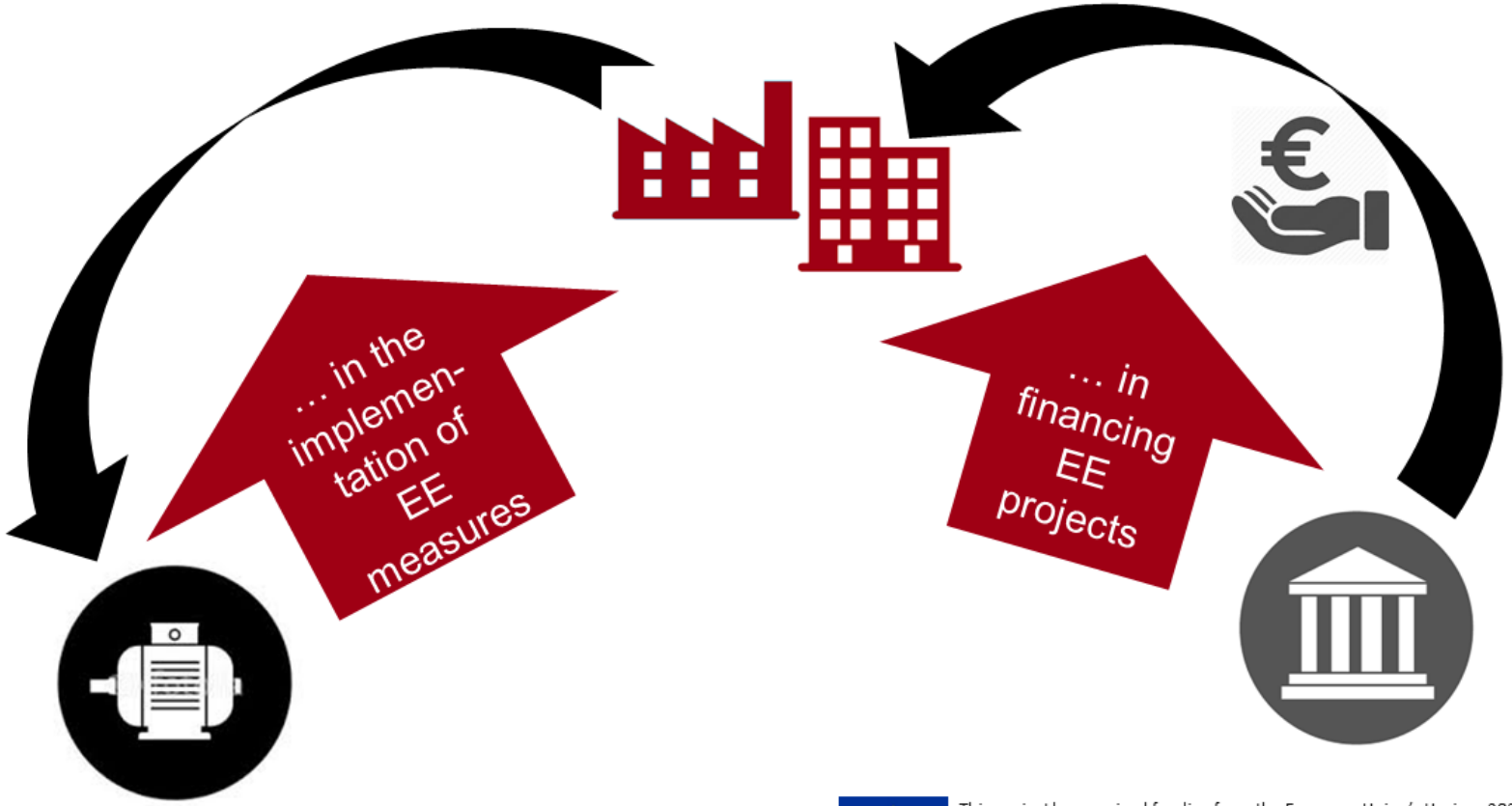
# Challenges & Risks

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# … in the Implementation of Energy Efficiency Measures

| | |
|---|---|
| Financial | • Access to finance<br>• Payback expectations / investment horizons<br>• Competing purchase decisions<br>• Price signals |
| Institutional and administrative | • Institutional<br>• Structural<br>• Multi-stakeholder issues<br>• Regulatory and planning issues |
| Awareness, advice and skills | • Information barriers<br>• Awareness of potentials / benefits<br>• Skills and knowledge related to professionals<br>• Financial awareness, advice and skills |
| Separation of expenditure and benefit | |

**It is important to be aware of these barriers in order to sell an energy efficiency loan**

**Discussion:**
**What are (main) barriers in your country?**

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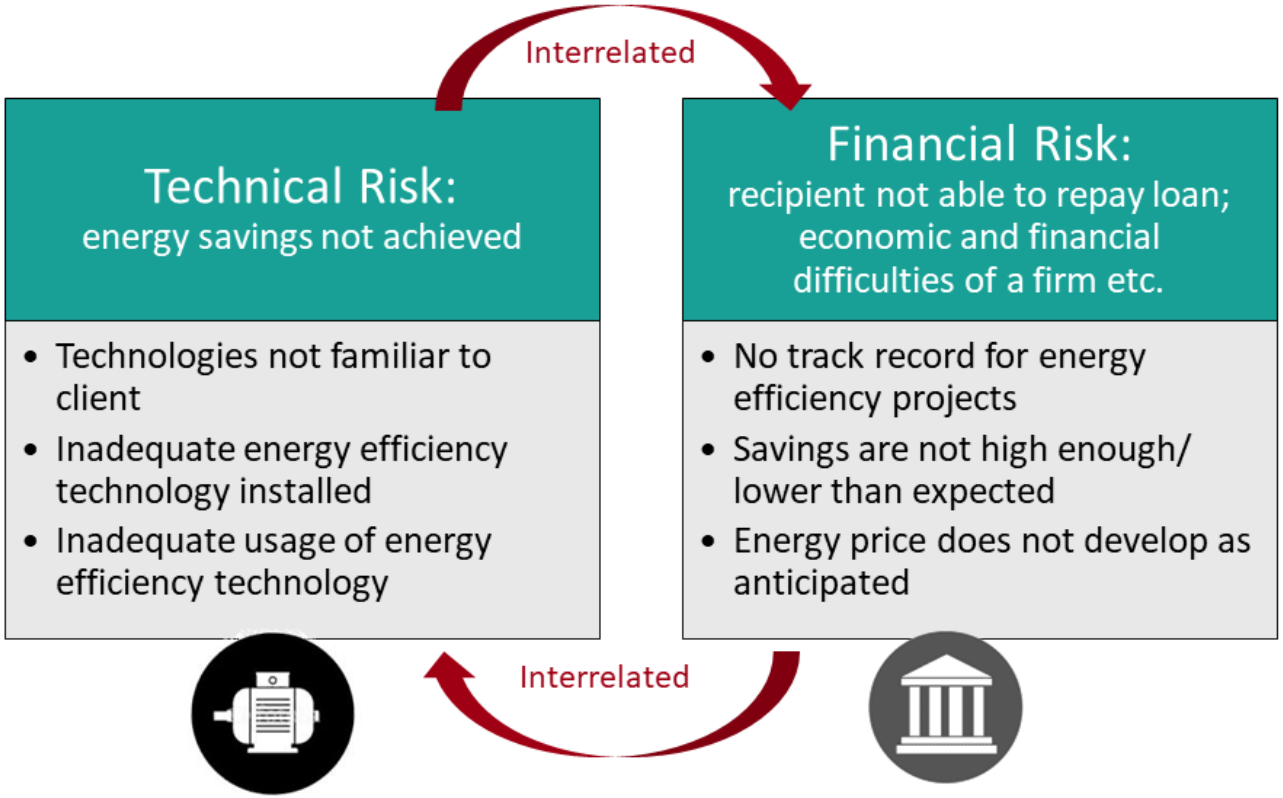
# … in Financing Energy Efficiency Projects

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# Instruments Reducing Risks of Energy Efficiency Projects

## Technical Risk

- Tools (e.g. eligibility checking & monitoring tools)
- Justification of savings through registered energy auditors

## Financial Risk

- Application of special financing models
- Cash flow based lending
- Adjusting collateral policy

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# Risk Reduction through Energy Efficiency Financing

- Retrofitting energy efficiency is cost-effective

  → reduction of default risk and hence credit risk

A financial risk management model:

- Energy consumption elements are directly affected by changes within the facility (intrinsic volatilities)
  - e.g. risks relating to the energy volume, asset performance and energy baseline uncertainty
- Energy consumption risks outside the facility that could be hedgeable (extrinsic volatilities)
  - e.g. energy price risk, labor cost risk, interest rate risk and currency risk

Such a risk management framework would allow energy efficiency experts and investment decision-makers to exchange the information they need to expand investment into energy efficient buildings projects

In addition, energy efficiency measures in buildings **increase their market value** and reduce energy costs for tenants

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Recommendations [and good practice examples]

General

- Reduce bureaucratic procedures regarding the access of the financing solutions
- Appointment of an energy manager in the SME (with proper energy efficiency training)
- Communication plays an essential role among all the participants in the energy efficiency domain

Energy audits for SMEs

- Encouragement of energy-intensive companies [Additional criterion for including/encouraging energy-intensive companies (e.g. Bulgaria, Czech Republic, Ireland, Italy, Romania)]
- Provision of implementation support [Implementation support for suggested measures (e.g. Germany)]
- Provision of low-interest capital for investments in recommendations
- Establishment of one-stop shops and involvement of key institutions [Central hub for seeking support and for reporting (e.g. Norway)]

Source: A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems, European Union, April 2016

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# Recommendations [and good practice examples]

Energy management for SMEs

- Step-wise implementation support [Provision of web-based implementation follow up (e.g. Ireland, Germany)]
- Advice and first certification support
- Guidance for different branches [Providing energy management guidelines for specific branches (e.g. Spain)]

Exchange mechanisms for SMEs

- Regular common exchange and follow-up for SMEs [Organization of various information sources and events as in many MS (e.g. conferences, workshops, helpdesks, etc.)]
- Ensuring institutional support [Cooperation with key institutions (e.g. business associations) for informing companies about the process as in many MS]
- Using a mix of approaches [Utilization of several approaches to cover a wide range of SMEs (e.g. Denmark) where appropriate]

[**Source**: *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems*, European Union, April 2016]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 1.6. Overview of specific energy management system options for SMEs

## ISO 50001

is the international standard for Energy Management Systems (EnMS)

- it follows the "Plan-Do-Check-Act" process for continual improvement
- provides a set of requirements that enable organizations to:
  - Develop a policy for more efficient use of energy
  - Fix targets and objectives to meet that policy
  - Gather data to better understand and make decisions concerning energy use
  - Measure the results obtained
  - Review the effectiveness of the policy
  - **Continually improve energy management**

[**Sources:** ISO 50001 *Energy management systems*, International Organization for Standardization, 2018; Wikimedia Foundation, ISO 50001, 2020 (https://en.wikipedia.org/wiki/ISO_50001) ]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 1.6. Overview of specific energy management system options for SMEs

## ISO 14001

is a standard for Environmental Management Systems (EMS)

It helps an organization achieve the intended outcomes of its environmental management system, which provide value for the environment, the organization itself and interested parties. Consistent with the organization's environmental policy, the intended outcomes of an environmental management system include:

- enhancement of environmental performance;
- fulfilment of compliance obligations;
- achievement of environmental objectives.

Focus on improving the environmental **management performance**, does not include an energy audit by an external expert.

**DIN EN ISO 14001:2015** is a revised and improved German version, e.g. with:

- A uniform basic structure for ISO management system standards, (so-called "high-level structure");
- Strengthening of management responsibility for environmental management and integration into the organisation's business processes;
- Greater emphasis on environmental performance improvement and its measurement through appropriate indicators.

[**Source:** ISO 14001:2015, International Organisation for Standardization, 2020 (https://www.iso.org/standard/60857.html )]

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# 1.6. Overview of specific energy management system options for SMEs

Focus on continuous improvement of environmental performance beyond legal requirements

## EMAS

(Eco-Management and Audit Scheme)

- covers all requirements of DIN EN ISO 14001 and is like this applicable worldwide.
- includes legal regulations concerning the registration and monitoring of the environmental verifiers
- registration of the companies and organisations
- compliance check with the authorities
- high credibility

SMEs can become EMAS registered by using the **EMAS Easy** method. Based on the Eco mapping concept, EMAS Easy is a way to implement EMAS that takes into account the size, financial capacity and organisational culture of small businesses.

[**Sources**: Umwelt Gutachter Ausschuss, EMAS – Mehrwert schaffen, Risiken vermeiden, 2018 (https://www.emas.de/fileadmin/user_upload/4-pub/Mit-EMAS-Mehrwert-schaffen_Vergleich-ISO14001.pdf);
European Commission, EMAS Corner, (https://ec.europa.eu/environment/emas/join_emas/what_if_i_am_an_sme_en.htm) ]

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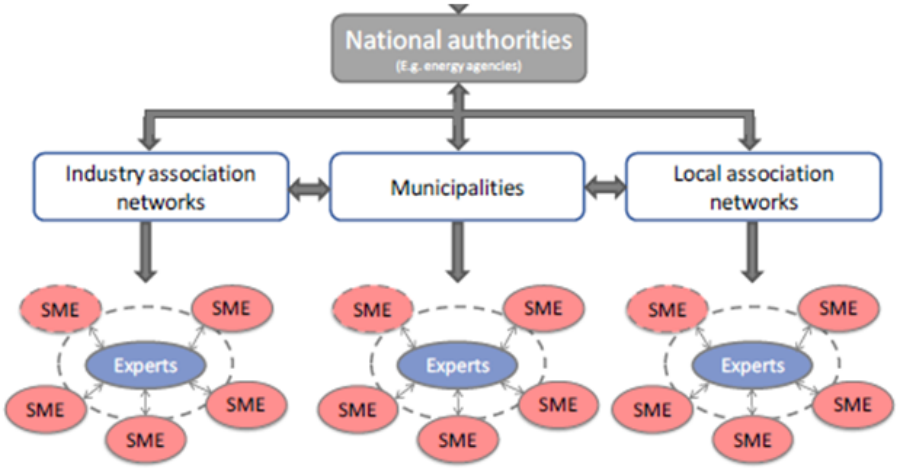
# 1.6. Overview of specific energy management system options for SMEs

- **Networking - could be "packaged assistance procedure" offered by regional centers a realistic and attractive solution? Are SMEs ready/ interested in common actions and cooperation.**
  - "packaged assistance procedure" concept
  - posible role of territorial offices for SMEs (identification of SMEs level and structure of energy consumption – data base)
  - possible cooperation in energy efficiency in SMEs sector to address support programs




- Networks should be better structured at different levels and actively used as a way to promote energy efficiency through sharing good practices as well as listings of **external help**
- Through subsectors also very small companies (bakeries, hairdressers etc.) could be reached cost efficiently. Similar SMEs could be grouped and common trainings with an energy efficiency consultant and other information sharing could be **better targeted to cut costs**.
- The networks could list recommended, trustworthy external energy efficiency experts that help to facilitate the energy efficiency process.

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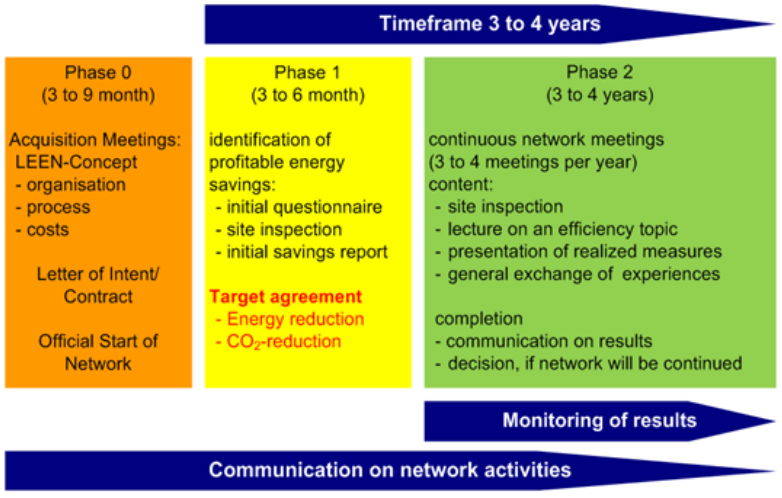
# Case study –networking

## LEEN (Learning Energy Efficiency Network) - concept, achievements and prospects

- In Energy Efficiency Networks (EEN) **10 to 15 regionally based companies** from different sec-tors share their experiences in efficiency activities in moderated meetings. After an initial consulting and identification of profitable efficiency potentials in each company, **all participants decide upon a joint target.**
- The main goals of an EEN are **to reduce transaction costs**, to overcome obstacles, **to raise the priority of energy efficiency**, all particularly in cross cutting technologies and, hence, **to reduce energy costs**.
- the basic ideea of the project is **to improve an existing network management system (MS**) to operate EENs at a high quality standard.
- The MS will consist of:
  - an EEN-manual with helpful documents (e. g. **contract templates, checklists, technical manuals**) and
  - about **25 software-based techno-economic calculation tools** under a unified user interface.

The **smaller companies** use too little energy to carry out full energy audits. However, they may **benefit from the knowledge provided by benchmarking systems** (both at the level of process energy and cross-cutting technology). They may also be supported via **special funds in carrying out (simplified) energy audits** because usually the amount of energy consumption is too small to justify in-depth audits




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

## Remarks on Learning Unit 1

- EU legislation gives the framework for implementation into national law
- EU countries must draw up National Energy Efficiency Action Plans (NEEAPs) every three years
- SMEs play an important role for the EU EE goals
- If properly implemented, SMEs can benefit from EE measures in many ways
- There are many barriers to overcome to reach high EE
- Voluntary implementation of an energy management system could help to overcome these barriers

## References for Learning Unit 1

[1] *Directive 2012/27/EU* of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC Text with EEA relevance, *Official Journal of the European Union*, L 315, November 14th , 2012. (link)

[2] R. Agster, adelphi, "Financing Energy Efficiency in Cyprus", Workshop, Nicosia, Cyprus, April 10th, 2019.

[3] "Framework Analysis Report. Identification of the current Energy Efficiency level in SMEs", *SMEmPower Efficiency – A holistic framework for Empowering SME's capacity to increase their energy efficiency*, Horizont 2020 research and innovation programme under grant agreement No 847132, March 2020. (link)

[4] *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems, "*Report on the fulfilment of obligations upon large enterprises, the encouragement of small- and medium-sized companies and on good-practice", European Commission, April 2016. (link)

[5] *ISO 50001*: "Energy Management Systems - Requirements with guidance for use", International Organization for Standardization, 2018. (link)

[6] *ISO 14001*: "Environmental Management Systems - Requirements with guidance for use", International Organization for Standardization, 2015. (link)

[7] ***SME Corner, European Commission website (link)

[8] "EMAS – Mehrwert schaffen, Risiken vermeiden. Die Stärken von EMAS gegenüber der ISO 14001", Umwelt Gutachter Ausschuss, 2018. (link)

[9] ***The transposition of the amended EED in Germany: "Bekanntmachung Richtlinie für die Bundesförderung der Energieeffizienz und Prozesswärme aus Erneuerbaren Energien in der Wirtschaft – Zuschuss und Kredit", January 22nd, 2020. (link)

[10] *A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems, "*Implementation of national minimum criteria for energy audits, in line with Annex VI of the Energy Efficiency Directive", European Commission, October 2015. (link)

# Learning Unit 2: Energy Efficiency Systems, Measures & Solutions – Energy Management Opportunities

## Introduction

| | |
|---|---|
| **AIM** | • To provide the fundamentals of energy conversion processes from fossils or renewable sources to thermal or/and mechanical energy.<br>• To create the competency to identify energy efficiency solutions and handle their implementation in SMEs. |
| **ECTs STRUCTURE** | **1.0 ECTS credits**<br>16 Lecture hours (including testing impact of self-study)<br>6 Practice hours (proposal preparation for new EE or RES equipment for own installations)<br>8 Self-study hours (study of technical prospectus/catalogues)<br>**Total hours 30** |
| **OBJECTIVES** | The learning unit will provide trainees with the background knowledge to identify, implement and evaluate energy efficiency solutions in their SMEs |
| **LEARTNING OUTCOMES** | • Design strategies: e.g. passive design (building envelope, orientation, shading, solar protection and gains)<br>• Building energy systems: focusing on primary energy, energy conversion, renewable, micro co-generation, and including heating/cooling technologies, ventilation and heat recovery systems, control technology, lighting systems<br>• Renewable energy sources and systems (wind, solar electric, solar thermal, biomass, hydrogen, aerogenerator (HP), geothermal) |
| **PREREQUISITES** | • Trainers should have a background in building physics, building energy systems and energy efficiency, also thermodynamics.<br>• Identification and synthesis of main existing energy consuming equipment in participating SMEs (for the case studies);<br>• Trainers should have a background in building physics, building energy systems and energy efficiency. |

# CONTENT OUTLINE of LU 2

2.1. ENERGY CONSUMPTION OPTIMIZATION

2.2. ENERGY EFFICIENCY MEASURES

2.3. RENEWABLE ENERGY SOURCES

2.4. GHG EMISSIONS REDUCTION

2.5. CONCLUSIONS

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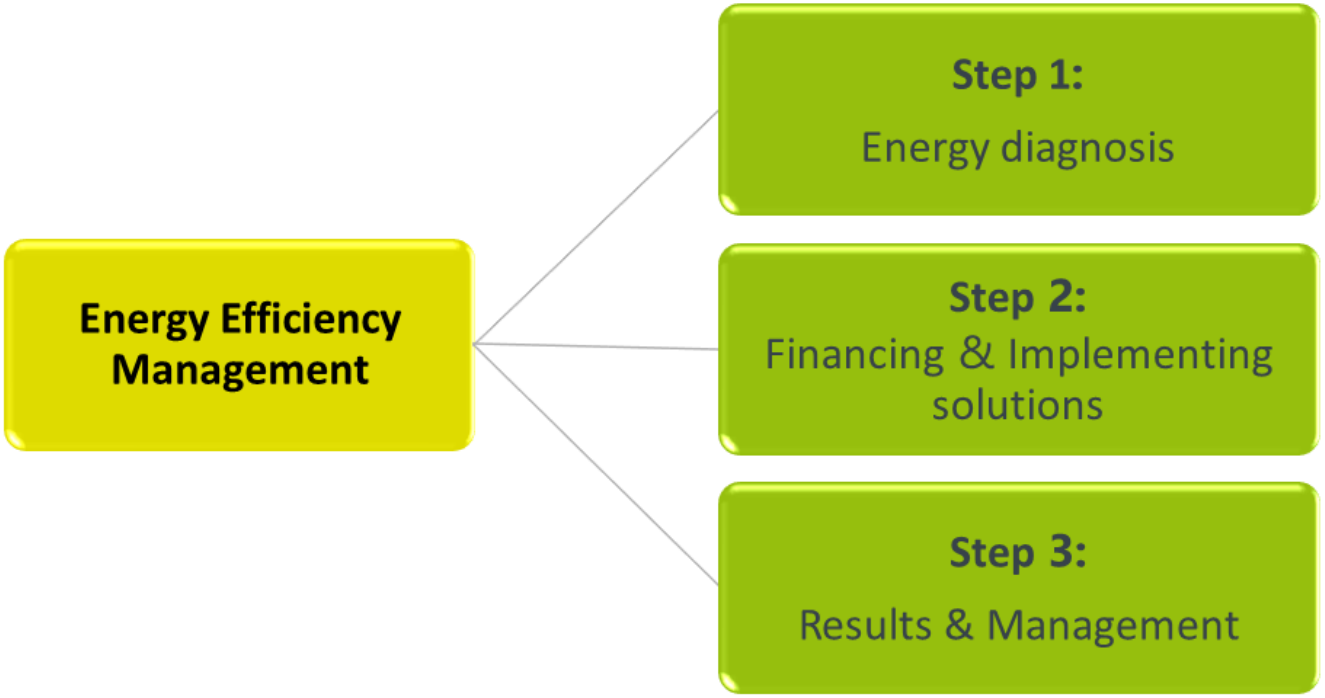
# 2.1. Energy Consumption Optimization

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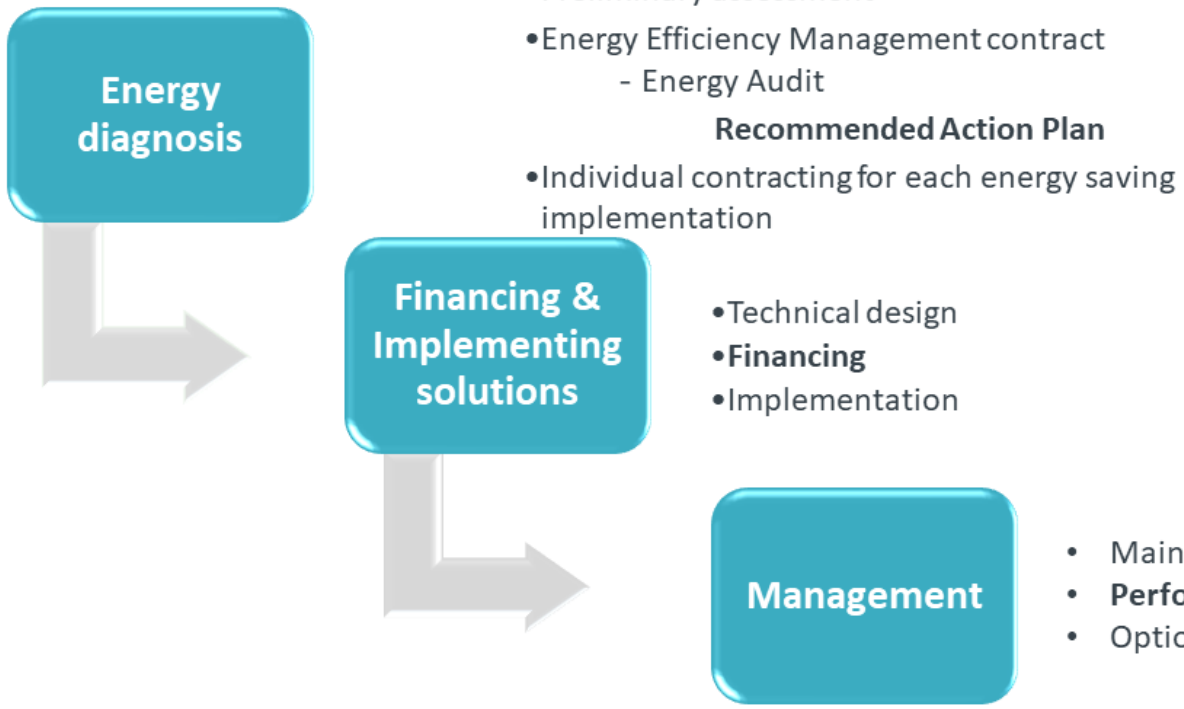
# Step 1: Energy Diagnosis

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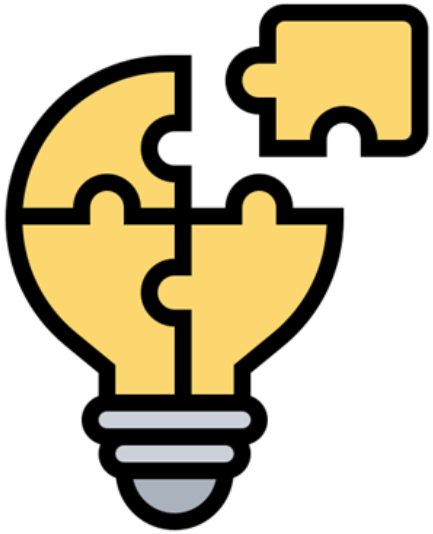
# 2.2. ENERGY EFFICIENCY SOLUTIONS



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Transition from low voltage to medium voltage

**Benefits:**

- Reducing the electricity bill by approximately 20%;
- Increasing security in power supply.

| Month | Average monthly energy consumption | Monthly economy/ MWh in invoice (EUR/MWh) | Total monthly savings on invoice |
|---|---|---|---|
| 1 | 210 | 28,12 | 5.905 |
| 2 | 210 | 28,12 | 5.905 |
| 3 | 210 | 28,12 | 5.905 |
| ... | ... | ... | ... |
| 25 | 210 | 28,12 | 5.905 |
| 26 | 210 | 28,12 | 5.905 |
| Total for 26 months | | | 153.530 |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# LV/MV electrical panels retrofit

**Benefits:**

- Safe operation of electrical installations;
- Increasing security in power supply;
- Reducing your own technological consumption and increasing the reliability of the power schemes;
- Identify weak contacts and avoid interruptions / accidents / fires.

