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First Transnational Learning Network
21st October 2014

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Support & Training for an Excellent Energy Efficiency Performance

Energy Efficiency in SME's

EE Assessment Method Typical area for improvements

Co-funded by the Intelligent Energy Europe Programme of the European Union

and coordinated by

EUROCHAMBRES

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Learning Objectives

Understand the need for energy efficiency in SME's ;

Understand the EE assessment method ;

Get to know the basics of energy efficiency in SME's energy systems

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What is the problem?

The need for energy efficiency in SME's ;

- Resource depletion: fossil fuel
- Supplying problems and energy prices
- Climate change
- Business and political insecurity
- The energy saving potential is unexploited
- Problems related to energy consumption in companies
- The benefits of the energy management not yet harvested

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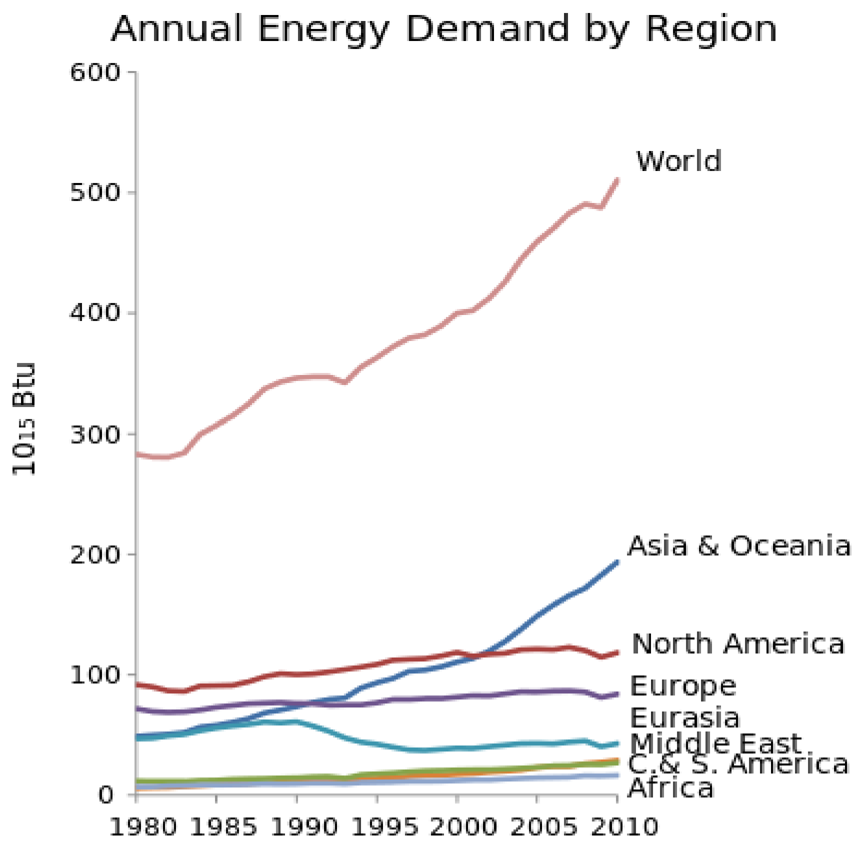
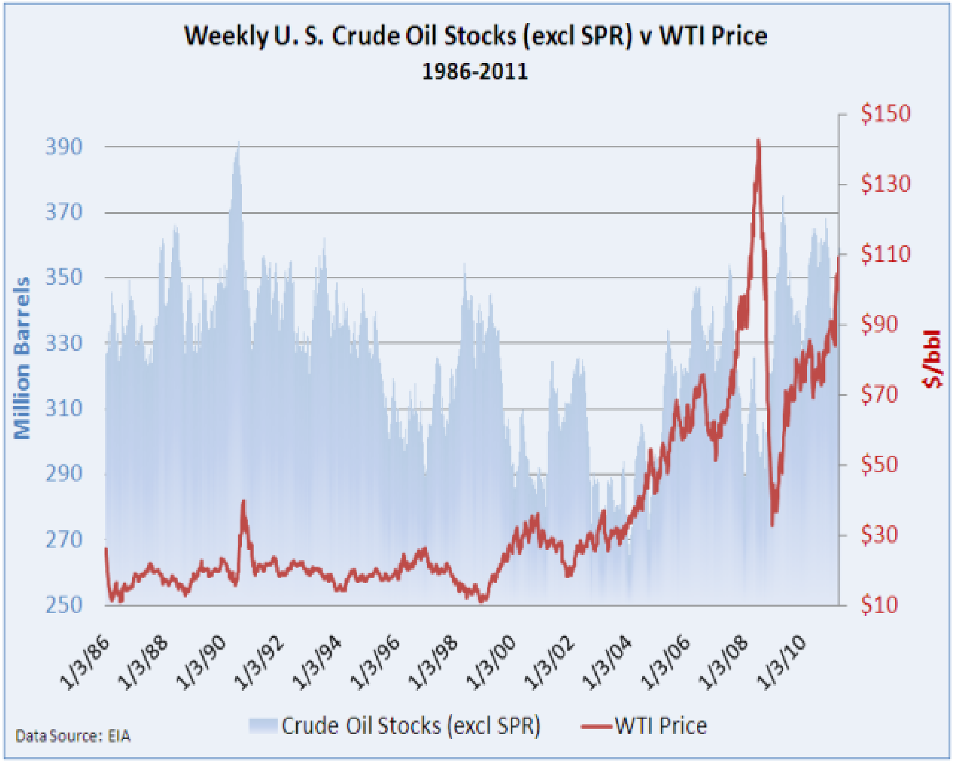
Increased energy consumption and prices





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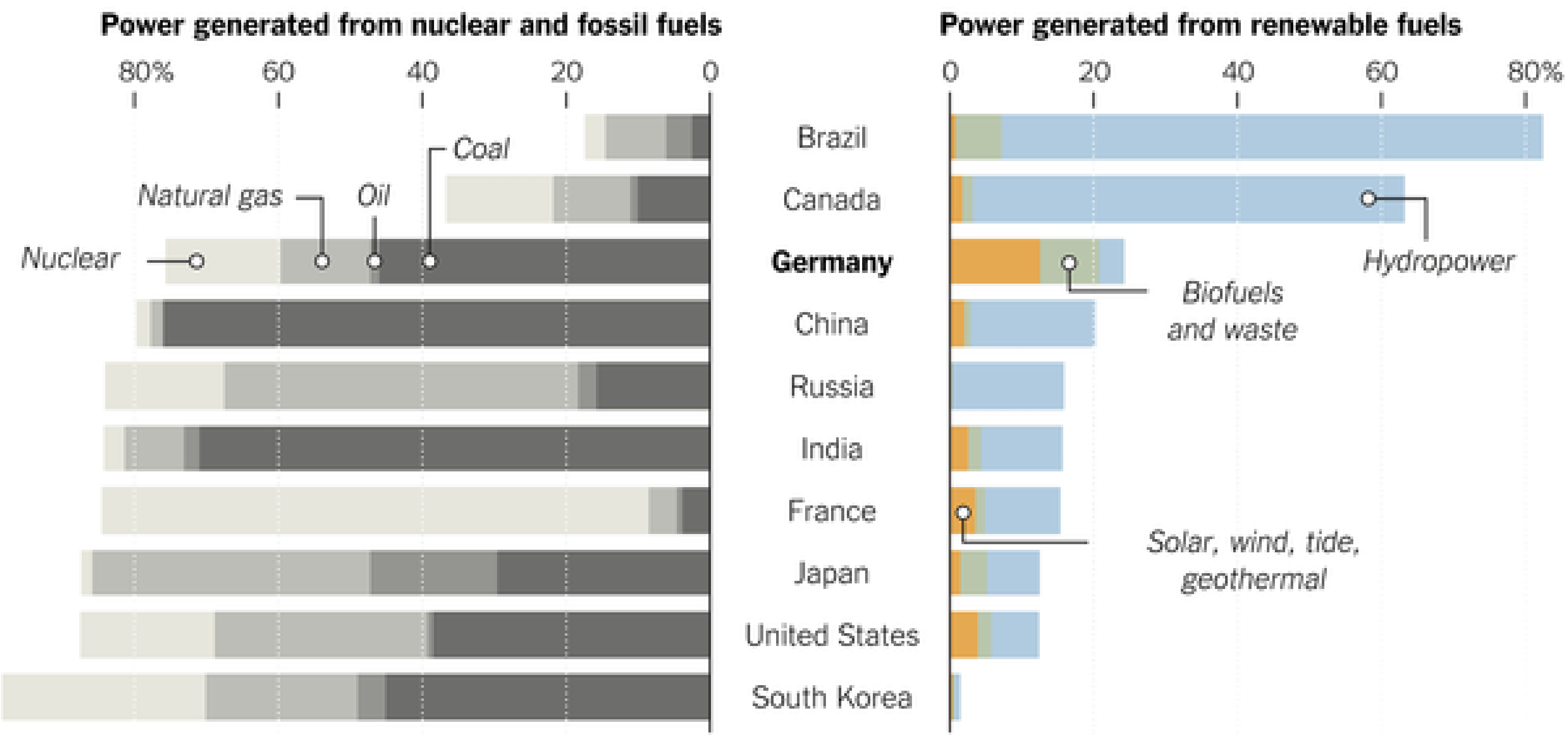
Generation of power



Source: Energy Efficiency Agency, 2012

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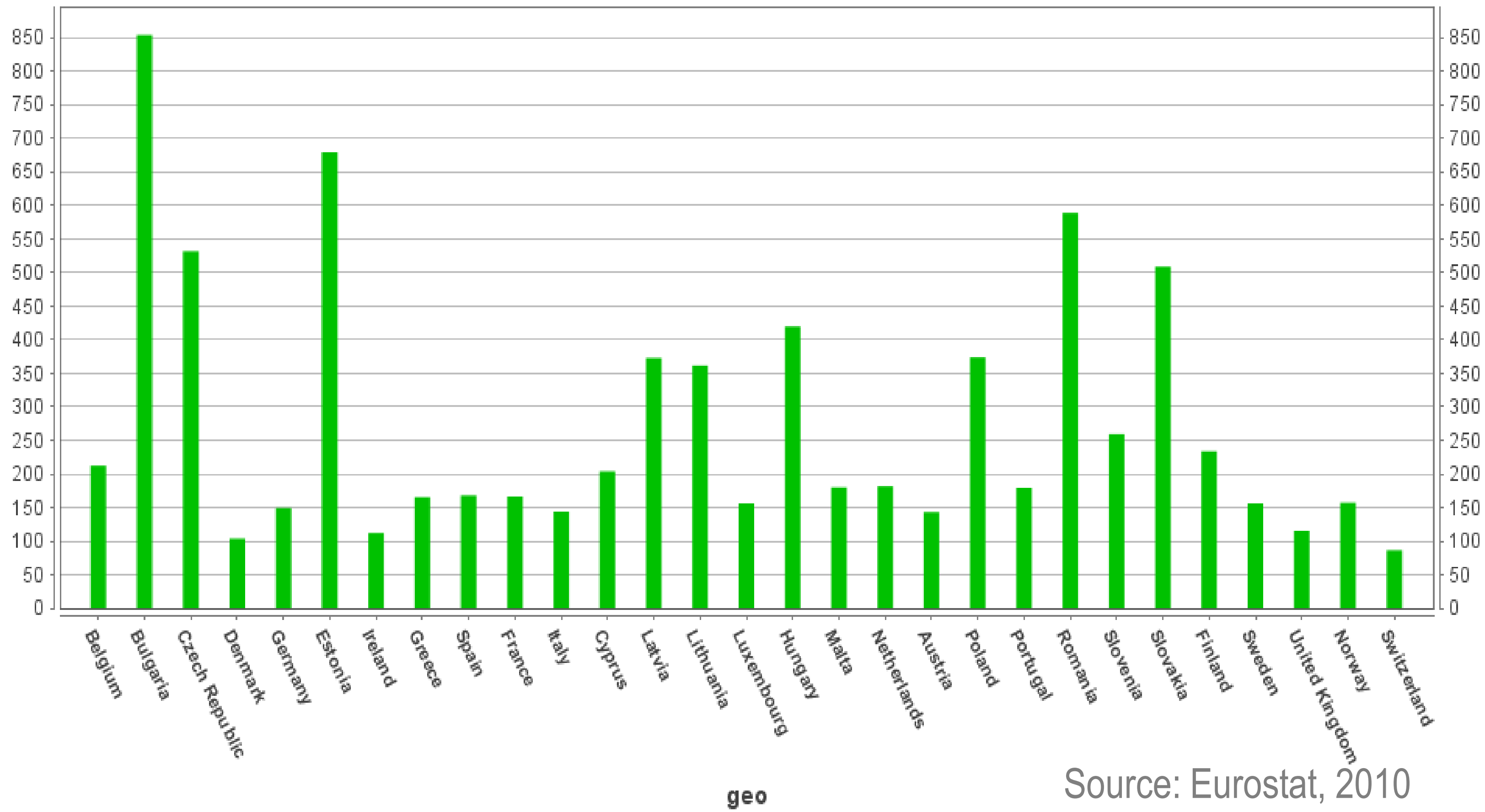
Energy intensity of the European economies



