



# Energy efficiency

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# Energy efficiency

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# Crossroads of the Energy in the 21th Century

- Energy is doubtless one of the most important factors of growing and welfare for a Country or Society.
- The availability of abundant and cheap energy is behind the great leap forward made by many countries during the 20th Century.

But...

# Crossroads of the Energy in the 21th Century (2)

But...

- Since late 1960's the Energy (extraction, transformation, use, etc.) has gradually been perceived as a pollution agent
    - Car-derived and Industry contamination, which has led to more and more restrictive regulations
    - Aggressive extraction and transportations of coal, oil and gas
    - Danger of nuclear power plants...
  - Since the first Oil Crisis (1973) the price of energy has substantially increased (and it is expected they continue to do so)
  - There is a very wide scientific agreement concerning the finding that CO2 emissions are responsible for the increase of our planet's temperature (climate change)
- ... taken together, all this has led to growing awareness of the need to reduce energy consumption.

# What do we mean with Energy Efficiency

- Energy efficiency (EE) is a rather simple but very broad concept.
  - EE can be defined as “a set of technologies and strategies designed to
    - save energy in a given process and/or
    - obtain more value (products and/or services) from a given amount of energy”.
  - Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input.
  - The concept of EE is related with the Laws of Thermodynamics, in particular with Second Law, which establishes that in an energetic cycle (or process) not all the energy given to it can be recovered as useful energy.
- there always will be energy losses in any process
- the amount of losses is related with the entropy concept
- we can reduce losses if we approach reversible processes.

# EE technologies & strategies

- EE technologies are based on well-known science and engineering fields
    - i.e. heat engine cycle efficiency, piping isolation, etc.
  - There are almost as many EE technologies as fundamental or basic processes: thermal, mechanical, electric...
  - Real processes in industry residential or transport repeat
- ➔ we can talk about “horizontal technologies”: EE technologies are present in several processes and apply to many of them
- For example, we may talk about electric motor efficiency which applies to industry, transport, households...

# EE technologies & strategies (2)

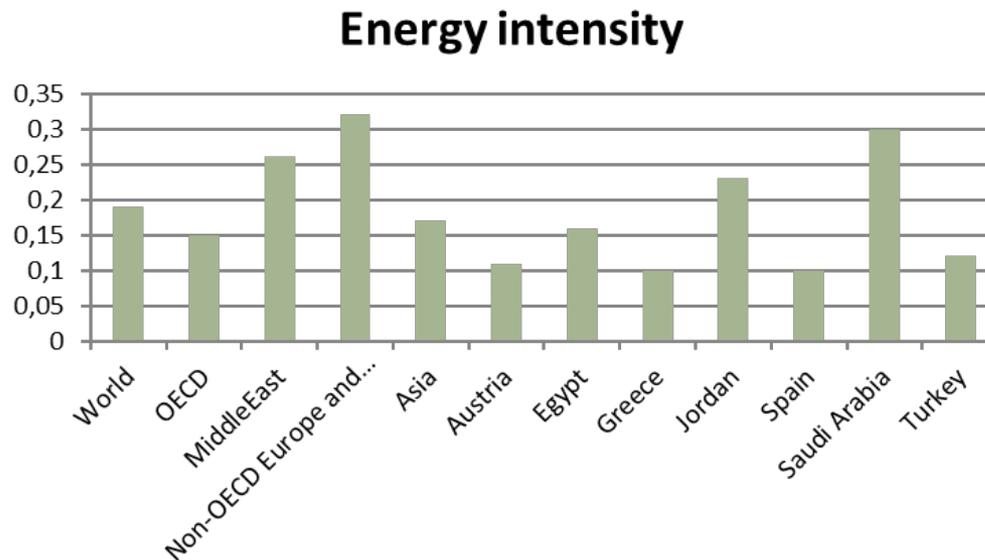
- In recent times
  - There has been feverous interest in increasing equipment efficiency
  - EE strategies have been developed in order to systematize system's analysis (energy audits) looking for opportunities to improve the use of the energy.
  - Informatics and Control Sciences make possible automatize and systematize the measurements of magnitudes and treat them for system analysis (energy accounting).
  - The EE integration with implemented plant control systems (such as Distributed Control Systems)

# What has changed in the turn of the Century with EE?

- Increasing sensibility about the environment, especially in climate change, that has put on the political and technological agenda the energy efficiency.
- There has been a general improved efficiency in devices and equipment and processes.
- New equipment and processes have been developed and others rescued from the technological parking lot to which they had been consigned.
- There has been a growing integration and control of technologies as a means to improve energy consumption
- Energy management has been standardized and normalized.

