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Applying Energy Efficient measures for metal and metalworking SMEs and industry (EE-METAL)
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Deliverable D2.8

Final Report gathering project conclusions

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Abstract	This repot compiles the results from all the activities carried out in the project, considering: - Methodologies developed within the project - BAT and good practice database - Results from energy audits - Results from the use of Energy Monitoring Systems identifying a set of guidelines - Results from Energy Management System - Financial options analysis

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1 Methodologies

1.1 Energy Audit Methodology

1.1.1 Brief description of the methodology

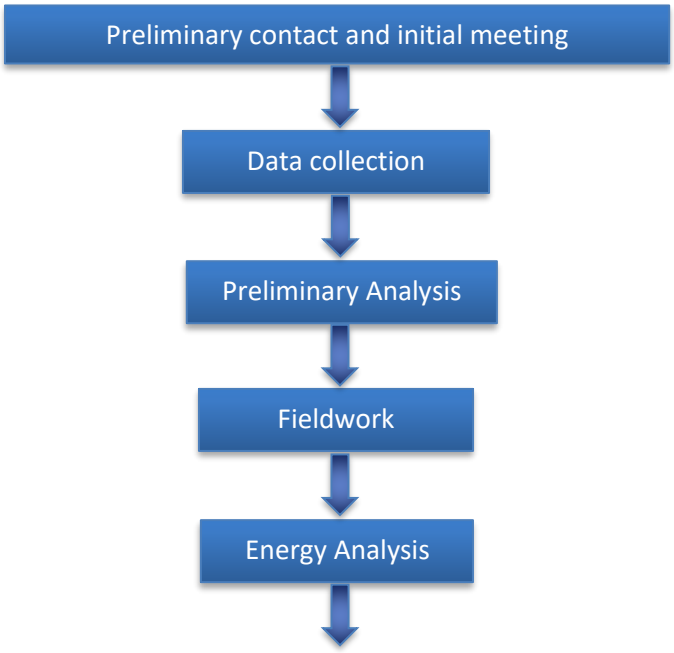
The Energy Audit methodology prepared by the EE-METAL Project aims to provide a detailed guide on the steps to be taken in order to carry out an orderly and concise energy review, and this way, to obtain objective information on the energy consumed, as well as to detect and propose saving measures that lead to an improvement of the energy performance of the company. This methodology is fitted to the specifications of small and medium-sized companies of the metal industry as described in "Deliverable D2.5. Common audit methodology for determining potential energy saving measures in SMEs of the MMA sector applicable at EU level. Final version".

1.1.2 Propose of the methodology and how it is used

The proposed methodology is according to the European Norm EN 16247:2014 Energy Audits Part 1: Generalities, and Part 3: Processes.

The methodology proposes a detailed planning of the steps to take for the realization of the Energy Audit, including specific references in each of them. Also, some savings measures are suggested, that can be taken into account when proposing saving measures that improve the energy efficiency of the company. Additionally, the different energy markets that govern the partner countries that make up the EE-METAL Project are described, so that it is understandable to the auditor.

More specifically, detailed planning envisages the following stages:



For Data-Collection, the methodology provides templates for use, establishing a detailed systematic criteria for this stage.

The Preliminary Analysis provides a guide that contemplates the overall energy analysis of the company by evaluating the data obtained in the previous stage.

During the Energy analysis process, in addition to establishing a procedure for its elaboration, savings measures are suggested that can be contemplated and studied for inclusion in the energy audit. In this case also the methodology provides a guide for the economic evaluation of the proposed savings measures and their profitability.

Finally, the methodology provides a report script, which includes all the aspects studied and dealt within the stages carried out.

1.1.3 Link to the public document in the EE-METAL website

Link to the document in English: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.5-Common-Audit-methodology.-Final-Version.pdf

The document in the national languages can also be found in the website of the project:

- French: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.5-M%C3%A9thode-commune-daudit-%C3%A9nerg%C3%A9tique-1.pdf
- Italian: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.5-Common-Audit-methodology-Final-Version-ITA.pdf
- Polish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.5-Common-Audit-methodology-Final-Version_PL.pdf
- Spanish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.5-Metodologia-auditoria-energetica-en-PYMEs-del-sector-metal.-Version-final-ES.pdf

1.2 Adaptation of the ISO 50.001 “Energy Management System”

1.2.1 Brief description of the methodology

This methodology prepared by the EE-METAL project is an adaptation of the ISO 50 001 standard which aims to take into account the specificities of small and medium-sized companies of the metal industry to guide them in the implementation of an energy management system and enable them to obtain ISO 50 001 certification. The main requirements of the standard are

explained and illustrated with examples and implementation tips as described in "Deliverable D2.7. Adaptation of the ISO 50 001 standard in companies of the metalworking sector applicable at the EU level. Final version".

