A holistic framework for Empowering SME's capacity to increase their energy efficiency

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List of Acronyms

Acronym	Meaning
BMS	Building Management System
BTU	British thermal unit
C&I	Commercial and Industrial
CDD	Cooling Degree-Days
CFL	Compact fluorescent lamp
CRT	cathode ray tube
E&T	Education & Training
EE	energy efficiency
EU	European Union
EUR	Euro
EV	Electrical vehicle
HDD	Heating Degree-Days
HPS	High Pressure Sodium
HVAC	Heating, ventilation and air conditioning
ICT	Information and Communication Technologies
IPMVP	International performance measurement and verification protocol
IRR	nternal Rate of Return
IT	Information Technology
kg	kilogram

KPI	Key Performance Indicator
kW	kilowatt
kWh	Kilowatt-hour
LED	Light-emitting diode
LPG	Liquefied petroleum gas
LU	Learning Unit
M&T	Monitoring & Targeting
M&V	Measurement & Verification
MWh	Megawatt-hour
NPV	Net Present Value
PV	Photovoltaic
QMS	Quality Management Systems
RDF	Refuse-derived fuel
RES	Reneawable Energy Source
SME	Small and medium enterprise
toe	tonne of oil equivalent
U.M	unit of measure
W	Watt

Due to their length, the list of figures and list of tables are presented at the final of the document.

Disclaimer: *"This document has been prepared in the context of SMEmPower Efficiency project, funded by the EU Horizon 2020 research and innovation programme under the Grant Agreement No 847132. This document reflects only the authors' views and the Agency and the Commission are not responsible for any use that may be made of the information it contains."*

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Executive summary

This Report has been developed through the implementation of the "SMEmPower Efficiency" project, funded by the Horizon 2020 under the Grant Agreement No. 847132/ 2019.

The SMEmPower Efficiency project is based on a holistic framework to "empower" SMEs to undergo energy audits and implement their proposals. An integrated Education & Training (E&T) program is going to support this objective, targeting energy-related SMEs staff. At the early stage of SMEmPower Efficiency, the consortium developed a methodology to gather data on SMEs energy cost, energy efficiency, and other important parameters. According to the procedure proposed as practical action in LU6 the candidates, organized into teams, among all the involved countries have performed energy evaluations or actualization of the energy audits of their pilot sites. The contents of the practical action were presented during the online sessions of the courses, and groups were formed consisting of proper multi-disciplinary mixtures of candidates with different professional backgrounds. As the courses have been delivered fully online with participants from different regions of each country, the groups worked together remotely using the SMEmPower resources (online platform and tools). The following document describes in detail the results of the practical action in each pilot site and the assessment of the proposed measures alongside with future energy action plans.

The carefully selected pilot sites in the 8 partner countries: Cyprus, Germany, Greece, Italy, Romania, Slovenia, Spain, and the United Kingdom, come to help the trainees during the E&T program to put into practice the actual knowledge gained. Using the Monitoring & Targeting (M&T) and the Measurement & Verification (M&V) tools developed within the project energy surveys have been performed and specific energy-saving measures for each pilot site have been proposed. In the first edition of the SMEmPower E&T courses 49 SMEs have been engaged as pilot sites, benefiting from the energy assessments performed by the course attendees.

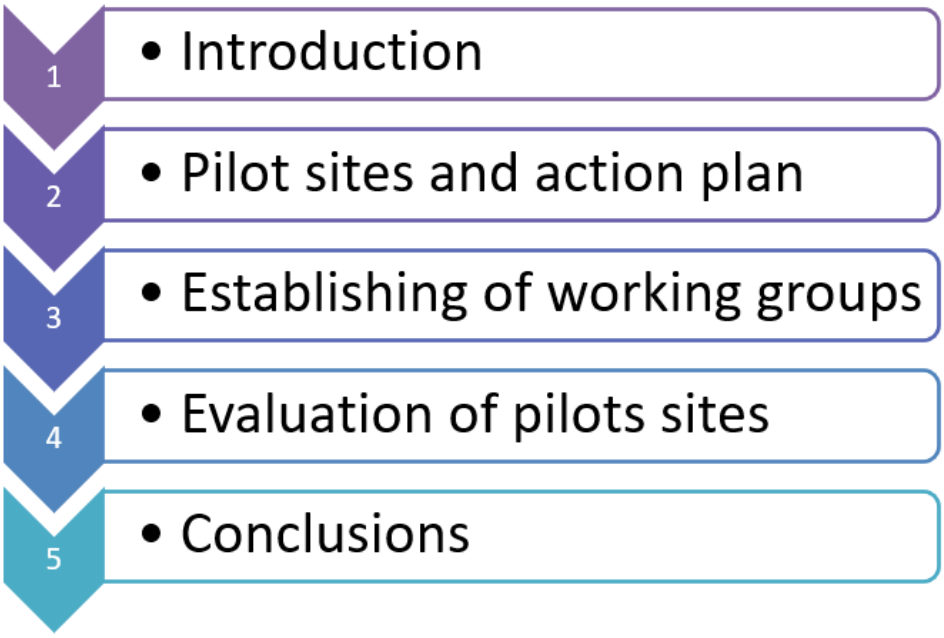
The COVID-19 pandemic affected the implementation of this first edition of the E&T courses, especially in the case of the implementationof LU6 - Practical action. The most challenging issue to overcome was the inability of the participants to visit the engaged SMEs in the framework of the practical action. Only in Italy and Cyprus, the practical session involved on-site, face-to-face meetings between the attendes and the SME staff. All the necessary data were provided by the SMEs representatives, who were also team members for the implementation of the case studies. All involved teams in all partner countries have succeeded to perform energy analyses in their assigned pilot sites, based on historical energy consumption and production data for different energy categories, e.g., electricity with interpretations and conclusions on the dynamics of consumption evolution. Moreover, each team proposed sustainable energy efficiency improvement measures and the use of renewable technologies in future action plans, calculating also the corresponding financial data, such as the required investments, but also benefits, such as energy savings considering MWh/year and Euro/year units, CO_2 emission reduction, and the payback period.

In order to have a global approach in the implementation of the foreseen practical action, the selected SMEs, as pilot sites, cover various fields of financial activity such as airports, water plants, wood processing factories, steel processing factories, food processing factories, plastic processing

factories and IT companies. In this way, the generic energy assessment procedure, developed during the early stages of the project, has been tested in SMEs of different sectors of finance with different profiles regarding energy consumption. Some of the proposed technical solutions within the future energy action plans, as proposed by the E&T course attendees in the case studies include the installation of PV systems, installation of biogas generators, replacement of conventional lighting lamps with LED lighting, implementation of sensors and controls, air compression machines, replacement of IE2 and IE3 type electrical motors with IE4. Since important energy savings can be achiened by improving the energy behavior of the SME employees, the SMEmPower consortium highlighted several good practices for implemention in the pilot sites, based on the practical action groups assessments and conclusions. These good practices are summarized below:

- Training and energy culture actions: yearly trainings for employees on climate and energy efficiency;
- Include climate and energy efficiency criteria when choosing upstream and downstream partners;
- Employees are encouraged to suggest improvements in the energy efficiency and other environmentally impact areas;
- Increasing the use of climate friendly production;
- Suppliers and service providers are chosen based on environmental standards;
- Greater decision-making power to the energy/environmental management officer;
- Work with suppliers to reduce carbon footprint of supply chain.

The report is structured in the following sections:



1. Introduction

The evaluation of pilot sites has been performed by the working groups under a procedure proposed as practical action in Learning Unit (LU) 6 of the SMEmPower E&T courses. The work in this task involved:

- Updating existing energy audits (if existing), extracting of relevant information and investment plans;
- Performing a walkthrough to gain an improved understanding of the energy flows inside the facility: follow technological processes – identify and monitor influence factors – monitor behavior of operators, technological parameters, production and energy data on shifts, individual discussion with operating personnel – organize internal debates on energy opportunities;
- Analyze and discuss opportunity of traditional and innovative technologies applied for energy efficiency and renewable local sources, contractual arrangements and energy performance contracting etc.
- Pursue a non-exhaustive list of actions: establish key performance energy related indicators – perform comparative analysis of production and energy data, in correlation with static or dynamic factors, establish optimized energy scenarios and targets;
- Energy evaluation of pilot sites by the formed working groups. Concise and easy to follow reports, for each pilot site, comprising added value energy analytics information, action plans and effective proofs of energy savings through applied M&V.

This report corresponds to the practical action carried out in the first edition of E&T Program, which has been carried out from December 2020 to April 2021, in all project partners countries.

2. Pilot sites and action plan

The practical on-site action is one of the six topics covered by the SMEmPower Efficiency Education & Training (E&T) Program, aiming to put into practice the knowledge gained throughout the poragram and fulfilling the tasks in working groups. Also, the Monitoring & Targeting and Measurement & Verification tools developed within the project encourage the trainees participating at the program to evaluate the energy related KPIs.

In the previous report Pilot sites selection, the selected SMEs are descriped in detail, including general information about the facility, energy profile and energy management. The recent report aims to present the evaluation of the selected SMEs, as pilot sites, which has been done during the practical action of the E&T Program. Due to the current situation, some pilot sites changed as they give up or because the SMEs represented by the trainees have been prioritised.

3. Establishing of working groups

3.1. Cyprus

The training course for energy managers was organized in collaboration with the University of Cyprus, as a Postgraduate Course. The training course was addressed to people who handle energy issues within their business, local authorities or other bodies and organizations, without necessarily having specialization or related academic qualifications. The training course combined theoretical lessons, exercises, personal learning and practical training, lasting a total of 44 hours. The award of the certificate requires mandatory attendance, submission of written work and success in a written examination. In total 29 people registered for the training course. 24 of the participants were employees and 5 were postgraduate students.

As regards the practical action, this started on the 2nd of April and ended on the 9th of April. Despite the pandemic and the several lockdowns, the participants had the opportunity to visit 5 SMEs. An effort was made to select SMEs that already participated in the course, but unfortunately, because of the pandemic, this was not possible. The reason was that some SMEs did not allow visitors in their premises because of the COVID-19. Nevertheless, site visits were organized in 5 SMEs, coming from different economic sectors. One was a hotel, one was an airport, one was a wood industry, one was a sewage treatment plant and the last was a company that manufactures plastic tanks. Participants were divided into 5 groups of 5-6 people each. Each site visit lasted approximately 3-4 hours. During the visit, the participants used a questionnaire that was provided to them in order to use it as a guideline to collect energy data and general information about the current situation of the SME. Specifically, the data collected include the following:

- Information about the main activities, products produced and/or services provided, etc. by the SME.
- Information about the production process.
- Year of construction, area covered, number of employees, energy and environmental standards that are in place, and any other information that is useful and affects the energy situation of the SME.
- Information about the building envelope (construction materials, the existence of thermal insulation, etc.).
- Technical characteristics of heating, cooling, ventilation and lighting systems.
- Information about RES systems (Photovoltaic system, solar thermal system) that exist in the SME.
- Energy consumption and production profile of the SME for at least two years.

Regarding the energy analysis, this was done based on the energy consumption history of the SME, where key performance indicators (e.g. kWh /m^2, kWh /product, kWh /guest-night, kWh / m^3) were extracted in order to assess energy and environmental performance of the SME. It was recommended to use the energy analysis tools, (Monitoring & Targeting, Measurement & Verification) developed as part of the project.

Finally, the participants had to identify energy efficiency improvement measures. Each proposed measure should include the following:

- Description of measure
- Assumptions used to calculate energy savings
- Energy analysis - Energy saving calculations
- Financial analysis (NPV, Payback period)

The Practical action was assessed with the delivery of a high-quality technical report and its presentation. The technical report should include all the above information.

3.2. Germany

The course was organised in collaboration with Beuth Technical University Berlin. Due to the corona pandemic the training course itself as well as the practical action were carried out in a virtual learning format.

For the practical action a total of seven SMEs were analysed as case studies. The SMEs are representing different sectors as shown by the NACE-codes in the report on the pilot sites. The SMEs covered different economic areas, ranging form manufacturing to service providers.

During the first edition of the training course 24 participants were allocated to four working groups, resulting in 5 -6 participants per working group. The working groups were assigned to two pilot sites each and had to analyse the pilot sites based on real consumption data. Since on-sites where unfortunately not possible we arranged at least one video call with a dedicated energy manager or an employee with knowledge on energy management respectively. It was possible to organise video calls with five pilot sites; additional information was exchanged via E-Mail.

After providing the necessary data and the details regarding the expected output within learning unit 5 (LU5), the working group members analysed the available data in close collaboration with their supervisors and with the representatives from the SMEs. During the practical action, the assigned team supervisors were regularly in contact with the team members in order to provide guidelines and feedback whenever necessary. The team members discussed and agreed on the distribution of sub tasks among them.

The members of each working group were of heterogenous professional background, ranging from master students to experienced energy managers. The interaction between the different working group members benefited greatly from the various backgrounds and was leading to controversial and enriching debates on appropriate energy saving measures for the respective pilot site.

3.3. Greece

The Greek accredited training program consists of two (2) separate parts, the theoretical first part consisting of lectures corresponding to the first five (5) LUs, followed by the second part which is the practical action of the trainees in collaboration with the engaged SMEs. Five (5) Greek SMEs have been selected for the pilot action of the first edition of the E&T course. These SMEs are active in different economic areas, from manufacturing, to service providers, while they are also

geographically dispersed across the country. Thus, a variety of different case studies was available for analysis by the formed working groups, aiming at preparing detailed project reports with the energy analysis and the suggestion of specific energy efficiency measures for the engaged SMEs.

During this first edition of the training courses, forty-five (45) energy related experts attended the theoretical part, while forty-three (43) of them concluded the first part successfully, as it is described in deliverable D3.4 E&T reports and participated in the practical action. The forty-three (43) trainees were divided into nine (9) working groups, consisting of four (4) to five (5) people. Due to the limited number of engaged SMEs, more than one team worked in the same company. Bigger SMEs offering more available option for energy efficiency improvements were allocated more than one group to investigate these different options. Consequently, different case studies were formulated and analyzed for the SMEs, providing multiple proposals for the improvement of their energy efficiency.

The members of each working group were of complementary background, with different professional specializations. They managed to interact successfully, in implementing the energy analysis and in the joint preparation of the final detailed report, to propose energy efficiency measures. Moreover, three (3) energy experts from the course delivery team, having significant experience in energy auditing, have been assigned to act as coordinators and supervisors for the working groups, one (1) per team. Representatives of the pilot SMEs participated in the procedure as members of the groups, after attending the theoretical part. Their role was twofold. To act as coordinators between the groups and the SMEs facilitating the acquisition of the necessary input data (e.g., energy consumption for the previous periods, production data etc.) and bridging the gap due to the distance feature of the practical action. Also, they will transfer the project outcomes to their SMEs, paving the way for the forthcoming short trainings in their SMEs.

Unfortunately, due to COVID-19 pandemic, the practical action was conducted exclusively online. At first, the members of each one of the teams were gathered through separate teleconferencings, to exchange contact information and to be informed about their assignment by their supervisors. A template for the final report, based on the existing official template for the Greek energy audit report, was formulated by the project experts, and was distributed to the group members, to achieve a common base for the reporting of the different groups for all case studies. The representatives of the companies also provided the necessary data to the participants, who had previously signed a confidentiality agreement, with detailed presentations and lots of pictures for the SMEs to help the group members to overcome the difficulties of not visiting the SME sites.

After providing the necessary data and the details on the expected final assignment, the group members analyzed the available data in close collaboration with their supervisors and with the representatives from the SMEs. During the practical action, the assigned supervisors were constantly in contact with the teams, to provide guidelines and feedback whenever necessary. The project work was uniformly distributed among the group members, as unanimously agreed by them during their first meeting.

In the final report, first, the general data of the company under analysis were presented. Next, the SME buildings layout and characteristics and the manufacturing procedures were analyzed, along with the heating and cooling installations and any existing renewable energy sources. Based on the

energy data provided by the SMEs, monthly consumption and final products profiles, for at least two (2) consecutive years were formulated. These profiles were evaluated using the official tool for energy auditing provided by the Greek Ministry of Environment and Energy to calculate the baseline for the electrical and thermal energy consumption and to execute statistical analysis. Finally, after the extensive use of the M&T and M&V tools formulated in the framework of the project and presented to the trainees during the first theoretical part of the courses, company and data specific energy efficiency measures were proposed. The proposed measures were afterwards evaluated regarding the expected savings and their payback period.

Regarding the scheduling of the practical action, two (2) weeks were allocated to the groups for the collection of the necessary data and to complete the final energy efficiency reports. After the conclusion of the assignments, the working groups presented their results publicly in a special session addressed to all the trainees who concluded successfully the training course, to the energy experts acting as team leaders and to the whole delivery team of the course. Company representatives were also invited in this session to see the outcomes of the practical action work and the prospective energy savings expected by the measures proposed by the case studies.

3.4. Italy

In the registration form participants were asked to provide their background. That information has been used by Energiada to create groups without overlapping of skills, so to have five homogenous groups. The minimum number of people per group was three. Another criterion has been an equal gender distribution.

Due to the pandemic, the groups worked remotely. This barrier has been turned into an opportunity; the group-work has been structured in a way that it is not necessary (although of course still highly recommended if possible) to visit the site, allowing a broader participation from SMEs as pilot cases which were remotely located, and that would have hardly had access to the training course otherwise.

The energy audit task was a four-step process, which groups had to accomplish in four weeks: gather of data, analysis, energy model, EE interventions. Each group was assigned a tutor to overview the work and make sure the groups were on track. Each tutor met the group for an update once a week, during short, prearranged meeting called check points. Each group was left in charge of self-organize their own communication, which was mainly done via email and via Whatsapp. Tutors made sure to facilitate this communication part and logistic aspects for the meetings. Finally, a Google folder was made available to each group, where the participants shared the information and working documents.

Only the first step, gathering of data, was mainly done by the SME/case pilot representative in the group. It followed a joint work where all group members contributed to all the other tasks. Some of them occasionally led more in accordance with her/his experience and knowledge, but in general all group members always collaborated in a balanced and equal way.

The energy audit task within LU6 was structured to turn into practice the acquired knowledge from LU1 to LU5 on actual case studies in different SMEs.

3.5. Romania

During the course, the trainees have been asked to form a group of 5-6 people, considering to have people from different fields. Each working group was responsible for one pilot site. The trainees had the possibility to bring a pilot site or case study for the practical action. Each working group had at least one responsible lecturer for providing support. There were organized meetings in small groups for discussing challenges, solutions. Each member of the working group was responsible for a subpart of the project that had to be submitted at the end of the course / practical action – the actual pilot site evaluation report.

Unfortunately, the current situation did not allow to visit the actual pilot sites, but all the working groups tried to use as many information as possible to conclude a successful and especially useful report for each pilot site.

The practical action final evaluation was held at the beginning of February, when the working groups had to submit a written report and also to present the results of the evaluation, including the energy efficiency action plan.

3.6. Slovenia

The working groups were formed around each company or participants (their pilot projects) that participated in the training. It means that members were: trainee, trainer, energy experts and coordinator from project partner (PP). There were 23 participants and 13 companies involved. It means 13 working groups were established. Till April 2021, 6 working groups were more active because 6 companies were more advanced in data collection and pilot design activities.

The work has been done in the way that the pilot sites and the trainees developed. Technocal detailes along with calculation will be presented and discussed within the whole group. The working groups have been checked existing energy audits, where it was the case.

Technical details and data were collected, analyzed and discussed and somecalculation of saving were done. The energy experts only visited and made walk-through audit and evaluated the real conditions in few pilot sites. The participants of the training are technically educated people but not all of them have enough experiences to design the measures according to real situation taking into account all conditions, circumstances and possible solution. The energy expert with experience is able to help with the development of the measures. The idea is that participants can use their well-developed pilot project to plan their investments and find financial sources. After the site visits the update of the energy audits will be done. Analysis and discussion about the opportunity of traditional and innovative technologies to be applied for energy efficiency and renewable local sources were discussed at the online meetings. Potential financial sources were not discussed yet, like energy performance contracting, because not all final potential savings were calculated. Only few companies collect the production related data and correlate them with energy data. Therefore, the KPI will be calculated, and optimized energy scenarios and targets will be prepared soon.

3.7. Spain

The participants were organized themselves according to their own preferences. The working groups were working online.

The tool used for the meetings was Microsoft Teams. The different companies were organised in different channels where information was shared and a video call was made with the participating members.

In total, these meetings lasted an average of 4 hours with each of the companies, where the need for advice and the desire to reduce the electricity bill was evident. However, it is worth noting the confidentiality requirements requested by the participants, to be taken into account in the development of the relevant methodologies and reports.

In addition, the teaching courses were also conducted via Teams and Blackboard in order to encourage interaction between the different participants.

The students were organised in small groups separated by channels so that they could comment in small groups on the lectures.

3.8. United Kingdom

The *"Energy Efficiency (Energy Efficiency and Sustainability for Energy Managers and Energy Professionals (in SMEs))"* course ran for a total of five 5-hour long sessions, once a week (with 2 weeks break for Easter, determined by Teesside University's academic calendar), using the Blackboard and Microsoft Teams online platforms.

The practical action was presented during the third online session of the course, and groups were formed consisting of a mixture of SME participants and post-graduate (MSc and PhD) students of different backgrounds (including MSc and PhD students in civil engineering, mechanical engineering, and project management).

As the course ran fully online with participants from different regions of the UK, the groups worked together remotely using Teesside University's IT resources (email, Microsoft Teams, and Blackboard). Communication and feedback was provided using the same platforms.

The students were initially split into 6 groups - one group per participating SME (4 in total), and 2 groups formed solely by post-graduate students. We provided an additional theoretical case study, using data from Teesside University's Clarendon building for the 2 groups composed solely of students. One of the participating SMEs also used this data set since they are currently working from home and have no access to representative energy consumption data for their business. At the end of the course 4 groups (3 SMEs, and one consisting solely of post-graduate students, a total of 15 participants) successfully completed the practical action.

During the last online session of the course, on the 22nd of April, each of the working groups presented and discussed the results of the practical action assignment (Figure 1). Each group also prepared and submitted a report, where each group member's contribution is detailed.

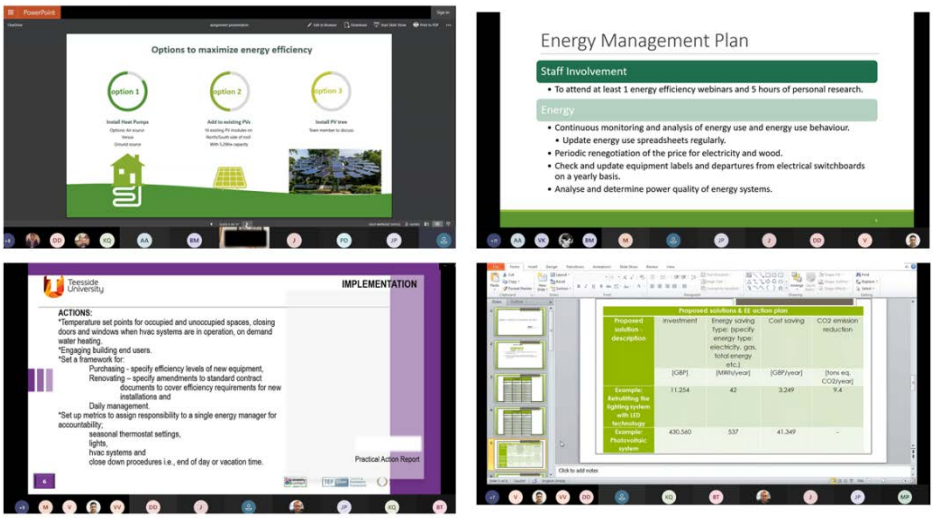


Figure 1. Presentations of the practical action group assignments

4. Evaluation of pilot sites

In the following section, the evaluation report for each pilot site engaged in the practical action will presented, categorized by country. The most relevant information is presented in order to reflect the main findings of the evaluation, especially focusing on the energy efficiency action plan and its calculated or estimated impact. For the evaluation report, a template was proposed in order to have a uniform approach throughout all the eight countries.

Also, a breief analysis of the evaluation is discussed in the ***Chapter 5 Analysis of the evaluation reports.***

4.1. Cyprus

4.1.1. Pilot site 1

Number of employees: 50
NACE Code: [C] Manufacturing, 222 Manufacture of plastics products

4.1.1.1. General description of the SME

The particular SME can manufacture the largest plastic products in Cyprus. In addition to water storage tanks, it manufactures fuel tanks, septic tanks, garbage cans, canoes, marine items (chairs, cots, etc.) and even manufactures specialized products, according to the orders received by its customers. This SME was founded in 1,983 and 2,000 expands its industrial facilities, implementing a new investment strategy in additional modern equipment. Today, this SME can be considered by far the largest of its kind in Cyprus, covering an area of 10,000 square meters.

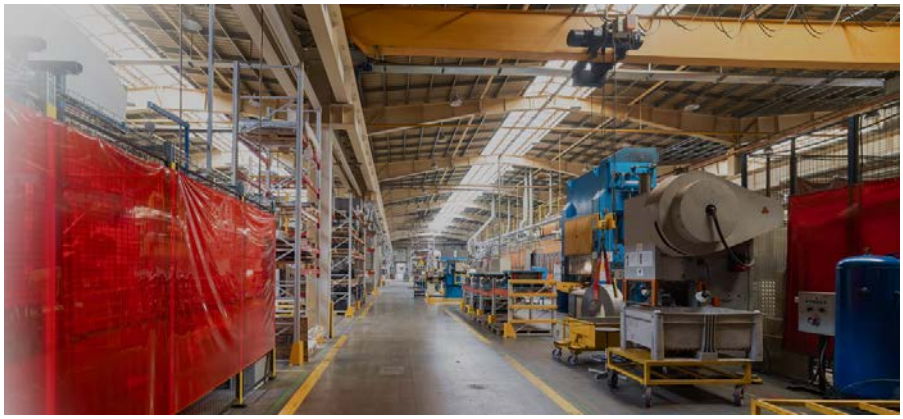


Figure 2. Pilot 1 – Manufacture of plastic products

4.1.1.2. Short description of the production process

There are 3 production lines which are described below:

<u>1st production Line: Press-twisting machine (Extruder)</u>

The process starts with an Extruder twisting machine, which heats LLDPE plastic to 270 ºC, where it is mixed with paint. It is then compressed, cooled with cold water and then passed through blades where it becomes granules.

Figure 3. Pilot 1 – Granules

2nd production Line: Mills (Pulverizes)

Special pulverizes mills, which turn plastic granules into powder.

Figure 4. Pilot 1 – Powder

3rd production Line: Furnaces - Final product

The powder is placed in metal molds, where they are heated to 270ºC for about 25 minutes by rotating in 2 axes, then cooled with cold water for about 25 minutes and finally, the molding is done.

Figure 5. Pilot 1 – Manufacturer of plastic products

Regarding the technical characteristics of the systems of the production lines, these are:

- Complete compounding extrusion lines with a total capacity of 1,200 kg/hr.

- Pulverisers with a capacity of 800 kg/hr.
- Two rotary training machines, carousel type with 4 independent arms, each, diameter swing 3,000mm.
- Grinder for plastic recycling.
- A range of other auxiliary machines.
- A large range of metal and aluminum molds.

Characteristics of the buildings

The SME is located in a privately owned building in an Industrial Area since 2000, and it covers 10,000 square meters. The SME operates 20 days a month, with working hours from 07:00 to 15:00, and employs about 50 people.

Table 1 Pilot 1 – Characteristics of the buildings

Building element	Construction materials	Existence of thermal insulation
External vertical walls	Cement blocks	**No**
External horizontal walls (roof)	aluminum roofing panels	**Yes**
Thermopanes	Single glass windows with aluminum frame	**No**

Description of HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

No space heating and cooling are applied in the factory area and therefore the energy survey was focused on the production processes and lighting systems.

In total: 60 lighting bulbs - 400 W each lighting bulb

Description of RES System

There is a 20 kW photovoltaic system installed on the roof of the factory, for self-consumption purposes (under the net-billing scheme). The system was installed in 2019 and includes 110 PV panels, 185 W of each PV panel.

Table 2 Pilot 1 – RES capacity

	Installed capacity (kW)	Share of produced electricity that is self-consume (%)
Under Net-Billing	20 kW	100 %

Production profiles per Production Line

- 1st production line: Extruder - Rice Grains

Table 3 Pilot 1 – Production data

Production – Pilot 1		
	2020-2021	**2020-2021**
Month	Production (input rice) [kg]	Production (output rice) [kg]
September 2020	43,025	44,403
October 2020	36,575	38,174
November 2020	9,775	9,907
December 2020	11,525	11,165
January 2021	20,575	20.040
February 2021	700	781
TOTAL	**122,175**	**124,470**

- 2nd production line: Mills (Pulverizes)

Table 4 Pilot 1 – Production data

Production – Pilot 1		
	2020-2021	**2020-2021**
Month	Production (input rice) [kg]	Production (output rice) [kg]
September 2020	42,076	41,907
October 2020	39,759	39,239
November 2020	23,825	23,958
December 2020	20,562	20,742
January 2021	28,036	28,728
February 2021	2,243	2,248
TOTAL	**156,501**	**156,822**

- 3rd production line: furnace

Table 5 Pilot 1 – Production data

Production – Pilot 1	
	2020-2021
Month	Production (raw materials) [kg]
March 2020	5,414
April 2020	23,075

May 2020	20,620
June 2020	32,377
July 202	37,484
August 2020	9,921
September 2020	36,045
October 2020	30,382
November 2020	35,788
December 2020	26,467
January 2021	24,443
February 2021	15,246
TOTAL	**297,262**

4.1.1.3. Energy analysis

The energy consumption profile and the cost of energy for the SME are presented in the following tables.

- Total energy consumption per energy source

Table 6 Pilot 1 – Energy consumption

	Energy consumption (kWh)		Cost of energy (€)	
	2019	**2020**	**2019**	**2020**
Electricity	163,436 kWh	282,073 kWh	17,978 €	31,028 €
LPG	458,925 kWh	801,660 kWh	34,430 €	60,143 €

- Energy consumption profile per Production Line

It is noted that the SME started monitoring energy data in March 2020. Therefore, the available data is from March 2020 to March 2021 (one year).

  - **Electricity**

Table 7 Pilot 1 – Electricity consumption

Energy consumption – Pilot 1 Electricity						
	1st production line: Extruder		**2nd production line: Mills (Pulverizes)**		**3rd production line: Furnaces**	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	-	6.3	-	9.4	-	3.2
February	-	0.3	-	0.6	-	2.2

March	4.2	-	5.1	-	0.8	-
April	4.3	-	6.2	-	2.4	-
May	5.8	-	8.3	-	2.6	-
June	6.4	-	8.6	-	3.8	-
July	9.4	-	10.2	-	4.5	-
August	9.8	-	12.2	-	1.1	-
September	12.3	-	13.1	-	4.3	-
October	11.6	-	11.1	-	3.4	-
November	3	-	8.3	-	3.6	-
December	3.5	-	7.7	-	2.4	-
TOTAL	**76.9**		**100.8**		**31.9**	

- **LPG**

Table 8 Pilot 1 - LPG consumption

Energy consumption – Pilot 1 LPG		
	3rd production line: Furnaces	
	2020	**2021**
Month	Consumption [MWh]	Consumption [MWh]
January	-	52.9
February	-	39.8
March	13.5	-
April	43.6	-
May	44.2	-
June	68.5	-
July	81.5	-
August	18.7	-
September	75	-
October	58.4	-
November	63.9	-
December	52.7	-
TOTAL	**612.4**	

Energy Performance Indicators (KPIs) per Production Line

- 1st production line: Extruder - Rice Grains

Table 9 Pilot 1 – Specific consumption

Production – Pilot 1		
	2020-2021	**2020-2021**

Month	Specific consumption [kWh/input kg]	Specific consumption [kWh/output kg]
September 2020	0.286	0.277
October 2020	0.318	0.305
November 2020	0.311	0.306
December 2020	0.307	0.316
January 2021	0.307	0.315
February 2021	0.350	0.314
AVERAGE	**0.313**	**0.306**

- 2nd production line: Mills (Pulverizes)

Table 10 Pilot 1 – Specific consumption

Production – Pilot 1		
	2020-2021	**2020-2021**
Month	Specific consumption [kWh/input kg]	Specific consumption [kWh/output kg]
September 2020	0.312	0.313
October 2020	0.280	0.284
November 2020	0.349	0.347
December 2020	0.372	0.369
January 2021	0.336	0.328
February 2021	0.274	0.274
AVERAGE	**0.321**	**0.319**

- 3rd production line: furnace

Table 11 Pilot 1 – Specific consumption

Production – Pilot 1	
	2020-2021
Month	Specific consumption [kWh/input kg]
March 2020	2.640
April 2020	1.995
May 2020	2.271
June 2020	2.233
July 202	2.296
August 2020	1.994
September 2020	2.199
October 2020	2.033
November 2020	1.884

December 2020	2.084
January 2021	2.296
February 2021	2.756
Average	**2.258**

4.1.1.4. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

Installation of PV system

Electricity consumption for 2019 and 2020 amounted to 163,426 kWh and 282,073 kWh, respectively, with electricity costs to be 17,978 euros for 2019 and 31,028 euros for 2020. Therefore, it is necessary to install a PV system to reduce the cost of electricity consumption.

The available space on the roof is about 1.000 m^2. Considering that approximately 7 m^2 are required for the installation of 1 kW PV panels, it is proposed to install a PV system of 120 kW, which will produce approximately 204,000 kWh/year (considering as average annual production of 1,700 kWh/kW). Based on the annual electricity production from the PV system, the annual revenues are estimated to be 22,400 euros. In addition, considering the indicative installation cost of 900 euro/kW, it is concluded that an initial investment cost of 108.000 euros is required.

Based on a 20-years economic analysis and with an interest rate of 7%, the payback period is calculated to be 4.8 years. The net present value of the investment (NPV) is positive, so the investment is viable and acceptable. The net present value amounts to 129,730 euros.

Figure 6 Proposed location for PV installation

Replacement of conventional lighting (Incandescent Bulbs)

According to information received from the SME and through the on-site visit, 60 floodlights (incandescent lighting bulbs) are used with a power of 400 W each. The total installed capacity in the SME is 24 kW.

Assuming that the SME operates 250 days per year for 8 hours per day, then the annual energy consumption is 48,000 kWh, corresponding to 5,280 euros.

