



[Applying Energy Efficient measures for metal and metalworking SMEs and industry \(EE-METAL\)](#)

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# Report on the potential energy saving measures in SMEs of the metalworking sector of 4 EU countries: a cross-country benchmarking

## Phase I

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Abstract	This document shows the energy analysis and the preliminary energy saving measures obtained from the energy audits carried out in accordance with work package 2, task 2.2.



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# REPORT ON THE POTENTIAL ENERGY SAVING MEASURES IN SMES OF THE METALWORKING SECTOR OF 4 EU COUNTRIES: A CROSS-COUNTRY BENCHMARKING

## PHASE I

### 1 INTRODUCTION

According to task 3.3 “Audit development and report of results Phase 1”, every country member should carry out 20 energy audits, 80 in total, based on the common methodology developed in task 2.2

This document aims to show the energy analysis and the obtained measurements of saving from the energy audits realized so much at sectorial level, by country as on a global scale, taking into account that the four countries involved in the project are: France, Italy, Poland and Spain.

### 2 COMPANIES AUDITED

Initially, the audited companies should fulfill the following requirements:

- To be a small or medium company.
- Belong to the following subsectors:
  - NACE 24
  - NACE 25
  - NACE 28
- To have an energy consumption in accordance to sectors:
  - NACE 24: < 38 GWh/year
  - NACE 25:> 0,5 GWh/year
  - NACE 28: > 0,5 GWh/year
- And be disaggregated in the following subsectors:
  - NACE 24: 12 audited companies. 3 companies per country.
  - NACE 25: 48 audited companies. 12 companies per country.



- NACE 28: 20 audited companies. 5 companies per country.

The business activities that encompass each of the sectors included in this document are described below:

NACE 24: Manufacture of basic metals.

Including some subsectors such as:

- C24.1 - Manufacture of basic iron and steel and of ferro-alloys
- C24.2 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
- C24.3 - Manufacture of other products of first processing of steel
- C24.4 - Manufacture of basic precious and other non-ferrous metals
- C24.5 - Casting of metals

NACE 25: Manufacture of fabricated metal products, except machinery and equipment

- C25.1 - Manufacture of structural metal products
- C25.2 - Manufacture of tanks, reservoirs and containers of metal
- C25.3 - Manufacture of steam generators, except central heating hot water boilers
- C25.4 - Manufacture of weapons and ammunition
- C25.5 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy
- C25.6 - Treatment and coating of metals; machining
- C25.7 - Manufacture of cutlery, tools and general hardware
- C25.9 - Manufacture of other fabricated metal products

NACE 28: Manufacture of machinery and equipment n.e.c.

- C28.1 - Manufacture of general-purpose machinery
- C28.2 - Manufacture of other general-purpose machinery
- C28.3 - Manufacture of agricultural and forestry machinery
- C28.4 - Manufacture of metal forming machinery and machine tools
- C28.9 - Manufacture of other special-purpose machinery

Finally, the audits carried out in Small and Medium companies have been:

N° OF COMPANIES				
	NACE 24	NACE 25	NACE 28	Total
FRANCE	1	12	1	14
ITALY	3	14	3	20
POLAND	3	13	5	21
SPAIN	3	13	4	20
<b>TOTAL</b>	<b>10</b>	<b>52</b>	<b>13</b>	<b>75</b>

With the following ranges of final energy consumptions:

FINAL ENERGY CONSUMPTION (GWh/y)			
	NACE 24	NACE 25	NACE 28
FRANCE	< 0,49	> 0,63 and < 6,55	> 0,47 and < 0,48
ITALY	> 0,98 and < 12,75	> 0,46 and < 16,15	> 0,63 and < 2,12
POLAND	> 0,72 and < 20,17	> 0,14 and < 12,50	> 0,52 and < 2,71
SPAIN	> 0,92 and < 17,60	> 0,14 and < 8,14	> 0,28 and < 3,81

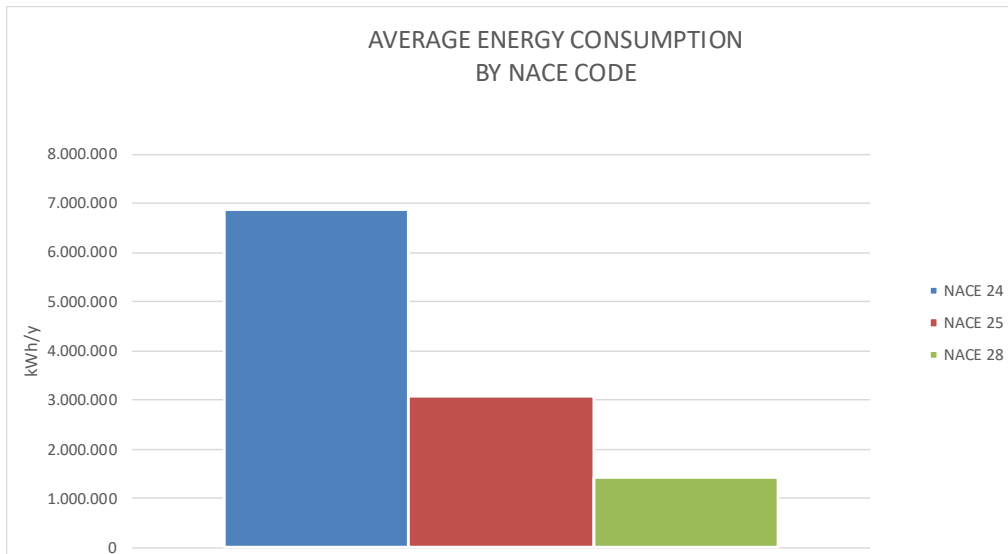
### 3 ENERGY ANALYSIS

In this paragraph it is intended to realize an energetic analysis of audited companies as a whole, by sector and by country. This study refers to final energy, that represents the sum of electricity and primary energy content of fuels taking into account gross calorific value of them (natural gas, diesel fuel, biomass etc.).

#### 3.1 AVERAGE FINAL ENERGY CONSUMPTION BY SECTOR

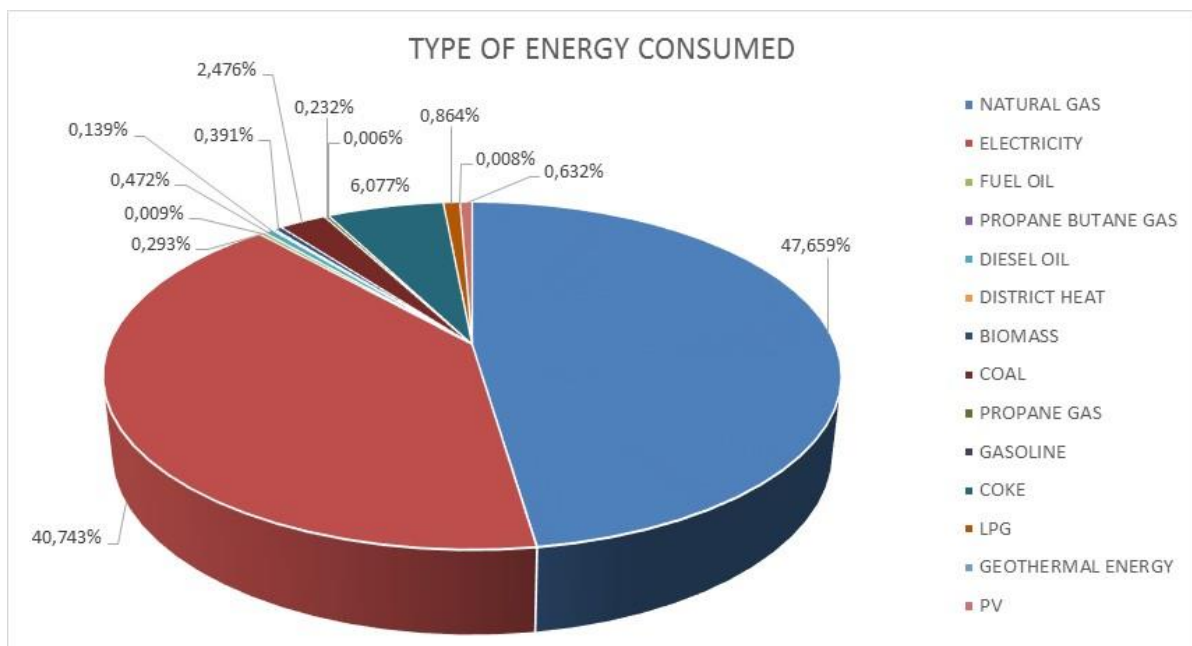
With the data acquired from the audits carried out, the following average final consumptions by sector were obtained:

AVERAGE FINAL ENERGY CONSUMPTION (GWh/y)	
NACE 24	6,87
NACE 25	3,02
NACE 28	1,44



### 3.2 TYPE OF FINAL ENERGY CONSUMPTION

The types of energy sources used by the audited companies are mainly natural gas and electricity, being the sum of both more than 98% of total consumption. Below is shown a chart with the different types of energy sources which have been consumed and the importance of each of them on the total.