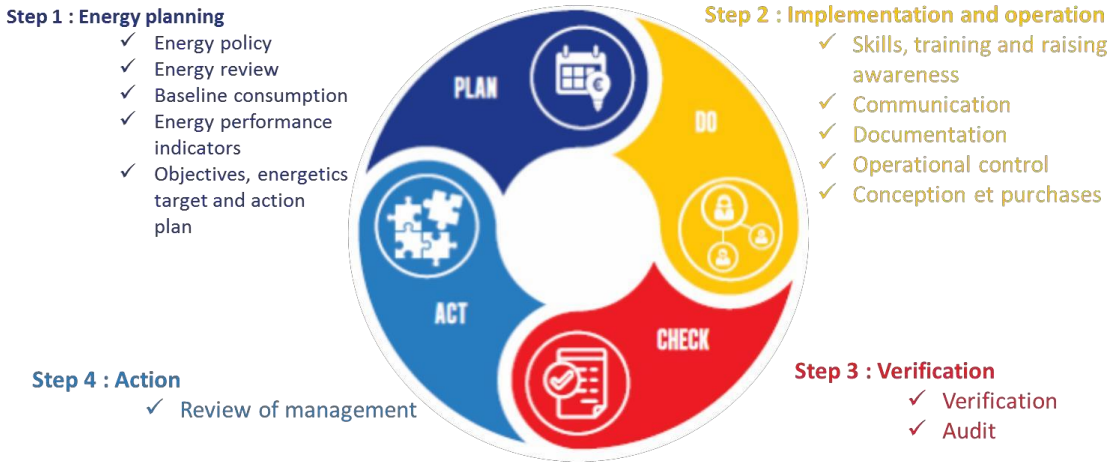
1.2.2 Propose of the methodology and how it is used

The proposed methodology is according to ISO 50 001 standard and is based on the PDCA (Plan, Do, Check, Act) approach, while taking into account the specificities related to the size of the targeted companies (small and medium-sized) and their sector of activity (metal industry).

The guidelines for the adaptation of the ISO 50 001 standard for SMEs metallurgy are:

- ✓ **Pragmatic and lightened approach (taking account of lesser availability of SMEs)**
- ✓ **Motivation of the players key (identify and train them)**
- ✓ **Flexible and pedagogic support (combine training and consulting)**

It consists of 4 steps, detailed in chronological order:



For each of these steps, methodological advices are given and models or examples are given in appendices to guide companies step by step.

1.2.3 Link to the public document in the EE-METAL website

Link to the document in English:

https://www.ee-metal.com/wp-content/uploads/2019/01/D2.7-Adaptation-of-ISO-50001-Energy-Management-System-standard-ENGLISH-Final-version.pdf

The document in the national languages can also be found in the website of the project:

- French: https://www.ee-metal.com/wp-content/uploads/2019/01/D2.7-Adaptation-of-ISO-50001-Energy-Management-System-standard-FRENCH-Final-version.pdf

- Italian: https://www.ee-metal.com/wp-content/uploads/2019/01/D2.7-Adaptation-of-ISO-50001-Energy-Management-System-standard-ITALIAN-Final-version.pdf
- Polish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.7-Adaptation-of-ISO-50001-Energy-Management-System-standard-POLISH-Final-version.pdf
- Spanish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.7-Adaptation-of-ISO-50001-Energy-Management-System-standard-SPANISH-Final-version.pdf

1.3 Benchmarking

1.3.1 Brief description of the methodology

The Benchmarking methodology, tries to be a tool to analyze SMEs in the Metal Sector in each code NACE 24, 25 and 28 from the energy point of view and which in turn provides the possibility of comparing a company with its homologous in the sector.

In the first phase the definition and description of the indicators to be part of the Benchmarking are drawn up. In order for these indicators to take into account the specificities of each of the countries that are part of the EE-METAL Project, data are harmonized by correction factors.

Following the completion of the energy audits and with the data obtained from them, the methodology and indicators are revised, finally obtaining a set of energy indicators that can be used by the company to compare with others of its same economic activity. These indicators are:

- Final energy consumption / Production value
- Primary energy consumption / Production value
- Carbon dioxide emissions / Production value
- Carbon dioxide emissions / Final energy consumption
- Carbon dioxide emissions / Primary energy consumption
- Power factor (cos Ø)
- Energy consumption in lighting / area * working hours
- Energy consumption in compressed air / Production value
- Energy consumption in process furnaces / Production value
- Average efficiency in electric engines

1.3.2 Propose of the methodology and how it is used

The base is the production of an Energy Ranking. This ranking sets up the different “categories”, for every energy efficiency indicator. These categories, in some cases, are NACE codes, different technologies, working pressures in the compressed air system, etc…, always depending on the availability of data.

The energy ranking is represented by a column chart. The axis X shall show the energy categories and axis Y the value of the energy efficiency indicator in each category.

Just in case a company wants to check its situation with respect to others in the same sector, the company will have to choose the indicator on which it wants to compare, look for the category corresponding to it in the abscissa axis and compare the data provided by the ordinate axis with its own. If this is below the value indicated by the graph, the company may consider that its energy efficiency is better than the average. However, if its own value is higher, the company may consider that it has the potential to improve its energy efficiency. It should be taken into account that this study is carried out with data from 81 companies, that within each NACE code there are a lot of types of production processes and that, therefore, the comparison must be taken with caution and serve to have an overview of the energy state of the company, not being the data representative for all of them.