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# Reactive power compensation

**Benefits:**

- Reducing monthly reactive energy costs by 90% -100%;
- The availability of the transformer Increases, the reagent requirement is produced where is consumed and the reactive energy is no longer transmitted through the operator's distribution lines;
- Improving the internal network voltage.

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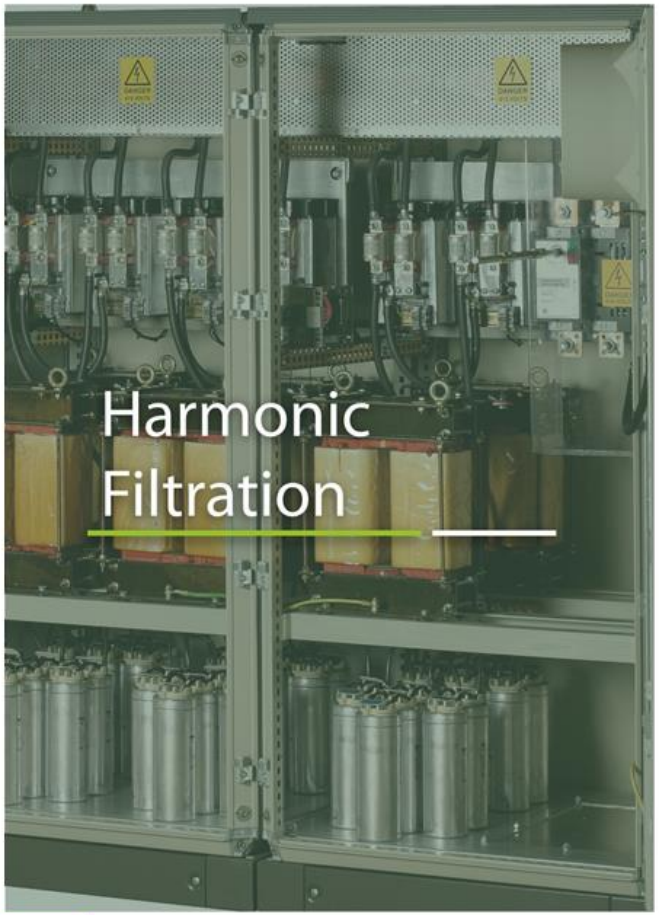
# Harmonic Filtration

**Benefits:**

- Prevents equipment damages, overheating and safe mode initiation;
- Realigns the electrical network to nominal work parameters;
- Improves the quality of the energy according to the local Distribution Operator standards.




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# LED Technology

**Benefits:**

- Reducing the energy use and costs.
- Updating the lighting solution according to the bright-technical standard;
- Low maintenance costs;
- Provides comfort to employees and a light distribution according to the standards;
- Withstand to extreme temperatures, of +/-50 Celsius degrees.

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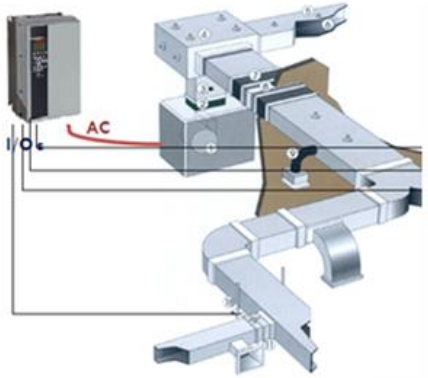
# Smart Metering System

**Benefits:**

- Determine and optimize the costs generated by the utilities consumption;
- Identify the energy waste and related costs in real time and based on an operating history;
- Group costs and consumptions on cost centers;
- Identify and analyze the factors that influence utility consumption / costs.

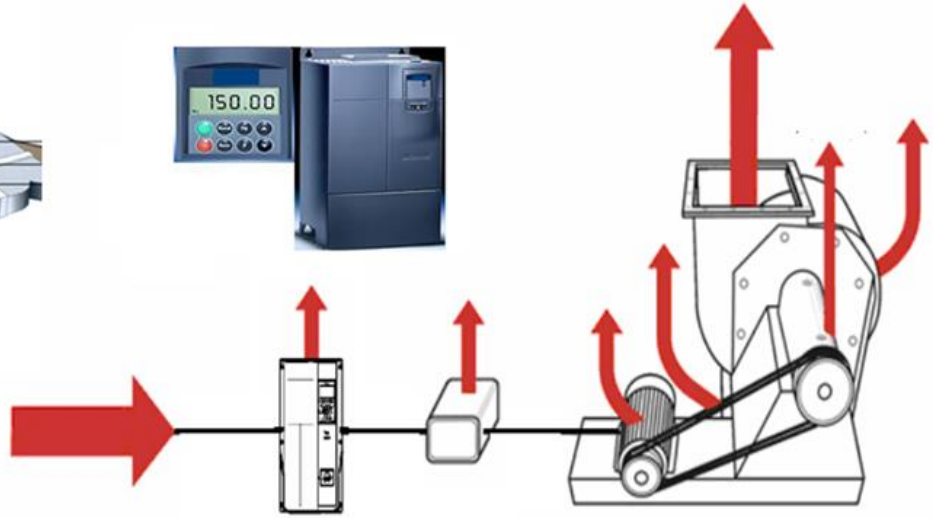
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Variable Speed Drive – Flow control









This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Power factor correlation

Medium voltage capacitor banks

Reactive power factor correction for transformers

Harmonic filters

Low voltage capacitor banks

Capacitive power factor correction – shunt coils

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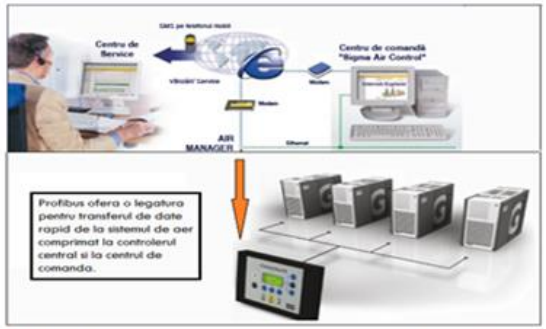
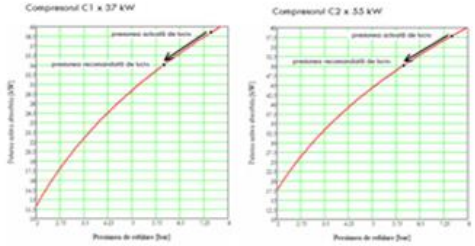
# Air compressors – production – distribution - consumption

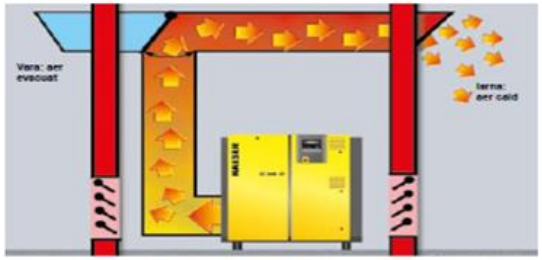
Cut off compressed air losses




Working pressure reduction



Working pressure reduction




Heat recovery

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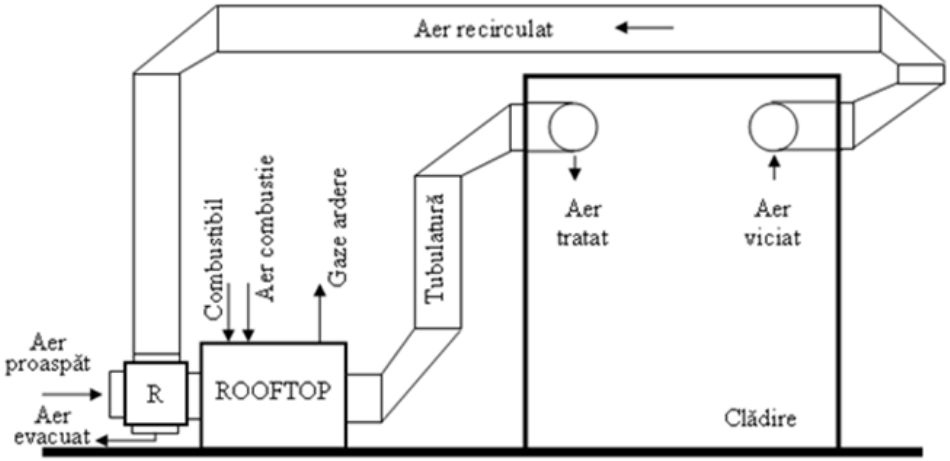
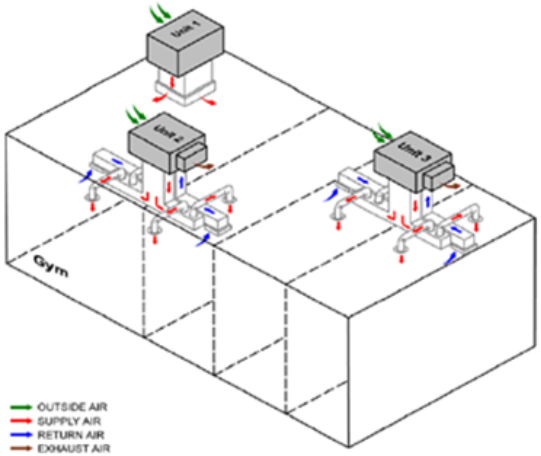
# Heat recovery from thermal processes or air treatment power stations




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Indoor and Outdoor Lighting

## Sensors

## Voltage control

## Efficient lamps

## Daylight roofs

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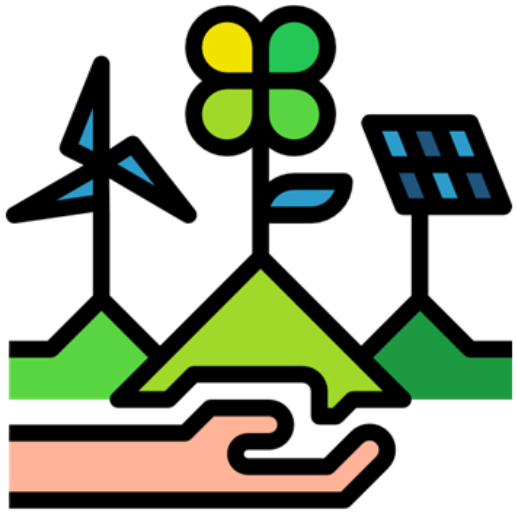
# 2.3. RENEWABLE ENERGY SOURCES



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

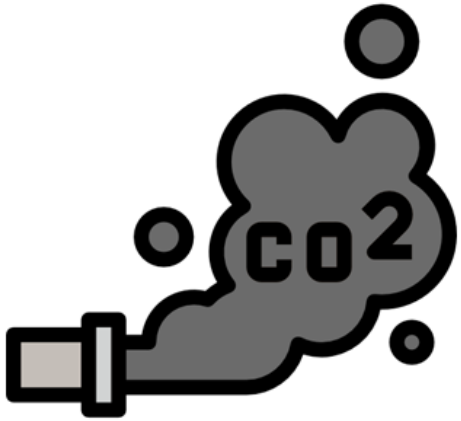
# Photovoltaic panels

**Benefits:**

- Energy production is done through modern, non-polluting technologies with the use of renewable energy sources;
- Reducing the dependence on energy produced by conventional technologies that use fossil fuels;
- The possibility to provide electricity for lighting, water pumps, cooling pumps, etc.;
- A positive impact on the environment;
- It can be used where there is no possibility of connection to the public energy network.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 2.4. GHG EMISSIONS REDUCTION




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# Cogeneration

**Benefits:**

- Optimize energy use and costs by up to 30%;
- Increase safety in power supply and reduce losses;
- Become independent from the power grid and from the fluctuations of the electricity costs;
- Reduce CO2 emissions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

## Remarks on Learning Unit 2

This leaning unit aims to provide trainees with:

- The fundamentals of energy conversion processes from fossils or renewable sources to thermal or/and mechanical energy;
- Competencies to identify energy efficiency solutions and handle their implementation in SMEs.

The LU will provide the **knowledge and skills** needed for trainees to carry out **energy audits** and implement their results in their SMEs:

- **Knowledge and skills:** Advanced knowledge and practical skills in identifying, implementing and evaluating energy efficiency solutions in SMEs buildings/facilities, based on the understanding of the underlying theory and principles of building physics and building energy management
- **Responsibility and autonomy:** Provide the technical background needed to carry out energy efficiency audits and implement their outcomes in the context of the SMEs

## References for Learning Unit 2

[1] *Directive 2012/27/EU* of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, *Official Journal of the European Union*, L 315, November 14th, 2012. (link)

[2] *Directive (EU) 2018/844* of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, *Official Journal of the European Union*, L 156, June 19th , 2018. (link)

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[4] W. Demtröder, *Mechanics and Thermodynamics*, ISBN: 978-3-319-27877-3, ed. Springer International Publishing, 2017.

[5] L. Brackney, A. Parker, D. Macumber, K. Benne: *Building Energy Modeling with OpenStudio*, ISBN: 978-3-319-77808-2, ed. Springer International Publishing, 2018.

# Learning Unit 3: Basics of Energy Surveys & Standards

## Introduction

| | |
|---|---|
| **AIM** | This Learning Unit (LU) describes the actual **energy audit** and management **standards in Europe**, together with the **procedure for energy audits** in **industrial SMEs**, including the fundaments of **energy assessment** and energy saving evaluation. |
| **ECTs STRUCTURE** | **1.0 ECTS credits**<br>10 Lecture hours (including 4 for testing impact of self-study)<br>10 Practice hours (including in presenting various energy measurement equipment)<br>10 Self-Study hours<br>**Total hours: 30** |
| **OBJECTIVES** | • Energy audit and management standards<br>• Necessary knowledge for preliminary in-house energy evaluation<br>• Methodology for developing energy audits<br>• Basic of energy consumption measurement and equipment<br>• How to use real energy database to forecast the energy demand and to evaluate contractual options with utility companies, in order to avoid various possible penalties and supplementary costs<br>• Understanding the potential of energy audits, and the benefits of economic and environmental aspects |
| **LEARTNING OUTCOMES** | • What to expect from an energy audit?<br>• Energy audit and management standards (e.g. EN 16247, ISO 50001, etc.)<br>• How to be prepared for a successful energy audit<br>• Understand the energy evaluation method for carrying out in-house preliminary energy audits<br>• Energy & Production data collection and basic energy analytics<br>• Evaluation of energy savings. Fundaments |
| **PREREQUISITES** | • Belonging to or collaborate with the **staff of an SME,** including (but not limited to) engineers, architects, energy or management professionals, qualified technicians.<br>• The E&T program will also be open to **other interested qualified individuals**: professionals, consultants, managers or anyone who want to gain further qualifications and could be a future SME employee<br>• Completing the learning units **LU1 and LU2** of the training course. |

## Content of Learning Unit 3

# CONTENT OUTLINE of LU3

**3.1. INTRODUCTION**

**3.2. ENERGY AUDITS**

**3.3. METHODOLOGY**

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# 3.1. INTRODUCTION

This lesson aims to answer the following questions:

**ENERGY AUDITS**

**What** is it?

What is its **purpose**?

**Who** should perform it?

Energy audit **target**?

What **contents** are required?

**How** do you do it?

[**Source:** https://grupodaboconsulting.com/certificados-de-eficiencia-energetica/]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 3.2. ENERGY AUDITS

## DEFINITION:

- Study, inspection and analysis of the energy consumption of a system to understand its dynamics and to look for opportunities to improve energy performance

## OBJECTIVES:

- Analyzing the energy flows in an installation
- Establish the most appropriate energy saving and efficiency strategies
- Evaluate and assess potential savings from a technical, economic and environmental point of view

## ENERGY AUDITOR :

- This is the person in charge of preparing a technical report, detailing the appropriate measures to carry out correct energy management
- Its main objective is to reduce energy consumption while maintaining the production needs of the company/facility to be audited
- The work of the energy auditor is reflected in the energy audits

[**Source:** https://gruposinelec.com/requisitos-para-ser-auditor-energetico/, https://www.tecpa.es/auditor-energetico/]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

## a) General data of the facility

a.1) Description of the **manufacturing plant**

a.2) General description of the **facilities**

a.3) **Production data** of the plant

a.4) Analysis of the **work activities hours** (work regime)

a.5) Production **cost structure**

[**Source**: https://tecnohotelnews.com/2015/10/05/10-pasos-para-hacer-una-auditoria-de-la-web-de-tu-hotel/ ]

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

a) General data of the facility

b) Sources of energy supply

c) Manufacturing processes

d) Energy analysis of the facility

e) Specific consumption and costs

f) Benchmarking

g) Evaluation of Benefits

h) Annexes

[**Source:** https://tecnohotelnews.com/2015/10/05/10-pasos-para-hacer-una-auditoria-de-la-web-de-tu-hotel/ ]

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

## a) General data of the facility

**a.1) Description of the manufacturing plant**

- ✓ Company name
- ✓ Autonomous Community
- ✓ Address
- ✓ Population
- ✓ Zip Code
- ✓ Province

- ✓ Address of the audited facility
- ✓ Autonomous Community
- ✓ Address
- ✓ Population
- ✓ Zip Code
- ✓ Province
- ✓ CNAE

**a.2) General description of the facilities**

- ✓ Description of the activities carried out at the facility
- ✓ Age of the facilities
- ✓ Number of employees

**a.3) Production data of the plant**

- ✓ Types of raw materials used and annual quantification
  - Production raw material (kg/year, pcs/year, m3/year, ...)
  - Water (m3/year)
  - Electricity (kWhe/year)
  - Fuels (kWht/year)
  - Other energy supplies (kWh/year)
- ✓ Types of products obtained and annual quantification

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

**b) Sources of energy supply**

b.1) **Power** energy

b.2) **Thermal** energy

b.3) **Other** sources

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | a) General data of the facility |
|---|---|
| **a.4) Analysis of the work activities hours (work regime)** | ✓ Work Shifts and schedules:<br>• Production (in its different sections)<br>• Offices<br>• Cleaning<br>✓ Seasonality of production<br>✓ Relationship between production and energy demand<br>✓ Dependence on the order book |
| **a.5) Production cost structure** | ✓ Raw material costs (%)<br>✓ Personnel costs (%)<br>✓ Cost of electricity, heat, water (%)<br>✓ Depreciation cost (%)<br>✓ Others (%) |

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | b) Sources of energy supply |
|---|---|
| **b.1) Power energy** | ✓ Description of the electricity delivery facilities:<br>• Delivery line characteristics (voltage, distribution)<br>• Characteristics of the transformer station<br>• Autoproduction - Cogeneration (if applicable)<br>✓ Annual electricity consumption (GWh/year) |
| **b.2) Thermal energy** | ✓ Description of thermal energy transformation facilities<br>✓ Type of fuel used:<br>• Fossil fuels<br>• Cogeneration / Heating distribution<br>• Cooling systems<br>✓ Annual fuel consumption<br>• In units of primary source (m3/year, kg/year, ...)<br>• In energy units (GWh/year) |
| **b.3) Other sources** | ✓ Renewable sources<br>✓ Storage<br>✓ Annual energy production |

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

**c) Manufacturing processes**

c.1) Description of the **Facilities** report

c.2) **Process** diagram

[**Source:** https://tecnohotelnews.com/2015/10/05/10-pasos-para-hacer-una-auditoria-de-la-web-de-tu-hotel/ ]

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | c) Manufacturing processes |
|---|---|
| **c.1) Description of the Facilities report** | ✓ Description of general service facilities:<br>• Cooling production and distribution<br>*Cold lines and characteristics (temperatures, coolant, configuration, elements and characteristics)*<br>• Heating production and distribution<br>*Heat lines and characteristics (temperatures, load bearing fluid, configuration, elements and characteristics)*<br>• Compressed air<br>*Configuration, number of compressors and characteristics, operating parameters*<br>• Exterior lighting<br>*Number, type and characteristics of outdoor lighting fixtures, description of installation, control elements*<br>• Interior Lighting<br>*Number, type and characteristics of luminaires per room, description of installation, control elements*<br>• Water treatment plant<br>*Configuration, characteristics, description of operations performed*<br>✓ Description of the different manufacturing lines, operations and equipment |
| **c.2) Process diagram** | ✓ Mass and energy flows, inputs and effluents |

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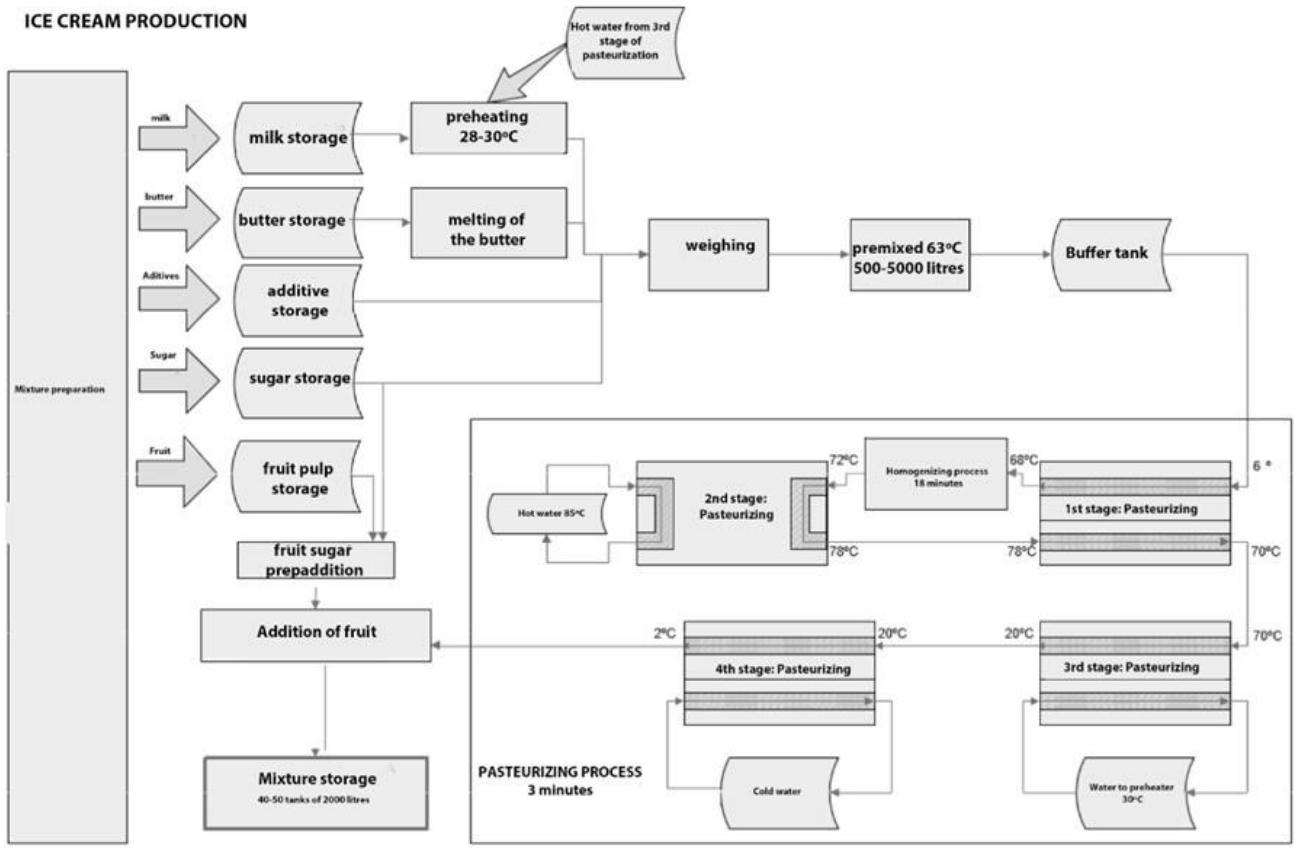
Process Diagram of ICE CREAM PRODUCTION

15. 51 – 01: Ice cream, milk and juice industry

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

**d) Energy Analysis**

d.1) Annual operating **energy consumption** of **main** production **activities**

d.2) Annual operating **energy consumption** of **ancillary** activities

d.3) **Environmental** Analysis

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

**d) Energy Analysis**

**d.1) Annual operating energy consumption of main production activities**

**PRODUCTION METHODS**

Tables and graphs:

- Annual electricity consumption (MWh/year)
- Annual thermal consumption by source (MWh/year)
- Annual water consumption (m3/year)

**d.2) Annual operating energy consumption of ancillary activities**

**GENERAL SERVICES**

Tables and graphs:

- Annual electricity consumption (MWh/year)
- Annual thermal consumption by source (MWh/year)
- Annual water consumption (m3/year)

**d.3) Environmental Analysis**

- ✓ Combustion analysis
  *$O_2$ (%); $CO_2$ (%); CO (ppm); Smoke Temperature (ºC); Combustion performance (%)*
- ✓ Waste treatment plants
  *Packaging; Waste; Discharges; Water*

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# 3.2. ENERGY AUDITS

## MINIMUM CONTENTS

## e) Specific energy consumption and costs

e.1) Specific **energy consumption** in the **site**

e.2) Specific **energy consumption** per **process**

e.3) **Energy costs** of the **site**.

e.4) Specific **energy costs** in the **site**.

e.5) **Process**-specific **energy costs**

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | e) Specific energy consumption and costs |
|---|---|
| **e.1) Specific energy consumption in the site** | ✓ Consumption per unit of product **IN THE SITE**:<br>• Specific electricity consumption<br>• Specific thermal consumption |
| **e.2) Specific energy consumption per process** | ✓ Consumption per unit of product **PER PROCESS**:<br>• Specific electricity consumption<br>• Specific thermal consumption |
| **e.3) Energy costs of the site.** | ✓ Monthly costs of:<br>• Electricity<br>• Thermal energy<br>✓ Actual Energy supply contracts<br>✓ Optimisation of the electricity contract |

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | e) Specific energy consumption and costs |
|---|---|
| **e.4) Specific energy costs in the site.** | ✓ Costs per product unit **IN THE SITE**:<br>• Specific electricity cost<br>• Specific thermal cost |
| **e.5) Process-specific energy costs** | ✓ Costs per product unit **PER PROCESS**:<br>• Specific electricity cost<br>• Specific thermal cost |

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS** | **f) Benchmarking (reference)**

f.1) **Situation** of the manufacturing sector at the **National** and **Europe** scale.

f.2) **Position** of the site among others in its sector

f.3) **Comparison** with the consumption of other sites in the sector

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | f) Benchmarking (reference) |
|---|---|
| **f.1) Situation of the manufacturing sector at the National and Europe scale.** | ✓ Analyse the economic sector and its emergy context.<br>✓ Analyse the situation of the company in the economic sector |
| **f.2) Position of the site among others in its sector** | ✓ Analyse the position of the company in the sector based on:<br>• Production<br>• Billing<br>• Employees<br>• Others |
| **f.3) Comparison with the consumption of other sites in the sector** | ✓ Carrying out sector studies and making a comparison in terms of:<br>• Total specific consumption<br>• Total specific costs |

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS**

**g) Evaluation of Benefits**

g.1) Energy **efficiency actions**

g.2) **Energy saving**

g.3) **Energy costs** savings

g.4) Other benefits: **Environmental**.

g.5) **Investments** and **economic** returns

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# 3.2. ENERGY AUDITS

| MINIMUM CONTENTS | g) Evaluation of Benefits |
|---|---|
| **g.1) Energy efficiency actions** | ✓ For each improvement detected, indicate:<br>• Description<br>• Benefits and advantages<br>• Area of application |
| **g.2) Energy saving** | ✓ For each measurement made, indicate:<br>• Energy savings (kWh/year) |
| **g.3) Energy costs savings** | ✓ For each measurement made, indicate:<br>• Savings in energy costs (€/year) |
| **g.4) Other benefits: Environmental.** | ✓ For each measurement made, indicate:<br>• Savings in $CO_2$ emissions (ton $CO_2$ /year) |
| **g.5) Investments and economic returns** | ✓ For each measurement made, indicate:<br>• Investment<br>• Return period (Pay back) |

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# 3.2. ENERGY AUDITS

## MINIMUM CONTENTS

## g) Evaluation of Benefits

g.1) Energy **efficiency actions**

g.2) **Energy saving**

g.3) **Energy costs** savings

g.4) Other benefits: **Environmental**.

g.5) **Investments** and **economic** returns

COLLECT INFORMATION IN A SUMMARY TABLE OF PROPOSED MEASURES

| Proposed actions | SAVINGS | | | | | | Investment cost [€] | Payback [year] | Emissions reduction [$CO_2$ ton/year] |
|---|---|---|---|---|---|---|---|---|---|
| | End-use energy [kWh/year] | | Final consumption [$m^3$/year] | Total End-use energy | | Annual financial [€] | | | |
| | Electric | Heat | Water | [kWh/year] | [tep/year] | | | | |
| Measure1 | | | | | | | | | |
| Measure2 | | | | | | | | | |
| ... | | | | | | | | | |
| ... | | | | | | | | | |
| Measuren | | | | | | | | | |

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# 3.2. ENERGY AUDITS

**MINIMUM CONTENTS** | **h) Annexes**

- ✓ Supporting **technical documentation** should be included in the **annexes**, such as:
  - Energy bills (last years)
  - Measurements made

    *Equipment used, data obtained, duration of campaigns, ...*
  - Load curves per day type
  - Technical drawings
  - ...

