SET: a methodology for energy efficiency of Small and Medium Companies in manufacturing industry

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ENEA
AGENZIA NAZIONALE
PER LE NUOVE TECNOLOGIE, L'ENERGIA
E LO SVILUPPO ECONOMICO SOSTENIBILE

Adopted Methodology

Data collection → Analysis and synthesis of results → Comparative analysis

Data collection
- Energy data
- Production data
- Process specific data

Analysis and synthesis of results
- Best practices
- Performance analysis - KPI

Comparative analysis
- Benchmark
- Specific analysis
- Gamification

Local (SET – EXCEL tool)

Web (SET – WEB tool)

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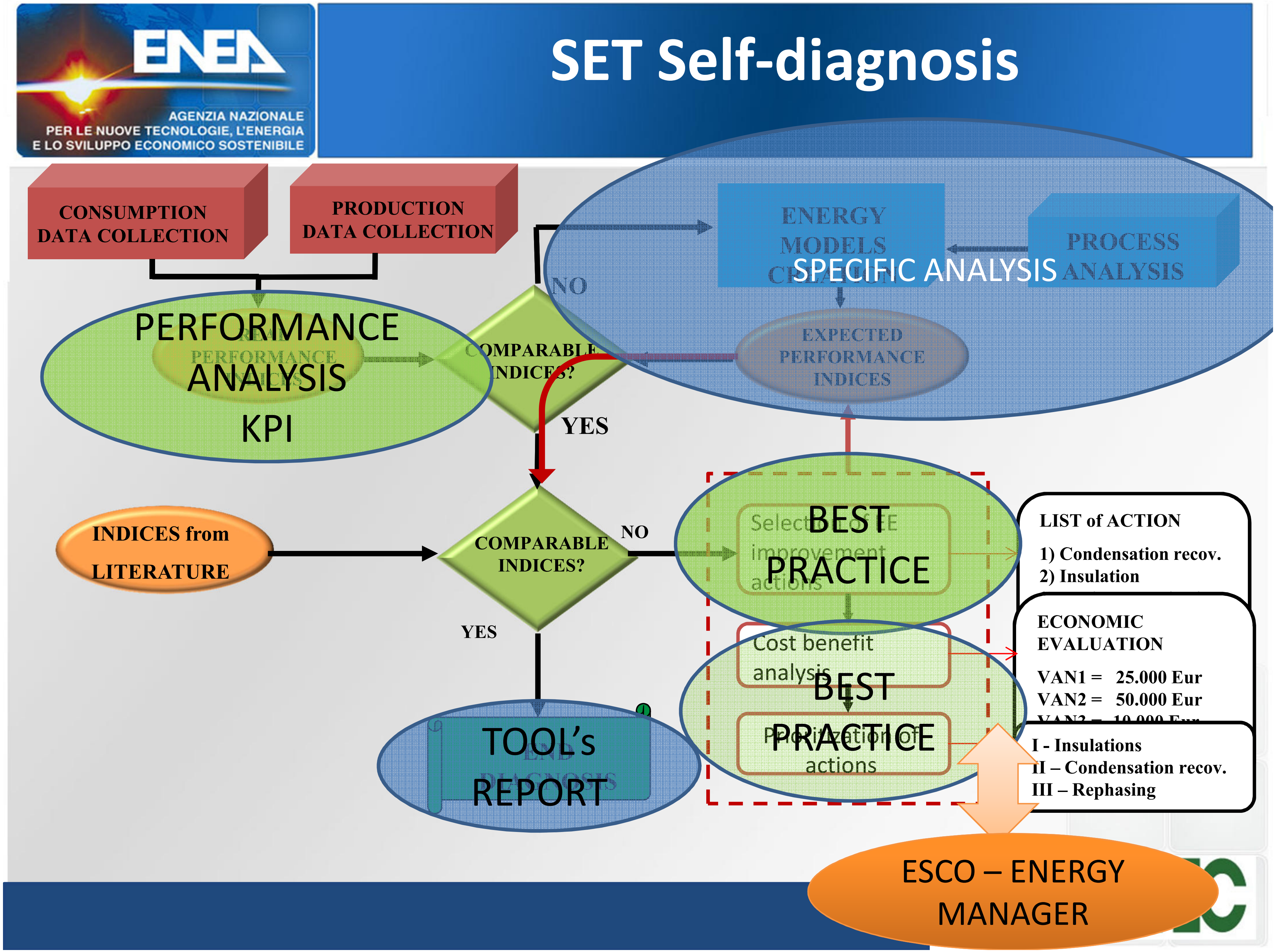
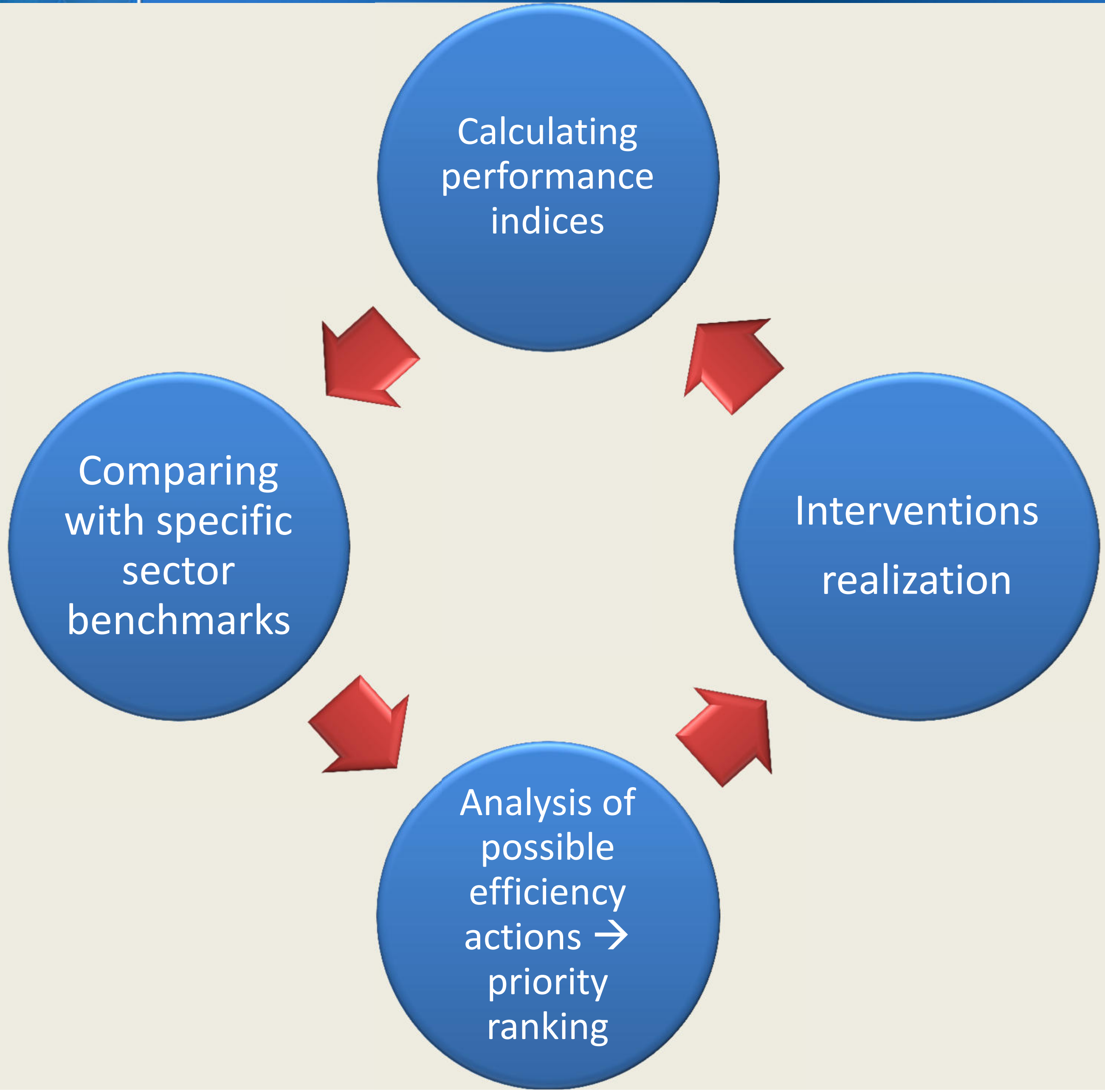
SET Self-diagnosis




Calculating performance indices
Comparing with specific sector benchmarks
Interventions realization
Analysis of possible efficiency actions → priority ranking