1.3.3 Link to the public document in the EE-METAL website

Link to the document in English: : https://www.ee-metal.com/wp-content/uploads/2019/02/D2-1-EE-Benchmarking-methodology-Rev3.pdf

2 BAT database

2.1 Description of the database

The Database of Best Available Techniques (BAT) applicable in the metal and metalworking sector (MMA sector) presents energy efficient technological solutions, optimization of process operations and energy use, use of renewable energies, innovative cross-cutting technologies and recommendations applicable in the metal and metalworking sector (MMA sector). Techniques include both the technology used and the way the installation is designed, built, maintained, operated and decommissioned. Proposed techniques include also organizational aspects such as production scheduling, monitoring and targeting or behaviour changes.

The Database's development consisted of analysis of the Best Available Techniques reference documents (BREFs) that have been adopted under both the Directive concerning integrated pollution prevention and control (IPPC Directive, 2008/1/EC) and the Industrial Emissions Directive (IED, 2010/75/EU), outcomes of other projects, information from financial institutions/ESCOs and equipment suppliers. Techniques for energy efficiency were gathered and selected taking into consideration, as the main criterion, the highest potential benefits for the MMA sector.

The database consists of techniques to consider at installation level in energy using systems, processes and activities and best available technologies including also innovative cross-cutting technologies. The BAT Database is divided into three main areas of interests: 1) heat, 2) electricity, 3) both heat and electricity. Every main area has its own sub-areas of interest. In heat

and heat/electricity area there are: processes, organizational aspects and recovery, in electricity area: the same three as mentioned above and lighting as additional one.

2.2 Link to the public document in the EE-METAL website

Link to the document in English: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.6-Database-about-technique-to-consider-at-installation-level-in-energy.-Final-version.pdf

The document in the national languages can also be found in the website of the project:

- French: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.6-Base-de-donn%C3%A9es-des-Meilleures-Techniques-Disponibles-MTD-applicables-dans-la-m%C3%A9tallurgie.pdf
- Italian: https://www.ee-metal.com/wp-content/uploads/2019/02/Deliverable-D2.6-BAT-ITA.pdf
- Polish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.6-BAT-Database_final-version_PL.pdf
- Spanish: https://www.ee-metal.com/wp-content/uploads/2019/02/D2.6-Base-de-datos-de-t%C3%A9cnicas-disponibles-en-energ%C3%ADa-FV_web_spanish_v1.pdf

2.3 BATs most identified in energy audits in WP3

1. LIGHTING

Artificial lighting accounts for a significant part of all electrical energy consumed in metal companies. Lighting represents a critical component of energy use today, especially in large buildings and for the large scale uses where there are many alternatives for energy utilization in lighting.

In case of the metal company the following measures can be identified:

- usage LED technology - LED lights can replace incandescent lights, energy saving lights and halogen lights resulting in important energy savings. LED lighting has several advantages, such as the small size and very low power consumption. LED lights have longer lifetime (over 50.000 hours), they need no warming-up time and can withstand frequent switching on and off. Some type LED lamps can also be dimmable. The energy savings will depend on the type of bulb that is being replaced. LED provides savings up to 80%, compared to an incandescent light bulb, and around 70% compared to a halogen lamp. Even compared to an energy saving lamp, the LED lamp consumes around a half of the energy and contains no toxic substances.
- usage of lighting management control systems including occupancy sensors, timers, etc. - identification of lighting requirements for each area, analysis of lighting quality and design, management of lighting - emphasize the use of lighting management control

systems including occupancy sensors, timers, etc. aiming at reducing lighting consumption, training of building occupants to utilize lighting equipment in the most efficient manner and maintenance of lighting systems to minimize energy wastage.

2. HEAT RECOVERY FROM EQUIPMENT

The heat recovery devices are associated with energy savings but they can also allow a reduction of installed thermal power requirements with significant reductions in the cost of heating systems, making them more economical and affordable. Depending on the heat recovery model and on external conditions can be achieved reductions around 20 to 40%.

In case of the metal company the following measures can be identified:

- installation of recuperators - using waste heat from furnace to preheat air will result in lower gas consumption. By installing recuperators system the discharged waste gas with a temperature of 900°C can be utilised to pre-heat the air entering the burner. The inlet air will have approximately the temperature of 200 to 400 °C and improves the combustion process. Experience showed that the installation of recuperators consisting of a plate or tabular heat exchanger reduces the natural gas consumption up to 27%.
- utilization of waste heat - excess heat of induction furnaces can be utilized for hot water preparation,
- heat recovery by using heat pumps - heat pumps enable the recovery of low grade heat, with primary energy consumption lower than the energy output (depending on the COP, and if the requirements for an good seasonal overall efficiency are fulfilled). This enables the use of low grade heat in useful applications, such as heating inside in the installation.

3. MODERNIZATION OF MACHINERY PARK AND OR TECHNOLOGICAL LINES

Energy efficient equipment reduces costs and improves product quality. To reduce energy consumption, increase the productivity and save material and the company can install modern equipment at several stages of the production line. The modernization can include high efficient motors and automatic measurement and control system account especially for energy saving. Equipment and technology to improve energy efficiency also include, but is not limited to edging and slitting lines, press machines, rolling mills, drilling machines etc.