- ✓ **Administrative Documentation** for the corresponding Authority

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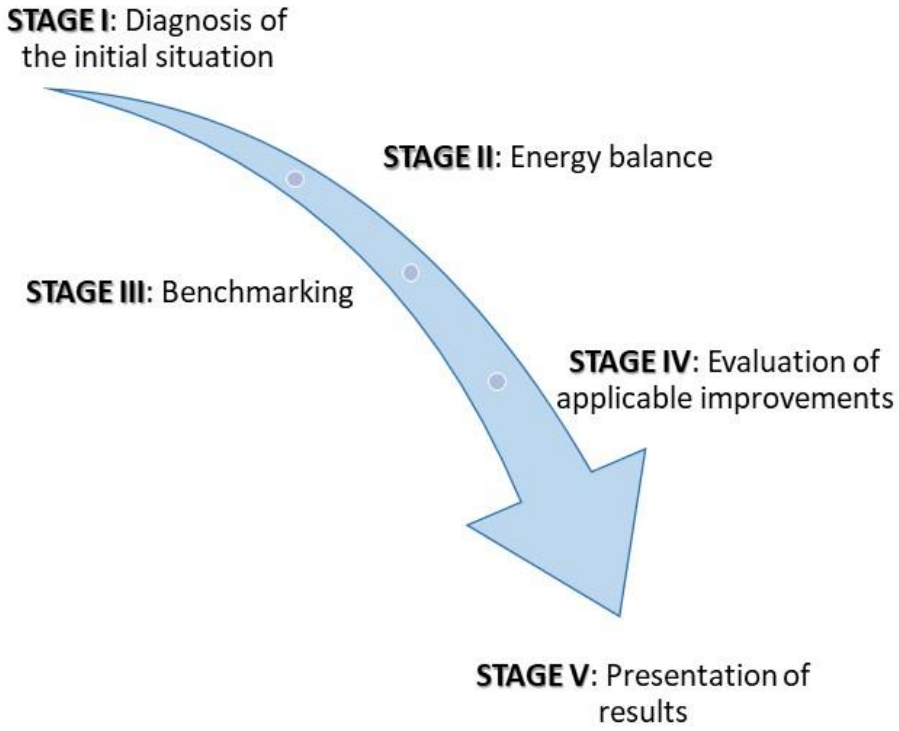
# 3.3. METHODOLOGY

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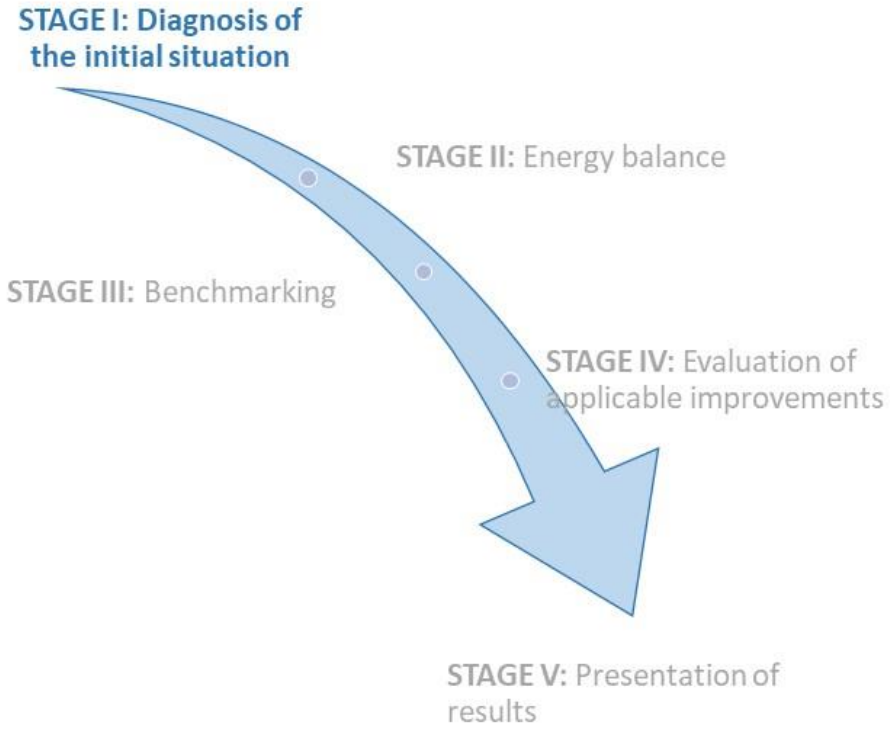


## STAGE I: Diagnosis of the initial situation

a) Data Collection and Documentation gathering
b) Visit to the facilities
   - *Pre-analysis of the information received*
   - *Preparation of the questionnaire*
   - *Conducting the interview*
c) Collecting on-site data measurements
d) Initial assessment of the facilities

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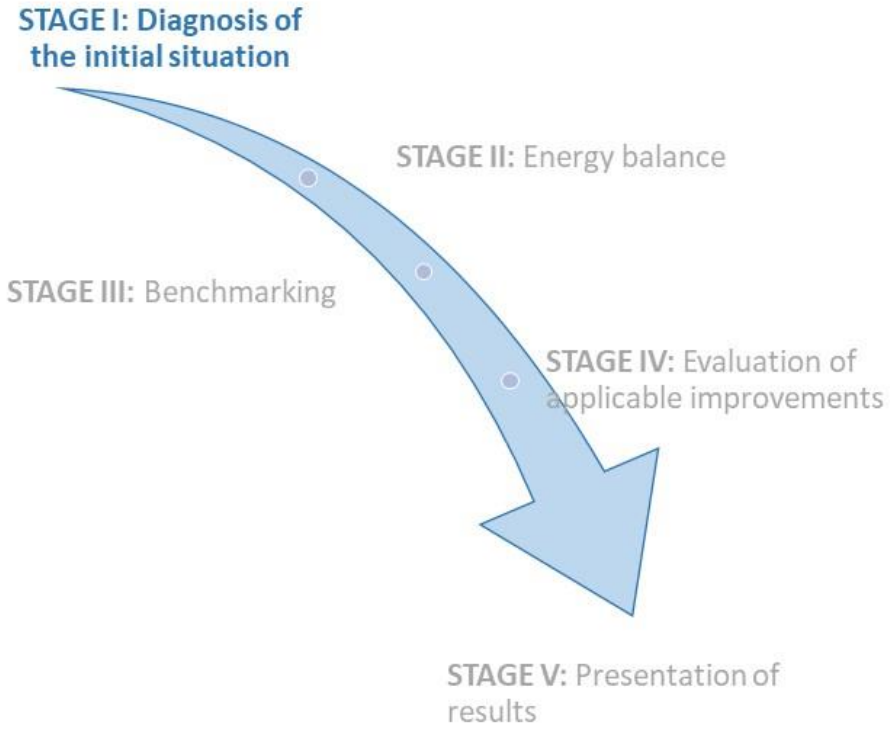


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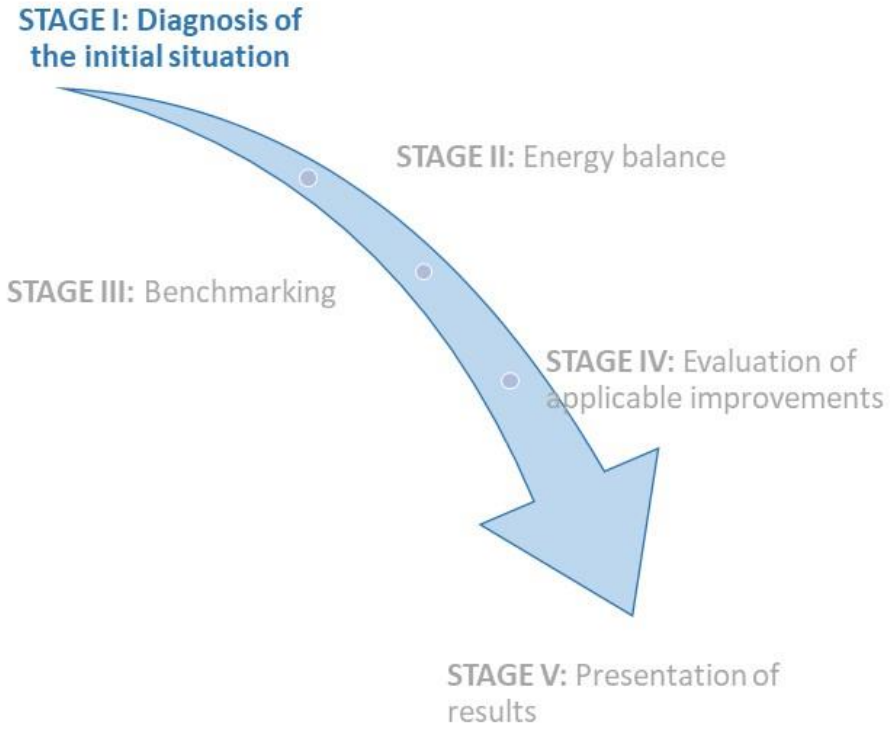


**a) Data Collection and Documentation gathering**

- ✓ Data required for pre-evaluation
- ✓ Accessible, if possible, before the visit
- ✓ Useful for preparing the interview
  - *Monthly consumption and costs (electric and thermal)*
  - *Monthly production for the last year*
  - *Electrical contract during the last year and current contract*
  - *Quarter-hour electrical curve in computer support, last year*
  - *Cost structure*
  - *Floor drawings and diagrams of the plant to be audited*
  - *Auxiliary diagrams, with the location of possible existing meters*

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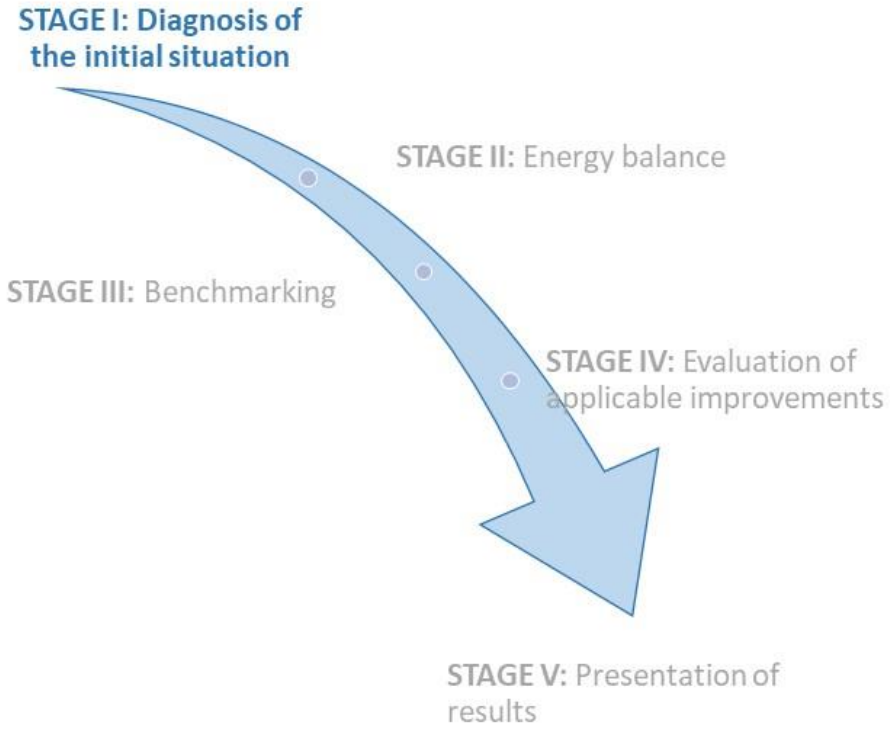


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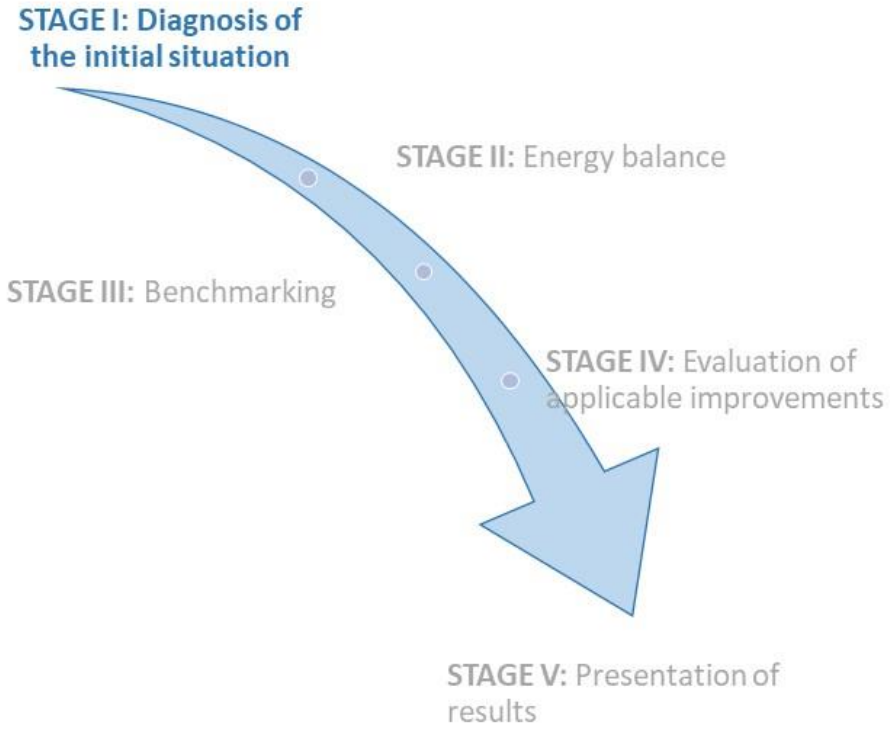


**a) Visit to the facilities**

**Pre-analysis of the information received**

- ✓ Detecting information gaps to be addressed
- ✓ Evaluate the size of the company (consumption and production)
- ✓ Evaluation of previous specific consumption
  - *Production rate (kWh/unit of production)*
  - *Cost Ratio (EUR/unit of output)*
  - *Comparison with consumers in your sector*
- ✓ Evaluate energy consumption profiles
  - *Seasonality*
  - *Time Discrimination*
  - *Stability of consumption*
- ✓ Costs: the importance of energy costs

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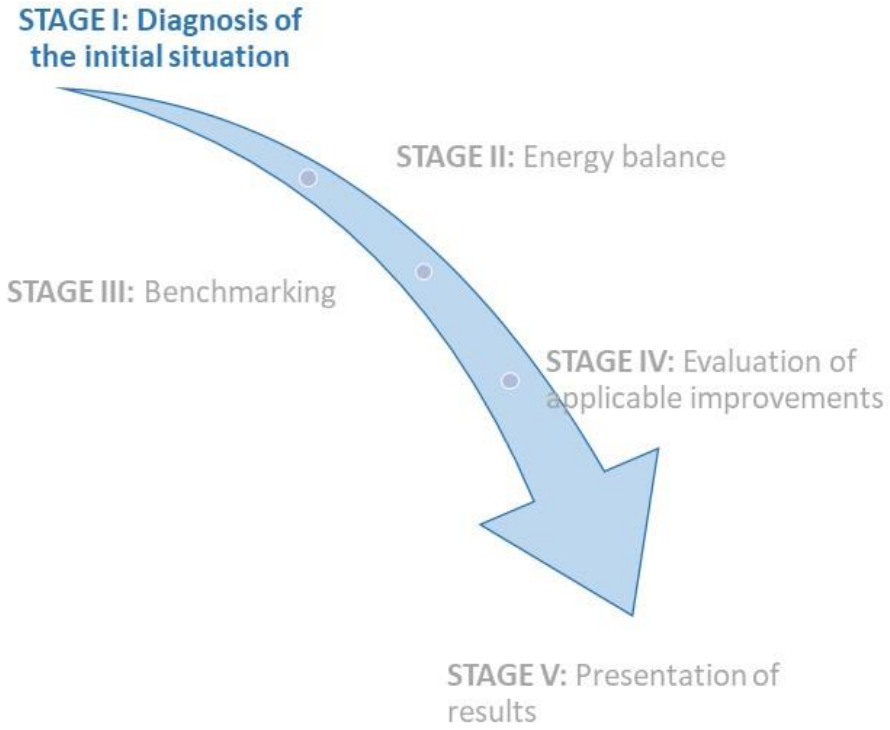


a) **Visit to the facilities**

**Preparation of the questionnaire**

**QUESTIONNAIRE:**

- ✓ Formalized the structure for gathering information
- ✓ Prepare specific questions to gather useful

**TYPES OF QUESTIONS :**

- ✓ Open - The answer is not pre-defined
  - *E.g. How does seasonality influence your production?*
- ✓ Closed - The answer is chosen from several defined
  - *E.g. How many hourly discrimination periods does your electricity contract have? 1, 2, 3 or 6*
- ✓ Semi-open - The answer is closed with an open item
  - *E.g. Indicate which of the following are sources of energy supply*

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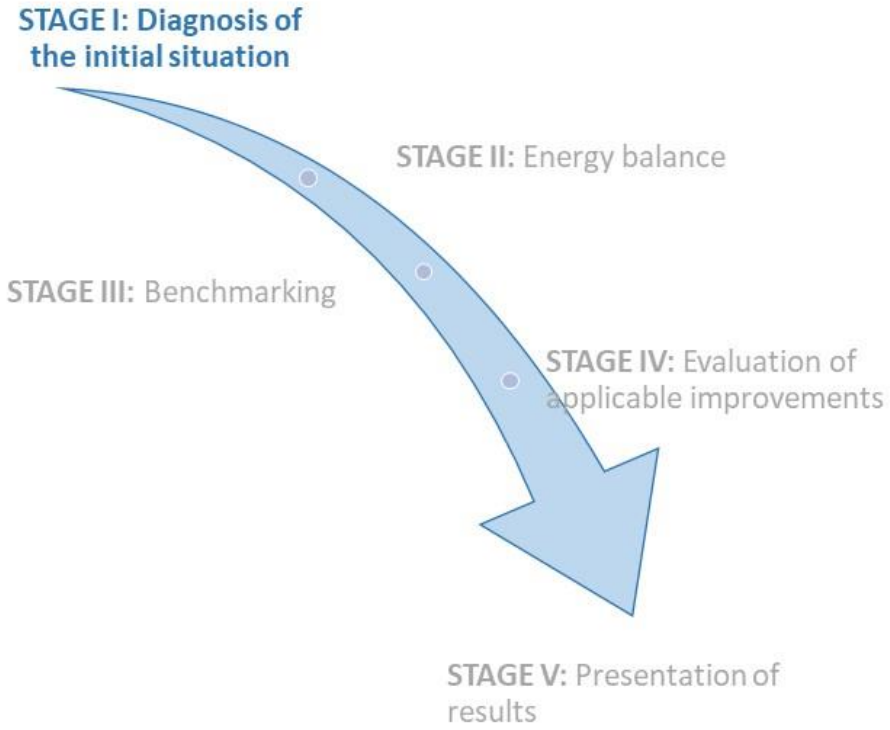


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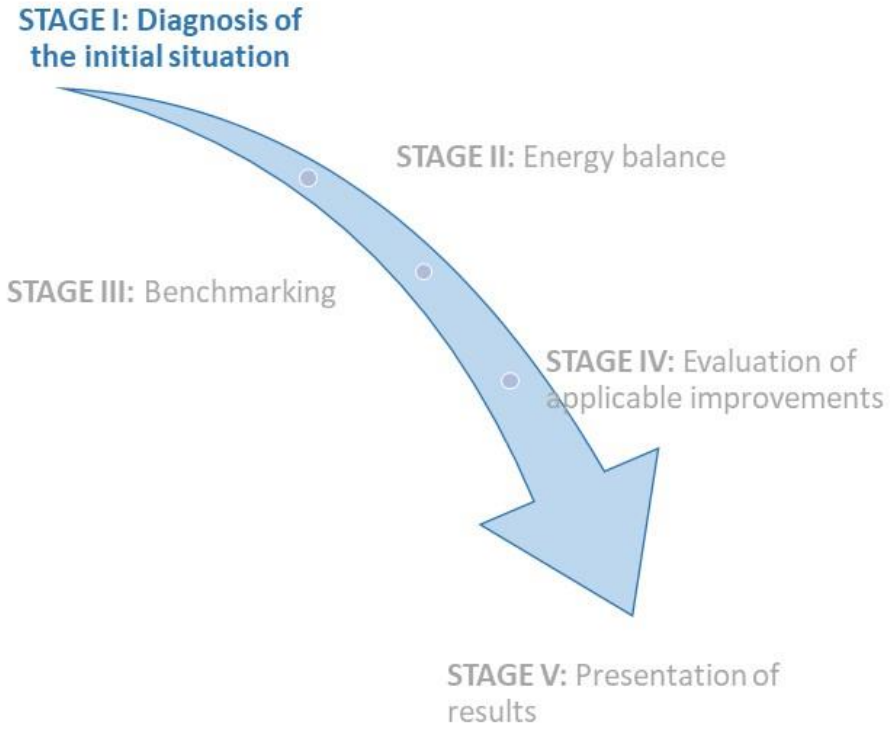


c) **Collecting on-site data measurements**

**Preparation data acquisition**

**DATA ADQUISTION:**

- ✓ Variables: Identify key parameters that need to be measured
- ✓ Time: Define the data collection period as well as the frequency of the data collection.
- ✓ Meters: Identify the best location for the meters

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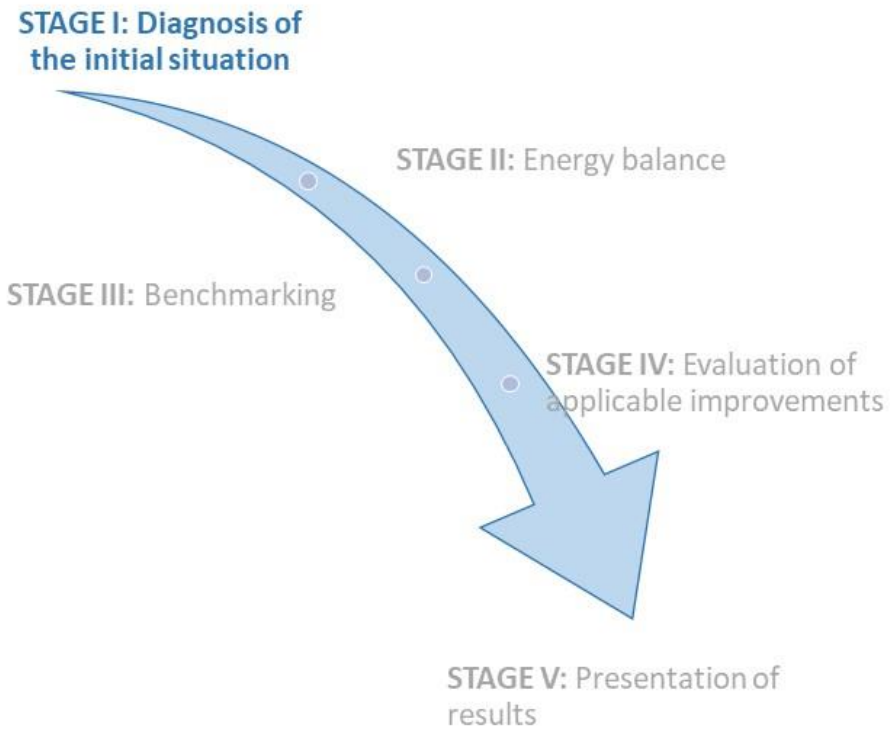