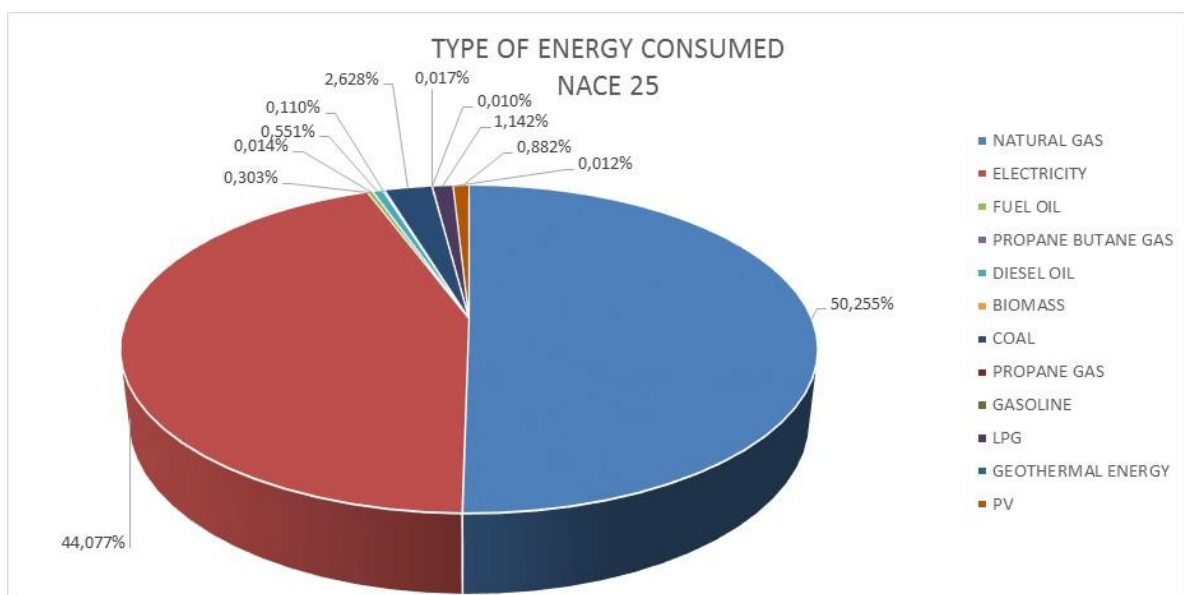
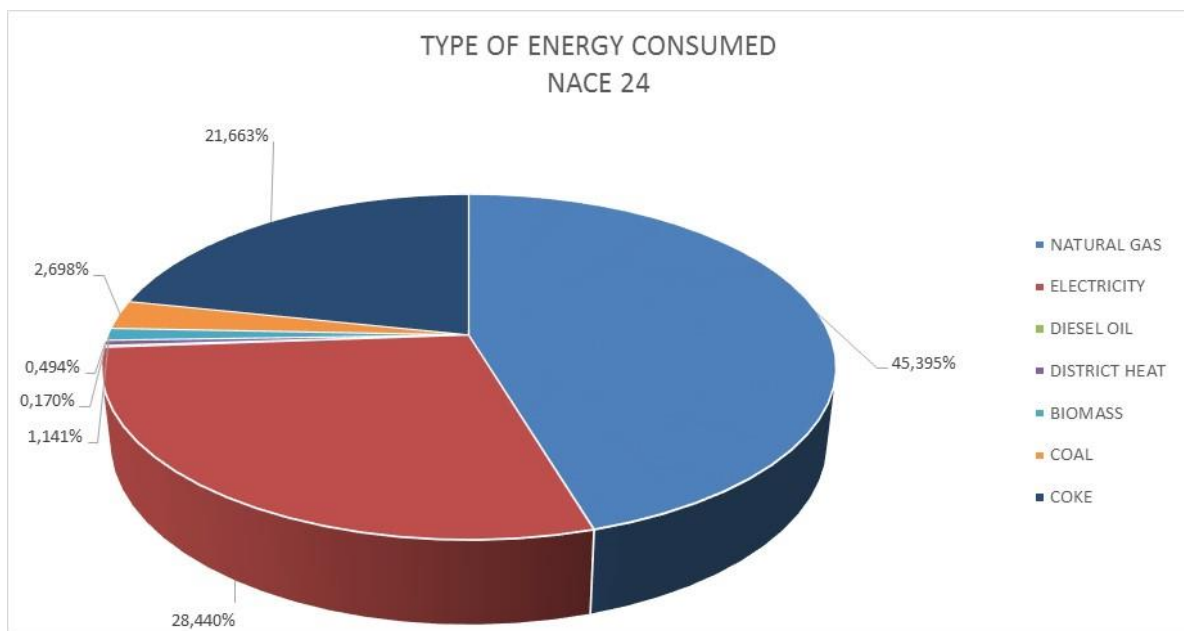


As shown in the graph, the third source of energy consumed is the coke, followed by coal.

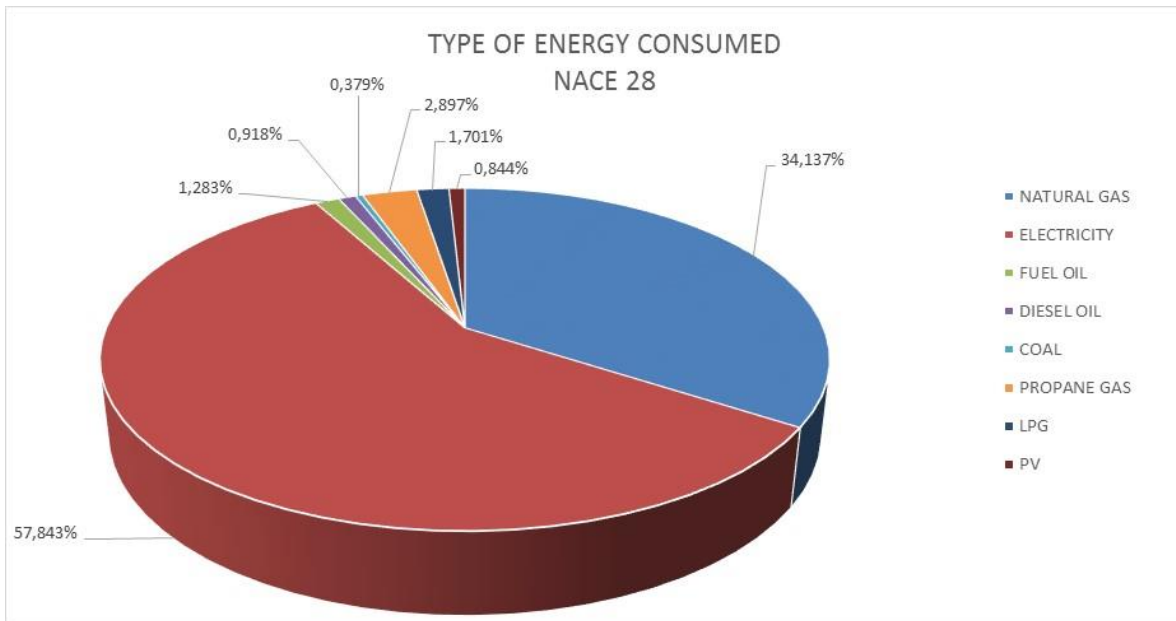
If it is focused by NACE, in Sector 24, the greatest energy weight are those sources whose use is heat production. This is why Natural Gas in conjunction with Coke takes more than 65% of total consumption.

Nevertheless, in sectors 25 and 28 the use of electricity increases its weight in global computation, being more than 70% higher than natural gas in sector 28.

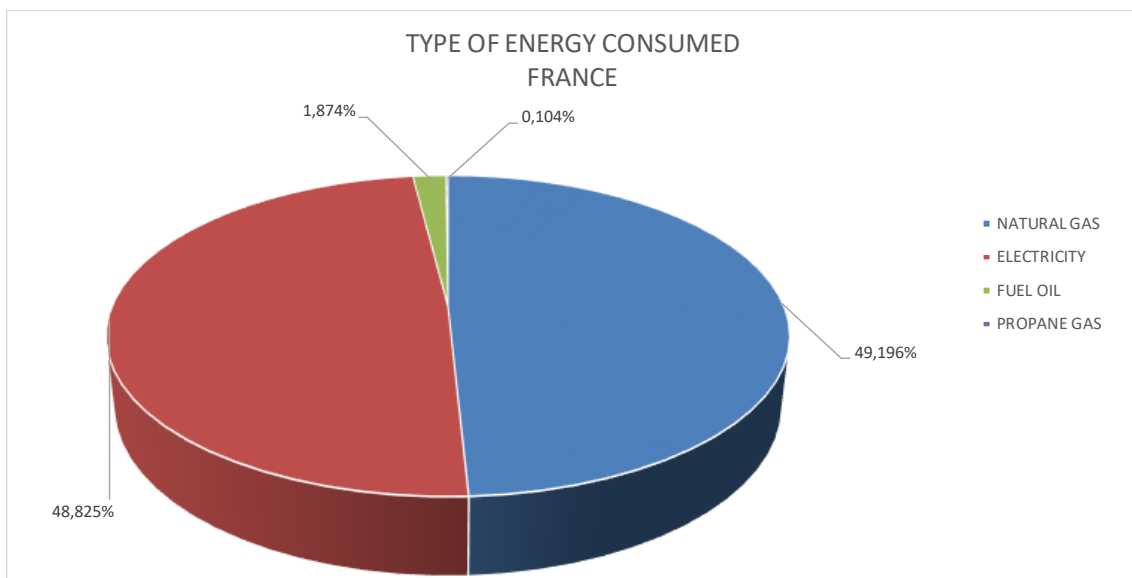
Below is shown the graphs of the energy types consumed in each of the sectors.