Experience showed that a significant part of the investment costs can be covered by energy savings. Metal processing plants offer a wide range of cost-saving opportunities. In case of the metal company the following measures can be identified:

- optimization of compressed air system - by replacing inefficient compressors, reducing leakages and applying management devices 15% or more energy can be saved,
- installation of variable speed drives - installation of controlling devices can save up to 50% of energy by adjusting motor speed of ventilators, motors and cooling pumps. Variable speed drives (on the electric motor) yield the maximum savings in matching pump output to varying system requirements, but they do have a higher investment cost compared to the other methods of capacity control. They are not applicable in all situations, e.g. where loads are constant.

4. SOLAR PHOTOVOLTAIC

Because of rising utility prices and a considerable decrease in the cost of buying and installing solar systems, solar power is a sustainable and cost-effective energy alternative for companies. Generating their own electricity means that companies will be using less from the utility supplier. This will immediately translate to savings on your energy bill. They can also make money by selling the unused electricity, which they have generated, back to the grid. It increases their energy self-reliance.

The estimated lifetime of a solar (PV) module is 30 years. Furthermore, the modules' performance is very high providing over 80% of the initial power after 25 years which makes photovoltaics a very reliable technology in the long term. Besides this solar (PV) modules are almost maintenance-free and offer an easy installation.

The costs of solar energy systems for businesses depend on the energy demand of the firm. As a result, the cost can vary significantly from one operation to another. A 30 kW solar power system is ideal for most small- to medium-sized businesses.

3 Energy Audits

3.1 Summary of the result of energy audits

To implement the Energy Audit Methodology developed in the EE-METAL Project, 81 energy audits are carried out in SMEs in the metal sector, 20 in each partner country, France, Italy, Spain and Poland, being this country where 21 audits have been carried out.

The results of these energy audits are available at the following link **(**https://www.ee-metal.com/wp-content/uploads/2019/01/D3.4-Final-report-on-the-potential-energy-saving.pdf**).** The linked document aims to show the characterization and energy analysis of the audited companies, both at sectoral level, by country, and at global level, as well as the savings measures identified during the development of the audits. In addition, for those saving measures, that SMEs are unable to carry out for economic or technical qualification reasons, the possibility of implementing them through innovative contracting schemes is explored, establishing contacts with Energy Services Companies (ESCOs).

The above is summarized below:

The **energy analysis** includes the characterization points of the sectors analyzed, which are:

- ✓ Average final energy consumption by sector
- ✓ Type of final energy consumed
- ✓ Energy costs
- ✓ Energy consumption by final use
- ✓ Characterization of the sectors

The main **energy saving measures** identified in the audits can be seen in the following table:

ENERGY SAVING MEASURE	Primary energy saving		Gross amortization period	CO2 emissions avoided		Companies in which the measure is proposed		Average savings (by company)
	(GWh/y)	(%)	(years)	(tCO2/y)	(%)	(Units)	(%)	kWh/y
Ligthing	**7,73**	**12,47%**	**6,57**	**1.311,51**	**11,31%**			
Change of tecnology (LED)	7,582	12,23%	6,69	1.307,28	11,27%	61,00	75,31%	124.288
Compressed air	**6,95**	**11,22%**	**1,63**	**1.073,91**	**9,26%**			
Leakages reduction of compressed-air system	2,682	4,33%	0,63	488,52	4,21%	36,00	44,44%	74.514
Optimization of compressor room and distribution, leak detection, measurement of air flow and reduction of pressure network.	1,520	2,45%	1,75	254,77	2,20%	21,00	25,93%	72.403
Motors, pumps and fans	**2,95**	**4,77%**	**3,29**	**442,65**	**3,82%**			
Use of variable speed drives	2,838	4,58%	3,04	426,07	3,67%	24,00	29,63%	118.232
Use of high efficiency motors	0,117	0,19%	6,68	16,58	0,14%	9,00	11,11%	12.993
Heating system	**1,91**	**3,08%**	**2,83**	**341,86**	**2,95%**			
Replacement of equipments and/or change heating system	0,650	1,05%	4,01	131,74	1,14%	12,00	14,81%	54.186
Installation of air destratification	0,298	0,48%	1,82	60,86	0,52%	5,00	6,17%	59.630
Heat revovery	**9,45**	**15,24%**	**4,10**	**2.078,56**	**17,92%**			
Heat recovery from equipments	9,448	15,24%	4,10	2.078,56	17,92%	30,00	37,04%	314.923
Process	**15,16**	**24,47%**	**3,62**	**2.257,89**	**19,47%**			
Cut off of machines in stand by	1,915	3,09%	0,80	60,77	0,52%	5,00	6,17%	382.967
Painting line energy efficiency improvment	0,712	1,15%	7,60	104,49	0,90%	2,00	2,47%	356.100
Optimization of heat treatment furnaces	3,126	5,04%	3,40	562,85	4,85%	2,00	2,47%	1.562.850
Renewable energies	**4,63**	**7,47%**	**12,84**	**1.013,16**	**8,74%**			
Solar photovoltaic	4,63	7,47%	12,84	1.013,16	8,74%	32,00	39,51%	144.578
Other	**13,19**	**21,29%**	**5,86**	**3.077,27**	**26,54%**			
Monitoring system for relevant energy user systems	0,452	0,73%	1,33	65,20	0,56%	18,00	22,22%	25.089
Building thermomodernization	7,042	11,36%	18,45	1.673,83	14,43%	8,00	9,88%	880.250
Analysis of consumption during off-peak hours	0,199	0,32%	0,00	28,66	0,25%	6,00	7,41%	33.089
Installation of meters and monitoring	0,469	0,76%	1,11	89,88	0,78%	3,00	3,70%	156.384
TOTAL EE_METAL	**61,97**		**4,91**	**11.596,80**				

All the measures identified can be consulted in document D3.4 Final report on the Potential energy Saving Measures in SMEs of the metalworking sector of 4 EU countries: a cross-country benchmarking. Phase II.