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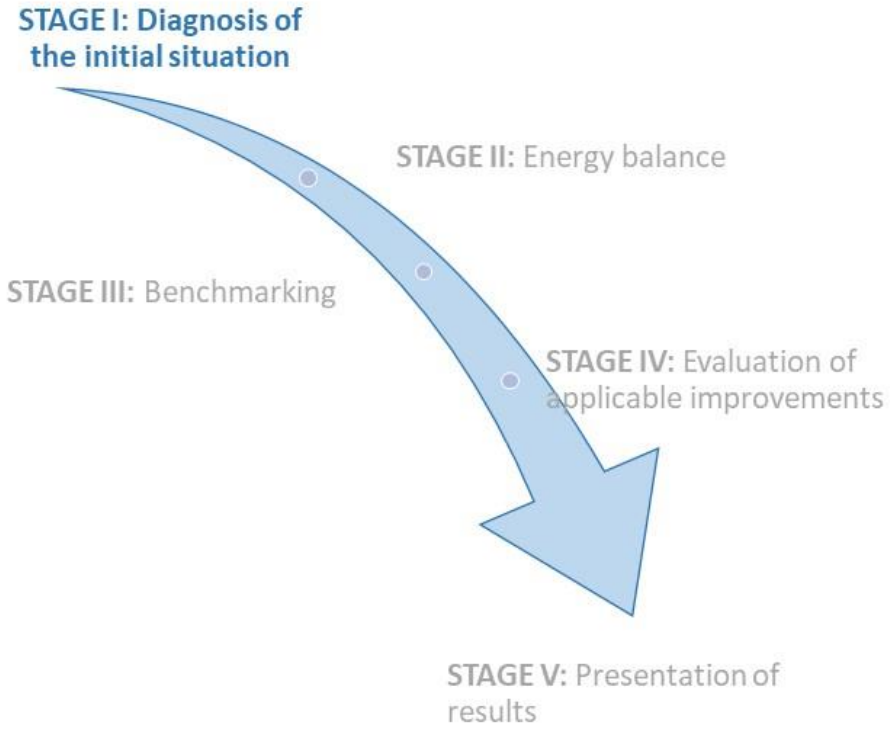


**d) Initial assessment of the facilities :**

- ✓ Evaluation of available information

  *Is there enough information; is the information consistent? Validation*

**ENERGY PRE-DIAGNOSIS:**

- ✓ Energy balance and preliminary matter balance
- ✓ Process diagram
- ✓ Initial assessment of possible savings measures to be implemented
  - *Standard Sizes*
  - *Special measures*
- ✓ Conclusion: Additional information will be needed

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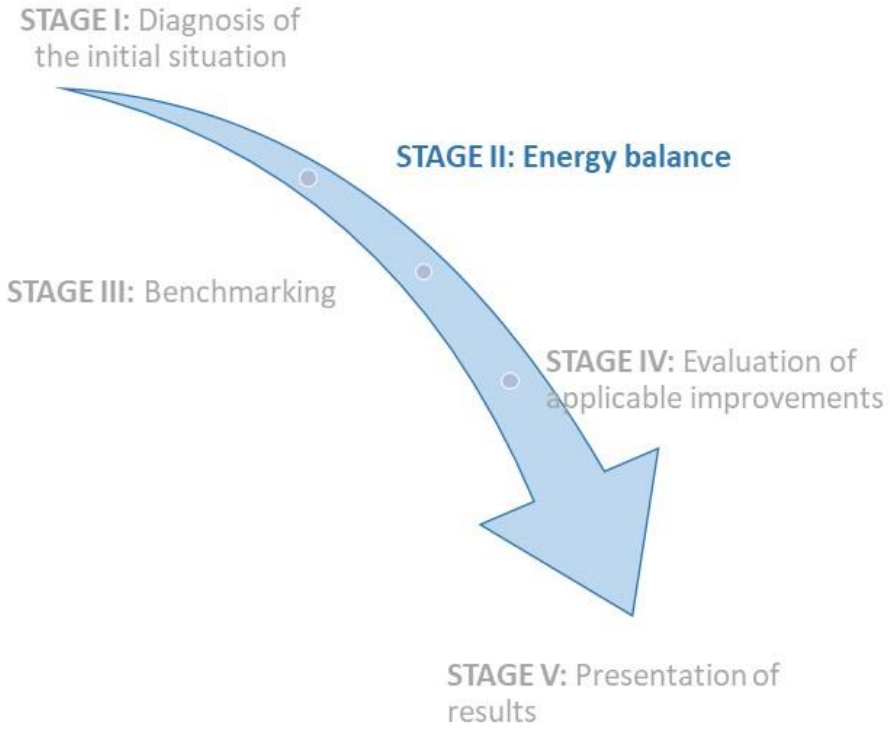


## STAGE II: Energy balance

a) Objectives and usefulness

b) Stages

1. *Detailed production analysis*
2. *Detailed analysis of energy consumption*
3. *Calculation of specific consumption and costs*

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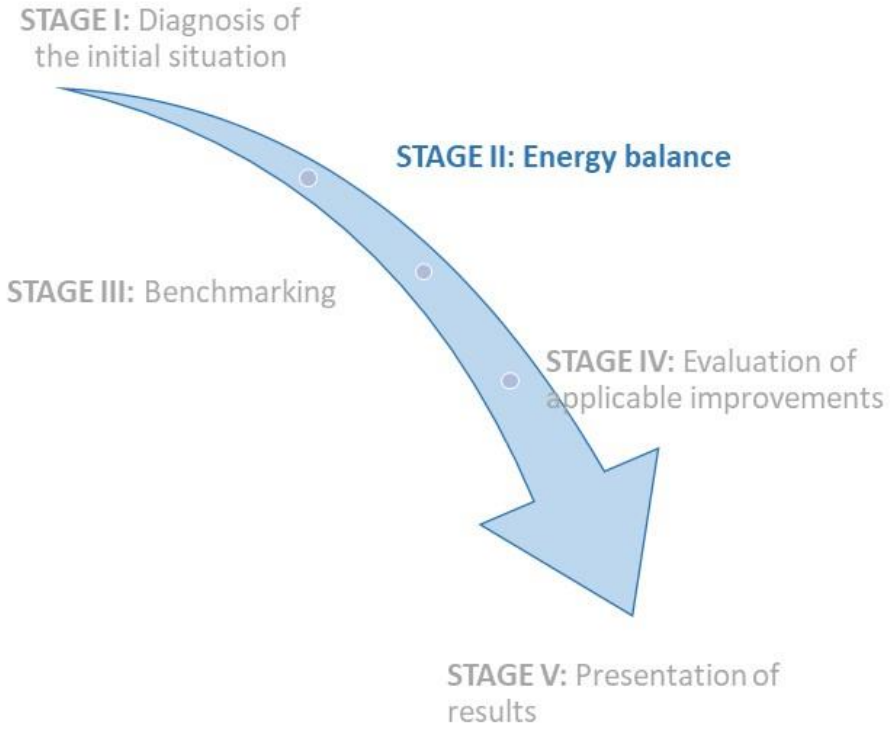


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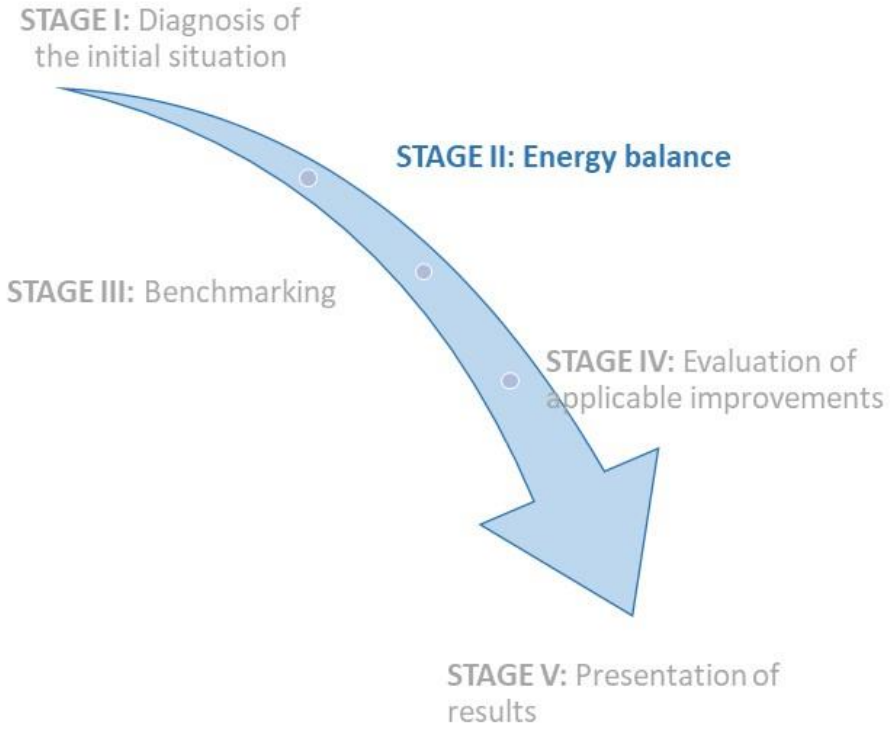


a) **Objectives and usefulness**

**OBJECTIVES:**

- ✓ Calculate the energy cost of the products obtained
- ✓ Calculate the economic cost of the products obtained

**USEFULNESS:**

- ✓ Allocate energy costs to end products
- ✓ Compare energetically plants or processes that carry out the same activity

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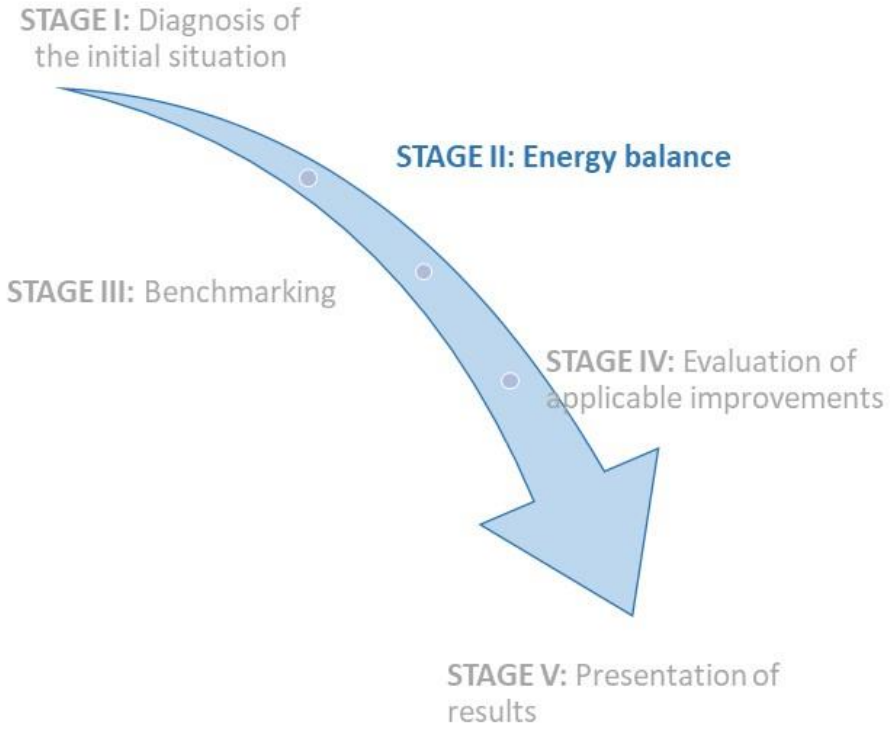


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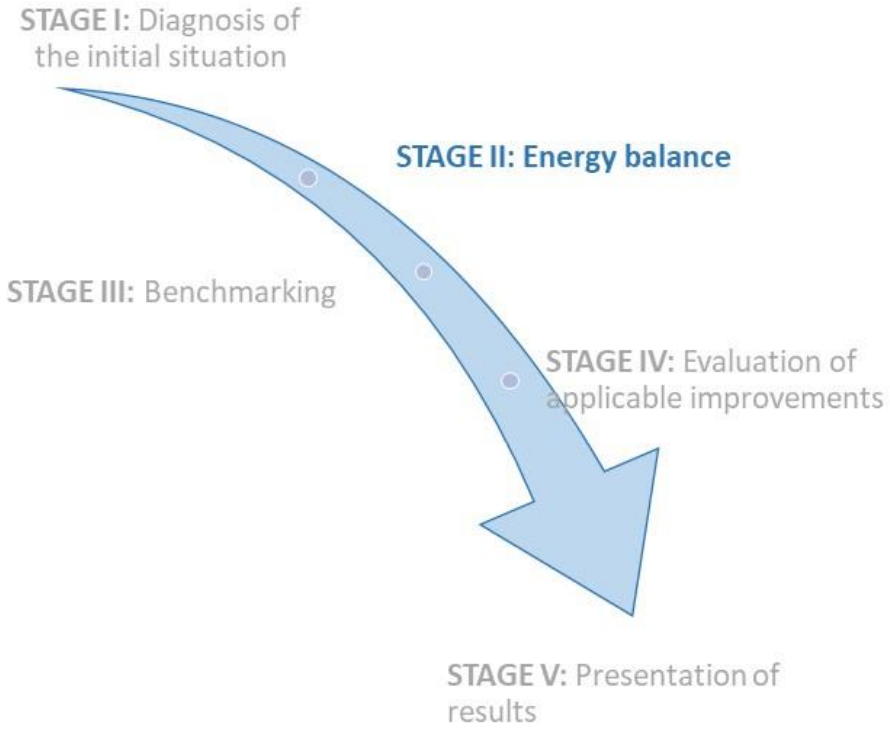


b) **Stages**

1. ***Detailed production analysis***

- ✓ Identify the final products of the manufacturing plant
- ✓ Set the units to be used

  *In service and commercial buildings: $m^2$*

  *In industry, production units (unit, ton, kg, $m^3$, ...)*

  *, ...*

  *Combinations $m^2$ / guest in hotels*

- ✓ Quantify the manufactuing production of the plant

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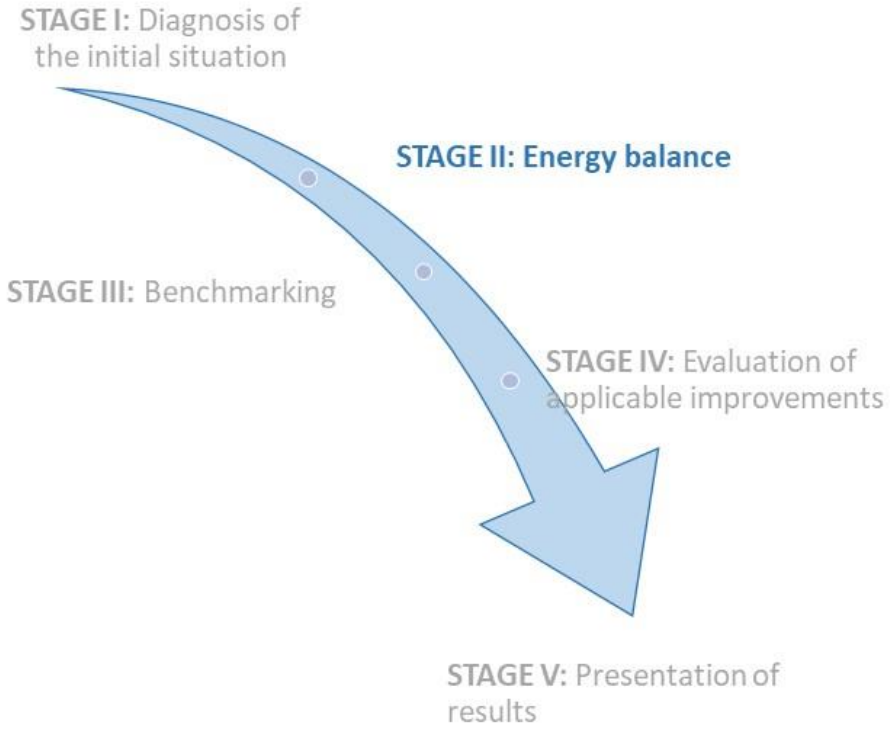
# 3.3. METHODOLOGY




b) Stages

*2. Detailed analysis of energy consumption*

STEP 1: Total consumption by process

- ✓ Data and measurements
- ✓ Theoretical calculations

STEP 2: Assigning processes to the final product

Different options depending on the product:

- ✓ Distribution by direct assignment
- ✓ Breakdown by production line
- ✓ Distribution by weight/ number of pieces

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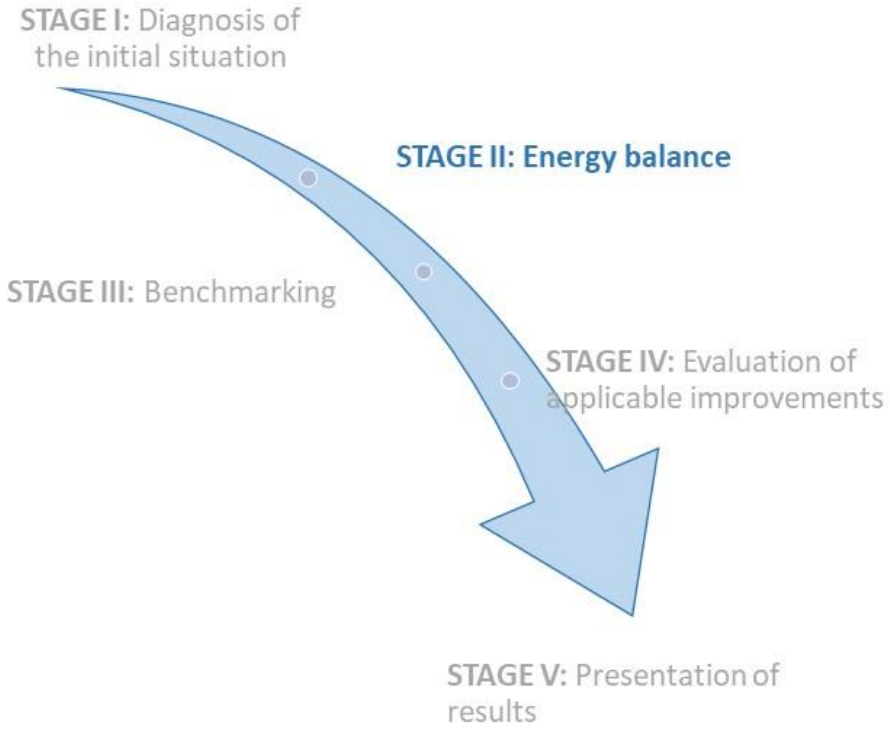
# 3.3. METHODOLOGY




**b) Stages**

***3. Calculate specific consumption and costs***

STEP 1: Calculate the total consumption of each of the processes assigned to each product

STEP 2: Calculate the total cost of each process assigned to each product

STEP 3: Calculate specific consumption and costs by dividing the above tables by the final production of each product type

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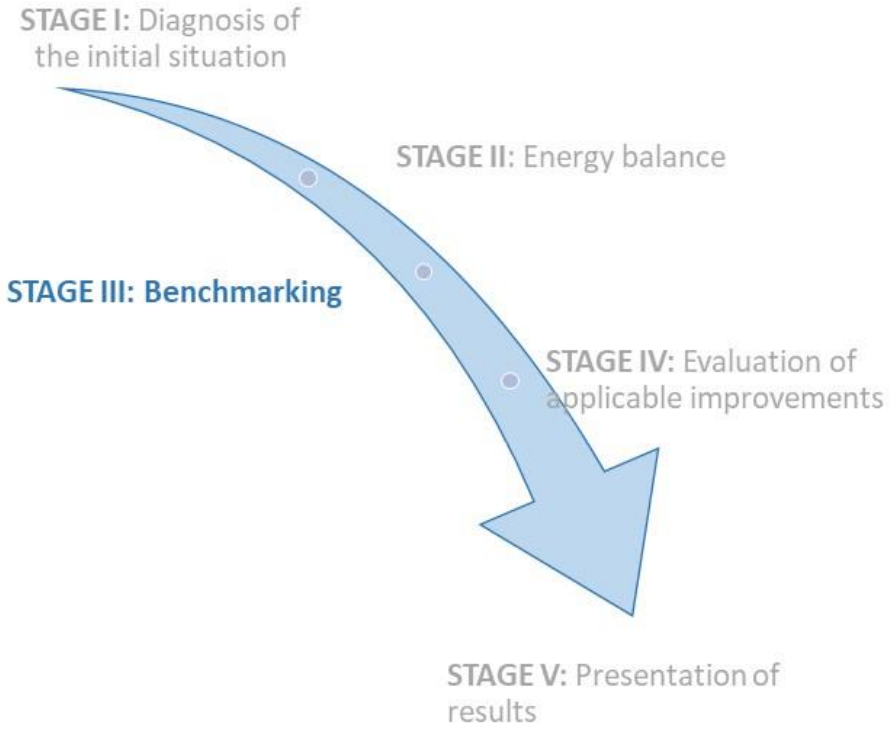
# 3.3. METHODOLOGY




## STAGE III: Benchmarking

a) Analyse the situation of the energy consumer within its economic activity sector.

b) Comparison of consumption and specific costs

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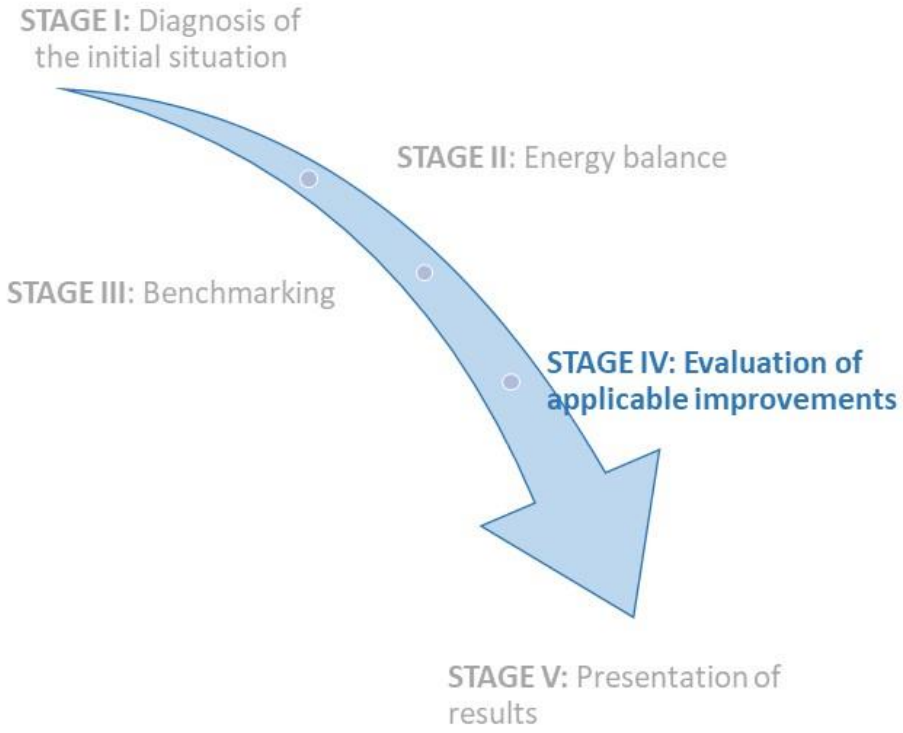
# 3.3. METHODOLOGY




## STAGE IV: Evaluation of applicable improvements

a) Analysis of potential energy improvements
b) Power Contract optimization
c) Technical, economic and environmental assessment

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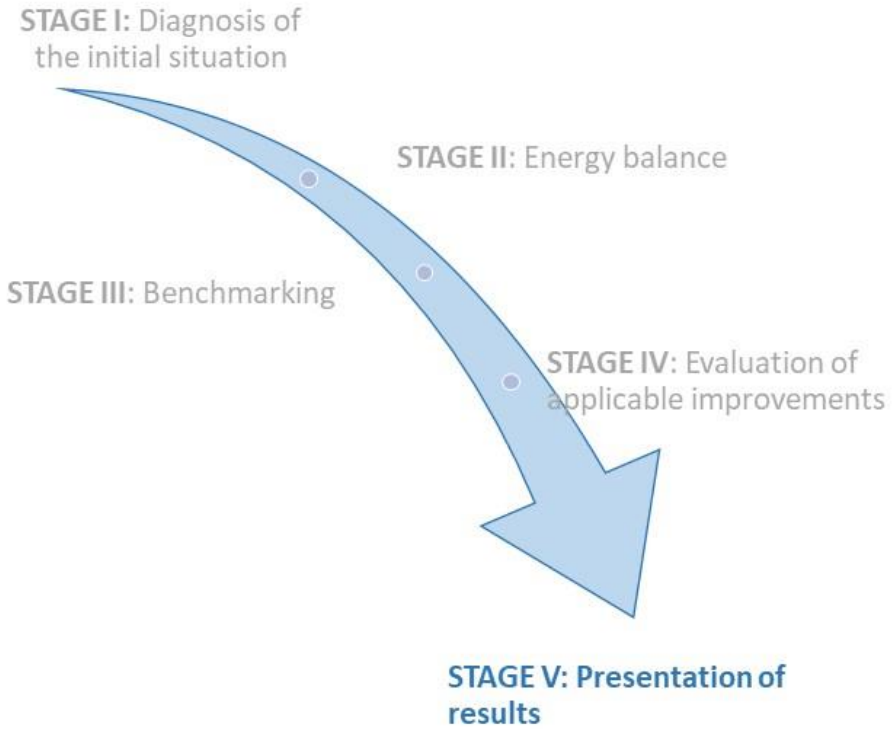
# 3.3. METHODOLOGY




## STAGE V: Presentation of results

- Writing the final report highlight the main outcomes.
- Rank the potential energy efficiency measures by:
  - No investment required
  - Minor investment
  - Major investment

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## Remarks on Learning Unit 3

This lesson aims to answer the following questions:

## References for Learning Unit 3

**Additional reading materials:**

[1] F. Kreith, D. Yogi Goswami: *Handbook of Energy Efficiency and Renewable Energy*, ISBN: 978-0-8493-1730-9, ed. CRC Press, 2007.