Source: Eurostat, 2010

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GHG emissions by sector

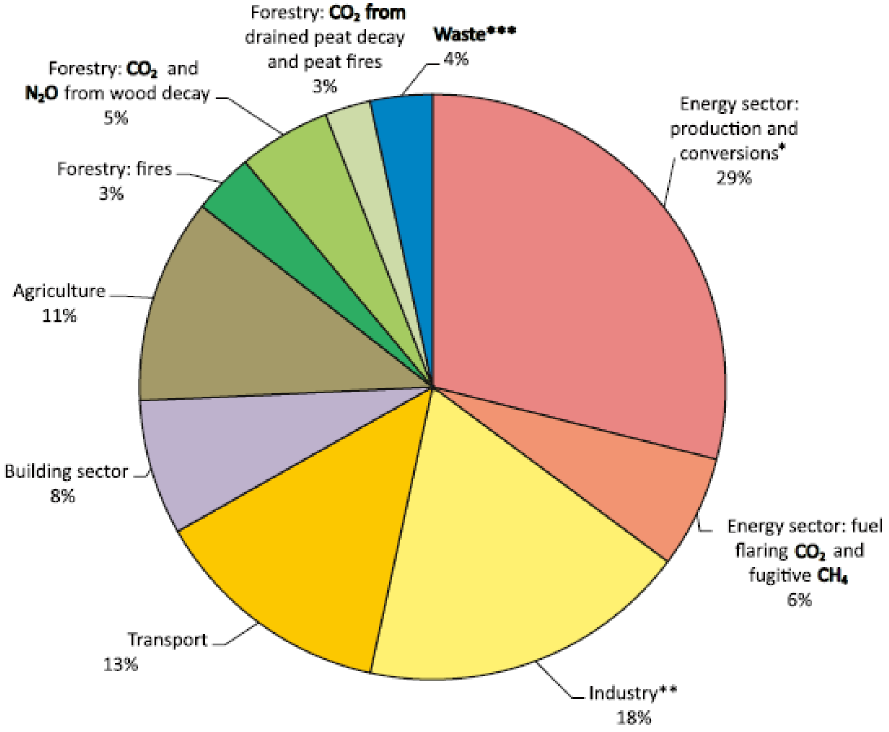
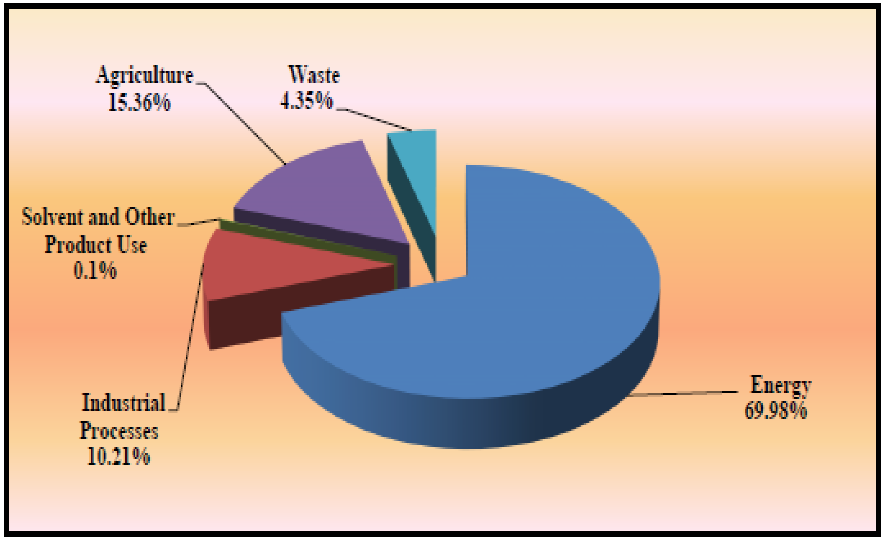


Figure 3.1 The contribution of Energy Sector to the total GHG emissions in Romania, 2011



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The emissions GAP report , UNEP 2010

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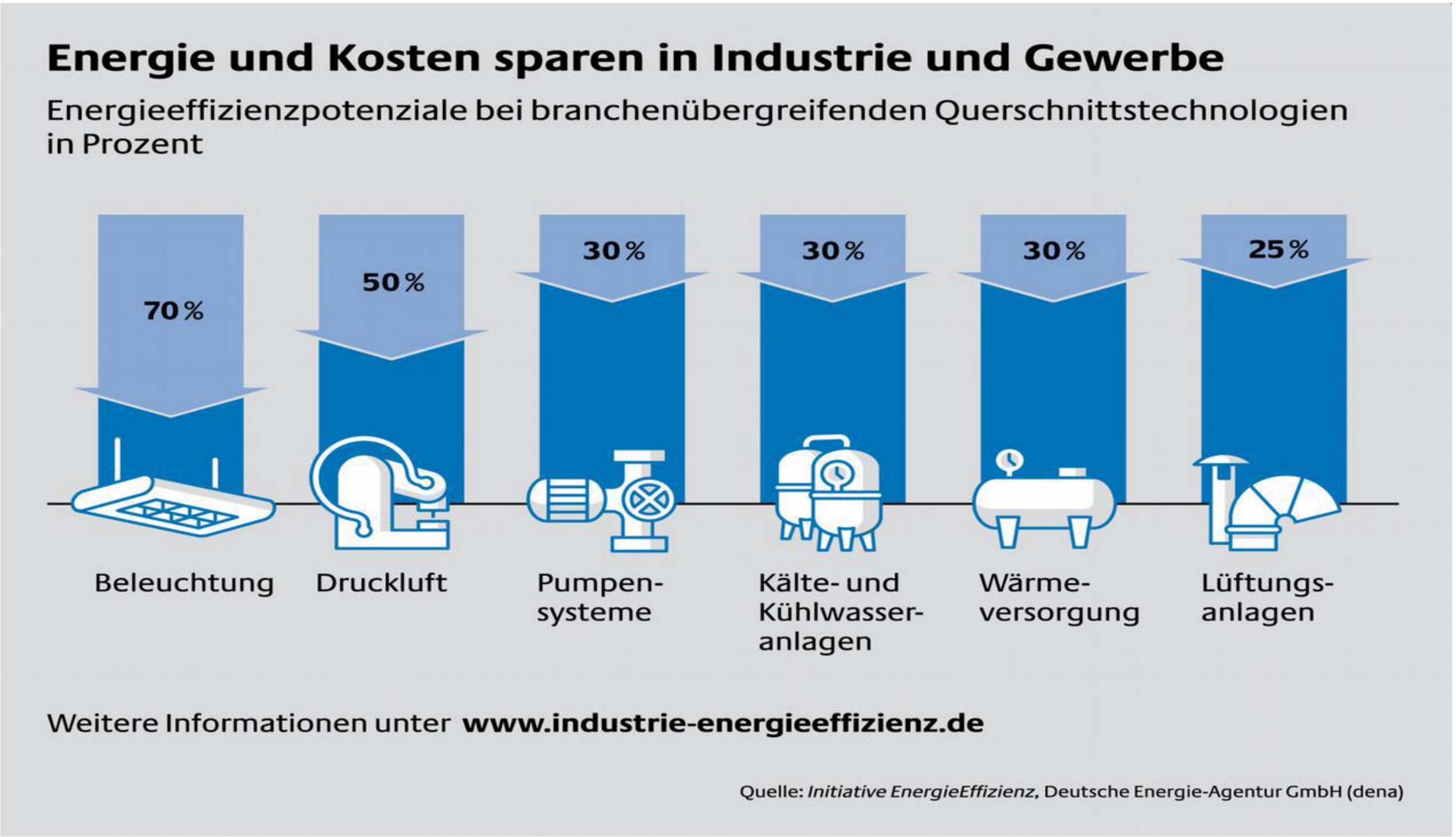
The energy saving potential in industry

Huge energy savings are possible with existing technologies



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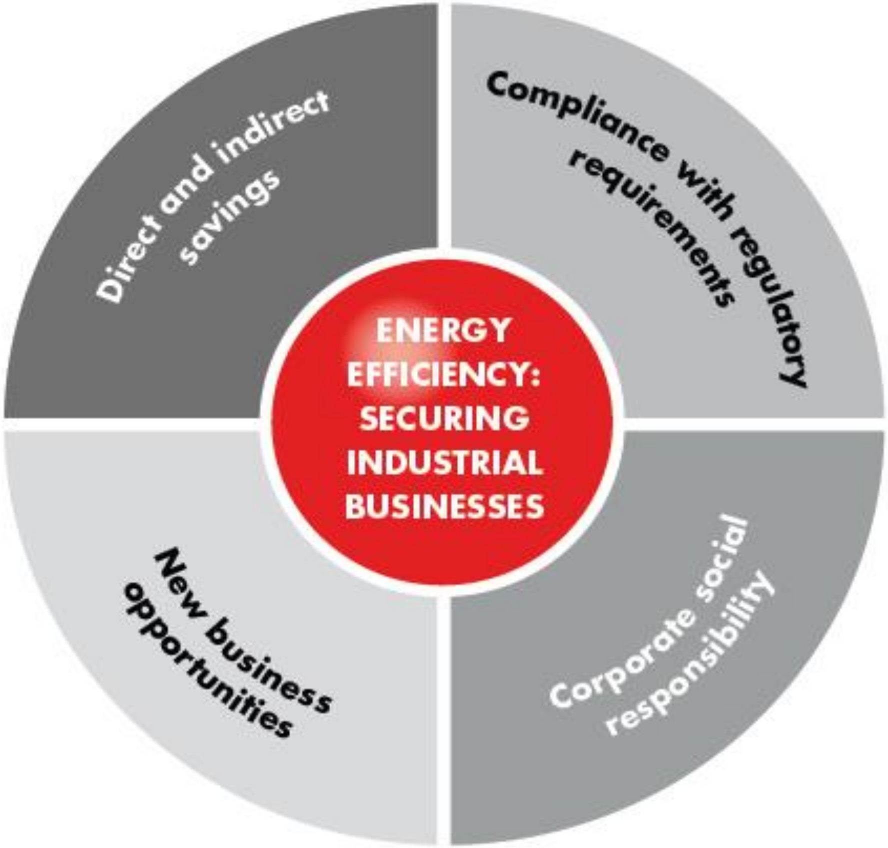
Energy saving benefits in a company