# A measure of EE: World energy intensity

**Energy intensity** may be considered as a measure of the energy efficiency of a country's economy. It shows the amount of energy needed for a unit of GDP.



There is room for improving efficiency for all countries

Energy intensity in TPES/GDP (PPP) (toe/1000 2005 USD)

TPES: Total Primary Energy Supply  
Toe: ton of Oil Equivalent

GDP (PPP): Gros Domestic Product at Purchasing Power Parity  
USD: US Dollar

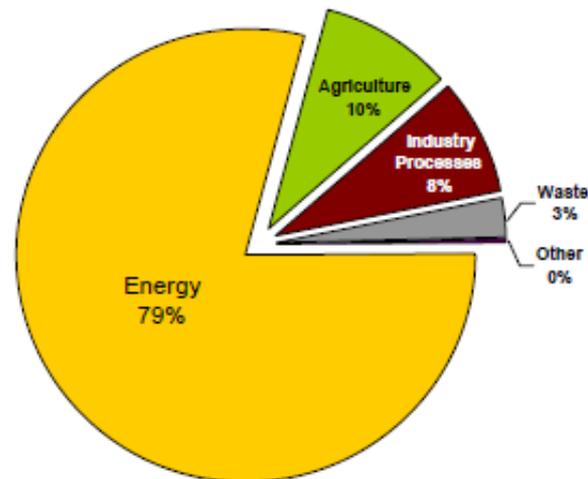
# Politic impulse: IEA & UE 2020 Strategy

Signs that an inflection point has occurred with EE is that  
(among others)

- International Energy Agency (IEA)
- EU (European Union)

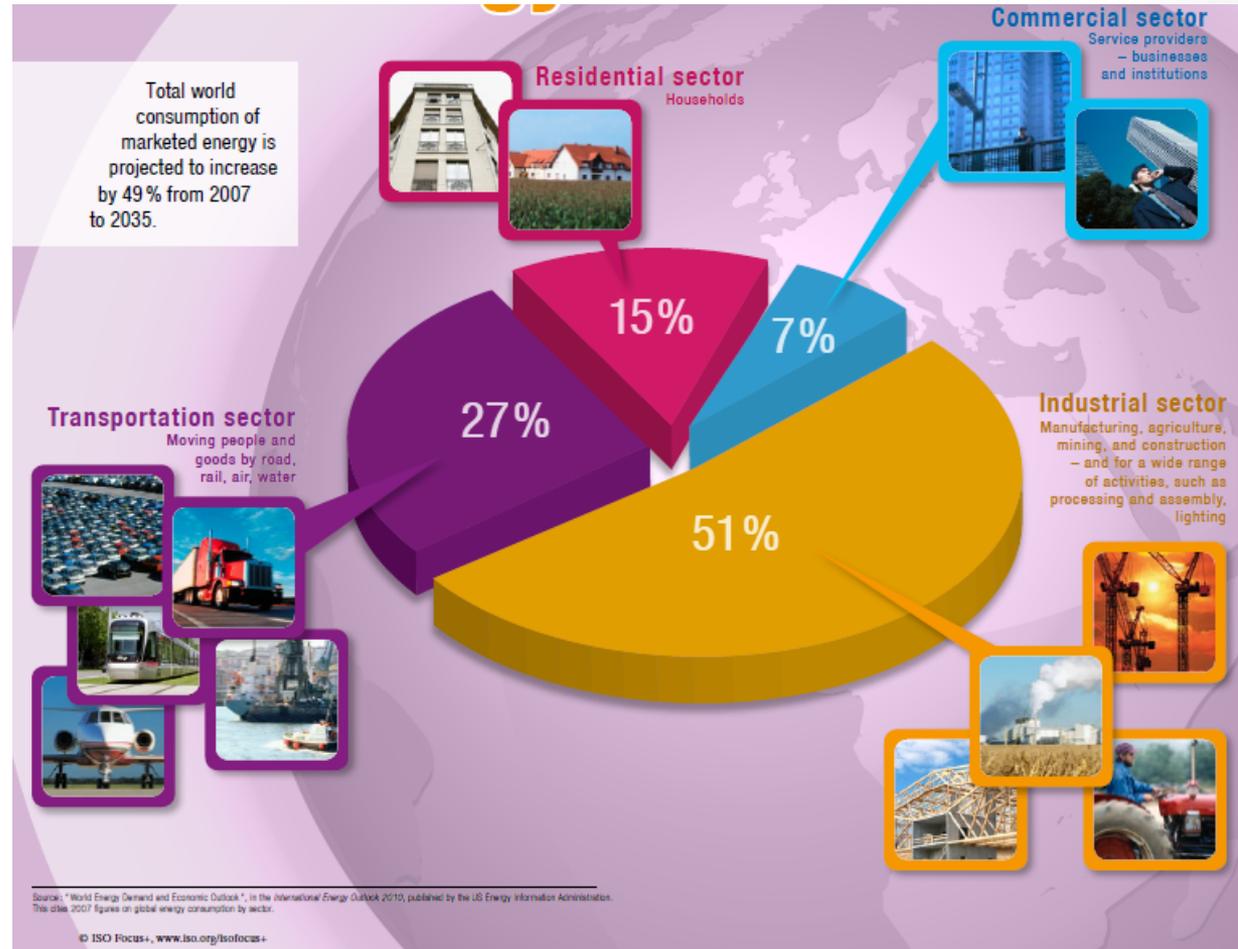
focus on EE as an strategic energy tool **EE, a new energy source**