The conclusions of the **contacts established with the Energy Services Companies** are:

- 81 companies were audited, and 20 of them were interested in getting in contact with Energy Service Companies.
- 48 were the number of energy saving proposals submitted by the ESCOs.
- The saving of Primary Energy proposed by these ESCOs represents 11,34% of the estimated energy savings in the audits.
- The energy saving measures proposed by the Energy Service Companies and the primary energy saved with the implementation of them are listed below:

MEASURES	PRIMARY ENERGY SAVING PROPOSED	Nº OF PROPOSALS MADE BY ESCOs	PRIMARY ENERGY SAVING PROPOSED / PROPOSAL
Building thermomodernization	2,94 GWh/y	5	0,59 GWh/y
Implementation of renewable energies (solar photovoltaic)	1,23 GWh/y	7	0,18 GWh/y
Replacement of lighting fixtures with LED technology	0,88 GWh/y	9	0,10 GWh/y
Control system of energy consumption.	0,66 GWh/y	8	0,08 GWh/y
Energy efficiency consulting service	0,39 GWh/y	4	0,10 GWh/y
Optimization of the compressed air system.	0,29 GWh/y	7	0,04 GWh/y
Optimization of the heating and air conditioning system	0,27 GWh/y	1	0,27 GWh/y
Natural lighting with special skylights	0,08 GWh/y	4	0,02 GWh/y
Implementation of power quality system	0,29 GWh/y	2	0,15 GWh/y
TOTAL	**7,04 GWh/y**	**47**	

***Note** that there are 48 proposals with different types of financing contracts by the ESCO, but 47 proposals have been included for the calculation of energy savings. This is because an SME has received two proposals from different ESCOs for the same saving measure. Only one of them has been accounted for in the total savings proposed by the ESCOs.*

- The types of contracts proposed by the ESCOs to the SMEs in the contacts maintained during the execution of this Phase are shown below:

TYPE OF CONTRACT PROPOSED BY THE ESCOs	Nº OF PROPOSALS
Performance consulting contracts, (eg project management,)	3
Result contracts, eg. Energy Performance Contract (shared savings)	22
Contracts with financing, partial or total, of interventions by the company (shared risks)	1
Equity (financial resources of the client)	17
Renting	0
Leasing	1
Other: Consulting project	4
TOTAL	**48**

3.2 Link to the public document in the EE-METAL website

Link to the document in English:

https://www.ee-metal.com/wp-content/uploads/2019/01/D3.4-Final-report-on-the-potential-energy-saving.pdf

4 Use of Energy Monitoring System

4.1 Summary of the result of energy savings provided by the use of EMS

The EE-METAL programme has made it possible to implement an energy monitoring system in 4 metallurgy SMEs (in 4 different countries).

Beyond the overall satisfaction of the managers of these companies, the solutions implemented perfectly meet the expectations expressed before they engage in the process:

- ✓ Monitor energy consumption in real time (in line with the energy audit carried out in 2017)
- ✓ Refine the consumption profiles of the most energy-intensive equipment (e.g.: evolution of consumption according to target cycles and temperatures)
- ✓ Detect consumption drifts linked to malfunction, incorrect adjustment or misuse of equipment (e.g. overconsumption at start-up)
- ✓ Improve production scheduling and the company's competitiveness (e.g optimize the programming of set temperatures and heating stages; start in the morning with the parts that require the lowest furnace temperatures and then gradually increase)

Concerning the results obtained following the installation of monitoring systems, it should be underlined that a monitoring campaign needs quite long observation time to provide data that can be meaningful, comparable and that provide useful information to identify necessary interventions. These times are not coherent with the closure of the EE-METAL program and for this reason the data measured with the systems implemented in the companies are not reported in the deliverable.

However, until at this stage it is still a little early to present reliable figures, the first results are encouraging as they confirm the measurements made during the energy audits. In the long term, the sensors will make it possible to refine these measurements (with continuous measurement) and make them more reliable.
On some equipment, continuous measurement of consumption makes it possible to detect peaks in consumption and to alert on equipment malfunctions (breakdowns, adjustment

problems, misuse...). This type of alert should enable companies to react more quickly, improve the operation of their equipment and thus save money.

Finally, energy monitoring solutions are beginning to be used in some companies as a means of improving production ranges. By monitoring the energy consumption of production lines, they can optimize the organization of production (delayed machine start-up, optimization of furnace heating times, equipment shutdown in the event of non-use, etc.).