Source: Bain & Company

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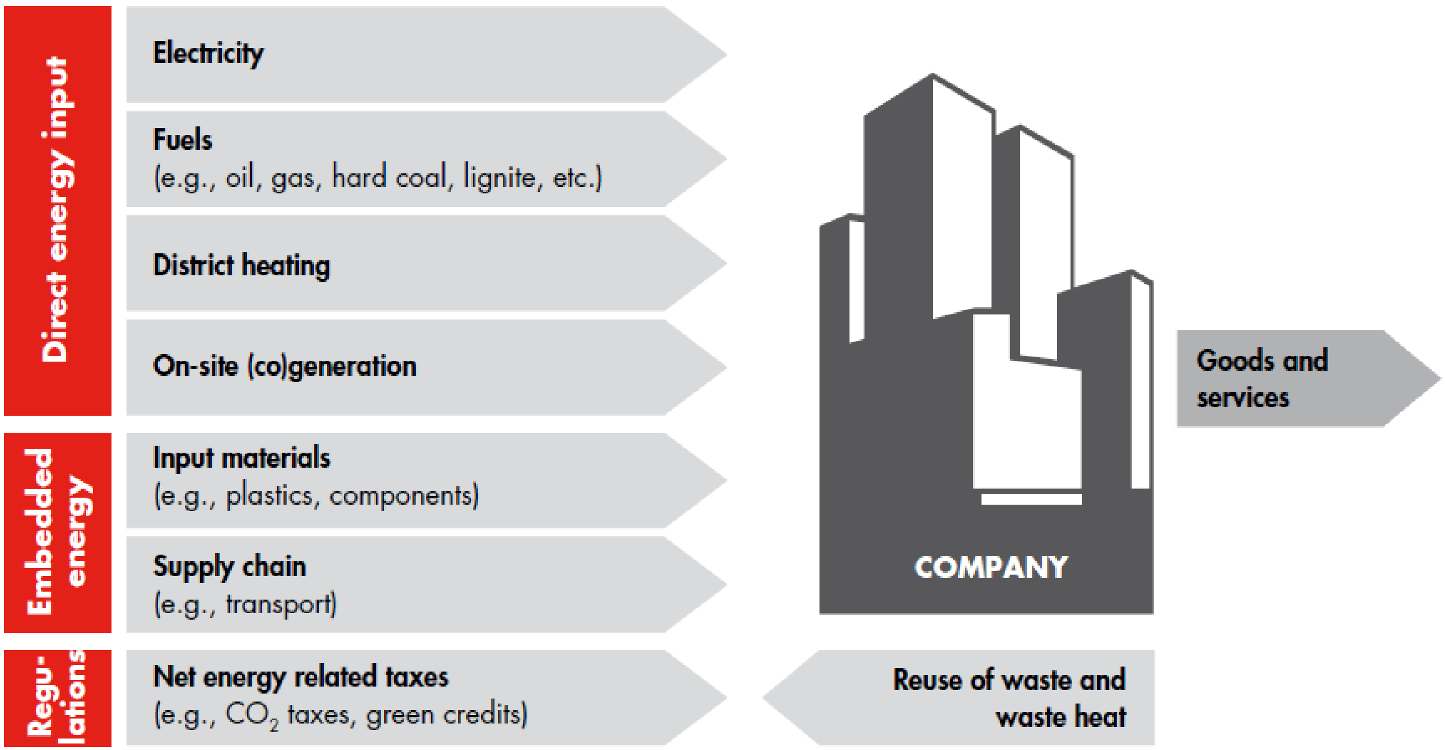
Energy exposure beyond the electricity price



Source: Bain & Company

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Nine levels to address energy efficiency in an integrated program

Energy-efficiency savings

Core production processes	Infrastructure and supply chain	Organization and people
1 Optimize energy provision Energy provision technologies and demand/response management	**4 Cross-optimize with suppliers** Collaboration with suppliers to reduce input costs	**7 Create commitment and track progress** Transparency, priorities, monitoring
2 Redesign core value-adding processes Optimized setup/layout of the value chain	**5 Upgrade buildings and infrastructure** Latest building automation and infrastructure technologies	**8 Enable through organization and management systems** Dedicated roles to drive implementation
3 Upgrade equipment efficiency Latest equipment/machinery technologies	**6 Redesign support processes** Support processes and layout	**9 Push behavioral change** Awareness creation and behaviors change

Source: Bain & Company

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Why a poor energy management?

Reasons for poor energy management :

- Lack of understand the whole system
- Lack of knowledge
- Lack of awareness on EE benefits
- Poor use of information, lake of training
- Poor planning of the business

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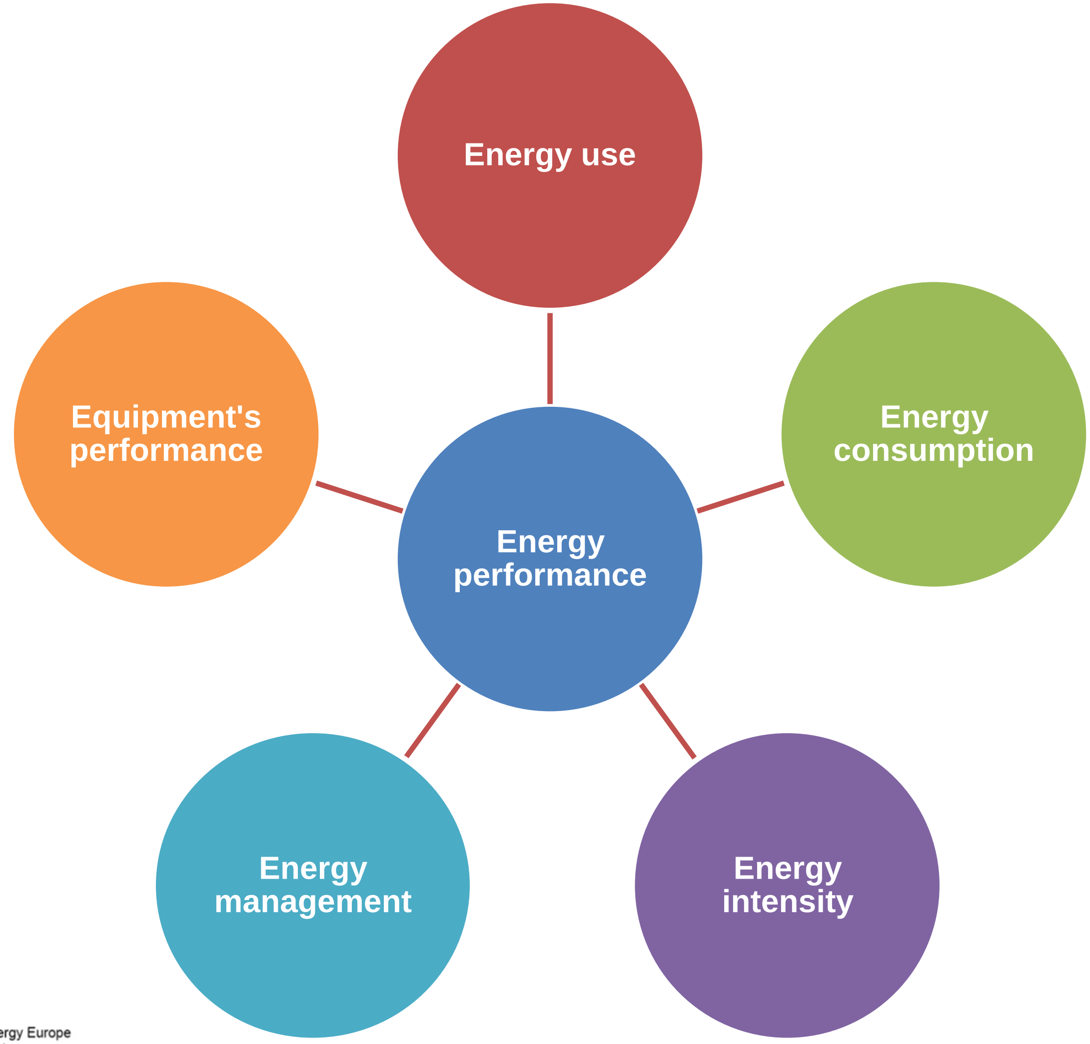
Energy performance



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The ad-hoc energy management

Source: UNIDO 2010

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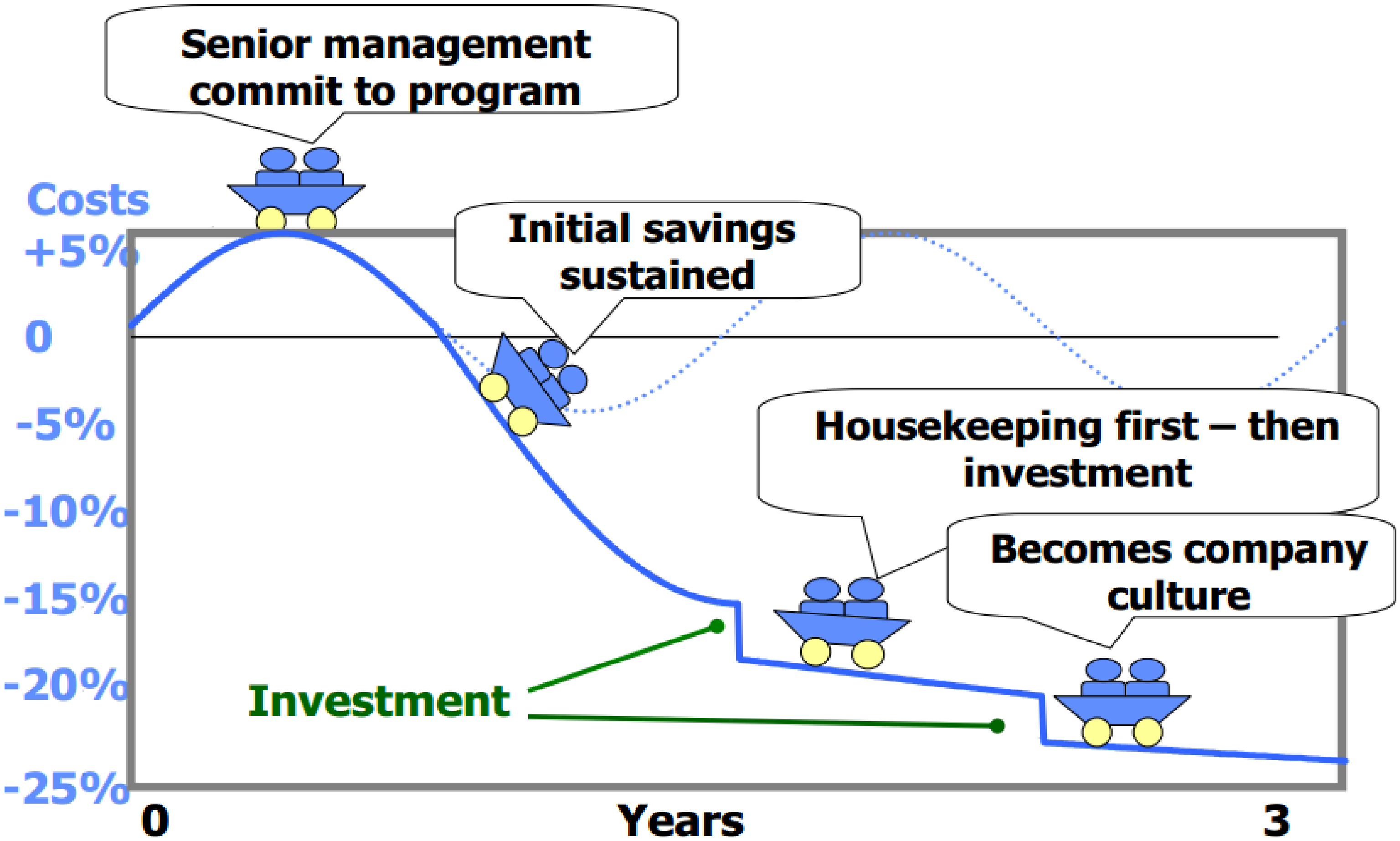
Structured approach of energy (EnMS)