Share of greenhouse gas emissions in 2008



# World Energy Consumptions by Sectors

- Industry and the Primary Sector consume half of the total primary energy
- The transport Sector consumes a quarter
- Residential + Services together consume the remaining quarter



# Politic impulse: IEA measures

In recent years IEA has focused on EE, demonstrating its concern with

- Climate Change
- New Energy Scenario
  - Increased world energy consumption
  - Foreseeable end to fossil fuels and increasing prices meanwhile
  - Enormous investments needed to implement renewable energies
  - Problems with nuclear power generation

**→ Proposal of 20 ideas for EE**

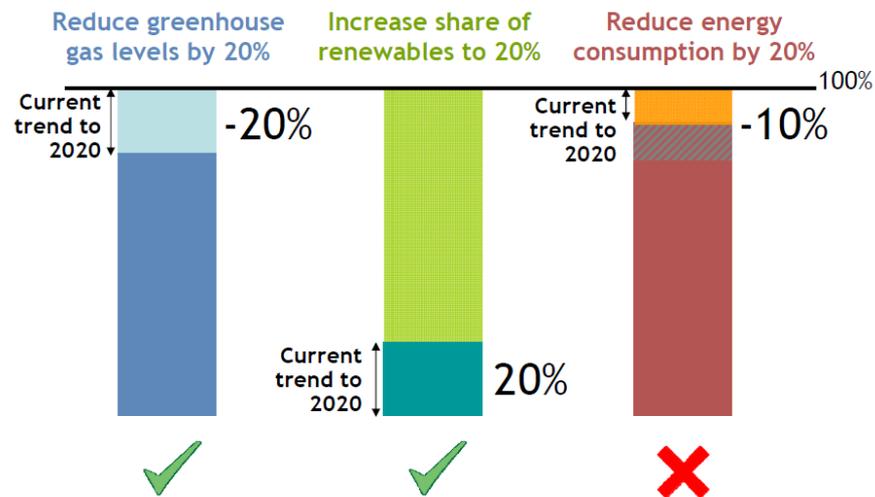
# Europe 2020 targets: Sustainable growth

UE has included energy on the short term agenda *Europe 2020 Strategy*.

- **Targets in climate change and energy sustainability:**
  1. **greenhouse gas emissions 20%** (or even 30%, if the conditions are right) lower than 1990
  2. **20% of energy from renewables**
  3. **20% increase in energy efficiency**

green industries

- Third target includes a **20% reduction in primary energy consumption**.
- ... and is the most difficult goal to achieve.



# New UE 2020 target: 20% GDP in Industry

- A new European target has been recently added to *2020 Strategy*: **Industry to reach a weight of 20%** in European GDP (Gross Domestic Product)
  - In EU Industry energy costs
    - are **the second in importance** after work force
    - have grown by 27% between 2005 and 2012, a trend that will probably continue in the near future
- ➔ EE has become a **competitiveness issue** for Industry.