SET Tool – Consumption shares

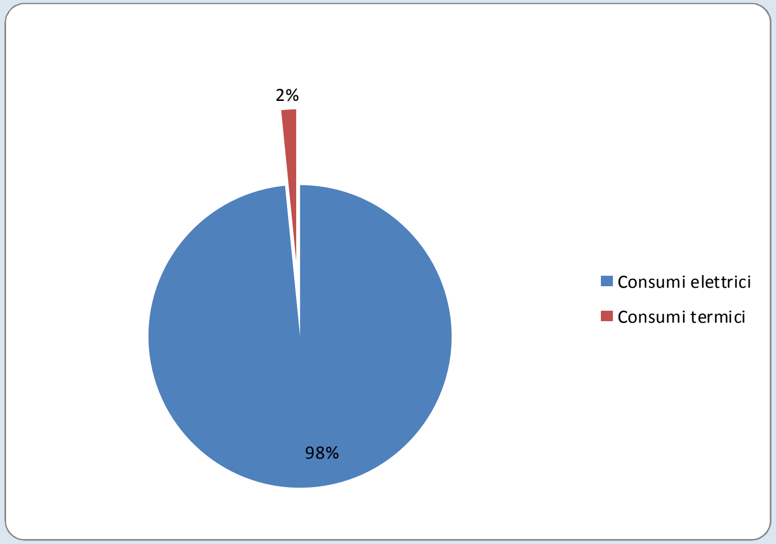
The tool supplies information on how much different energy consumptions are related to production

Specific consumption shares company 1

1. **Consumi energetici per l'attività dello stabilimento**

Ripartizione dei consumi specifici per vettore energetico

	TEP/kg	%
Consumi elettrici	0,000566	98,41
Consumi termici	0,000009	1,59
Tot.	0,000575	100,00

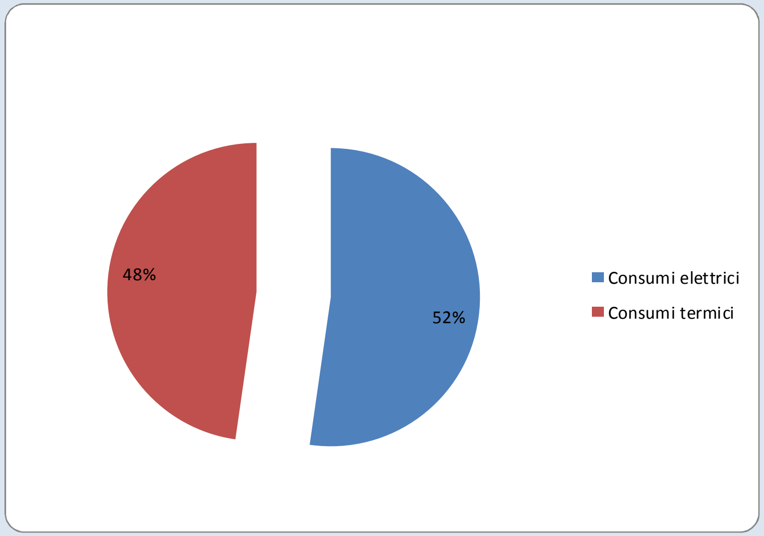


Specific consumption shares company 2

1. **Consumi energetici per l'attività dello stabilimento**

Ripartizione dei consumi specifici per vettore energetico

	TEP/kg	%
Consumi elettrici	0,001640	52,28
Consumi termici	0,001497	47,72
Tot.	0,003137	100,00



SET Tool – Economic comparison

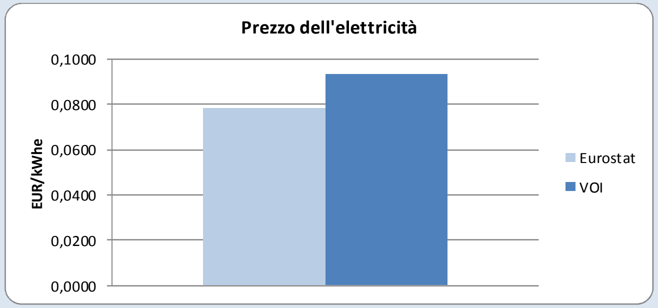
Comparison of electricity and natural gas prices in relation to:

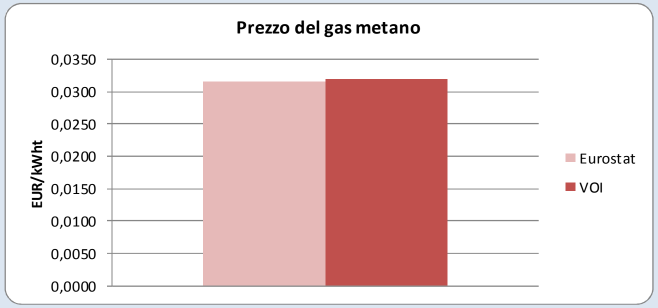
- Country
- Consumption band
- Year

4. **Comparazione dei prezzi dell'energia**

I valori Eurostat sono stati elaborati in base alla Nazione e alla banda di consumo

	Eurostat	VOI	
Prezzo dell'elettricità	0,0785	0,0931	EUR/kWhe
Prezzo del gas metano	0,0315	0,0318	EUR/kWht

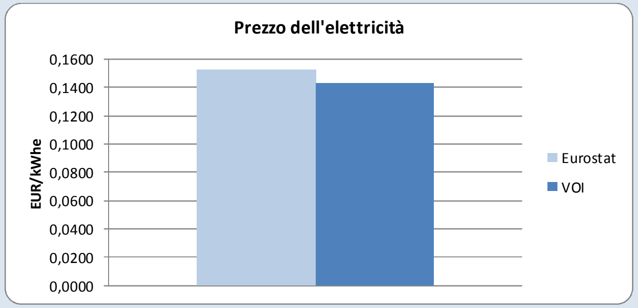


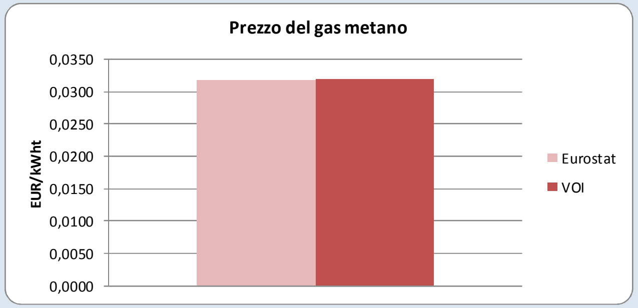


4. **Comparazione dei prezzi dell'energia**

I valori Eurostat sono stati elaborati in base alla Nazione e alla banda di consumo

	Eurostat	VOI	
Prezzo dell'elettricità	0,1523	0,1434	EUR/kWhe
Prezzo del gas metano	0,0316	0,0320	EUR/kWht

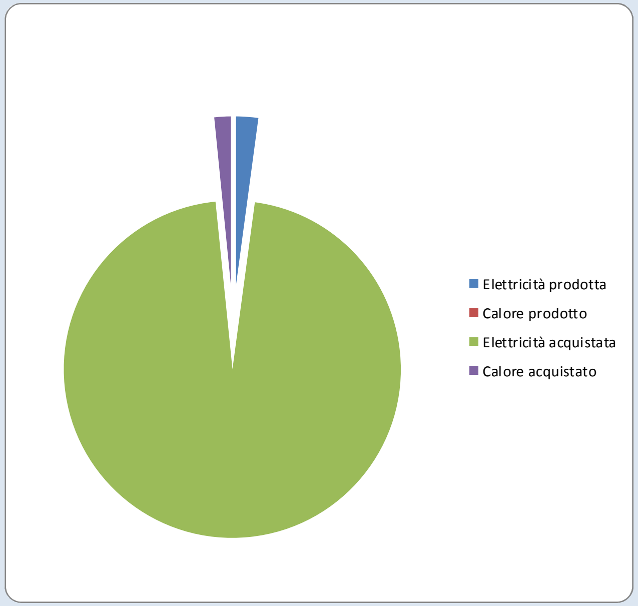




SET Tool –Energy sources allocation (es. photovoltaic)

3. Fonti energetiche per le attività di stabilimento

	Fonti energetiche utilizzate per alimentare tutte le attività	
	TEP/anno	%
Elettricità prodotta	23,27	2,13
Calore prodotto	0,00	0,00
Elettricità acquistata	1051,13	96,28
Calore acquistato	17,40	1,59
Elettricità venduta	0,00	-
Calore venduto	0,00	-
Tot.	1091,80	100,00