Source: UNIDO 2010

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Planning the energy management process

Input planning

- Energy use
- Variables that affects energy consumption

Assessment

- Analyze energy use and consumption
- Identify significant energy consumers
- Identify opportunities for energy efficiency

Output planning

- Energy efficiency
- Objectives
- Targets
- Action Plans

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The CP – EE assessment steps

Step 1 – Planning and organization

- Management commitment
- Organize EE Team
- Compiling existing basic information
- Baseline energy indicators - draw up the Energy Profile
- Define the focus area

Step 2- Pre- assessment

- Preparing process flow diagram
- Conducting walk through
- Input and output energy quantification and characterization
- Finalize de baseline data

Step 3 – Detailed assessment

- Prepare detailed energy balance with losses
- Conduct cause diagnosis
- Generate energy efficiency options
- Screening the options

Step 4 – Feasibility analysis

- Conduct technical, economic and environmental evaluation
- Select feasible options

Step 5 - Implementation and continuation

- Prepare EE implementation plans
- Sustaining EE assessments and management

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Step 1– Compiling the existing basic information

Step 1 – Planning and organization

General company information

2. General production flows
3. Technical information

   major energy conversion equipment

   supplying utilities (steam, compressed air, cooling, warm water)

   energy intensive equipment

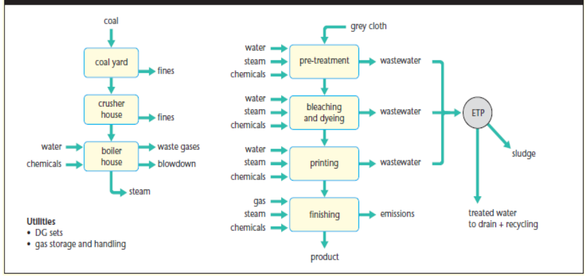
4. Baseline energy indicators

   energy consumption data (electrical, gaz, fuel); production data

   graphical representatin of the data (monthly/annual variation)

5. Define the focus area of the EE assessment

Completed Worksheet 4b: General production flowchart



Completed Worksheet 4d: Resource consumption

On average, the unit processes 8.0 tons of cloth per day. As is typical of textile processing units, the process requires steam, water, gas, compressed air, dyes and printing chemicals, etc. Consumption of major resources per ton of cloth processed in the year 2002 is tabulated below.

Resources	Unit	Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Total average
Purchased water	m^3/ton cloth	115	122	136	148	136	172	143	133	123	136	135	125	135
Total water	m^3/ton cloth	201	208	222	234	222	258	229	219	209	222	221	211	221
Coal	t/ton cloth	3		4	4	3	3	4	4	4	4	4	3	3
Gas	m^3/ton cloth	772	846	697	625	611	804	629	656	582	576	623	553	664
Grid electricity	kWh/ton cloth	698	663	345	1 587	234	294	225	234	208	1 469	1 641	1 356	746
Diesel	litre/ton cloth	247	256	363	0	608	417	421	366	361	0	0	0	253
Eqivalent electricity from diesel	kWh/ton cloth	827	858	1 216	0	2 037	1 395	1 410	1 227	1 209	0	0	0	848
Total kWh electricity	kWh/ton cloth	1 525	1 521	1 561	1 587	2 272	1 690	1 636	1 461	1 417	1 469	1 641	1 356	1 595
Dyes	kgs/ton cloth	61	65.4	60.5	65.1	60.1	74.2	61	61.4	61.8	61.3	64	63.5	63.2
Gums	kWh/ton cloth	82	80	88	93	85	110	100	93	87	90	99	85	91

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Source: CP-EE Manual, UNEP 2004

Example: Drawing up list of equipments

Which equipment is responsible for each energy use?

Worksheet 7: Assessment of power consumption points

Purpose of use	Consumer (type, fonction)	Year	Rated power	Full load hours per year	Consumption [kWh/a]	Remarks
Wort cooling	NH_3 compound	1984	190 kW	6,482	1,231,580	
Beer refrigerat.	R_{22} compound	1988	55 kW	7,021	386,155	
Wort boiler	Exh.vap. compr.	1991	95 kW	820	77,900	
	CO_2 equipment	1990	52 kW	808	42,000	
Lighting			56 kW	2,400	134,400	
Bottling			80 kW	4,180	332,580	
Brewing			35 kW	5,200	184,000	
Oil firing			15 kW	3,950	59,200	
	total:				2,447,815	
					= 76.1 % of total consumption	

From counter or estimation

From watt plate

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Collecting and recording energy data

Measuring energy consumption

- Energy bills
- Energy counters
- Direct measurements using special devices (metering equipment, infrared devices, etc)
- Calculations

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Step 2 – Pre – assessment

1. **Preparing energy flow diagram**

   List the important process unit /operation and associated utility supply – each process unit can be represented as block diagram showing:
   (a) Major input supply; energy, raw materials
   (b) Intermediate and final products
   (c) Waste streams (waste water, exhaust, heat radiation)

2. **Conducting walk through**

   (a) Record the obvious housekeeping lapses: leaks of steam, water, condensate, fuel, oil, compressed air, etc
   (b) Prepare and collect simple diagrams: water supply and drainage; electricity distribution; refrigeration circuit; steam and warm water distribution, compressed air distribution

3. **Input and output energy quantification and characterization**
   (a) materials and energy must be quantified, measured or estimated
   (b) parameters to characterize the material/energy streams

4. **Generating and finalizing the baseline data**
   (a) historical consumption and cost data for all input material and energy
   (b) energy conversion equipment, specifications, parameters

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Energy performance indicators

Benchmarking – performance of the production system /equipment

Comparison with targets to asses improvement potential

Possible performance indicators

- ***Specific material consumption for each material input (*****tons of input material/ton of product)**
- ***Specific energy consumption for electricity and fuels*** **(kWh per ton of product, kg or litre of fuel per ton of product).**
- ***Specific energy utility consumption*** **(TR/ton product, steam/ton product).**
- ***Equipment-related energy performance indicators*** **(ton steam/ton coal, kW/cfm of fan air).**
- ***Production cost*** **(per ton of product).**
- ***Electricity, fuel, water, chemicals, transport, manpower as a percentage of production cost*****.**

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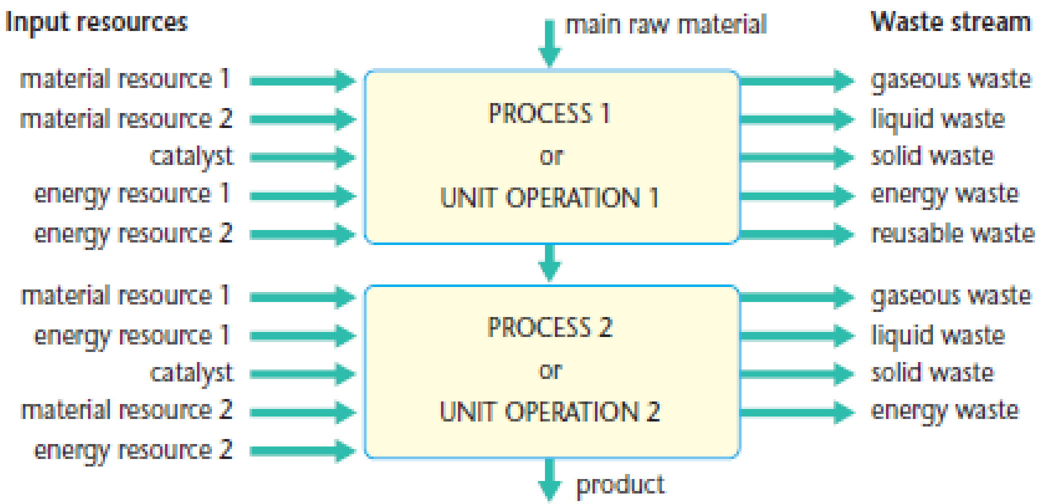
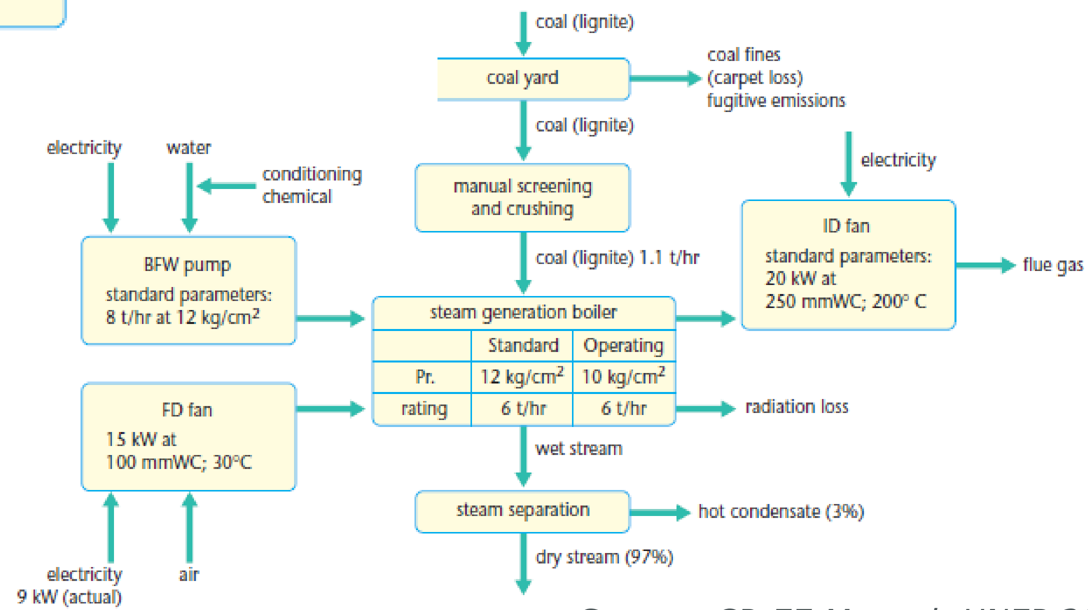
Example process flow chart





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Source: CP-EE Manual, UNEP 2004

Step 3 – Detailed assessment

Step 3 – Detailed assessment

1. **Preparing a detailed energy balance including losses**

2. **Root cause diagnosis – why (energy) waste is generated ?**

   Example method: Fish bone diagram – primary and secondary causes assigned to four categories: man /method/ material /equipment

3. **Generating options**

   Brainstorming

   Apply CP-EE Strategies

3. **Screening options**

   Options that can be implemented directly

   Options requiring further analysis

- 1. Good housekeeping
- 2. Process optimization
- 3. Input materials substitution
- 4. Technology/equipment change
- 5. Improved product design
- 6. On site recycling and reuse
- 7. Production of useful by products

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Step 4: Feasibility analysis

Step 4 – Feasibility analysis

1. Technical evaluation

(a) Identification and evaluation of required new equipment and necessary changes in existing plant infrastructure

- » Will it work?
- » What do we have to do to make it work

(b) Assessment of the impact of the respective option on energy balance

- » What will we gain?