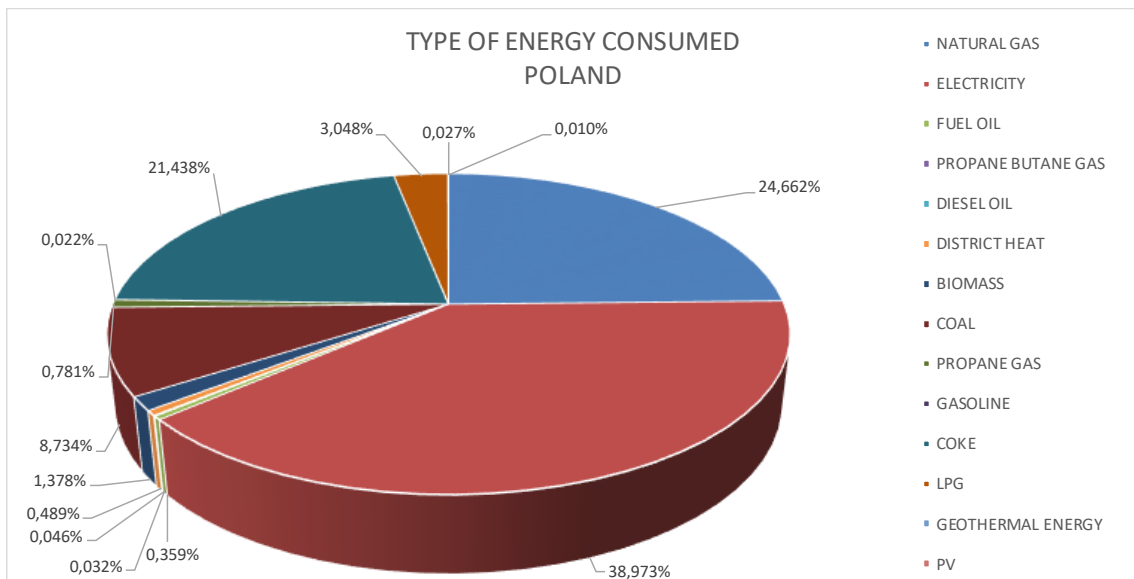
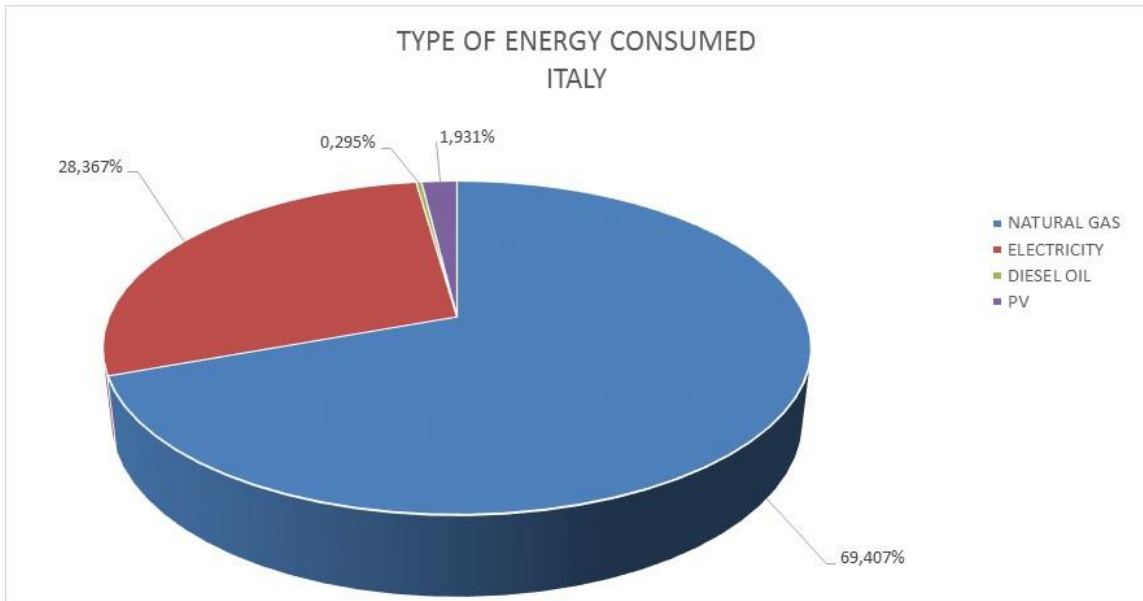


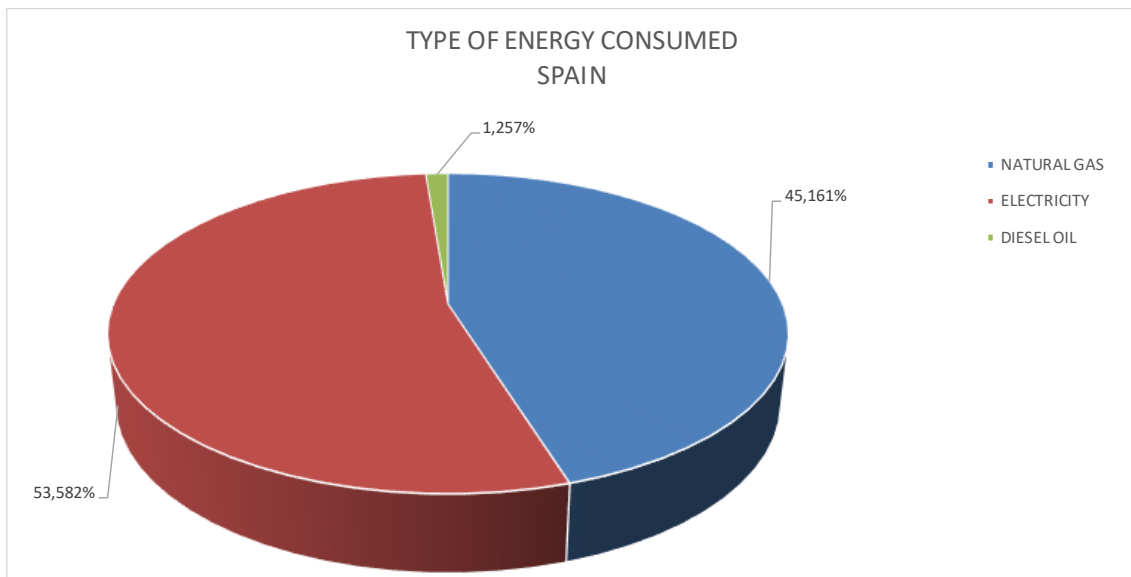




If it is focused on types of energy sources used by country and its weight on the global consumption of each of them, we will obtain the following graphs:





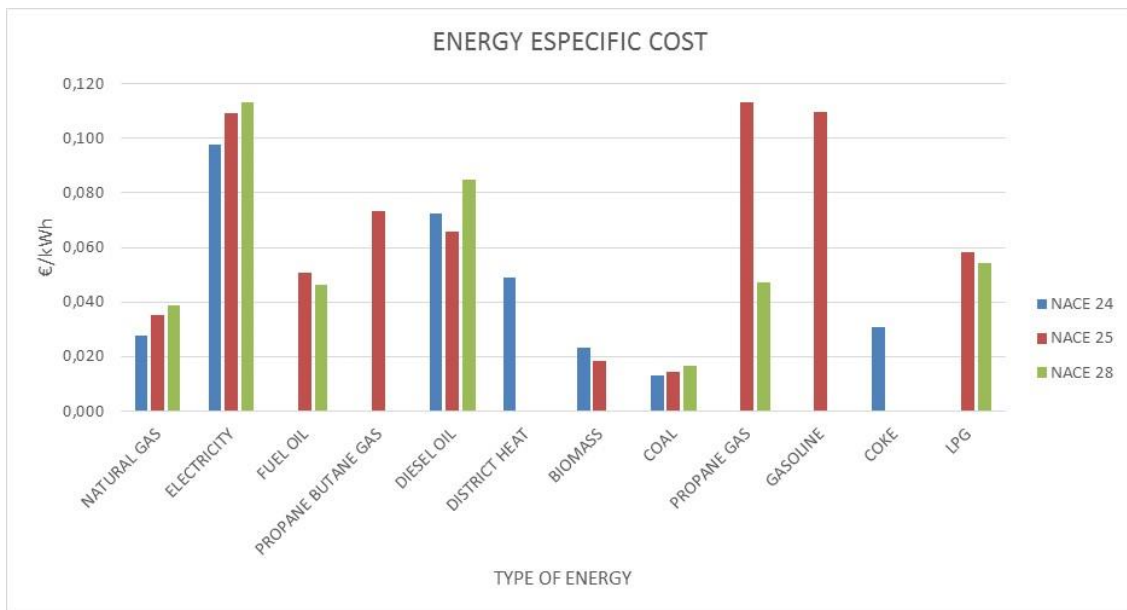


Highlight the diversity of energy sources used in Poland. Energy sources such as coke and coal are only being used in Poland, as well as renewable sources such as biomass, geothermal energy and the use of district heating to convert heat needs. Photovoltaic energy is also used in Poland and Italy, with percentages close to 2% in Italy.

### 3.3 ENERGY COSTS

This section aims to show the energy cost of the different energy sources used in the audited companies.

The following chart represents the specific cost of energy sources used in each sector studied.



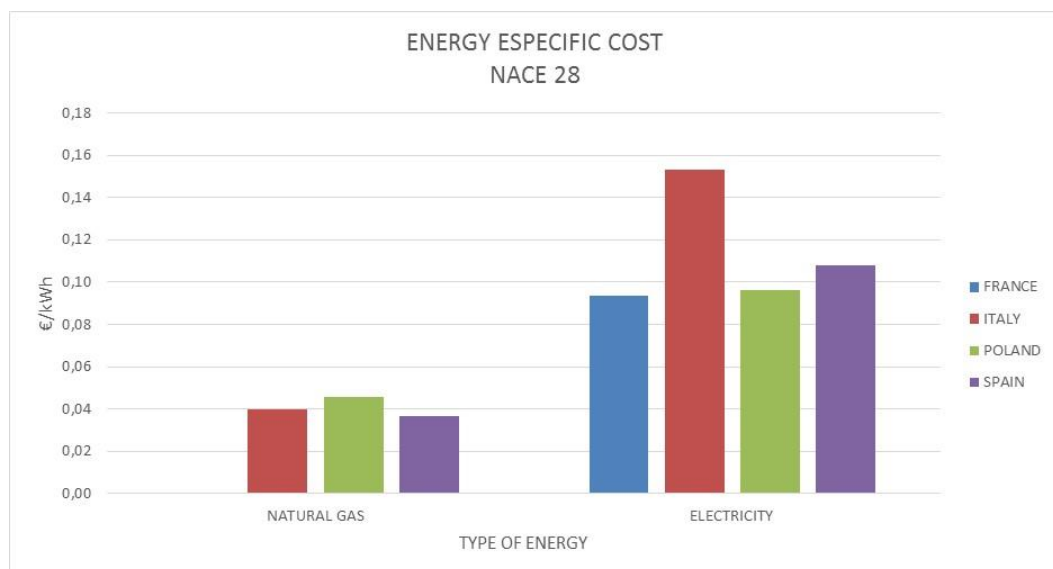
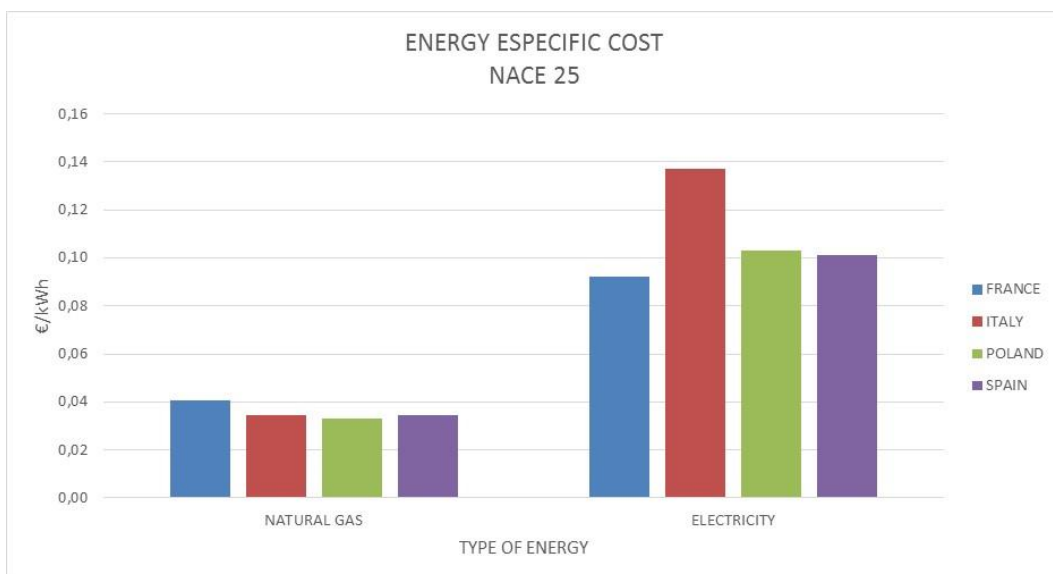
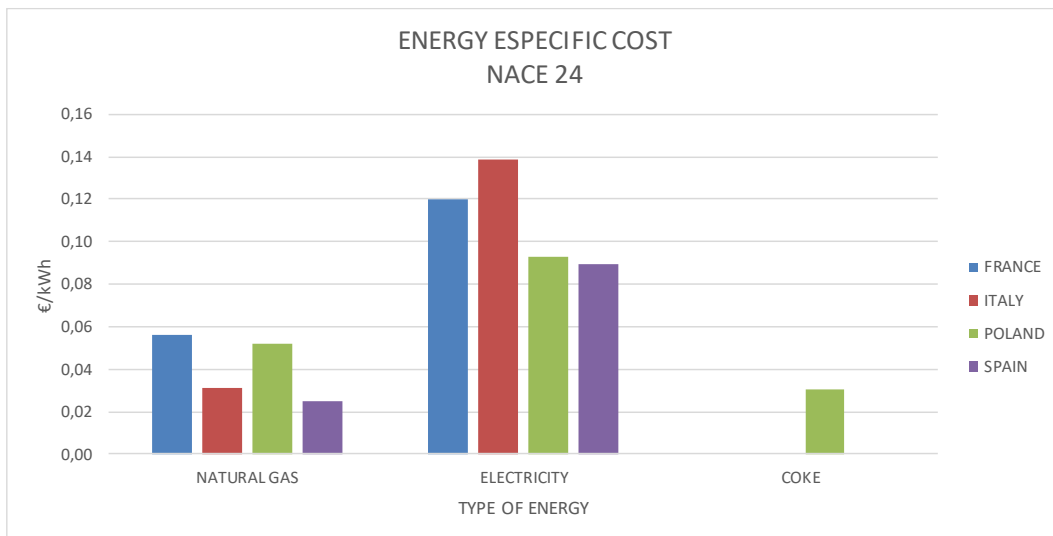
As it has been indicated previously on a global scale, the sum of the consumption of natural gas and electricity means more than 88 % of the total consumption of the audited companies. As it can be seen in the previous graph, in case of both types of energy, to higher consumption lower is the specific cost.