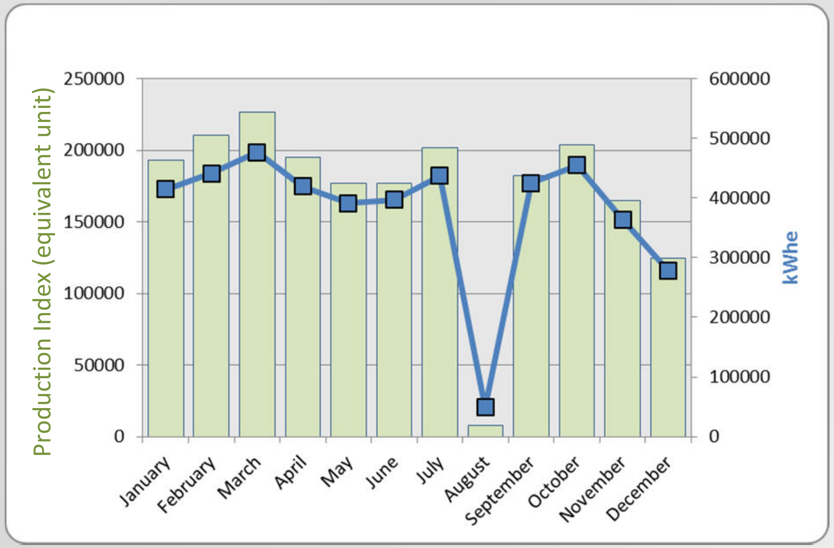


The quantities of electric and thermal purchased energy and, if present, self-produced energy are calculated and detailed in percentage

SET Tool
– Electric consumptions trends

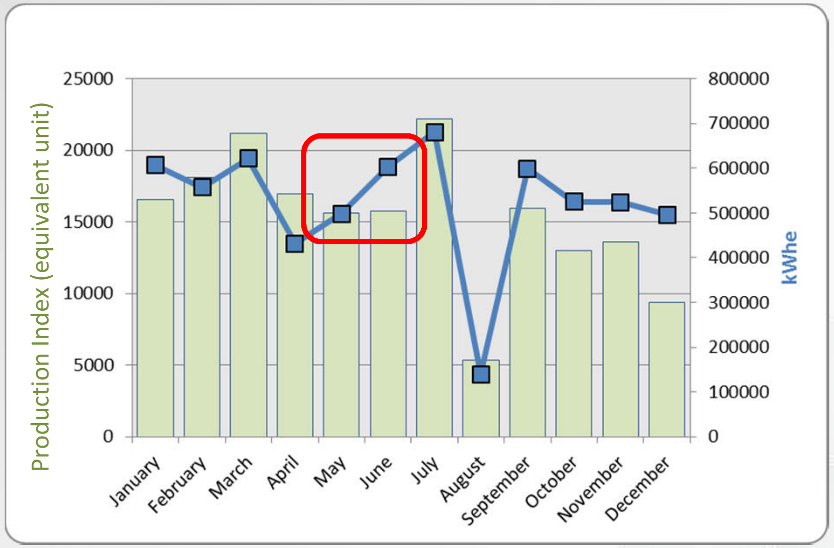
Monthly Electric consumptions trend analysis

Company 1

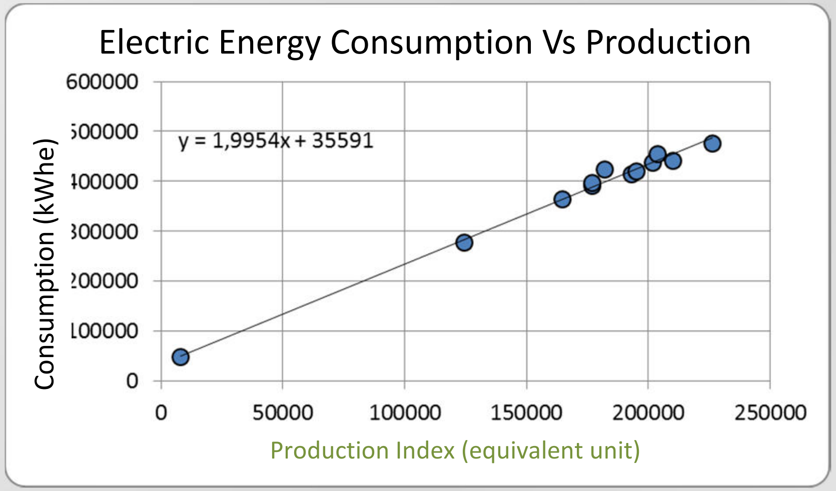


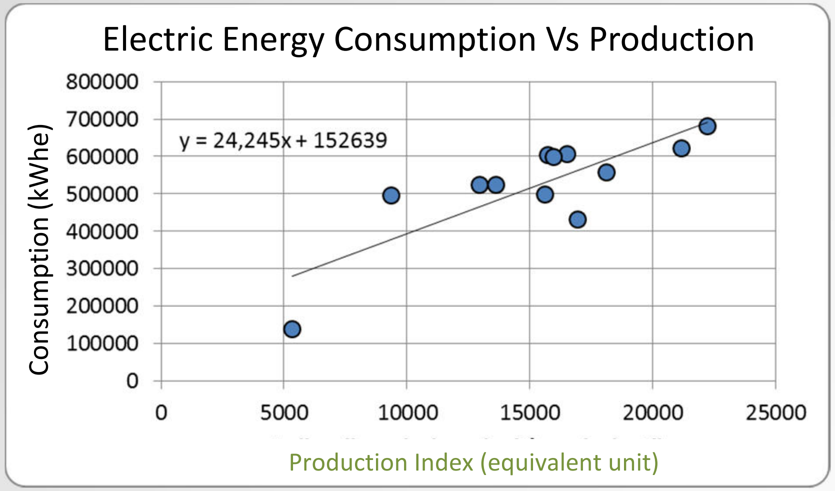
Monthly Electric consumptions trend analysis

Company 2



SET Tool – Regression analysis

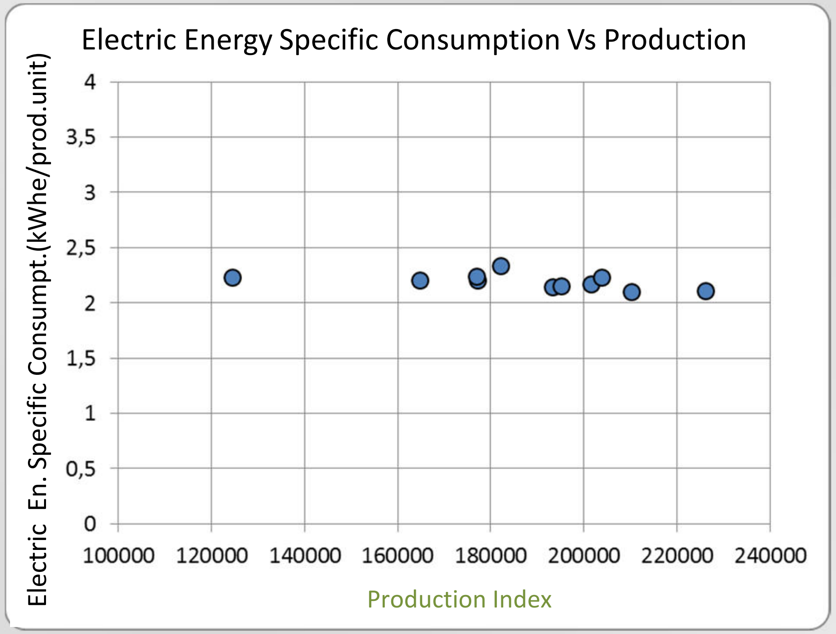


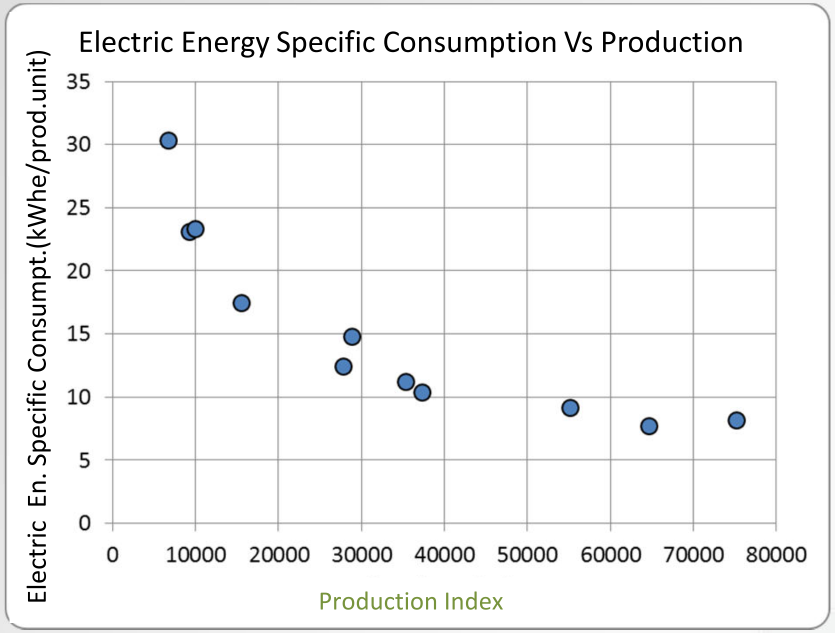


	Electric
R-square	0,99
Electric cosumptions when production is Zero (kWhe)	35.591,24
Consumption for equivalent additional unit (kWhe)	2,00
Basic energy consumption (kWhe)	9,39