[2] *ISO 50001*: "Energy Management Systems - Requirements with guidance for use", International Organization for Standardization, 2018. (link)

[3] ***SPEEDIER – SME Program for Energy Efficiency through Delivery and Implementation of EneRgy Audits*, Horizont 2020 research and innovation programme under grant agreement No. 847034, project webpage (link)

[4] ***EUREMnext – Taking European EnergyManagers to next efficiency levels by implementing energy audit recommendations*, Horizont 2020 research and innovation programme under grant agreement No. 785032, project webpage (link)

[5] ***MEnS - Meeting of Energy professional Skills. Provide and enhance the NZEB Skills of Builiding Managers*, Horizont 2020 research and innovation programme under grant agreement No. 649773, project webpage (link)

[6] ***USE Efficiency - Universities and Students for Energy Efficiency*, Intelligent Energy Europe project IEE/08/526/SI2.528395, project webpage (link)

[7] ***ASSET – Learning Community & Ecosystem that Offers Educational Services in Energy Transition*, Horizont 2020 research and innovation programme under grant agreement No. 837854 (link)

# Learning Unit 4: Tools for Monitoring and Managing Energy

## Introduction

| | |
|---|---|
| **AIM** | • Advance and effective tools, techniques, and concepts in monitoring & targeting (M&T) and measurement & verification (M&V), according to IPMVP for Energy Savings and Renewable Energy: |
| **ECTs STRUCTURE** | **1.0 ECTS credits**<br>10 Lecture hours (including testing impact of self-study)<br>10 Practice hours (testing of M&T and M&V tools)<br>10 Self-study hours (proposal preparation for improvement of energy management in own company)<br>**Total hours: 30** |
| **OBJECTIVES** | • Energy measurements;<br>• Concept and basic knowledge on M&T;<br>• Tools for M&T: presentation and demonstration (or case study);<br>• Concept and basic knowledge on M&V;<br>• Tools for M&V: presentation and demonstration (or case study);<br>• General presentation of IPMVP; international experience |
| **LEARTNING OUTCOME** | • Tools for energy monitoring and measurement;<br>• Day by day in-house energy consumption/generation analysis;<br>• How to identify EE and RES opportunities using the M&T and M&V tools;<br>• How to evaluate energy savings after implementing EE and RES |
| **PREREQUISITES** | • Preparation of short reports on existing energy measurement equipment in course participants own installations. |

## Contents of Learning Unit 4

# CONTENT OUTLINE of LU4

**4.1. INTRODUCTION**

**4.2. FIRST STEPS**

**4.3. ENERGY ANALYTICS TOOLS**

**4.4. FACTS & FIGURES**

**4.5. CONCLUSIONS**

Source: Capstone turbines world application

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 4.1. Introduction

**What's in for the participants**:

- Day by day energy in-house energy analysis in SMEs;
- Tools for energy monitoring;
- How to identify EE and RES opportunities using the M&T and M&V tools;
- How to evaluate energy savings after implementing EE and RES.

**Source**: AEE – Certified Energy Manager training materials

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# 4.1. Introduction – continued

**Aim of the learning unit:**

Advance and effective tools, techniques and concepts in monitoring & targeting (M&T) and measurement & verification (M&V), according to IPMVP for Energy Savings and Renewable Energy:

- ✓ Energy measurements;
- ✓ Concept and basic knowledge on M&T;
- ✓ Tools for M&T: presentation and demonstration (or case study);
- ✓ Concept and basic knowledge on M&V;
- ✓ Tools for M&V: presentation and demonstration (or case study);
- ✓ General presentation of IPMVP; international experience.

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# 4.1. Introduction – continued

**Facts and figures regarding before getting into energy analytics**:

- How to put together energy & production / facility data;
- Preliminary energy evaluation;
- Inventories of energy users;
- Energy balance sheets;
- ISO 50001 Energy Management system.

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# Aim of the LU

Learning Objectives & Contents

Awareness of:

- How to start an energy efficiency project into an SME;
- Energy evaluation objectives / steps / expected results;

Ability to:

- Apply basic M&T and M&V tools.

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# 4.2. First steps

When developing an energy efficiency project on an SME…

- Designate a project team

- Top management must provide support for:
  1. Setting goals and getting inter-company in team work;
  2. Collecting production & energy use and cost data;
  3. Ensure financial resources to implement the most cost-effective solutions as well as behavior change etc.

**Source**: AEE – Certified Energy Manager training materials

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# 4.2. First steps – continued

Before getting into energy analytics and audit / management tools…

Start with a question in the decision making level:

Why your SME is interested in energy efficiency?

- Are energy invoices perceived as high?
- New public authorities programs or regulations?
- Business requirements?
- …

**Source:** AEE – Certified Energy Manager training materials

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847132

# 4.2. First steps – continued

For the implementation of an energy efficiency project:

- The highest effort consists in the energy audit well defined objectives, so as to identify and implement feasible measures and solutions;

- The objectives should focus on:
  - Waste elimination as a priority and first step;
  - Low-risk energy efficiency actions as a second step;
  - High impact conservation actions before high capital investment projects.

**Source:** AEE – Certified Energy Manager training materials

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# 4.2. First steps – continued

Energy users in an SME facility – industrial site or building

- HVAC for indoor conditioning
- Indoor / outdoor lighting
- Building Automation
- Hot water boilers
- Steam generation
- Compressed Air
- Motors for Pumps, Ventilation, Hydraulics
- Refrigeration
- Local generation – RES, CHP
- Data Centers
- Elevators
- Building Envelope
- Plug Loads etc.

**Source:** AEE – Certified Energy Manager training materials

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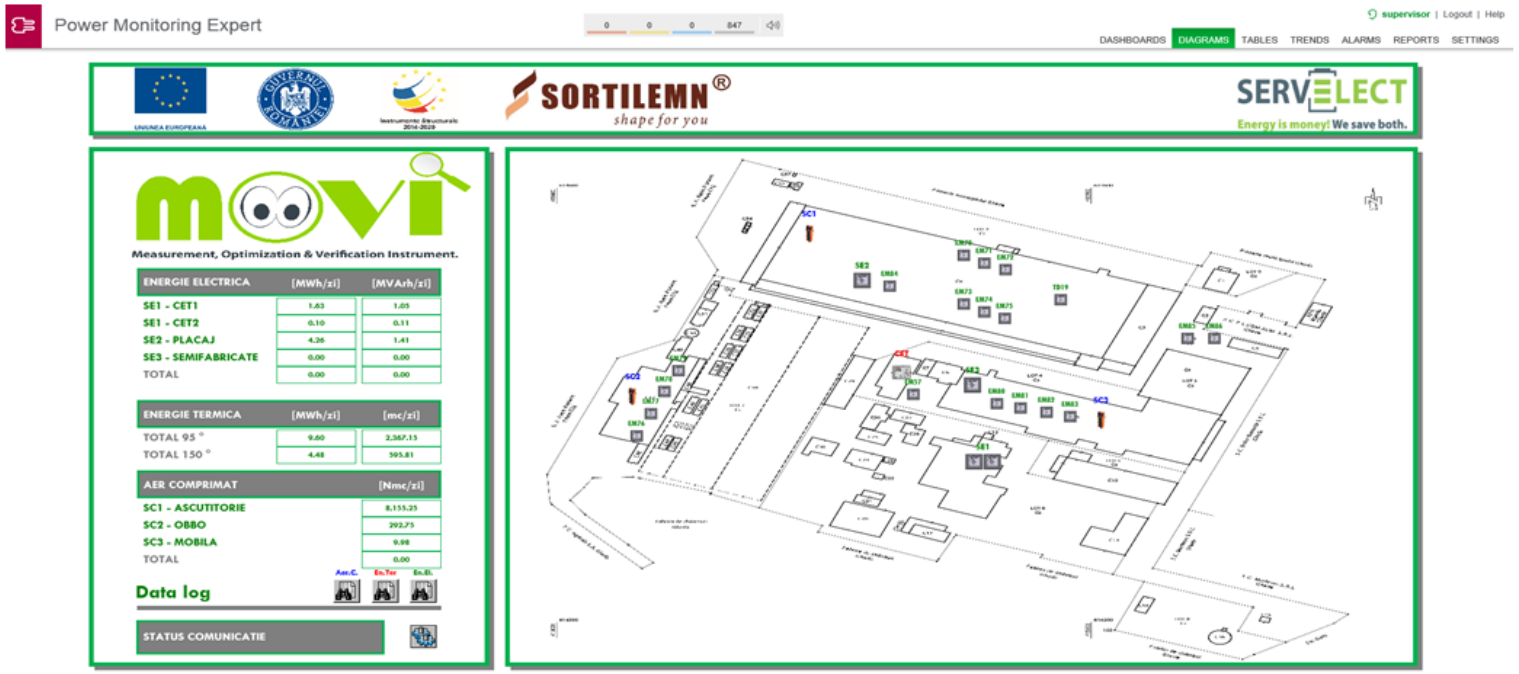
# 4.2. First steps – continued

If there is an energy monitoring system, get into its details:




**Source:** Energy Monitoring System in an wood plant – SME

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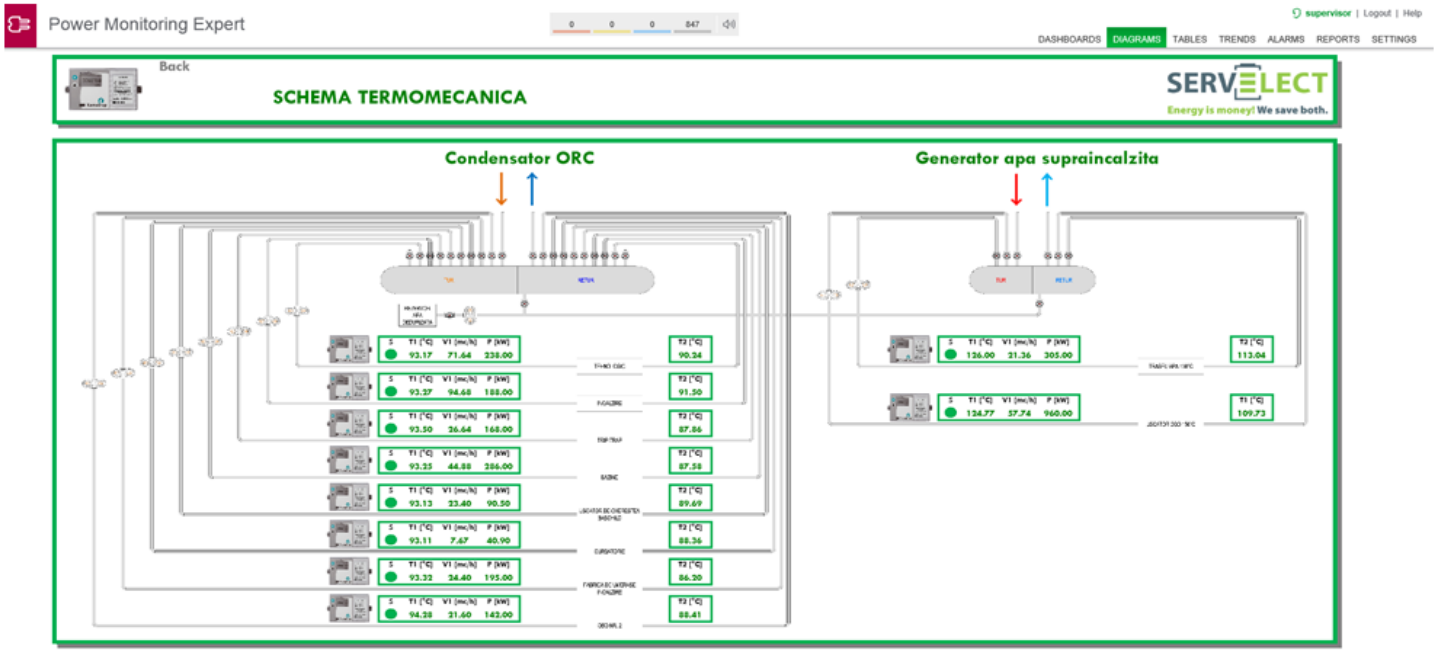
# 4.2. First steps – continued

Understand which are the main energy flows:




**Source:** Energy Monitoring System in an wood plant – SME

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# 4.2. First steps – continued

Identify the load profiles and data segmentation:

**Source:** Energy Monitoring System in an wood plant – SME

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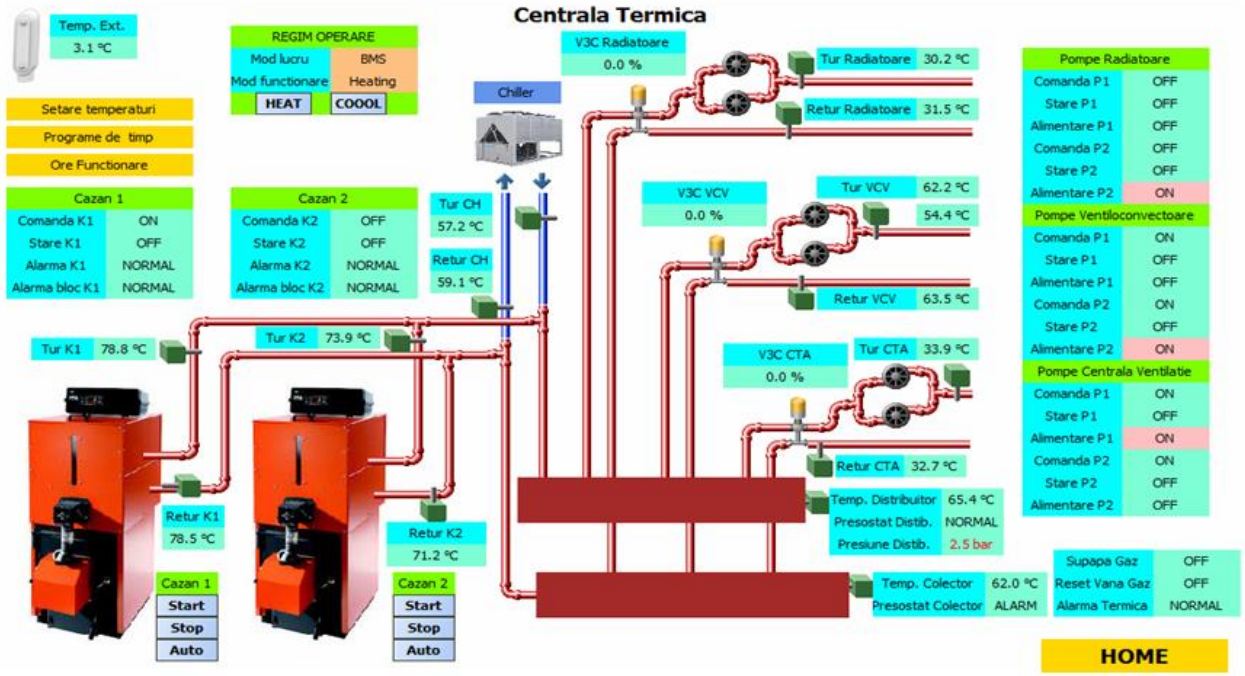
# 4.2. First steps – continued

Get used with the Building Energy Monitoring System – BEMS:




**Source:** BEMS in a research public building

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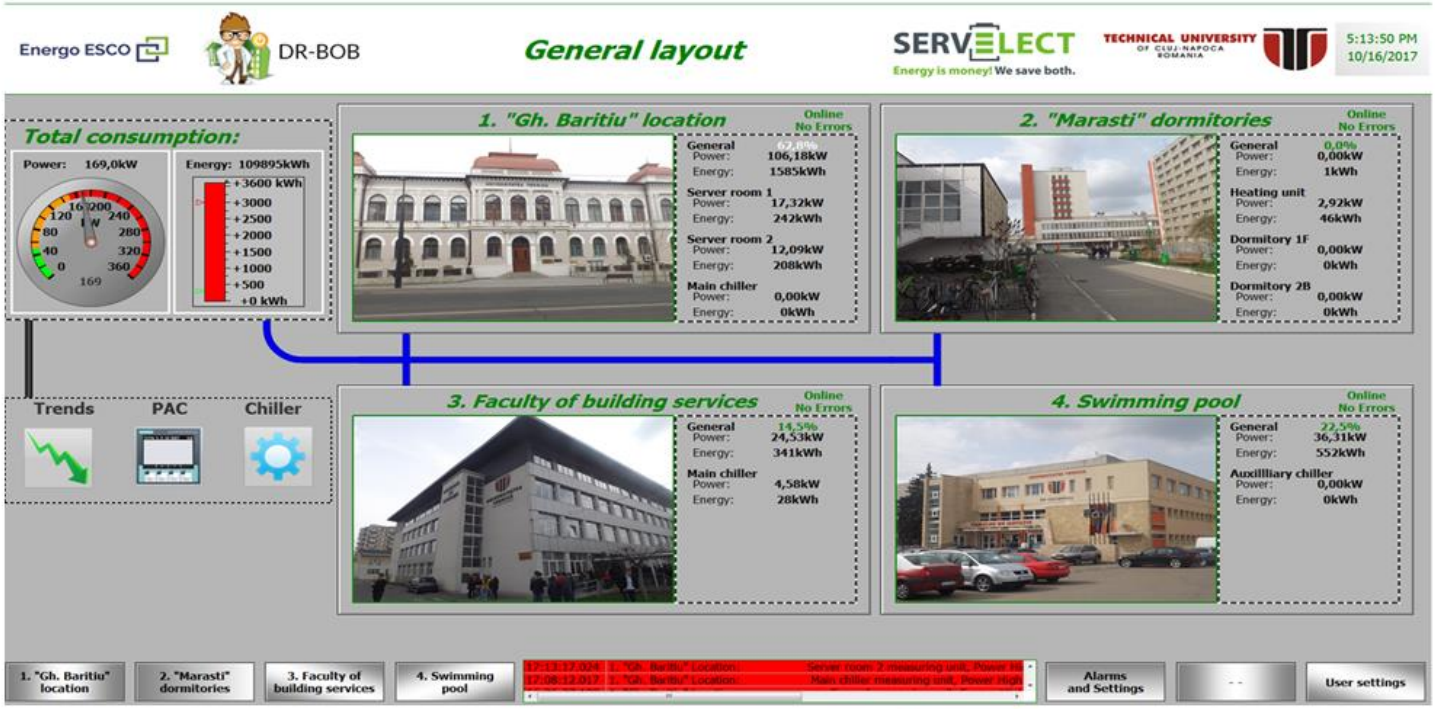
# 4.2. First steps – continued

Get used with the Building Energy Monitoring System – BEMS:




**Source:** BEMS in TUCN buildings

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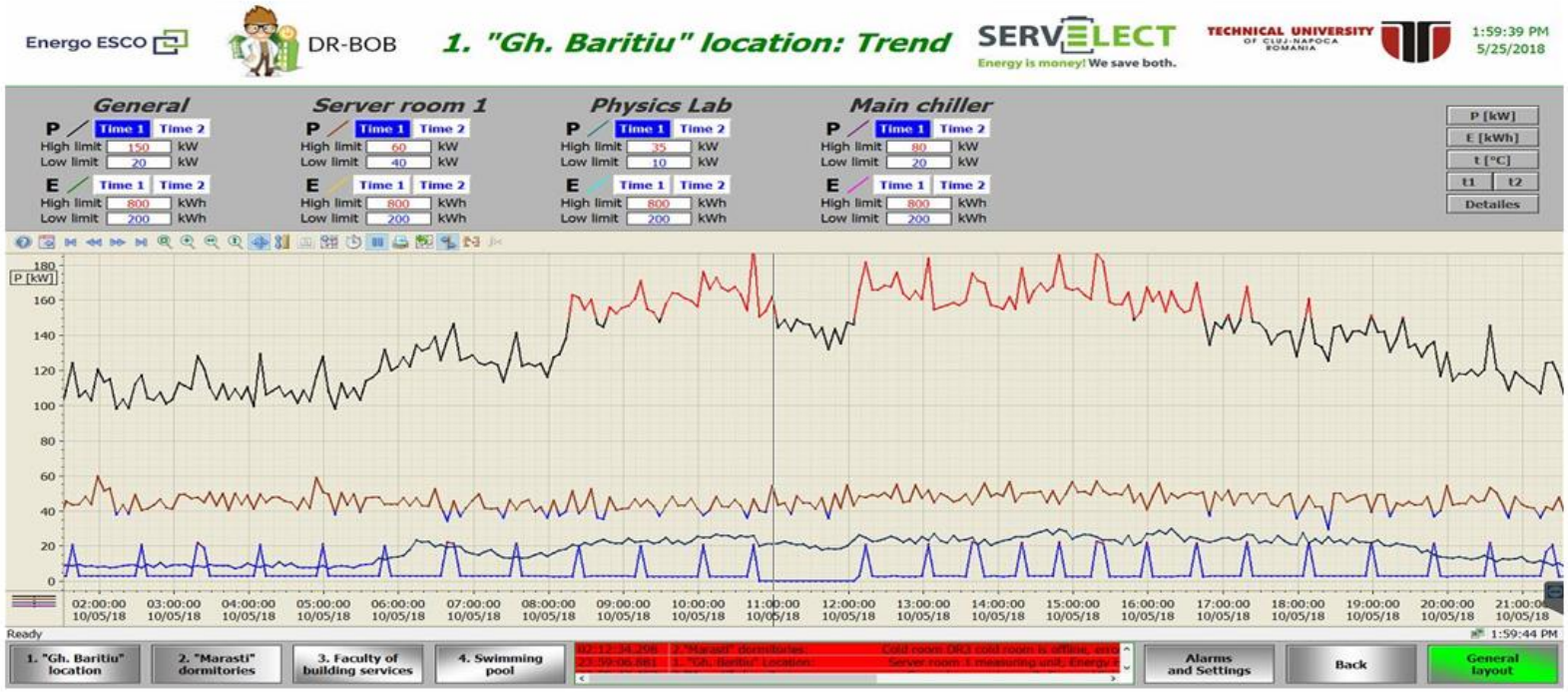
# 4.2. First steps – continued

Identify peaks and gaps in the load curve:




**Source:** BEMS in TUCN buildings

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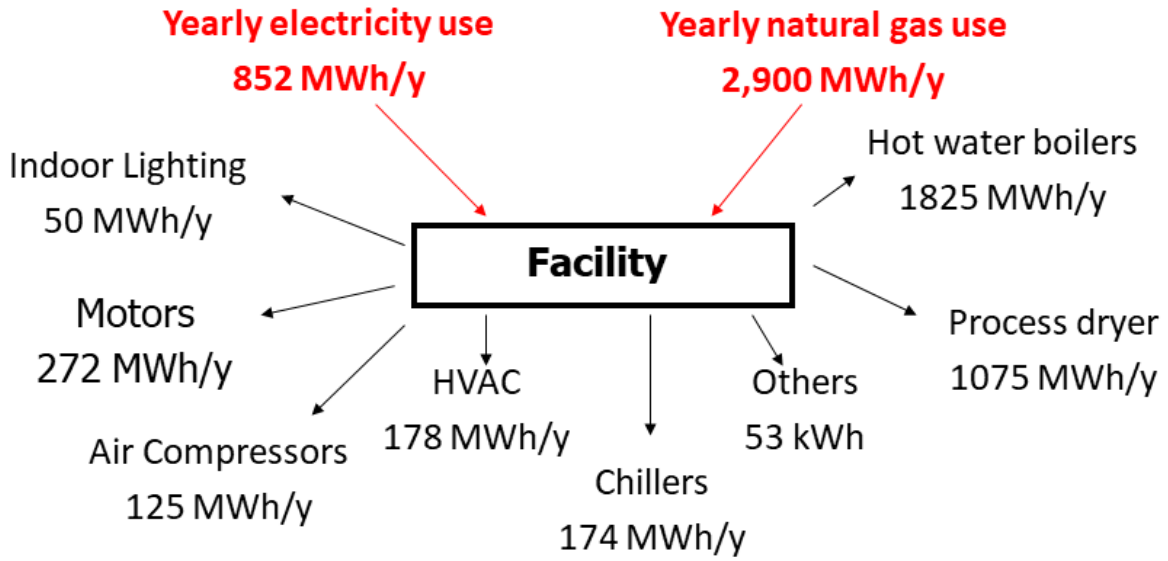
# 4.2. First steps – continued

Energy Balance in a typical SME site:

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# 4.2. First steps – continued

## Energy Management - ISO5001

ISO 50001 sees an internationally recognized **framework**, for the integration of best practices regarding **energy management** in the use of your company.

Not a law

Methodology

ISO 50001 is **compatible** with:

- ISO 9000: 2008 standard on Quality Management System
- ISO 14001: 2004 standard Environmental Management System.

It can be integrated with other ISO certifications due to the similar structure.

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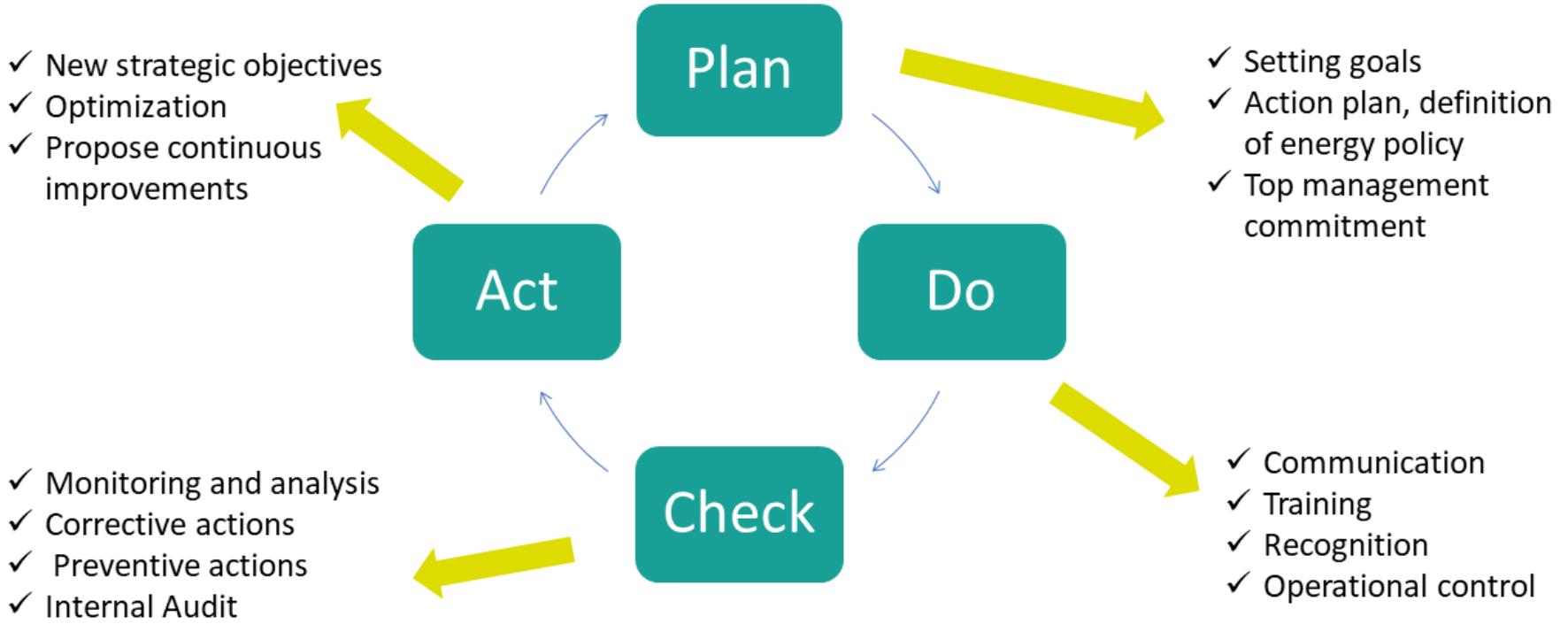
# 4.2. First steps – continued

## Energy Management - ISO5001

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# 4.2. First steps – continued

After getting into all the above presented issues, we can effectively move on to the **energy analytics tools** to be applied.

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# 4.3. Energy Analytics Tools

Required data to collect for proper and impact energy analytics

1. **Start with the SME goals**
   - Why the SME wants to do energy efficiency?
   - What are the "financial criteria" to approve projects – connection with LU5
   - Do they have a budget or a financing alternative to fund projects?