In case of NACE 24 which average consumption per company is  $6,8 \times 10^6$  kWh/year the specific cost of natural gas and electricity is the minimum obtained, 0,028 €/kWh and 0,098 €/kWh respectively.

In case of NACE 25 which average annual consumption per company is  $3,02 \times 10^6$  kWh/year the specific cost of natural gas and electricity is 0,035 €/kWh and 0,109 €/kWh respectively.

And in case of NACE 28 with the average annual consumption per company lower,  $1,44 \times 10^6$  kWh/year, the specific cost of natural gas and electricity is the highest, 0,039 €/kWh and 0,113 €/kWh respectively.

With the data provided by the audited companies we can also obtain the charts corresponding to the specific costs of each country of the main energy sources used in each NACE.



Note that the data obtained from specific cost of natural gas and electricity by sector are quite similar to the data obtained from Eurostat for 2016 (average of the two semesters of the year) for Non-household consumers in the ranges of values of average final consumption by NACE in each of the countries

These data are:

DATA OF EUROSTAT	NATURAL GAS COST (€/kWh). Non-household consumers. Excluding VAT and other recoverable taxes and levies.			ELECTRICITY COST (€/kWh). Non-household consumers. Excluding VAT and other recoverable taxes and levies.		
	NACE 24	NACE 25	NACE 28	NACE 24	NACE 25	NACE 28
FRANCE	0,04	0,04	0,04	0,08	0,08	0,09
ITALY	0,03	0,03	0,04	0,14	0,14	0,15
POLAND	0,03	0,03	0,03	0,07	0,07	0,08
SPAIN	0,03	0,03	0,04	0,09	0,09	0,11

NOTE: NACE 24: Natural gas consumption between 10.000 and 100.000 GJ  
 NACE 25: Natural gas consumption between 10.000 and 100.000 GJ  
 NACE 28: Natural gas consumption between 1.000 and 10.000 GJ  
 NACE 24: Electricity consumption between 2.000 and 20.000 MWh  
 NACE 25: Electricity consumption between 2.000 and 20.000 MWh  
 NACE 28: Electricity consumption between 500 and 2.000 MWh

The data obtained from the audited companies are:

DATA OF EE_METAL	NATURAL GAS COST (€/kWh).			ELECTRICITY COST (€/kWh).		
	NACE 24	NACE 25	NACE 28	NACE 24	NACE 25	NACE 28
France	0,06	0,04		0,12	0,09	0,09
Italy	0,03	0,03	0,04	0,14	0,14	0,15
Poland	0,05	0,03	0,05	0,09	0,10	0,10
Spain	0,02	0,03	0,04	0,09	0,10	0,11

Highlight that the data obtained from the audits of Poland are the most distant from those offered by Eurostat.

Likewise, the data obtained from France in NACE 24 are also higher than those provided by Eurostat. In this case, it should be noted that the data provided by France in this sector are not representative since the number of companies audited is lower than initially provide.

In addition, it should be noted that the number of companies audited in this project are 72 compared to the more than 55.000 values included in Eurostat.

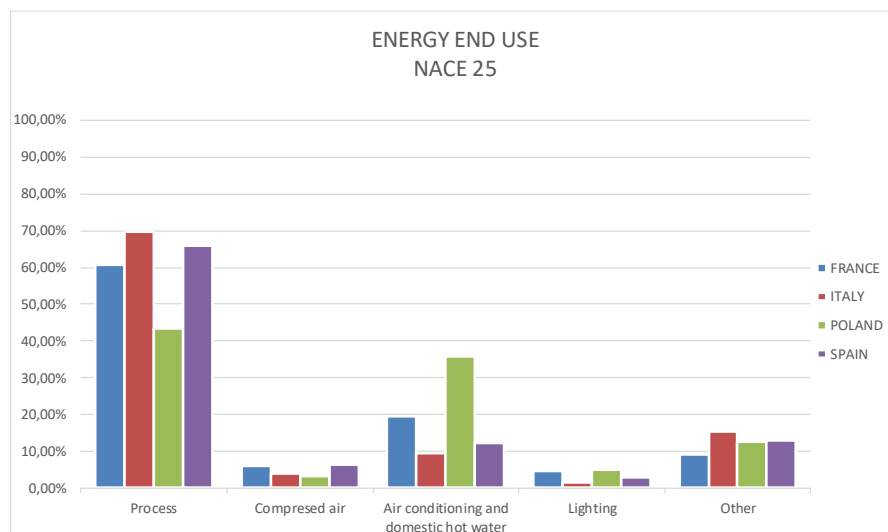
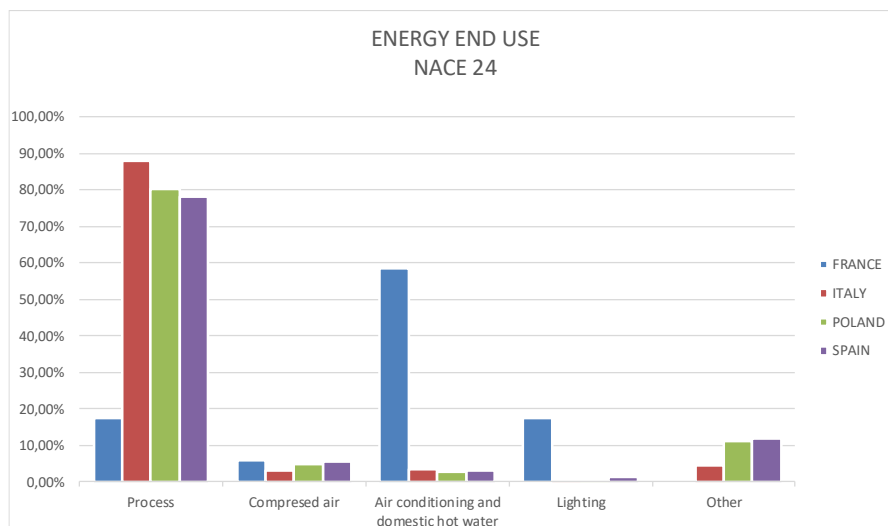
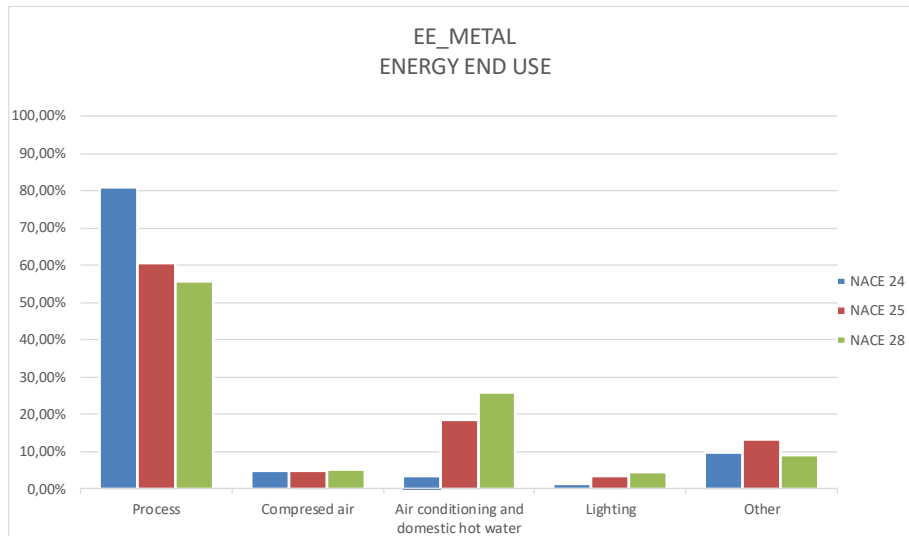
### 3.4 ENERGY CONSUMPTION BY END USE