After market research, it was found that the existing lighting bulbs (400 W incandescent bulbs) can be replaced with 50 W LED bulbs, without affecting the illumination levels. Considering that the cost of buying incandescent lamps (3 euros/lamp), the lifespan of incandescent lamps (0,5 years), the cost of buying LED lamps (30 euros/lamp) and the duration lifespan of LED lamps (10 years), it turns out that the replacement cost is 1.800 euros. Based on a 10-years economic analysis with an interest rate of 7%, the payback period is around 2 months and the Net Present Value (NPV) is positive at 55,934 euros.

Therefore, replacing incandescent bulbs with LED bulbs is a measure that is recommended to be done immediately.

Replacement of the extruder machinery

Following the on-site visit and the data analysis, it is concluded that there is significant energy saving potential by upgrading the existing extruder system.

The existing system was installed in 1996 and has a 30 kW motor. According to the data provided by the SME, the average consumption of this system is about 7,350 kWh per month, with an average output product of 140 kg per operating hour. Its energy efficiency was estimated at 60%.

The proposed new extruder system will have a 37 kW motor and can produce about 250 kg of product per operating hour. Considering the efficiency of the new system at 85%, the energy saving that can be achieved is about 54,000 kWh, corresponding to a cost saving of about 6,000 euros. In addition, it was considered that the maintenance costs of the new system would be reduced. For the existing system, the maintenance cost is approximately 2,000 euros, while for the new system it is estimated to be about 500 euros.

The initial cost of the new proposed system, according to the market research, will be around 100,000 euros. It was also estimated that the residual value of the existing system will be about 10,000 euros and therefore the SME can benefit from this amount.

Based on a 20-years economic analysis and with an interest rate of 7%, the payback period is around 12 years and the Net Present Value (NPV) is negative and amounts to -11,104 euros. Therefore, this investment is considered unsustainable at this stage of analysis.

Table 12 Pilot 1 – Proposed solutions & EE action plan

Proposed solutions & EE action plan for Pilot 1						
Proposed solution - description	**Investment**	**Energy saving Type: electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]
Installation of PV system	108,000	204	22,440	144	4.8	129,730
Replacement of conventional lighting (Incandescent Bulbs)	1,800	42	8,220	30	0.2	55,934

Replacement of the extruder machinery	100,000	54	7,447	38	12.1	-11,104

Table 13 Pilot 1 – KPIs

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.1.1.5. Measurement and verification of the results

The tools were not used.

4.1.1.6. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed):

Table 14 Pilot 1 – Proposed financial resources

Type	Description
Support Scheme for RES: Net-billing for PV systems	This scheme is related to the installation of PV systems which are implemented only in the premises of SMEs (under commercial or industrial pricing) for the purpose of generating electricity for their own use with the methodology of net-billing. The installed capacity of each installed RES system ranges from 10kW to 10MW per installation.

4.1.1.7. Energy management plan

In addition to the 3 energy savings measures proposed above, the following measures are proposed which can bring significant energy and cost savings to the SME.

- **Heat recovery:** Based on the on-site visit, it is noted that the needs for heat in the production process are increased. In addition, it was observed that a considerable part of the heat used in the 2 furnaces (produced by the combustion of LPG) escapes into the atmosphere. Therefore, the installation of a heat recovery system in the 2 furnaces is recommended, which can lead to a reduction in the LPG consumption.
- **Combustion of alternative fuels:** The heat produced in the 2 furnaces is achieved by LPG boilers. Due to the geographical location of the SME, it is expected that the supply of alternative fuels such as industrial or commercial waste RDF (Refuse-derived fuel) would be possible, resulting in a significant reduction in LPG consumption for heat production. It is therefore recommended to study the modification of the burners of the 2 furnaces so that they can accept alternative fuels.

- **Installation of Energy Management System:** The implementation of an Energy Management System such as ISO 50001, would automate the processes of recording and monitoring the energy consumption, enabling continuous improvement of the energy behavior of the SME. By monitoring various energy efficiency indicators, it will significantly help the company to save energy as well as to use more efficient the equipment, preventing the high maintenance cost. In addition, the staff will be continuously trained to improve their energy awareness, leading to the creation of an energy behavior within the company.

4.1.2. Pilot site 2

Number of employees: 24

NACE Code: [C] Manufacturing, 16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials

4.1.2.1. Introduction for data and current situation

Short description of the SME

The particular SME is a wood manufacturing company that deals with wooden constructions such as furniture, wooden roofs and kitchens. The company design, manufacture and deliver each wooden project.

Figure 7 Pilot 2 – Wood manufacturing

4.1.2.2. Short description of the production process

Depending on the project that will arise, the craftsmen make an on-site visit to the customer's premises, in order to measure and make the appropriate design. Then, the craftsmen construct the project by operating different types of machines. In the factory, there are various machines such as cutting, gluing and painting machines. Finally, all the individual pieces are assembled, so that to complete the construction of the final product and to deliver it to the customer.

Specifically, during the production process wood cutting and gluing machines are used as well as an electric oven for painting the wood. For the delivery of the wood products, 3 trucks are used.

4.1.2.3. Characteristics of the buildings

- Year of construction: 2005
- Area of covered areas: 1,700m^2
- Opening hours/months: 07:30 – 17:00 from Monday to Friday and sometimes on Saturdays, depending on the workload.

Table 15 Pilot 2 – Characteristics of the building

Building element	Construction materials	Existence of thermal insulation
External vertical walls	Sandwich Panel and Block	No
External horizontal walls (roof)	Sandwich Panel	No
Thermopanes	Single Glass	No

4.1.2.4. Description of HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Table 16 Pilot 2 – Description of the HVAC system

Space heating	**Oil-fired boiler: 15 years old ~ 85% efficiency**
Space cooling	Only in offices: 5 AC split units (2 in continuous operation)
Domestic Hot Water	Solar thermal system
Ventilation	2 Exhaust fans are used in the production line: - 22.3 kW, operating 8 hours per day (in continuous operation) - 8 KW, operating 7 hours per day
Lighting	Utilize natural Lighting LED and CFL Bulbs

Description of RES System

There is a solar thermal system to cover the needs of domestic hot water. There is no PV system installed.

Production profiles per Production Line

The company does not have data for the wooden products that are manufactured. The only available data is the input wood quantities that are used, which are about 369 m^3 (335m^3 of OSB, hardwood plywood, etc. and 34 m^3 of solid wood) each year. It can be assumed that the input wood is equal for each month, as presented in the following table.

Table 17 Pilot 2 – Production data

Production – Pilot 2	
2020	
Month	Production (input wood) [m^3]
January	61.5
February	
March	61.5
April	
May	61.5
June	
July	61.5
August	
September	61.5
October	
November	61.5
December	
TOTAL	369

4.1.2.5. Energy analysis

The energy consumption profile for the SME is presented in the following tables.

<u>Energy consumption profile per energy type</u>

- **<u>Electricity</u>**

Table 18 Pilot 2 – Electricity consumption

Energy consumption – Pilot 2 Electricity			
	2018	**2019**	**2020**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	11.3	16.7	17.5
February			
March	9.2	14.8	14
April			
May	10	13.8	7.3
June			
July	9.6	15	14
August			
September	9.7	11.7	12.3
October			
November	10.4	16.8	12

December			
TOTAL	60.2	88.8	77.1

- **Heating diesel**

The SME consumes about 3,200 litres of heating diesel each year, corresponding to 31,600 kWh per year. There is no available data per month for the consumption of the heating diesel. It can be assumed that the heating diesel consumption is equal for each month, as presented in the following table.

Table 19 Pilot 2 - Heating diesel data

Energy consumption – Pilot 2 Heating diesel	
	2020
Month	Consumption [MWh]
January	5.26
February	
March	5.26
April	
May	5.26
June	
July	5.26
August	
September	5.26
October	
November	526
December	
TOTAL	31.6

- **Diesel for transportation**

The SME consumes about 11,271 litres of diesel each year for the delivery of their products. This amount corresponds to about 110,454 kWh per year. There is no available data per month for the consumption of diesel. It can be assumed that the diesel consumption is equal for each month, as presented in the following table.

Table 20 Pilot 2 – Diesel consumption

Energy consumption – Pilot 2 Heating diesel	
	2020
Month	Consumption [MWh]
January	18.4

February	
March	18.4
April	
May	18.4
June	
July	18.4
August	
September	18.4
October	
November	18.4
December	
TOTAL	110.4

Energy Performance Indicators (KPIs) per Production Line

Table 21 Production data

Production – Pilot 1	
	2020
Month	Specific consumption [MWh/input m^3]
January	
February	0.67
March	
April	0.61
May	
June	0.5
July	
August	0.61
September	
October	0.58
November	
December	0.58
AVERAGE	**0.59**

4.1.2.6. Proposed solution and EE action plan

Installation of Power Factor Correction System

The main energy source of the SME comes from electricity consumption, where a large percentage of the electricity consumption derived from the operation of the electric motors. Electric motors use reactive power which is consumed without producing work. Installing a power factor correction system can result in an 8-15% reduction in electricity consumption. The cost for this investment ranges from 1,000-1,500 euros and the payback period can be less than a year.

Installation of Photovoltaic System

PV system can be installed on the roof of the SME. According to the annual electricity consumption of the SME, a PV system with a power of 45-47 kWp is capable of producing energy equal to the annual electricity consumption of the SME. (It is considered that the annual electricity production is 1,400-1,600 kWh / kWp, depending on the orientation of the PV panels). The cost saving that can be achieved is about 13,000-15,000 euros per year.

Utilization of wood waste for the production of Pellet/briquette

As stated by the SME, the volume of sawdust or wood waste is about 10% of the total input wood. The total volume of wood discarded is about 12 skips per year. However, it is estimated that only 50% of the wood waste is suitable to be used as a pellet or briquette. Therefore, installing a pellet-making machine can reduce significantly the volume of wood waste. Considering that the cost for each skip is about 150 euros, then the cost savings can reach 900 euros per year. Also, the final product (pellet/briquette) can be sold or used for the company's space heating (replacement of existing oil-fired boiler with pellet boiler).

Replacement of existing oil-fired boiler with pellet boiler

The oil-fired boiler is used to cover the needs for space heating during the winter period. By taking into amount the above measure (Utilization of wood waste for the production of Pellet/briquette), the replacement of the oil-fired boiler with a pellet boiler can be a viable measure that can contribute to the cost reduction for heating. It is estimated that the cost savings can be 500-900 euros per year.

Replacement of the central ventilation with an inverter pump

In the SME there is a central ventilation-absorption system of wood dust (sawdust), which operates more than 8 hours a day and is one of the most energy-consuming equipment. The ventilation system operates continuously regardless of the volume of sawdust to be removed. It is recommended to install a variable volume ventilation system with automatic suction-inlet ports. This measure can reduce the operating power of the pump and therefore energy saving can be achieved. The energy consumption of the existing ventilation system is estimated at 20.000 kWh per year. It is estimated that the energy consumption can be reduced by 40% -50% (8,000-10,000 kWh), corresponding to 1,600-2,000 euros savings per year.

Table 22 Pilot 2 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 2					
Proposed solution – description	**Investment**	**Energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Installation of Power Factor Correction System	1,000-1,500	3.6-5.5	800-1,100	2.5	1-1,5
Installation of Photovoltaic System under net-billing scheme	50,000	70	14,000	49	3,5-4
Utilization of wood waste for the production of Pellet/briquette + Replacement of existing oil-fired boiler with pellet boiler	15,000 for pellet making machine + 6,000 for pellet boiler = 21,000	31.6 (kWh for heating)	900 for the wood waste management + 2,500 avoided cost (heating diesel) for space heating = 3,400	8	6
Replacement of the central ventilation with an inverter pump	6,000-9,000	8-10	1,600	6	4-6

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.	X	

4.1.2.7. Measurement and verification of the results

The tools were not used.

4.1.2.8. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed):

Table 23 Proposed financial resources

Type	Description
Support Scheme for RES: Net-billing for PV systems	This scheme is related to the installation of PV systems which are implemented only in the premises of SMEs (under commercial or industrial pricing) for the purpose of generating electricity for their own use with the methodology of net-billing. The installed capacity of each installed RES system ranges from 10kW to 10MW per installation.

4.1.2.9. Energy management plan

The following measures will contribute to raise awareness of the SME's staff and to improve the energy efficiency and environmental behavior of the SME:

- Utilize natural lighting, where possible.
- Advise the employees to switch off production line machines that are not in use.
- Distinguish the hazardous wood waste from solid wood waste.
- Train the employees to improve their energy awareness and change their behavior through special training actions, information and frequent reminders.
- Reward employees who propose and implement energy-saving measures.
- Where possible, conduct virtual meetings without visiting customer facilities in order to save fuel for transportation.
- Implementation of energy and environmental standard system (such as ISO50001, ISO14001, EMAS) in order to monitor the company's energy indicators.

4.1.3. Pilot site 3

Number of employees: 125

NACE Code: [I] Accommodation and Food Service Activities, 55101 Hotels

4.1.3.1. Introduction for data and current situation

Short description of the SME

The particular SME is a tourist accommodation that was built in the early 1990s. Until 2018 it consisted of 166 rooms, of which 10 of with 2 bedrooms and 156 with one bedroom. Since 2019, after a major renovation, some of the rooms have been divided into studios and so now consists of 10 rooms with 2 bedrooms, 139 with 1 bedroom and 32 studios. In total, the hotel has 181 rooms. The hotel is located in the coastal area and it is a seasonal hotel, which operates from April to October.

Short description of the production process

The hotels offer a variety of facilities and services. The hotel consisted of 32 buildings (4 to 6 rooms in each building) and the main building, which includes the reception, kitchen, restaurants, food and material warehouses, management offices, gym and indoor pool. In addition, the hotel has a tennis court, two large swimming pools, and various restaurants and bars.

Characteristics of the buildings

The hotel was built with single 25 cm brick plus exterior and interior plaster, without thermal insulation and single glazed windows, as there were no relevant energy requirements in those years. For cooling purposes, every single room had a 24,000 BTU/hr (7 kW) AC split unit installed. The 2-bedroom rooms additionally had a 12,000 BTU/hr (3,5 kW) AC split unit.

After the renovation, the single-glazed windows were replaced with new double-glazed ones and solar thermal systems were installed to cover the needs for domestic hot water in rooms. In addition, the air conditioners were replaced with higher energy efficient ones (SEER 6,5). All rooms are equipped with occupancy sensors so that the AC systems do not work when there are no people inside the room or when the windows are open.

Table 24 Pilot 3 - Characteristics of the buildings

Building element	Construction materials	Existence of thermal insulation
External vertical walls	Single brick 25 cm and plaster	No
External horizontal walls (roof)	cement	No
Thermopanes	Double glaze windows with aluminum frame	No


Figure 8 Pilot 3 - Hotel

4.1.3.2. Description of HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Space heating	No
Space cooling	AC split units in all rooms. VRF system for the main building
Domestic Hot Water	Solar thermal systems in all rooms. LPG boiler is installed to cover the needs for hot water in the kitchen, with the contribution of 6 solar water collectors.
Ventilation	Exhaust fans in every room
Lighting	LED lighting

Figure 9 Pilot 3 - HVAC system

Description of RES System

	Number of systems	Share in total demand (%)
Solar thermal systems	138	100%

4.1.3.3. Production profile (room nights and guest-nights)

Table 25 Pilot 3 – Room nights

Production – Pilot 1			
	2017	**2018**	**2019**
Month	Production [Room nights]	Production [Room nights]	Production [Room nights]
January	0	0	0
February	0	0	0
March	0	0	0
April	3,047	2,785	0

May	4,841	4,764	1,873
June	4,831	4,829	5,166
July	4,992	4,942	5,204
August	5,050	5,015	5,364
September	4,833	4,764	5,226
October	4,829	4,692	5,121
November	291	157	0
December	0	0	0
TOTAL	**32,714**	**31,948**	**27,954**

Table 26 Pilot 3 – Guest nights

Production – Pilot 1			
	2017	**2018**	**2019**
Month	Production [guest-nights]	Production [guest-nights]	Production [guest-nights]
January	0	0	0
February	0	0	0
March	0	0	0
April	9,072	7,936	0
May	13,716	13,932	5,611
June	15,402	14,814	16,310
July	16,427	16,109	16,793
August	16,901	16,152	16,973
September	13,512	12,708	14,215
October	14,515	13,932	15,487
November	920	533	0
December	0	0	0
TOTAL	**100,465**	**96,116**	**85,389**

4.1.3.4. Energy analysis

The energy consumption profile of the hotel is presented in the following tables. Because of the pandemic COVID-19, 2020 was not a representative year so the analysis was made from 2017-2019.

- **Electricity**

Table 27 Pilot 3 – Electricity consumption

Energy consumption – Pilot 3 Electricity			
	2017	**2018**	**2019**

Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	8.9	9.2	11
February	6.5	8.9	9.6
March	8	12.3	10.7
April	89	79.6	11.8
May	131.7	140.3	72.9
June	179.6	182.4	166.5
July	252.7	233.1	195.3
August	239	241	200.7
September	180	190.2	162.3
October	130	137.7	135
November	27.2	21.2	21.4
December	8,1	11.2	11.2
TOTAL	**1,260.7**	**1,267.1**	**1,008.4**

- **LPG**

The LPG consumption is used mainly for the kitchen equipment but also for the kitchen needs of hot water production (through the LPG-boiler).

Table 28 Pilot 3 – LPG consumption

Energy consumption – Pilot 3 LPG			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	0	0	0
February	0	0	0
March	0	0	0
April	16.2	10.2	3.3
May	29.2	31	18.9
June	23.2	27	28.8
July	25.6	30.3	37.3
August	29.9	30.1	33.3
September	15.4	25.1	35.5
October	25.5	30.2	30.1
November	0	0	3

December	0	0	0
TOTAL	**165**	**183.9**	**190.2**

Table 29 Pilot 3 – Total consumption

TOTAL Energy consumption – Pilot 3 Electricity & LPG			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	8.9	9.2	11
February	6.5	8.9	9.6
March	8	12.3	10.7
April	105.2	89.8	15.1
May	160.9	171.3	91.8
June	202.8	209.4	195.3
July	278.3	263.4	232.6
August	268.9	271.1	234
September	195.4	215.3	197.8
October	155.5	167.9	165.1
November	27.2	21.2	24.4
December	8.1	11.2	11.2
TOTAL	**1,425.7**	**1,451**	**1,198.6**

Energy Performance Indicators (KPIs)

Table 30 Pilot 3 – Specific consumption

Specific Energy consumption – Pilot 3			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/room night]	Specific consumption [MWh/room night]	Specific consumption [MWh/room night]
January	0	0	0
February	0	0	0
March	0	0	0
April	0.035	0.032	0
May	0.033	0.036	0.049
June	0.042	0.043	0.038
July	0.056	0.053	0.045

August	0.053	0.054	0.044
September	0.040	0.045	0.038
October	0.032	0.036	0.032
November	0.093	0.135	0
December	0	0	0
AVERAGE	**0.048**	**0.054**	**0.041**

Table 31 Pilot 3 – Specific consumption

Specific Energy consumption – Pilot 3			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/guest-night]	Specific consumption [MWh/guest-night]	Specific consumption [MWh/guest-night]
January	0	0	0
February	0	0	0
March	0	0	0
April	0.012	0.011	0
May	0.012	0.012	0.016
June	0.013	0.014	0.012
July	0.017	0.016	0.014
August	0.016	0.017	0.014
September	0.014	0.017	0.014
October	0.011	0.012	0.011
November	0.030	0.040	0
December	0	0	0
AVERAGE	**0.016**	**0.017**	**0.013**

4.1.3.5. Proposed solution and EE action plan

Installation of PV system in the parking lot with Net Billing

The installation of a PV system under the Net-Billing scheme is a solution that is widely used in recent years in various residential, commercial and industrial units in Cyprus. The PV system can be installed in the parking area of the hotel in the form of shading for the vehicles. The total capacity will be 500 kW (1,000 PV panels).

Data obtained:

- Installation cost: € 500,000
- Electricity cost 0.16 €/kWh
- Cost of excess electricity from the PV production sold to electricity authority 0.075 €/kWh

Assumptions:

- 1,650kWh per year per installed kWp
- The distribution of electricity produced by PV system during the summer (April to October) period is 77% and 23% in the winter period (November to March).
- Electricity production from PV system: 825,000kWh/year
- Discount rate of 4%.
- Reduction in the efficiency of PV panels: 2% in the second year and by 1% for each subsequent year.

Installation of autonomous PV system for the operation of the swimming pool pumps

There are two swimming pools in the hotel that use 3 filtration pumps. All pumps have a capacity of 5.5 HP or 4.1 KW. It is recommended to install 48 photovoltaic panels to cover the consumption of these pumps during the day. The installation can be done on the hotel's roof.

Data obtained:

- Installation cost: € 18,000
- Electricity cost 0.16 € cent/KWh

Assumptions:

- 1,650kWh per year per installed kWp
- Swimming operation days: 214
- Discount rate of 4%.
- Reduction in the efficiency of PV panels: 2% in the second year and by 1% for each subsequent year.

Installation of Building Management System (BMS)

The installation of a BMS in the hotel can provide many benefits, including improving its energy efficiency. Through the central control system, it is possible to monitor the energy consumption or the behavior of many machines, central or individual, in order for the technical team to intervene and improve their operation or detect a fault, preventing energy waste that would result. The system can monitor the consumption of electricity, water and LPG but also control and monitor the consumption of various equipment (kitchen equipment, rooms, pumps, air conditioning systems, lighting, etc.). As a first step, it is proposed to install a simple BMS which will control the following:

- Electricity Meters: central, in the kitchen, in one room
- LPG meters: central, for hot water
- Water meters: central
- Air conditioning systems
- Refrigerators

Assumptions:

- Energy savings: 5% for electricity consumption and 5% for LPG consumption.
- a discount rate of 4%.
- Installation cost: € 25,000
- Electricity cost: 0.16 € cent/KWh
- LPG cost: 1 € / Kg

Roof thermal insulation

The installation of thermal insulation in the building reduces the thermal requirements for heating and cooling and improves thermal comfort.

This hotel has no thermal insulation in its building envelope. The lack of thermal insulation undoubtedly leads to increased energy consumption for cooling purposes. It is proposed to install thermal insulation on the roof of hotel's buildings

Proposed Measures without techno-economic analysis

- Installation of a solar thermal system for the Kitchen need. Although there are 6 solar panels installed for the production of hot water for the kitchen, nevertheless an LPG-boiler is used to meet their needs. It is suggested to observe the consumptions (eg through the BMS), and then to proceed with the installation of a solar thermal system that will cover 100% of the kitchen needs for hot water.
- Installation of light sensors for the outdoor lighting
- Installation of dehumidification units with heat recovery in the indoor pool area.
- Replacement of LPG-boiler with a heat pump system.
- Improve the thermal insulation of piping.
- Installation of Voltage Optimizer.
- Replacement of refrigerator compressors with inverter type.

Table 32 Pilot 3 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 3						
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]
Installation of Building Management System (BMS)	25,000	64	9,550	45	3	124,191 (25 years)
Installation of autonomous PV system for the operation of the swimming pool pumps	18,000	26.3	4,211	37	5	28,825 (15 years)
Installation of PV system in the parking lot with Net Billing	500,000	825	119,000	580	5	732,004 (15 years)
Roof thermal insulation per hotel room	1,900	0.9 (for cooling which is through electricity consumption)	135	0.6	14	746 (25 years)

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.1.3.6. Measurement and verification of the results

The tools were not used.

4.1.3.7. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed):

Type	Description
Support Scheme for RES: Net-billing for PV systems	This scheme is related to the installation of PV systems which are implemented only in the premises of SMEs (under commercial or industrial pricing) for the purpose of generating electricity for their own use with the methodology of net-billing. The installed capacity of each installed RES system ranges from 10kW to 10MW per installation.

4.1.3.8. Energy management plan

- Inform and train the staff frequently on energy and environment topics.
- Frequent presentation of the various actions implemented by the hotel to save energy is very important.
- Staff training at regular intervals, as well as the various signage in public areas and rooms, could raise awareness among both staff and hotel visitors.

Reporting any problems that occurred immediately is important and could result in energy savings and reduced cost. The reward of the most energy-conscious employee is proposed in order to further enhance their efforts.

4.1.4. Pilot site 4

Number of employees: 75

NACE Code: [E] Water Supply, Sewerage, Waste Management and Remediation Activities, 37 Sewage

4.1.4.1. Introduction for data and current situation

Short description of the SME

The mission of the wastewater treatment plant is the construction, operation and maintenance of the central sewerage system for the collection and treatment of municipal wastewater of the greater

Limassol area, the re-use of the treated water for agricultural and other purposes and optimum sludge disposal. Its main aim is not to discharge even a drop of treated wastewater into the sea, considering the wastewater as a valuable resource that can be utilized more effectively and efficiently.

Figure 10 Pilot site 4

4.1.4.2. Short description of the production process

What happens in a sewage treatment plant is the same as what happens in a river or at sea. The role of such an installation is to accelerate the natural processes by which water is self-purifying. In these natural decomposition processes, bacteria and other microorganisms recognize various pollutant particles as a food source. As microorganisms bind their food, they produce new bacterial cells, carbon dioxide and other products. As bacteria break down they also consume oxygen necessary for all their metabolic functions.

Liquid waste, ie wastewater comes from human activities of a city or village from homes or tourist complexes, hotels or even industries. Sewage contains human feces, kitchen cleaning fluids, food scraps, decomposing water, chemicals, etc.

They can also be called dirty water because the waste is for the most part (more than 99.9%) by the weight of water.

The rest are substances dissolved or suspended in water. About 80% of water consumption from urban houses or hotels is estimated as sewage.

Because dissolved oxygen is a key element in an organism's life, it is very important to measure how much oxygen bacteria will use to break down a waste unit. This unit is called the biochemically required oxygen analysis and is abbreviated as BOD. The higher the BOD of the waste, the greater the amount of oxygen required by the bacteria to degrade it.

4.1.4.3. Characteristics of the buildings

The buildings and facilities have been constructed in two phases, one in 1995 and 2008. In 2008 it has been expanded to be able to treat a larger amount of wastewater.

The total covered area of the various premises is 3,227 m^2. The plant implements various energy and environmental standards. The plant has in place no-stop machines that operate automatically throw-out the year (24/7).

In the current energy mix, apart from the electricity, there are also two 311 KW biogas generators that work non-stop (currently only one biogas generator is operated), a 120 kW PV system under the net-billing scheme and a 44 kW PV system that operates with a feed-in tariff (commercial purposes).

Table 33 Pilot 4 – Characteristics of the builfings

	Construction materials	Existence of thermal insulation
External vertical walls	Cement blocks	No
External horizontal walls (roof)	Cement	No
Thermopanes	Single glass windows with aluminum frame	No

4.1.4.4. Description of HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Table 34 Pilot 4 – HVAC system

Space heating	No
Space cooling	only on some rooms with sensitive electronic equipment
Domestic Hot Water	Yes, with a solar thermal system
Ventilation	Yes with exhaust fans
Lighting	Yes, High-Pressure Sodium (HPS)

Description of RES System

Table 35 RES capacity

	Installed capacity (kW)	Share of produced electricity that is self-consume (%)
PV system with feed-in tariff	44 KW	0 %
Under Net-Billing	120 KW	100 %

4.1.4.5. Production profile

The treatment plant treats quantities of wastewater on average 28,000m^3 per day. The following table presents the estimated quantities of wastewater (m^3) per month for 2 years.

Table 36 Pilot 4 - Production data

Production – Pilot 4 Wastewater treated		
	2019	**2020**
Month	Production [m^3]	Production [m^3]
January	840,480	908,023
February	877,980	870,207
March	849,540	887,265
April	844,980	807,426
May	844,830	810,203
June	877,410	815,280
July	861,510	817,742
August	830,760	779,023
September	856,500	812,500
October	883,200	804,765
November	822,840	786,090
December	886,860	802,471
TOTAL	**10,276,890**	**9,900,993**

4.1.4.6. Energy analysis

The energy consumption profile and the cost of energy of the SME are presented in the following table for two years.

Table 37 Pilot 4 – Electricity consumption

Energy consumption – Pilot 4 Electricity				
	2019		**2020**	
Month	Consumption [MWh]	Cost of energy [€]	Consumption [MWh]	Cost of energy [MWh]
January	370	63,212	326	57,523
February	300	50,754	303	55,481
March	357	58,934	366	59,789
April	359	60,184	293	46,165
May	417	74,519	335	50,260

June	386	82,541	415	66,149
July	406	83,757	338	51,967
August	369	77,696	311	47,270
September	328	69,282	316	54,318
October	345	64,204	368	53,234
November	324	59,347	335	50,269
December	355	64,836	303	43,635
TOTAL	**4,317**	**809,266**	**4,009**	**636,060**

Table 38 Pilot 4 – Energy production

Green Energy production from PV systems production started 04/07/2019		
	2019	**2020**
Month	Energy production [kWh]	Energy production [kWh]
January	-	8,398
February	-	8,693
March	-	12,429
April	-	11,299
May	-	14,674
June	-	18,651
July	15,922	14,413
August	16,799	12,657
September	16,125	14,774
October	12,886	13,606
November	10,933	8,628
December	9,458	7,638
TOTAL	**82,123**	**145,860**

Table 39 Average distribution of energy

	Average distribution of energy source (%)
Electricity	61%
PV system	4%
Biogas system	35%

Energy Performance Indicators (KPIs)

Table 40 Pilot 4 – Specific consumption

Specific consumption – Pilot 4				
	2019		**2020**	
Month	Specific consumption [kWh/m³]	Specific consumption [€/m³]	Specific consumption [kWh/m³]	Specific consumption [€/m³]
January	0.44	0.08	0.36	0.06
February	0.34	0.06	0.35	0.06
March	0.42	0.07	0.41	0.07
April	0.42	0.07	0.36	0.06
May	0.49	0.09	0.41	0.06
June	0.44	0.09	0.51	0.08
July	0.47	0.10	0.41	0.06
August	0.44	0.09	0.40	0.06
September	0.38	0.08	0.39	0.07
October	0.39	0.07	0.46	0.07
November	0.39	0.07	0.43	0.06
December	0.40	0.07	0.38	0.05
AVERAGE	**0.42**	**0.08**	**0.41**	**0.06**

4.1.4.7. Proposed solution and EE action plan

The vision of the wastewater treatment plant is to invest in RES projects (biogas, solar energy and probably wind energy) and to fine-tune the treatment process by replacing low-efficiency rotors with air diffusers with significantly higher efficiency and to control the street lighting expenses by replacing the existing 150 W HPS lamps with LED 20 W.

Regarding the exploitation of wind energy in the plant, consultation was carried out with some relevant bodies in Cyprus. However, because of the limited time for assessing the profitability of the installation of wind turbines on the specific location of the plant, more efforts are required in the next months.

Proposed solutions and energy efficiency action plan:

- ***Addition of 2nd Biogas Generator 311 kW to operate in parallel to the 1st Biogas Generator 311 kW;***

There is enough biogas which currently is burned by the Gas torch. This biogas could have exploited for electricity production and contribute to the plant's energy needs. Any Electrical and other Technical issues need to be studied and any obstacles need to be solved. One issue is the current condition of the digestor which needs improvement, an increase of methane rich primary sludge

input into digesters and the 10- year service on biogas generator to be completed at a cost of € 50,000 for both units. The Annual service on each generator is € 2,000.

- **Expand the capacity of the 1st PV park under the net-billing scheme from 120 KW to 160 KW;**

All cables and electrical switchgear are already designed for 160 kW.

- **Construct and commission a 2nd PV park 200 KW on the west available roof areas;**
- **Replace all street lighting lamps HPS 150 W lamps with 20 W LED lamps.**

Proposed solutions & EE action plan for Pilot 4							
Proposed solution – description	**Investment**	**Energy saving Type: electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Addition of 2nd Biogas Generator 311 kW to operate in parallel to the 1st Biogas Generator 311 kW.	€10,000 electric works + €50,000 engines service + €20,000 digesters deep cleaning from sand = €80,000	1,095	€227,950	770	0.4	1,521,025 in 10 years	260
Expand the capacity of the 1st PV park under net billing scheme from 120 KW to 160 KW.	20,000	64	13,500	45	2	74,800 in 10 years	56
Construct and commission a 2nd PV park 200 KW on the west available roof areas	257,000	320	67,200	225	4	185,418 in 10 years	13
REPLACE ALL street lighting lamps HPS 150 W lamps with 20 W LED lamps	2,000	23.7	3,500	17	0.7	22,990 in 10 years	160

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.1.4.8. Measurement and verification of the results

The tools were not used.

4.1.4.9. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed):

Type	Description
Support Scheme for RES: Net-billing for PV systems	This scheme is related to the installation of PV systems which are implemented only in the premises of SMEs (under commercial or industrial pricing) for the purpose of generating electricity for their own use with the methodology of net-billing. The installed capacity of each installed RES system ranges from 10kW to 10MW per installation.

4.1.4.10. Energy management plan

- Monitoring and training of staff to improve their energy awareness and behavior change (eg. special training, information and awareness actions, etc.).
- Launch of a reward system for employees who propose/implement energy-saving measures.
- Systematic monitoring of energy indicators, in order to identify possible problems in advance.

4.1.5. Pilot site 5

Number of employees: 240

NACE Code: [H] Transportation and Storage, 52233 Operation of airports

Total energy consumption: 7,362.8 MWh/an (2019)

4.1.5.1. Introduction for data and current situation

There are two airports in Cyprus that belong to the same company. The particular airport was built in 2008 and is the smaller of the two. The airport offers world-class and state-of-the-art facilities with an emphasis on excellent passenger and customer service. In recent years, connectivity and passenger traffic at this Airport has increased dramatically. Indicative of this is aircraft traffic (from 14,000 in 2014 to more than 21,000 in 2020) as well as passenger traffic, which increased by 89% over ten years (from 1.6 million passengers in 2010 to 3.05 million in 2020).

4.1.5.2. Short description of the production process

For the operation of the airport, a series of processes take place that has to do with the safe and smooth operation of the facilities and the provision of services and comfort to passengers. Several of these processes have been identified as major processes and as major energy consumers within the airport.