Furthermore...

- ➔ Reaching the objective of 20% in EE may represent **400.000 new jobs**.

# European Directive on Energy Efficiency

## General (1)

Evidence that reduction in energy consumption target was not going to be reached → **European Directive on Energy Efficiency (2012):**

- **Common framework of measures** in order to ensure the achievement of the 20 % target on energy efficiency and further savings beyond that date.
- **Legally binding measures** to increase the efforts of Member States at all stages of the energy chain—transformation -- distribution -- consumption.
- **Legal obligation to establish energy efficiency obligations** schemes or policy measures in all Member States establishing national EE targets for 2020.

The real main new are the compulsory policies

# European Directive on Energy Efficiency

## General (2)

- It lays down rules designed to
  - **remove barriers** in the energy market and
  - **overcome market failures** that impede efficiency in the supply and use of energy.
- These will drive energy efficiency improvements in households, industries and transport sectors.
- Exemplary role to be played by the **public sector** is stated
- **Right of consumers** to know the energy they actually consume.
- Promotion of **energy services** concept and **energy services providers**

... We'll see them more detailed for Sectors

# EU EE Directive proposals

- Compulsory planning, regulation and **public sector exemplarity** for **Member States**
- **Energy companies**
  - Compulsory improvement in energy efficiency in the **transformation and distribution of energy**
  - **Waste heat recovery** (CHP) for new and existing power & industrial plants
  - Conversion into **energy services companies**.
  - Implementation of ***demand management systems***

# EU EE Directive proposals (2)

- **Industry**

- Compulsory audits for large companies & incentives for the implementation of recommended measures and the introduction of **Energy Management Systems**
- Incentives for SME businesses (audits and EMS)

- **Households & Services**

- EU defends consumers
  - ➔ **Appropriate information, accuracy & frequency of billing** based on real consumption (included in the bill)
  - ➔ Who pays for new **individual energy meters**?
- Actual presence of **energy services providers**

# EU Directive on Energy Efficient Road Transport Vehicles

- The Directive on the **Promotion of Clean and Energy Efficient Road Transport Vehicles** aims at a broad market introduction of environmentally-friendly vehicles.
- It requires that energy and environmental impacts linked to the operation of vehicles over their whole lifetime are taken into account in all purchases of road transport vehicles.
- It defines common rules for calculating the lifetime costs linked to the operation of vehicles.

# Bunch of technologies

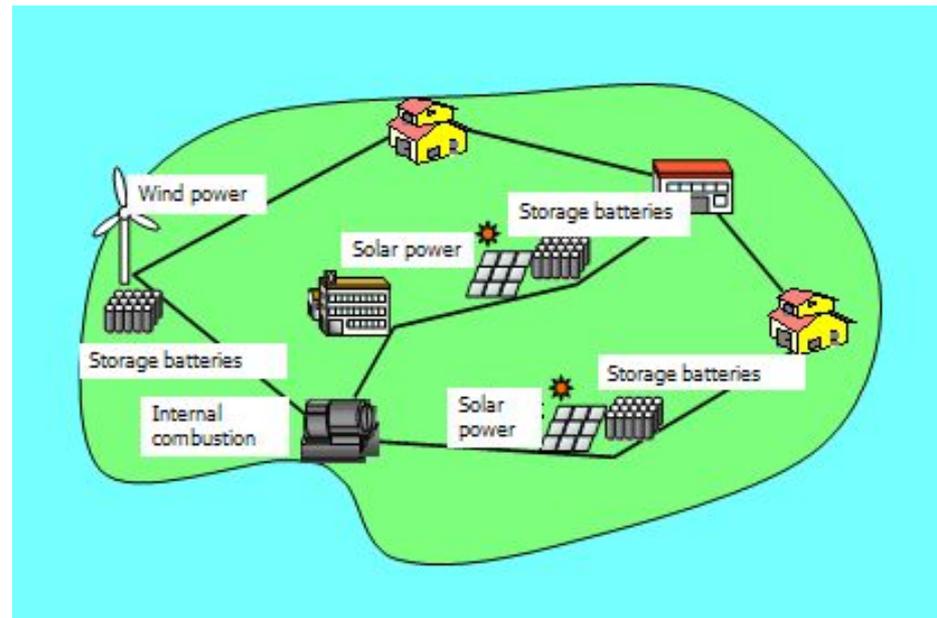
## EE in Industry

- Energy costs can account for 25% of production costs
- Good practices in **electric motors**:
  - **right sizing**
  - **high power factor**, balanced phases and no harmonics
  - **on-line transmission**
  - use of **variable-frequency drive (VFD)** for adapting to real charges
- **Correct operational setting** of pumps, compressors, etc.
- Close relationship between EE and **Industrial maintenance**
- Implementation of **energy accounting system** as energy management tool.
- ... and of course **cogeneration** (or CHP) when there are thermal and electrical demands!