In this section, through the audits carried out, it is intended to establish for each NACE, ratios of energy consumed depending on the end use of it. In this section, through the audits carried out, it is intended to fix for each NACE energy ratios consumed according to the final use of it. However, due to the variety and plurality of the audited companies, only 5 types of final use of energy have been established. These types of end use energy are:

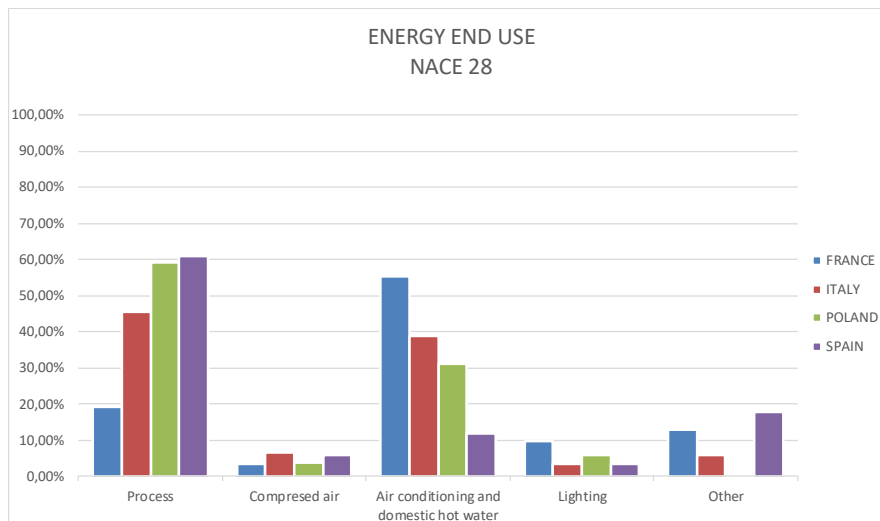
- Process
- Compressed air
- Air conditioning and domestic hot water
- Lighting
- Other

According to these end uses and the information extracted from the audits, the following energy ratios have been obtained:

% OF TOTAL CONSUMPTION						
NACE	END USE	FRANCE	ITALY	POLAND	SPAIN	EE_METAL
24	Process	17,30%	88,11%	80,41%	78,01%	80,93%
	Compressed air	5,89%	3,21%	4,96%	5,57%	4,79%
	Air conditioning and domestic hot water	58,55%	3,60%	2,77%	2,93%	3,36%
	Lighting	17,48%	0,61%	0,72%	1,49%	1,11%
	Other	0,78%	4,47%	11,14%	12,00%	9,81%
25	Process	60,86%	69,61%	43,54%	65,85%	60,71%
	Compressed air	6,03%	4,01%	3,25%	6,26%	4,61%
	Air conditioning and domestic hot water	19,40%	9,40%	35,85%	12,11%	18,36%
	Lighting	4,64%	1,66%	4,86%	2,90%	3,21%
	Other	9,07%	15,32%	12,50%	12,87%	13,11%
28	Process	19,02%	45,41%	59,33%	61,06%	55,65%
	Compressed air	3,24%	6,45%	3,55%	5,95%	5,20%
	Air conditioning and domestic hot water	55,16%	38,89%	31,17%	11,83%	25,90%
	Lighting	9,64%	3,30%	5,95%	3,42%	4,40%
	Other	12,94%	5,95%	0,00%	17,73%	8,84%







From the data obtained the following conclusions can be drawn:

- As indicated above, the data of France in NACE 24 and 28 are not representative since the number of audited companies in these sectors is smaller than initially agreed.
- Therefore, without taking into account the data from France it can establish that the energy consumption in process for NACE 24 exceeds 75%, with similar repercussions for all other uses in all countries.
- In NACE 25, the end-use of energy is similar in all countries, with the exception of Poland, where consumption in heating and domestic hot water is considerably higher than in other countries.
- In NACE 28, the final use of energy is more disparate, balancing the consumption in process with consumption in heating and domestic hot water. The other uses are similar in all countries.

### **3.5 CHARACTERIZATION OF THE SECTORS**

The establishment of an energy baseline is the most appropriate method to characterize each of the sectors of the present study has been considered.

An energy baseline represents the current energy behaviour of a company, reflects a specified period and can act as a reference at the time of implementing improvement opportunities, quantifying the savings obtained.

To calculate the baseline, the statistical method called Linear regression analysis will be used. This method consists of developing the dispersion of energy consumption chart VS the independent variable that is considered of greater influence in the process.

Then, by means of linear regression, you get the straight line equation which indicates the influence of the independent variable on energy consumption.

The form of the equation is of the type:

$$y = a + bx$$

"a" is the fixed consumption of the system and "x" the independent variable with a multiplying factor "b".

If the independent variable "x" is known, it is possible to calculate the consumption of energy "y" (independent variable) for a known period.

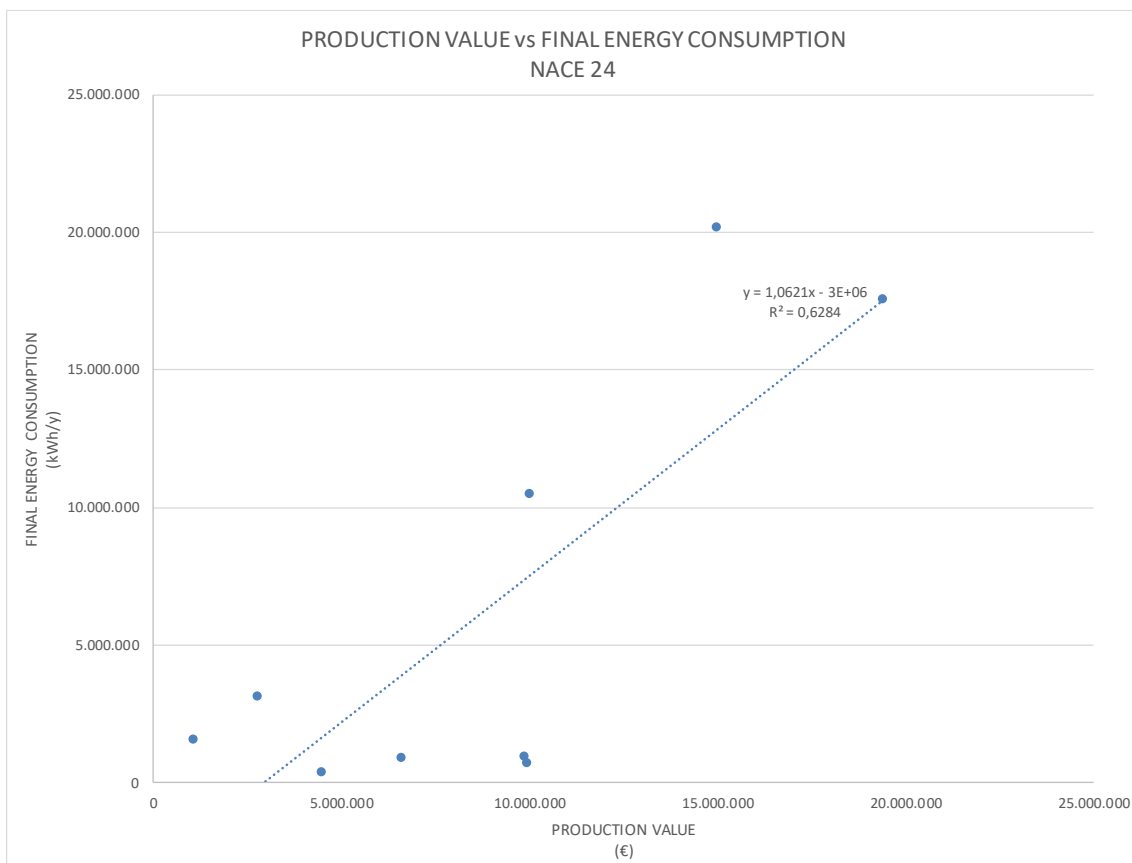
This way you can establish the difference between the expected and actual consumption.

Due to the diversity of companies, even within each NACE, an energy baseline is established in each of the sectors.

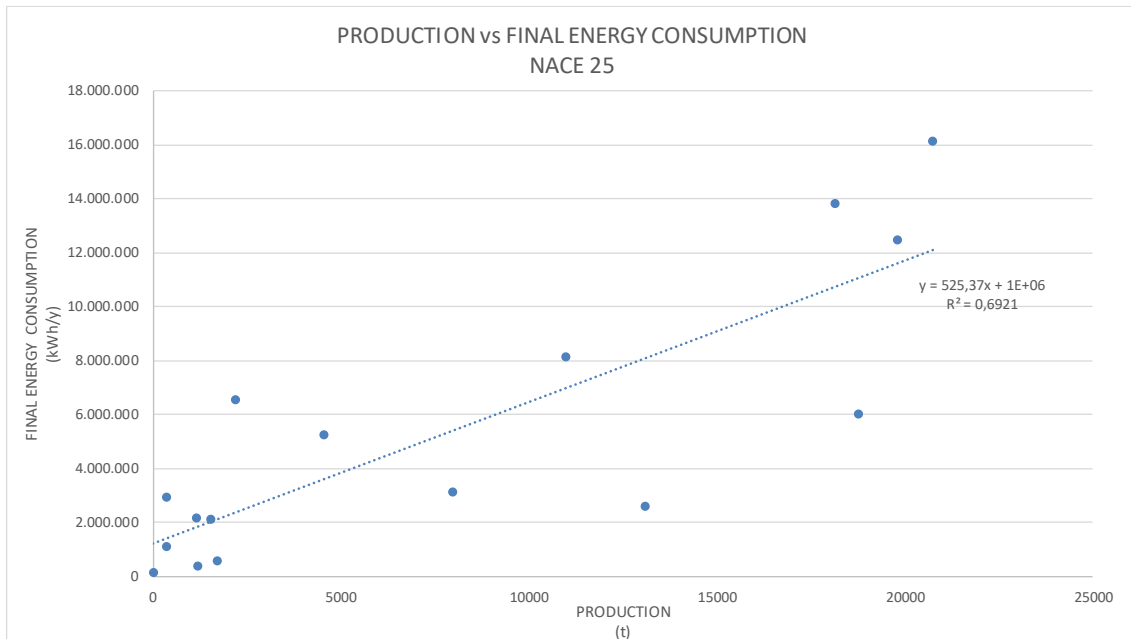
For NACE 24 the value of production in euro will be used as the independent variable and for NACE 25 and 28 the production in tonnes.