The main processes and their technical characteristics are the following:

- Airport Parking - Equipment/machines are used for the operation of parking spaces, payment, lighting of spaces, etc. There are car rental offices and a charging station for electric vehicles.
- Baggage Handling System - The baggage management, control and separation systems from and to the planes. Motors, belts, tomographs are used to check luggage, etc.
- Security systems - Systems that deal with the control of passengers and staff and their personal belongings. They also include hundreds of access control points, CCTV units, etc.
- Ventilation, cooling and heating system - For smooth operation based on predefined parameters as previously analyzed.
- IT equipment - Information screens, computers, radar, air aids, etc.
- Lighting - More than 5.000 lighting units are installed at the airport premises, including the runway, the aircraft roads, etc.
- Restaurants and shops - Passenger service areas. Most of the consumption from this process is used in kitchens, refrigerators, lighting, etc.
- Auxiliary buildings/services such as Control Tower, Fire Department, oil storage facilities for supply to aircraft, pilot training schools, office complexes for support, etc.

4.1.5.3. Characteristics of the buildings

The terminal building of the Airport was constructed between May 2006 and October 2008. The building was commissioned in November of the same year and covers an area of 20.260 square meters. The total area of the airport (including runway/runway, sidewalk, runway, auxiliary buildings, etc.) is 404 hectares.

It operates on a 24-hour basis throughout the year. However, given the attraction of a large number of tourists in Cyprus during the summer months, its operation is increased in the period April-October.

The terminal building consists of:

- Shopping center and cafes 2,020m^2
- 4 electronic boarding ports
- 44 BorderXpress ó kiosks ™
- 28 ticket checkpoints
- 2 Tagomats
- 2 Bagomats
- 6 security checkpoints
- 6 passenger boarding gates
- 5 Pedestrian gates

- 3 luggage handling straps

Table 41 Pilot 5 – Building characteristics

Building element	Construction materials	Existence of thermal insulation
External vertical walls	Single brick 25 cm and plaster	No
External horizontal walls (roof)	Corrugated aluminum deck Cement with thermal insulation	Yes
Thermopanes	Double glazed windows with aluminum frame	No

4.1.5.4. Description of HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

The systems that exist for the supply of heating and cooling in the building are:

- Cooling/heating coils contained in the DX Rooftop
- Cooling/heating coils contained in DX capital air units
- Heat pump chiller
- indoor units with VRF or split units.

Ventilation is performed by:

- Roof Top Units (RTUs)
- Central air units and related extractor fans
- Air transfer systems from high-pressure areas to low-temperature pressure areas.

Control and adjustment are done through Building Management System (BMS) in the following systems:

- Roof Top AC Units
- Fresh air AHU's
- VRF and split AC units
- Extract fans
- Fire pumps
- Domestic Water pumps
- Water treatment and Dosing plant
- Grease Interceptor

There were different types of lighting inside and outside the building. The interior lighting is exclusively LED. The luminaires in the common areas are controlled and monitored through central control and monitoring system. The indoor lights are divided into different zones in order to isolate lights in places that are not used or in places where there is enough natural light.

The floodlights, that illuminate the aircraft parking lot, are of the HPS 1000W type and their operation is done through an automated SCADA system. Street lighting consists of LED luminaires and is controlled through the same system.

The lights in the runway and aircraft road areas are mostly halogen and are controlled via a central SCADA system.

Table 42 Pilot 5 – HVAC system

Space heating	Packaged Rooftop Units
Space cooling	Chiller, Packaged Rooftop Units
Domestic Hot Water	Instant water heaters (electricity)
Ventilation	Central Exhaust fans
Lighting	LED lighting

4.1.5.5. Description of RES System

This airport has secured the required permits for the installation of a PV system with a capacity of 1.1MWp that will operate with the method of net-billing. This system is expected to cover 30% of the total electricity consumption.

	Installed capacity (kW)	Share of produced electricity that is self-consume (%)
PV system under net-billing	1,100	29.5%

Production profile (U.M passengers)

Table 43 Pilot 5 – Production data

Production – Pilot 5			
	2017	**2018**	**2019**
Month	Production [passengers]	Production [passengers]	Production [passengers]
January	294,086	312,102	320,425
February	273,479	303,369	301,017
March	343,825	411,353	402,891
April	558,605	592,060	598,873
May	745,954	775,812	812,615
June	878,069	921,445	942,297

July	1,045,608	1,063,231	1,064,870
August	1,076,319	1,105,133	1,107,648
September	942,096	970,942	982,330
October	844,808	846,829	873,799
November	400,008	417,821	448,113
December	331,433	347,058	374,468
TOTAL	**7,734,290**	**8,067,155**	**8,229,346**

4.1.5.6. Energy analysis

The energy consumption situation is presented in the following tables (electricity, diesel, petrol, l and heating diesel for two auxiliary buildings). Because of the pandemic COVID-19, 2020 was not a representative year so the analysis was made from 2017-2019.

- **Electricity**

Table 44 Pilot 5 – Electricity data

Energy consumption – Pilot 5 Electricity			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	397.8	422.6	437.8
February	363	363.9	386.8
March	417.2	418.8	431.8
April	470.2	479.2	465.2
May	536.5	604.8	570.3
June	630.2	664.8	671.2
July	787.5	769.1	767.0
August	771.2	783.7	785.5
September	685.7	689.4	680.4
October	570.8	591.3	615.7
November	448.3	452.7	465.1
December	423.6	427.8	449
TOTAL	**6,501.9**	**6,668.1**	**6,725.7**

- **Diesel for transport**

Table 45 Diesel consumption

Energy consumption – Pilot 5 Diesel			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	11.7	5.6	15
February	8	16.8	14.4
March	14.2	16.2	14.2
April	11.3	11.6	11.9
May	15.5	7.2	16.1
June	11	14	12.9
July	15.2	25.8	14.4
August	12.2	15.3	15.5
September	12.6	14.8	15
October	1.4	18.2	14.3
November	25.1	15.3	16.1
December	12.7	12.9	7.4
TOTAL	**150.9**	**173.7**	**167.2**

- **Petrol for transport**

Table 46 Petrol consumption

Energy consumption – Pilot 5 Diesel			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	2.7	0.4	0.7
February	1.5	0.4	2.4
March	2.3	0.8	0.4
April	2.8	0.3	0
May	3.6	3.1	0
June	4.2	4.1	0
July	4.1	0.4	0.4
August	4.1	1.3	0.8
September	3.4	1.2	0
October	1.2	1.8	0.8
November	1.1	0.3	0
December	0.7	0.9	0.7
TOTAL	**31.7**	**15.0**	**6.2**

- **Heating diesel**

Table 47 Heating diesel consumption

Energy consumption – Pilot 5 Diesel			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	52.6	53.2	77.9
February	97.2	24.9	53.8
March	44.6	66.6	55.6
April	52.6	25.3	76.5
May	22.8	19.8	41.8
June	22.5	21.8	0
July	19.8	19.8	22.8
August	0	27.8	25.6
September	23.8	26.8	22.8
October	21.8	25.9	19.8
November	33.7	43.6	44.2
December	47.1	27.1	22.8
TOTAL	**438.7**	**382.8**	**463.6**

- **Total energy**

Table 48 Pilot 5 – Total energy consumption

TOTAL Energy consumption – Pilot 5 Electricity, diesel, petrol & heating diesel			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	464.8	481.8	531.3
February	469.7	406	457.4
March	478.3	502.4	501.9
April	536.8	516.4	553.7
May	578.4	634.9	628.2
June	668	704.7	684.1
July	826.6	815.2	804.6
August	787.5	828	827.4
September	725.4	732.2	718.3
October	595.2	637.3	650.5
November	508.3	512	525.4

December	484.1	468.8	480
TOTAL	**7,123.1**	**7,239.6**	**7,362.8**

Energy Performance Indicators (KPIs)

Table 49 Pilot 5 - Specific consumption consumption

Specific Energy consumption – Pilot 5			
	2017	**2018**	**2019**
Month	Specific consumption [kWh/passenger]	Specific consumption [kWh/passenger]	Specific consumption [kWh/passenger]
January	1.58	1.54	1.66
February	1.72	1.34	1.52
March	1.39	1.22	1.25
April	0.96	0.87	0.92
May	0.78	0.82	0.77
June	0.76	0.76	0.73
July	0.79	0.77	0.76
August	0.73	0.75	0.75
September	0.77	0.75	0.73
October	0.70	0.75	0.74
November	1.27	1.23	1.17
December	1.46	1.35	1.28
AVERAGE	1.08	1.01	1.02

4.1.5.7. Proposed solution and EE action plan

Installation of PV system under the Net-Billing Scheme

Installation of a PV system on the premises of the airport to cover its energy needs. The PV system will operate with the net-billing methodology. For the proper operation of the system, the installation site, the equipment to be selected, etc., a study is necessary to show that it does not affect with reflection the air traffic control (control tower) as well as the approach corridors (for the pilots). In general, it must be ensured through the study that the operation of the airport is not affected.

Assumptions:

- Any excess energy produced will be entering into the grid and will not be compensated (based on the operation/regulations that are expected to enter into force with the opening of the energy market).
- Energy consumption was based on the 2019 consumption profile.
- The cost of electricity is € 0.14 per kilowatt-hour and increases by 1% per year from 2023 to 2031.

- The discount rate is 5.7%
- The park will be reimbursed upon completion of its construction.
- Maintenance costs will be stable for the next ten years.
- Completion of construction in 2021 and energy production from January 2022.
- The self-production fee remains stable until 2031 at € 0.163 per kilowatt-hour.
- The carbon dioxide emission factor remains stable until 2031 and is equal to 638 gCO_2 / kWh.

Replacement of check-in screens

Replacement of the 16 screens of check-in counters with others with lower energy consumption. The screens used to operate 24 hours a day, but after actions taken by the airport, they are currently active for just 9 hours per day. However, the replacement of those screens was considered necessary due to their low energy efficiency.

Assumptions:

- The cost of electricity is € 0.14 per kilowatt-hour and remains stable for the next ten years.
- The discount rate is 5.7%
- The project will be reimbursed upon completion of its construction.
- Maintenance costs will not change.
- Implementation of the project in 2021 and energy savings from January 2022.
- Opening hours are not affected (9 hours per day)
- Existing monitors have a power consumption of 200W and the new ones 39W.
- The purchase cost of the new screens is 400 euros per unit.
- The annual benefit is calculated based on the consumption difference.

Airport apron lighting

The Airport Runway is illuminated by 71 (1,000W each) High-Pressure Sodium (HPS) headlights. The need for proper and continuous lighting arises from the international regulations of ICAO & EASA. The metered consumption constitutes 5% of the total electricity consumption. The replacement of the HPS headlights with LED is expected to save energy, considering that the illumination levels will be maintained according to the regulations.

Assumptions:

- Illumination levels will be maintained at the level of regulations. This affects the choice of the new headlights.
- The headlights will have the same operating hours as they have today. (4,300 hours/year)
- The new headlights will have a lifespan of 100,000 hours as opposed to the existing ones which have 20,000 hours.
- The maintenance of the headlights will be drastically reduced if its lifespan is longer.

Replacement of airport road lights with LED

On the airport roads, there are 350 luminaires installed which serve the safe wheeling of aircraft. The share of electricity consumption of these luminaires reaches 7% of the total electricity consumption and therefore they are considered an important energy-consuming sector. There are two options for reducing electricity consumption in these lighting systems:

- Replacement of halogen lamps with LED of operating intensity 6A.
- Replacement of halogen lamps with LEDs of operating intensity 2A, installation, and adjustment of the existing control system.

Although the second option will dramatically reduce heat loss (1,226W / km) in ultra-long primary cables, it is not recommended as the cost of installing a control system is currently prohibitive (€ 500,000).

Assumptions:

- Cost of electricity per kWh: 0.14 €.
- Interest rate: 5.7%.
- Operating hours of luminaires per day: 10.
- All luminaires were considered elevated.
- The length of the primary and secondary power circuits was entered approximately.
- The maintenance factor of the luminaires is not taken into account.
- The cost of electronic cards in case of failure before the end of the useful life of LED luminaires is not taken into account.

Replacement of "obstruction lights" with LED

Replacement of 22 conventional lighting systems (Obstruction Lights) with LED. This measure will result in energy savings and maintenance cost savings.

Assumptions:

- The lifespan of existing lighting is 10,000 hours. The lifespan of the new LED is 100,000 hours.
- The cost of electricity is € 0.14 per kilowatt-hour and remains stable for the next ten years.
- The discount rate is 5.7%.
- The project will be reimbursed upon completion of its construction.
- Maintenance costs will not change.
- Implementation of the project in 2021 and energy savings from January 2022.
- Opening hours are not affected: 11.5 hours per day
- Existing luminaires have a consumption of 18W and the new LED 3W.
- The cost of purchasing and installation of the new lights is € 560, the cost of replacing existing light bulbs at the end of their life is € 2.
- The annual benefit is calculated based on the difference in consumption and the cost for replacing the existing light bulbs is calculated at the end of their life.

Modification of the airport street lighting guidelines

The maneuvering areas at the airport, according to international regulations, are equipped with illuminated signposts. The illuminated signs are intended to guide/indicate to pilots the correct runway. There are a total of 64 illuminated signposts installed, 16 of which are with LED technology. Existing light bulbs are 45W (the number is determined by the size of the plate). The need for illuminated signposts arises through international ICAO & EASA regulations. It is considered that the replacement of these lights with LED, will not affect the illumination levels.

Assumptions:

- The new LED bulbs will have the same operating hours as the existing ones.
- The new bulbs will have a lifespan of 50,000 hours as opposed to the existing ones which have 1,500.
- The maintenance of the luminaires will be drastically reduced.
- The cost of replacing the bulbs (end of life), as well as the cost of man-hours, were included in the analysis. This cost is deducted from the annual contract amount.
- Cost per kilowatt hour: 0.14 €/kWh
- Project duration: 10 years.
- Interest rate 5.7%.

Replacement of 64 conventional lightings (emergency lighting) with LED

Replacement of 64 conventional lighting fixtures (emergency lighting) with LED technology. This measure will save energy and maintenance costs and improve the level of safety due to the greatly increased service life of LED luminaires.

Assumptions:

- The lifespan of the existing lamp is 10,000 hours, while the new LED lamp is 50,000 hours.
- The cost of electricity is € 0.14 per kilowatt-hour and remains stable for the next ten years.
- The discount rate is 5.7%.
- The project will be reimbursed upon completion of its construction.
- Maintenance costs will not change despite the reduction in maintenance needs but will be limited to visual inspection and cleaning.
- Implementation of the project in 2021.
- Opening hours are not affected (24/7).
- The power of the existing lamp is 8W and the LED lamp is 2W.
- The cost of buying and replacing LED is € 36, the cost of replacing existing light bulbs at the end of their life is €2.
- The annual benefit is calculated based on the difference in electricity consumption and the cost of replacing existing light bulbs is calculated at the end of their life.

Installation of voltage optimization

This system cleans and conditions the incoming power supply. It optimizes the incoming voltage by a set amount (from 240V to 225V) in order to match electrical equipment requirements on-site providing energy consumption savings.

Table 50 Pilot 5 – Proposed action plan

Proposed solutions & EE action plan for Pilot 5							
Proposed solution - description	**Investment**	**Energy saving Type: electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Installation of PV system under the Net-Billing Scheme	900,600	1,870	226,490	1,316	4.9	751,112	22
Replacement of check-in screens	6,400	8.7	1,213	6.1	7.5	2,657	13.71
Airport apron lighting	103,076	62.8	30,234	44.2	3.4	135,597	27
Replacement of airport road lights with LED	84,257	72.4	33,256	51	3.8	164,023	-
Replacement of "obstruction lights" with LED	12,320	1.4	194	1	-	-10,872	-
Modification of the airport street lighting guidelines	39,861	31.5	12,746	22.2	3.1	124,569	35
Replacement of 64 conventional lightings (emergency lighting) with LED	2,304	3.4	599	2.4	4.8	433	20
Installation of voltage optimization	150,000	378	40,000	266	2.8	275,831	26.8

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.1.5.8. Measurement and verification of the results

The tools were not used.

4.1.5.9. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed):

Type	Description
Support Scheme for RES: Net-billing for PV systems	This scheme is related to the installation of PV systems which are implemented only in the premises of SMEs (under commercial or industrial pricing) for the purpose of generating electricity for their own use with the methodology of net-billing. The installed capacity of each installed RES system ranges from 10kW to 10MW per installation.

4.1.5.10. Energy management plan

- Establishment of an Energy saving team.
- Timely annual targeting of measures.
- Monitoring and training of staff to improve their energy awareness and behavior change.
- Informing the employees about the energy-saving projects that were implemented as well as about the goals and the planning of new projects.
- Exchange of information and views with all stakeholders at the airport.
- Organization of an Annual Energy and Environment Day.
- Creating a Culture of Energy Saving and Environmental Protection throughout the airport community.
- Reward innovative new ideas for energy saving and environmental protection.

4.2. Germany

4.2.1. Pilot site 1

Number of employees: 247

NACE Code: C17

4.2.1.1. Introduction for data and current situation

- Short description of the evaluated SME (NACE code, country, number of employees, description of the main activity/activities);
  - Location: Kaiserslautern, Germany
  - Main Activities: Production and distribution of folding boxes and special solutions made of cardboard and laminated corrugated board.
- Description of the technological process(es): description, presentation of the technological process diagram if any, presentation of the monthly production for at least two years;
  - The production process for folding packaging follows these basic steps: Printing, punching, gluing, and finishing and assembly. The company uses 8 printing machines, 5 punching machines, 8 gluing machines for various needs, and 8 assembly machines.

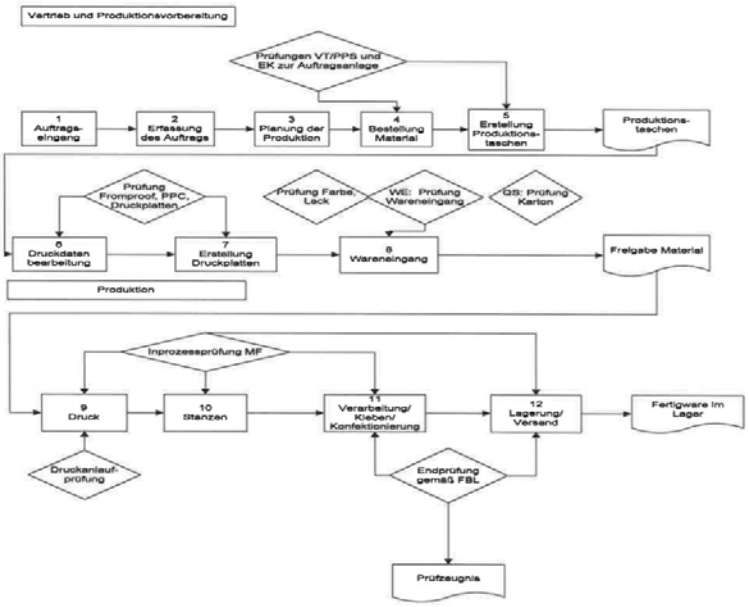


Figure 11 Pilot 1 – Tehcnological process

- Characteristics of the buildings;
  - 6 main production halls and 1 administrative building.

Table 51 Pilot 1 – Production data

Production – Pilot 1 Folding packages			
	2017	**2018**	**2019**
Month	Production	Production	Production

	(pieces)	(pieces)	(pieces)
January	80,590,250	79,522,242	74,380,088
February	80,590,250	79,522,242	74,380,088
March	80,590,250	79,522,242	74,380,088
April	80,590,250	79,522,242	74,380,088
May	80,590,250	79,522,242	74,380,088
June	80,590,250	79,522,242	74,380,088
July	80,590,250	79,522,242	74,380,088
August	80,590,250	79,522,242	74,380,088
September	80,590,250	79,522,242	74,380,088
October	80,590,250	79,522,242	74,380,088
November	80,590,250	79,522,242	74,380,088
December	80,590,250	79,522,242	74,380,088
TOTAL	**976,083,000**	**954,266,905**	**892,561,062**

*Only yearly data was available

4.2.1.2. Energy analysis

Electricity

Table 52 Pilot 1 – Energy consumption

Energy consumption – Pilot 1 Electricity			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	651.25	654.17	655
February	651.25	654.17	655
March	651.25	654.17	655
April	651.25	654.17	655
May	651.25	654.17	655
June	651.25	654.17	655
July	651.25	654.17	655
August	651.25	654.17	655
September	651.25	654.17	655
October	651.25	654.17	655
November	651.25	654.17	655
December	651.25	654.17	655
TOTAL	**7,815**	**7,850**	**7,860**

Thermal energy

Table 53 Pilot 1 –Thermal energy

Energy consumption – Pilot 1 Heating			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	132.75	144.3	160.9
February	132.75	144.3	160.9
March	132.75	144.3	160.9
April	132.75	144.3	160.9
May	132.75	144.3	160.9
June	132.75	144.3	160.9
July	132.75	144.3	160.9
August	132.75	144.3	160.9
September	132.75	144.3	160.9
October	132.75	144.3	160.9
November	132.75	144.3	160.9
December	132.75	144.3	160.9
TOTAL	**1,593**	**1,732**	**1,931**

Specific consumption

Table 54 Pilot 1 - Specific consumption

Specific consumption energy per 100k Pieces – Pilot 1			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/100,000 Pieces]	Specific consumption [MWh/100,000 Pieces]	Specific consumption [MWh/100,000 Pieces]
January	0.96385	1.00412	1.09696
February	0.96385	1.00412	1.09696
March	0.96385	1.00412	1.09696
April	0.96385	1.00412	1.09696
May	0.96385	1.00412	1.09696
June	0.96385	1.00412	1.09696
July	0.96385	1.00412	1.09696
August	0.96385	1.00412	1.09696
September	0.96385	1.00412	1.09696
October	0.96385	1.00412	1.09696

November	0.96385	1.00412	1.09696
December	0.96385	1.00412	1.09696
AVERAGE	**0.96385**	**1.00412**	**1.09696**

4.2.1.3. Proposed solution and EE action plan

- LED retrofit is an essential step in lowering energy consumption for a firm operating on a 3-shift schedule, meaning the factory is in operation 24 hours a day from Sunday at 22.00 to Saturday 18.00 o'clock. The constant need for lighting during the evening and night shifts meant that there was huge potential in reducing consumption from lighting.
- Air compression machines also play a big role in electricity consumption within the production as compressed air is used in a variety of production tasks. The limited estimated investment of just over 10,000 euros and a relatively short payback period of 2.5 years made this an economical choice. As production runs around the clock air compressors were a good choice above other machines as they are used overarchingly in a variety of tasks, thus the energy savings can be realized in a number of processes as opposed to investment in a single machine or segment of production.

Table 55 Pilot 1 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 1					
Proposed solution - description	**Investment**	**Energy saving Type: Electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
LED lighting system retrofit	232,645	294	49,075	137.5	4.74
Improved air compressors	10,617	17.7	4,246	82.8	2.5

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.1.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Pieces]	[MWh]	[kWh/Piece]	[____]	[MWh]	[kWh/Piece]	[MWh]	[kWh/Piece]	[%]	[%]	[MWh]	[____]	[kWh/____]
1	JAN	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	7.0	758.8	74380088	0.0
2	FEB	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	5.0	775.1	74380088	0.0
3	MARCH	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	12.0	718.0	74380088	0.0
4	APRIL	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	6.0	766.9	74380088	0.0
5	MAY	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	6.0	766.9	74380088	0.0
6	JUNE	74380089	815.9	0.0109693	74380089	735.9	0.0098938	80.0	0.00	10%	8.0	750.6	74380089	0.0
7	JULY	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	5.0	775.1	74380088	0.0
8	AUG	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	8.0	750.6	74380088	0.0
9	SEPT	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	5.0	775.1	74380088	0.0
10	OCT	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	11.0	726.2	74380088	0.0
11	NOV	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	9.0	742.5	74380088	0.0
12	DEC	74380088	815.9	0.0109693	74380088	735.9	0.0098938	80.0	0.00	10%	8.0	750.6	74380088	0.0
	TOTAL	892561057	9791	0.0109693	892561057	8830.8	0.0098938	960.0	0.0	10%		9056.5	892561057.0	0.0

Figure 12 M&T & M&V result

Note: Only monthly data was available.

4.2.1.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Table 56 Proposed financial resources

Type	Description
KfW-Energieeffizienzprogramm 276, 277, 278	KFW loan with a 1% interest rate and up to a 17.5% repayment subsidy. Can be used for individual measures such as LED retrofitting.
BAFA - Bundesförderung für Energieeffizienz in der Wirtschaft: Querschnittstechnologien (Modul 1) – Zuschuss	A direct subsidy (40%) to be used for upgrading to more energy efficient production machinery.

4.2.1.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Yearly trainings for employees on climate and energy efficiency.
- Yearly internal environmental audits to identify areas for improvement.
- Include climate and energy efficiency criteria when choosing upstream and downstream partners.

4.2.2. Pilot site 2

Number of employees: 125

NACE Code: C11.0.5 Beer manufactures. Brewing and bottling

4.2.2.1. Introduction for data and current situation

- Description of the technological process(es):
  - Shredded barley and wheat are mixed with water in large vats and heated. These settle at the bottom and are sold as animal feed. The liquid without sediment is then cooked with hops for 60 minutes. Once cooled yeast is added and the mixture is allowed to ferment in sealed tanks at 0 ºC for 4-5 weeks. Lastly, the beer is filtered and either bottled or filled in barrels.
- Characteristics of the buildings;
  - One production building with a PV roof for self-consumption. One administrative building completed in 2011.

Table 57 Pilot 2 – Production data

Production – Pilot 2 Beer and Radler (tons of finished product)			
	2017	**2018**	**2019**
Month	Production Tonnes	Production Tonnes	Production Tonnes
January	1,716	1,819	1,838
February	1,716	1,819	1,838
March	1,716	1,819	1,838
April	1,716	1,819	1,838
May	1,716	1,819	1,838
June	1,716	1,819	1,838
July	1,716	1,819	1,838
August	1,716	1,819	1,838
September	1,716	1,819	1,838
October	1,716	1,819	1,838
November	1,716	1,819	1,838
December	1,716	1,819	1,838
TOTAL	**20,597**	**21,835**	**22,055**

4.2.2.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.

- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Electricity

Table 58 Pilot 2 – Energy consumption

Energy consumption – Pilot 2 Electricity			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	206.1	204.6	205.1
February	206.1	204.6	205.1
March	206.1	204.6	205.1
April	206.1	204.6	205.1
May	206.1	204.6	205.1
June	206.1	204.6	205.1
July	206.1	204.6	205.1
August	206.1	204.6	205.1
September	206.1	204.6	205.1
October	206.1	204.6	205.1
November	206.1	204.6	205.1
December	206.1	204.6	205.1
TOTAL	**2,473**	**2,455**	**2,461**

Thermal energy

Table 59 Pilot 2 – Thermal energy consumption

Energy consumption – Pilot 2 Thermal energy			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	516.4	544.6	569.7
February	516.4	544.6	569.7
March	516.4	544.6	569.7
April	516.4	544.6	569.7
May	516.4	544.6	569.7
June	516.4	544.6	569.7

July	516.4	544.6	569.7
August	516.4	544.6	569.7
September	516.4	544.6	569.7
October	516.4	544.6	569.7
November	516.4	544.6	569.7
December	516.4	544.6	569.7
TOTAL	**6,197**	**6,535**	**6,836**

Specific consumption

Table 60 Pilot 2 – Specific consumption

Specific consumption – Pilot 2			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]
January	0.470	0.460	0.467
February	0.470	0.460	0.467
March	0.470	0.460	0.467
April	0.470	0.460	0.467
May	0.470	0.460	0.467
June	0.470	0.460	0.467
July	0.470	0.460	0.467
August	0.470	0.460	0.467
September	0.470	0.460	0.467
October	0.470	0.460	0.467
November	0.470	0.460	0.467
December	0.470	0.460	0.467
AVERAGE	**0.470**	**0.460**	**0.467**

4.2.2.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- To reduce electricity consumption in the bottling process new air compressors are proposed.
- To improve energy efficiency in the various heating and cooling processes which are the main source of energy consumption in the brewing process, improved insulation for the boiler, fittings, and pipelines are proposed.

Table 61 Pilot 2 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 2					
Proposed solution - description	**Investment**	**Energy saving Type: Total energy**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
New air compressors for bottling	25,426	16.5	5,790	7.7	4.4
Insulation of the boilers, fitting and pipelines	17,300	92.3	5,750	43.2	3

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.2.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[_____]	[MWh]	[kWh/Ton]	[_____]	[MWh]	[kWh/Ton]	[MWh]	[kWh/ Ton]	[%]	[%]	[MWh]	[_____]	[kWh/_____]
1	JAN	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	5.0	736.0	1838	400.4
2	FEB	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	5.0	736.0	1838	400.4
3	MARCH	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	8.0	712.8	1838	387.8
4	APRIL	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	6.0	728.3	1838	396.2
5	MAY	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	6.0	728.3	1838	396.2
6	JUNE	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	8.0	712.8	1838	387.8
7	JULY	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	5.0	736.0	1838	400.4
8	AUG	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	8.0	712.8	1838	387.8
9	SEPT	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	5.0	736.0	1838	400.4
10	OCT	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	11.0	689.5	1838	375.2
11	NOV	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	9.0	705.0	1838	383.6
12	DEC	1838	774.8	421.52	1838	724.8	394.31	50.0	27.20	6%	8.0	712.8	1838	387.8
	TOTAL	22056	9297	421.5	22056	8697.0	394.31	600.0	27.2	6%		8646.2	22056.0	392.0

Figure 13 M&T & M&V results

Due to the lack of monthly data a linear equation could not be generated. A logarithmic equation was used instead.

4.2.2.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Energy Efficiency Incentive Programme (APEE)	The BAFA grants additional incentives for the optimisation of a heating system
BMWI Bundesförderung für Energieeffizienz in der Wirtschaft Module 4	SMEs receive up to 40% of investment costs when optimising production processes to be more energy efficient.

4.2.2.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Internal and external trainings on climate and energy efficiency to increase the conscientiousness of employees. Employees are encouraged to suggest improvements in energy efficiency and other environmentally impactful areas such as water usage.
- Continuous improvement of processes through the energy managements system. Close monitoring of all key environmental indicators.
- Increase use of climate friendly production inputs.
- Suppliers and service providers are chosen based on strict environmental standards.

4.2.3. Pilot site 3

Number of employees: 157

NACE Code: C31.0.1 Production of office furniture.

4.2.3.1. Introduction for data and current situation

- Description of the technological process(es):
  - All products are made to order. Raw materials are delivered to the factory. These include (faux) leather, polyester cushions, wood, and steel. The main machinery includes precision cutters, punching machines, sewing machines, and packaging units.
- Characteristics of the buildings; 2 main production halls and an administrative building.
- Monthly production data for <u>at least 2 years.</u>

Table 62 Pilot 3 – Production data

Production – Pilot 3 Revenue			
	2017	**2018**	**2019**

Month	Production Euros (000)	Production Euros (000)	Production Euros (000)
January	671.04	674.4	666.25
February	671.04	674.4	666.25
March	671.04	674.4	666.25
April	671.04	674.4	666.25
May	671.04	674.4	666.25
June	671.04	674.4	666.25
July	671.04	674.4	666.25
August	671.04	674.4	666.25
September	671.04	674.4	666.25
October	671.04	674.4	666.25
November	671.04	674.4	666.25
December	671.04	674.4	666.25
TOTAL	**8,052.52**	**8,093.19**	**7.995,00**

4.2.3.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Electricity

Table 63 Pilot 3 Energy consumption data

Energy consumption – Pilot 3 Electricity			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	28.46	30.15	29.91
February	28.46	30.15	29.91
March	28.46	30.15	29.91
April	28.46	30.15	29.91
May	28.46	30.15	29.91
June	28.46	30.15	29.91
July	28.46	30.15	29.91
August	28.46	30.15	29.91
September	28.46	30.15	29.91

October	28.46	30.15	29.91
November	28.46	30.15	29.91
December	28.46	30.15	29.91
TOTAL	**341.52**	**361.87**	**358.93**

Thermal energy

Table 64 Pilot 3 – Thermal energy consumption

Energy consumption – Pilot 3 District heating			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	51.97	50.03	44.63
February	51.97	50.03	44.63
March	51.97	50.03	44.63
April	51.97	50.03	44.63
May	51.97	50.03	44.63
June	51.97	50.03	44.63
July	51.97	50.03	44.63
August	51.97	50.03	44.63
September	51.97	50.03	44.63
October	51.97	50.03	44.63
November	51.97	50.03	44.63
December	51.97	50.03	44.63
TOTAL	**623.70**	**600.40**	**535.50**

Diesel

Table 65 Pilot 3 - Diesel consumption

Energy consumption – Pilot 3 Diesel			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	113.45	113.89	139.75
February	113.45	113.89	139.75
March	113.45	113.89	139.75
April	113.45	113.89	139.75
May	113.45	113.89	139.75
June	113.45	113.89	139.75
July	113.45	113.89	139.75

August	113.45	113.89	139.75
September	113.45	113.89	139.75
October	113.45	113.89	139.75
November	113.45	113.89	139.75
December	113.45	113.89	139.75
TOTAL	**1,361.47**	**1,366.78**	**1,677.07**

Specific consumption

Table 66 Pilot 3 – Specific consumption

Specific consumption – Pilot 3			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/T€]	Specific consumption [MWh/T€]	Specific consumption [MWh/T€]
January	0.289	0.288	0.322
February	0.289	0.288	0.322
March	0.289	0.288	0.322
April	0.289	0.288	0.322
May	0.289	0.288	0.322
June	0.289	0.288	0.322
July	0.289	0.288	0.322
August	0.289	0.288	0.322
September	0.289	0.288	0.322
October	0.289	0.288	0.322
November	0.289	0.288	0.322
December	0.289	0.288	0.322
AVERAGE	**0.289**	**0.288**	**0.322**

Table 67 Pilot 3 – Specific consumption

Specific consumption (without diesel) – Pilot 3			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/T€]	Specific consumption [MWh/T€]	Specific consumption [MWh/T€]
January	0.120	0.119	0.112
February	0.120	0.119	0.112
March	0.120	0.119	0.112
April	0.120	0.119	0.112
May	0.120	0.119	0.112

June	0.120	0.119	0.112
July	0.120	0.119	0.112
August	0.120	0.119	0.112
September	0.120	0.119	0.112
October	0.120	0.119	0.112
November	0.120	0.119	0.112
December	0.120	0.119	0.112
AVERAGE	**0.120**	**0.119**	**0.112**

4.2.3.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Optimized heat distribution to reduce energy consumption from the district heating network.
- LED retrofitting.
- Energy efficiency upgrades to air compression machines. Air compression machines are used in a number of processes such as stamping out leather and sewing.