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Step 4: Feasibility analysis

Step 4 – Feasibility analysis

2. Economical analysis

(a) Calculate the costs
- Determine the capital or investment cost of the project
- Establish the lifetime of the equipment and compute annual depreciation

(b) Calculate the benefits
- Determine revenue implications of the project
- Estimate any changes in operating costs

(c) Calculate incremental cash flow

(d) Assess the project’s financial viability using various decision rules

3. Environmental analysis

(a) Reduction of the amount of CO2 emissions generated

(b) Reduction of energy consumption

(d) Reduction of water consumption

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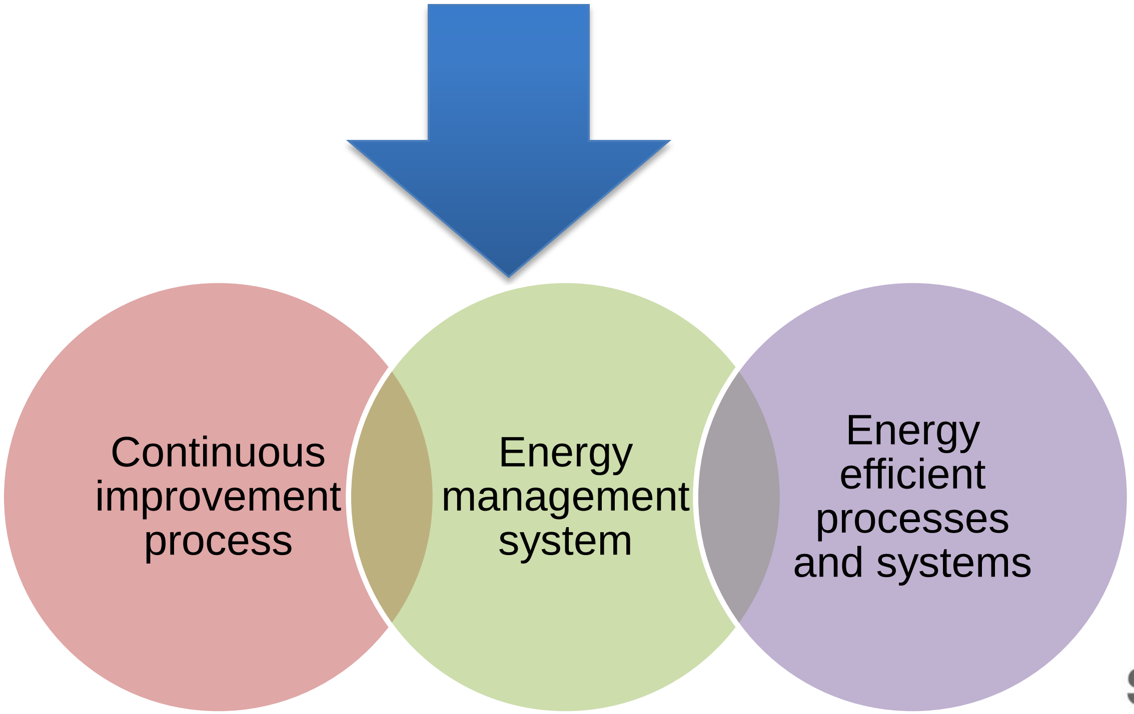
Step 5 – Implementation and continuation

Step 5 - Implementation and continuation

1. Plan and implement feasible options
2. Monitor EE economical and environmental benefits
3. Integrate EE in management



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Typical areas of improvement

1. Compressed air
2. Cooling/freezing/air conditioning
3. Thermal systems
4. Electricity management systems
5. Electrical motors
6. Lighting

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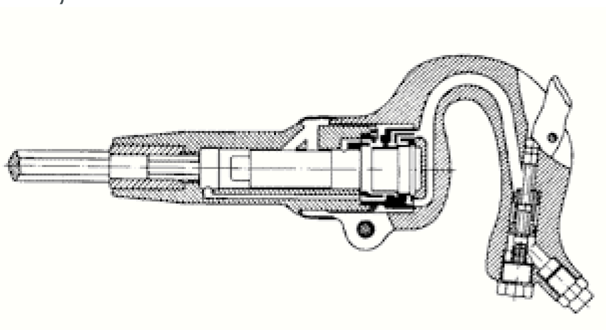
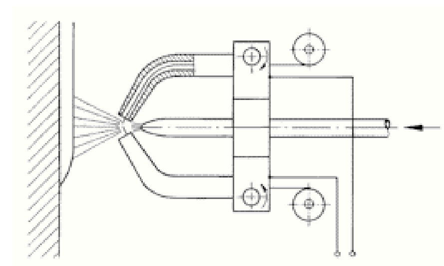
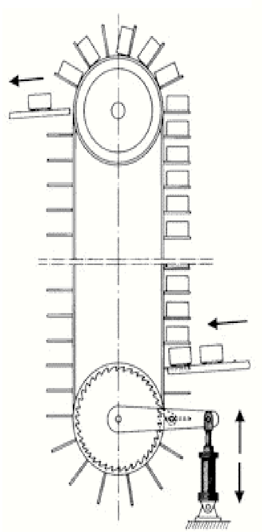
1. Compressed air

Pneumatic actuators:
Tools, valve actuators



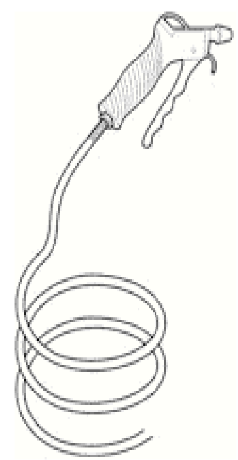
Syringes: Painting, sandblasting





Transportation:
Pneumatic conveyor

Blow process:
Air-cleaning



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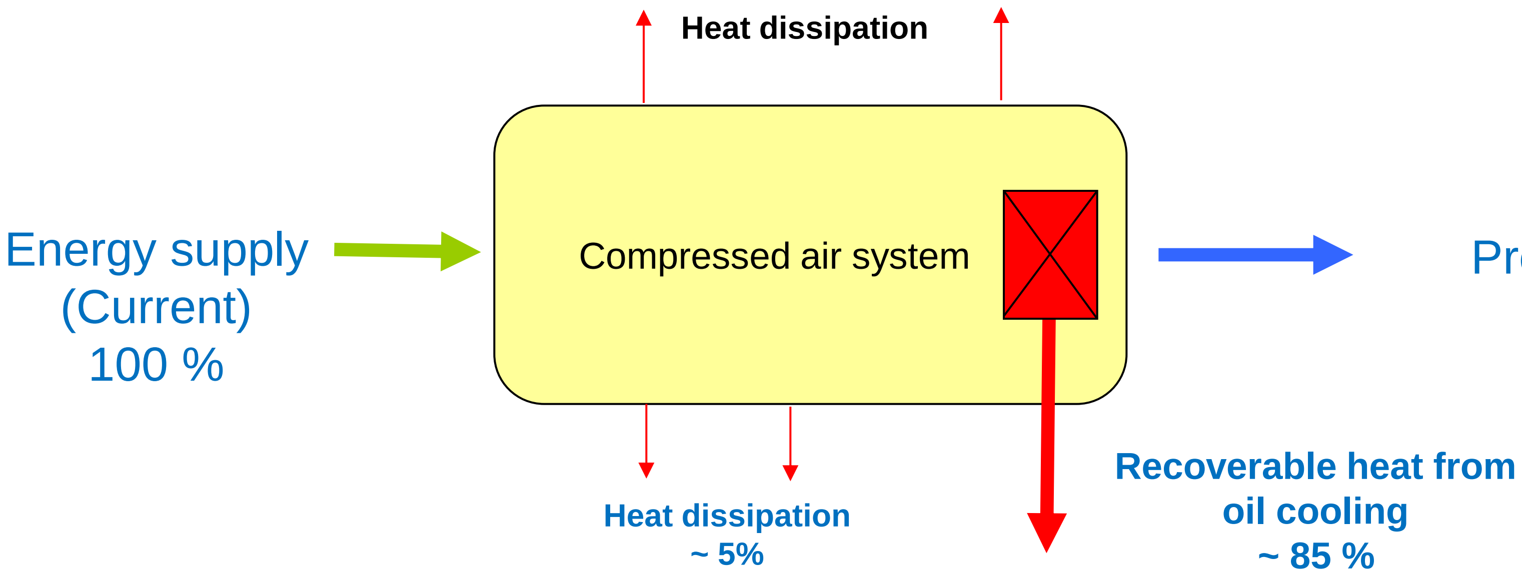
1. Compressed air – energy balance



- About 10% from the electric power is converted into compressed air. The rest is given off as heat.
- About 85% of energy in the form of heat can be recovered and re-used from the cooling oil. The remaining 5% are emitted as radiation losses into the environment.

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1. Compressed air : Dimensioning of pipelines

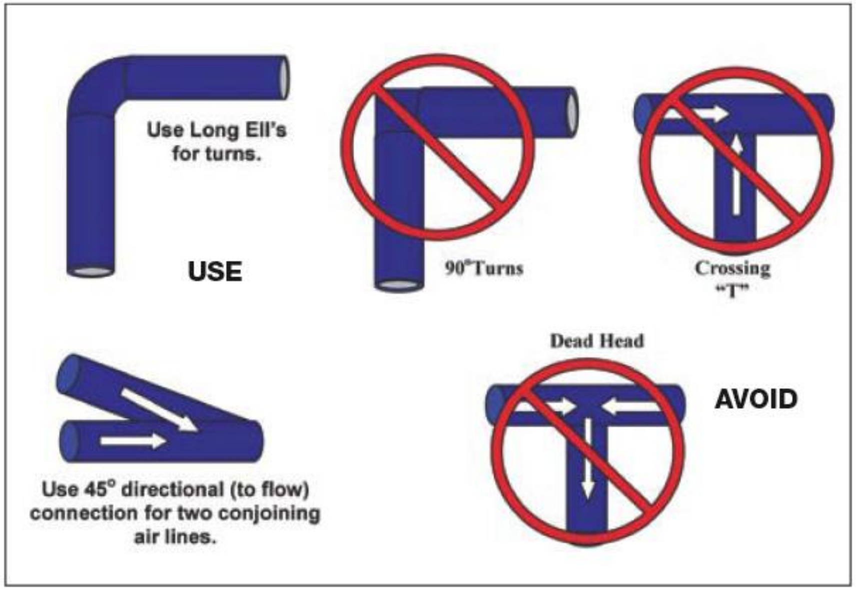
The correct sizing of the pipes of a network is of great economic importance. Too small pipe diameters cause high pressure losses, which must be offset by higher compression again, to ensure the performance of the consumer.