4.2 Link to the public document in the EE-METAL website

Link to the document in English: https://www.ee-metal.com/wp-content/uploads/2019/02/D4.5-Energy-savings-provided-by-the-use-of-EMS-ENGLISH.pdf

The document in the national languages can also be found in the website of the project:

- French: https://www.ee-metal.com/wp-content/uploads/2019/02/D4.5-Energy-savings-provided-by-the-use-of-EMS-FRENCH.pdf
- Italian: https://www.ee-metal.com/wp-content/uploads/2019/02/D4.5-Energy-savings-provided-by-the-use-of-EMS-ITALIAN.pdf
- Polish: https://www.ee-metal.com/wp-content/uploads/2019/02/D4.5-Energy-savings-provided-by-the-use-of-EMS-POLISH-Website.pdf
- Spanish: https://www.ee-metal.com/wp-content/uploads/2019/02/D4.5-Energy-savings-provided-by-the-use-of-EMS-SPANISH.pdf

4.3 Recommendations

- **Clearly define your needs:** identify the equipment and data already available, be clear on the expected results or targets, draft specifications...
- **Do not be too ambitious:** it is better to opt for a simple but scalable solution and user friendly solution...
- **Have internal resources:** designate and train an energy referent...
- **Integrate this monitoring as part of a more global approach to improving performance:** improving productivity, facilitating maintenance...

5 Implementation of Energy Management System

5.1 Summary of the results of EMS implementation

The EE-METAL program has made it possible to support 8 SMEs in the metal and metalworking sector in the implementation of an energy management system and to obtain ISO 50 001 certification.

The implementation was carried out in 4 steps:

- Selection of companies
- Support in the implementation
- Internal audit
- Certification audit

Each of these phases was decisive in the success of this implementation. The identification of criteria for the selection of companies has increased the chances of success by selecting motivated companies that already have experience in management systems and are economically interested in potential energy gains.

The support was also an important step in transferring methodology and know-how to companies for the implementation of their energy management systems. The method defined in deliverable D2.7 was particularly appreciated by SMEs for its pragmatism and ability to help step by step.

In order to ensure that certification is obtained, an internal audit was organised in each company. Results, observations and non-conformities were capitalized to allow companies to improve.

Thanks to this program and methodology, the 8 companies, from 4 different countries, all obtained ISO 50 001 certification on the first try and in a short period of time (less than 9 months).

5.2 Reference to the energy savings

While it is difficult to quantify the energy savings achieved through the management system, it has ensured continuity with previous energy audits. Indeed, the principle of continuous improvement has encouraged companies to implement the recommendations made during audits, particularly on technical aspects (lighting, compressed air, processes, etc.).

The awareness raising of employees carried out as part of the energy management system has also contributed to energy savings by influencing behaviour.

Finally, and even if it will take longer to observe, taking into account energy performance criteria in purchasing and design processes should also result in significant energy savings in the long term.

5.3 Recommendations

- **Capitalize on the experience acquired** in other management systems (quality, environment, etc.)
- **Appoint a dedicated management** representative to be the energy referent
- **Seek simplicity in approach and actions**, particularly on the energy planning aspect
- **Give confidence and motivation to employees** with simple actions that bring visible results quickly

6 Financial options

6.1 Summary of the results

The results of the work done by the EE-Metal project consortium for promoting actions to support the access of ESCOs to the MMA sector, benchmarking the different financial products being implemented in the partner countries for financing energy saving measures in the industrial sector, are described in detail in the report "Deliverable D5.1. Technical measures, energy service contracts and financial products for increasing energy savings in MMA SMEs" (https://www.ee-metal.com/wp-content/uploads/2019/01/D5.1-Technical-measures-energy-service-contracts-and-financial-products-for-increasing-energy-savings-in-MMA-SMEs.pdf).
The overall aim has been to provide SMEs of the MMA sector a toolbox for overcoming the existing technical, commercial and financial barriers to the implementation of energy saving measures. This has been achieved supporting the access of ESCOs within the SMEs involved in EE-Metal project for energy auditing phase, implementation of ISO 50001 management systems and installation of Energy Monitoring networks.

Energy efficiency measures are characterized by some barriers that limit their development, especially in SMEs. Generally speaking, the more an industrial company is bigger, the more internal energy consumption (expressed in kWh or natural gas Sm3) is numerically high and the more it has an interest in investing in trying to reduce them. That's why big industries are the ones more interested in such investments and it is in this perspective that EU has issued many regulatory rules dedicated in particular to large companies (eg the 2012/27/EU Energy Efficiency Directive). Even though in small and medium-sized companies the energy consumptions, and

therefore energy costs, are not so high in absolute terms, they can represent significant quotas in percentage terms of increase in production costs. Another barrier for spreading energy efficiency actions in SMEs, for obvious dimensional and organizational reasons, could be the gap in internal expertise for evaluation of measures to be taken (sometimes improvement measures are even not considered at all).
In this context ESCOs could play an important role, accompanying companies in the processes and supporting required investments for energy efficiency.

The EE-METAL consortium analysed the role of ESCOs, with a focus on the SMEs of the metalworking sector, involving them in interviews and informing them about the results of energy analysis conducted in SMEs of metal working sector. Interviews show that Energy Service Companies sector is relatively young, with around 70% of considered ESCOs that started their energy activities after 2004 and around 50% after 2009. This trend could be an index of an increasing attention of industries and companies towards energy topics during the last two decades. Large majority of ESCOs have customers in industrial sector, which represents the most active and dynamic field for energy activities. Other secondary areas are tertiary buildings and public buildings or lighting. Involved ESCOs identified lack of knowledge of industries about financing instruments, together with propensity of companies towards projects with short payback time and low market confidence in ESCOs, as the main barriers to the access of ESCOs in metalworking companies.
In the current state, the ESCOs are moving on the market operating essentially on three types of contract: Energy Supply Contract, Build-own-operate-transfer, Energy Performance Contract. (EPC).