2. **Energy data:**
   - Rate and tariff structures if exist;
   - Recommended a minimum of 2 years of monthly energy & cost data;

3. **SME information:**
   - Facility map and operational hours for each process stage;
   - List of major energy consuming equipment, as previously enumerated;
   - Benchmarking or KPI data if available;
   - Prior energy audit reports.

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# 4.3. Energy Analytics Tools– continued

For the energy analytics tools use, one should understand:

- Identify Significant Energy Users (SEU's);
- Identify Key Performance Indicators (KPI's);
- Identify, qualify and quantify the opportunities;
- Provide an action plan for the SME, if at least a preliminary energy evaluation exists.

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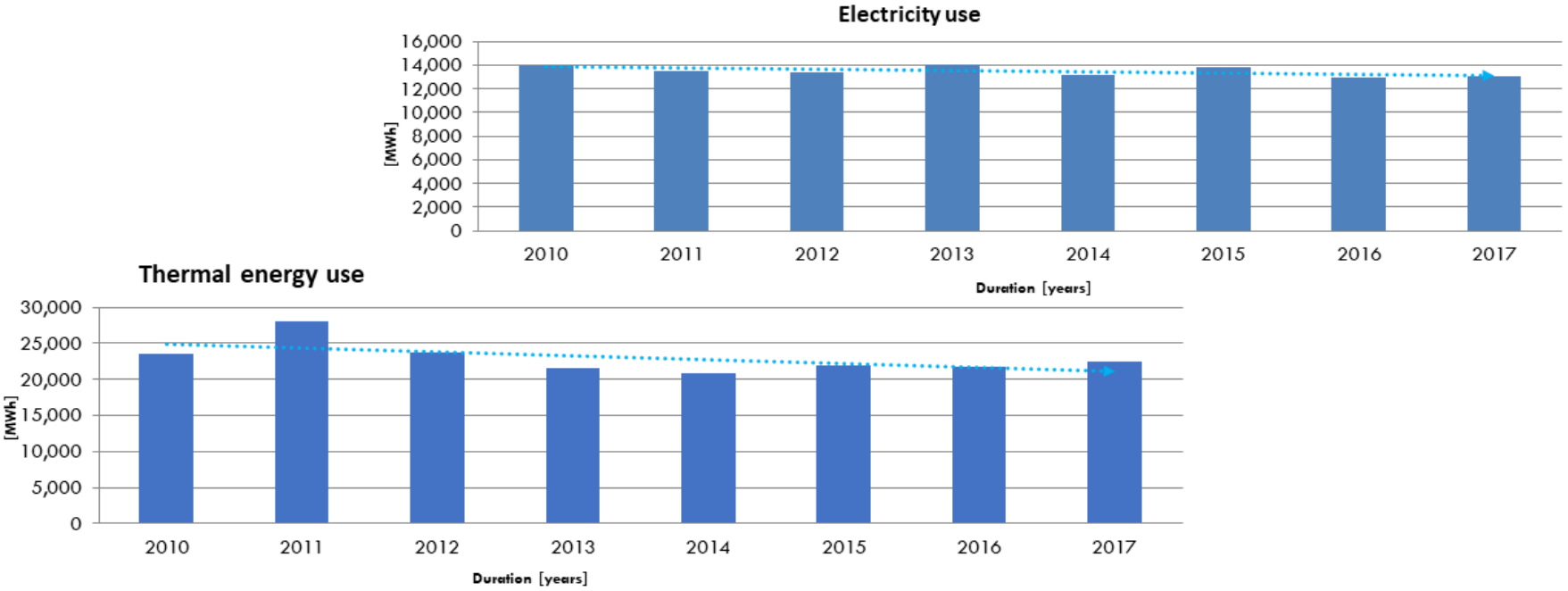
# 4.3. Energy Analytics Tools– continued

Have a first look on the **gross yearly energy data**:

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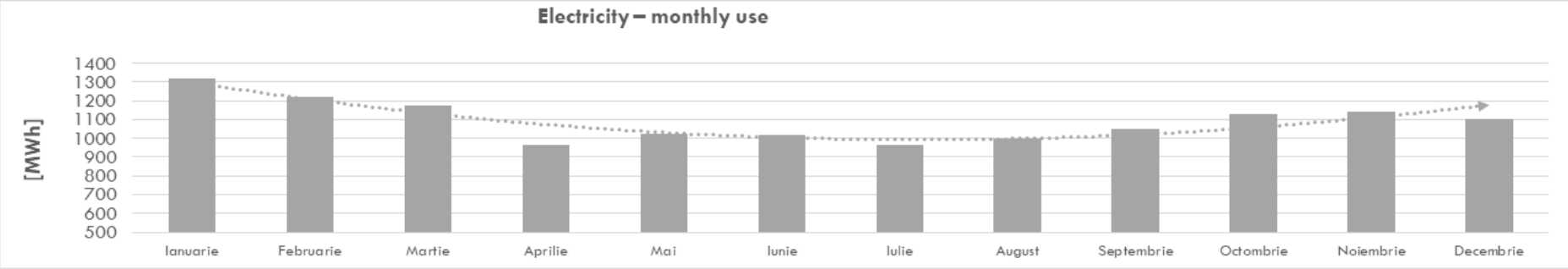
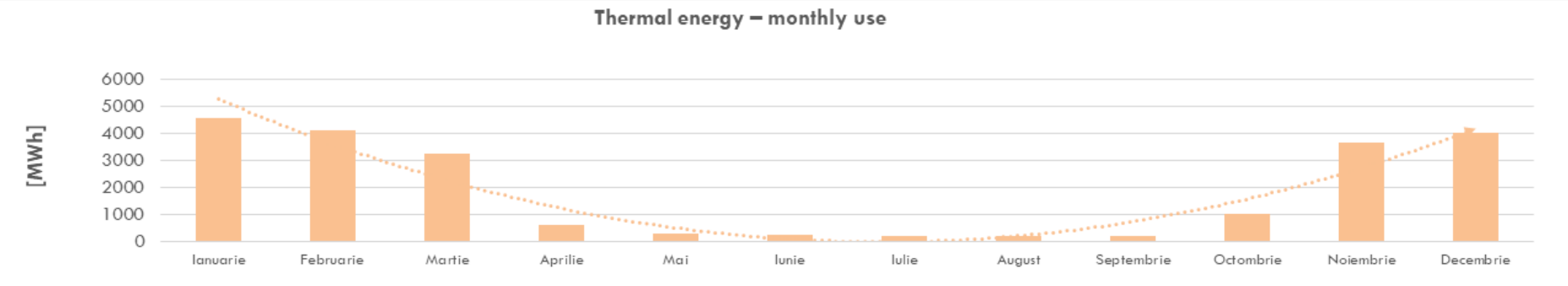
# 4.3. Energy Analytics Tools– continued

Get into details on the **monthly energy data**:

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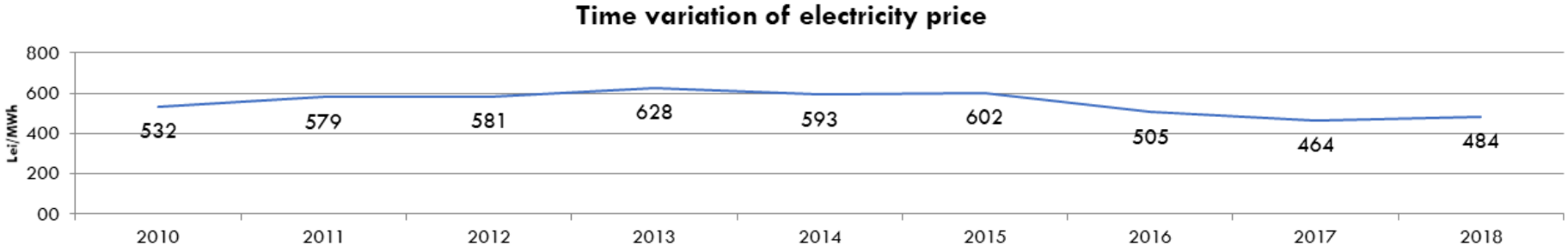
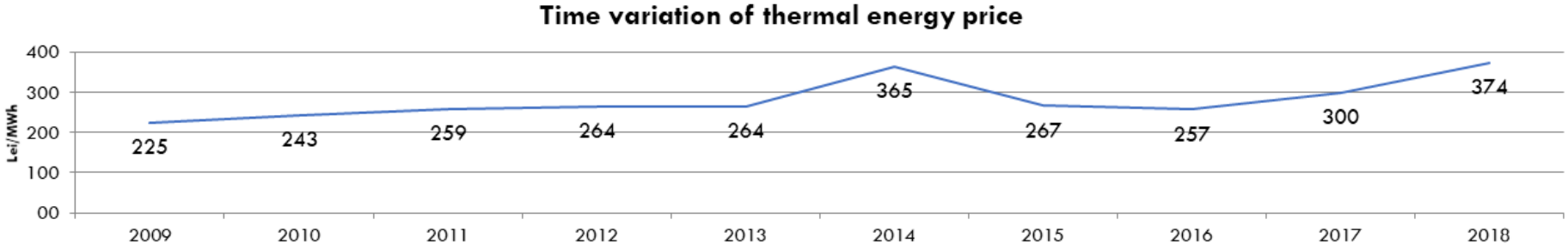
# 4.3. Energy Analytics Tools– continued

If available, reflect the time variation of **energy price**:

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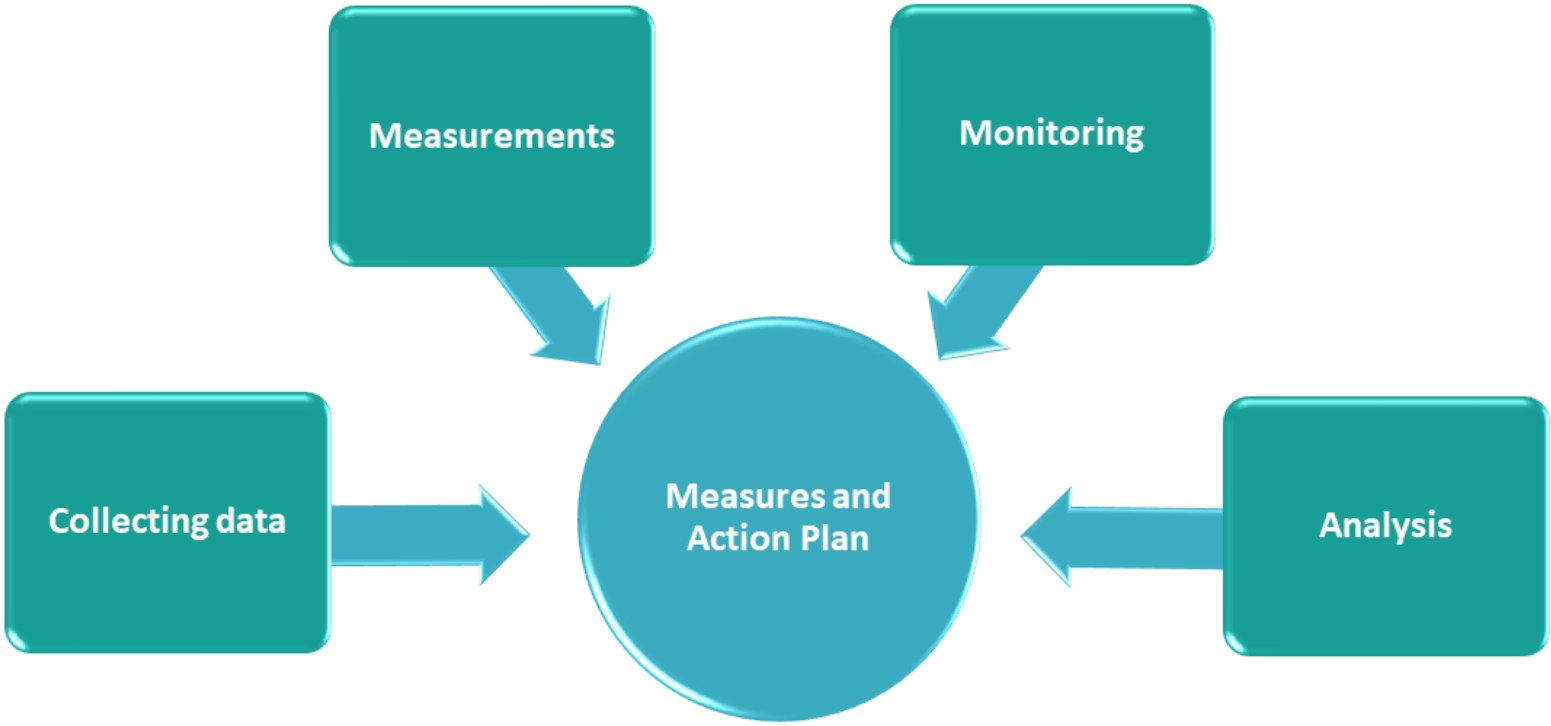
# 4.3. Energy Analytics Tools– continued

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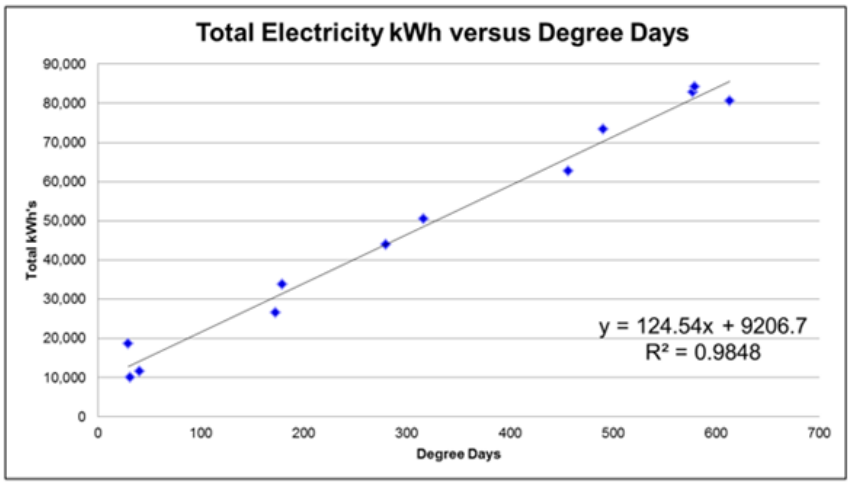
# 4.3. Energy Analytics Tools– continued

Then, start using the predefined regression modelling
(*Can be used to predict the correlation between energy use and weather (or other variables)*




$y = mx + b$

**y:** kWh Consumption

**m**: Slope of the line (how much kWh per independent variable)

**x**: Independent variable (Degree Days, or Production Output, Occupancy Hours etc.)

***$R^2$ is the "coefficient of correlation" and measures the strength of the relationship between your model and the dependent variable on a convenient 0 – 100% scale***

**Source:** AEE – Certified Energy Manager training materials

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# 4.3. Energy Analytics Tools– continued

## Monitoring and Targeting (M&T)

**Monitoring:** Used for determining specific consumption of electricity, fossil fuel, domestic water and industrial water, other utilities per unit of product.

**Targeting:** Using different types of regressions (linear, logarithmic, exponential), the consumption target can be imposed.

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# 4.3. Energy Analytics Tools – continued

## Measurement and Verification (M&V)

**Importance of an M&V Plan**

1. Establish from the beginning **what** we need to know / control / measure, in an energy efficiency (EE) project;
2. Establishes from the beginning **how** we find / inform / measure / verify the performance of an EE project;
3. Determine from the start **who** and **how much** assumes the performance of the EE project.

**Don't forget:**

- "You can't control what you can't measure!"
- "The failure of planning means planning of failure!"

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# 4.3. Energy Analytics Tools – continued

## Principles of the M&V Plan

| | |
|---|---|
| **Correctness** | • M&V reports must be as **accurate** as possible (within the available budget). |
| **Complexity** | • The reporting of energy savings must take into account all the effects that may influence the EE project. |
| **Caution** | • In the event of uncertain conditions, M&V procedures must be designed to **minimize errors in the calculation of savings**. |
| **Compatibility** | • There must be a compatibility between **different types of EE projects**, **different time periods** of the same project, etc. |
| **Relevance** | • Focus on **measuring basic parameters**, while other less decisive or predictable parameters can be estimated. |
| **Transparency** | • All M&V activities must be **clearly and fully highlighted.** |

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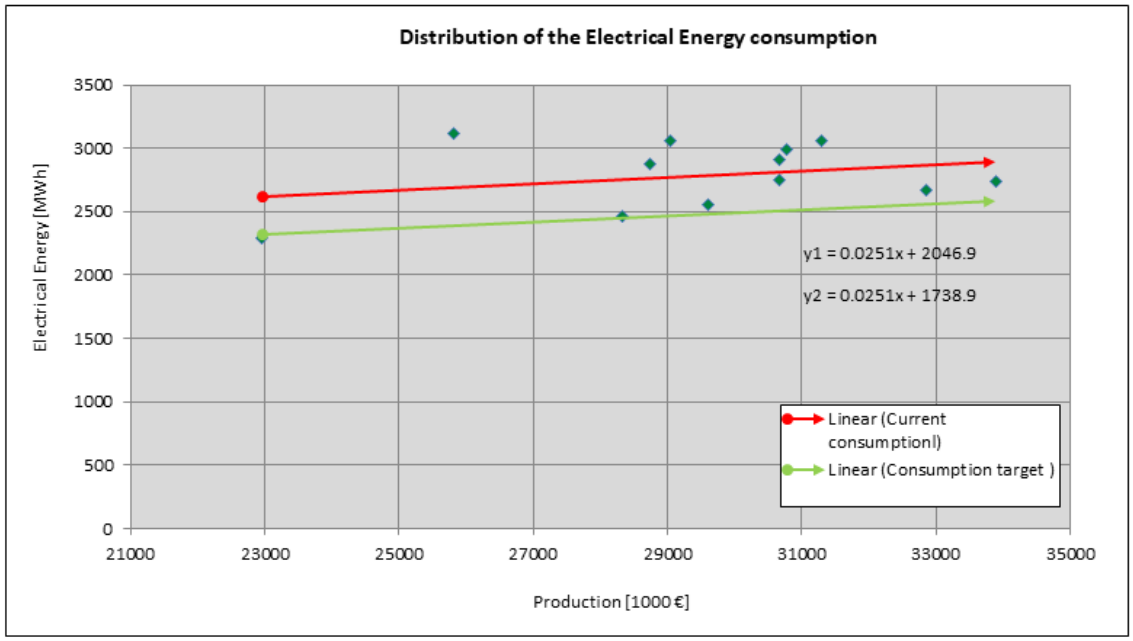
# 4.4. Facts and Figures

## Monitoring and Targeting (M&T) – example:
Distribution of the Electrical Energy consumption




**Input data:**

- ✓ Electrical energy consumption
- ✓ Production

**Graph:**

- The **linear regression** is used in order to determine the optimized consumption.
- **Optimized consumption**: The area between the current and targeted consumption.

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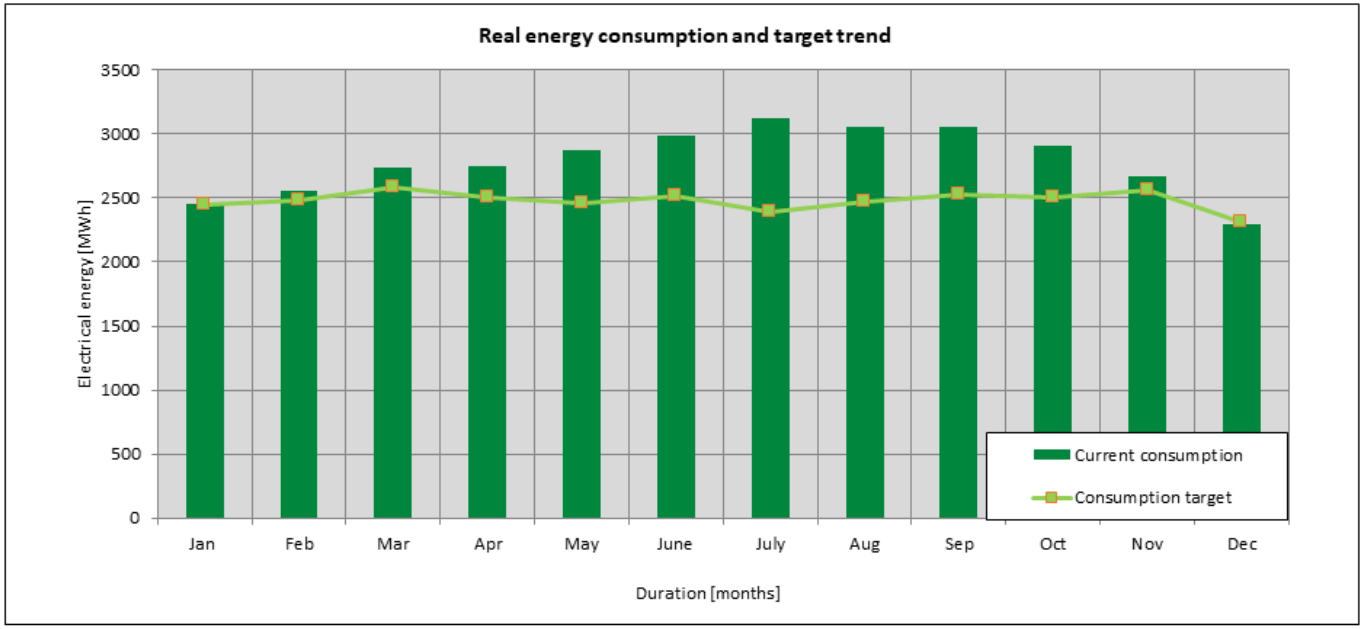
# 4.4. Facts and Figures – continued

**Monitoring and Targeting (M&T) –example:**
Real energy consumption and target trend

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# 4.4. Facts and Figures – continued

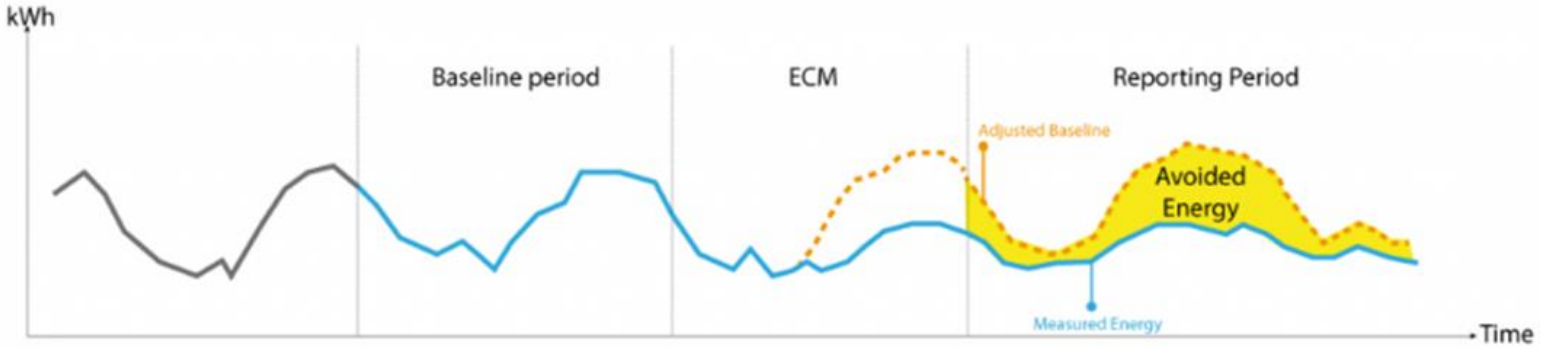
## Measurement and Verification (M&V) Tool

**Input**

- Baseline energy data
- Production data

**Output**

- ✓ Baseline energy use
- ✓ Specific energy use
- ✓ Potential savings, optimization




**Note:** ECM – Energy Conservation Measure

**Source:** Wattics

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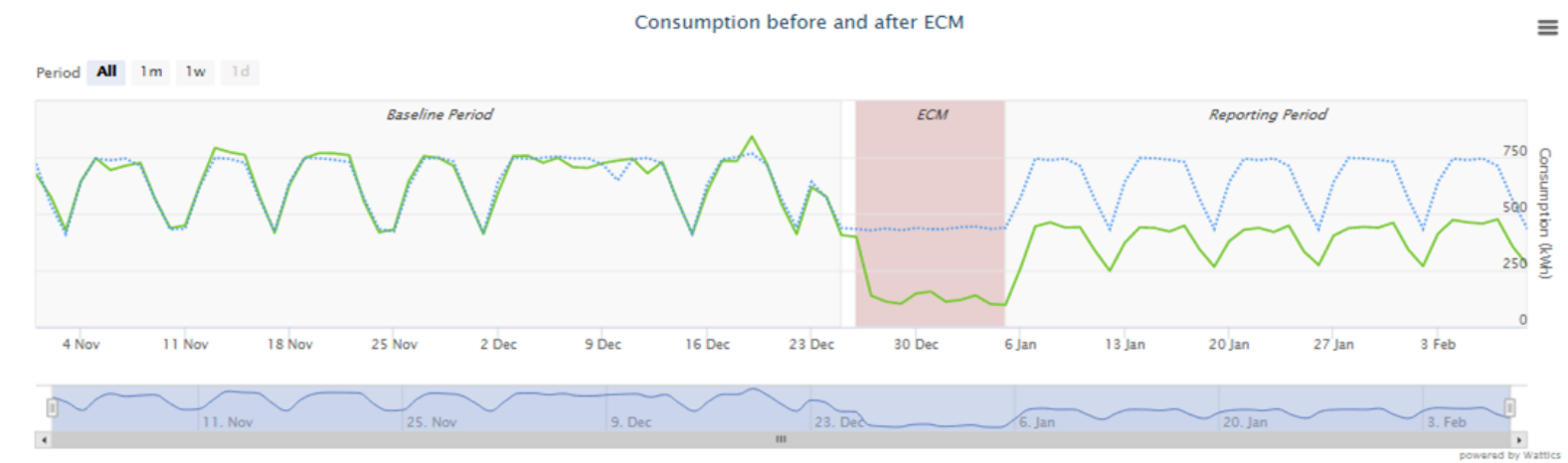
# 4.4. Facts and Figures – continued

## Measurement and Verification (M&V) – example

*See the relevant values and graphs for the whole project life-cycle and provide an executive summary.*