	Electric
R-square	0,66
Electric cosumptions when production is Zero (kWhe)	152.639,43
Consumption for equivalent additional unit (kWhe)	24,25
Basic energy consumption (kWhe)	29,16

SET Tool – Electric Specific Consumption Trends

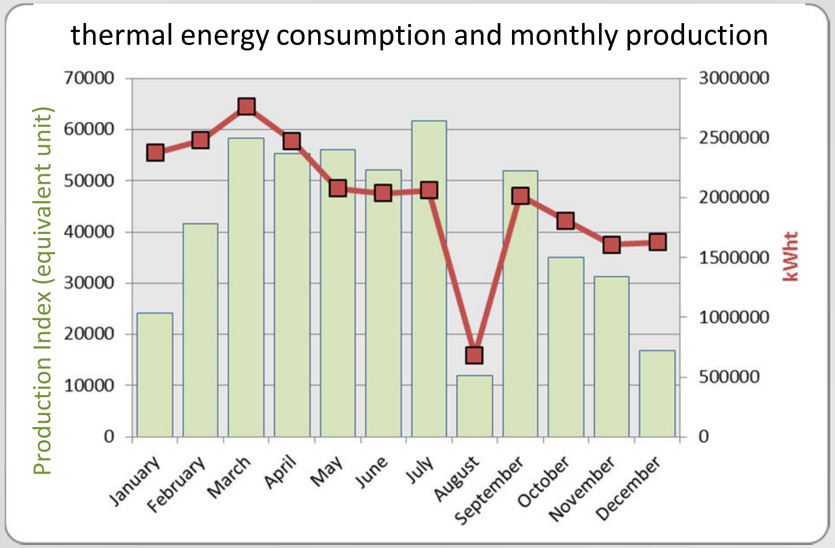




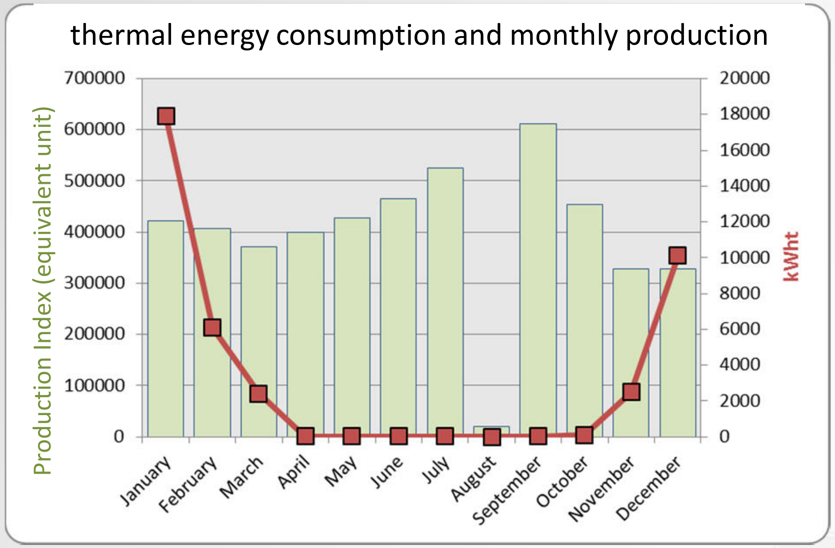
SET Tool
– Thermal consumption trends

Thermal consumption trends analysis

Company 1



Company 2

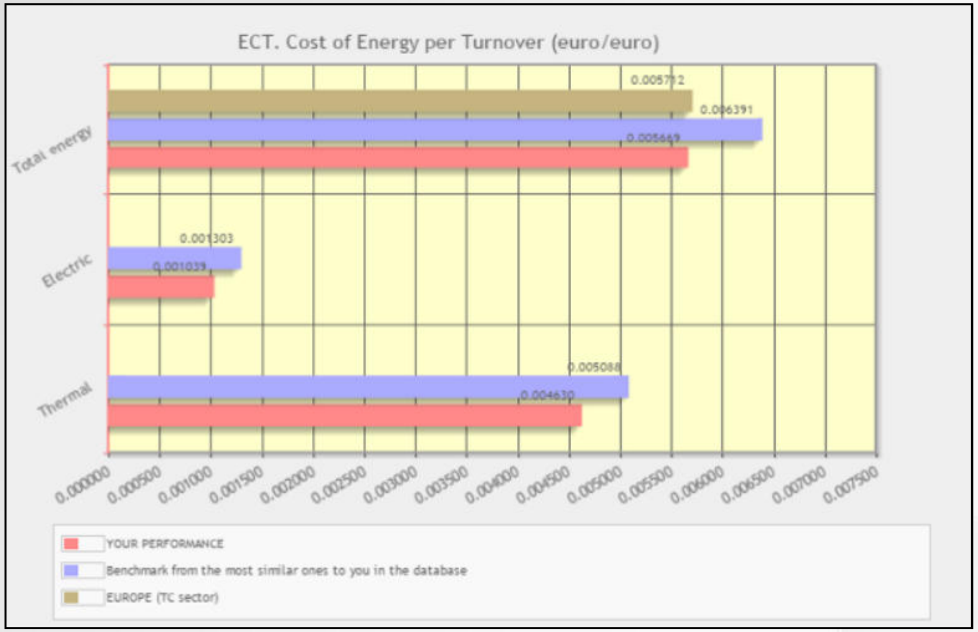


SET WEB

SET WEB is a web application accessible from Set Tool or from www.em2m.enea.it

It collects in ANONYMOUS way the energy data of the companies and allows comparison of energy performances toward a dynamic benchmark of SIMILAR companies

BENCHMARKING

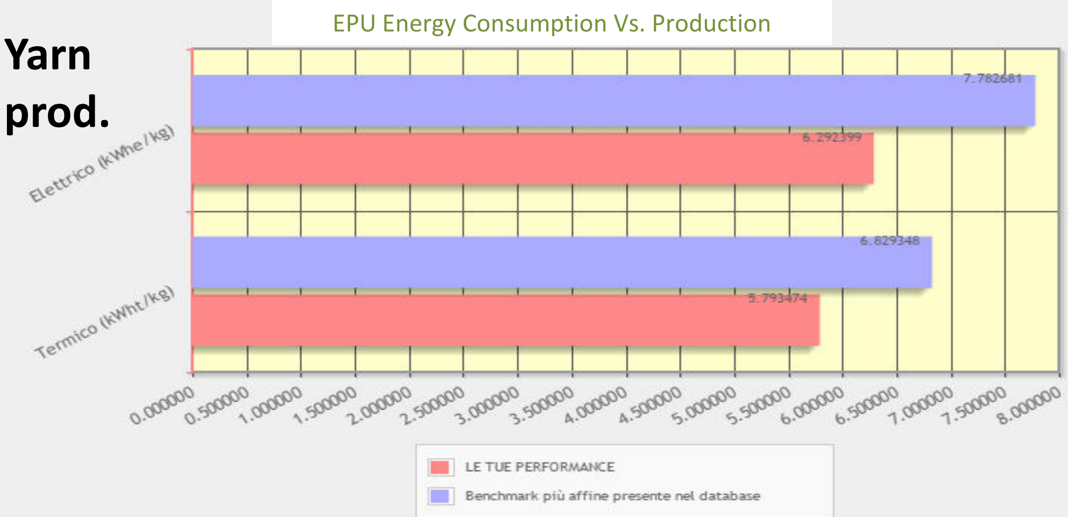


Me and my competitors

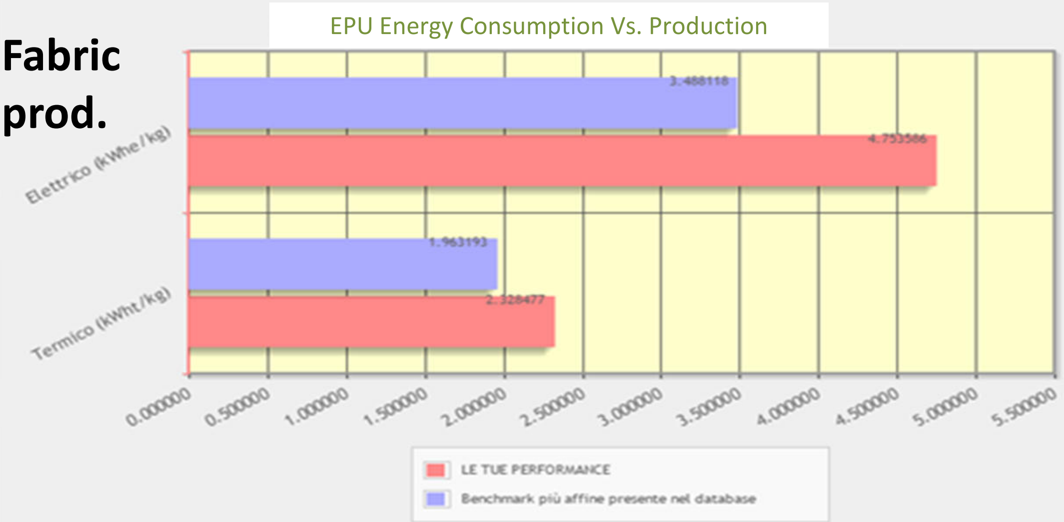
Indices: consumptions and energy costs for product and turnover unit

SET WEB/2

Yarn prod.