Table 68 Pilot 3 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 3							
Proposed solution - description	**Investment**	**Total energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
LED Retrofit	13,060	14.3	2,432	6.7	5.3	-	-
Optimized heat distribution	975	11.7	900	5.5	1.1	-	-
Energy efficiency upgrades to air compression machines.	6,500	23	1,040	10.7	6.5	-	-

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.3.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Tons]	[MWh]	[kWh/Tons]	[_____]	[MWh]	[kWh/Tons]	[MWh]	[kWh/ Tons]	[%]	[%]	[MWh]	[_____]	[kWh/_____]
1	JAN	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	7.0	69.3	666	104.0
2	FEB	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	5.0	70.8	666	106.2
3	MARCH	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	12.0	65.6	666	98.4
4	APRIL	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	6.0	70.0	666	105.1
5	MAY	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	6.0	70.0	666	105.1
6	JUNE	666	74.5	111.86	666	64.5	96.85	10.0	15.02	13%	8.0	68.5	666	102.9
7	JULY	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	5.0	70.8	666	106.2
8	AUG	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	8.0	68.5	666	102.9
9	SEPT	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	5.0	70.8	666	106.2
10	OCT	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	11.0	66.3	666	99.5
11	NOV	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	9.0	67.8	666	101.8
12	DEC	666	74.5	111.82	666	64.5	96.81	10.0	15.01	13%	8.0	68.5	666	102.9
	TOTAL	7995	894	111.8	7995	774.0	96.81	120.0	15.0	13%		827.0	7994.8	103.4

Figure 14 M&T & M&V results

Note: Monthly data was not available.

4.2.3.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Energy Efficiency Incentive Programme (APEE)	The BAFA grants additional incentives for the optimisation of a heating system
BMWI Bundesförderung für Energieeffizienz in der Wirtschaft Module 4	SMEs recieve up to 40% of investment costs when optimising production processes to be more energy efficient.

4.2.3.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Promote ecological product development
- Reduce primary material waste during production.
- Employee trainings on climate and energy efficiency.
- More decision-making power to the energy manager to quickly address optimization opportunities.
- Continuous internal and external energy monitoring and audits.

4.2.4. Pilot site 4

Number of employees: 30

NACE Code: C22 production of plastics such as PET, ABS, PS, PE, as well as organic plastics such as PLA

4.2.4.1. Introduction for data and current situation

- Description of the technological process(es): description, presentation of the technological process diagram if any, presentation of the monthly production for at least two years;
  - Raw material rolls are heated to be formed into the necessary shape and thickness. After this they are punched into the necessary sizes.

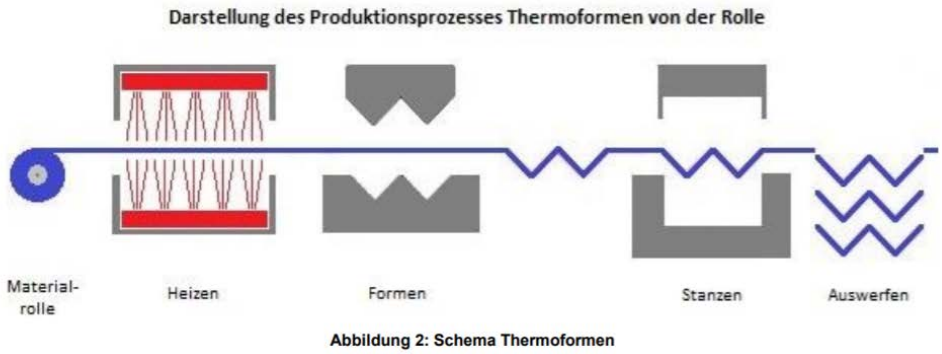


Figure 15 Pilot 4 Tehcnological processes

- Characteristics of the buildings; 1 main production hall, 2 storage warehouses, 1 administrative building.
- Monthly production data for <u>at least 2 years.</u>

Table 69 Pilot 4 – Production data

Production – Pilot 4 Thermo-formed plastic parts			
	2016	**2017**	**2018**
Month	Production Mio. Of pieces	Production Mio. Of pieces	Production Mio. Of pieces
January	4,292	5,293	5,091
February	4,292	5,293	5,091
March	4,292	5,293	5,091
April	4,292	5,293	5,091
May	4,292	5,293	5,091
June	4,292	5,293	5,091
July	4,292	5,293	5,091
August	4,292	5,293	5,091
September	4,292	5,293	5,091

October	4,292	5,293	5,091
November	4,292	5,293	5,091
December	4,292	5,293	5,091
TOTAL	**51,503**	**63,515**	**61,092**

4.2.4.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Total energy consumption

Table 70 Total energy consumption

Energy consumption – Pilot 4 Total energy consumption			
	2016	**2017**	**2018**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	72.3	66.4	64.7
February	72.3	66.4	64.7
March	72.3	66.4	64.7
April	72.3	66.4	64.7
May	72.3	66.4	64.7
June	72.3	66.4	64.7
July	72.3	66.4	64.7
August	72.3	66.4	64.7
September	72.3	66.4	64.7
October	72.3	66.4	64.7
November	72.3	66.4	64.7
December	72.3	66.4	64.7
TOTAL	**867.8**	**796.7**	**776.5**

Specific consumption

Table 71 Specific consumption

Specific consumption – Pilot 4			
	2016	**2017**	**2018**

Month	Specific consumption [MWh/Mio. Pieces]	Specific consumption [MWh/Mio. Pieces]	Specific consumption [MWh/Mio. Pieces]
January	0.01685	0.01254	0.01271
February	0.01685	0.01254	0.01271
March	0.01685	0.01254	0.01271
April	0.01685	0.01254	0.01271
May	0.01685	0.01254	0.01271
June	0.01685	0.01254	0.01271
July	0.01685	0.01254	0.01271
August	0.01685	0.01254	0.01271
September	0.01685	0.01254	0.01271
October	0.01685	0.01254	0.01271
November	0.01685	0.01254	0.01271
December	0.01685	0.01254	0.01271
AVERAGE	**0.01685**	**0.01254**	**0.01271**

4.2.4.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- The plastic heater is an essential part of the production line as it makes the plastics malleable and more easily punched. It runs continuously and thus uses a lot of energy. Better insulation around the machine increases heat retention and reduces energy consumption for heating by the machine.
- A retrofit of the control and measurement systems of the air compressor allows for more precise adjustment based on the needs and thus saves energy. More detailed monitoring also allows for optimization for energy efficiency.

Table 72 Pilot 4 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 4					
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Heat insulation on plastics heater (heat fan)	3,870	6.45	1,030	3.01	3.75
Retrofit control and measurement of air compressor	24,500	10.32	3,900	4.82	6.2

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.4.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Mio. Pieces]	[MWh]	[kWh/Mio. pieces]	[Pieces]	[MWh]	[kWh/Mio Pieces]	[MWh]	[kWh/Mio. pieces]	[%]	[%]	[MWh]	[.....]	[kWh/.....]
1	JAN	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	7.0	60.2	5091	11.8
2	FEB	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	5.0	61.5	5091	12.1
3	MARCH	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	12.0	56.9	5091	11.2
4	APRIL	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	6.0	60.8	5091	11.9
5	MAY	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	6.0	60.8	5091	11.9
6	JUNE	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	8.0	59.5	5091	11.7
7	JULY	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	5.0	61.5	5091	12.1
8	AUG	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	8.0	59.5	5091	11.7
9	SEPT	5090	64.7	12.71	5090	49.7	9.76	15.0	2.95	23%	5.0	61.5	5090	12.1
10	OCT	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	11.0	57.6	5091	11.3
11	NOV	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	9.0	58.9	5091	11.6
12	DEC	5091	64.7	12.71	5091	49.7	9.76	15.0	2.95	23%	8.0	59.5	5091	11.7
	TOTAL	61091	776	12.7	61091	596.4	9.76	180.0	2.9	23%		718.2	61091.0	11.8

Figure 16 M&T & M&V results

Note: Monthly data was not available.

4.2.4.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Table 73 Proposed financial resources

Type	Description
KfW-Energieeffizienzprogramm 276, 277, 278	KFW loan with a 1% interest rate and up to a 17.5% repayment subsidy. Can be used for individual measures such as LED retrofitting.
Energy Efficiency Incentive Programme (APEE)	The BAFA grants additional incentives for the optimisation of a heating system

4.2.4.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Trainings for employees on energy efficiency and climate issues
- Work with customers and suppliers on how to increase sustainability in the supply chain and product life cycle
- Increasing use of renewable inputs.

- Close monitoring of energy consumption and continuous optimization

4.2.5. Pilot site 5

Number of employees: 240

NACE Code: C20 Polypropylene production

4.2.5.1. Introduction for data and current situation

- Description of the technological process(es):
  - In the production of polypropylene, a plastic powder is produced from the raw material propylene by polymerisation, which is degassed in downstream process steps.

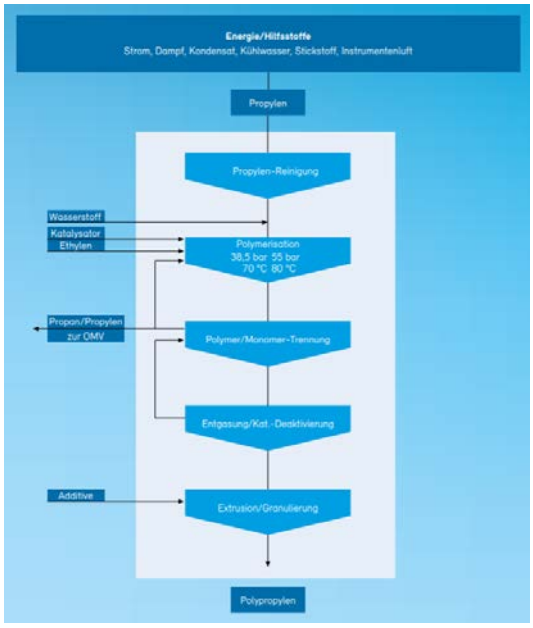


Figure 17 Pilot 5 – Tehcnological processes

- Characteristics of the buildings;
  - Located in a chemicals business park. 2 production units and storage silos.

Table 74 Pilot 5 – Production data

Production – Pilot 5 Polypropylene			
	2017	**2018**	**2019**
Month	Production [Tons] Polypropylene	Production [Tons] Polypropylene	Production [Tons] Polypropylene
January	48,794.75	48,960	48,486.6
February	48,794.75	48,960	48,486.6
March	48,794.75	48,960	48,486.6

April	48,794.75	48,960	48,486.6
May	48,794.75	48,960	48,486.6
June	48,794.75	48,960	48,486.6
July	48,794.75	48,960	48,486.6
August	48,794.75	48,960	48,486.6
September	48,794.75	48,960	48,486.6
October	48,794.75	48,960	48,486.6
November	48,794.75	48,960	48,486.6
December	48,794.75	48,960	48,486.6
TOTAL	**585,537**	**587,520**	**581,839**

4.2.5.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Electricity

Table 75 Pilot 5 – Electricity consumption

Energy consumption – Pilot 5 Electricity			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	15,120.1	15,079.7	14,793.7
February	15,120.1	15,079.7	14,793.7
March	15,120.1	15,079.7	14,793.7
April	15,120.1	15,079.7	14,793.7
May	15,120.1	15,079.7	14,793.7
June	15,120.1	15,079.7	14,793.7
July	15,120.1	15,079.7	14,793.7
August	15,120.1	15,079.7	14,793.7
September	15,120.1	15,079.7	14,793.7
October	15,120.1	15,079.7	14,793.7
November	15,120.1	15,079.7	14,793.7
December	15,120.1	15,079.7	14,793.7
TOTAL	**181,440.4**	**180,956.1**	**177,524.9**

Specific consumption

Table 76 Pilot 5 – Specific consumption

Specific consumption – Pilot 5			
	2017	**2018**	**2019**
Month	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]
January	0.30987	0.308	0.30511
February	0.30987	0.308	0.30511
March	0.30987	0.308	0.30511
April	0.30987	0.308	0.30511
May	0.30987	0.308	0.30511
June	0.30987	0.308	0.30511
July	0.30987	0.308	0.30511
August	0.30987	0.308	0.30511
September	0.30987	0.308	0.30511
October	0.30987	0.308	0.30511
November	0.30987	0.308	0.30511
December	0.30987	0.308	0.30511
AVERAGE	**0.30987**	**0.308**	**0.30511**

4.2.5.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- LED lighting retrofit
- Replacement compression air pumps. Switch to a newer more energy efficient technology.

Table 77 Pilot 5 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 5					
Proposed solution - description	**Investment**	**Energy saving Type: Electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO2/year]	[years]
Retrofitting the lighting system with LED technology	30,900	47	4,900	21.9	6.3
Replacement compression air pumps	45,400	49	8,090	22.9	10.4

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.5.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Tons]	[MWh]	[kWh/Ton]	[Ton]	[MWh]	[kWh/Ton]	[MWh]	[kWh/Ton]	[%]	[%]	[MWh]	[.....]	[kWh/.....]
1	JAN	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	7.0	13.8	48469	0.3
2	FEB	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	5.0	14.1	48469	0.3
3	MARCH	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	12.0	13.0	48469	0.3
4	APRIL	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	6.0	13.9	48469	0.3
5	MAY	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	6.0	13.9	48469	0.3
6	JUNE	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	8.0	13.6	48469	0.3
7	JULY	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	5.0	14.1	48469	0.3
8	AUG	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	8.0	13.6	48469	0.3
9	SEPT	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	5.0	14.1	48469	0.3
10	OCT	48470	14.8	0.31	48470	11.8	0.24	3.0	0.06	20%	11.0	13.2	48470	0.3
11	NOV	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	9.0	13.5	48469	0.3
12	DEC	48469	14.8	0.31	48469	11.8	0.24	3.0	0.06	20%	8.0	13.6	48469	0.3
	TOTAL	581627	177	0.3	581627	141.5	0.24	36.0	0.1	20%		164.2	581626.8	0.3

Figure 18 M&T & M&V results

Note: Monthly data was not available.

4.2.5.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Table 78 Proposed financial resources

Type	Description
KfW-Energieeffizienzprogramm 276, 277, 278	KFW loan with a 1% interest rate and up to a 17.5% repayment subsidy. Can be used for individual measures such as LED retrofitting.
BAFA - Bundesförderung für Energieeffizienz in der Wirtschaft: Querschnittstechnologien (Modul 1) – Zuschuss	A direct subsidy (40%) to be used for upgrading to more energy efficient production machinery.

4.2.5.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Trainings for employees on energy efficiency and climate issues
- Work with suppliers to reduce carbon footprint of supply chain.
- Continuous monitoring and improvement of the energy management system.
- Greater decision-making power to the energy/environmental management officer.

4.2.6. Pilot site 6

Number of employees: 98

NACE Code: C13 Textiles production. For use in workwear and bed linens for hospitals, hotels and care facilities.

4.2.6.1. Introduction for data and current situation

- Description of the technological process(es):
  - Primary inputs such as cotton and polyester are transformed into final products such as bedsheets and work clothes. The technological process employed includes washing, bleaching, sewing and stitching.
- Characteristics of the buildings;
  - 1 large production building and 1 small administrative building.

Table 79 Pilot 6 – Production data

Production – Pilot 6 Finished textile			
	2016	**2017**	**2018**
Month	Production Meters	Production Meters	Production Meters
January	826,444	843,710	816,671
February	826,444	843,710	816,671
March	826,444	843,710	816,671
April	826,444	843,710	816,671
May	826,444	843,710	816,671
June	826,444	843,710	816,671
July	826,444	843,710	816,671
August	826,444	843,710	816,671
September	826,444	843,710	816,671
October	826,444	843,710	816,671
November	826,444	843,710	816,671
December	826,444	843,710	816,671
TOTAL	**9,917,330**	**10,124,530**	**9,800,060**

4.2.6.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.

- Specific consumption

Table 80 Pilot 6 – Electricity consumption

Energy consumption – Pilot 6 Electricity			
	2016	**2017**	**2018**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	329.05	327.02	343.3
February	329.05	327.02	343.3
March	329.05	327.02	343.3
April	329.05	327.02	343.3
May	329.05	327.02	343.3
June	329.05	327.02	343.3
July	329.05	327.02	343.3
August	329.05	327.02	343.3
September	329.05	327.02	343.3
October	329.05	327.02	343.3
November	329.05	327.02	343.3
December	329.05	327.02	343.3
TOTAL	**3,948.54**	**3,924.23**	**4,119.78**

Table 81 Pilot 6 – Thermal energy consumption

Energy consumption – Pilot 6 Heat (Gas)			
	2016	**2017**	**2018**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	2,190.8	2,148.4	2,320.1
February	2,190.8	2,148.4	2,320.1
March	2,190.8	2,148.4	2,320.1
April	2,190.8	2,148.4	2,320.1
May	2,190.8	2,148.4	2,320.1
June	2,190.8	2,148.4	2,320.1
July	2,190.8	2,148.4	2,320.1
August	2,190.8	2,148.4	2,320.1
September	2,190.8	2,148.4	2,320.1
October	2,190.8	2,148.4	2,320.1
November	2,190.8	2,148.4	2,320.1
December	2,190.8	2,148.4	2,320.1
TOTAL	**26,289.46**	**25,781.06**	**27,850.00**

Table 82 Pilot 6 – Specific consumption

Specific consumption – Pilot 6			
	2016	**2017**	**2018**
Month	Specific consumption [MWh/Meter]	Specific consumption [MWh/Meter]	Specific consumption [MWh/Meter]
January	0.00305	0.00293	0.00326
February	0.00305	0.00293	0.00326
March	0.00305	0.00293	0.00326
April	0.00305	0.00293	0.00326
May	0.00305	0.00293	0.00326
June	0.00305	0.00293	0.00326
July	0.00305	0.00293	0.00326
August	0.00305	0.00293	0.00326
September	0.00305	0.00293	0.00326
October	0.00305	0.00293	0.00326
November	0.00305	0.00293	0.00326
December	0.00305	0.00293	0.00326
AVERAGE	**0.00305**	**0.00293**	**0.00326**

4.2.6.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- LED retrofit for both the main production floor as well as the administrative building.
- Compressed air is needed to operate machinery at various production stages. An upgrade to more modern, energy efficient air compressors can save a lot of energy.
- Sewing and weaving machines use a lot of the energy during production, replacing individual electric motors for more energy efficient ones can save energy during the production process.

Table 83 Pilot 6 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 6					
Proposed solution - description	**Investment**	**Energy saving Type: Electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
LED lighting retrofit	24,000	30.8	5,880	14.4	4.1
Improved air compressors	41,900	108	16,800	50.5	2.5

Replacing singular electric engines on sewing machines	5,875	9.2	1,440	4.3	4.1

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.6.4. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Meters]	[MWh]	[kWh/meter]	[Meters]	[MWh]	[kWh/Meter]	[MWh]	[kWh/Meter]	[%]	[%]	[MWh]	[.....]	[kWh/.....]
1	JAN	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	7.0	2477.0	816671	3.0
2	FEB	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	5.0	2530.2	816671	3.1
3	MARCH	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	12.0	2343.8	816671	2.9
4	APRIL	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	6.0	2503.6	816671	3.1
5	MAY	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	6.0	2503.6	816671	3.1
6	JUNE	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	8.0	2450.3	816671	3.0
7	JULY	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	5.0	2530.2	816671	3.1
8	AUG	816670	2663.4	3.26	816670	2623.4	3.21	40.0	0.05	2%	8.0	2450.3	816670	3.0
9	SEPT	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	5.0	2530.2	816671	3.1
10	OCT	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	11.0	2370.4	816671	2.9
11	NOV	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	9.0	2423.7	816671	3.0
12	DEC	816671	2663.4	3.26	816671	2623.4	3.21	40.0	0.05	2%	8.0	2450.3	816671	3.0
	TOTAL	**9800051**	**31961**	**3.3**	**9800051**	**31480.8**	**3.21**	**480.0**	**0.0**	**2%**		**29563.7**	**9800051.0**	**3.0**

Note: Monthly data was not available.

Figure 19 M&T & M&V results

4.2.6.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
KfW-Energieeffizienzprogramm 276, 277, 278	KFW loan with a 1% interest rate and up to a 17.5% repayment subsidy. Can be used for individual measures such as LED retrofitting.
BMWI Bundesförderung für Energieeffizienz in der Wirtschaft Module 4	SMEs receive up to 40% of investment costs when optimising production processes to be more energy efficient.

4.2.6.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Hire a dedicated energy/climate manager
- Staff training on climate and energy efficiency topics.

- Continuous incremental upgrades to production machinery in favour of more energy efficient options.

4.2.7. Pilot site 7

Number of employees: 49

NACE Code: C10 - Manufacture of food products

- Main Activities: Manufacture of fats and oils, plant and dairy based. Sales to food manufacturers such as candy and ice cream, as well as supermarket sales.
- Description of the technological process(es):
  - Vegetable oil is extracted mechanically. The seeds are heated up and pressed. After that the oil is refined to increase purity and shelf life.
  - Butter is produced in centrifuges that separate the milks fat content from the water content. Blenders are used to emulsify butter and vegetable oil to make margarine.
- Characteristics of the buildings;
  - Historic production site in the city center, 7,000 m^2

Table 84 Pilot 7 – Production data

Production – Pilot 7 Fat Products			
	2016	**2017**	**2018**
Month	Production Tons	Production Tons	Production Tons
January	664,883	680,325	651,360
February	664,883	680,325	651,360
March	664,883	680,325	651,360
April	664,883	680,325	651,360
May	664,883	680,325	651,360
June	664,883	680,325	651,360
July	664,883	680,325	651,360
August	664,883	680,325	651,360
September	664,883	680,325	651,360
October	664,883	680,325	651,360
November	664,883	680,325	651,360
December	664,883	680,325	651,360
TOTAL	**7,978,599**	**8,163,904**	**7,816,326**

4.2.7.1. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Table 85 Pilot 7 – Thermal energy

Energy consumption – Pilot 7 Gas			
	2016	**2017**	**2018**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	217.6	226.33	223.33
February	217.6	226.33	223.33
March	217.6	226.33	223.33
April	217.6	226.33	223.33
May	217.6	226.33	223.33
June	217.6	226.33	223.33
July	217.6	226.33	223.33
August	217.6	226.33	223.33
September	217.6	226.33	223.33
October	217.6	226.33	223.33
November	217.6	226.33	223.33
December	217.6	226.33	223.33
TOTAL	**2,611**	**2,716**	**2,680**

Table 86 Pilot 7 – Electricity consumption

Energy consumption – Pilot 7 Electricity			
	2016	**2017**	**2018**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	102.6	123.4	107
February	102.6	123.4	107
March	102.6	123.4	107
April	102.6	123.4	107
May	102.6	123.4	107

June	102.6	123.4	107
July	102.6	123.4	107
August	102.6	123.4	107
September	102.6	123.4	107
October	102.6	123.4	107
November	102.6	123.4	107
December	102.6	123.4	107
TOTAL	**1,231**	**1,481**	**1,284**

Table 87 Pilot 7 – Specific consumption

Specific consumption – Pilot 7			
	2016	**2017**	**2018**
Month	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]	Specific consumption [MWh/Ton]
January	0.514	0.543	0.539
February	0.514	0.543	0.539
March	0.514	0.543	0.539
April	0.514	0.543	0.539
May	0.514	0.543	0.539
June	0.514	0.543	0.539
July	0.514	0.543	0.539
August	0.514	0.543	0.539
September	0.514	0.543	0.539
October	0.514	0.543	0.539
November	0.514	0.543	0.539
December	0.514	0.543	0.539
AVERAGE	**0.514**	**0.543**	**0.539**

4.2.7.2. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Significant savings can be achieved via an LED retrofit to the lighting system.
- The 7,000m^2 of roof offer space for a PV installation to meet some of the energy needs of the business.

Table 88 Pilot 7 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 7					
Proposed solution - description	**Investment**	**Energy saving Type: Electricity**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Retrofitting the lighting system with LED technology	36,440	86.4	13,300	40	2.7
Photovoltaic system	300,000	340	58,000	159	5.2

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.2.7.3. Measurement and verification of the results

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings			Manual target			
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption		Target consumption reduction	Target consumption	Production	Specific Consumption
		[Tons]	[MWh]	[kWh/Tons]	[Tons]	[MWh]	[kWh/Tons]	[MWh]	[kWh/Tons]	[%]	[%]	[MWh]	[.....]	[kWh/.....]
1	JAN	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	7.0	307.2	651360	0.5
2	FEB	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	5.0	313.8	651360	0.5
3	MARCH	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	12.0	290.7	651360	0.4
4	APRIL	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	6.0	310.5	651360	0.5
5	MAY	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	6.0	310.5	651360	0.5
6	JUNE	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	8.0	303.9	651360	0.5
7	JULY	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	5.0	313.8	651360	0.5
8	AUG	651363	330.3	0.51	651363	300.3	0.46	30.0	0.05	9%	8.0	303.9	651363	0.5
9	SEPT	651363	330.3	0.51	651363	300.3	0.46	30.0	0.05	9%	5.0	313.8	651363	0.5
10	OCT	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	11.0	294.0	651360	0.5
11	NOV	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	9.0	300.6	651360	0.5
12	DEC	651360	330.3	0.51	651360	300.3	0.46	30.0	0.05	9%	8.0	303.9	651360	0.5
	TOTAL	7816326	3964	0.5	7816326	3604.0	0.46	360.0	0.0	9%		3666.7	7816326.0	0.5

Figure 20 M&T & M&V results

Note: Monthly consumption was not available.

4.2.7.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
KfW-Energieeffizienzprogramm 276, 277, 278	KFW loan with a 1% interest rate and up to a 17.5% repayment subsidy. Can be used for individual measures such as LED retrofitting.
KfW - Programm Erneuerbare Energien 'Standard' - Photovoltaik (Nr. 270) (Förderkredit)	KFW subsidised loan. Covered PV installations up to 20MW, up to 50 million euros loan.

4.2.7.5. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Staff training on climate and energy efficiency topics.
- Continuous incremental upgrades to production machinery in favour of more energy efficient options.
- Increasing use of renewable inputs.
- Close monitoring of energy consumption and continuous optimization
- Greater decision-making power to the energy/environmental management officer.

4.3. Greece

4.3.1. Pilot site 1

Number of employees: 20

NACE Code: C26.1.1 Manufacturing of electronic components

4.3.1.1. Short description of the SME

Description of the main activities:

The company activities are related to the Internet of Things (IoT). The company designs and develops microelectronic systems and software towards the smart, simple, and efficient management of the devices and facilities, in business or home environment, remotely through a smart device or the user's personal computer. The company also provides specialized solutions for every market. Based on the variety of products and services that can provide, the company is able to support its residential, as well as Commercial and Industrial (C&I) customers, to control and reduce their energy costs, along with their environmental footprint.

The portfolio of the company devices includes products that enable the implementation of smart cities concept, such as a power logger capable to measure both energy quantities (current, voltage, power, power factor) and harmonics (total harmonic current and voltage), a powerful state-of-the-art small form industrial type hub based on Linux, for the acquisition, collection and transmission of ZigBee sensor data from metering devices and sensors, for applications in online analysis services,

but also an energy analysis platform that uses the latest Information and Communication Technologies (ICT) to offer a powerful and scalable tool for managing operational energy data.

Description of the technological process

The company deals with the design, production of smart wireless electricity meters and customer support by providing intelligent energy monitoring and management tools for exporting data useful for the electricity consumers. The production process consists of successive phases corresponding to each one of the products. Depending on the product, the main processes may be assembly, welding, calibration, functional testing, and packaging.

Short description of the systems utilized in the production process

Table 89 Pilot 1 – Production process

		
Analogue power supply unit for electric screwdrivers	*Welding station*	*Calibration system*

4.3.1.2. Characteristics of the buildings

General building description:

- Year of construction: Office building 1989, Production building 2003
- Area: net office area 138sqm, net production area 107sqm
- Number of employees: 18 in the office building, 2 in the production area
- Energy environmental standards applied: ISO 14001
- Opening hours: 09:00 – 17:00
- Months of operation: 12

Building envelope characteristics

Table 90 Pilot 1 – Characteristics of the buildings

	Construction material	Thermal insulation
External masonry	Brick wall	Yes
Roof	Reinforced concrete	Yes
Window frames	Aluminum frame with double glazing	Yes

Technical characteristics of the heating, cooling, ventilation, and lighting systems

Table 91 Pilot 1 – HVAC system

Space Heating	Air Conditioner
Space Cooling	Air Conditioner
Hot water	–
Ventilation	Windows
Lighting	Fluorescent lamps

Table 92 Pilot 1 – Production data

Production – Pilot 1 Insert product name		
	2019	**2020**
Month	**Production [pieces]**	**Production [pieces]**
January	23	53
February	41	79
March	1,118 (*)	23
April	18	44
May	1,564 (*)	1
June	112	9
July	200	1,109
August	60	60
September	43	13
October	143	59
November	473	44
December	183	138
TOTAL	**3,978**	**1,632**

4.3.1.3. Energy analysis

The electricity consumption and the specific consumption profiles of the SME are presented in the following tables.

Table 93 Pilot 1 – Energy consumption

Energy consumption – Pilot 1 Electricity		
	2019	**2020**
Month	Consumption [kWh]	Consumption [kWh]
January	1759	1,644.5
February	1,537.25	1,389.25
March	1,537.25	1,389.25
April	1,537.25	1,389.25

May	1,537.25	1,389.25
June	1,889.25	1,844.75
July	1,889.25	1,844.75
August	1,889.25	1,844.75
September	1,889.25	1,844.75
October	1,644.5	1,579.25
November	1,644.5	1,579.25
December	1,644.5	1,579.25
TOTAL	**20,398.5**	**19,318.25**

Table 94 Pilot 1 – Specifc consumption

Specific consumption – Pilot 1		
	2019	**2020**
Month	**Specific consumption [kWh/piece]**	**Specific consumption [kWh/piece]**
January	76.48	31.03
February	37.49	17.59
March	1.38	60.40
April	85.40	31.57
May	0.98	1389.25
June	16.87	204.97
July	9.45	1.66
August	31.49	30.75
September	43.94	141.90
October	11.50	26.77
November	3.48	35.89
December	8.99	11.44
AVERAGE	**27.29**	**165.27**

As illustrated in the table above, the energy consumption of the company is not directly related to the production. Therefore, the energy consumption related to the ambient temperature will be considered, taking into account the heating and cooling degree days of the year.

4.3.1.4. Proposed solution and EE action plan

The proposed measures for the improvement of the SME energy efficiency are described below:

<u>1st Proposed Energy Efficiency Measure</u>

- Reduction of the consumption of the lighting systems
- Change in lighting systems: Replacement of the fluorescent lamps 88x18W and 4x58WT8 with electronic ballast, with LED lamps, with lower power consumption.

- Lighting control: Adjusting of the lighting system operation to the occupancy. Adjusting of the lighting levels to the natural light, installation of controlled sunblinds.

2nd Proposed Energy Efficiency Measure

- Reduction of the consumption for space heating and cooling
- Air-conditioning units: Replacement of the 6 air-conditioning units with high performance inverter units
- Installation of external thermal insulation around the ground floor, which hosts the production processes.
- Installation of external sunblinds on the glazing areas of the eastern side of the office building.

Table 95 Pilot 1 – Porposed EE action pan

Proposed solutions & EE action plan for Pilot 1					
Proposed solution - description	**Investment**	**Energy saving Type: electricity**	**Cost saving**	**Payback period**	**NPV**
	[EUR]	[kWh/year]	[EUR/year]	[years]	[EUR]
Lighting	4,850	663.714	72.42	2	4,208.68
Air-conditioning	9,358	3,057.6	351.624	2	6,711.22

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh	X	
Cost saving	EUR	X	

4.3.1.5. Measurement and verification of the results

Results from the M&T and M&V tools.