# Bunch of technologies

## EE in Industry (2): microgrids

- Microgrids are a set of aggregated microgenerators and loads (Distributed Energy Resource, **DER**) operating as one sole system that can interact with the public electrical network, consuming or supplying electricity to the grid or supplying it to a third consumer.
- Microgrids need powerful software for energy management in order to coordinate the actions of their elements.
- Microgrids consist of :
  - Generators
  - Energy consuming equipment
  - Energy storage systems
  - Controllable loads
  - Outside public network
  - Thermal generator and consumer when applicable, as with cogeneration groups



# Bunch of technologies EE in household

- Extension of
  - **Building Energy Certification**
  - **Labelling Energy Efficient** Home and Office Equipment
- **Energy audits**
- Development of **smart grids**: electricity producers and consumers communicate and make decisions about how and when to produce and consume kWh
  - Can yield significant **efficiency improvements**.
  - Customers can help deliver **lower electricity costs up to 30%** reducing power peaks, line losses, infrastructures investments, etc.
  - Facilitates **smart energy bill** (EU EE Directive)



# Bunch of technologies

## EE in household (2)

Other actions...

- Changing to **more efficient lamps** or bulbs: compact fluorescent lamps (CFL) with electronic ballast, LED, etc.
- Control systems that match **artificial lighting** with the presence of people and/or natural lighting.
- ***Micro-co and trigeneration*** (combustion engines, microturbines, fuel cells...)

... and let's not forget **maintenance**! (sometimes simply cleaning devices will be sufficient to save energy)

# EE in Transport

- Very competitive sector
- The measures focus on the **public transport**, where the potential for savings is greatest.
  - **Urban Mobility Plans**
  - **Business Transport Plans**
- Road transport and passenger car **fleet renewal**
- More efficient **engines, generators or car parts**
  - Electric car
  - Fuel cells
  - Resurrection of internal combustion engines? Others?
  - Lighter cars
  - Lower friction tyres
- **Car sharing** and other smart efficient strategies

# Bunch of technologies

## EE in Primary sector

- Agricultural sector represents **5 % of total energy mix**
  - **Low technical training** in vast areas
  - Many people with **low incomes** who cannot afford high energy prices
  - Small farmers/growers need to save energy in order **to compete with great companies**
  - Energy in large amounts is sometimes **difficult to access** in the countryside.
- **Pumping water and agricultural machinery** are great consumers of energy which may be substantially lessened.
  - modernizing **agricultural fleets**
  - **optimizing pumping** devices
  - changing of sprinkler systems to **drip irrigation**.

# Bunch of technologies

## Summary

- Improving efficiency devices (and equipment for improving efficiency devices) and plants
- Implementation of Best Available Technologies (BAT)
- Development of energy audits in buildings and industry
- Certification and labelling
- Implementation of micro/smart energetic grids
- Appropriate maintenance of equipment, building and plants

**And... we are not talking about renewable energies, but of course they apply too!**

# Standardisation

- Just ten years ago activities concerning with the use of Energy were scarcely regulated by international standards.
- Recently standards referring to
  - Energy certification (buildings)
  - Energy labelling
  - Energy Management Systems
  - Energy auditsare an important tool for the improvement of the use of energy.
- The standardization organizations have identified the overall energy management as a priority due to its potential to reduce greenhouse emissions worldwide.