Below we can see the graphs and equations of the resulting energy baselines based on the independent variables indicated previously:

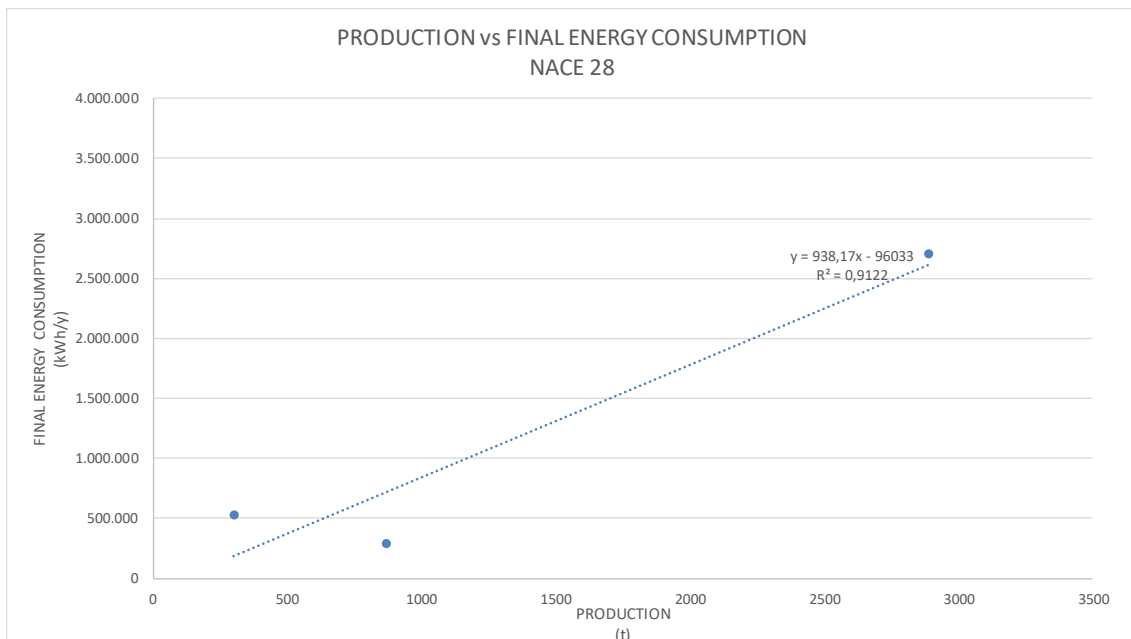
#### NACE 24



### NACE 25



### NACE 28



As can be seen in the graphs, in NACE 24 the number of companies that are part of the baseline are 9. They are those of which are available the data used in the elaboration of the same. In NACE 25 the companies that form the baseline are 16, companies that have the production data in tons. And in NACE 28 the companies that form the baseline are 3, companies that have the data of production in tons. The rest of the companies, due to the

diversity of the elaborated product or of the production, use other type of indicators, even in some cases they do not have established control indicators.

## 4 ENERGY SAVING MEASURES

In addition to the analysis and energy review of companies, energy audits are used to propose savings measures. In our case and due to the diversity of the companies involved in the project, the saving measures proposed are of varied nature. However, these have been classified into seven groups, depending of the end use of energy.

These groups are:

- Lighting: Saving measures that decrease consumption in lighting.
- Compressed air: Saving measures that decrease the consumption in compressed air systems.
- Motors, pumps and fans: Saving measures that decrease the consumption of main electric motors of auxiliary facilities.
- Heating system: Saving measures that reduce the consumption of heating systems.
- Heat recovery: Measures to use of the residual heat of processes or auxiliary facilities.
- Process: Saving measures in the production processes themselves.
- Renewable energies: Implementation of renewable energies.
- Other: Savings measures not included in the previous sections. In this group is included the Building thermomodernization measure proposed in some companies of Poland. This is because the weather conditions are very important in the energy consumption of companies in this country and therefore the building is one of the significant points to take into account.

With this classification, the energy saving obtained by the implementation of the measures is:

Energy saving measure	Final energy saving (GWh/y)	Primary energy saving (GWh/y)	Primary energy saving (tep/y)
Lighting	2,53	6,74	3.238,95
Compressed air	3,03	6,20	2.060,83
Motors, pumps and fans	1,12	2,61	871,06
Heating system	1,04	1,56	477,32
Heat recovery	5,30	6,66	5.346,55
Process	6,15	10,62	2.696,93
Renewable energies	1,72	4,63	2.393,68
Other	8,62	12,76	9.857,81
<b>TOTAL EE_METAL</b>	<b>29,51</b>	<b>51,78</b>	<b>26.943,14</b>



The saving measures obtained from the energy audits classified in the previous groups are the following:

<b>ENERGY SAVING MEASURE</b>
<b>Lighting</b>
Change of technology (LED)
Installation of a twilight detector
Setting up of clock (programming)
Suppression of fluorescent lamps in excess
<b>Compressed air</b>
Leakages reduction of compressed-air system
Optimization of compressor room and distribution, leak detection, measurement of air flow and reduction of pressure network.
Installation of VSD compressor
Heat recovery from compressors
Reduction of the set pressure by 1 bar
Installation of a fresh air inlet
Cut off during nights and weekends
Addition of a buffer tank over the compressed air network
Segmentation of the compressed air network
Installation of energy saving blow gun (venturi effect)
Regulation between 2 compressors
<b>Motors, pumps and fans</b>
Use of variable speed drives
Use of high efficiency motors
<b>Heating system</b>
Replacement of equipments and/or change heating system
Reduction of setpoint temperature
Installation of air destratification
Turn off the equipment
Compensation of the air extracted by ventilation
Management by zone
Optimization of the heating system
Optimization of distribution network for heating system
Optimization of combustion boilers
<b>Heat recovery</b>
Heat recovery from equipments
<b>Process</b>
Cover put on heated baths of surface treatment
Cut off of machines in stand by
Painting line energy efficiency improvement
Reduction in the number of surface treatment baths
Optimization of heat treatment furnaces
Reduction of the air extraction in standby phase on painting line
High efficiency furnaces
Optimization of electric furnaces

<b>ENERGY SAVING MEASURE</b>
Replacement of melting furnace
Using covers during melting of non-ferrous metals
Change of cast steel cleaning system
Increasing the speed of a tunnel furnace operational service
Closing covers of wax regenerators
Using covers during melting of metals in the furnace
Modernization of machinery park and/or technological lines
Reduction of heat losses in the electric furnace
Heat loss reduction in the furnace
Modernization of paint shop
Modernization of cooling system
Cover tanks
Isolation of pipes
New technologies for rectifiers
Optimization of combustion equipments
Programmable temperature control
Replacement of maintenance furnaces
<b>Renewable energies</b>
Solar photovoltaic
<b>Other</b>
Installation of meters and monitoring
Decrease in the number of transformers (5 to 4)
Analysis of night electricity consumption on working days
Energy performance analysis and energy management system
Monitoring system for relevant energy user systems
Optimization/analysis of consumption during plant stop
Electric cabin - renovation of measurement tools, power factor correction, backup of transformer
Repair of insulation for hot water pipes
Analysis of consumption during off-peak hours
Air treatment unit's maintenance and regulation
Analysis of efficiency of chiller
Compressed air flow monitoring system
Optimization of electrical transformers
Installation of high efficiency chiller
Closing of entering area of shed
Filters and pressure control for VSD air extractor in spray booth
Low cost investments
Logistics changes
Modernization of the heat source
Transformer ventilation
Adjustment of energy contracts
Compensation of power factor
Building thermomodernization



By sector, the savings measures proposed in each of them are:

NACE	ENERGY SAVING MEASURE
24	Change of technology (LED)
	Installation of VSD compressor
	Reduction of the set pressure by 1 bar
	Optimization of compressors room, leak detection, reduction of pressure
	Leakages reduction of compressed-air system
	Replacement of equipments and/or change heating system
	Heat recovery from equipments
	Use of variable speed drives
	Replacement of maintenance furnaces
	Using covers during melting of metals in the furnace
	Using covers during melting of non-ferrous metals
	Cut off of machines in stand by
	High efficiency furnaces
	Change of cast steel cleaning system
	Closing covers of wax regenerators
	Increasing the speed of a tunnel furnace operational service
	Modernization of machinery park and/or technological lines
	Modernization of cooling system
	Solar photovoltaic
	Low cost investments
Building thermomodernization	
25	Change of technology (LED)
	Installation of a twilight detector
	Setting up of clock (programming)
	Suppression of fluorescent lamps in excess
	Leakages reduction of compressed-air system
	Reduction of the set pressure by 1 bar
	Optimization of compressor room and distribution, leak detection, measurement of air flow and reduction of pressure network.
	Installation of VSD compressor
	Installation of a fresh air inlet
	Addition of a buffer tank over the compressed air network
	Heat recovery from compressors
	Cut off during nights and weekends
	Regulation between 2 compressors
	Installation of energy saving blow gun (venturi effect)
	Segmentation of the compressed air network
	Optimization of the heating system
	Optimization of distribution network for heating system
	Modernization of paint shop
	Modernization of cooling system
	Reduction of setpoint temperature

NACE	ENERGY SAVING MEASURE
	Installation of air destratification
	Management by zone
	Replacement of equipments and/or change heating system
	Turn off the equipment
	Use of variable speed drives
	Heat recovery from equipments
	Cover put on heated baths of surface treatment
	Cover tanks
	Optimization of electric furnaces
	Cut off of machines in stand by
	Heat loss reduction in the furnace
	Painting line energy efficiency improvement
	Modernization of machinery park and/or technological lines
	Reduction of heat losses in the electric furnace
	Reduction in the number of surface treatment baths
	Optimization of heat treatment furnaces
	New technologies for rectifiers
	Programmable temperature control
	Optimization of combustion equipments
	Solar photovoltaic
	Installation of high efficiency chiller
	Isolation of pipes
	Air treatment unit maintenance and regulation
	Analysis of consumption during off-peak hours
	Decrease in the number of transformers (5 to 4)
	Optimization of electrical transformers
	Monitoring system for relevant energy user systems
	Adjustment of energy contracts
	Compensation of power factor
	Logistics changes
	Low cost investments
	Building thermomodernization
<b>28</b>	Change of technology (LED) Leakages reduction of compressed-air system Optimization of compressor room and distribution, leak detection, measurement of air flow and reduction of pressure network. Heat recovery from compressors Compressor location change Use of variable speed drives Use of high efficiency motors Compensation of the air extracted by ventilation Replacement of equipments and/or change heating system Adjustment of energy contracts Monitoring system for relevant energy user systems





NACE	ENERGY SAVING MEASURE
	Heat recovery from equipments
	Cover tanks
	New technologies for rectifiers
	Modernization of machinery park and/or technological lines
	Programmable temperature control
	Solar photovoltaic
	Modernization of the heat source
	Transformer ventilation
	Analysis of consumption during off peak hours
	Low cost investments
	Adjustment of energy contracts
	Compensation of power factor

Within these proposals, in addition to the energy savings obtained, the investment necessary for its implementation and the gross return period of said investment are also valued.