Heating degree-days (HDD)

Measurement & Verification - before

Utility type	Energy
Regression type	Linear
Target trend transposition coefficient	-0,13

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No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings		
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption	
		[HDD]	[MWh]	[kWh/HDD]	[HDD]	[MWh]	[kWh/HDD]	[MWh]	[kWh/HDD]	[%]
1	JAN	293,56	1,6445	5,60	293,56	1,25141	4,2629	0,4	1,3	24%
2	FEB	220,99	1,3893	6,29	220,99	1,25625	5,6847	0,1	0,6	10%
3	MARCH	176,07	1,3893	7,89	176,07	1,25925	7,1520	0,1	0,7	9%
10	OCT	29,96	1,5793	52,71	29,96	1,26900	42,3566	0,3	10,4	20%
11	NOV	128,58	1,5793	12,28	128,58	1,26242	9,8182	0,3	2,5	20%
12	DEC	173,88	1,5793	9,08	173,88	1,25940	7,2429	0,3	1,8	20%
	TOTAL	1023,04	9,1608	8,95	1023,04	7,55773	7,3875	1,6	1,6	17%

Figure 21 M&T & M&V results

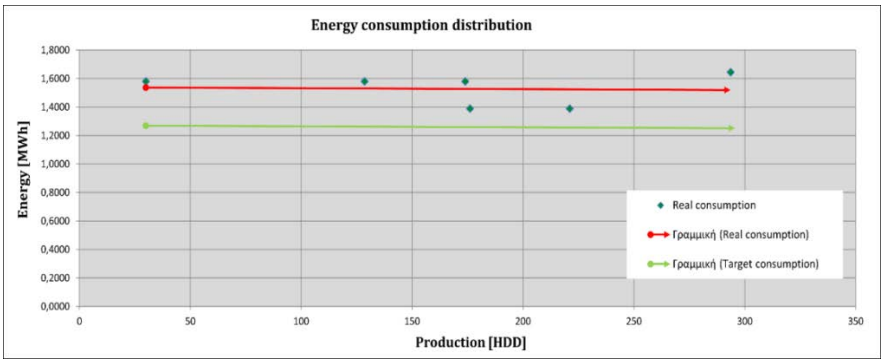


Figure 22 M&T results

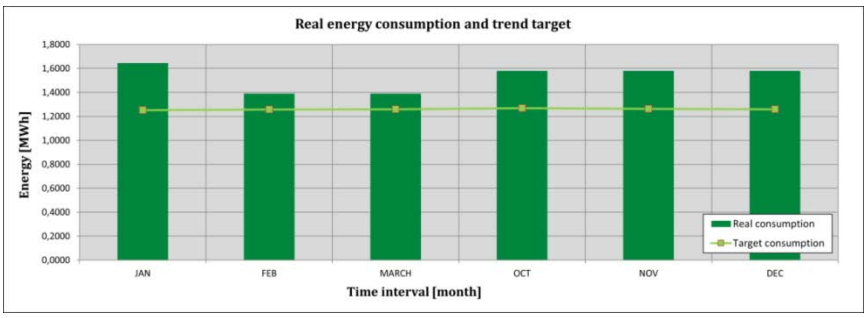


Figure 23 M&T results

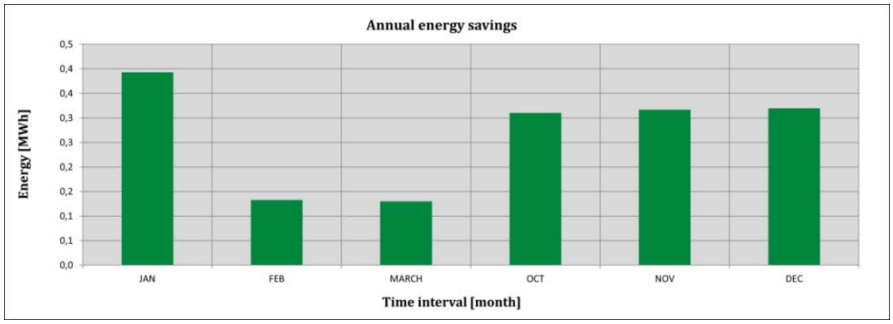


Figure 24 M&T results

Insert data after enegry conservation measures				
No.	Duration	Real - after the energy efficiency implementation		
	Month	Production	Consumption	KPI
		[HDD]	[MWh]	[kWh/HDD]
1	JAN	293,56	1,121	3,82
2	FEB	218,06	1,058	4,85
3	MARCH	174,03	1,058	6,08
10	OCT	25,40	1,257	49,50
11	NOV	131,20	1,257	9,58
12	DEC	180,50	1,257	6,97
TOTAL		1023	7	6,9

Figure 25 M&T results

Measurement & Verification results			
Beneficiary/Location	Client	European Union	
NACE Code 2341	Ceramics factory		

Utility type	After the energy efficiency implementation							
							Unit price [euro/MWh]	
							101	

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use			Total energy use					
	9,0	[kWh/[...]]		9	[MWh/yr.]		Achieved energy savings		
Energy	After the energy efficiency implementation							2,0	[MWh/yr.]
	Specific energy use			Total energy use			Achieved cost savings		
	6,9	[kWh/[...]]		7	[MWh/yr.]			199	[euro/yr.]

Figure 26 M&V results

Measurement and Verification													
No.	Duration	Real - after the energy efficiency implementation		Verification									
	Month	Production	Measured consumption	Estimated consumption based on baseline trend	Estimated consumption based on target optimized trend	Estimated consumption based on target manual trend	Baseline trend SAV %	Optimized target trend SAV %	Manual target trend SAV %	Baseline trend conclusion	Optimal trend conclusion	Manual trend conclusion
		[.....]	[.....]	[.....]	[.....]							
1	JAN	294	1,121	1,519	1,251	1,297	-26,2	-10,4	-19,8	energy saving	energy saving	energy saving
2	FEB	218	1,058	1,524	1,256	1,402	-30,6	-15,8	-24,5	energy saving	energy saving	energy saving
3	MARCH	174	1,058	1,527	1,259	1,404	-30,7	-16,0	-24,7	energy saving	energy saving	energy saving
10	OCT	25	1,257	1,538	1,269	1,414	-18,2	-0,9	-11,1	energy saving	energy saving	energy saving
11	NOV	131	1,257	1,529	1,262	1,407	-17,8	-0,4	-10,6	energy saving	energy saving	energy saving
12	DEC	181	1,257	1,526	1,259	1,404	-17,6	-0,1	-10,5	energy saving	energy saving	energy saving
TOTAL		1022,75	7,0	9,5	7,6	8,4	-23,5	-7,3	-16,8	energy saving	energy saving	energy saving

Figure 27 M&V results

Cooling degree-days (CDD)

Measurement & Verification - before	
Utility type	Energy
Regression type	Linear
Target trend transposition coefficient	-0,03

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings		
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption	
		[CDD]	[MWh]	[kWh/CDD]	[CDD]	[MWh]	[kWh/CDD]	[MWh]	[kWh/CDD]	[%]
1	APR	48,72	1,38925	28,51	48,72	1,35925	27,8992	0,0	0,6	2%
2	MAY	49,68	1,84475	37,13	49,68	1,36116	27,3985	0,5	9,7	26%
3	JUN	152,18	1,84475	12,12	152,18	1,56462	10,2814	0,3	1,8	15%
10	JUL	164,92	1,84475	11,19	164,92	1,58991	9,6405	0,3	1,5	14%
11	AUG	88,3	1,84475	20,89	88,30	1,43782	16,2833	0,4	4,6	22%
12	SEP	17,08	1,57925	92,46	17,08	1,29644	75,9043	0,3	16,6	18%
TOTAL		520,88	10,3475	19,87	520,88	8,60919	16,5282	1,7	3,3	17%

Figure 28 & M&V results

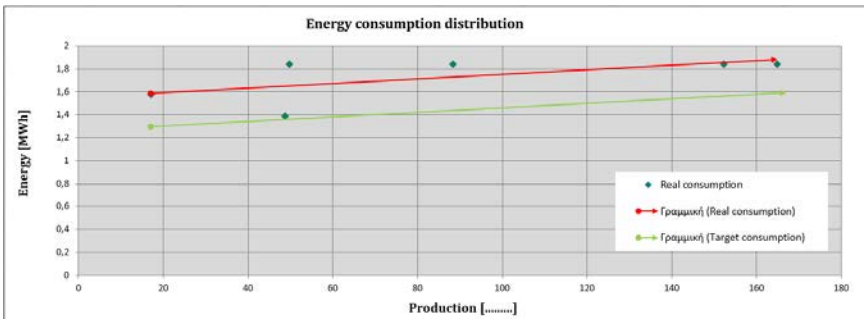


Figure 29 M&V results

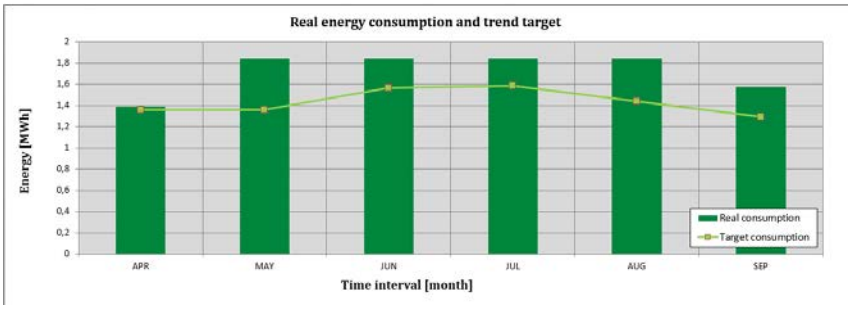


Figure 30 M&V results

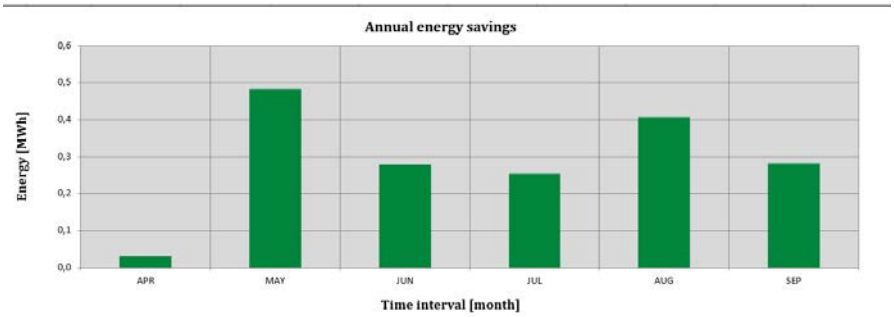
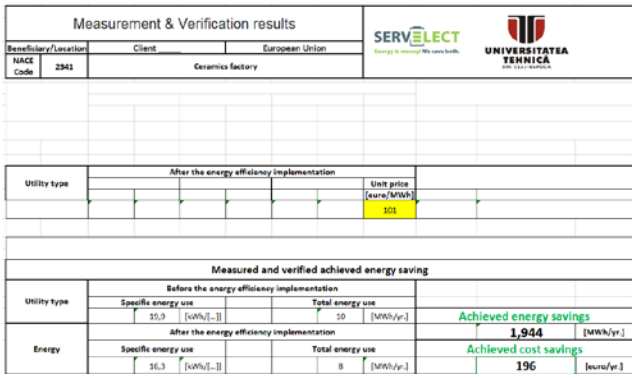


Figure 31 M&T results

Insert data after enegry conservation measures				
No.	Duration	Real - after the energy efficiency implementation		
	Month	Production	Consumption	KPI
		[CDD]	[MWh]	[kWh/.....]
1	APR	41,5	1,29731	31,26
2	MAY	48,75	1,45642	29,88
3	JUN	155,78	1,45642	9,35
10	JUL	165,65	1,45642	8,79
11	AUG	91,3	1,45642	15,95
12	SEP	19,48	1,37634	70,65
TOTAL		522	8	16,3

Figure 32 M&V results



Measurement & Verification results

Beneficiary/Location		Client	European Union
NACE Code	2341	Ceramics factory	

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Utility type	After the energy efficiency implementation						Unit price [euro/MWh]
							101

Measured and verified achieved energy saving

Utility type	Before the energy efficiency implementation							
	Specific energy use			Total energy use			Achieved energy savings	
	10,9	[kWh/[..]]		10	[MWh/yr.]			
Energy	After the energy efficiency implementation						1,944	[MWh/yr.]
	Specific energy use			Total energy use			Achieved cost savings	
	16,3	[kWh/[..]]		8	[MWh/yr.]		196	[euro/yr.]

Measurement and Verification

No.	Duration	Real - after the energy efficiency implementation		Verification								
	Month	Production	Measured consumption	Estimated consumption based on baseline trend	Estimated consumption based on target optimized trend	Estimated consumption based on target manual trend	Baseline trend SAV %	Optimized target trend SAV %	Manual target trend SAV %	Baseline trend conclusion	Optimal trend conclusion	Manual trend conclusion
		[ ]	[ ]	[ ]	[ ]							
1	APR	42	1,3	1,6	1,3	1,3	-20,6	-3,5	-13,7	energy saving	energy saving	energy saving
2	MAY	49	1,5	1,6	1,4	1,5	-11,7	7,1	-4,0	energy saving	not energy saving	energy saving
3	JUN	156	1,5	1,9	1,6	1,7	-21,8	7,3	-15,0	energy saving	energy saving	energy saving
10	JUL	166	1,5	1,9	1,6	1,7	-22,6	-8,5	-15,0	energy saving	energy saving	energy saving
11	AUG	91	1,5	1,7	1,4	1,6	-16,0	0,9	-8,7	energy saving	not energy saving	energy saving
12	SEP	19	1,4	1,6	1,3	1,5	-13,5	5,8	-6,0	energy saving	not energy saving	energy saving
TOTAL		522,46	8,5	10,4	8,6	9,5	-17,9	-1,3	-10,7	energy saving	energy saving	energy saving

Figure 33 M&V results

4.3.1.6. Energy management plan

For the improvement of the company energy efficiency, the following energy management plan is proposed.

- The change of the energy behavior of the employees and the incentives that can be provided by the supervisors to boost such behavior are important for the improvement of the energy management. Specifically, the training of the staff through workshops and special training actions will enhance the improvement of their energy and ecological awareness and behavior.
- Moreover, the employer is prompt to reward the employees who propose and implement energy saving measures with financial (bonuses) or other (extra leaves) means.
- Finally, following the company expertise, the utilization of the hardware and software produced by the company through the installation of smart meters, sensors, and hydrometers for the systematic monitoring of the energy indicators and the automated / remote operation of devices (schedule, motion sensors, etc.) is proposed.

4.3.2. Pilot site 2

Number of employees: 6

NACE Code: M71.1.2 - Engineering activities and related technical consultancy

4.3.2.1. Introduction for data and current situation

The company is active in the fields of Environment, Energy Carbon Economy. It offers comprehensive, specialized techno-economic services related to carbon economy (emission portfolio management) and projects of flexible mechanisms, renewable energy, energy saving, energy efficiency and greenhouse gas emission management strategies, while promoting sustainable development and 'green' technologies. Particularly in the field of greenhouse gas management, the company services include analytical measurement - calculation of the carbon footprint of the operation of organizations and businesses, as well as of products, services and events.

Description of the technological process

For the daily operation of the office, the following devices are used:

- 3-5 Laptops (45W – 3 due to teleworking) = 135W
- 3 Computer Monitors (19.7W – 2 of them are used) = 39.4W
- 1 TV (84W – Used only as a projection screen during meetings) = 84W
- 1 Desktop (rarely used) = 200W
- 1 Kettle (Used at most 1-2 times per day) = 2,200W
- Refrigerator (0.42 kWh/day) = 83W
- Microwave Oven (Used at most once per day) = 1,100W
- Printers (minimum use) = 1,020W
- Air-Conditioning unit 24,000 BTU, used mainly for cooling, and sometimes for heating = 7033W

- Lighting: 1,249W

The Total Installed Power is 11,894.4W.

4.3.2.2. Characteristics of the buildings

General building description:

The SME is located on the second floor of a building, with other companies located in the ground floor. In the building, an autonomous natural gas heating system and an elevator are used. The area of the office is equal to 94sqm. Currently, due to teleworking, the number of the employees working in the office is equal to 3. Normally, the total number of employees is equal to 6.

Working hours: 5days/week, 09:00 – 17:00

Months of operation: 12

Table 96 Building envelope characteristics

	Construction material	Thermal insulation
External masonry	Brick walls – EPS (5cm)	Yes (EPS)
Roof	–	–
Window frames	Aluminum frame	–

Technical characteristics of the heating, cooling, ventilation, and lighting systems:

Heating radiators and air-conditioning units are used for space heating and cooling. Specifically, during winter the radiators are used (6 radiators 75cm x 55cm and 2 radiators 40cm x 55cm) connected to a natural gas heating system, while during summer, 1 large air-conditioning unit is used for space cooling. Moreover, on the roof, there is a solar heater with a triple energy boiler, which covers the office hot water needs.

For lighting, there are 35 wall lamps on the office roof. Specifically, the types of the wall lamps are the following:

- PL: 26 x 2 x 20W
- CFL: 2 x 12W and 3 x 15W
- LED: 6 x 10W
- Incandescent: 2 x 40W

The electricity consumption for space lighting is low (used especially during no-sunny days). There are windows throughout the office, with large openings for natural light exploitation.

Table 97 Pilot 2 – HVAC system

Space Heating	
Space Cooling	
Hot water	
Lighting	

4.3.2.3. Energy analysis

The electricity and natural gas consumption profiles of the SME are presented in the following tables.

Table 98 Pilot 2 – Electricity consumption

Energy consumption – Pilot 2 Electricity		
	2019	**2020**
Month	Consumption [kWh]	Consumption [kWh]
January	212	172
February	147	156
March	163	86
April	158	77
May	163	94
June	186	204
July	315	345
August	260	285
September	155	170
October	96	148
November	73	113
December	134	205
TOTAL	**2,062**	**2,055**

Table 99 Pilot 2 – Natural gas consumption

Energy consumption – Pilot 2 Natural gas		
	2019	**2020**
Month	Consumption [kWh]	Consumption [kWh]
January	282.9	1507.8
February	142.7	1386.2
March	132.4	750
April	84.5	0
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	0
December	0	1,074.7
TOTAL	**642.5**	**4,718.7**

For the average monthly external temperatures, measurements from the National Observatory of Athens were used, extracted from the nearest to the company meteorological station, as depicted in the table below.

Table 100 Pilot 2 – Natural gas

Average monthly external temperature [°C]		
Month	**2019**	**2020**
Month	**[°C]**	**[°C]**
January	9.8	10.1
February	10.6	12
March	14.1	13.9
April	15.6	15.5
May	19.4	20.6
June	26.4	24.2
July	28.1	28.8
August	29.7	28.9
September	25.3	26.4
October	21.9	21.5
November	18.5	15.7
December	13	14.4

The heating degree-days (HDD) and the cooling degree-days (CDD) were calculated considering the temperature setpoint equal to 18°C.

Table 101 Pilot 2 – HDD & CDD

HDD & CDD				
	2019		2020	
Month	HDD	CDD	HDD	CDD
January	8.2	0	7.9	0
February	7.4	0	6	0
March	3.9	0	4.1	0
April	2.4	0	2.5	0
May	0	1.4	0	2.6
June	0	8.4	0	6.2
July	0	10.1	0	10.8
August	0	11.7	0	10.9
September	0	7.3	0	8.4
October	0	3.9	0	3.5
November	0	0.5	2.3	0
December	5	0	3.6	0

Using the cooling and heating degree-days presented, the following KPIs were calculated:

Table 102 Pilot 2 - Specific consumption

Specific consumption – Pilot 2		
	2019	2020
Month	Specific consumption [kWh/CDD]	Specific consumption [kWh/CDD]
January	0	0
February	0	0
March	0	0
April	0	0
May	116.43	36.15
June	22.14	32.9
July	31.19	31.94
August	22.22	26.15
September	21.23	20.24
October	24.62	42.29
November	146	0
December	0	0
AVERAGE	**62.46**	**159.76**

Table 103 Pilot 2 – Specific consumption

Specific consumption – Pilot 2		
	2019	2020
Month	Specific consumption [kWh/HDD]	Specific consumption [kWh/HDD]
January	60.35	212.63
February	39.16	257.03
March	75.74	203.9
April	101.03	30.8
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	49.13
December	26.8	355.47
AVERAGE	**100.54**	**256.58**

4.3.2.4. Proposed solution and EE action plan

To find the appropriate energy efficiency measures, the identification of the most energy consuming process is necessary. The yearly consumption distribution is as depicted in the following diagram.

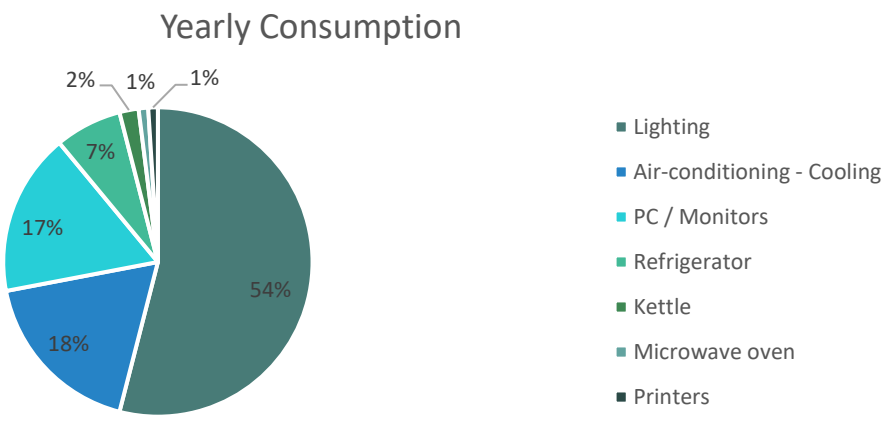


Figure 34 Pilot 2 - Share of consumption

It is obvious that the lighting is the most energy consuming procedure in this company.

The following measures are proposed to improve the energy efficiency of the SME:

- Replacement of the lamps with LED (145mm diameter, 9W, 6,500K white 810lm, 4 pieces, 33€/piece) = 132€ total investment cost
- Installation of twilight sensor switches in the switchboard (4 pieces, 87€/piece) = 348€ total investment cost
- Installation of smart meters in the switchboard (1 piece, 26€/piece) = 26€ total investment cost
- Installation of thermal reflective radiator surface (8 pieces, 8.2€/piece) = 65.6€ total investment cost
- Installation of thermostatic valves in the heating panels, 8 pieces, 20€/piece, 160€ total investment cost
- Cost for installation = 150€

Table 104 Pilto 2 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 2						
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[kWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]
Equipment purchase	794	2,237.7	166	0.1924	5	35.75

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.3.2.5. Measurement and verification of the results

Results from the M&T and M&V tools.

For HDD = 0 :

Measurement & Verification - before

Utility type	Energy
Regression type	Linear
Target trend transposition coefficient	-0,0175

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings		
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption	
		[CDD]	[MWh]	[kWh/CDD]	[CDD]	[MWh]	[kWh/CDD]	[MWh]	[kWh/CDD]	[%]
1	MAY_2019	1,40	0,163	116,43	1,40	0,0171	12,20	0,15	104,23	90%
2	JUN_2019	8,40	0,186	22,14	8,40	0,1525	18,15	0,03	3,99	18%
3	JUL_2019	10,10	0,315	31,19	10,10	0,1854	18,36	0,13	12,83	41%
4	AUG_2019	11,70	0,260	22,22	11,70	0,2163	18,49	0,04	3,73	17%
5	SEP_2019	7,30	0,155	21,23	7,30	0,1312	17,98	0,02	3,26	15%
6	OCT_2019	3,90	0,096	24,62	3,90	0,0654	16,78	0,03	7,83	32%
7	NOV_2019	0,50	0,073	146,00	0,50	-0,0003	-0,66	0,00	146,00	0%
8	MAY_2020	2,60	0,094	36,15	2,60	0,0403	15,50	0,05	20,66	57%
9	JUN_2020	6,20	0,204	32,90	6,20	0,1099	17,73	0,09	15,17	46%
10	JUL_2020	10,80	0,345	31,94	10,80	0,1989	18,42	0,15	13,52	42%
11	AUG_2020	10,90	0,285	26,15	10,90	0,2009	18,43	0,08	7,72	30%
12	SEP_2020	8,40	0,170	20,24	8,40	0,1525	18,15	0,02	2,08	10%
13	OCT_2020	3,50	0,148	42,29	3,50	0,0000	0,00	0,00	42,29	0%
TOTAL		82,20	2,346	28,540	82,20	1,470	17,885	0,80	10,7	34%

Figure 35 Use of M&V tool for the months with HDD = 0

Tc (min)	-0.018
Tc(max)	0.128570

The manual target set leads to estimated reduction of electricity consumption equal to 40% for the months that HDD is equal to 0, and the new consumption values for the same production values (CDD) are extracted using the model.

Manual target				
Target consumption reduction	Target consumption	Production	Specific Consumption	Savings
[%]	[MWh]	[HDD]	[kWh/HDD]	[MWh]
40,0	0,098	1,400	69,9	0,065
40,0	0,112	8,400	13,3	0,074
40,0	0,189	10,100	18,7	0,126
40,0	0,156	11,700	13,3	0,104
40,0	0,093	7,300	12,7	0,062
40,0	0,058	3,900	14,8	0,038
40,0	0,044	0,500	87,6	0,029
40,0	0,056	2,600	21,7	0,038
40,0	0,122	6,200	19,7	0,082
40,0	0,207	10,800	19,2	0,138
40,0	0,171	10,900	15,7	0,114
40,0	0,102	8,400	12,1	0,068
40,0	0,089	3,500	25,4	0,059
	1,408	**82,200**	**17,1**	**0,938**

Figure 36 Use of M&V tool for the months with HDD = 0

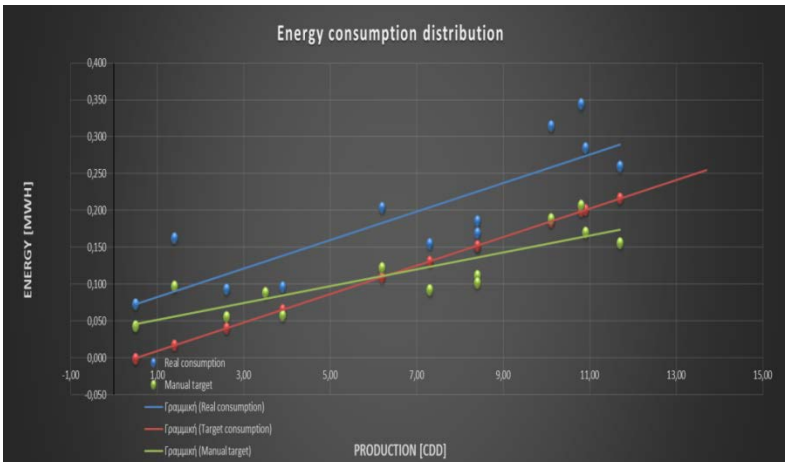


Figure 37 Energy consumption distribution per CDD

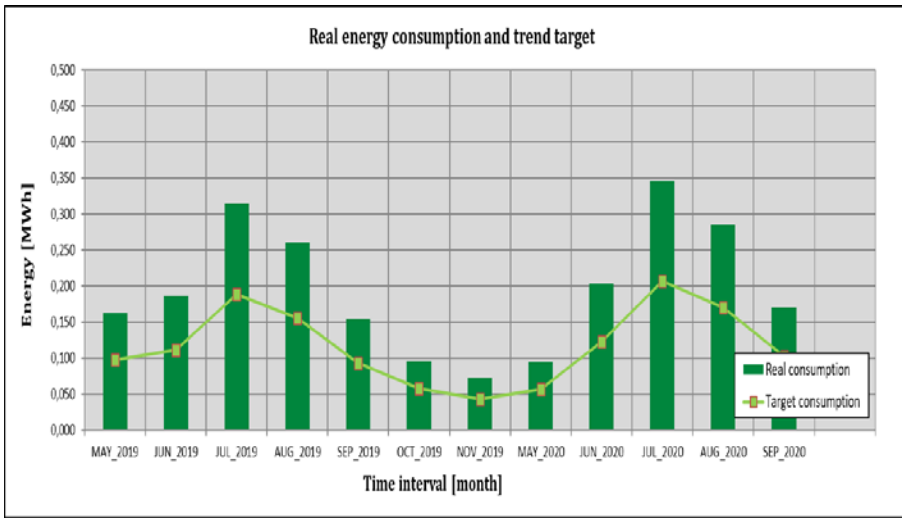


Figure 38 Real energy consumption and trend target for the months with HDD = 0

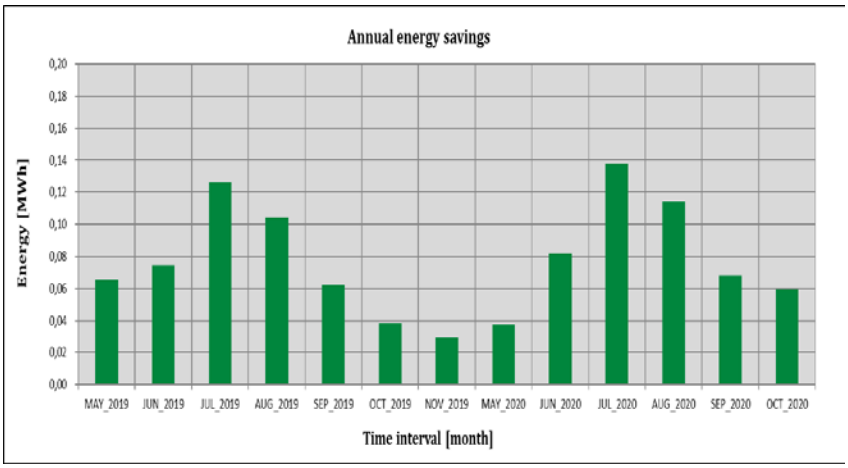


Figure 39 Energy savings for the months with HDD = 0

For CDD = 0:

Measurement & Verification - before	
Utility type	Energy
Regression type	Linear
Target trend transposition coefficient	-0,015

No.	Duration	Real - before the energy efficiency implementation			Optimized			Potential estimated savings		
	Month	Production	Consumption	Specific Consumption	Production	Energy Consumption	Specific Consumption	Savings	Potential savings - Specific Consumption	
		[HDD]	[MWh]	[kWh/HDD]	[HDD]	[MWh]	[kWh/HDD]	[MWh]	[kWh/HDD]	[%]
1	JAN_2019	8,20	0,212	25,85	8,20	0,1112	13,56	0,1	12,29	48%
2	FEB_2019	7,40	0,147	19,86	7,40	0,1034	13,97	0,0	5,90	30%
3	MARCH_2019	3,90	0,163	41,79	3,90	0,0690	17,70	0,1	24,09	58%
4	APRIL_2019	2,40	0,158	65,83	2,40	0,0543	22,64	0,1	43,20	66%
5	DEC_2019	5,00	0,1340	26,80	5,00	0,0798	15,97	0,1	10,83	40%
6	JAN_2020	7,90	0,172	21,77	7,90	0,1083	13,70	0,1	8,07	37%
7	FEB_2020	6,00	0,156	26,00	6,00	0,0896	14,94	0,1	11,06	43%
8	MARCH_2020	4,10	0,086	20,98	4,10	0,0710	17,32	0,0	3,66	17%
9	APRIL_2020	2,50	0,077	30,80	2,50	0,0553	22,12	0,0	8,68	28%
10	NOV_2020	2,30	0,1130	49,13	2,30	0,0533	23,19	0,1	25,94	53%
11	DEC_2020	3,60	0,2050	56,94	3,60	0,0661	18,36	0,1	38,58	68%
TOTAL		53,30	1,623	30,450	53	0,861	16,162	0,8	14,3	47%

Figure 40 Use of M&V tool for the months with CDD = 0

Tc (min)	-0.018
Tc(max)	0.128570

The manual target set leads to estimated reduction of electricity consumption equal to 40% for the months that CDD is equal to 0, and the new consumption values for the same production values (CDD) are extracted using the model.

Manual target				Savings
Target consumption reduction	Target consumption	Production	Specific Consumption	
[%]	[MWh]	[HDD]	[kWh/HDD]	[MWh]
40,0	0,127	8,20	15,51	0,085
40,0	0,088	7,40	11,92	0,059
40,0	0,098	3,90	25,08	0,065
40,0	0,095	2,40	39,50	0,063
40,0	0,080	5,00	16,08	0,054
40,0	0,103	7,90	13,06	0,069
40,0	0,094	6,00	15,60	0,062
40,0	0,052	4,10	12,59	0,034
40,0	0,046	2,50	18,48	0,031
40,0	0,068	2,30	29,48	0,045
40,0	0,123	3,60	34,17	0,082
	0,974	**53,30**	**18,27**	**0,649**

Figure 41 Use of M&V tool for the months with CDD = 0

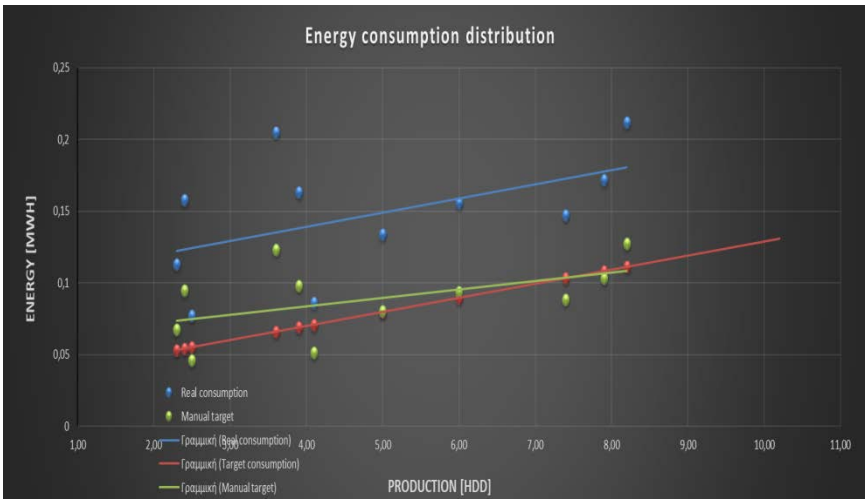


Figure 42 Energy consumption distribution per HDD

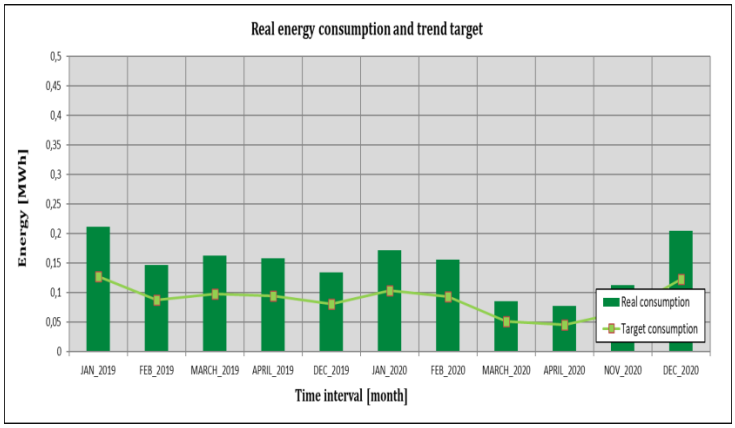


Figure 43 Real energy consumption and trend target for the months with CDD = 0

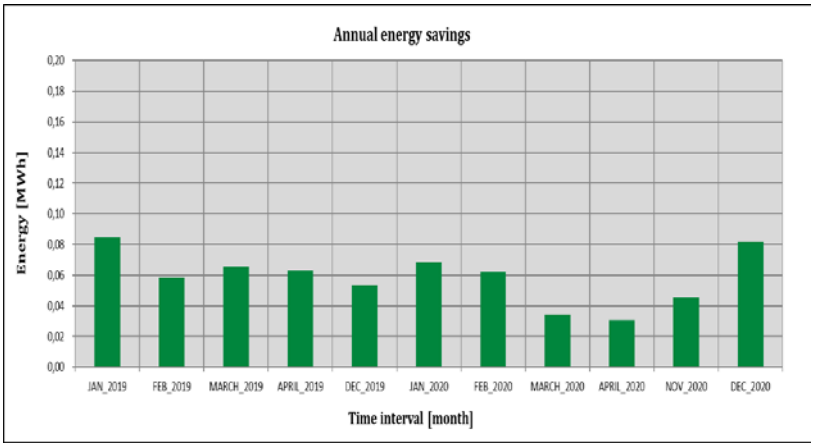


Figure 44 Energy savings for the months with CDD = 0

Minimum Verifiable Energy Efficiency Target according to IPMVP = 50.80%

It can be observed that the proposed measure for energy savings leads to 40% energy saving, a value lower than the minimum verifiable energy efficiency target based on IPMVP. Therefore, the

formulated model is not able to accurately evaluate the energy saving measure proposed to be implemented.