# ISO 50001. Energy management systems

- **ISO 50001:2011, Energy management systems- Requirements with guidance for use** provides a policy mechanism for promoting
  - energy efficiency of organisations, driving investment in that field
  - the widespread adoption of best energy practices
  - the reduction of greenhouse gases.
- The standard set the principles of **Energy Management Systems (EnMS)**, but does not prescribe minimum performance criteria, energy reductions, or targets for organisations.
- The standard could influence **up to 60% of the world's energy use.**

# ISO 50001

## In the organisations

- ISO 50001 is based on the **Plan-Do-Check-Act approach** to continual improvement.
- ISO 50001 provides organizations with an **internationally recognized framework for efficiently managing and improving their energy performance**. The standard addresses:
  - Energy use and consumption
  - Measurement, documentation, and reporting of energy use and consumption
  - Design and procurement practices for energy-using equipment, systems, and processes
  - All variables affecting energy performance that can be monitored and influenced by the organization.

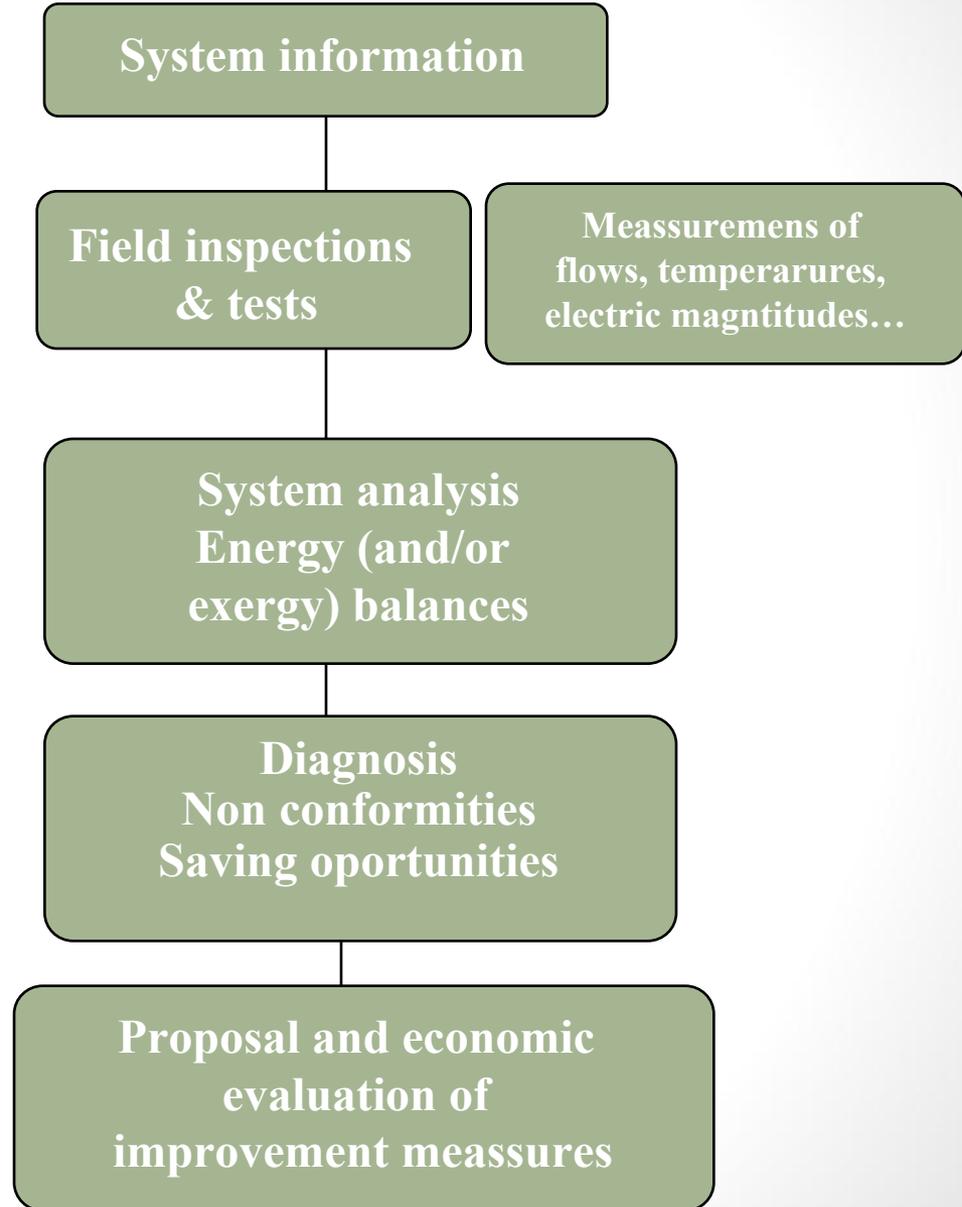
# ISO 50001 Certifications

- Factors expected to drive broad adoption of ISO 50001:
  - the growth of corporate sustainability programs, related to CSR
  - the spread of energy management standards along the manufacturing supply chain.
- Organizations earning certification under ISO 50001
  - will signal to customers their responsible stewardship of energy resources.
  - will improve economic competitiveness.
  - will enjoy the associated benefits of carbon reduction, energy-related risk reduction, and certified sustainability—all of which are likely to increase in value.