Fabric prod.



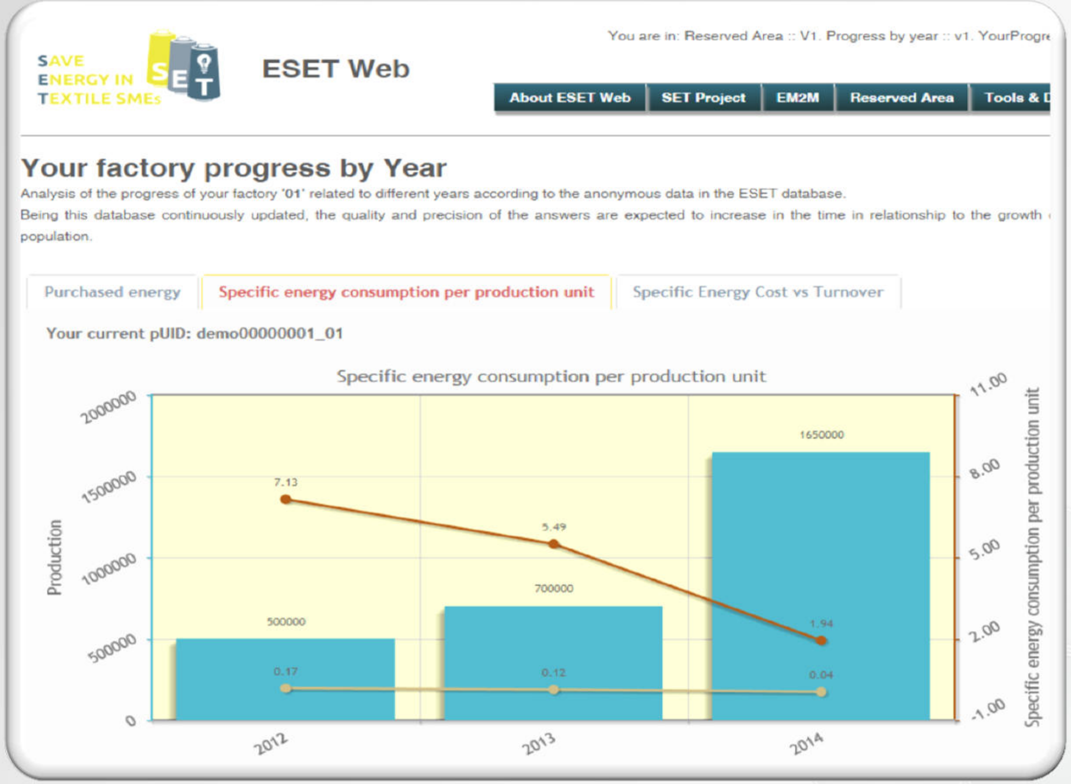
A comparison is effected towards firms that have a similar process (indices of similarity)

It allows to identify a possible incorrect evaluation of shares of energy consumptions of the departments

SET WEB/3

SET WEB allows to compare performance evolution year by year through indices like:

- specific energy consumption
- energy / turnover
- energy's price



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SET WEB -Production machines models

Electric energy expected consumption		Actual figures of your Factory			Evaluated deviation
Energy consumption for the whole production F=(a*D)/(b)	Specific energy consumption per production unit G=(F/D)	Electric energy consumption (C)	Production (D)	Specific energy consumption per production unit E=(C/D)	Evaluation (G-E)/E %
7029146,3 kWhe	3,28 kWhe/kg	7170018 kWhe	2141012 kg	3,35 kWhe/kg	 3,35 (+2%)

It compares your own machines consumption toward the expected results foreseen by models based on the adopted technologies and the mix of jobs.

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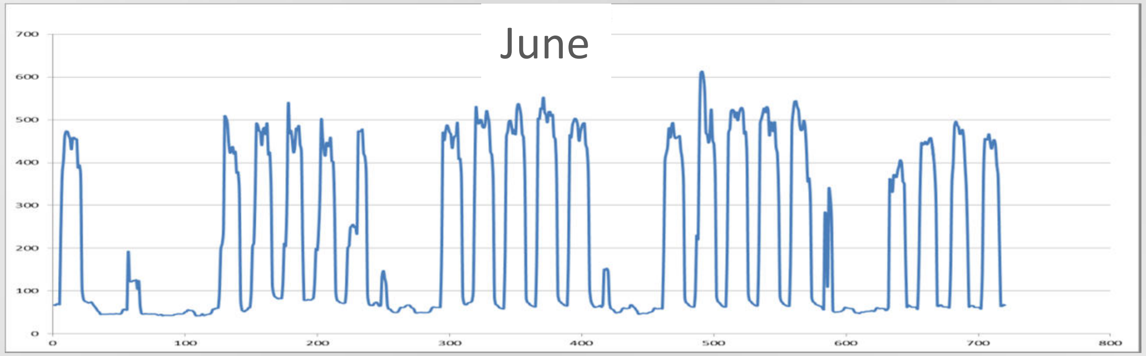
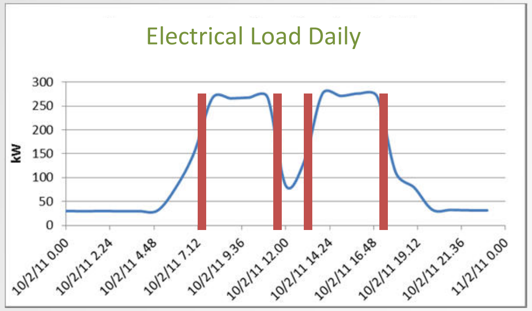
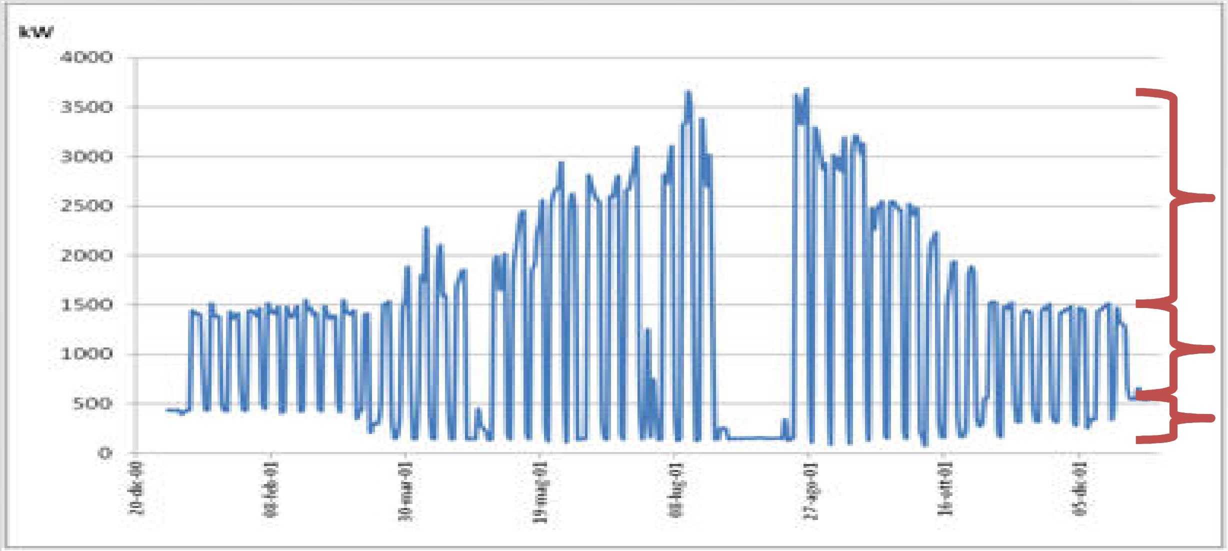
Detailed Analysis – Load profiles