The EPCs are the most promising opportunities to enhance investments: with EPC an ESCO undertakes a project to deliver energy efficiency improvements in the premises of the client, and uses the stream of income from the cost savings to repay the costs of the project. The approach is based on the transfer of technical risks from the client to the ESCO based on performance guarantees given by the ESCO. Thus company can immediately benefit of a turnkey plant without economical outlay or maintenance/ management cost.
A modern approach is to support the company in a global performance framework implemented gradually according to its energy maturity. From consumption analysis and monitoring to the financing projects and to the installation of SCADA equipment.
An innovative EPC contract (2nd generation) is the one that integrate the whole environmental performance, not only the energy dimension. In this new contracts, one important parameter is the maintenance: the savings will be provided by the new equipment (technology) and also by the maintenance optimization, included in the contract.

Energy performance contracts can represent a very interesting tool for implementation of efficiency actions because they can overcome some important barriers that are typical of small and medium size companies: poor awareness of energy contents and lack of economic and human resources to be employed for efficiency actions (priority is given to manufacturing process and its equipment), to mention only a few.
Anyway, EPC contracts are more suitable and attractive when one or more of the following conditions occur: high technical complexity, high cost investment, actions on auxiliary services, significant working time, offer of ancillary and complementary services.

Some typical examples of energy efficiency actions EPC contracts can be applied to are presented below.

Action	Technical complexity	Cost investment	Complementary services	Suitable EPC contract				
				Guaranteed savings	Shared savings	First Out	Energy Plus	Chauffage
Cogeneration	High	Very high	Insurance, supply contract, incentives, authorization, management and maintenance	✓	✓	✓	✗	✓
Trigeneration	High	Very high	Insurance, supply contract, incentives, authorization, management and maintenance	✓	✓	✓	✗	✓
ORC turbine	Very high	Very high	Insurance, incentives, authorization, management and maintenance	✓	✓	✓	✗	✗
LED	Low	Medium or high	Insurance, supply contract, incentives, management and maintenance	✓	✓	✓	✗	✓
Thermal plant	Depending on the action	Depending on the action	Insurance, supply contract, incentives, authorization, management and maintenance	✓	✓	✓	✓	✓
Photovoltaic power plant	Medium	High, depending on installed power	Insurance, incentives, authorization, management and maintenance	✓	✓	✓	✗	✗

So it is clear that energy performance contract represents a virtuous and promising business model because it encourages investments by companies reducing their risks. Nevertheless, the stipulation of an EPC contract between an ESCO and an SME implies, starting from the initial phase of the execution of the contract, a series of risks associated with the energy efficiency system. Risks can arise both before and after the implementation of the energy saving measure and are classified by type of effect, according to the following categories: patrimonial risks, financial risks, economic risks.

An innovative risk reduction model linked to the EPC contract is offered by the insurance market. Insurance companies intervene to cover risks, making easier for both companies and ESCOs to sign an EPC contract. Insurance can operate to cover all kind of risks.

Finally, the EE-METAL consortium conducted a further analysis on the role of Financial institutions, with a focus on the SMEs of the metalworking sector, involving them in interviews and informing them about the results of energy analysis conducted in SMEs of metal working sector. Results show a first relevant information: many financial institutions do not offer specific financial products for energy efficiency measures. Thus market seems not to be completely mature in this sense and, even if some positive signs are going to appear, this partial lack of financing instruments can act as a brake on SMEs development for implementation of energy efficiency measures. Surveyed financial institutions indicated the payback period of energy efficiency actions as one of the most important barriers to companies' access to funding.

EE-METAL project permitted to enhance connections between involved SMEs of metalworking sector and ESCOs or financial institutions, but lot of work need to be still done in order to create greater opportunities to bring energy efficiency actions to the center of business interests. At the current time, some collaborations are rising between the ESCOs and the SMEs in the metal sector, but still little is done at the level of financial instruments. The SMEs need to improve their

competitiveness in order to consolidate their position in the market and furthermore they are starting to be aware of the importance of the energy efficiency measures implementation. Predictably, this process could be a little slow because in general, companies in the metal sector are not very innovative and they have a very traditional character. By the other hand, financing is a critical point for them and ESCOs can help them to overcome the barriers for financing energy saving measures. In addition to, Energy efficiency industry has generated at European level a set of policies, laws (The Directive 2006/32/EC on the energy efficiency and the Council Directive 93/76/EC on energy services) and actors that are nowadays the main milestone of the energy efficiency sector. Economic situation is improving gradually and our society is achieving a greater sensitivity in environmental issues.
Consequently, for all these aspects, ESCOs can play an important role in the energy efficiency sector.