The main influences on the tube inner diameter:

• Flow (reserve reckon for extensions)

• Aerodynamic pipe length (favorable flow components used)

• Operating pressure (low pressure means low operating pressure losses in the network)



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1. Compressed air: Substitution of air driven consumers

1. The use of pneumatic cylinders in automated processes is ten times higher than electric or hydraulic drives

2. In many cases it is possible to replace pneumatic by electric tools. For example: Screwdrivers, drills, etc.

Savings: 10-20%

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Example: Leaks in the compressed air system

Leakiness hole Ø [mm]	amount of air flowing at 8 bar [m³/min]	Losses [kW]	[€*/a]
1	0,065	0,47	412
2	0,257	1,85	1.620
4	1,03	7,42	6.500
6	2,31	16,6	14.594

*Current price: 0,10 €/kWh
Operating hours: 8 760 h/a

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Example: Leaks visible and audible

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Auditing air compressed systems

An CP audit determines:

- the output (flow) of a compressed air system,
- energy consumption in kilowatt-hours,
- annual cost of operating the system and total air losses due to leaks.
- all components of the compressed air system are inspected individually and problem areas are identified:

  losses and poor performance due to **system leaks**,

  inappropriate use,

  demand events,

  poor system

Compressed air is
VERY expensive !!!

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Typical savings with compressed air

- **correct size, type, and control of compressor**
- **good maintenance saves electricity**
- **reduction of the grid pressure**
  - reduction of electricity consumption of 6 – 10 % per bar reduction
- **intake air at compressor cool and clean**
  - every 5° C increase of the intake air will increase by 1% electricity consumption

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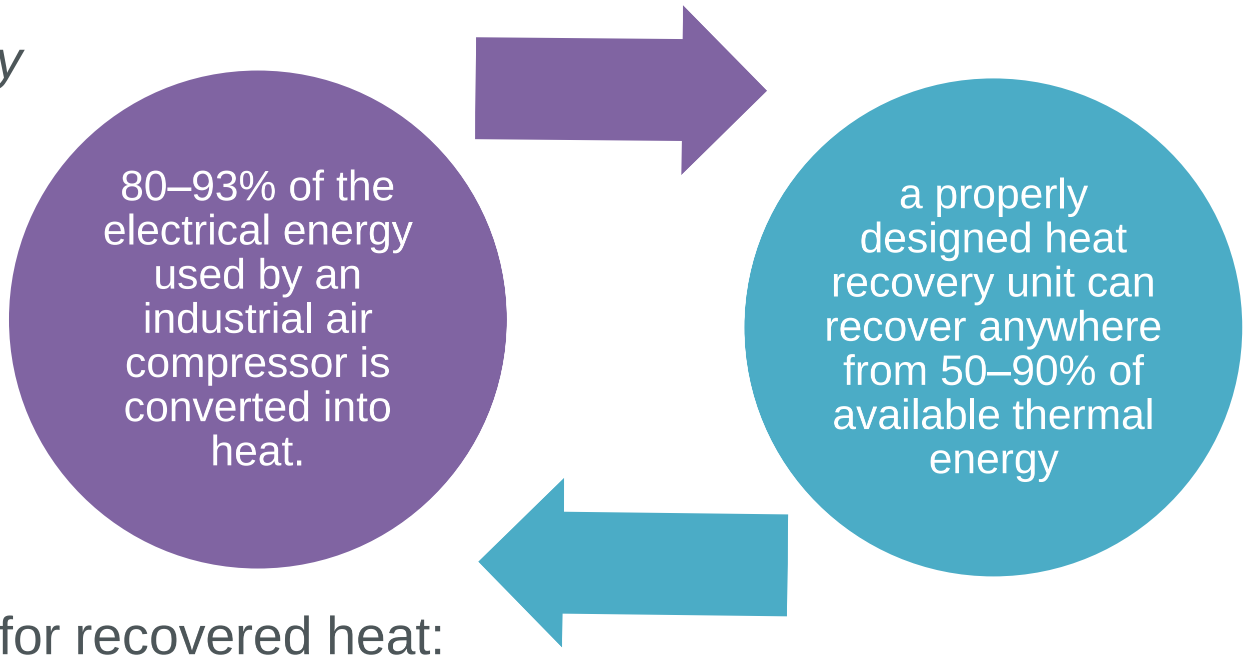
Typical savings with compressed air

Heat recovery



Typical uses for recovered heat:

additional space heating,
industrial process heating,
water heating,
make up air preheating,
boiler make up water preheating.

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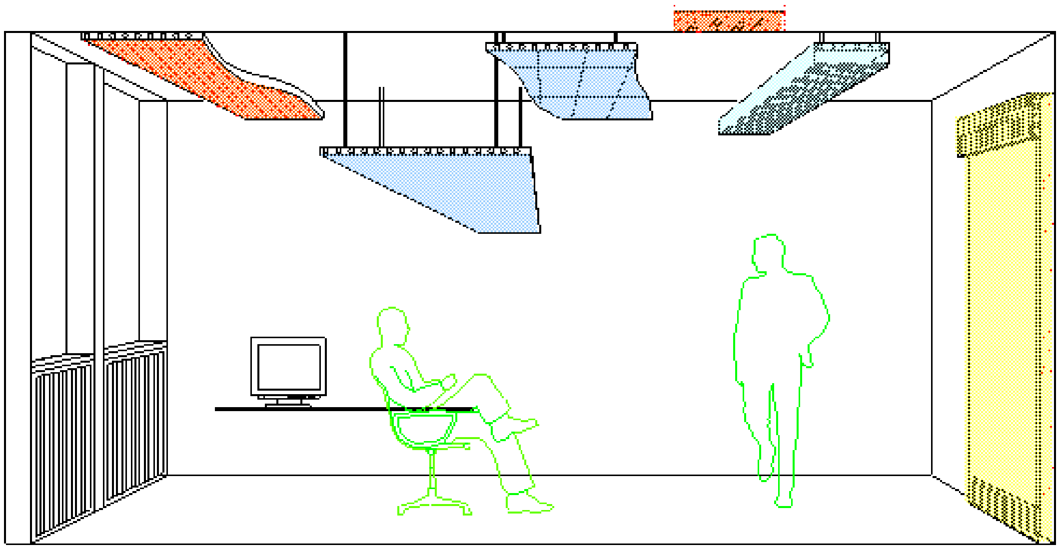
2. Ventilation, air conditioning

You can cool without air system!

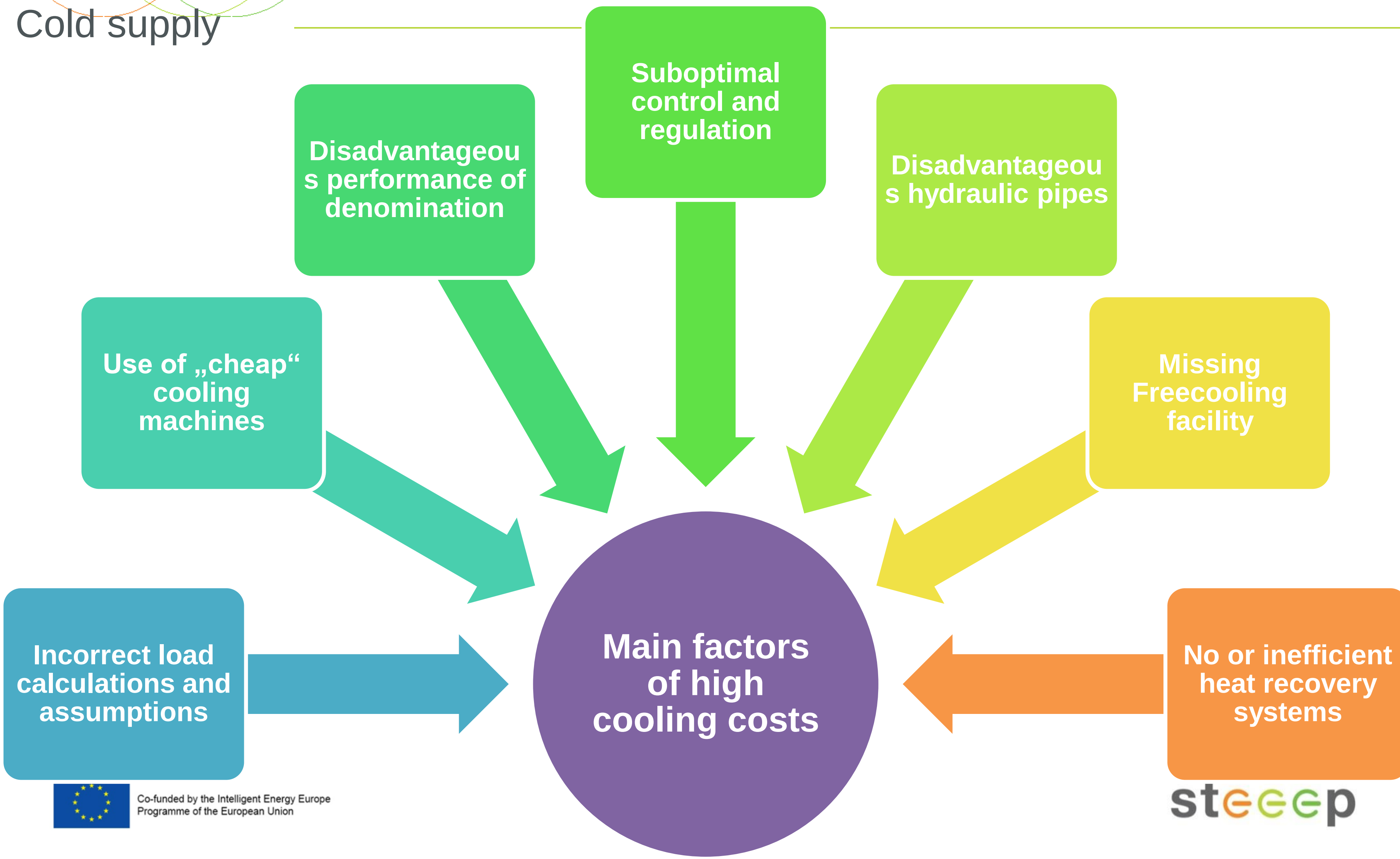
- ⇨ No energy demand for air transport
- ⇨ Important! Ventilation systems and humidity control are still needed!