4.3.2.6. Energy management plan

Because of the business activity, it is considered that the staff is sufficiently aware of energy consumption issues, and the energy consumption in the company is the minimum one, while the energy behavior of the employees is the best achieved. Replacing the lighting bulbs with LED ones will yield as much energy savings as possible.

The only thing that can be implemented as a good practice is the regular consumption monitoring from now on, in order to monitor and identify any unusually high energy consumptions.

4.3.3. Pilot site 3

4.3.3.1. Introduction for data and current situation

Number of employees: 8

NACE Code: C23.7 – Cutting, shaping and finishing of stone

Description of the main activities:

The company is active in the field of processing marble, granite, natural stones, along with 3D CNC constructions. Eight (8) people are employed in the company, who handle the state-of-the-art mechanical equipment owned by the company for cutting, sanding, scraping, aging, finishing and for any other materials processing related action. The staff is properly trained, and the company owns its own means of transport, thus offering high quality products and services. Recently, there was an investment on a multifunctional machine, having five axis lathe, CNC, which can construct even the most demanding design. The total company energy consumption is approximately equal to 60MWh/year. The company offers marbles, granites, and natural stones at competitive prices, in a wide variety of colors, designs and dimensions for installations in floors, walls, intricate kitchen constructions, stairs, bathrooms, fireplaces, both in indoor and in outdoor areas. Moreover, special marble monuments can be created. The products are sold both in wholesale and in retail market.

The company processes are complied with the Quality Management Systems (QMS) according to the International Standard ISO 9001, and with the Environmental Management according to the International Standard ISO 14001. This proves the good quality of the company services, the efforts towards environmental protection and customer satisfaction.

Description of the technological process

The production process of the company is summarized in the following chart. At first, the marble to be processed is collected and checked for its purity by the well-trained personnel. The raw material is driven to a vertical cutting machine. The pure marble is transferred to the main production line machines. There, the material to be polished is selected and is driven to the polishing machines, where it is stored after being polished and before being cut by the appropriate machines. The

production process continues with an additional polishing process – sanding of special pieces, and with the process of finishing edges, when required. After the conclusion of the processing procedure, the dimensions of the products are checked and if appropriate, the products are slab stored, until shipped to customers either in slabs or in boxes. The products that are non-compliant, are sent for additional process.

Figure 45 Organic cleaning (2.025kW) and sewage pump (7.5kW)

Table 105 Pilot 3 – In situ photos

		
Air-compressor (11kW) and dryer machine (0.76kW)	*Bridge cranes (12.375kW and 11.475kW)*	*500kg arm bridge (0.4kW)*

Table 106 Pilot 3 – In situ photos

	
Polishing machine (13.162kW)	*Polishing machine (4.125kW)*

	
Slate transport wagon (1.5kW)	*Milling machine (20.452kW)*

		
Cutting machine (11.25kW)	*Dust absorber (5.625kW)*	*Buffers (4.5kW) and hand-held sanders (0.45kW)*

Table 107 List of equipments

EQUIPMENT USED FOR THE PRODUCTION-MAINTENANCE		
No.	**NAME OF THE MACHINE**	**Power [kW]**
1	Sander – Polishing machine	4.13
2	Cutter 1	11.25
3	Cutter 2	9.00
4	Milling machine 1	30.00
5	Milling machine 2	20.45
6	Finishing edges machine	36.75
7	Frames polishing machine	82.50
8	Slate polishing machine	13.16
9	Head cutter 1	7.50
10	Head cutter 2	7.50
11	Organic cleaning	2.03

12	Buffers	4.50
13	Buffers	1.13
14	Hand-held sander	0.45
15	Dust absorber	5.63
16	Slate transport wagon	1.50
17	Arm bridge 500kg	0.40
18	Bridge cranes 1	12.38
19	Bridge cranes 2	11.48
20	CNC	33.00
21	Organic sewage pumps	7.50
22	Air-compressor VS11-10A	11.00
23	Dryer	0.76

4.3.3.2. Characteristics of the buildings

General building description:

The company occupies a total area of 12,000sqm, consisting of three (3) buildings, with the first one constructed in 1979. Two of the buildings are used for the production processes, while one building is used for showroom and offices. The second building allocated to the construction processes is the extension of the first one, while the exhibition-office building is independent and newer than the other ones. The total area of covered spaces is equal to 3048.8sqm. The entire company is located in a rural area. The company buildings are not surrounded by other buildings or trees, therefore they are nor protected from the weather, while also they are not subject to shading.

Working hours: 5days/week, shift cycle

Building envelope characteristics:

The building envelope is of mixed construction. It consists of metal columns and beams, while also reinforced concrete exists in parts of the construction. Between the roof and the siding panels, 5cm polyurethane thermal insulation panels have been installed.

Table 108 In situ photos



Table 109 Construction materials

	Construction material	Thermal insulation
External masonry	5cm polyurethane thermal insulation panels	Yes
Roof	5cm polyurethane thermal insulation panels	Yes
Window frames	Fixed double glazing aluminum glass curtains, opening aluminum double glazing frames, natural lighting from polycarbonate sheets	Yes

Technical characteristics of the heating, cooling, ventilation, and lighting systems:

Table 110 Technical characteristics of the HVAC system

	Space		Power (kW)	
			Thermal	Electric
Space Heating	Production Building	LPG roof mirrors	315	–
	Exhibition-office	Air-water Heat pump	14.39	4.35
		4xAir-air Heat pump	4x20.2	4x8
Space Cooling	Exhibition-office	Air-water Heat pump	12.49	3.28
		4xAir-air Heat pump	4x15.5	4x8
Hot water	Exhibition-office	Vertical floor water tank		
Lighting	Production Building	Conventional bulbs	–	5.00
	Exhibition-office	Conventional bulbs	–	6.85

Figure 48 Space heating system in the production areas

Figure 49 Boiler room of the company facilities

Figure 46 Heat pump

Figure 47 LPG boiler

Table 111 Production data

Production – Pilot 3 Insert product name: products of stone				
	2017	**2018**	**2019**	**2020**
Month	**sqm**	**sqm**	**sqm**	**sqm**
January	0	125.79	73.47	68.91
February	32.4	571.35	945.52	637.79
March	600.74	491.25	482.87	257.1
April	720.27	425.29	799.15	6.7
May	933.62	892.91	903.69	404.9
June	1,105.85	1,062.54	628.07	935.65
July	958.17	1,240.83	1,108.71	966.53
August	952.33	917.75	1,186.64	839.51
September	1,080.68	821.33	1,055.13	1,154.14
October	1,203.16	938.74	600.67	1,221.92
November	818.17	798.94	665.05	1,150.77
December	335.57	343	497.22	605.67
TOTAL	**8,740.96**	**8,629.72**	**8,946.19**	**8,249.59**

4.3.3.3. Energy analysis

The main consumed form of energy in the company is the electricity. In the table below the electricity consumption for the period 2017-2020 is presented. Except for electricity, LPG is also used for space heating, while also oil and gasoline by the company vehicles. These data are not presented, as they are not considered in the framework of this study.

Table 112 Pilot 3 – Electricity consumption

Energy consumption – Pilot 3 Electricity				
	2017	**2018**	**2019**	**2020**
Month	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**
January	5,520	5,160	5,000	4,080
February	4,360	5,240	5,000	4,560
March	4,680	5,600	4,160	3,480
April	4,200	4,920	4,880	1,400
May	5,290	6,000	4,880	3,240
June	6,160	5,960	4,880	5,360
July	6,320	6,840	6,680	6,520
August	5,880	5,360	5,480	4,920
September	6,000	5,800	5,080	5,120
October	6,080	5,640	5,080	5,040
November	5,800	6,040	4,360	–
December	5,360	6,120	4,520	–
TOTAL	**65,650**	**68,680**	**60,000**	–

Table 113 Pilot 3 – Specific consumption

Specific consumption – Pilot 3				
	2017	**2018**	**2019**	**2020**
Month	**Specific consumption [kWh/sqm]**	**Specific consumption [kWh/sqm]**	**Specific consumption [kWh/sqm]**	**Specific consumption [kWh/sqm]**
January	–	41.02	68.05	59.21
February	134.57	9.17	5.29	7.51
March	7.79	11.40	8.62	13.54
April	5.83	11.57	6.11	208.96
May	5.67	6.72	5.40	8.00
June	5.57	5.61	7.77	5.73
July	6.60	5.51	6.03	6.75
August	6.17	5.84	4.62	5.86
September	5.55	7.06	4.81	4.44
October	5.05	6.01	8.46	4.12
November	7.09	7.56	6.56	–
December	15.97	17.84	9.09	–
AVERAGE	**18.71**	**11.25**	**11.73**	**32.37**

4.3.3.4. Proposed solution and EE action plan

1st Proposed Energy Efficiency Measure

For the improvement of the energy efficiency in the company, it is proposed to install PV system with net-metering as energy billing policy, with total installed capacity equal to 44.4kWp. The PV system is proposed to be installed with East-West orientation, with slope equal to 9°.

2nd Proposed Energy Efficiency Measure

It is recommended to replace the conventional light bulbs with similar lighting efficiency LEDs, and the installation of motion and light detectors.

In the framework of the analysis, all the bulbs were replaced, except for the LED headlights and some bell type lights in the exhibition area, which are not used. Motion detectors were installed to control SMD T5 luminaires in the exhibition area, manual switching has been selected for the reception area, automatic lighting control (with natural light sensor) was selected for the control of SMD T8 luminaires, while a motion sensor was installed in the warehouse.

Table 114 Pilot 3 – Porposed EE action plan

Proposed solutions & EE action plan for Pilot 3						
Proposed solution - description	**Investment**	**Energy saving Type: -**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[kWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]

Installation of PV system with total capacity equal to 44.4kWp	26,500	52,736	5,820	27.95	4.6	54,571
Replacement of conventional bulbs with LED and sensors installation	2,686	8,469	1,609	1,974	1.7	9,841.85

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.3.3.5. Measurement and verification of the results

The SMEmPower M&T and M&V tools were not used. The analysis was based on third party software.

4.3.3.6. Energy management plan

Regarding the energy management plan, the following measures were proposed by the two (2) working groups:

- Smart meters installation to measure the energy consumption in several parts of the production process. Additionally, several KPIs can be adopted, to identify faults in real time.
- Rewarding of the employees who adopt energy efficiency measures.
- Staff training towards the improvement of the energy behavior (e.g., workshops organization related to every-day control and fix of issues occurred related to the compressed air system, to avoid waste in the air-compressor system of the company).
- Purchase of equipment aiming to trace technical malfunctioning (thermal camera, air leakage detector, etc.) or appointing an expert to implement yearly audits using proper equipment.

4.3.4. Pilot site 4

4.3.4.1. Introduction for data and current situation

Number of employees: 57

NACE Code: 17.12.59.00 / C17.2.9 - Manufacture of other articles of paper and paperboard

Description of the main activities:

The company is active in the manufacturing of cardboard, specifically in the production of monolayer smooth paper, exploiting recycled material. It is a medium-sized company, employing fifty-seven (57) people. The raw and auxiliary material used in the production process are equal to $4x10^7$ kg paper for

recycling, while the quantity of the products produced is equal to $3.4x10^7$ kg of paper. To cover the energy needs for the production process, electricity and natural gas are used.

Description of the technological process

The production process used by the company is the following:

1. The raw material, which consists of recycle paper and foreign materials to be removed, is pulped. Aim is to produce a clean and homogeneous pulp.
2. The pulp moves through a cyclone cleaner to retain the heavy materials, removing them.
3. Then it moves through successive screenings to remove other impurities.
4. The processed pulp is spread on the paper production line, containing 1.5-2% paper, with the rest being moisture. After this step, the pulp must contain only 5-6% moisture, with the rest being paper.
5. The moisture initially is removed through gravity, air gaps, presses and felts. After that, it is processed using superheated steam circulating in drums in the drying section (no direct contact with the paper). Through this process, the moisture is heated up and it is evaporated.
6. At the end of the paper production line, paper with proper characteristics (grammage, moisture, thickness, strength, surface finish, generally the color is not specified except for a few occasions – orders) is wrapped in a 2 meters wide roll. Then these rolls are cut depending on the order, packaged and stored.
7. In every step, the process is monitored through special measuring devices to check the specifications. The values are recorded to facilitate the tracking in case of malfunctioning.

The production process consists of eleven (11) parts, which are presented in the following table:

Table 115 Parts of the production process

NAME OF THE MACHINE	Power [kW]
AR-1	825
AR-2	739
AR-3	186
AR-4	528
AR-6	231
AR-8	124
AC-Drives	150
Couch Vacuum	90
REF2	250
Organic	134
UTILITIES (AIR-COMPRESSOR – BOILER ROOM – OTHER)	253

Figure 50 Raw material storing area

Figure 51 The raw material is transported via conveyor belt for the process to start

Figure 52 The conveyor belt in the pulping machine

Figure 53 The pulping machine smashes paper and converts it into pulp

Figure 54 Knives and screens of the pulping machine

Figure 55 Cyclone used to export heavy particles

Figure 56 Tank 1 of paper pulp and pump used for its transportation to tank 2

Figure 57 Screening machine to remove unwanted particles

Figure 58 Screen baskets. The clean pulp passes through the holes

Figure 59 Tank 2 and the pump used to transport the pulp to tank 3

Figure 60 Equipment for quality improvement of the paper pulp fibers located between tanks 2 & 3

Figure 61 Tank 3 and the pump used to transport pulp to tank 4

Figure 62 Tank 4 and the corresponding pump

Figure 63 The pulp in tank 4 reaches tank 3

Figure 64 Constant flow wet pulp tank

Figure 65 Paper production line

Figure 66 Air gaps for repelling moisture

Figure 67 Top former with air gap, for paper formatting

Figure 68 Air gaps

Figure 69 Machines used to reduce moisture and increase the paper strength

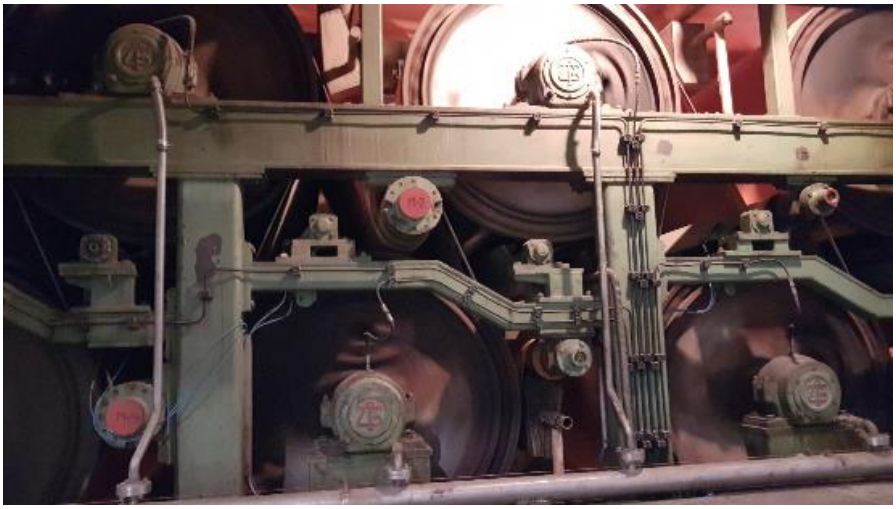


Figure 70 The paper circulates around the superheated steam drums in the drying section

Figure 71 Paper calendaring process

Figure 72 Quality control to monitor the grammage and the moisture of the final product

Figure 73 Paper cylinder ready for cutting

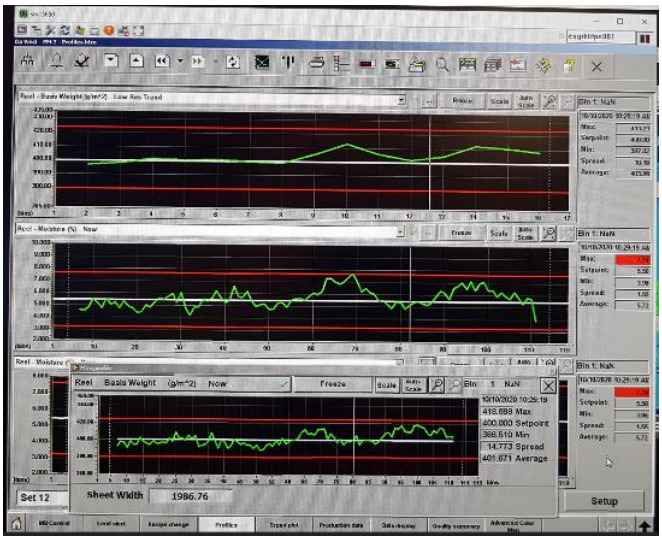


Figure 74 Controller monitor

Figure 75 Cutting machine

Figure 76 Product ready to get packaged

Figure 77 Shipping

Figure 78 Labelling and packaging

Figure 79 Final product stored in the warehouse

4.3.4.2. Characteristics of the buildings

General building description:

The company is located in its own eight (8) buildings, consisting of one (1) for offices, five (5) for production, and two (2) for warehouses (end products and motors). The total gross area (main and auxiliary buildings) is equal to 43,560 sqm, while the net area is equal to 35640 sqm.

Working hours: 7days/week, 24hours/day, excluding scheduled maintenance time periods (5-10 days during October, 2-4 per month, lasting 4-6 hours each, as well as 2-3 days during Christmas and Easter holidays)

During December 2019, energy auditing was implemented in the company related to the thermal energy, which resulted in the following energy efficiency measures: LED lighting, inverters, encoders (instead of tachogenerators), alternator reconstruction, vacuum pump upgrade, steam boiler with two stages economizer and fumes condensing chimney, anaerobic treatment.

Building envelope characteristics:

The building envelope consists mainly of industrial panels, while also there is some peripheral masonry. There are no other data available.

Technical characteristics of the heating, cooling, ventilation, and lighting systems:

Table 116 HVAC system

Space Heating	Gas boiler and split air-conditioning units to cover the needs of 800sqm area
Space Cooling	30 split air-conditioning units, total power 160kW, to cover the needs of 100sqm area
Hot water	2 double energy solar water heaters and an electric heater
Ventilation	Mechanical ventilation in the production area, 45kW
Lighting	LED, except for the office building

Table 117 Pilot 4 – Production data

Production – Pilot 4 Insert product name: paper				
	2017	**2018**	**2019**	**2020**
Month	**tn**	**tn**	**tn**	**tn**
January	2,660.17	2,576.47	2,912.31	1,986.52
February	2,619.91	2,598.01	2,634.15	2,649.47
March	2,860.29	2,739.73	2,997.60	2,873.48
April	2,893.28	2,748.10	2,514.20	2,848.31
May	2,941.62	2,925.05	2,917.48	2,791.49
June	2,799.53	2,996.18	2,886.17	2,912.90
July	2,977.93	3,219.35	3,006.59	2,853.88
August	3,021.23	2,982.77	2,781.07	3,031.73
September	2,932.42	3,206.51	3,073.13	2,222.75

October	2,234.03	2,788.46	2,124.65	3,153.04
November	2,778.75	2,203.19	2,968.25	2,909.29
December	2,685.54	2,568.91	2,483.80	2,732.42
TOTAL	**33,404.69**	**33,552.74**	**33,299.38**	**32,965.27**

4.3.4.3. Energy analysis

The monthly profiles of electricity and natural gas consumption are presented in the tables below:

Table 118 Pilot 4 – Energy consumption

Energy consumption – Pilot 4 Electricity				
	2017	**2018**	**2019**	**2020**
Month	[kWh]	[kWh]	[kWh]	[kWh]
January	880,923.80	828,931.40	896,073.20	621,596.80
February	836,288.20	819,976.40	807,761.00	846,662.40
March	850,198.20	845,002.00	855,010.60	892,422.60
April	864,304.00	795,351.40	710,765.20	843,570.00
May	891,966.60	863,554.80	853,168.20	845,108.60
June	855,629.40	850,665.20	834,701.00	856,981.80
July	922,740.40	919,571.80	860,588.60	858,308.00
August	963,640.40	853,481.40	900,112.00	838,146.60
September	919,290.20	881,038.60	911,811.40	687,925.61
October	744,151.60	807,619.20	648,718.80	855,137.60
November	871,762.80	673,628.20	863,882.20	821,330.60
December	819,163.00	794,603.40	764,679.20	765,340.60
TOTAL	**10,420,058.60**	**9,933,423.80**	**9,907,271.40**	**9,732,531.21**

Table 119 Pilot 4 – Natural gas

Energy consumption – Pilot 4 Natural Gas				
	2017	**2018**	**2019**	**2020**
Month	[MWh]	[MWh]	[MWh]	[MWh]
January	3,316.59	2,873.97	3,143.06	2,276.89
February	3,008.7	2,828.72	2,824.1	3,171.79
March	3,180.61	3,128.79	3,115.73	3,307.55
April	3,128.18	2,787.75	2,552.51	3,158.52
May	3,185.01	2,990.75	2,909.94	3,025.35
June	3,122.81	2,890.9	2,849.62	2,927.51
July	3,155.33	3,092.85	2,928.1	2,920.73
August	3,253.95	2,799.74	2,882.49	3,050.27
September	3,347.53	3,030.32	3,077.4	2,254.84
October	2,478.85	2,796.64	2,196.17	3,232.85

November	2,993.66	2,279.78	3,002.67	3,237.73
December	2,873.85	2,706.92	2,698.88	3,140.51
TOTAL	**37,045.07**	**34,207.14**	**34,180.67**	**35,704.52**

Table 120 Pilot 4 – Specific consumption

Specific consumption – Pilot 4				
	2017	**2018**	**2019**	**2020**
Month	**Specific electricity consumption [MWh/tn]**	**Specific electricity consumption [MWh/tn]**	**Specific electricity consumption [MWh/tn]**	**Specific electricity consumption [MWh/tn]**
January	0.331	0.321	0.306	0.312
February	0.319	0.315	0.285	0.319
March	0.297	0.308	0.282	0.310
April	0.298	0.289	0.292	0.296
May	0.303	0.295	0.289	0.302
June	0.305	0.283	0.286	0.294
July	0.309	0.285	0.323	0.300
August	0.318	0.286	0.296	0.276
September	0.313	0.274	0.305	0.309
October	0.333	0.289	0.291	0.271
November	0.313	0.305	0.307	0.282
December	0.305	0.309	0.306	0.280
AVERAGE	**0.312**	**0.297**	**0.299**	**0.296**

Table 121 Pilot 4 – Specific consumption

Specific consumption – Pilot 4				
	2017	**2018**	**2019**	**2020**
Month	**Specific thermal consumption [MWh/tn]**	**Specific thermal consumption [MWh/tn]**	**Specific thermal consumption [MWh/tn]**	**Specific thermal consumption [MWh/tn]**
January	1.247	1.115	1.079	1.146
February	1.148	1.089	1.072	1.197
March	1.112	1.142	1.039	1.151
April	1.081	1.014	1.015	1.109
May	1.083	1.022	0.997	1.084
June	1.115	0.965	0.987	1.005
July	1.060	0.961	0.974	1.023
August	1.077	0.939	1.036	1.006
September	1.142	0.945	1.001	1.014
October	1.110	1.003	1.034	1.025

November	1.077	1.035	1.012	1.113
December	1.070	1.054	1.087	1.149
AVERAGE	**1.110**	**1.024**	**1.028**	**1.085**

Table 122 Pilot 4 – Specific consumption

Specific consumption – Pilot 4				
	2017	**2018**	**2019**	**2020**
Month	**Specific total energy consumption [MWh/tn]**	**Specific total energy consumption [MWh/tn]**	**Specific total energy consumption [MWh/tn]**	**Specific total energy consumption [MWh/tn]**
January	1.578	1.437	1.387	1.459
February	1.468	1.404	1.379	1.517
March	1.409	1.450	1.325	1.462
April	1.380	1.304	1.298	1.405
May	1.386	1.318	1.290	1.387
June	1.421	1.249	1.277	1.299
July	1.369	1.246	1.260	1.324
August	1.396	1.225	1.360	1.283
September	1.455	1.220	1.298	1.324
October	1.443	1.293	1.339	1.297
November	1.391	1.341	1.303	1.395
December	1.375	1.363	1.394	1.429
AVERAGE	**1.423**	**1.321**	**1.326**	**1.382**

4.3.4.4. Proposed solution and EE action plan

1st Proposed Energy Efficiency Measure

The company has no monitoring system for measuring the electricity consumption. Thus, it is proposed to install a 'Metering System EnMS-Energy Consumption Management Platform'. Specifically, the investment on a project for installing an extensive energy metering system in all the high electricity consuming loads of the production process is proposed, accompanied by the corresponding software. Seventeen (17) 3-phase power loggers are necessary for measuring and analysis of the electricity consumption. In particular, the power loggers are about to be installed in the distribution transformers and in the large switchboards, considering the coupling points of the large loads and lines, along with the generators, as follows:

1. In the three (3) transformers
2. In the switchboard corresponding to AR1
3. In the refiner switchboard (pulping machine)
4. In the switchboard corresponding to AR2
5. In the switchboard corresponding to AR3
6. In the switchboard corresponding to AR4

7. In the switchboard corresponding to PM-58
8. In the switchboard corresponding to AR8
9. In the switchboard corresponding to AC-Drives
10. In the switchboard corresponding to AR6
11. In the switchboard corresponding to the boiler room
12. In the switchboard corresponding to the air-compressors
13. In the switchboard corresponding to the lighting
14. In the 100kVA generator 1
15. In the 200kVA generator 2

The seventeen (17) power loggers can monitor approximately the total electricity consumption. The metering devices will be connected in a network connected to a host computer. Appropriate communication software, data collection, real-time data display, database design, data processing and automated report generation will be installed in the computer. The proposed metering system is expandable, to accept additional loggers for individual loads or individual motors.

Minimum requirements from the metering devices include: voltage, current, active power, reactive power, apparent power, power coefficient, harmonics power coefficient, voltage-current harmonics analyzer, frequency.

The use of the proposed monitoring system will help in the continuous monitoring of the specific energy consumption (kWh/tn) per production line and per product. Therefore, it will be able to accurately calculate the cost of the production process, and the expected energy consumption that corresponds to given production. Moreover, the real-time display of the measurements will contribute to the reduction of downtime of the production process through the immediate fault detection, while also providing data to facilitate the equipment maintenance.

To achieve the above-mentioned targets, it is important to train the staff to be able to use efficiently the equipment, and to proper utilize the collected data.

The investment cost of the proposed monitoring system is estimated to 15,500€, including the commissioning and installation of all the metering devices and software. In particular, the average cost of each monitoring system (hardware), which includes the seventeen (17) power loggers to be installed, three (3) current transformers depending on the rated power of the monitored load, the communication subsystem (module), the installation costs, as well as the commissioning subsystem, is equal to 500€/logger. Therefore, the total cost of the seventeen (17) loggers is equal to 8,500€. The cost of the energy management platform (software) is approximately equal to 7,000€, including the following subsystems (modules):

- Real-time monitoring
- Automatic reports
- Cost center allocation
- Energy consumption modeling
- Measurement and verification

2nd Proposed Energy Efficiency Measure

The Harmonics Passive Filters Installation and the Improvement of the Motors Power Coefficient is proposed as a second measure for achieving energy efficiency improvement in the company.

3rd Proposed Energy Efficiency Measure

The installation of speed controllers was chosen as an energy saving measure, replacing the simple star-delta starters.

The following pumps have been selected:

1. **Pump T1:** Function: the pulp is exported from the 1st tank (T1) and through a screening basket > 3cm, where certain pressure is needed at the inlet, the pulp is ducted to the 2nd tank (T2)
2. **Pump T3:** Function: the pulp is exported from the 3rd tank (T3), and while controlling the flow through choke valve, the pulp is ducted to the 4th tank (T4). Water is added and the density is controlled and adjusted.
3. **1st and 2nd metal tank pumps:** one in operation and one stand-by. Water that contains fibers of paper is ducted to the metal tank through natural flow. Their purpose is to duct these fibers to the 1st tank (T1). Their operation is controlled by a float procedure, through an immersed 4-20 mA level-pressure transmitter.

Table 123 Pilot 4 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 4						
Proposed solution - description	**Investment**	**Energy saving Type: -**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[kWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]
Metering System EnMS-Energy Consumption Management Platform	15,500	680,000	24,000	249.4	0.65	179161 (10 years, i = 4%)
Harmonics Passive Filters Installation and Improvement of the Motors Power Coefficient	46,500	21,4000	19,169	122.4	2.5	6,720.70
VFD system installation in pumps T1, T3 and two metal tank pumps	28,700	356,550	28,333.20	187.90	1.01	47,517.77

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.3.4.5. Measurement and verification of the results

<u>1st Proposed Energy Efficiency Measure</u>

For the verification of the 1st proposed energy efficiency measure, the project M&V tool was utilized. The data corresponding to 2020 were used, which were considered as baseline, i.e., depicting the situation before the implementation of energy efficiency measures. The calculation of the target was implemented manually, for expected saving percentage equal to 1.5%, uniformly distributed among the months. For the year after the implementation of the energy savings measure, the production and consumption data corresponding to 2020 were considered, with the consumption values being 1.5% less than the ones before the applied measures.

The values of real production and consumption of the year 2020 and the energy saving target

	Duration	Real - before the energy efficiency implementation			Manual target			
	Month	Production	Consumption	Specific Consumption	Target consumption reduction	Target consumption	Production	Specific Consumption
		[tn]	[MWh]	[kWh/tn]	[%]	[MWh]	[tn]	[kWh/tn]
1	JAN	1987	2898,5	1459,08	1,5	2855,0	1987	1437,2
2	FEB	2649	4018,5	1516,70	1,5	3958,2	2649	1493,9
	MARCH	2873	4200,0	1461,63	1,5	4137,0	2873	1439,7
4	APRIL	2848	4002,1	1405,08	1,5	3942,1	2848	1384,0
5	MAY	2791	3870,5	1386,52	1,5	3812,4	2791	1365,7
6	JUNE	2913	3784,5	1299,22	1,5	3727,7	2913	1279,7
7	JULY	2854	3779,0	1324,17	1,5	3722,3	2854	1304,3
8	AUG	3032	3888,4	1282,57	1,5	3830,1	3032	1263,3
9	SEPT	2223	2942,8	1323,93	1,5	2898,6	2223	1304,1
10	OCT	3153	4088,0	1296,52	1,5	4026,7	3153	1277,1
11	NOV	2909	4059,1	1395,21	1,5	3998,2	2909	1374,3
12	DEC	2732	3905,8	1429,44	1,5	3847,3	2732	1408,0
	TOTAL	32965	45437	1378,3		44755,5	32965,3	1357,7

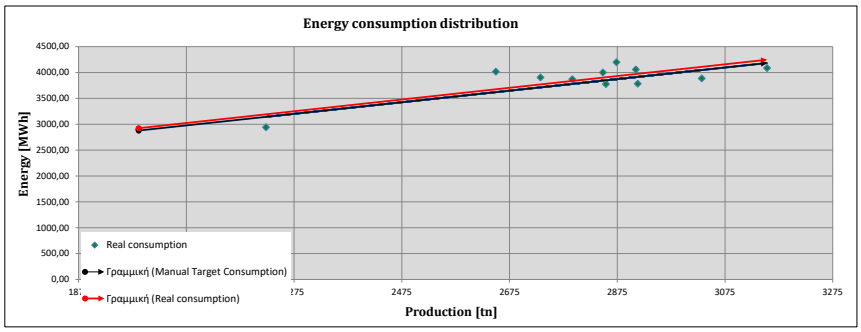


Figure 80 Energy consumption depending on the energy production based on the real data and after the implementation of the proposed energy savings measure

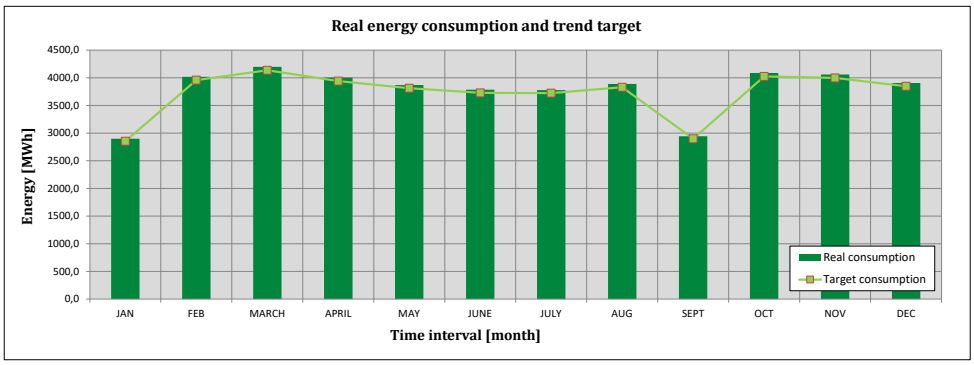


Figure 81 Real energy consumption and trend target

Insert data after energy conservation measures				
No.	Duration	Real - after the energy efficiency implementation		
	Month	Production	Consumption	KPI
		[tn]	[MWh]	[kWh/tn]
1	JAN	1987	2855,0	1437,20
2	FEB	2649	3958,2	1493,95
3	MARCH	2873	4137,0	1439,71
4	APRIL	2848	3942,1	1384,00
5	MAY	2791	3812,4	1365,72
6	JUNE	2913	3727,7	1279,73
7	JULY	2854	3722,3	1304,31
8	AUG	3032	3830,1	1263,33
9	SEPT	2223	2898,6	1304,07
10	OCT	3153	4026,7	1277,07
11	NOV	2909	3998,2	1374,28
12	DEC	2732	3847,3	1408,00
TOTAL		32965	44755	1357,7

Figure 82 Consumption values for year 2020 and the real production values, reduced in 1.5% after the implementation of energy savings measure

Utility type	After the energy efficiency implementation									
							Unit price [euro/MWh]			
							101			
Measured and verified achieved energy saving										
Utility type	Before the energy efficiency implementation									
	Specific energy use				Total energy use					
		1378,3	[kWh/[...]]			45437	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation								681,6	[MWh/yr.]
	Specific energy use				Total energy use			Achieved cost savings		
		1357,7	[kWh/[...]]			44755	[MWh/yr.]		68837	[euro/yr.]