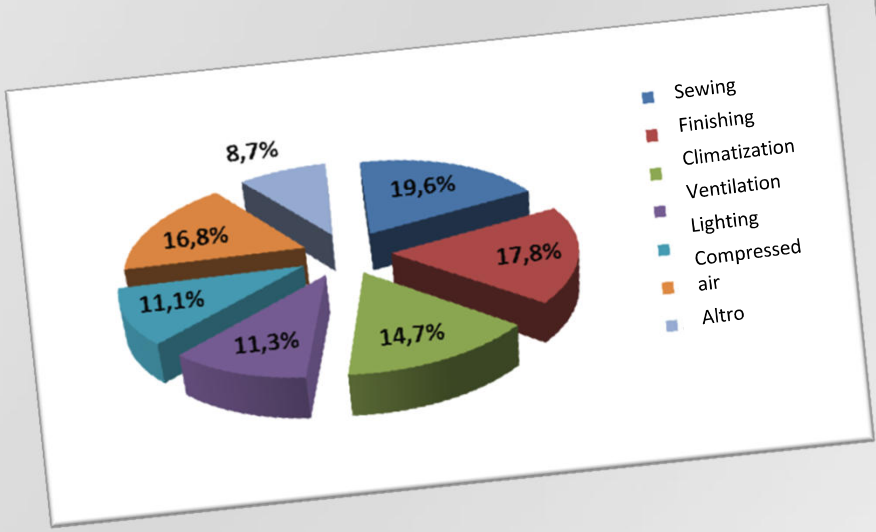


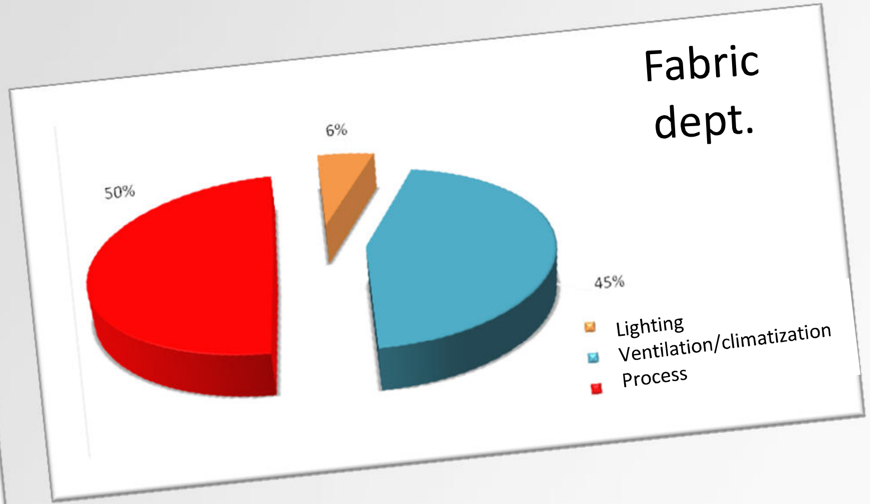


Detailed analysis: Energy cost centers

Installed power

Department level energy cost centers

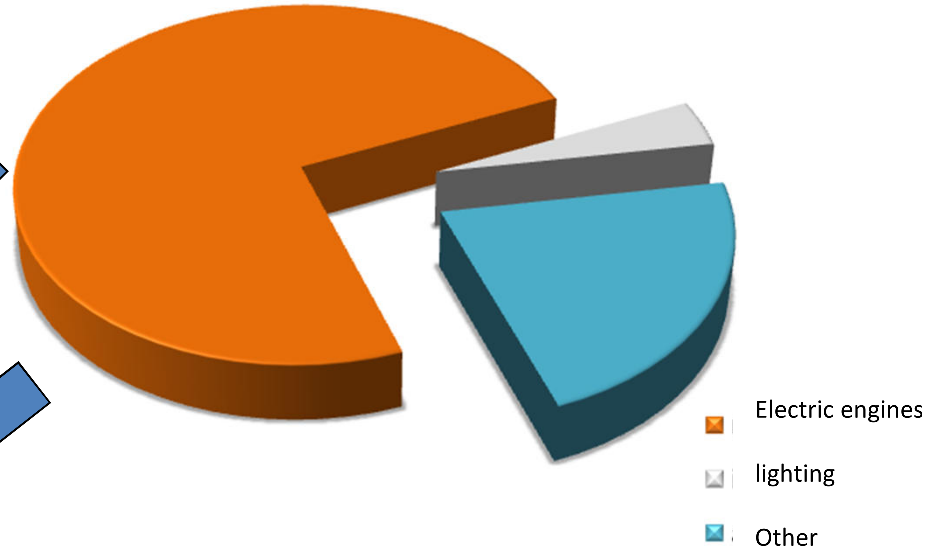


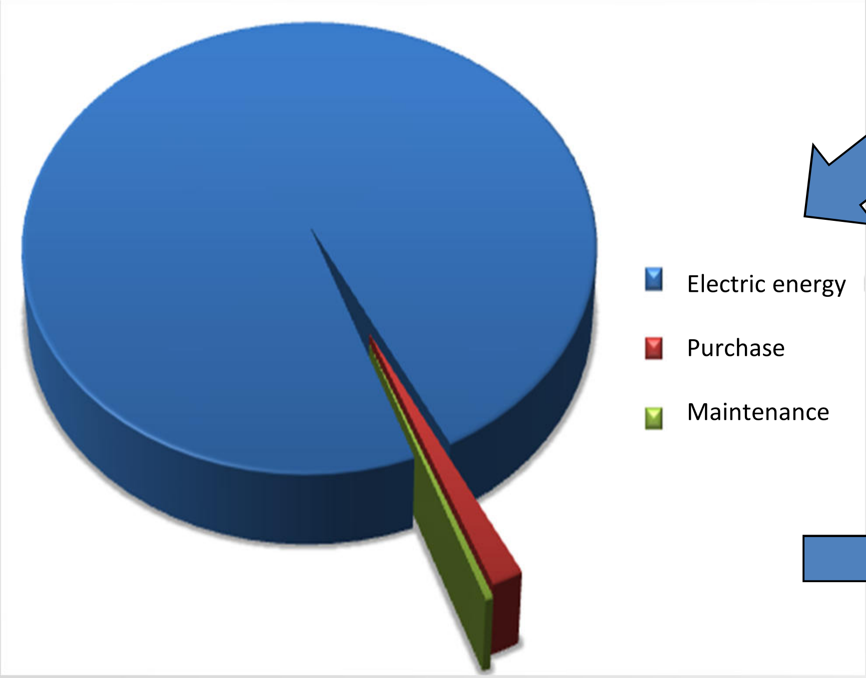


Factory energy cost centers

Interventions synthesis - Electric engines

Main electric consumptions in manufacturing industry





15 kW Motor, load ratio 75% ,efficiency 87%, hours in a year 3840, ten years lifetime

- High efficiency electric motors
- Over-sized electric motors
- Inverters and motors management
- Mechanical transmissions

Detailed analysis – Compressed air

- Pipeline losses
- Lower temperature of air drown into the system
- Lower air production pressure within the pipelines

HOLE Ø (mm)	Flow rate @ 7bar (l/s)	Power loss (kW)
1	1,2	0,4
3	11,1	4
5	31	10,8
10	124	43

Detailed analysis
- Thermal Interventions

- Steam/ heat generators
- Distribution system
- Systems efficiency actions and thermal wastes recovery
- HVAC systems (Heating, Ventilation and Air Conditioning)

Detailed analysis – Steam/heat generators

A heat generator has three types of losses:

Q_1 = HIGH TEMPERATURE IN COMBUSTION EXHAUST GASES

Q_2 = UNBURNED FUEL

Q_3 = HEAT LOSSES FROM RADIATION

Other types of losses are of less importance.

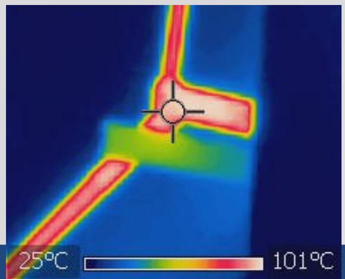
Detailed analysis – Steam/heat distribution

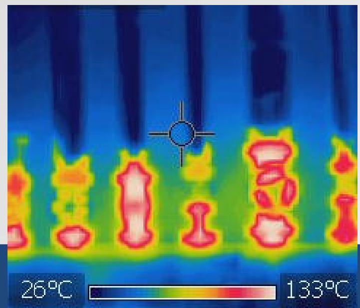
Lacking or collapsed insulation restore. Insulation of the inside steam lines is expected to reduce losses at least 90% in comparison to the naked pipeline.

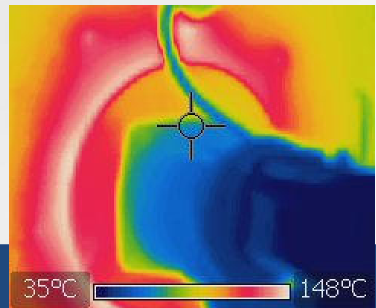
Besides, the lack or the collapse of the insulation don't guarantee the steam supply at the correct pressure to the use.

Steam losses: valves, flanges, cracks.

Steam re-compression: whenever available exhausted and low pressure steam can be mechanically re-compressed to serve steam uses demanding lower temperatures.