- e.g. by:
- Cooling blankets
- Component activation



Cold supply

2. Ventilation, air conditioning



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2. Optimization of cooling process

Optimization steps

1. Optimize demand:
   - Need-based flow
   - Use comfort range
   - Minimize cooling use in summer
   - Avoid heat loss in winter

2. Minimize distribution losses:
   - Reduce pressure losses
   - Insulate pipes

3. Optimize production:
   - Fans + pumps
   - Refrigeration machine
   - Heat / cold / humidity recovery

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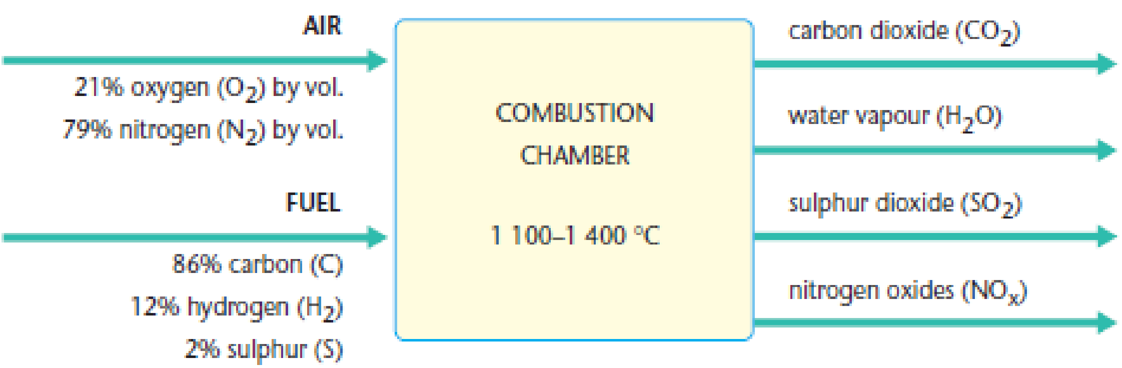
3. Thermal systems – Combustion

Fuel + O2 => CO2 + H2O + SO2 (+ N2)



Source: UNEP CP-EE Manual

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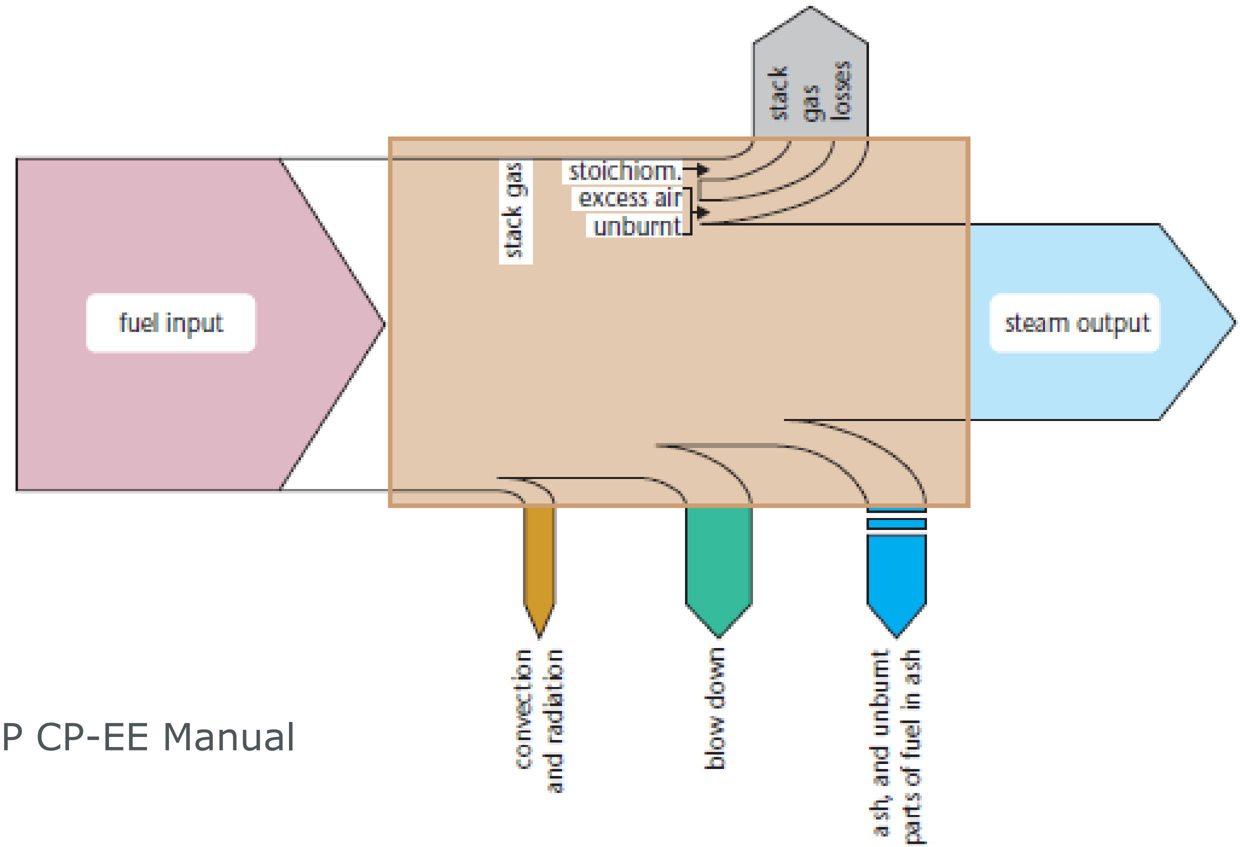
3. Thermal systems - Boilers

- Factors: construction – operation – maintenance
- Heat balance - Boiler energy flow diagram



Source: UNEP CP-EE Manual

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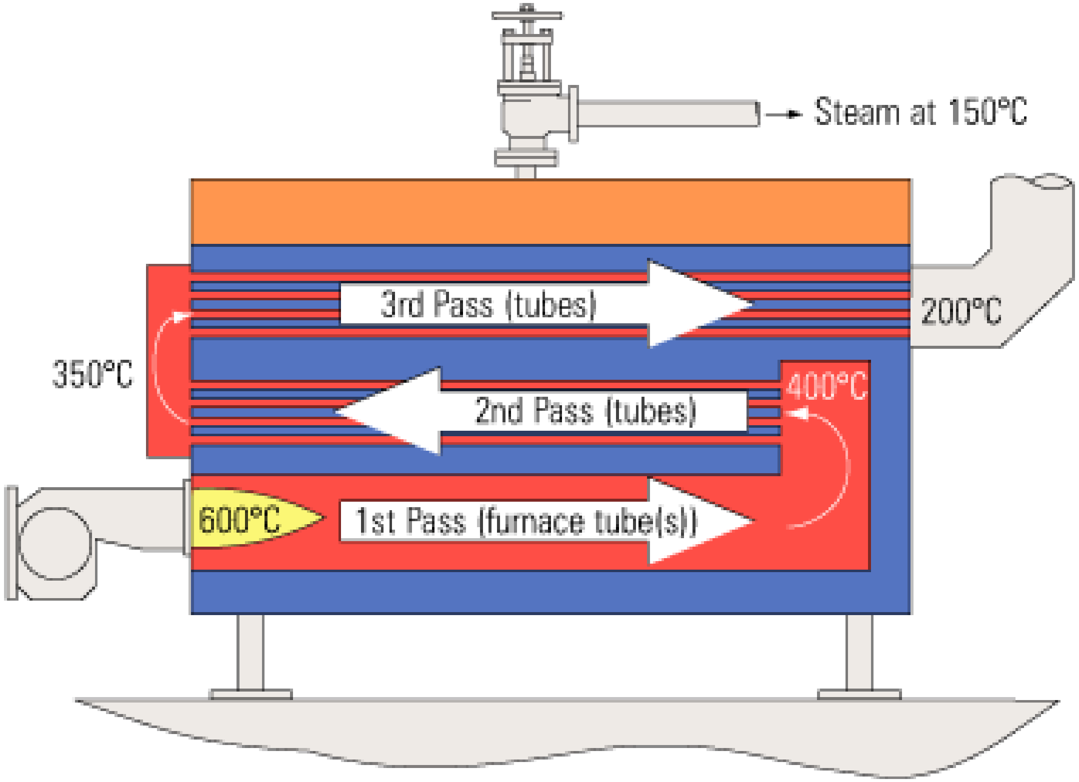
3. Thermal systems - Boilers



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Example: Exhaust gas heat losses of an oil boiler

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Example: Damaged heat exchanger, blocked with scale

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Example: Condensate loss

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Example: Insulation losses

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Typical savings - Waste heat use

- Which waste heat is available?
  - ⇨ Temperature level
  - ⇨ Load profile (when and which performance, time pattern)
- What are the potential heat users?
  - ⇨ Necessary temperature level
  - ⇨ Load profile (which is when power needed?)
- Local conditions
  - ⇨ Distance between heat accumulation and potential heat users

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Waste heat use

- Easy possible if:
  - ⇨ Suitable temperature level
  - ⇨ Seizure and use of waste heat at the same time
  - ⇨ No large distances
- Unfavorable:
  - ⇨ Insufficient temperature level
  - ⇨ Heat accumulation and heat demand at different times
  - ⇨ Large distances
- Possible Usage
  - ⇨ Heating
  - ⇨ Preheating (for example, air, drinking water, ...)
  - ⇨ for absorption refrigeration (at sufficiently high temperature level)

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4. Electricity management systems

Electricity cost:

- **Energy costs in the true sense** (i.e. the cost of the kWh consumed)- can be reduced primarily by reducing electricity consumption
- **Costs of power demand** (i.e. the cost of the peak electrical power requirement) - can be reduced by other means—by reducing peaks of power consumption

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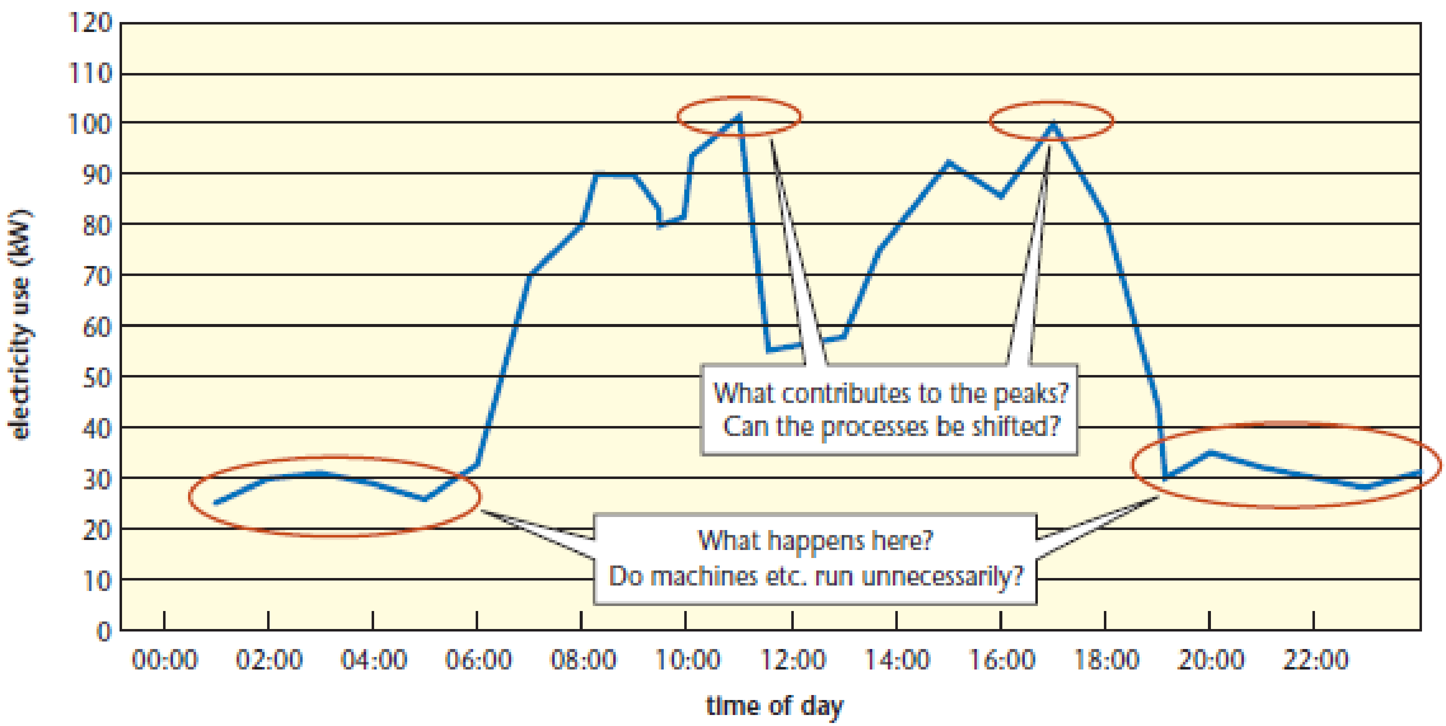
Electric load management includes

- control of maximum demand
- scheduling of its occurrence during peak/off peak periods.