**Baseline Period**

*1 November 2013 - 24 December 2013*

**Reporting Period**

*5 January 2014 - 9 February 2014*

**Estimated annualized consumption without ECM:** 236,301.95 kWh ( £21,267.18 )

**Annualized actual consumption:** 140,968.18 kWh ( £12,687.14 )

**Savings per year:** **95,333.77 kWh ( £8,580.04 )**

**Payback Period:** **1.75 Year**

**Source:** Energy Monitoring System in SME

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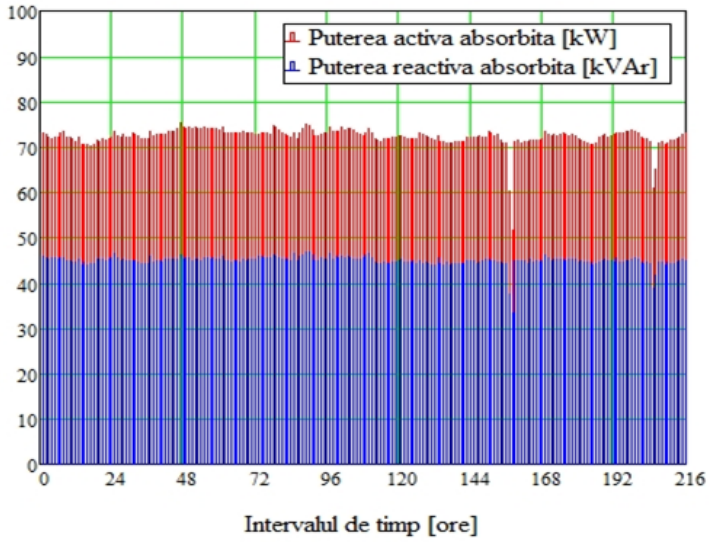
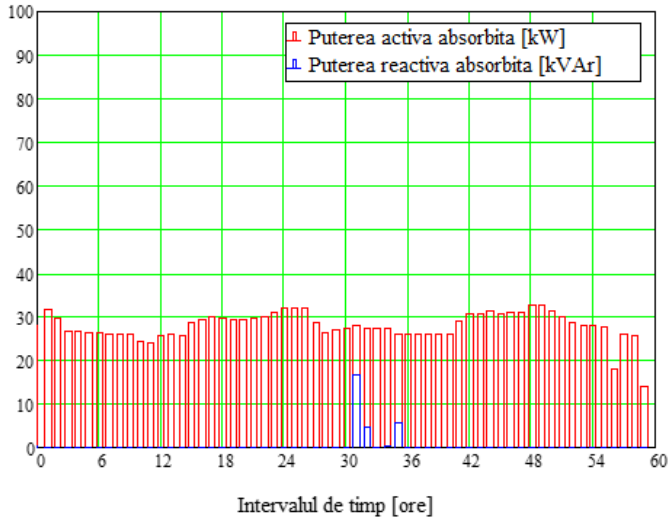
# 4.4. Facts and Figures – continued

## Measurement and Verification (M&V) for a motor drive – example:

### Star / Triangle




### Variable Speed Drive

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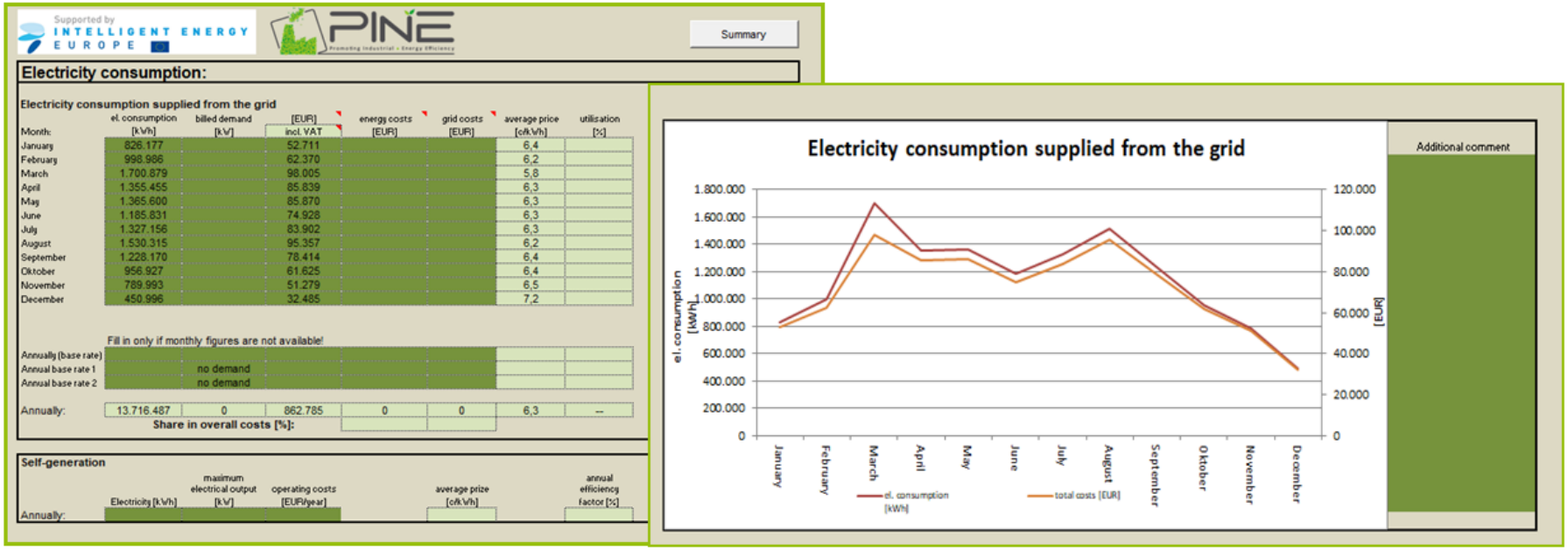
# 4.4. Facts and Figures – continued

## Example- PInE Audit Tool



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PINE

Summary

**Electricity consumption:**

**Electricity consumption supplied from the grid**

| Month: | el. consumption [kWh] | billed demand [kW] | [EUR] incl. VAT | energy costs [EUR] | grid costs [EUR] | average price [c/kWh] | utilisation [%] |
|---|---|---|---|---|---|---|---|
| January | 826.177 | | 52.711 | | | 6,4 | |
| February | 998.986 | | 62.370 | | | 6,2 | |
| March | 1.700.879 | | 98.005 | | | 5,8 | |
| April | 1.355.455 | | 85.839 | | | 6,3 | |
| May | 1.365.600 | | 85.870 | | | 6,3 | |
| June | 1.185.831 | | 74.928 | | | 6,3 | |
| July | 1.327.156 | | 83.902 | | | 6,3 | |
| August | 1.530.315 | | 95.357 | | | 6,2 | |
| September | 1.228.170 | | 78.414 | | | 6,4 | |
| Oktober | 956.927 | | 61.625 | | | 6,4 | |
| November | 789.993 | | 51.279 | | | 6,5 | |
| December | 450.996 | | 32.485 | | | 7,2 | |
| Fill in only if monthly figures are not available! | | | | | | | |
| Annually (base rate) | | | | | | | |
| Annual base rate 1 | | no demand | | | | | |
| Annual base rate 2 | | no demand | | | | | |
| Annually: | 13.716.487 | 0 | 862.785 | 0 | 0 | 6,3 | -- |
| Share in overall costs [%]: | | | | | | | |

**Self-generation**

| | Electricity [kWh] | maximum electrical output [kW] | operating costs [EUR/year] | average prize [c/kWh] | annual efficiency factor [%] |
|---|---|---|---|---|---|
| Annually: | | | | | |



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## Remarks on Learning Unit 4

- ✓ Form a Project **Team**
- ✓ How to use my data? (Energy & Production) – **Preliminary energy evaluation**
- ✓ Start with **questions**
- ✓ Identify **Energy users** in SME facility

- ✓ Identify: SME's goals, Energy data and Other relevant information about SME
- ✓ Use advance and effective tools:
  - **Monitoring & Targeting**
  - **Measurement & Verification**

## References for Learning Unit 4

[1] A. Thumann, T. Niehus, W.J. Younger: *Handbook of Energy Audits*, 9th edition, ISBN: 978-1-4665-6162-5-1730-9, ed. The Fairmon Press and CRC Press, 2013.

[2] "Action Plan for Energy Efficiency: Realising the Potential", Communication for the Commission of the European Communities, Brusseles, COM/2006/0545. (link)

[3] "Metering, Load Profiles and Settlement in Deregulated Markets", Eurelectric Ref: 2000-220-0004, March 2000.

[4] "Green Paper on Energy Efficiency or Doing More With Less", Communication for the Commission of the European Communities, Brusseles, COM/2005/0265 final. (link)

[5] ******Energy efficiency guide for industry in Asia*** webpage (link)

[6] C.V. Ionescu, G. Darie: "New Method to Assess the Energy Efficiency and Energy Effectiveness to the Industrial End-Users", *International Conference and Exposition on Electrical and Power Engineering (EPE)*, ISBN: 978-1-5386-5061-5, Iasi, Romania, October 18-19, 2018. (link)

# Learning Unit 5: Financing Energy Efficiency Measures, Tools & Evaluation

## Introduction

| | |
|---|---|
| **AIM** | The aim of this LU is to provide trainees with the adequate training, skillset, and financial literacy to perform planning and evaluation of energy saving policy strategies in SMEs as part of the integrated Education and Training (E&T) program. |
| **ECTs STRUCTURE** | **0.5 ECTS credits**<br>6 Lecture hours (including testing impact of self-study)<br>4 Practice hours (in eco design)<br>5 Self-Study hours<br>**Total hours: 15** |
| **OBJECTIVES** | • Understand the basics of energy projects' economic analysis<br>• Evaluate an energy efficient investment employing standard metrics<br>• Identify alternative financing options for an energy project<br>• Understand how performance contracts work and how these contracts can be beneficial for an SME<br>• Understand how a CBA and LCCA operates |
| **LEARTNING OUTCOME** | • The financial aspect of the energy efficiency measures and the evaluation of the corresponding results<br>• Energy performance contracts (EPC)<br>• Cost Benefit Analysis (CBA) and Life Cycle Cost Analysis (LCCA)<br>• The opportunity of accessing financial schemes for energy efficiency<br>• The trainees will be able to deliver formal reports containing not only a technical part and justifying the proposed measures but also provide the relative financial part with all essential KPIs, e.g. IRR, NPV, etc. |
| **PREREQUISITES** | • Basic understanding of economic principles and financing schemes is preferable such that the trainee will better understand better the learning materials of the module.<br>• Basic computational skills.<br>• Interest in investment on energy efficiency<br>• Interest in SME's energy issues. |

## Content of Learning Unit 5

# CONTENT OUTLINE of LU5

**5.1. CAPITAL INVESTMENT CHARACTERISTICS AND SOURCES OF FUNDS**
**5.2. DESCRIPTION OF BASIC ELEMENTS OF ECONOMIC ANALYSIS**
**5.3. SIMPLE AND COMPOUND INTEREST**
**5.4. COST OF CAPITAL AND TIME VALUE OF MONEY**
**5.5. PRESENT AND FUTURE VALUE**
**5.6. CASH FLOWS AND SERIES CASH FLOWS**
**5.7. NPV AND IRR**
**5.8. PAYBACK PERIOD AND MARR**
**5.9. ROI AND SENSITIVITY ANALYSIS**
**5.10. FINANCING ENERGY PROJECTS**
**5.11. FINANCIAL EVALUATION**
**5.12. EPC - ENERGY PERFORMANCE CONTRACTING**

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# 5.1 Capital investment characteristics and sources of funds

The basic *Capital investment characteristics* are the following:

a) A relatively large initial cost is required

b) The benefits resulting from the initial cost occur with a time delay , normally over a period of years

c) It is irreversible resulting in substantial cost consequences

To perform the investment, *sources of funds* can be internal or external financial sources. The external sources can be in the form of:

a) using third party lenders

b) postponing the project

c) installing part of the upgrades by breaking the project into smaller pieces.

The solution of postponing or delaying the project can, in fact, be the most expensive alternative.

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# 5.2. Basic elements of economic analysis

- ***Capital:*** a commodity/ economic good expressed in monetary units having the ability to increase, producing new capital, through producing new commodities, technology, knowledge.

- ***Interest:*** the amount of money produced by the capital during a certain period of time. It is actually the return (increase) of the capital for a specific period of time.

- ***Time:*** the time period during which an economic analysis of an investment is performed.

- ***Interest rate (i):*** the interest corresponding to 1 money unit for 1 period of time.

- ***Discount rate:*** refers to the interest rate related either to the loan's charges or the discounted cash flow analysis, to determine the present value of future cash flows. It is usually equal to the incremental cost of capital.

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# 5.2. Basic elements of economic analysis

- ***Taxes:*** may occur in many forms, e.g. income taxes, sales taxes, etc., aiming at generating revenues for governmental entities. Taxes should be always taken into consideration when an investment is assessed and before the decision-making.

- ***Depreciation:*** the value decrease of the assets in the course of a business, over the years.

- ***Inflation:*** the increase in prices over time. It is typically measured using some price index, and the percentage change is referred to as the inflation rate.

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# 5.3. Simple and Compound interest

***Simple interest:*** the interest charged only on the original principal amount at the rate of *i%* per year. Every time period, the interest is calculated in the initial capital, without incorporating the amount of the interest return and it is the same, every year. The total amount of the interest is incorporated in the end of the investment period. The total amount of money at the end of *n* years will be:

$$F = P \cdot (1 + n \cdot i)$$

***Compound interest:*** the interest incorporated into the capital every year. Then the new interest is calculated on the new amount of the capital (capital + previous period interest). The amount of the compound interest increases every year. The total amount of money at the end of *n* years will be:

$$F = P \cdot (1 + i)^n$$

Where, *F* and *P* denote the future and present amount, *i* denotes the interest rate and *n* the number of years.

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# 5.3. Simple and Compound interest Example 1/2

Assuming that you want to deposit to the bank 100€ for 2 years. You have 2 options regarding the interest:

1) 10% simple interest
2) 10% compound interest

Which one is the most attractive?

---

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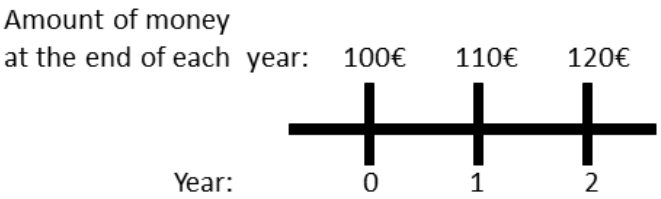
# 5.3. Simple and Compound interest
# Example 2/2

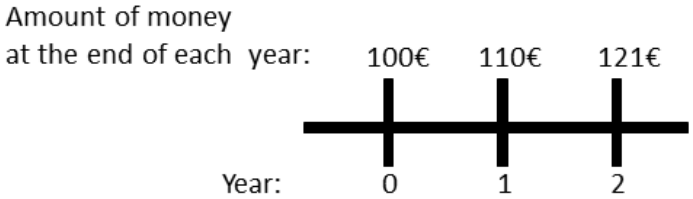
1st option:

The interest is charged on the amount of 100€ for the first and for the second year. The interest charged during the first year is not incorporated into the initial capital.




2nd option:

The interest of the first year is incorporated into the initial capital. The interest of the second year is charged on this amount.




In the second option the interest is converted into capital and produces new interest.

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# 5.4. Cost of capital and time value of money

***Cost of capital (cost of borrowing):*** the interest rate charged to the capital and it is dependent on:

- The borrower's credit rating
- Risks related to the project itself and to external factors

It influences the return of investment inversely: when the cost of capital increases, the return of investment decreases

***Time value of money:*** the idea that time affects the value of cash flows. It happens that an amount of money is more valuable today than tomorrow. So, receiving an amount of money today has a greater benefit than receiving the same amount later. In this sense, different amounts of money can be equals in value if they are compared for different time instants. Their difference is the interest.

***Capitalization of the interest:*** the incorporation of the interest to the capital. Otherwise there is a decrease in purchasing power due to inflation.

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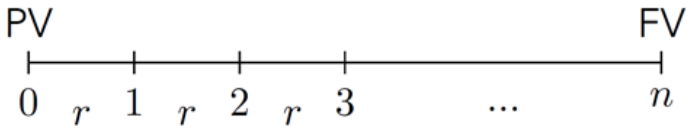
# 5.5. Present and Future value

- ***Present value (PV):*** the current value/ worth of a future amount of money or future cash flows, using the discount rate.
- ***Future Value (FV):*** the worth of the initial capital in a specific future time instant (at the end of a time period), by using and interest rate.

$$FV = PV + Total_Interest$$

- ***Number of time periods (n):*** is the total of the time periods every when the interest is calculated.
- ***Timeline***




For 1 period of time: $FV = PV \cdot (1+i)$ $PV = \frac{FV}{1+i}$

For n$^{th}$ periods of time: $FV = PV \cdot (1+i)^n$ $PV = \frac{FV}{(1+i)^n}$

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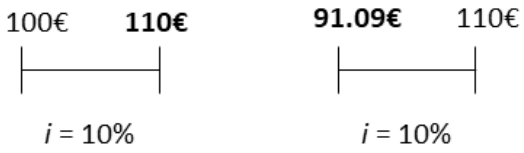
# 5.5. Present and Future value Example

Let the interest rate be $i$ = 10%. Given options: a) 100€ today and b) 100€ in a year. Which of the two options is more profitable?

Comparing the two options, we obtain:

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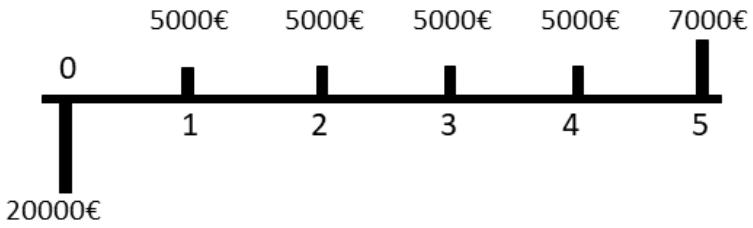
# 5.6. Cash flows and series cash flows
## Cash flows

***Cash flow:*** the amount of money that denotes the revenues/ profit (positive cash flow) or expenses (negative cash flow) of the investment/ borrowing. It is actually a time movement of money.

For example, the simplified (net) cash flow diagram for the purchase of an instrument with initial cost 20000€ follows. For 5 years after the purchase, the instrument will generate net profits of 5000€ and a final salvage of 7000€. The profits are the revenues minus the expenses related to maintenance each year.

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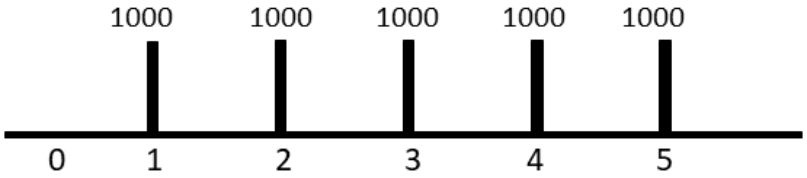
# 5.6. Cash flows and series cash flows
## Series Cash flows

***Series cash flows:*** the sum of the future worth of each individual cash flow. Similarly, the present worth of a series of cash flows is the sum of the present worth of each one.

***Uniform series of cash flows:*** exists when the cash flows are in a series, occurring every year and are all equal in value.




The discount rate for the calculation of the FV and the PV are $\frac{(1+i)^n-1}{i}$ and $\frac{(1+i)^n-1}{i(1+i)^n}$, respectively. Additionally, the sinking fund for the calculation of the cash flow amounts every time period to obtain a certain amount of money at the end of all the period is $\frac{i}{(1+i)^n-1}$.

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# 5.6. Cash flows and series cash flows
# Cash flows examples

1) If someone deposits 200€ every year for 7 years, assuming $i$ = 6%. At the end of the seven years, how much will be the final amount?

$$FV = 200 \cdot \frac{(1+0.06)^7 - 1}{0.06} = 1678.76€$$

2) If someone wants to have 1600€ at the end of 7 years, assuming $i$ = 6%, how much should be the annual amount to be deposited?

$$A = 1600 \cdot \frac{0.06}{(1+0.06)^7 - 1} = 190.56€$$

3) If someone wants to obtain an amount of 20000€ every year for the next 15 years, assuming $i$ = 6%, what is the amount that should be deposited now?

$$PV = 20000 \cdot \frac{(1+0.06)^7 - 1}{0.06 \cdot (1+0.06)^7} = 194244€$$

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# 5.7. NPV and IRR
## NPV

***Net Present Value (NPV):*** an assessment method for different investments. It is based on the difference of the present value of the future cash flows minus the investment today. If it is positive, the investment is acceptable. It converts the worth of a future amount of money into what is its worth today ("time zero" or present), by using a given discount rate. It serves to compare the cost of a project and to evaluate projects and products with cash flows spread over time. It accounts for the time value of money. It is calculated by the costs (negative cash flows) and benefits (positive cash flows) for a certain period of time of an investment.

$$NPV = \sum_{n=0}^{N} \frac{R_n}{(1+i)^n}$$

Here, $N$ denotes the number of time periods, and $R$ the difference of positive and negative cash flow occurred during the period $n$.

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# 5.7. NPV and IRR

## IRR

***Internal rate of return (IRR):*** a discount rate that makes the NPV of all cash flows from a particular project equal to zero. It is used to measure the investment's expected future rate of return (profit) excluding external factors, such as inflation and risks.

IRR is an indicator of the efficiency of the investment while NPV is an indicator of the net value added by the investment.

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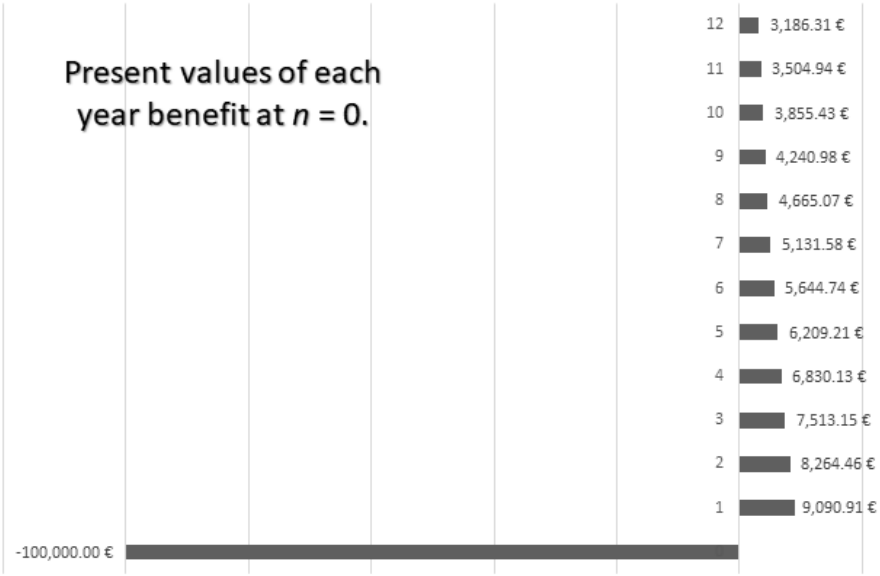
# 5.7. NPV and IRR
# NPV - Example

The initial Capital required for an investment is 100,000€. It is expected to provide benefits of 10,000€ every year for 12 years. The negative cash flows are assumed to be zero, except the initial investment. No cost other costs are considered. The discount rate is 10%.




Total PV = 68,136.91€
NPV = Benefits – Costs =
= -31,863.09€

The example is adopted from
[**Source:** https://en.wikipedia.org/wiki/Net_present_value]

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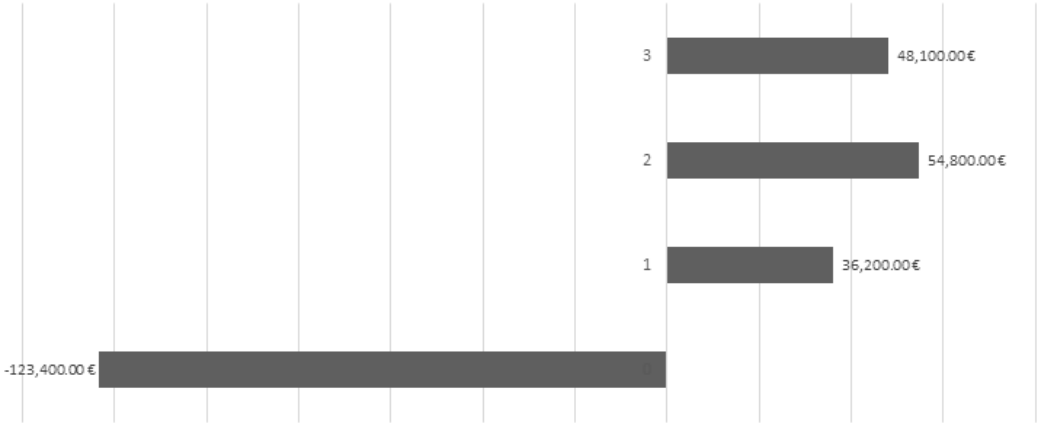
# 5.7. NPV and IRR
# IRR - Example

The cash flows of an investment are as below:




For the calculation of the *IRR*, *NPV* is set to zero:

$$NPV = -123400 + \frac{36200}{(1+i)^1} + \frac{54800}{(1+i)^2} + \frac{48100}{(1+i)^3} = 0$$

So, $i = 5.96\%$.

The example is adopted from
[**Source:** https://en.wikipedia.org/wiki/Net_present_value]

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# 5.8. Payback period and MARR

***Payback period:*** the minimum number of time periods at the end of which the sum of net cash flows becomes positive.

***Minimum Attractive Rate of Return (MARR):*** a company's critical rate for investing in projects. If an investment has a return on investment greater than the MARR, it is accepted. The MARR is also used as the discount rate to determine the "net present value" (NPV).

The MARR is the lowest accepted return given:

a) the risks associated with this project

b) the other opportunities for investment

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# 5.9. ROI and Sensitivity Analysis

***Return on Investment (ROI):*** is used to indicate the percentage of the initial capital returned from the investment. For a certain period of time it is defined as

$$ROI = \frac{net_profit}{initial_capital}$$

It is an indicator used in evaluating the efficiency of an investment or in comparing different investments.

***Sensitivity analysis:*** a method that leads to the optimal decision. In the single factor sensitivity analysis, only one factor varies while the rest are hold constant. This factor ranges into a predefined interval. The effect of its value changes on the measure of worth is assessed and the most attractive alternative is chosen.

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# 5.9. ROI and Sensitivity Analysis Exercise 1/3

A company hired you to perform the feasibility analysis for the improvement of its energy efficiency, by installing heat pumps, PV panels and by upgrading its buildings envelopes, within the next 3 years. There are two possible options for investment, A and B. The initial cost is 1,400,000€ and 1,900,000€ for A and B respectively. Both solutions will be initially financed using loan. The annual expenses for salaries are 300,000€ for option A and 160,000€ for option B. The interest rate is 7%, the discount rate is 4% and the inflation rate is 2%. Which option is more attractive?

Solution:

The interest rate for the loan of the initial capital is 7% and the loan should be repaid within 3 years, For the repayment, the company will pay a constant amount of money *R*, at the end of each year.

$$R = P\frac{i \cdot (1+i)^N}{(1+i)^N - 1}$$

Here, *P* is the present value of the initial capital, *i* is the interest rate and *N* the number of repayment years.

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# 5.9. ROI and Sensitivity Analysis Exercise 2/3

For the two options the amount to be paid at the end of each year is:

$$\text{Option A:} \quad R_A = P_A \frac{i \cdot (1+i)^N}{(1+i)^N - 1} = 1400000 \frac{0{,}07 \cdot (1+0{,}07)^3}{(1+0{,}07)^3 - 1} = 533472€$$

$$\text{Option B:} \quad R_B = P_B \frac{i \cdot (1+i)^N}{(1+i)^N - 1} = 1900000 \frac{0{,}07 \cdot (1+0{,}07)^3}{(1+0{,}07)^3 - 1} = 723998€$$

The loan installment is constant and not affected by the inflation. On the contrary, the operational costs are subject to inflation every year. The total expenses for a year m<N=3 will be:

$$k_m = R + k_{eo}(1+a)^m$$

$a$ is the inflation rate.