**Currently, EnES certification is a reality: in 2011, first year life, 461 certifications has been done all over the World.**

# Energy audits

**Energy audit:** a detailed inspection, survey and analysis of energy flows in a process or system (building, plant...) in order to understand the dynamic of the energy into it with the aim of reducing the energy input without negatively affecting the output(s).



# Energy audits

## Benefits

- An energy audit is
  - a powerful tool for reaching EE
  - can help in a better knowledge of the plant
  - complementary to maintenance actions
  - a key in the Energy Management Systems
- Recently energy audits has extended to plants, buildings, processes, etc.
  - UE EED set it as compulsory for big plants or advisable for other organisations

# Energy audit standard UNE 216501

- Spanish standard **UNE 216501: Energy audits: Requirements**, provides guidelines for carrying out energy audits. (After which others have appeared).
- It requires UNE-EN 16001:2010 **Energy Management System** (now ISO 50001) for application.
- According to UNE 216501 an energy audit is a **systematic, independent and documented process** for obtaining evidence and objective assessment of an organization or part of it, in order to:
  - obtain **reliable knowledge of energy consumption** and its associated costs;
  - identify and **characterize what affects energy consumption**;
  - identify and evaluate the various **opportunities for savings, improved efficiency and diversification of energy** and its impact on energy and maintenance costs, as well as other benefits and associated costs.

# Energy audits

## Structure

- The standard UNE 216501 mainly mentions:
  - **Definitions**
  - **Defining scope and extent**
  - **Measurement methodology, data collection, process analysis and energy accounting**
  - **Final report**
- We can follow the formal procedure mentioned in **ISO 19011 Guidelines for quality and/or environmental systems auditing**, relating to topics such as
  - **Plant / process information**
  - **Audit plan**
  - **Checklists**
  - **Audit criteria**
  - **Conformities and nonconformities**
  - **Audit team: composition, training and competences of the members**

# Energy/environmental audits

- Energy audits can be considered a kind of environmental audits
- The main differences is
  - In environmental audits **most audit criteria are stated by current laws.**
  - Energy audits pursue certain inefficiencies, most of them **not explicitly prohibited by regulations.**
    - ➔ Usually we should convince its realization by profit.

# Final reflexions on EE

## What to do for the EE may be implemented

- There are **many oportunities for saving energy** in industry, residential or service buildings, transport, etc. ... and **everybody knows it**.
- Everybody knows that energy consumption is
  - **not healthy for the People,**
  - **not sustainable for the Planet,**
  - **very expensive for most of the Countries.**
- But
  - Objectively, **energy is currently cheap** (and that is good), despite of many people think.
  - **EE actions are expensive**, although the investment is usually recovered in a reasonable period of time.

# Final reflexions on EE

## EE in companies

Energy Efficiency (EE)

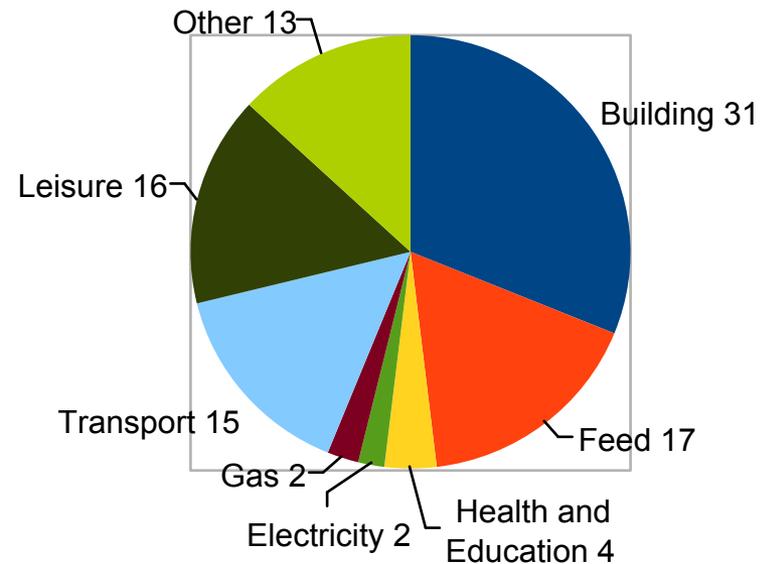
- **reduces current expenditure**
- is an **element of competitiveness**
- is important for **public image**: environmental effects, image of modernity and technical development, Corporate Social Responsibility (CSR), etc,