Figure 83 Energy and cost savings achieved through the implementation of the proposed measure, based on 2020 production and consumption data

2nd Proposed Energy Efficiency Measure

The verification of the proposed measure was done using the project M&V tool. The results are presented below:

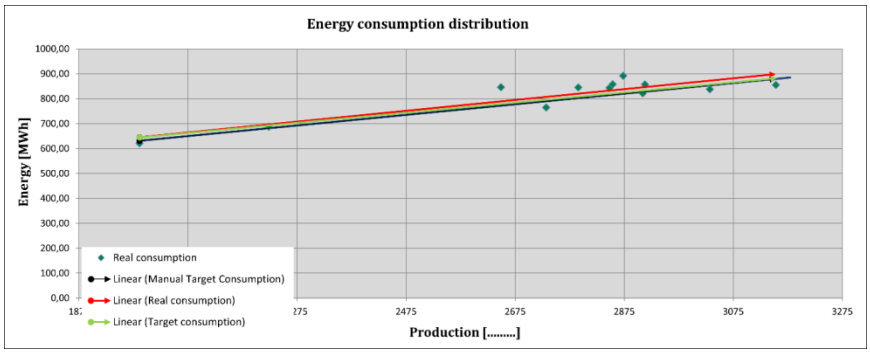


Figure 84 M&V results

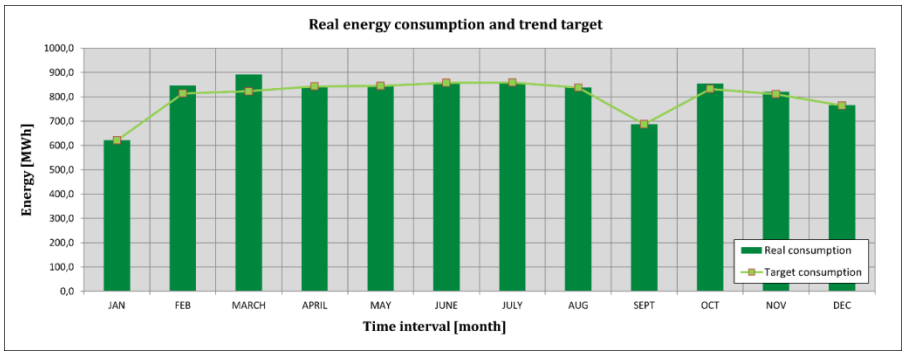


Figure 85 M&V results

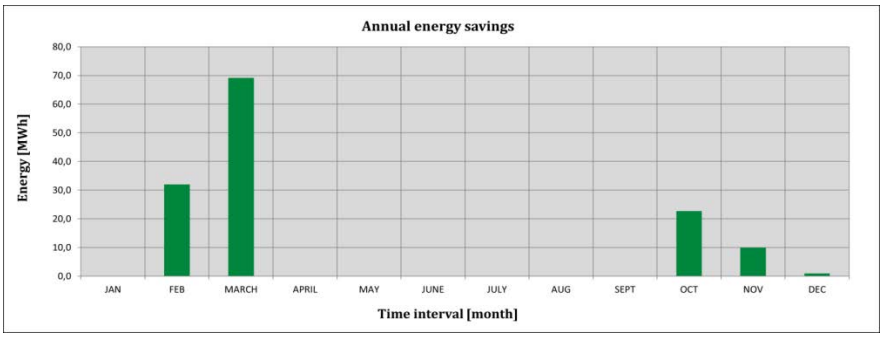


Figure 86 M&V results

Measurement and Verification													
No.	Duration	Real - after the energy efficiency implementation		Verification									
	Month	Production	Measured consumption	Estimated consumption based on baseline trend	Estimated consumption based on target optimized trend	Estimated consumption based on target manual trend	Baseline trend SAV %	Optimized target trend SAV %	Manual target trend SAV %	Baseline trend conclusion	Optimal trend conclusion	Manual trend conclusion
		[tonnes]	[MWh]	[MWh]	[MWh]							
1	JAN	1986	607,3	645,2	644,3	631,0	-5,9	-5,7	-3,7	energy saving	energy saving	energy saving
2	FEB	2649	827,4	789,4	779,5	772,0	4,8	6,1	7,2	not energy saving	not energy saving	not energy saving
3	MARCH	2673	872,4	838,1	825,1	819,7	4,1	5,7	6,4	not energy saving	not energy saving	not energy saving
4	APRIL	2648	824,5	832,7	820,0	814,3	-1,0	0,5	1,2	energy saving	not energy saving	not energy saving
5	MAY	2791	826,4	820,3	808,4	802,2	0,8	2,2	3,0	not energy saving	not energy saving	not energy saving
6	JUNE	2913	838,1	846,8	833,3	828,2	-1,0	0,6	1,2	energy saving	not energy saving	not energy saving
7	JULY	2854	839,1	834,0	821,2	815,6	0,6	2,2	2,9	not energy saving	not energy saving	not energy saving
8	AUG	3032	819,6	872,7	857,5	853,5	-6,1	-4,4	-4,0	energy saving	energy saving	energy saving
9	SEPT	2223	671,9	695,7	692,6	681,4	-3,6	-3,0	1,4	energy saving	energy saving	energy saving
10	OCT	3153	936,2	899,0	882,2	879,2	-7,0	-5,2	-4,9	energy saving	energy saving	energy saving
11	NOV	2909	802,9	845,9	832,5	827,3	-5,1	-3,5	-2,9	energy saving	energy saving	energy saving
12	DEC	2732	748,2	807,4	796,4	789,7	-7,3	-6,1	-5,3	energy saving	energy saving	energy saving
TOTAL		32963	9514,0	9726,0	9593,2	9514,0	-2,2	-0,8	0,0	energy saving	energy saving	energy saving

Figure 87 M&V results

It is proved that the estimated energy saving can be achieved.

4.3.4.6. Energy management plan

Regarding the energy management plan, the following measures were proposed:

- Smart meter installation to measure continuously the electric energy consumption of the company. Direct notification of the energy manager when the consumed power/energy exceeds the predefined limits.
- Rewarding of the employees who identify/implement energy efficiency measures.
- Staff training to improve their energy behavior (e.g., training, information and awareness-raising actions).
- Control of KPIs to identify problems on-time.
- Monitoring of the technology trends in the market, to decide on investments in new equipment to improve the energy efficiency or to increase the energy savings.

Establishment of an energy management team, consisting of members of the production, technical and administration staff, that will have regular meetings to evaluate the energy profile of the company. The same team could be appointed to monitor the company energy indicators.

4.3.5. Pilot site 5

4.3.5.1. Introduction for data and current situation

Number of employees: 25

NACE Code: C23.19.00 Manufacture and processing of other glass, including technical glassware

Description of the main activities:

The company designs and manufactures carbon cylinders, using composite materials through the filament winding process around metallic substrate. Cylindrical constructions with up to 1800mm diameter and a total length of 12,000mm can be produced. Fiberglass, carbon fibre, resin systems, films and pre-impregnated sheets are used as raw materials. The composite materials are characterized by their high-quality mechanical properties, while leading to lightweight products, an

advantage compared to their metallic counterparts. Their much lower weight, without affecting their mechanical strength, makes their production process environmentally friendly, as the machines are operating consuming significantly less electrical energy.

The production process consists of three (3) production lines (filament winding), two (2) curing ovens, one (1) 4-axis CNC turning center, one (1) 4-axis processing center with the ability to process pieces up to 4000mm long, and one (1) 3-axis turning machine capable of processing pieces up to 3000mm long, for the processing of semi-finished products.

Description of the technological process

The technological process is built upon three (3) filament winding production lines.

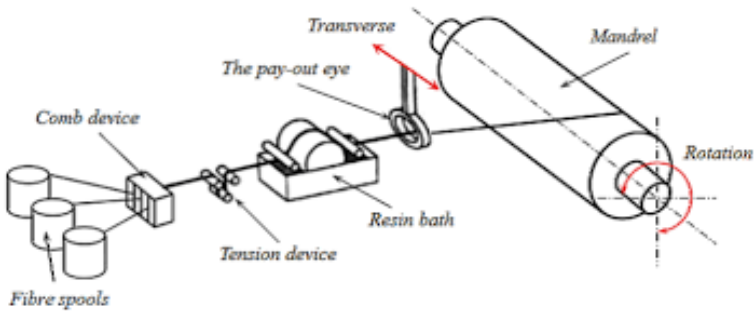


Figure 88 Filament Winding technique

Figure 89 Filament Winding

- The filament winding technique around a metallic substrate is the construction technique used mainly for the construction of open (cylinders) or closed (pressure vessels or tanks) structures.
- The process involves the on-load filament winding around a rotating shaft-substrate-mandrel. The substrate rotates around its axis (Axis 1 or X), while the delivery eye (Axis 3-4 or Z-W) placed on a carriage (Axis 2 or Y) crosses horizontally the axis of the rotating substrate, placing the fibers in the desired pattern or angle.
- The most common fibers are the fiberglass and the carbon fiber. They are soaked with resin and then rolled up on the substrate. Once the substrate coating is completed, i.e., the desired thickness is achieved, the resin polymerization process follows.
- Depending on the resin system and its characteristics, the rotating shaft-mandrel is often placed in an oven or under infrared radiation heaters until the polymerization process is completed.
- Once the resin has acquired its final characteristics, the shaft-mandrel is removed or extracted, providing the hollow end product.
- For some products, such as gas cylinders, the 'shaft' can stay as a permanent part of the end product, to form a liner to prevent gas leakage, or as a barrier to protect the composite material from the fluid to be stored.
- The filament winding is suitable for automation, while there are many applications, such as pipes and small pressure vessels that are wound and treated without human intervention. The control variables for winding are the fiber type, the resin content, the wind angle, the bar or bandwidth and the fiber bundle thickness. The angle affects the properties of the final

product. A high angle 'rim' will provide perimeter strength, while lower angle models (polar or helical) will provide greater longitudinal / axial tensile strength.

4.3.5.2. Characteristics of the buildings

General building description:

The company facilities consist of:

1. Five (5) production buildings, with total area equal to 5000 sqm (year of construction: 2009)
2. One (1) warehouse building (year of construction: 2009)
3. One (1) office building, with total area equal to 980 sqm (year of construction: 2010)

Opening hours: 08:00 – 17:00, throughout the whole year.

The company procedures comply with the Energy Management standard, ISO 14001.

Building envelope characteristics:

The envelope characteristics of the **offices building** are presented below:

Table 124 Pilot 5 – Building characteristics

	Construction material	Thermal insulation
External masonry	Double bricklaying with intermediate thermal insulation on reinforced concrete body	Yes (5cm EPS)
Roof	Wooden	Yes (10cm EPS)
Window frames	PVC frame, double glazing	–

The envelope characteristics of the **production buildings** are presented below:

Table 125 Pilot 5 – Building characteristics

	Construction material	Thermal insulation
External masonry	Metal frame with polyurethane panels	Yes (5cm polyurethane)
Roof	Polyurethane panels	Yes (5cm polyurethane)

Technical characteristics of the heating, cooling, ventilation, and lighting systems:

Table 126 Pilot 5 – HVAC system

Space Heating - Cooling (Offices)	Heating (October to April) with floor LPG fan coils and with auxiliary air-conditioning units used mainly for cooling
Space Heating – Cooling (Production area)	Heating (October to April) mainly with LPG infrared radiation mirrors. Air-conditioning of two quality control rooms (ensuring constant temperature equal to 20°C) using two (2) air-conditioning units.
Hot water	–
Ventilation (Production area)	Two (2) central ventilation units of 15kW total power. Local fans, six (6) motors of 3kW total power.

Lighting (Offices)	LED
Lighting (Production area)	LED Mirror light tubes, for natural light exploitation

Two (2) PV systems with total installed capacity equal to 200kW have been installed near company facilities. The used energy billing policy is the Feed-in-Tariff.

Table 127 Pilot 5 – Production data

Production – Pilot 5 Insert product name: cylindrical products				
	2017	**2018**	**2019**	**2020**
Month	**pieces**	**pieces**	**pieces**	**pieces**
January	140	250	363	333
February	210	237	444	753
March	285	403	1351	772
April	171	347	296	557
May	168	496	193	702
June	111	621	351	396
July	180	198	450	615
August	173	530	349	220
September	208	395	958	397
October	197	570	525	657
November	158	332	344	552
December	186	108	573	670
TOTAL	**2,187**	**4,487**	**6,197**	**6,624**

Table 128 Pilot 5 –Production data

Production – Pilot 5 Insert product name: cylindrical products				
	2017	**2018**	**2019**	**2020**
Month	**used raw material [kg]**	**used raw material [kg]**	**used raw material [kg]**	**used raw material [kg]**
January	1,003.437	1,114.93	3,109.34	3,699.91
February	1,519.888	1,899.86	4,730.03	6,021.50
March	3,268.645	3,533.67	5,803.64	4,791.65
April	2,341.976	2,927.47	3,133.89	7,476.52
May	2,842.093	5,413.51	2,764.44	3,288.75
June	2,711.441	5,239.50	2,662.13	1,312.26
July	4,637.697	5,096.37	6,477.74	5,072.17
August	2,999.808	3,571.20	4,695.29	1,466.58
September	1,790.864	2,295.98	4,753.43	3,026.43
October	4,982.168	5,357.17	6,557.75	3,644.63

November	3,333.584	3,876.26	2,922.99	4,636.45
December	638.633	818.76	4,329.33	3,931.72
TOTAL	**32,070.23**	**41,144.68**	**51,940.00**	**48,368.57**

4.3.5.3. Energy analysis

The monthly profiles of electricity and LPG consumption are presented in the tables below:

Table 129 Pilot 5 – Electricity consumption

Energy consumption – Pilot 5 Electricity				
	2017	**2018**	**2019**	**2020**
Month	**[kWh]**	**[kWh]**	**[kWh]**	**[kWh]**
January	9,840	14,400	15,280	15,680
February	10,080	13,040	14,320	16,480
March	8,560	13,760	12,560	13,760
April	5,360	10,720	11,280	13,840
May	6,480	10,640	11,200	10,800
June	6,480	11,360	9,520	9,680
July	7,040	11,200	11,520	12,800
August	7,120	9,280	10,800	9,040
September	6,320	9,680	11,600	12,080
October	7,360	10,800	11,440	14,000
November	11,120	11,200	12,880	16,000
December	10,400	10,560	12,240	16,400
TOTAL	**96,160**	**136,640**	**144,640**	**160,560**

Table 130 Pilot 5 – LPG consumption

Energy consumption – Pilot 5 LPG								
	2017		**2018**		**2019**		**2020**	
Month	**[lt]**	**[€/lt]**	**[lt]**	**[€/lt]**	**[lt]**	**[€/lt]**	**[lt]**	**[€/lt]**
January	–	–	1,000	0.94	950	0.85	1,952	1.03
February	–	–	–	–	738	0.92	–	–
March	–	–	–	–	–	–	–	–
April	–	–	–	–	–	–	2,510	0.74
May	–	–	–	–	–	–	–	–
June	–	–	–	–	–	–	–	–
July	–	–	–	–	–	–	–	–
August	2,300	0.45	–	–	–	–	–	–
September	–	–	1250	0.53	–	–	–	–

October	–	–	–	–	–	–	–	–
November	–	–	–	–	2,603	0.91	–	–
December	–	–	–	–	–	–	1,209	0.75
TOTAL	**2,300**	**1,035.00€**	**2250**	**1,602.50€**	**4,291**	**3,855.19€**	**5,671**	**4,774.71€**

Table 131 Pilot 5 – Specific consumption

Specific consumption – Pilot 5				
	2017	**2018**	**2019**	**2020**
Month	**Specific energy consumption [kWh/piece]**	**Specific energy consumption [kWh/piece]**	**Specific energy consumption [kWh/piece]**	**Specific energy consumption [kWh/piece]**
January	70.28571	57.6	42.09366	47.08709
February	48	55.0211	32.25225	21.88579
March	30.03509	34.14392	9.296817	17.82383
April	31.34503	30.89337	38.10811	24.8474
May	38.57143	21.45161	58.03109	15.38462
June	58.37838	18.29308	27.12251	24.44444
July	39.11111	56.56566	25.6	20.81301
August	41.15607	17.50943	30.94556	41.09091
September	30.38462	24.50633	12.10856	30.42821
October	37.36041	18.94737	21.79048	21.30898
November	70.37975	33.73494	37.44186	28.98551
December	55.91398	97.77778	21.36126	24.47761
AVERAGE	**45.91013**	**38.87038**	**29.67935**	**26.54812**

Table 132 Pilot 5 – specific consumption

Specific consumption – Pilot 5				
	2017	**2018**	**2019**	**2020**
Month	**Specific energy consumption [kWh/kg]**	**Specific energy consumption [kWh/kg]**	**Specific energy consumption [kWh/kg]**	**Specific energy consumption [kWh/kg]**
January	9.8063	12.9156	4.91423	4.23794
February	6.63207	6.86366	3.02746	2.73686
March	2.61882	3.89397	2.16416	2.87166
April	2.28867	3.66187	3.59936	1.85113
May	2.28001	1.96545	4.05145	3.28392
June	2.38987	2.16815	3.57608	7.37659
July	1.51799	2.19764	1.7784	2.52357
August	2.37349	2.59857	2.30018	6.164

September	3.52902	4.21606	2.44034	3.9915
October	1.47727	2.01599	1.7445	3.84127
November	3.33575	2.88938	4.40645	3.45092
December	16.2848	12.8976	2.82723	4.1712
AVERAGE	**4.5445**	**4.85699**	**3.06915**	**3.87505**

Assuming temperature setpoint equal to 18°C and using meteorological data for the region where the company is located, the hot days (HDD) were calculated. The results are provided in the following table:

Table 133 HDD per month data

HDD per month			
Month	**Mean monthly temperature [°C]**	**Temperature setpoint [°C]**	**HDD**
January	0.6	18	539.4
February	2.8	18	425.6
March	7.0	18	341
April	11.7	18	189
May	16.9	18	34.1
June	21.1	18	0
July	23.4	18	0
August	22.8	18	0
September	18.2	18	0
October	12.9	18	158.1
November	7.2	18	324
December	2.0	18	496

4.3.5.4. Proposed solution and EE action plan

1st Proposed Energy Efficiency Measure – Installation of solar thermal system

Solar thermal systems collect solar radiation and convert it into thermal energy. There are different types of solar thermal systems and the difference lies in the water temperatures that they can achieve, i.e., low, medium or high temperature collectors. High temperature solar thermal systems can be also used to generate electricity as concentrated solar power systems.

Low and medium temperature collectors are flat plates that use solar energy to heat water in the frame. These systems do not produce electricity. They produce hot water for domestic or industrial use.

The vacuum tube collectors trap solar energy inside the vacuum tube, resulting in low to minimal heat losses to the environment. Thus, higher temperatures are achieved in cold days than the ones achieved using conventional solar heater collectors. However, their efficiency is lower under full sunshine conditions. Moreover, the vacuum tube collector useful life is over 25 years, in contrast to

the conventional collector useful life, where the efficiency gradually decreases over time. Global research has shown that their efficiency is 30-40% higher compared to flat collectors. Also, after 10-15 years, 40% is the maximum efficiency reduction, meaning that after 15 years they will have about the same efficiency as the flat collectors at their first year.

The water heated by the solar collectors will be collected in a 2000 lt tank. Then, through a heat exchanger, the hot air, reaching temperatures up to 90°C, will be channeled into the oven through the existing air supply system. The product polymerization is implemented in two phases, in 90°C for 2 hours and in 150-200°C for 3-5 hours. Through the solar thermal collector system, no electricity consumption will be needed for the first heating phase of the oven to 90°C, thus resulting in significant energy savings. The first phase needs 48kW, while the second one needs 80kW.

For the extraction of the results provided in the table below, two different cases are studied, as follows:

1. It is considered that the second polymerization phase lasts for 4 hours in 180°C, with 0.078€/kWh electricity price.
2. It is considered that the second polymerization phase lasts for 3 hours in 150°C, with 0.11€/kWh and 264 operation days. When the external temperature is low (during Autumn, Winter and beginning of Spring) the excess thermal energy produced may be used for space heating of the Administrative building, through heating the fan coils in offices area, achieving higher energy savings for the company.

<u>2nd Proposed Energy Efficiency Measure – Installation of photovoltaic system + Net-metering</u>

The installation of photovoltaic system on the roof of the offices building is proposed, applying Net-metering as energy billing policy. Two (2) separate cases are studied:

1. Total installed capacity equal to 107kWp.
   - Characteristics: 107.1kW DC power, 100kW AC power, DC/AC ratio equal to 1.07.
   - Total yearly nominal capacity equal to 157,550kWh
   - Total yearly usable capacity equal to 78,775kWh
   - Installation costs equal to 50,000€
   - Expected income equal to 6,144€/year (0.078€/kWh)
2. Total installed capacity equal to 62.54kWp.
   - The panels are proposed to be installed with azimuth equal to 51°, and slope equal to 0.
   - 118 monocrystalline solar panels with nominal power equal to 530kWp, with efficiency equal to 20.99%.
   - Cost of panels: 262€/panel
   - Inverter cost: 4,200€
   - Installation costs: 9,500€

Table 134 Pilot 5 – PV data

Database used:	PVGIS-SARAH
PV technology:	Crystalline silicon
PV installed [kWp]:	62.45
System loss [%]:	20
Simulation outputs:	
Slope angle [B°]:	0
Azimuth angle [B°]:	51
Yearly PV energy production [kWh]:	65,280.84
Yearly in-plane irradiation [kWh/sqm]:	1,498.37
Year-to-year variability [kWh]:	2,813.24
Changes in output due to:	
Angle of incidence [%]:	-3.64
Spectral effects [%]:	0.78
Temperature and low irradiance [%]:	-10.2
Total loss [%]:	-30.24
PV electricity cost [per kWh]:	0,11€

<u>3rd Proposed Energy Efficiency Measure – Replacement of conventional lighting bulbs</u>

The replacement of 44 old conventional lighting bulbs with LED is also proposed.

- Old conventional lighting bulbs: 60W, New LED bulbs: 8W
- 2,400 hours of operation

Table 135 Pilot 5 – Proposed EE action p

Proposed solutions & EE action plan for Pilot 5						
Proposed solution - description	**Investment**	**Energy saving Type: -**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**
	[EUR]	[kWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]
Installation of solar thermal system – 1	16,000	28,800	2,446	6.7	10	7.371
Installation of solar thermal system – 2	16,000	25,344	2,788	25.065	5.74	15,978.14
PV system installation + Net-metering – 1	50,000	78,775	6,144	183.7	15	20,468
PV system installation + Net-metering – 2	44,616	42,966.85	4,726.35	42.494	9.04	1,0902.46
Replacement of light bulbs with LED	2,200	17,971	1,400	4.2	7	7,350

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.3.5.5. Measurement and verification of the results

Considering the period 2019-2020 as the study period, the project M&V tool was used for energy monitoring and targeting according to the International Performance Measurement and Verification Protocol (IPMVP).

For the calculation of the results from the two linear regressions predicted by the M&V tool, the official Greek tool for energy auditing was used with correlation of the consumed energy with the production and the hot days through multiple linear regression. The following results were used:

Dmax	2,203 (kWh)
Dmin	-2,832 (kWh)
Consumption (min)	9,040 (kWh)
Tc (min)	-6,208 (kWh)
Tc(max)	5,035 (kWh)

The following results were extracted using the M&V tool:

Table 136 Production and energy consumption data

No.	Duration	Real - before the energy efficiency implementation		
	Month	Production	Consumption	Specific Consumption
		[kgr]	[kWh]	[kWh/kgr]
1	January 2019	3,109.34	15,280.0	4.914
2	February 2019	4,730.03	14,320.0	3.027
3	March 2019	5,803.64	12,560.0	2.164
4	April 2019	3,133.89	11,280.0	3.599
5	May 2019	2,764.44	11,200.0	4.051
6	June 2019	2,662.13	9,520.0	3.576
7	July 2019	6,477.74	11,520.0	1.778
8	August 2019	4,695.29	10,800.0	2.300
9	September 2019	4,753.43	11,600.0	2.440
10	October 2019	6,557.75	11,440.0	1.745
11	November 2019	2,922.99	12,880.0	4.406
12	December 2019	4,329.33	12,240.0	2.827
13	January 2020	3,699.91	15,680.0	4.238

14	February 2020	6,021.50	16,480.0	2.737
15	March 2020	4,791.65	13,760.0	2.872
16	April 2020	7,476.52	13,840.0	1.851
17	May 2020	3,288.75	10,800.0	3.284
18	June 2020	1,312.26	9,680.0	7.377
19	July 2020	5,072.17	12,800.0	2.524
20	August 2020	1,466.58	9,040.0	6.164
21	September 2020	3,026.43	12,080.0	3.992
22	October 2020	3,644.63	14,000.0	3.841
23	November 2020	4,636.45	16,000.0	3.451
24	December 2020	3,931.72	16,400.0	4.171
TOTAL		**100,308.57**	**305,200.0**	**3.043**

Table 137 Optimized energy consumption

No.	Duration	Optimized		
	Month	Production	Consumption	Specific Consumption
		[kgr]	[kWh]	[kWh/kgr]
1	January 2019	3,109.34	13,169.0	4.235
2	February 2019	4,730.03	12,812.0	2.709
3	March 2019	5,803.64	12,502.0	2.154
4	April 2019	3,133.89	10,366.0	3.308
5	May 2019	2,764.44	8,996.0	3.254
6	June 2019	2,662.13	8,687.0	3.263
7	July 2019	6,477.74	9,997.0	1.543
8	August 2019	4,695.29	9,385.0	1.999
9	September 2019	4,753.43	9,405.0	1.979
10	October 2019	6,557.75	11,293.0	1.722
11	November 2019	2,922.99	11,377.0	3.892
12	December 2019	4,329.33	12,240.0	2.827
13	January 2020	3,699.91	13,372.0	3.614
14	February 2020	6,021.50	13,256.0	2.201
15	March 2020	4,791.65	12,155.0	2.537
16	April 2020	7,476.52	11,856.0	1.586
17	May 2020	3,288.75	9,176.0	2.790
18	June 2020	1,312.26	8,224.0	6.267
19	July 2020	5,072.17	9,515.0	1.876
20	August 2020	1,466.58	8,277.0	5.644
21	September 2020	3,026.43	8,812.0	2.912
22	October 2020	3,644.63	10,293.0	2.824
23	November 2020	4,636.45	11,965.0	2.581
24	December 2020	3,931.72	13,103.0	3.333
TOTAL		**100,308.57**	**260,233.0**	**2.594**

Table 138 Potential estimated energy consumption savings

No.	Duration	Potential estimated savings		
	Month	Savings	Potential savings - Specific Consumption	
		[kWh]	[kWh/kgr]	[%]
1	January 2019	2,111.0	0.68	13.8
2	February 2019	1,508.0	0.32	10.5
3	March 2019	58.0	0.01	0.5
4	April 2019	914.0	0.29	8.1
5	May 2019	2,204.0	0.80	19.7
6	June 2019	833.0	0.31	8.8
7	July 2019	1,523.0	0.24	13.2
8	August 2019	1,415.0	0.30	13.1
9	September 2019	2,195.0	0.46	18.9
10	October 2019	147.0	0.02	1.3
11	November 2019	1,503.0	0.51	11.7
12	December 2019	0.0	0.00	0.0
13	January 2020	2,308.0	0.62	14.7
14	February 2020	3,224.0	0.54	19.6
15	March 2020	1,605.0	0.33	11.7
16	April 2020	1,984.0	0.27	14.3
17	May 2020	1,624.0	0.49	15.0
18	June 2020	1,456.0	1.11	15.0
19	July 2020	3,285.0	0.65	25.7
20	August 2020	763.0	0.52	8.4
21	September 2020	3,268.0	1.08	27.1
22	October 2020	3,707.0	1.02	26.5
23	November 2020	4,035.0	0.87	25.2
24	December 2020	3,297.0	0.84	20.1
TOTAL		**44,967.0**	**0.45**	**14.7**

Installation of solar thermal system – 2

Table 139 Solar thermal system information

	Installation of solar thermal system – 2			
Month	Target consumption reduction	Target consumption	Production	Specific Consumption
	[kWh]	[kWh]	[kgr]	[kWh/kgr]
1	2,788.00	12,492.0	3,109.34	4.018
2	2,788.00	11,532.0	4,730.03	2.438
3	2,788.00	9,772.0	5,803.64	1.684

4	2,788.00	8,492.0	3,133.89	2.710
5	2,788.00	8,412.0	2,764.44	3.043
6	2,788.00	6,732.0	2,662.13	2.529
7	2,788.00	8,732.0	6,477.74	1.348
8	2,788.00	8,012.0	4,695.29	1.706
9	2,788.00	8,812.0	4,753.43	1.854
10	2,788.00	8,652.0	6,557.75	1.319
11	2,788.00	10,092.0	2,922.99	3.453
12	2,788.00	9,452.0	4,329.33	2.183
13	2,788.00	12,892.0	3,699.91	3.484
14	2,788.00	13,692.0	6,021.50	2.274
15	2,788.00	10,972.0	4,791.65	2.290
16	2,788.00	11,052.0	7,476.52	1.478
17	2,788.00	8,012.0	3,288.75	2.436
18	2,788.00	6,892.0	1,312.26	5.252
19	2,788.00	10,012.0	5,072.17	1.974
20	2,788.00	6,252.0	1,466.58	4.263
21	2,788.00	9,292.0	3,026.43	3.070
22	2,788.00	11,212.0	3,644.63	3.076
23	2,788.00	13,212.0	4,636.45	2.850
24	2,788.00	13,612.0	3,931.72	3.462
TOTAL	**66,912.0**	**238,288.0**	**100,308.57**	**2.376**

PV system installation + Net-metering – 2

Table 140 PV system installation

Duration	PV system installation + Net-metering – 2			
Month	**Target consumption reduction**	**Target consumption**	**Production**	**Specific Consumption**
	[kWh]	**[kWh]**	**[kgr]**	**[kWh/kgr]**
1	2,276.42	13,003.6	3,109.34	4.182
2	2,897.18	11,422.8	4,730.03	2.415
3	4,756.84	7,803.2	5,803.64	1.345
4	6,466.04	4,814.0	3,133.89	1.536
5	7,807.14	3,392.9	2,764.44	1.227
6	8,592.46	927.5	2,662.13	0.348
7	9,295.80	2,224.2	6,477.74	0.343
8	8,363.46	2,436.5	4,695.29	0.519
9	5,704.92	5,895.1	4,753.43	1.240
10	4,224.81	7,215.2	6,557.75	1.100
11	2,849.51	10,030.5	2,922.99	3.432

12	2,046.27	10,193.7	4,329.33	2.355
13	2,276.42	13,403.6	3,699.91	3.623
14	2,897.18	13,582.8	6,021.50	2.256
15	4,756.84	9,003.2	4,791.65	1.879
16	6,466.04	7,374.0	7,476.52	0.986
17	7,807.14	2,992.9	3,288.75	0.910
18	8,592.46	1,087.5	1,312.26	0.829
19	9,295.80	3,504.2	5,072.17	0.691
20	8,363.46	676.5	1,466.58	0.461
21	5,704.92	6,375.1	3,026.43	2.106
22	4,224.81	9,775.2	3,644.63	2.682
23	2,849.51	13,150.5	4,636.45	2.836
24	2,046.27	14,353.7	3,931.72	3.651
TOTAL	**130,561.7**	**174,638.3**	**100,308.57**	**1.741**

4.3.5.6. Energy management plan

The proposals for energy efficiency improvement in the company are listed below:

- Training and awareness increase of the employees through leaflets, social media, video presentations, training programs, and workshops to exchange information and good practices with other SMEs.
- Providing bonuses to the employees, financial or other (leaves), or using special applications towards the development of energy culture using serious games, i.e., the employees chase scores and win prizes through entering comments and proposals for energy saving achievement, while also having access to educational material, interactive quizzes and personalized tips.
- Smart Indicators adoption, i.e., SRI for the evaluation of the buildings ability to adjust their operation to the users and grid needs (flexibility), SPI for the evaluation of the ability to self-control, self-healing, self-improvement, and KPI for the evaluation of the success in achieving energy targets posed by the SME.
- Support provided by the energy experts, the financial institution, industry associations and other relevant organizations.
- Rational use of external openings to achieve the desired comfort level of temperature with the lowest possible energy consumption.
- Control of thermostat settings in office and production areas.
- Rational use of lighting systems, especially during non-active periods.
- Optimal exploitation of natural light.
- Appointment of an energy manager to monitor individual energy consumption in industry and to monitor the energy indicators, to identify potential faults in advance.
- Inspection and repair of damaged external structural elements.
- Periodic maintenance of heating and cooling systems.
- Supply temperature reduction at the fan coils terminals.

- Leakages control and repair in hot water pipes for heating and coolant pipes for air-conditioning.
- Cleaning, inspection and maintenance of lamps and luminaires.

4.4. Italy

4.4.1. Pilot site 1

NACE Code: 71.1 - Data processing

4.4.1.1. Introduction for data and current situation

The company has been working for over 10 years in the design of photovoltaic systems and 3 years ago it opened its own research laboratory on renewable sources and environmental impact, structured as a workshop. The workshop's website is visited every year by an increasing number of students and tourists.

Green technologies and technological processes related to energy production and transformation. Primary materials: photovoltaic and wind

Final products: 5,700 kWh/year

The company is on a plot of land located in province of Enna, Sicily. It has an extension of 28,100.00 square meters. The property includes two buildings probably from the XIX century made of squared stones and covering in Sicilian tiles. One building has a rectangular plan, dimensions 6.2 and 5.4 meters, thickness of the wall of 65cm, total surface 33.48 sqm. The second building has a rectangular plan, dimensions 6.5 and 6 meters, thickness of the wall of 60cm.

4.4.1.2. Energy Analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

  The pilot case as PV and wind plants. The estimated production for the two pants is estimated as 5,700 kWh/ year. The energy from renewable sources is accumulated through a battery of 100 Ah.