Detailed analysis – HVAC systems (Heating, Ventilation and Air Conditioning)

- Mobile barriers against heat escapes
- Environment thermostats with automatic management program
- Warm / cold air heating system
- Recovery of heat finalized to heating
- Interventions on the buildings infrastructure (coat, ventilated wall, insulating plaster)
- Free cooling
- De-stratifying
- Transition management

Case Study – Compressed air

From hourly load data it is noticed, when machines stop, a consumption of about 50 kWhe

They used to never turn off compressors
Compressor net analysis → elevated losses

Evaluation of the savings gotten by turning off machines when not working

16.000 €/year

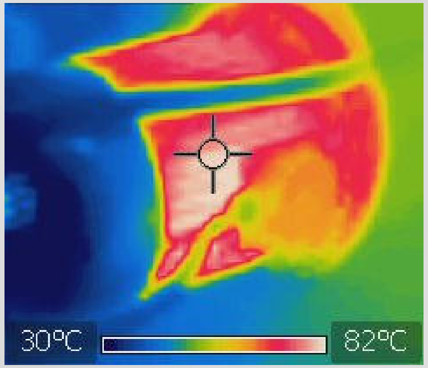
Estimation of the savings gotten through reparation of the pipelines, diminution of the pressure of exercise and the temperature of entry

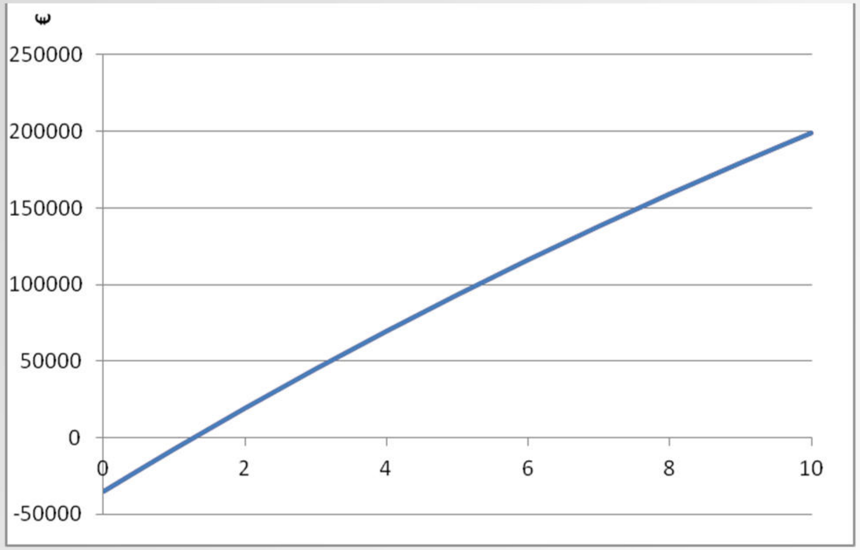
63.000 €/year

Case Study – Electric Motor

Substitution of 16 standards motors (not end of life), working 7680 hours/year, with more efficient (IE3) motors

Investment 35200 €



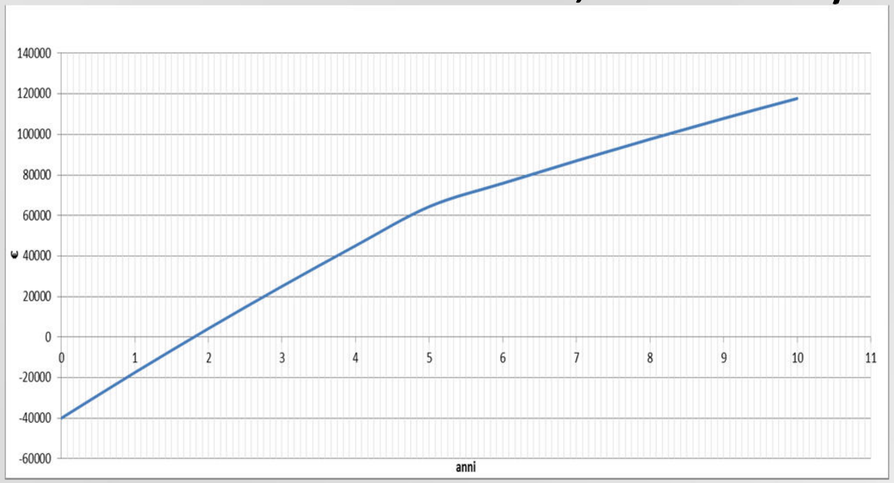


Investment payback time estimation

Case Study – Heat Recovery

Installation of a heat exchanger for heat recovery from the high temperature in combustion exhaust gases with the purpose to preheat input water of the steam generator.

After the intervention, efficiency is 94% (+4% increase).



Otherwise you can consider the possibility to preheat the combustive air.

Case Study – Cogeneration

- reduces the energetic dependence of the factory, potentially to the simple purchase of fuel (natural gas or any other)*

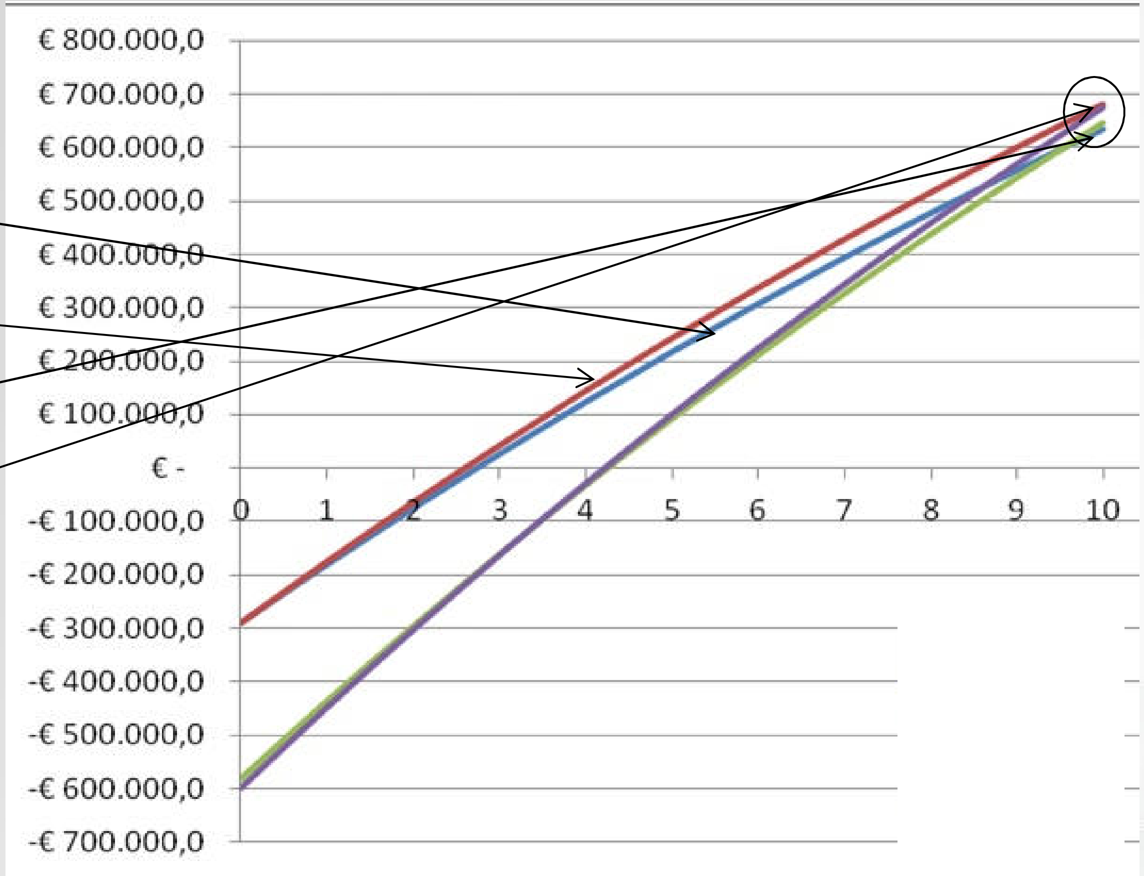
- makes available heat at different temperatures (exhaust gas, liquid of cooling, motor oil) that might be used for various purposes (generation of steam, heating of water, building heating..)