OVERCOMING BARRIERS FOR FINANCING ENERGY SAVING IN MMA SMES: FINAL RECOMMENDATIONS
1. Dissemination of special credit lines extend by development banks to local financial institutions, which on-lend the funds to their clients
2. Development of energy savings insurance, which pays out if the projected value of energy saving is not met as the answer to the lack both the technical capacity to assess the potential of more capital-intensive energy efficiency investments and the confidence that they will pay back
3. Establishment of sustainable fiscal incentives for SMEs (tax breaks, loan interest rate discounts), without however distorting the evaluation of the real sustainability of the interventions
4. Dissemination and promotion of energy-efficiency information and investment opportunities, including special financing platforms, energy saving technology and standard databases
5. Promotion of energy audits to overcome lack of information about energy consumption and possible investments
6. Establishment of special financial institutions to promote innovation of financing products to perform energy efficiency, including combined green bond issuance to SMEs
7. Regular organizing of different level trainings and seminars about financing strategies, risk management, technological development, etc.
8. Combining different financial instruments or to use different instruments for different sub-segments, for example, grants for small enterprises and preferential loans for medium-sized enterprises
9. Streamlining application processes or providing additional information and guidance in case of applying for a grant
10. Providing initial capital for energy efficiency projects by an energy supplier, this will be repaid through a debt repayment charge on energy bills

6.2 Link to the public document in the EE-METAL website

Link to the document in English: https://www.ee-metal.com/wp-content/uploads/2019/01/D5.1-Technical-measures-energy-service-contracts-and-financial-products-for-increasing-energy-savings-in-MMA-SMEs.pdf

An executive summary of the document in the national languages can also be found in the website of the project:

- French: https://www.ee-metal.com/wp-content/uploads/2019/02/D.5.1-Mesures-techniques-contrats-de-services-%C3%A9nerg%C3%A9tiques-...-dans-les-PME.pdf
- Italian: https://www.ee-metal.com/wp-content/uploads/2019/02/D.5.1-Executive-Summary-ITA.pdf
- Polish: https://www.ee-metal.com/wp-content/uploads/2019/02/D5.1-Executive-Summary_PL-ok.pdf
- Spanish: https://www.ee-metal.com/wp-content/uploads/2019/02/D5.1-Executive-Summary__web_spanish_v1.pdf

7 Final Conclusions

The EE-METAL project has enabled us to work with SMEs in the MMA sector for 3 years in a relevant, targeted and systemic way. The actions were carried out in a coherent manner and we were able to provide a complete support, very appreciated by the companies. Many of the companies audited have studied the recommendations made and have started energy efficiency projects.

We have been able to act on a large number of levers to encourage energy efficiency actions: audits; training of energy referents in companies; promotion of SCADA systems benefits; awareness raising and ongoing dialogue with decision-makers; provision of information on energy consumption to enable manufacturers to compare their position; provision of databases on the best available technologies, contacts with potential ESCOs partners (ESCO's interventions in meetings, BtoB meetings, direct contact on a case-by-case basis).

In some countries the lack of support programs at the national and regional level for energy-saving projects in the current EU financial perspective has an ambiguous impact on their implementation by SMEs. In other countries support programs are too complex for an SME, and sometimes insufficient. On the one hand, it clearly inhibits the undertaking of these activities, and on the other hand, it causes the search for other financial solutions, including ESCO partners. For the development of ESCOs and the increase of investment in energy-saving solutions, the offer of financial institutions in the form of financial instruments especially addressed to SMEs must be improved.

Information and awareness-raising actions (mainly workshops and conferences) are crucial to develop a dynamic around energy efficiency in SMEs in the MMA sector. The subject is not a priority for industrialists, they have no visibility on what is being done in other companies and, moreover, the offer of ESCOs is very complex. What is more, SMEs have not identified the potential of the energy efficiency to improve their competitiveness. Who to work with? Where

to start? Through networking between ESCOs and industrial representatives and testimonies on successful projects, we have mainly reinforced and demystified the subject with a large number of companies, which is a very important step towards action. Informing and raising awareness are key actions to integrate energy efficiency into the company's priority projects.

The SMEs involved in the various actions of the EE-METAL project would undertake more energy efficiency initiatives if some conditions (factors) are improved:

- turnkey solutions integrating the implementation of energy efficiency solutions and the financial package. Nowadays ESCOs focus their efforts in large companies; SMEs represent small investments with long payback periods
- simple and effective contracts with ESCOs
- have guarantees on the results (remove risk reticence)
- third-party funding

From the perspective of the last three years in which the EE-METAL project was conducted, changing macroeconomic conditions, including new legislative regulations and rising energy prices were observed. The following changes, especially in terms of energy costs, increase the importance of energy efficiency and the use of energy-saving solutions in SMEs of the metal and metalworking industry.

In conclusion, this program has mainly led us to create and develop the conditions so that the SMEs have at their disposal all the information and all the means to undertake actions of energetic efficiency. The period of time estimated in the project for the implementation of measures has been too short to record all the measures that companies will undertake. Energy efficiency is a process and EE-METAL project offered us only a window of about one year to trace the measures undertaken and their impact.

The 7 actors who worked in this project have acquired significant experience and now have tools and methods at their disposal that they will continue to use in contact with companies. Awareness-raising meetings, reporting on the evolution of practices and solutions available to manufacturers, will be organised. We are committed to being vectors of communication and resource places for all SMEs in the MMA sector who wish to engage in this approach.