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# 5.9. ROI and Sensitivity Analysis Exercise 3/3

The PV of the whole investment, including the repayment cost of the loan and the operational costs during all the years of the repayment, is:

$$k_0 = R\frac{(1+i)^N - 1}{i\cdot(1+i)^N} + k_{eo}\frac{(1+q)^N - 1}{q\cdot(1+q)^N}$$

Where, $q = i - a$.

For each option we obtain:

Option A: $k_{0A} = 533472\dfrac{(1+0{,}04)^3 - 1}{0{,}04\cdot(1+0{,}04)^3} + 300000\dfrac{(1+0{,}02)^3 - 1}{0{,}02\cdot(1+0{,}02)^3} = 1480433 + 865164 = 2345597€$

Option B: $k_{0B} = 723998\dfrac{(1+0{,}04)^3 - 1}{0{,}04\cdot(1+0{,}04)^3} + 160000\dfrac{(1+0{,}02)^3 - 1}{0{,}02\cdot(1+0{,}02)^3} = 2009160 + 461421 = 2470581€$

So, the more feasible solution is the A.

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# 5.10. Financing energy projects

- **Two approaches** for financing projects, namely:
  - *"pay-as-you-go"*: using available cash
  - *"pay-as-you-use"*: borrowing money from an external party
- Energy efficiency projects lead to energy and money savings **over the project lifetime**, so *"pay-as-you-use"* approach sounds more economically feasible.
- A company can purchase equipment, using **retained earnings, a loan, a bond, a capital lease or by selling stock**.
- Alternatively, a company can utilize equipment using a **true lease or an energy performance contract**.

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# 5.10. Financing energy projects

- ***Retained earnings****:* the net income left over for the company, "cash-on-hand"

"Pros" →
- The company keeps all savings and equipment (good for long-term use)
- Tax-deductible payments (depreciation, interest)
- No external interest charges

"Cons" →
- No external interest charges means lost opportunities for tax-deductible benefits
- Too risky for the company
- The company must have technical background

- ***Loan:*** money lent from an external party (usually bank); future repayment with added interest rate and other charges

"Pros" →
- The company keeps all savings and equipment (good for long-term use)
- Tax-deductible payments (depreciation, interest)
- Banks specialized in financing such projects (direct or intermediated EIB finance)

"Cons" →
- Too risky for the company
- The company must have technical background
- Collateral needed

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# 5.10. Financing energy projects

- ***Bond**:* similar to a loan, but with no bank involvement; the amount of money is repaid when bond reaches maturity (date agreed a priori); fixed or variable interest payments

"Pros" →
- The company keeps all savings and equipment (good for long-term use)
- Tax-deductible payments (depreciation, interest)
- Tax-free rates for governmental bodies

"Cons" →
- Too risky for the company
- The company must have technical background

- ***Sell stock:*** the company sells stock to raise money and invest in energy projects; part of the money earned are distributed to shareholders (dividends)

"Pros" →
- The company keeps all savings and equipment (good for long-term use)
- Tax-deductible payments (depreciation, interest)
- Elasticity in distributing dividends to shareholders

"Cons" →
- Too risky for the company
- The company must have technical background
- No tax-deductible dividends

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# 5.10. Financing energy projects

***Rent equipment from another party***

- ***Capital lease**:* the company owns the equipment; effective for long-term energy projects; opportunity to buy the equipment after the end of the leasing period

"Pros" →
- The company keeps all savings and potentially equipment
- No external interest charges
- Flexibilty in financing / quick approval

"Cons" →
- The company must have technical background
- Only interest payments are tax-deductible
- The cost of the equipment must be paid to keep the ownership

- ***True lease:*** the company does not own the equipment; effective for short-term energy projects

"Pros" →
- Tax-deductible lease payment
- Flexibility in financing / quick approval
- No risk / The lease can be cancelled

"Cons" →
- The company must have technical background
- There is no opportunity to buy the equipment after the leasing period

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# 5.10. Financing energy projects

- ***Energy Performance Contracts (EPC)****:* a contract between the company and an **Energy Service Company** (ESCO), which provides energy savings and guarantees energy and money savings

- The payment of an ESCO is directly related to the savings accomplished as a result of the implementation of measures towards energy efficiency improvement.

- Energy saving measures are identified and applied after extensive **energy audits** and through the strong collaboration between the ESCO and the company.

"Pros" →
- Reduces the risk related to investments in energy projects
- No need for further technical knowledge (ESCO as a consultant)
- ESCO guarantees the effectiveness of the proposed measures
- Little upfront investments

"Cons" →
- The company does not keep all the savings
- Tax and other economic benefits have to be negotiated
- Complex contracts

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# 5.10. Financing energy projects Tools and indicators

To decide whether it will be profitable to finance an energy project:

- **Weighted Average Cost of Capital (WACC):** firm's cost of capital, proportionately arranged in each category of capital.

  - The higher the WACC, the company has to overcome more borrowing costs to create a profit.
  - Compared to MARR, it is used by the company to judge whether a project is worth the expenditure and to decide which method to use to acquire the money.

- **Formulation of Risk Assessment Matrix:** It describes the risk related to investment, along with the level of risk and strategies that can be used to mitigate those issues.

| | Relative Risk Level Associated with Financing Options | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Risk Factors | #1 | #2 | #3 | #4 | #5 | #6 | Major Variables | Mitigating Strategies |
| Equipment performance warranty | 3 | 3 | 3 | 3 | 3 | 1 | Quality of specs, Selection process, Contract conditions | In-house / consultants' expertise, Legal ability available |
| Construction/ installation | 5 | 4 | 3 | 2 | 2 | 1 | Vendor / subcontractor qualifications, Contract provisions | Selection process, Performance / payment bonds, Legal ability |
| Savings persistence | 5 | 4 | 4 | 4 | 3 | 1 | Varies by measure, Administrative commitment, O&M attitudes, Training / experience | Contractual obligations, Vendor selection, ESCO selection, Guarantees offered |

*[Source:* A. Thumann, Eric Woodroof: *Energy Project Financing: Resources and Strategies for Success*, ed. The Fairmont Press, 2008]

Legend: N/A not applicable; 1 low risk; 2 low-medium risk; 3 medium risk; 4 medium-high risk; 5 high risk

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# 5.10. Financing energy projects
# Tools and indicators

- ***Monitoring and Targeting (M&T):*** identify, record and analyse the energy consumption across the installation based on data collected; set targets in comparison with baseline energy consumtpion patterns

  ➡ Improved data lead to better productivity and maintenance, as irregularities can be identified

  ➡ Improved budgeting and product costing, as future consumption can be predicted

- ***Measurement and Verification (M&V):*** to quantify the savings related to the implementation of energy efficiency measures; crucial if payments depend on savings

  ➡ Understand the potential risks and ensure the continuing performance of actions

  ➡ M&V protocols, particularly the International Performance Measurement and Verification Protocol (IPMVP)

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# 5.11. Financial evaluation
# Cost-benefit analysis

***Cost-benefit analysis (CBA):*** It is used for assessing investments and constitutes a tool for decision making. It evaluates the economic advantages and disadvantages of an investment. It is an approach to estimate the long and short term consequences of a project based on predefined objectives. The results of actions implementation in every possible aspect (economical, environmental, social, etc) are expressed in economic terms.

- The investment cost of an energy project is subtracted from the sum of the benefits gained from the corresponding applied actions after being discounted.
- NPV and IRR indicators are used.
- CBA can also be used to compare the cash flows when energy project is applied with the cash flows of a Business As Usual scenario, to estimate the effectiveness of actions.
- It can be used before, during or after the implementation of energy efficiency measures.

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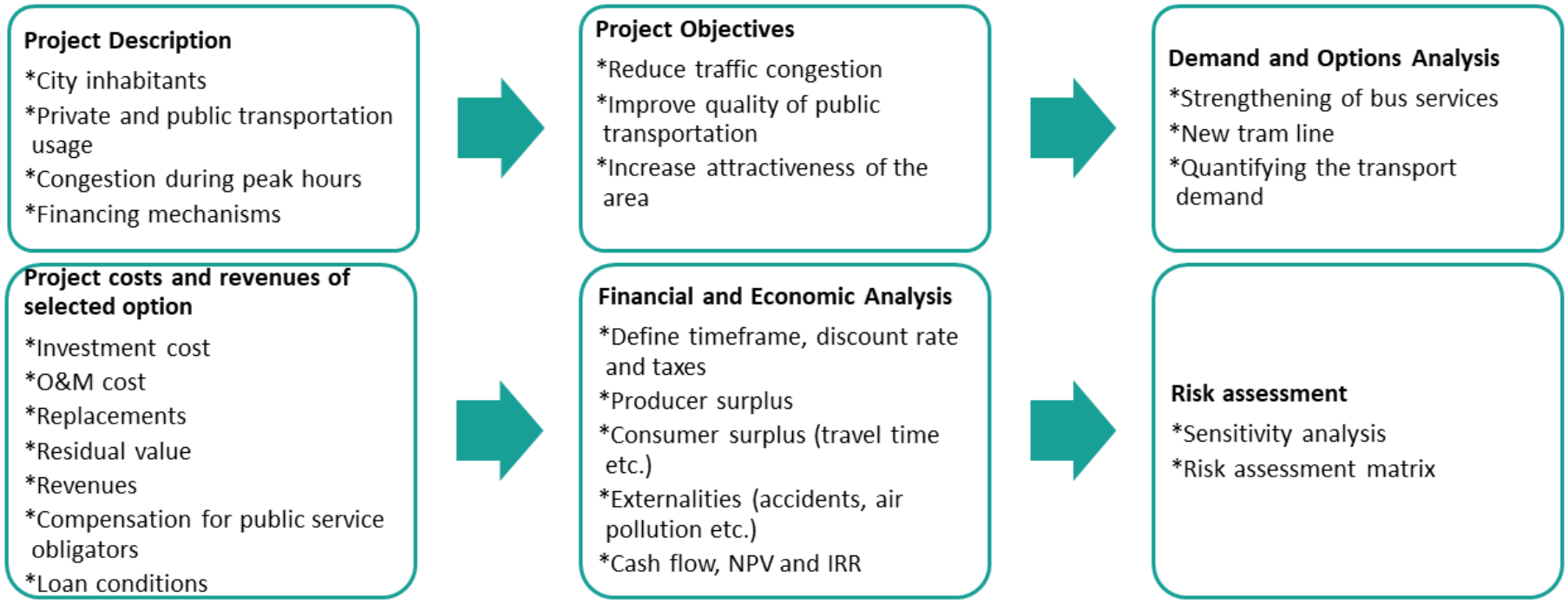
# 5.11. Financial evaluation
# Cost-benefit analysis - Example

**Urban Transport**

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# 5.11. Financial evaluation
# Life cycle cost analysis

***Life cycle cost analysis (LCCA):*** a framework to find the most cost-effective option taking into consideration the cost of purchasing, owning, operating, maintaining and disposing a product, i.e. asset/ process/ project/ investment. It depicts the overall cost of the alternatives form the early initial stages of the design process up to the final disposal of all the parts of the product. These costs can be the initial costs fuel costs, O&M, repair costs, replacement costs, disposal costs, loan interest payments, utilities costs, taxes, environmental costs, etc.. The NPV is used for the assessment.

Note: Not to be confused with the Life Cycle Analysis or Assessment (LCA) that has a broader scope, including also environmental costs. LCA covers all the stages of a products life, since the extraction of the raw materials used until its disposal. It depicts the overall environmental profile of a product.

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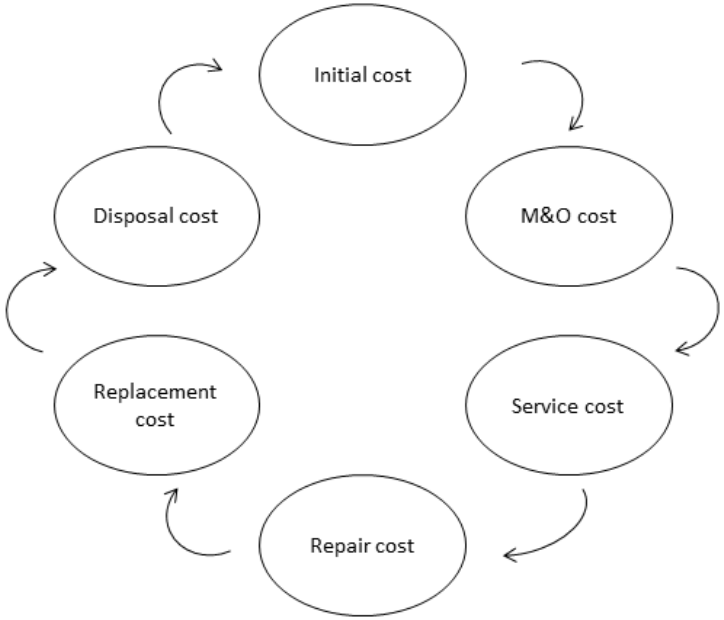
# 5.11. Financial evaluation
# Life cycle cost analysis - Example

Let consider someone wants to install PV on the roof of his house. The LCCA will include the following costs:

- Purchase of the PV panels, including transportation costs
- Replacement of the roof if needed
- Installation costs
- Other tax, bank interest costs, if any
- Maintenance costs
- Replacement costs of any part of the installation that may brake.
- Dismantling costs
- Disposal costs

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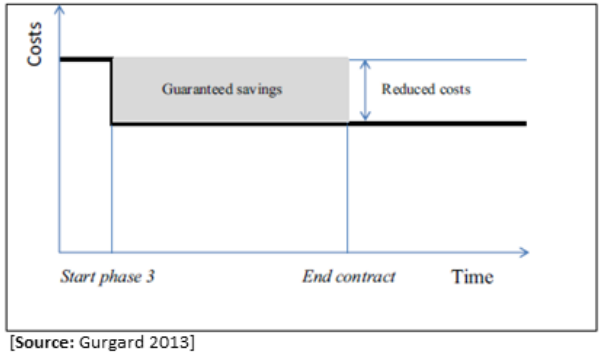
# 5.12. EPC – Concept, Mechanism, Possible business model

- Energy performance contracting (EPC) is a particular form of service contract in that the contractor pledges, through a binding commitment, that a specified amount of energy will be saved through the project.
- A typical EPC project is delivered by an energy service company (ESCO) and the contract is accompanied with a guarantee for energy savings.
- Generally, an energy service contract implies that a contractor has a long-term responsibility and incentive to maintain and improve equipment performance of a given physical structure



[**Source:** Gurgard 2013]

**Key characteristics of an Energy Performance Contracting (EPC) project**

❖**Turnkey service**: The EPC provider provides all the services required to design and implement a comprehensive energy saving project at the customer's facility, energy audit to measurement and verification of savings.

❖ **No need for up-front capital** from the customer : Energy efficiency investments are repaid directly from energy savings and related financial savings,.

❖Risks for customers minimised: The EPC provider assumes the contractually agreed performance risks of the project.

❖**Savings guaranteed**: The EPC provider guarantees the achievement of the contractually agreed level of savings and is obliged to **compensate savings shortfalls**.

❖**Support in securing financing**: The capital to finance the EPC project can either be

❖Supplied out of the client's own funds or **by the EPC provider or a third party.** Financing by the EPC provider is an option, not a necessary part of the EPC project.

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# EPC Contract Model
## Main steps in contracting procedure, Basic provisions

**The minimum items that should be included in energy performance contracts (Annex XIII of the EED) and consist in**:

- Clear and transparent **list of the efficiency measures** to be implemented or the efficiency results to be obtained.
- **Guaranteed savings** to be achieved by implementing the measures of the contract.
- **Duration** and milestones of the contract, terms and period of notice.
- Clear and transparent **list of the obligations of each contracting party.**
- **Reference date(s)** to establish achieved savings.
- Clear and transparent list of steps to be performed to implement a measure or package of measures and, where relevant, associated costs.
- Obligation to fully implement the measures in the contract and documentation of all changes made during the project.

- Obligation to fully implement the measures in the contract and **documentation of all changes made during the project.**
- Regulations specifying the inclusion of equivalent requirements in any **subcontracting with third parties**.
- Clear and transparent display of financial implications of the project and **distribution of the share of both parties** in the monetary savings achieved (i.e. remuneration of the service provider).
- Clear and transparent **provisions on measurement and verification** of the guaranteed savings achieved, **quality checks and guarantees**.
- Provisions clarifying the procedure to deal with **changing framework conditions** that affect the content
- Outcome of the contract (i.e. changing energy prices, use intensity of an installation).
- Detailed information on the obligations of each of the contracting party and of the **penalties** for their breach.

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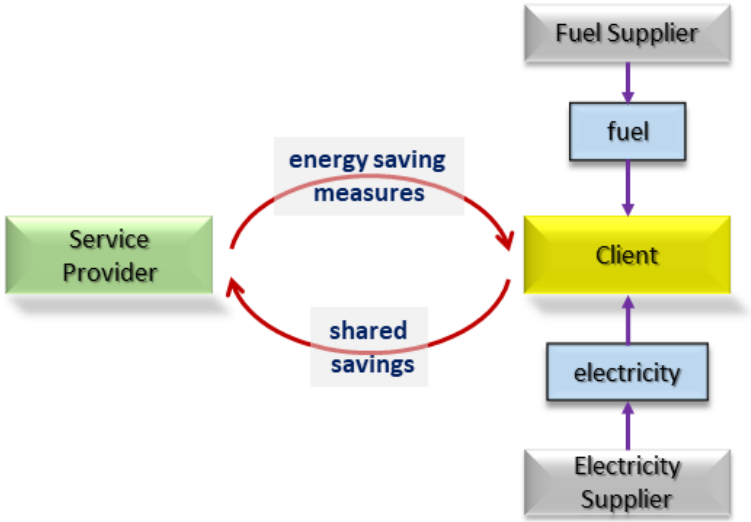
# EPC model contract
# European Code of Conduct for Energy Performance Contracting

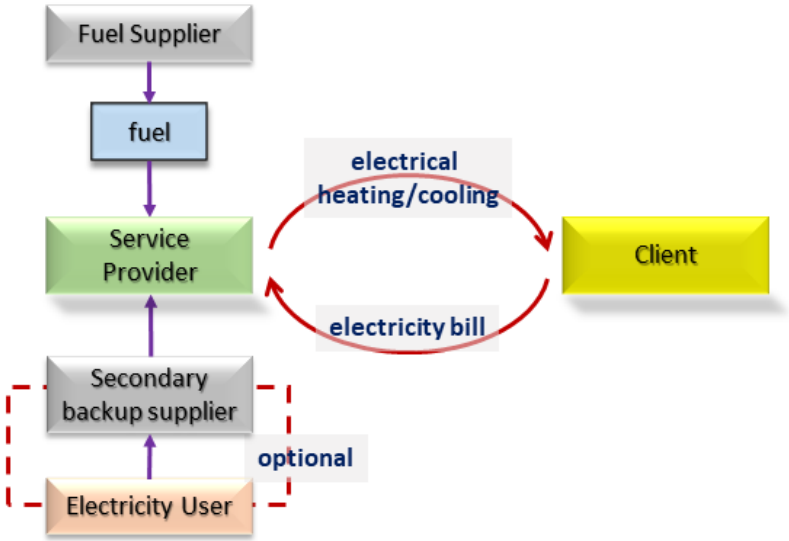
## Type of contracts

**Energy Performance Contract**
energy savings

- Guaranteed savings model (more frequently used)
- The shared savings model




**Energy Delivery Contract**
energy cost savings

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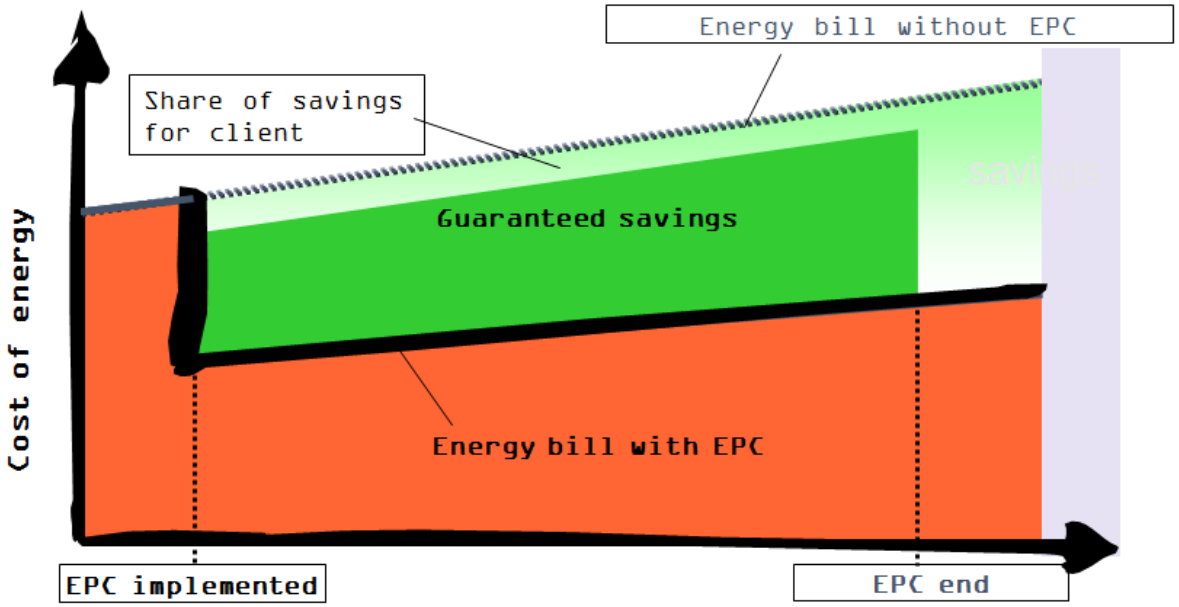
# Energy Performance Contract

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| | Energy Performance Contracting (EPC) / Guaranteed savings mode | Shared Savings model | Energy Supply Contracting (ESC)/Energy Contracting (EC) |
|---|---|---|---|
| **Service provider** | ESCO | ESCO | Energy Supply Service Company |
| **Key elements** | Implementation of energy saving measures (ESM) with ongoing monitoring & verification services to provide guaranteed energy savings | Implementation of ESM to provide cost savings associated with the overall energy bill | Efficient supply of useful energy such as heat, steam or electricity is contracted, measured and delivered in physical units. |
| **Energy savings potential** | High - comprehensive and detailed approach covering both supply and demand side | High - ESCO's primary focus and incentive is for energy cost savings with technical operation requirements as secondary. | Usually low - limited to the supply side (boilers, chillers, etc.) without regard to demand-side equipment. |
| **Guarantees** | Yes. The ESCO guarantees the performance related to the level of energy saved throughout the contract life (i.e. to energy cost savings in constant prices) | Not as standard. However, the ESCO may guarantee a minimum performance related to cost of energy saved in current prices throughout the contract life | May include incentives related to energy use reduction on the supply side, but without assuming any risk in case the expected efficiency improvement is not reached. |

| | Energy Performance Contracting (EPC) / Guaranteed savings mode | Shared Savings model | Energy Supply Contracting (ESC)/Energy Contracting (EC) |
|---|---|---|---|
| **Payment** | Payment derived from the energy savings achieved in constant prices of the base year | Payment linked to the current energy prices | Payment at a fixed rate/tariff without any energy performance requirements |
| **Provider's risk** | Assumes technical design, implementation and performance guarantee risks | Assumes performance risk, risk of energy price change (depends on current prices) and customer credit risk | Usually does not assume technical risk connected to ESM neither financial risk |
| **Energy savings transparency** | The energy consumption is measured before and after ESM are implemented. The transparency however depends on the quality of measurement & verification (M&V) is provided. In general the more independent M&V, the more transparent are the energy savings. | Depends whether and what quality M&V is provided. In general, the more independent M&V, the more transparent are the energy savings. | Low - a specific energy bill reduction is established (in monetary, not physical units). Usually the contract does not take into account the measurement of the energy efficiency. |

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**Contract model** – source BEA

**Annexes of the EPC contract**

Annex 1 - List of objectives
Annex 2 - Data entry form
Annex 3 - The authorized representatives of the parties
Annex 4 - Execution program
Annex 5 - Mandatory measures
Annex 6 - Investment structure and product list
Annex 7 - Reference consumption and prices for energy
Annex 8 - Calculation instructions
Annex 9 - Verification of energy consumption
Annex 10 - Payment regularization

**Criteria for evaluating the ESCOs offers**:

1. Energy saving guaranteed bigger as much as possible

2. Customer participation in guaranteed energy savings

3. Contract duration as short as possible

4. The share of investments in total costs as high as possible

5. The concept of energy management

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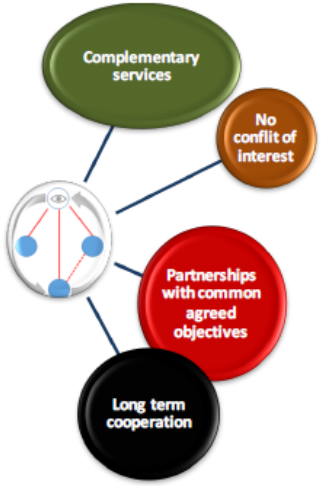
## Case study –SMEs networking to facilitate access to Performance Contracting

**- SMEs cluster to act as an ESCO – EPS+ project**
**- SMEs cluster to act as ESCO client for common energy saving measures- ESCO4Gent project**

- **The EPC+** project aims at developing and promoting new business models for the implementation of energy efficiency services through cooperation between Small and Medium-sized Enterprises (SMEs).
- Basic idea : **SME Partnerships for Innovative Energy Services** is an **organized cluster** of independent companies, mainly SME's, that **jointly supply energy efficiency services** and that have a **structured long-term collaboration with commonly agreed objectives**.
- SMEs will not engage in Collaboration unless there is a **strong feeling of Need, Trust, and Control**
- For SME's to engage in a SPIN (networking agreement) the starting point is to show the benefits of working together **ESCO4Gent** aims at achieving this ambition and effectively improving the energy efficiency of the companies in the industrial area of Ghent - This is achieved through a targeted inventory of the potential savings and the **creation of an targeted area ESCO** The potential energy savings in one SME is often not large enough, **but integrating multiple SME's in a targeted area ESCO makes these projects feasible.**

Standardization of technical measures
Simplification of EPC models
Financing tools
Simplified M&V
LOW TRANSACTION COSTS

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## Remarks on Learning Unit 5

The brief outline of the Education & Training program material presented above highlights the aim of the program: provide the trainee with the essential elements of economic analysis, energy projects investing and financing, and evaluation of financial decisions.

As the Energy Manager of an SME the trainee will be equipped with the minimum required skillset and knowledge to successfully tackle all major challenges that they might face during the design and implementation of a successful energy saving strategy and policies.

Upon successful completion of LU5 the trainee will be able to understand the basics of the economic analysis of an energy project, explore financing options and evaluate the corresponding investment employing basic financial knowledge and relative tools.

Thus, the trainees will be able to work on case studies of energy efficiency and deliver formal reports regarding the strategy/project under inspection.

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