The following table shown a summary of the savings measures obtained from the energy audits carried out. It shows the savings obtained, both energy and economic, investment, the gross amortization period of such investment, the number of companies in which the saving measure has been proposed and the CO<sub>2</sub> emissions avoided by the proposal.



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ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
<b>Lighting</b>	<b>2,53</b>	<b>11,00%</b>	<b>6,74</b>	<b>15,05%</b>	<b>3.238,95</b>	<b>15,51%</b>	<b>264.560,71</b>	<b>14,53%</b>	<b>1.831.121,03</b>	<b>23,70%</b>	<b>6,92</b>	<b>1.656,51</b>	<b>18,68%</b>		
Change of technology (LED)	2,475	10,75%	6,586	14,720%	3.226,092	15,444%	258.830,707	14,216%	1.827.371,03	23,653%	7,060	1.278,711	14,424%	56	75,68%
Installation of a twilight detector	0,026	0,11%	0,067	0,150%	5,769	0,028%	2.730,000	0,150%	2.500,00	0,032%	0,916	89,335	1,008%	4	5,41%
Setting up of clock (programming)	0,012	0,05%	0,031	0,069%	2,651	0,013%	1.000,000	0,055%	1.250,00	0,016%	1,250	164,724	1,858%	1	1,35%
Suppression of fluorescent lamps in excess	0,020	0,09%	0,052	0,115%	4,438	0,021%	2.000,000	0,110%	0,00	0,000%	0,000	123,736	1,396%	1	1,35%
<b>Compressed air</b>	<b>3,03</b>	<b>13,14%</b>	<b>6,20</b>	<b>13,87%</b>	<b>2.060,83</b>	<b>9,87%</b>	<b>259.540,28</b>	<b>14,26%</b>	<b>448.347,84</b>	<b>5,80%</b>	<b>1,73</b>	<b>1.016,85</b>	<b>11,47%</b>		
Leakages reduction of compressed-air system	0,907	3,94%	2,495	5,576%	1.312,869	6,285%	82.414,284	4,527%	54.800,00	0,709%	0,665	474,639	5,354%	31	41,89%
Optimization of compressor room and distribution, leak detection, measurement of air flow and reduction of pressure network.	0,663	2,88%	1,520	3,399%	338,980	1,623%	96.266,430	5,287%	168.122,20	2,176%	1,746	254,772	2,874%	21	28,38%
Installation of VSD compressor	0,279	1,21%	0,669	1,496%	57,416	0,275%	30.599,000	1,681%	73.552,00	0,952%	2,404	60,997	0,688%	6	8,11%
Heat recovery from compressors	0,984	4,27%	1,024	2,289%	308,847	1,479%	30.519,640	1,676%	119.673,64	1,549%	3,921	211,920	2,390%	10	13,51%
Reduction of the set pressure by 1 bar	0,034	0,15%	0,089	0,198%	7,616	0,036%	3.227,000	0,177%	500,00	0,006%	0,155	2,506	0,028%	7	9,46%
Installation of a fresh air inlet	0,004	0,02%	0,010	0,022%	0,846	0,004%	337,922	0,019%	1.800,00	0,023%	5,327	0,747	0,008%	2	2,70%
Cut off during nights and weekends	0,025	0,11%	0,063	0,141%	5,436	0,026%	2.400,000	0,132%	0,00	0,000%	0,000	1,789	0,020%	1	1,35%
Addition of a buffer tank over the compressed air network	0,024	0,10%	0,061	0,136%	5,236	0,025%	3.550,000	0,195%	4.000,00	0,052%	1,127	1,723	0,019%	2	2,70%



ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
Segmentation of the compressed air network	0,019	0,08%	0,049	0,109%	4,194	0,020%	1.600,000	0,088%	1.500,00	0,019%	0,938	1,380	0,016%	1	1,35%
Installation of energy saving blow gun (venturi effect)	0,017	0,08%	0,045	0,100%	3,856	0,018%	1.626,000	0,089%	600,00	0,008%	0,369	1,269	0,014%	3	4,05%
Regulation between 2 compressors	0,070	0,30%	0,181	0,404%	15,532	0,074%	7.000,000	0,384%	23.800,00	0,308%	3,400	5,110	0,058%	1	1,35%
<b>Motors, pumps and fans</b>	<b>1,12</b>	<b>4,85%</b>	<b>2,61</b>	<b>5,84%</b>	<b>871,06</b>	<b>4,17%</b>	<b>102.460,46</b>	<b>5,63%</b>	<b>362.447,85</b>	<b>4,69%</b>	<b>3,54</b>	<b>432,85</b>	<b>4,88%</b>		
Use of variable speed drives	1,063	4,62%	2,496	5,579%	860,964	4,122%	94.380,465	5,184%	308.447,85	3,993%	3,268	416,273	4,695%	23	31,08%
Use of high efficiency motors	0,054	0,23%	0,117	0,261%	10,100	0,048%	8.080,000	0,444%	54.000,00	0,699%	6,683	16,582	0,187%	9	12,16%
<b>Heating system</b>	<b>1,04</b>	<b>4,53%</b>	<b>1,56</b>	<b>3,49%</b>	<b>477,32</b>	<b>2,29%</b>	<b>74.581,07</b>	<b>4,10%</b>	<b>206.466,17</b>	<b>2,67%</b>	<b>2,77</b>	<b>273,71</b>	<b>3,09%</b>		
Replacement of equipments and/or change heating system	0,355	1,54%	0,650	1,453%	370,661	1,774%	34.056,550	1,871%	136.568,57	1,768%	4,010	131,742	1,486%	12	16,22%
Reduction of setpoint temperature	0,070	0,31%	0,083	0,185%	7,126	0,034%	3.415,000	0,188%	3.500,00	0,045%	1,025	13,317	0,150%	4	5,41%
Installation of air destratification	0,142	0,62%	0,142	0,318%	12,225	0,059%	6.000,000	0,330%	10.000,00	0,129%	1,667	28,999	0,327%	3	4,05%
Turn off the equipment	0,057	0,25%	0,060	0,134%	33,481	0,160%	2.743,330	0,151%	0,00	0,000%	0,000	12,745	0,144%	3	4,05%
Compensation of the air extracted by ventilation	0,072	0,31%	0,186	0,415%	15,975	0,076%	6.700,000	0,368%	10.000,00	0,129%	1,493	5,256	0,059%	1	1,35%
Management by zone	0,095	0,41%	0,095	0,212%	8,170	0,039%	3.700,000	0,203%	1.000,00	0,013%	0,270	19,380	0,219%	1	1,35%
Optimization of the heating system	0,112	0,49%	0,112	0,250%	9,632	0,046%	3.226,000	0,177%	24.517,60	0,317%	7,600	22,848	0,258%	1	1,35%
Optimization of distribution network for heating system	0,075	0,33%	0,164	0,366%	14,000	0,067%	12.000,000	0,659%	20.880,00	0,270%	1,740	23,622	0,266%	1	1,35%
Optimization of combustion boilers	0,064	0,28%	0,070	0,157%	6,054	0,029%	2.740,192	0,151%	0,00	0,000%	0,000	15,805	0,178%	3	4,05%
<b>Heat recovery</b>	<b>5,30</b>	<b>23,04%</b>	<b>6,66</b>	<b>14,88%</b>	<b>5.346,55</b>	<b>25,60%</b>	<b>191.933,91</b>	<b>10,54%</b>	<b>896.656,06</b>	<b>11,61%</b>	<b>4,67</b>	<b>1.509,40</b>	<b>17,03%</b>		
Heat recovery from equipments	5,303	23,038%	6,658	14,881%	5.346,553	25,596%	191.933,906	10,542%	896.656,06	11,606%	4,672	1.509,396	17,026%	27	36,49%



ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
<b>Process</b>	<b>6,15</b>	<b>26,73%</b>	<b>10,62</b>	<b>23,75%</b>	<b>2.696,93</b>	<b>12,91%</b>	<b>391.477,89</b>	<b>21,50%</b>	<b>1.581.634,21</b>	<b>20,47%</b>	<b>4,04</b>	<b>1.648,46</b>	<b>18,59%</b>		0,00%
Cover put on heated baths of surface treatment	0,022	0,094%	0,056	0,125%	4,815	0,023%	2.000,000	0,110%	3.000,00	0,039%	1,500	2,730	0,031%	1	1,35%
Cut off of machines in stand by	0,029	0,127%	0,075	0,168%	6,479	0,031%	2.975,000	0,163%	1.000,00	0,013%	0,336	2,132	0,024%	3	4,05%
Painting line energy efficiency improvement	0,570	2,476%	0,712	1,592%	61,249	0,293%	31.200,000	1,714%	237.120,00	3,069%	7,600	104,490	1,179%	2	2,70%
Reduction in the number of surface treatment baths	0,550	2,389%	1,419	3,172%	122,034	0,584%	46.475,000	2,553%	0,00	0,000%	0,000	40,150	0,453%	1	1,35%
Optimization of heat treatment furnaces	0,165	0,717%	0,426	0,952%	36,610	0,175%	13.943,000	0,766%	47.406,20	0,614%	3,400	12,045	0,136%	1	1,35%
Reduction of the air extraction in standby phase on painting line	0,045	0,195%	0,116	0,260%	9,985	0,048%	2.700,000	0,148%	4.500,00	0,058%	1,667	3,285	0,037%	1	1,35%
High efficiency furnaces	0,145	0,631%	0,144	0,323%	12,400	0,059%	4.000,000	0,220%	30.400,00	0,393%	7,600	29,520	0,333%	1	1,35%
Optimization of electric furnaces	0,023	0,100%	0,050	0,112%	4,300	0,021%	3.700,000	0,203%	12.580,00	0,163%	3,400	7,244	0,082%	1	1,35%
Replacement of melting furnace	1,762	7,655%	1,752	3,915%	150,200	0,719%	62.000,000	3,405%	400.000,00	5,178%	6,452	249,936	2,819%	1	1,35%
Using covers during melting of non-ferrous metals	0,091	0,395%	0,274	0,612%	235,250	1,126%	9.624,840	0,529%	0,00	0,000%	0,000	75,280	0,849%	1	1,35%
Change of cast steel cleaning system	0,003	0,013%	0,009	0,020%	7,380	0,035%	301,830	0,017%	0,00	0,000%	0,000	2,360	0,027%	1	1,35%
Increasing the speed of a tunnel furnace operational service	0,117	0,508%	0,351	0,785%	301,810	1,445%	12.347,660	0,678%	0,00	0,000%	0,000	96,570	1,089%	1	1,35%
Closing covers of wax regenerators	0,010	0,043%	0,031	0,069%	26,570	0,127%	1.087,020	0,060%	0,00	0,000%	0,000	8,500	0,096%	1	1,35%
Using covers during melting of metals in the furnace	0,054	0,235%	0,161	0,360%	138,570	0,663%	5.669,370	0,311%	0,00	0,000%	0,000	44,340	0,500%	1	1,35%



ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
Modernization of machinery park and/or technological lines	0,341	1,481%	1,022	2,284%	879,400	4,210%	33.491,570	1,840%	112.061,45	1,451%	3,346	281,390	3,174%	8	10,81%
Reduction of heat losses in the electric furnace	0,013	0,056%	0,040	0,089%	34,420	0,165%	1.004,640	0,055%	709,22	0,009%	0,706	11,010	0,124%	1	1,35%
Heat loss reduction in the furnace	0,095	0,413%	0,104	0,232%	89,700	0,429%	5.710,470	0,314%	37.115,84	0,480%	6,500	19,150	0,216%	1	1,35%
Modernization of paint shop	0,135	0,586%	0,148	0,331%	127,470	0,610%	5.885,920	0,323%	107.550,00	1,392%	18,272	27,220	0,307%	1	1,35%
Modernization of cooling system	0,055	0,239%	0,165	0,369%	141,420	0,677%	6.881,960	0,378%	53.191,50	0,689%	7,729	45,260	0,511%	3	4,05%
Cover tanks	0,113	0,493%	0,273	0,609%	23,445	0,112%	12.198,013	0,670%	75.000,00	0,971%	6,149	40,501	0,457%	3	4,05%
Isolation of pipes	0,720	3,128%	0,774	1,731%	66,595	0,319%	28.800,000	1,582%	50.000,00	0,647%	1,736	163,296	1,842%	1	1,35%
New technologies for rectifiers	0,340	1,479%	0,818	1,829%	70,364	0,337%	33.642,818	1,848%	193.000,00	2,498%	5,737	121,553	1,371%	4	5,41%
Optimization of combustion equipments	0,064	0,278%	0,069	0,154%	5,910	0,028%	1.874,100	0,103%	0,00	0,000%	0,000	14,491	0,163%	2	2,70%
Programmable temperature control	0,074	0,322%	0,178	0,398%	15,311	0,073%	7.681,678	0,422%	42.000,00	0,544%	5,468	26,450	0,298%	4	5,41%
Replacement of maintenance furnaces	0,615	2,672%	1,456	3,255%	125,244	0,600%	56.283,000	3,091%	175.000,00	2,265%	3,109	219,555	2,477%	1	1,35%
<b>Renewable energies</b>	<b>1,72</b>	<b>7,45%</b>	<b>4,63</b>	<b>10,34%</b>	<b>2.393,68</b>	<b>11,46%</b>	<b>160.397,26</b>	<b>8,81%</b>	<b>2.058.829,99</b>	<b>26,65%</b>	<b>12,84</b>	<b>1.013,16</b>	<b>11,43%</b>		
Solar photovoltaic	1,716	7,455%	4,63	10,341%	2.393,68	11,459%	160.397,26	8,810%	2.058.829,99	26,649%	12,84	1.013,16	11,428%	32	43,24%
<b>Other</b>	<b>2,13</b>	<b>9,25%</b>	<b>5,72</b>	<b>12,78%</b>	<b>3.803,08</b>	<b>18,21%</b>	<b>375.699,68</b>	<b>20,64%</b>	<b>340.173,86</b>	<b>4,40%</b>	<b>0,91</b>	<b>1.314,50</b>	<b>14,83%</b>		
Installation of meters and monitoring	0,013	0,056%	0,033	0,074%	2,853	0,014%	1.500,000	0,082%	4.000,00	0,052%	2,667	0,939	0,011%	2	2,70%
Decrease in the number of transformers (5 to 4)	0,200	0,869%	0,516	1,153%	44,376	0,212%	16.900,000	0,928%	57.460,00	0,744%	3,400	14,600	0,165%	1	1,35%
Analysis of night electricity consumption on working days	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%



ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
Energy performance analysis and energy management system	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Monitoring system for relevant energy user systems	0,207	0,899%	0,452	1,009%	75,600	0,362%	48.650,000	2,672%	64.600,00	0,836%	1,328	65,196	0,735%	18	24,32%
Optimization/analysis of consumption during plant stop	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Electric cabin - renovation of measurement tools, power factor correction, backup of transformer	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Repair of insulation for hot water pipes	0,044	0,192%	0,053	0,118%	4,500	0,022%	1.584,000	0,087%	3.000,00	0,039%	1,894	10,795	0,122%	1	1,35%
Analysis of consumption during off-peak hours	0,091	0,395%	0,199	0,444%	17,000	0,081%	14.000,000	0,769%	0,00	0,000%	0,000	28,662	0,323%	6	8,11%
Air treatment unit's maintenance and regulation	0,022	0,096%	0,048	0,107%	4,100	0,020%	3.300,000	0,181%	11.220,00	0,145%	3,400	6,929	0,078%	1	1,35%
Analysis of efficiency of chiller	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Compressed air flow monitoring system	0,000	0,000%	0,000	0,000%	0,000	0,000%	1.500,000	0,082%	1.500,00	0,019%	1,000	0,000	0,000%	1	1,35%
Optimization of electrical transformers	0,012	0,051%	0,026	0,057%	2,200	0,011%	1.800,000	0,099%	3.600,00	0,047%	2,000	3,685	0,042%	1	1,35%
Installation of high efficiency chiller	0,013	0,054%	0,027	0,061%	2,300	0,011%	1.800,000	0,099%	13.680,00	0,177%	7,600	3,937	0,044%	2	2,70%
Closing of entering area of shed	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Filters and pressure control for VSD air extractor in spray booth	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1,35%
Low cost investments	1,370	5,952%	4,116	9,201%	3.539,060	16,943%	129.578,390	7,117%	0,00	0,000%	0,000	1.132,460	12,774%	21	28,38%



ENERGY SAVING MEASURE	Final energy saving		Primary energy saving		Primary energy saving		Cost savings		Investment		Gross amortization period	CO2 emissions		Companies in which the measure is proposed	Companies in which the measure is proposed
	(GWh/y)	(%)	(GWh/y)	(%)	(tep/y)	(%)	(€/y)	(%)	(€)	(%)	(years)	Avoided (tCO2/y)	(%)	(Units)	(%)
Logistics changes	0,051	0,222%	0,057	0,127%	48,710	0,233%	4.769,420	0,262%	4.728,130	0,061%	0,991	13,580	0,153%	1	1,35%
Modernization of the heat source	0,054	0,235%	0,060	0,134%	51,220	0,245%	7.601,780	0,418%	52.009,46	0,673%	6,842	14,440	0,163%	1	1,35%
Transformer ventilation	0,007	0,031%	0,017	0,038%	1,461	0,007%	774,811	0,043%	3.600,00	0,047%	4,646	2,524	0,028%	1	1,35%
Adjustment of energy contracts	0,000	0,000%	0,000	0,000%	0,000	0,000%	116.996,640	6,426%	25.946,48	0,336%	0,222	0,000	0,000%	13	17,57%
Compensation of power factor	0,047	0,204%	0,113	0,252%	9,699	0,046%	24.944,644	1,370%	94.829,79	1,227%	3,802	16,755	0,189%	5	6,76%
Building thermomodernization	6,488	21,987%	7,042	13,600%	6.054,730	22,472%	157.327,640	7,954%	2.902.392,40	27,309%	18,448	1.673,830	15,88%	8	10,81%
<b>TOTAL EE_METAL</b>	<b>29,51</b>		<b>51,78</b>		<b>26.943,14</b>		<b>1.977.978,89</b>		<b>10.628.069,41</b>		<b>5,37</b>	<b>10.539,27</b>			



## 5 CONCLUSIONS

The following results can be highlighted as conclusions of the report:

- With the implementation of the measures obtained from energy audits, the proposed energy saving represents 12,05% of the total consumption of the companies involved in the project.
- The energy savings proposed with the measures whose gross amortization periods are less than 1 year, represents 1,51% of the total consumption of the companies involved in the project.
- Measures with low gross amortization periods, such as measurements in the compressed air system and heating system, are measures proposed in the end use energy classification groups of the highest impact (excluding the process). In sectors 25 and 28, the sum of the consumption of the compressed air and heating system is more than 20% of the total consumption.
- The measures proposed with less than 1 year gross amortization periods represent a saving of more than 12,5% of the total savings proposed.
- The proposed measures that have greater energy savings are included in the energy end use groups "Others". They are measures focused on the specificities of each company and each country.
- The proposed measures to reduce consumption in lighting, represent a significant saving in relation to the total proposed savings (8,5%). However, the gross amortization period of the investment exceeds 5 years, a much high than the companies have in consideration for the implementation of measures.
- Implementation of renewable energies (photovoltaic in our project) have gross amortization periods of more than 10 years, which is an important barrier to its installation.