- interesting return of investment

Case Study
- Modular Cogenerator

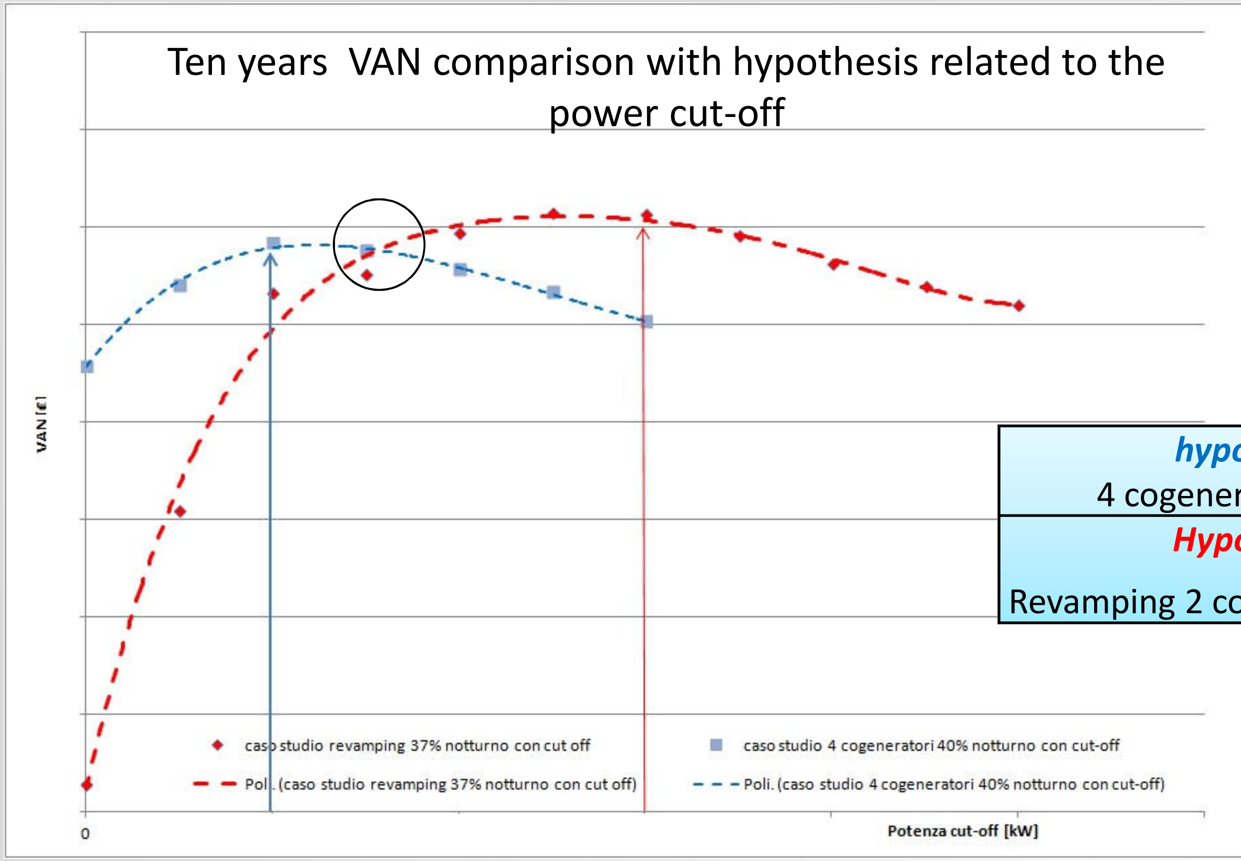
Revamping or new cogenerator ?

hypothesis 1   Revamping without any control logic
hypothesis 2   Revamping with control logic
hypothesis 3   New cogenerator 600 kW
hypothesis 4   Two cogenerators 300 kW



Case Study – Cogenerator Management

For different cogenerators we need different management policies



hypothesis 1   4 cogenerators 300 kW
Hypothesis 2   Revamping 2 cogenerators 600 kW

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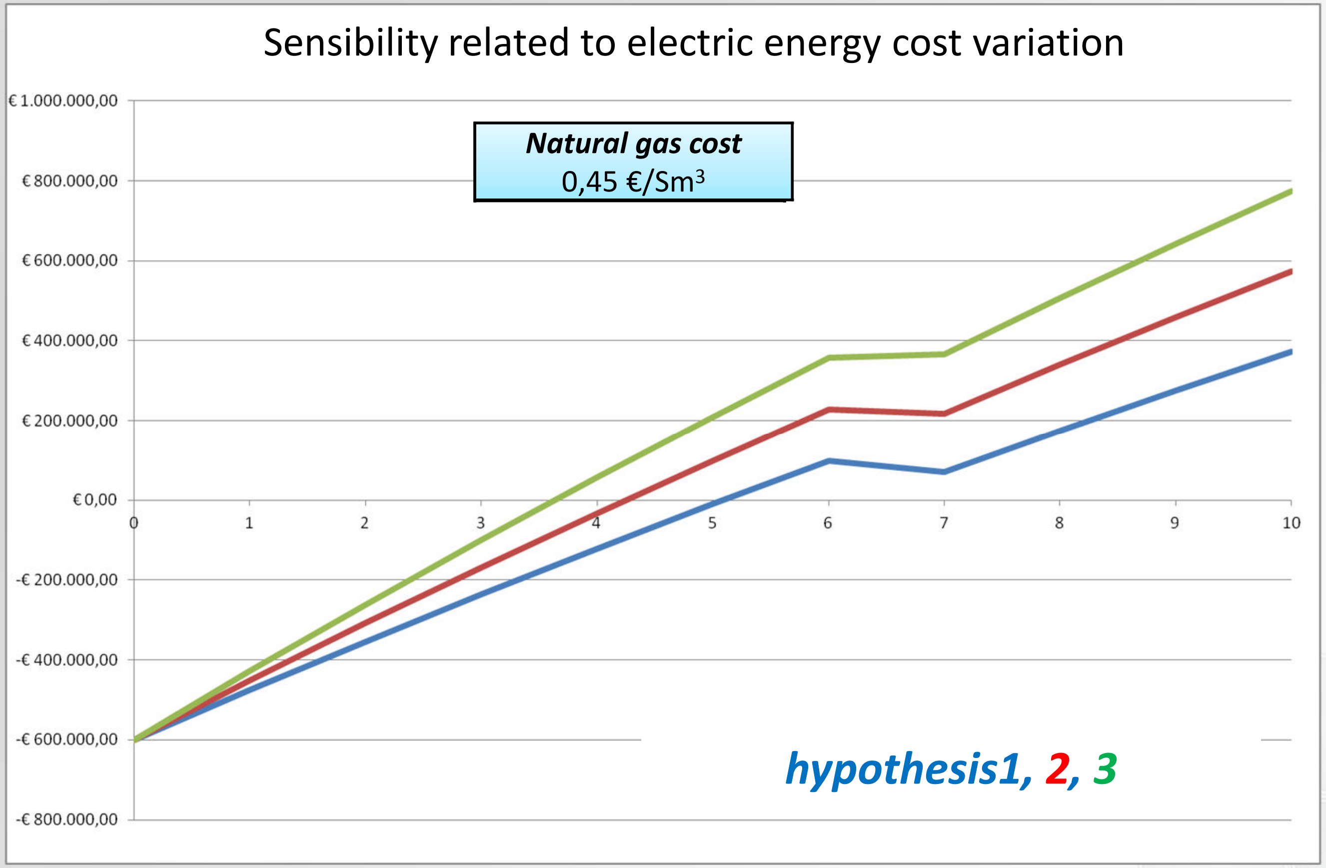
Case Study - Revamping

hypothesisi 1 peak 0,140 €/kWhe out of peak 0,127 €/kWhe
hypothesis 2 peak 0,145 €/kWhe out of peak 0,132 €/kWhe
hypothesis 3 peak 0,155 €/kWhe out of peak 0,142 €/kWhe



Results for the company

- Savings for plants reconfiguration (obtained savings for over 25% of the consumptions)
- New more efficient technologies deployed
- Recontracting Energy supply
- Perception of own energy consumption costs in comparison to the average of sector (process specific)
- Job shifts optimisation, energy loads and processes optimization
- Definition and adoption of management policies for cogeneration and for renewable source systems
- Specific efficency actions

Quantitative Results

Visited companies within the SESEC and ARTISAN projects : about 30 (Europe), assisted companies to today within SET (in progress): 56 (Europe)

Some results of Energy-to-Measure Campaign

- DAMEL (PT) has identified savings on lighting, speed operational machines and insulations that can allow 5% saving on the electric consumption and 3% on the thermal consumption (SESEC)
- CANALI (IT) has identified optimization areas in its own electric and technical uses (SESEC)
- Marc Cain (D) has identified possible reduction of the times of stand-by of the machines with possible saving by 20% of energy electric and analogous saving in the use of the conditioner (ARTISAN)
- Marchi&Fildi (IT) has identified interventions on efficiency on the auxiliary systems that have allowed to reduce by 25% the electric consumptions (ARTISAN)

Final outcomes

A general methodology, specialized on one manufacturing industrial sector (the textile and clothing), but transferable to analogous ones

A set of tools to interact with small and medium firms

An approach finalized to change the behaviours and the awareness as point of departure to the energy efficiency

The companies participation to a community allows the construction and use of a system of dynamic industry benchmarks

Thanks for your attention

EM2M: www.euratex.eu/em2m
SET project: www.euratex.eu/set
SET WEB Tool: www.em2m.enea.it

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