# Final reflections on EE

## Energy cost

- Broad variation:
  - usually 3-12 %
  - more than 50 % in some metallurgical, mining or chemical industries.
- In Spain
  - **electricity costs exceed 4% of overall costs only in 6 industrial sectors** (concrete, metallurgy, siderurgy, paper and artificial fibre)
  - **In households only 4% of spending is on electricity and gas**

Spanish household spending on energy (%)



# Final reflections on EE

## Energy savings

- **Savings margin of 15-30 %.**

... but

- money is needed to bring about these enhancements and
- relatively long pay back time (from months to 7-8 years)
- There are economic incentives in some countries (USA, UK, Germany...), but the **main investment is private.**
- The EU wants **Energy Services Companies** to finance energy savings included in the bill of gas or electricity.

**The main barriers to EE are the cost of the investment and the project pay-back time**

# Final reflections on EE

## For this to work...

- For this to work...
  - **Public impulse and support** (active policies, demonstrative actions, founding, etc.) is currently very convenient, almost essential.
  - **Binding regulation** for the implementation of EE technologies based upon BAT, from project to end use of the good (a building, a device, an equipment).
  - **Staff** (engineers, scientists, technicians, economists...) well prepared in EE technologies and strategies.
  - **People must be aware** of how important is the efficient use of energy: money saving, health, the preservation of the Planet as a whole.
  - EE actions must **reach common people** in an easy way - easy to understand, easy to implement.

### In this respect

- European EE Directive and IEA Ideas are a good start for reducing the energy consumption

# Final reflections on EE

## Energy Service Companies (ESCO)

- Energy savings can be described as “***not too much not too little***”
  - ***Not too much for an ordinary company*** whose main concern is not energy
  - ***Not too little for a specialized company.***
- Alternative: the **Energy Service Company (ESCO)**, a commercial business **providing overall energy solutions** including finances
  - well trained **staff and technicians**
  - **aware of new devices, developments, technologies**, etc
  - who knows **how to manage and maintain the whole plant**
  - **aware of public incentives** and opportunities
  - which **manage how to finance the investment**
- The owner (company, building occupants, etc. ) benefit from the energy savings and pay a fee to the ESCO in return.

# Final reflections on EE

## Energy Service Companies (2)

- An Energy Service Company (acronym: ESCO or ESCo) is a commercial business providing energy solutions from design to fit and overall management of energy involved projects, such as savings, conservation, generation, etc.
  - with well trained staff and technicians able to provide a broad range of comprehensive energy solutions
  - aware of new devices, developments, technologies, etc of this changing field
  - who knows how to manage and maintain the whole plant from the technical and economic point of view
  - aware of public incentives and opportunities
  - which manage how to finance the investment
- The owner (company, building occupants, etc. ) benefit from the energy savings and pay a fee to the ESCO in return.

# Final reflections on EE

## New Energy Investment Cycle?

- In some countries (Spain is one) the current Energy Investment Cycle is exhausted, and we are at an impasse.
- Oil will run out one day
- Shale gas and non conventional oil are now emerging, but for how long?
- Nuclear energy involves too many unsolved problems
- Renewable energy is growing everywhere and has a long way to run, but public help is needed and in some countries this is difficult - especially now

# Final reflections on EE

## New Energy Investment Cycle? (2)

- What about EE itself?
- Why not develop the more renewable MWh that exists?
- ... this which **we do not consume** or **need**?
  - **Many jobs may be created** (in 2011, 136,000 employees in UK, ESCO billing of 5 billion \$ in USA...)
  - The **pollution would be reduced** immediately
  - **No big infrastructures** are needed
  - **Energy dependence would decrease...**

**WELCOME TO REAL ENERGY EFFICIENCY**

Thank you very much for your  
attention

Questions, please?