Analyzing peak loads

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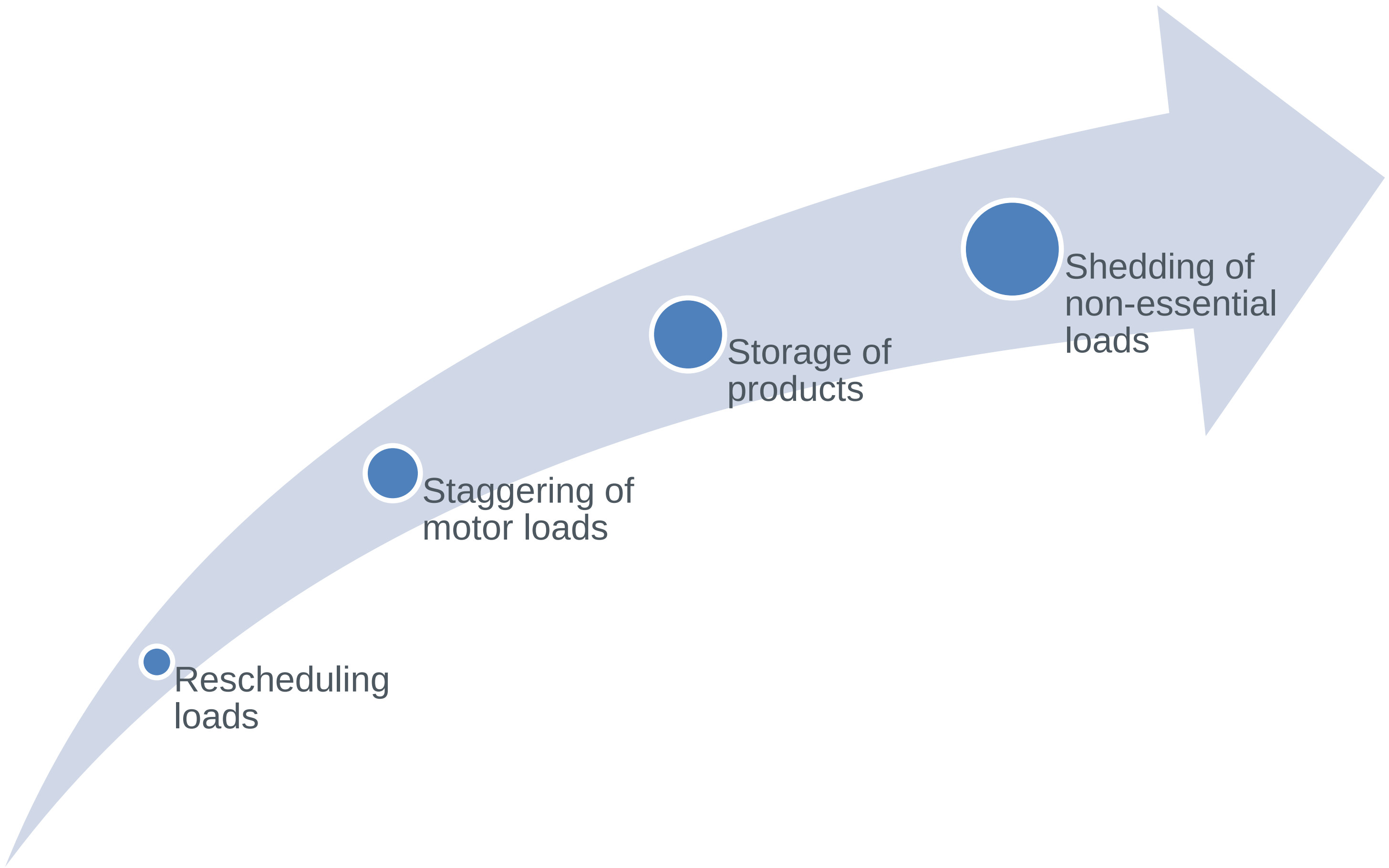
Typical solution for load management



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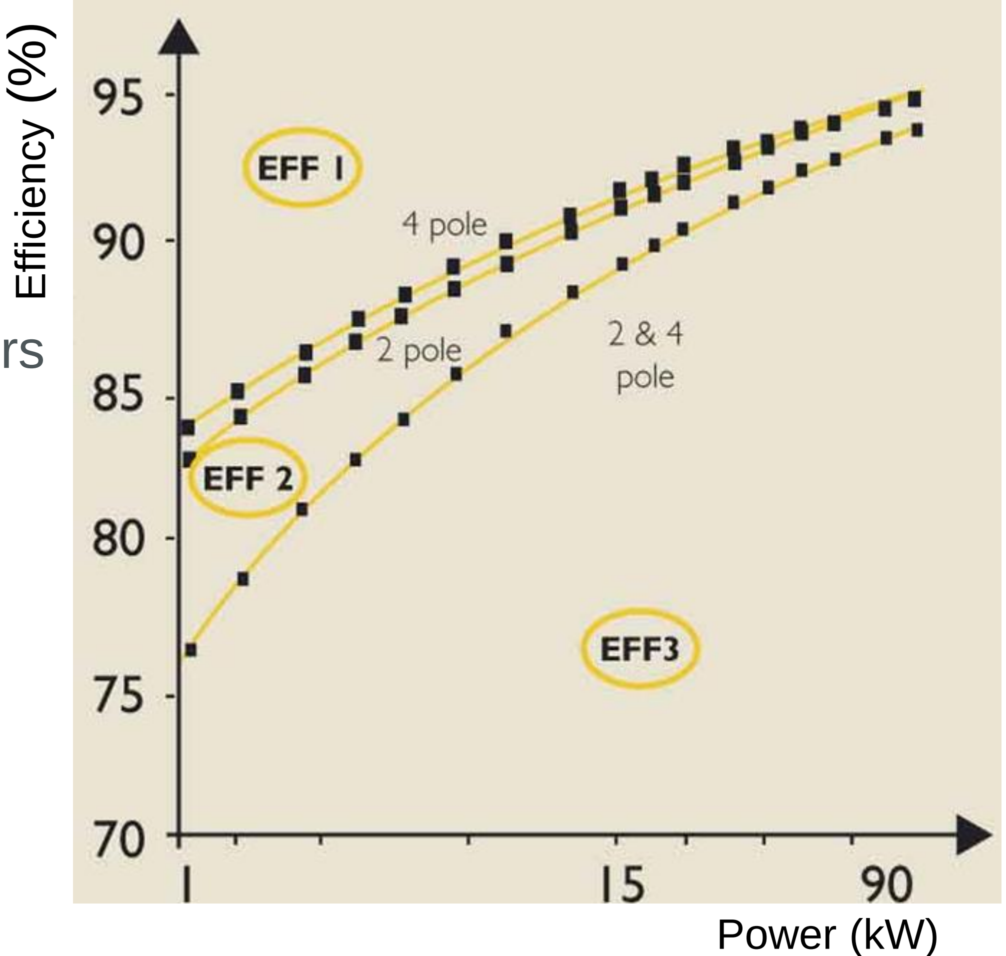
Motor efficiency class

European Standard:

- EFF1: High efficiency motors
- EFF2: Standard efficiency motors
- EFF3: Poor efficiency motors



Energy Management

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Typical solutions to improve electric motors performance

- Operating motor with correct, balanced voltage, giving 3–5% savings and longer life.
- Proper lubrication
- Proper ventilation and heat evacuation
- Regular check on motor loading (amps) is recommended monitor variations.
- Alignment, bearings, cable terminations, lubrication

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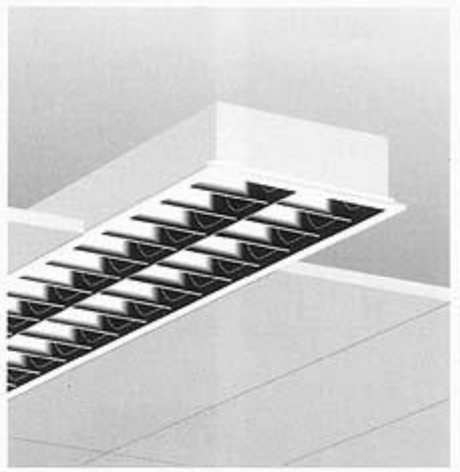
6. Lighting

- Adopt efficient lighting solutions
- Turn off lights when not needed
- Use timer or motion detector
- Use daylight as much as possible
- Service and clean the lighting units
- Clean windows, ensure efficient design of rooms
- Use energy saving bulbs or led lamps



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LED – light of the future?

Why do we speak of LED today?

- Energy and CO_2 savings as the most important topics
- Reaction to ban incandescent bulbs

(Sept 2011 - Prohibition of 60W bulb)

- Toxins in light bulbs and fluorescent tubes
- The current state of development of LED!

z.B.: LED Straßenleuchte

z.B.: LED Hallenleuchte

z.B.: LED Gebäude-Deckenstrahler

z.B.: LED Röhre

z.B.: LED Gehwegs Leuchte

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Benefits of LED

- Very high energy savings
- Low maintenance and long life
- Targeted lighting by specific spread
- Low heat generation → no burning of debris
- No electromagnetic radiation (important in hospitals)
- Emerging no toxic substances (see energy saving lamp?)
- Problem-free disposal (see fluorescent tube)
- No unpleasant flickering (stroboscopic effect)

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Group exercise

Beyond picking the low hanging fruits to changing the overall consumption in energy systems

1. How engineers should communicate with management?

Financial terms, risks, other aspects

3 groups
1 facilitator
10 min each group
presentation on flipchart

2. Which supporting material do we need?

Which knowledge, abilities are we missing so far..

How can we manage transition to renewable energy?

Technical aspects, competition with food products…

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References / Literature

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Thank you

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