Table 141 Pilot 1 – Electrical energy consumption

Electrical consumption – Pilot 1			
	2018	**2019**	**2020**
Month	Consumption [KWh/year]	Consumption [KWh/year]	Consumption [KWh/year]
January	-	73	49
February	-	57	41
March	-	56	47
April	-	56	49
May	-	52	56
June	-	41	38
July	-	74	49
August	-	73	52
September	71	70	54
October	73	50	64
November	71	50	69
December	73	52	56

4.4.1.3. Proposed solution and EE action plan

The proposed energy efficiency solutions are easy to implement and great efficacy:

a) using light and occupancy sensors in all rooms;
b) installation of a smart home systems as hotel type, able to activate/deactivate the electrical systems for utilities such as stoves, printers, PC, split;
c) purchase of electric cars
d) installation of heat pumps to replace electric stoves;
e) installation of solar thermal panels for the production of sanitary hot water;
f) check of supply contracts to identify cheaper ones.

Table 142 Proposed interventions

Intervention	Unit cost	Quantity	Total cost
a)	40,00 €	13	520.00 €
b)	500,00 €	3	1,500.00 €
d)	800	5	4,000 €
e)	300	2	600 €
Total investment			6,620.00 €
Yearly electricity consumption in €	733.70 €	saving	733.70 €
			50.00%

Table 143 Pilot 1 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 1						
Proposed solution - description	**Investment**	**Energy saving Type:**	**Cost saving**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[years]	[EUR]	[%]
a) presence and brightness sensors	520	electricity	231.20 €	-	-	-
b) Home automation access control device/system (card, reader and panel modification)	1500	electricity	167.50 €	-	-	-
d)Heat pump	4000	thermal	167.50 €	-	-	-
e)water heater with solar panel	600	thermal	167.50 €	-	-	-
TOT	6,620€	-	733.70 €	5	569.0 €	6.9%
Electric cars	18,000 €	-	1,164.00 €	-	-	-

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Cost saving	EUR	X	

4.4.1.4. Measurement and verification of the results

Results from the M&T and M&V tools are presented below. The below tables show the electricity consumption for the two buildings.

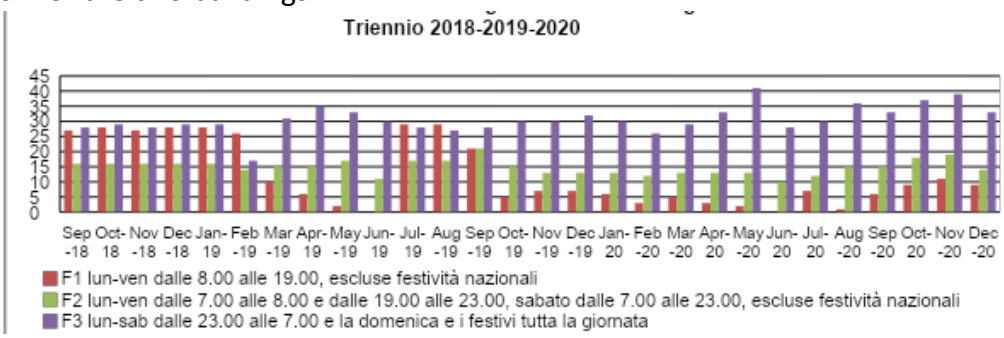


Figure 90 Pilot 1 - Electricity consumption building 1

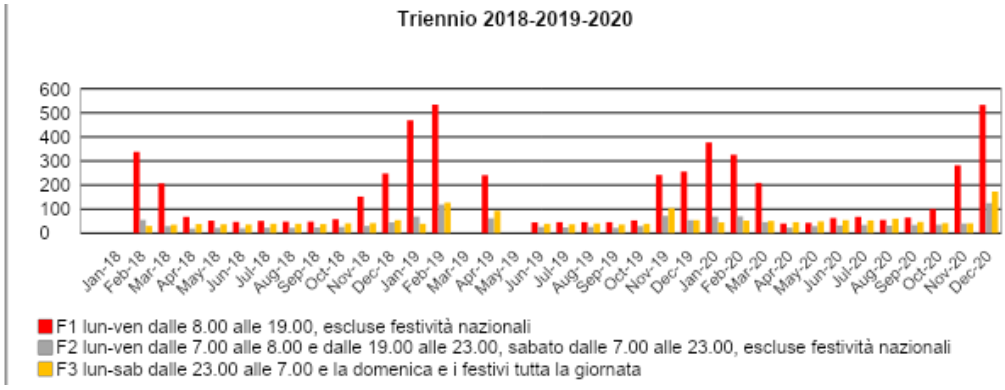


Figure 91 Pilot 1 – Electricy consumption building 2

The below table shows the comparison of the benchmarks used before and after hypothesized interventions.

Table 144 Pilot 1 – Comparison of the benchmarks

Consumptions, costs and benchmark electric energy before intervention						
Site	Gross surface m^2	Average values in three years				
		Total consumption [kWh]	Total cost [Euro]	€/kWh	kWh/m^2	10^{-3} toe/m^2
Building 1	308	2,672	1,250	0.46	8.67	1.99
Building 2	79	700	650	0.92	8.86	203
Consumptions, costs and benchmark electric energy after intervention						
Building 1	308	1,502	702,5	0.46	4.88	1.12
Building 2	79	393	365	0.92	4.99	1.14

4.4.1.5. Financial resources

Table 145 Pilot 1 – Financial resources

Input data	
IO	6,620 €
Saving	734 €
Year	5
Interest rate	2,070 €
Conto termico*	15%
% given to professional	20%
tax	20%
ESCO allowance	-15%
year	5
Payback period	9
NPV**	569 €

* The Conto Termico was introduced by Ministerial Decree on 28/12/12. It provides incentives for renewable energy production as well as efficiency savings in the heating and cooling sector
** NPV – Net Present Value

Year and analysis of return of investment

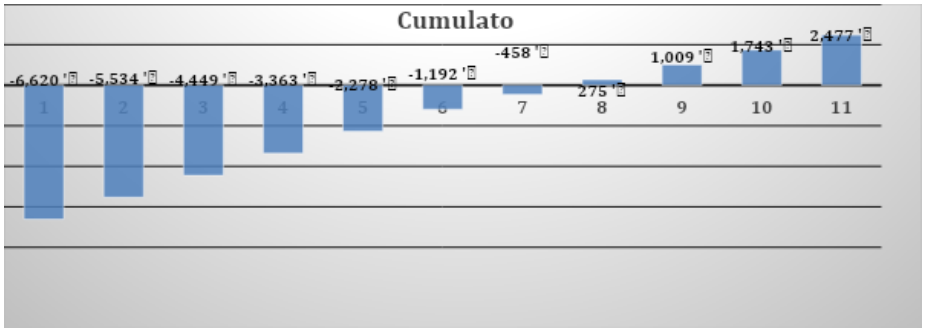


Figure 92 Analysis of return of investment

Table 146 Proposed measures

	Building 1	Building 2	Total
Electrical consumption	1,156 €	519 €	1,675 €
Saving on F3 (tax) (Solution a)	115.60 €	259.50 **€**	231.20 €
Saving **Home automation** (Solution b)	115.6 €	51.9 €	167.5 €
Saving **Heat pump** (solution d)	115.6 €	51.9 €	167.5 €
Saving **sanitary hot water** (solution e)	115.6 €	51.9 €	167.5 €
Total			733.70 €

Electric car (Solution c)

Table 147 Car consumption comparison

	Fuel Cost	Annual Fuel Consumption	Total
Average Diesel consumption (Jeep)	1.60 €	1,000 liters	1,600 €
Average Electric consumption (electric vehicle)	0.2 €	2,180 kW/h	436 €
Saving per year			**1,164.00 €**

4.4.2. Pilot site 2

4.4.2.1. Introduction for data and current situation

Number of employees: 60

NACE Code: 27.11.00

- The main activity: manufacture of electric motors, generators and transformers Total annual energy consumption (use more relevant units): approximately 156 MWh/year
- Description of the technological process(es): The pilot case 2 is an innovative SME established in 2015, which plans, builds and manages micro-cogeneration plants of electricity and heat based on gasification technology and holds an industrial patent for the current line gasification and cogeneration plants powered by biomass.
- Characteristics of the buildings;
  Total net surface: 4,444 m^2
  Total gross surface: 4,581 m^2
  Total surface (one building + external annexes): 10,000 m^2

- Monthly production data for at least 2 years.
  With reference to period of diagnosis from January 2018 to December 2020, the production management has been implemented few months ago and the available data are not sufficiently representative. Therefore, the reference index for energy consumption has been the accumulation of the hours necessary to complete the work carried out, especially for welding and carpentry.

4.4.2.2. Energy analysis

The analyzed building is the one where the company moved in December 2020. Therefore, the energy consumption has been evaluated from the data available to the previous plant.

The only energy source used is electric energy, which feeds all site activities including air conditioning (through wall air conditioning and heat pumps). Total consumption: 156 MWh/year Consumption from energy meters, electricity consumption (detail) and related expenditure (possibly three years) below.

Table 148 Pilot 2 – Electrical consumption

Electrical consumption – Pilot 2			
	2018	**2019**	**2020**
Month	Consumption [kWh]	Consumption [kWh]	Consumption [kWh]
January	6,554	9,535	13,115
February	6,194	9,165	10,490
March	6,343	7,393	5,897
April	3,683	5,703	3,962
May	3,279	5,808	5,970
June	2,649	4,942	5,987
July	2,804	6,482	6,502
August	2,539	5,141	4,808
September	3,092	6,140	5,830
October	4,551	7,019	8,268
November	5,467	8,491	8,690
December	6,040	9,763	18,004
TOTAL	**53,195**	**85,582**	**97,523**

Not having the data, the working group created graphs to simulate the energy consumption for heating in year 2020.

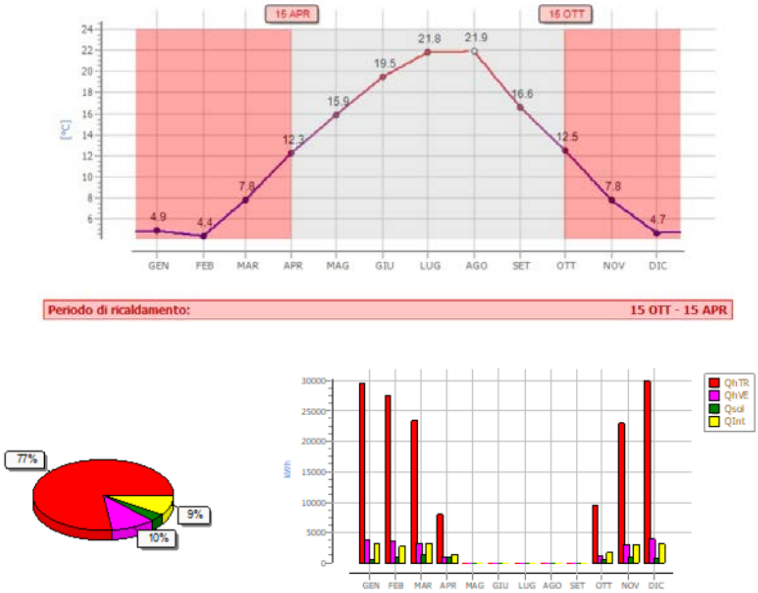


Figure 93 Analysis

The breakdown of consumption data was carried out on the basis of the estimated operating hours, utilization factor (FU) and load factor (FC) of each machinery / plant / device present on the site. The list of equipments with the related consumption estimates is shown below.

Table 149 Consumption breackdown

Electrical Equipment						
Equipment	**Brand & model**	**Nominal Power**	**hour/year**	**FU**	**FC**	**Energy Consumption**
		kW	**h**			**kWh**
Calandra		6	1760	10%	100%	1,056
Cesoia		30	0	0%	0%	0
Piegatrice		22	1760	10%	100%	3,872
Taglio laser			0	0%	0%	0
Fresa			0	0%	0%	0
Tornio	MORKAI MACHINEY JL 410SX 1500	4.5	1760	10%	100%	792
Muletto elettrico						0
Compressore	ABAC BLN 270 FT4	3	1980	50%	80%	2,376
Trapano a colonna	FERVI 0252/400V	1.5	1760	10%	100%	264
Trapano a colonna	FERVI T062	1.5	1760	10%	100%	264
Trapano a colonna		0.55	1760	10%	100%	97

Molatrice da banco	OPTIMUN GU20	0.6	1760	10%	100%	106
Pompa di calore	Technibel PHRV 72	39	0	0%	0%	0
Pompa di calore	Technibel PHRV 72	39	0	0%	0%	0
Saldatrice MIG/MAG	MIGATRONIC Sigma Select 400 C	18	1760	50%	50%	7.920
Saldatrice MIG/MAG	TELWIN INVERTEPULSE 320 MIG/TIG/MMA 400V	52.5	1760	50%	50%	23.100
Aspirazione fumi saldatura	Filcar ECOMINOR	6.6	1760	100%	70%	8.131
Taglio al plasma	TELWIN SUPERIOR PLASMA 100 400V	13.5	0	0%	0%	0
Curvatubi	CML MG 030V2T	3.5	1760	10%	100%	616
Sgolatubi e smerigliatrice	CML EN 180-1V	4	1760	10%	100%	704
Segatrice semiautomatica	MEP SHARK 332 SXI evo	2.5	1760	10%	100%	440
Segatrice a nastro	BIANCO 370 A	2.83	1760	10%	100%	498
Essiccatore	ABAC DRY 25 (A0)	0.173	1980	50%	100%	171

Facility: **Offices**						
Unit	**brand & Model**	**Nominal Power**	**hour/year**	**FU**	**Energy consumption**	**Surface**
		kW	**h**		**kWh**	**m²**
16	PC	0.065	1760	50%	915.20	17.63
16	monitor	0.02	1760	100%	563.20	17.63
2	Fotocopiatrice	0.475	1760	10%	167.20	
3	Stampante	0.661	1760	10%	349.01	
1	Distrbutore caffè/vivande	3.7	1760	60%	3,907.20	
1	Server-1	1.6	8760	100%	14,016.00	
1	Server-2	1.1	8760	100%	9,636.00	
13	condizionatore a parete	1.03	1760	50%	11,783.20	
7	condizionatore a soffitto	0.11	1760	50%	677.60	
10	PC	0.065	1760	50%	572.00	130.15
18	monitor	0.02	1760	50%	316.80	130.15
4	PC desktop	0.4	1760	80%	2,252.80	19.84

2	Fotocopiatrice	0.475	1760	10%	167.20	110.31
1	Stampante	0.661	1760	10%	116.34	19.84
1	Distributore caffè/vivande	3.7	1760	60%	3,907.20	
1	distributore acqua		0	0%	0	
1	plotter	0.15	1760	5%	13.20	19.84
7	condizionatore a soffitto	0.11	1760	50%	677.60	

Table 150 Pilot 2 – Consumption breackdown

Domestic hot water								
Unit	**brand & type**	Nominal Power	**consumption/year**	**Energy Driver**	**FU**	**FC**	**hours/year**	**Energy consumption**
		kW		**(m^3 hot water)**				**kWh**
Boiler	Hoval 5-CombiVal WPE	2,395	1,153	0,314	40%	100 %	1760	704

4.4.2.3. Proposed solution and EE action plan

Thanks to the energy diagnosis, three different energy improvement measures have been identified:

- Installation of a BEMS (Building Energy Management System);
- Construction of a thermal coat on the facade of the office building;
- Installation of a cogeneration plant through gasification of biomass production

Table 151 Pilot 2 – Propsoed EE action plan

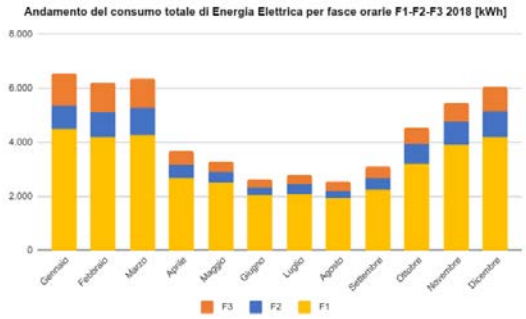
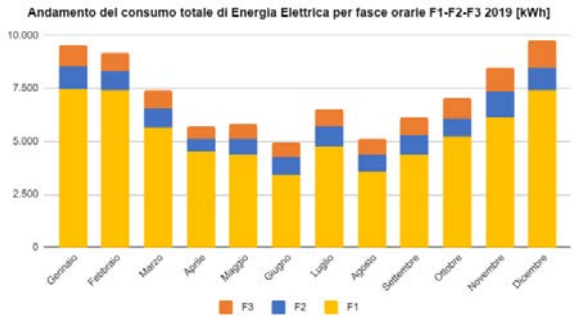
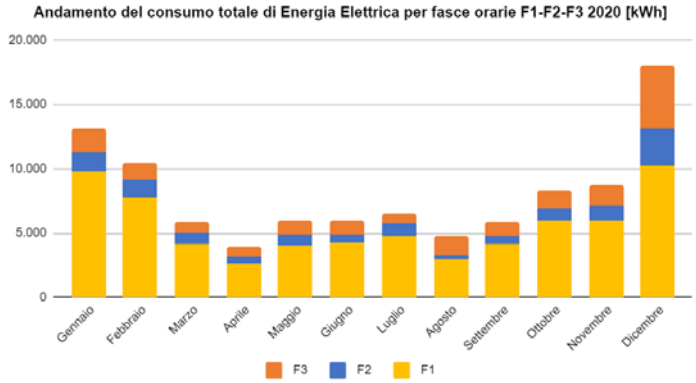
Proposed solutions & EE action plan for Pilot 2				
Proposed solution - description	**Investment**	**Energy saving**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR]	[%]
The BEMS, Building Energy Management System	10,000 €	40,514.57 (total energy)	1.23	100,121.25 €
Thermal coat	11,025 €	5,993 thermal energy)	9.2	5,264.37 €
Installation of a cogeneration system through biomass gasification (CHP)	101,400 €	90,000 (electrical energy)	5.63	143,225.87 €

KPI	U.M	Calculated	Estimated
Investment	EUR	X	

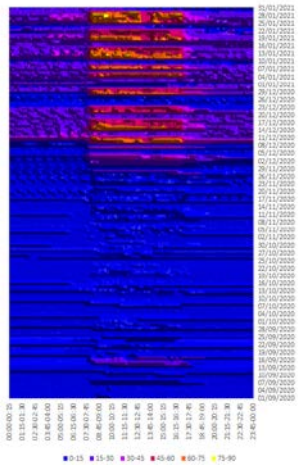
Energy saving	MWh	X	

4.4.2.4. Measurement and verification of the results

With the collected data the group created graphs to monitor and evaluate the electricity energy consumption according to the different time bands (F1, F2, F3 in the graphs) given by the energy provider.

2018	**2019**
	
2020	
	

Other graph



The kick-off of activities in the new plant (1st December 2020) can be seen in the upper part of the graph. The average power during the production working shift (8:00 - 17:00) is around 60 kW. An initial analysis reveals excessive consumption (in purple) during the closing periods of the plant, with an average power of about 22 kW.

The average power during the Christmas closing turns out to be 6 kW and this can reasonably be assumed as a base load. The excessive consumption found is due to the non-optimal management of the plant's winter air conditioning systems (offices).

4.4.2.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Ecobonus 65%	Introduction of a new deduction (65%, up to a maximum value of deduction of 100,000 euros) for the purchase and installation of micro-cogeneration replacing existing systems, and for the thermal coat. Completed The intervention with the realization of the thermal coat the company will have a saving of 5993 kWh/year.

4.4.3. Pilot site 3

4.4.3.1. Introduction for data and current situation

Number of employees: 38

NACE Code: 96.01.10 Iindustrial laundries

Turnover: about 3 million euro per year
The company is autonomous and not included in the list of energy-intensive companies.

- Description of the technological process(es):
  Industrial laundry that performs activities of rental and washing flat linen and work clothes for hotels, restaurants, industry, institutions.
- Monthly production data for at least 2 years.
  Data for the years 2018 and 2019 were taken into account. No 2020 data were taken into account as production times and volumes were not validated as a result of the COVID-19 emergency in Italy. The group suggested the verification of the statistical model created with data 2018 and 2019 using data 2020.
  Monthly production: the service consists in the reconditioning of textile garments received dirty and returned sanitized, after appropriate process of washing and finishing. The finished product is textile treated in its various forms (sheet, pillowcase, tablecloth, etc.). There are no semi-finished products.
  Below the data on the total monthly production, for the years 2018 - 2019.

Table 152 Pilot 3 – Production data

Production – Pilot 3		
	2018	2019
Month	Production Kg	Production Kg
January	124,957	130,081
February	117,858	112,603
March	140,810	134,838
April	150,150	172,971
May	195,565	186,680
June	196,902	202,625
July	244,034	265,965
August	270,205	276,606
September	197,487	211,434
October	196,528	206,177
November	122,510	128,371
December	106,642	129,411
TOTAL	**2,063,649**	**2,157,763**

Table 153 Pilot 3 – Photovoltaic self-production

Photovoltaic self-production – Pilot 3		
	2018	**2019**
Month	Production Kg	Production Kg
January	5,901.25	6,122
February	9,295.25	9,775.75
March	12,557.75	18,669.25
April	18,388.00	15,784.00

May	18,120.00	20,132.50
June	23,892.75	23,077.75
July	24,811.00	22,302.25
August	19,169.75	19,775.00
September	18,537.75	16,309.75
October	10,727.00	9,750.75
November	4,159.75	4,010.75
December	3,898.50	3,645.25
TOTAL	**169,458.75**	**169,355.00**

4.4.3.2. Energy analysis

Table 154 Pilot 3 – Electricity consumption

Electric energy consumption – Pilot 3		
	2018	**2019**
Month	Consumption [KWh]	Consumption [KWh]
January	42,775.539	40,892.052
February	35,103.63	32,693.514
March	35,918.07	31,926.1
April	31,815.771	38,565.88
May	38,580.357	35,442.976
June	34,776.561	36,500.178
July	41,004.222	45,202.352
August	49,039.779	48,744.768
September	36,698.652	41,694.472
October	45,886.563	48,811.838
November	38,620.96	38,784.088
December	38,157.084	40,853.2
TOTAL	**468,377.188**	**480,111.418**

Table 155 Pilot 3 – Photovoltaic self-consumption

Photovoltaic self-consumption – Pilot 3		
	2018	**2019**
Month	Consumption [Kwh]	Consumption [Kwh]
January	4,860.49	5,113.4
February	7,233.05	7,692.43
March	10,438.19	13,369.09
April	12,462.64	11,667.28
May	14,141.76	16,464.46
June	16,881.27	16,388.59
July	18,488.68	17,832.25

August	14,688.47	15,364.28
September	14,066.91	12,527.95
October	8,594.36	7,659.39
November	3,688.99	3,253.79
December	2,989.5	2,787.97
TOTAL	**128,534.31**	**130,120.88**

Table 156 Pilot 3 – Natural Gas consumption

Natural Gas consumption – Pilot 3		
	2018	**2019**
Month	Consumption [Smc]	Consumption [Smc]
January	24,520	28,565
February	24,342	23,611
March	26,407	25,465
April	24,982	28,891
May	30,977	30,525
June	29,408	30,029
July	7,566	36,801
August	33,429	32,583
September	2,3971	27,382
October	29,819	32,978
November	22,006	23,959
December	25,171	27,486
TOTAL	**302,598**	**348,275**

Table 157 Pilot 3 – Fuel oil consumption

Fuel oil consumption – Pilot 3		
	2018	**2019**
Month	Consumption [Sm3_eq]	Consumption [Sm3_eq]
January	2,528.9939	0
February	0	0
March	0	0
April	0	0
May	0	0
June	0	0
July	29,775	3567.20
August	4,373	7084.51
September	6,779	5352.58
October	3,207	0

November	3,902	0
December	0	0
TOTAL	**50,565.624**	**16,004.29**

Table 158 Pilot 3 – Natural Gas + Fuel oil consumption

Natural Gas + Fuel oil consumption – Pilot 3		
	2018	**2019**
Month	Consumption [Sm3]	Consumption [Sm3]
January	27,048.99394	28,565
February	24,342	23,611
March	26,407	25,465
April	24,982	28,891
May	30,977	30,525
June	29,408	30,029
July	37,341.3697	40,368,2
August	37,801.58182	39,667.50909
September	30,750.22424	32,734.58182
October	33,026.27273	32,978
November	25,908.18182	23,959
December	25,171	27,486
TOTAL	**353,163.62**	**364,279.29**

4.4.3.3. Proposed solution and EE action plan

Monitoring system: the first intervention proposed is the installation of measurement and monitoring system of primary users not measured (basically the steam network) and an integrated system of continuous monitoring.

Inverter pumping system: variable speed drives (inverters) are used to change the speed of an electric motor, which is usually fixed and depends on the number of poles of the engine. An inverter modulates the feed frequency of the motor and therefore its speed according to the load. It is proposed to install inverters in the pump unit n. 4 pumps (par.fr. 2+2) with rated power of 12kw and in the submerged pump of well water (6.8 kW). The maximum obtainable saving is of 20%. It has been theorized a cost of the inverters of 5,000 € without final ransom and a life of 10 years.

Compressed air: two interventions concerning the compressed air system:
1) Search for compressed air leaks
It is proposed to perform an analysis of the compressed air network based on the inspection of the systems during their operation and during the site stops, keeping the compressors on. This intervention can have a maximum saving of 10% of the electrical consumption of compressors and has a cost (theoretical) of 3,000€, it is proposed to achieve it once every 4 years.

2) Heat recovery by installation of water exchanger.

The compressor of the compressed air system dissipates between 80% and 95% of electrical consumption to the surrounding environment. A system of recovery of this heat is proposed as the first stage of heating the well water before the entry to the washing machines. The recovery system of dissipated in the can reach 85% of electricity consumption. The system is complex to having to make a heat recovery system and an exchanger for preheating well water. It is estimated a theoretical cost of the system of 40,000€ and 10 years of useful life.

Motorized hydraulic pumps: the laundry is equipped with a purifier, in which are installed some motorized hydraulic pumps controlled by on-off switches. The pumps work all year round, to optimize their performance it is useful to equip them with a variable speed drive (inverter). The inverter, varying the frequency, varies the speed of the pump engine and consequently the flow rate of the pump that is therefore suitable for the needs of the load.

Cogeneration system: the laundry, as we have seen, uses both electricity and steam for the process. Steam is mainly produced by a natural gas-fired steam generator. The possibility and cost-effectiveness of a cogeneration system has therefore been assessed. Some simulations have been carried out to identify the type of cogenerator, the size, the efficiency that best integrate into the present plant and provide the best energy and environmental performance.

Table 159 Pilot 3 – Propsoed EE action plan

Proposed solutions & EE action plan for Pilot 3						
Proposed solution - description	**Investment**	**Energy saving Type:**	**Cost saving**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[years]	[EUR]	[%]
Monitoring system	20,000 €	-	5,250 €	3.8	18,640 €	22.92%
Inverter pumping system	5,000 €	-	1,090 €	4.8	2,464 €	15.58 %
Compressed air	3,000 €	electricity	972 €	3.2	172.63 €	8.52 %
Heat recovery by installation of a water cooler compressed air compressor	30,000 €	-	8,262 €	3.8	26,581 €	13.78 %
Motorized hydraulic pumps	4,540 €	-	29,760 €	1.52	10,347 €	493 %
Cogeneration system (100 kWe)	280,000 €	Electricity, thermal	31,510 €	8.9	42,996 €	7.67 %

4.4.3.4. Measurement and verification of the results

Collection of data

By the very nature of the business, energy consumption is mainly linked to the production process; therefore, at least in the first analysis, the consumption related to the building, both administrative and production can be neglected.

The following process related data is collected.

Data relating to energy sources:

- electricity from the electricity grid
- self-produced electricity (photovoltaic)
- self-consumed electricity
- natural gas from the distribution network;
- fuel oil (purchase in tanker and storage in tank)

Production data:

- total weight of treated linen
- Volumes of water for the washing process.

With regards to the measures, the following measures are active in the plant in addition to the fiscal ones (electricity and gas from the distribution network):

- two electric users are equipped with a measuring device
- all direct gas utilities (excluding the steam generator) are equipped with a volumetric gas meter;
- All the main process water users are equipped with meters (washing machines + thermal cycle reintegration).

The data relating to the weight washed, the water consumed by the process users and the gas consumption of the direct gas users are recorded daily and collected weekly.

Data reorganized monthly were used for the statistical analysis.

In carrying out the analysis, the weather data was also used, collected and recorded at 5-minute intervals, from the meteorological station owned by the company, connected to the detection system of the Lombard Meteorological Center and available in real time on the site of the company.

Description of the implementation of the monitoring strategy

The laundry energy flow diagram is shown in the following graph:

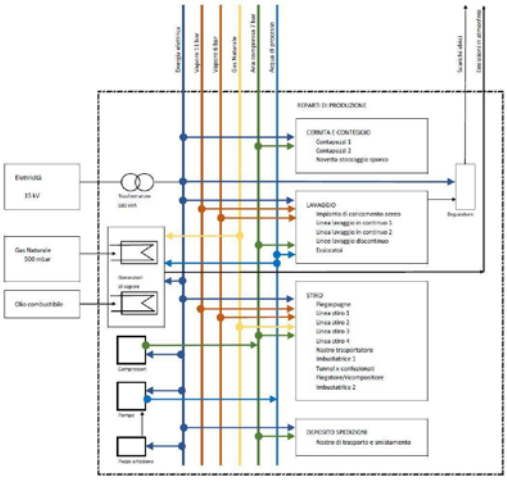


Figure 94 Pilot 3- Energy flow diagram

As described in the previous paragraph, with reference to each energy vector, the following measures are available:

Electricity

- Purchase / sale from the electricity grid (fiscal)
- Photovoltaic production (fiscal)
- Electricity consumption of the purification plant

Please note, self-consumption is calculated by the difference between photovoltaic production and sale, while the total consumption is the sum of purchased energy and self-consumed energy

Natural gas

- Purchase from the distribution network
- Consumption of each direct user (4 gas dryers + 1 gas tunnel)

Burning oil:

- Total weight unloaded from tank truck

Please note, the weekly consumption is calculated through the tank's volumetric table, on the basis of the levels recorded weekly.

Process water

- Counter on each washing machine (2 continuous washers, 3 washer extractors)
- Counter on thermal cycle reinstatement

No measurements are available on the compressed air and steam network.

There are no measurements on building heating utilities.

Energy models

The electrical model was reconstructed starting from the electrical powers of the individual users, considering the sum of the electrical powers installed on each system, applying a contemporaneity coefficient derived from experience and multiplying by the annual operating hours. The results have been collected in a separate spread sheet.

Thermal model

Due to the complexity of the laundry process, the thermal model was created starting from a series of operational data (see data collection), making calculations related to experience and knowledge of the processes. The results have been collected in a separate spread sheet.

4.4.3.5. Financial resources

The group has not specified specific incentives. However, the report made by the group stated that the pilot case benefitted in the past of several national financial mechanism and incentives, such as Conto Energia and White certificates.

4.4.4. Pilot site 4

4.4.4.1. Introduction for data and current situation

Number of employees: 169

NACE Code: 24.42.00 manufacture of ceramic sanitary ware

- Description of the technological process(es):
  The company is listed in the "energy-intensive company" or "energy-intensive" category (Italian Ministry Decree 21 dicember2017); it is included in the annual list of energy-intensive companies established by the Energy and Environmental Services Box - FAT1 category in 2021. For this reason, the company falls under the obligation of energy diagnosis dictated by Legislative Decree no.102/201. To ensure compliance with the guidelines provided by ENEA, named “Guidelines for Monitoring in the industrial sector for energy audits pursuant to art. 8 of the Legislative Decree no. 102/2014”, a monitoring system of energy consumption was installed in 2018 and the last energy diagnosis was made in 2019.
- Characteristics of the buildings;
  The industrial plant is used in the production of sanitary ware, washbasins, toilets and ceramic bidets for the furnishing of bathrooms. It consists of two buildings, one in which the actual production takes place, and another in which the administrative and management offices are present. In the first building you can distinguish the production departments, where the various processes take place, plus a part used for the offices that manage the shipment.
- Monthly production data for <u>at least 2 years.</u>
  This diagnosis refers to the year 2019, extending the diagnosis to the year 2020 in some analyses, to better understand the influence of consumption not strictly related to production. It is indeed essential to say that the year 2020 was characterized by some production blockages due to the pandemic caused by SARS-COV2, and that therefore some periods do not have consumption comparable to the production at the factory regime.

4.4.4.2. Energy analysis

Data on electricity consumption and expenditure were extracted from the available electricity bills in 2019 and 2020. With regards to the consumption from August to December 2019, and according to the data communicated by the Network Distributor, the consumption trend was almost identical in various months, without any reduction in consumption in August and December. In these months the management of the company stopped the production activities (summer holidays for almost the whole month of August and winter holidays the last week of the year).

The figures are in line with the anomalies noted, being present more balances with final reporting data different but more consistent.

In the following table the data from the above-mentioned reference years are presented.

Table 160 Pilot 4 – Electricity consumption

Electric energy consumption – Pilot 4		
	2019	**2020**
Month	Consumption [KWh]	Consumption [KWh]
January	302,589	296,224
February	307,277	330,443
March	331,310	298,679
April	307,489	94,431
May	331,302	301,743
June	316,358	330,843
July	334,039	364,024
August	222,309	236,321
September	311,752	350,063
October	326,787	361,395
November	318,347	363,000
December	242,430	293,030
TOTAL	**3,651,989**	**3,620,194**

Table 161 Pilot 4 – Reactive energy

Reactive energy– Pilot 4		
	2019	**2020**
Month	Consumption [KVARh]	Consumption [KVARh]
January	97,979	103,808
February	99,399	125,199
March	106,694	110,435
April	98,731	27,948
May	107,832	114,286
June	104,496	131,161
July	117,341	156,488
August	78,680	90,232
September	109,745	142,244
October	115,467	143,017
November	112,676	147,425
December	86,115	106,071
TOTAL	1,235,155	1,398,314

The data on natural gas consumption (and the related expenditure) were extrapolated from the bills made available for the years 2019 and 2020.

Table 162 Pilot 4 – Natural gas consumption

Natural gas consumption – Pilot 4		
	2019	**2020**
Month	Specific consumption [Sm3]	Specific consumption [Sm3]
January	2,653,640	2,476,577

February	2,599,192	2,576,775
March	2,760,129	2,076,.482
April	2,449,145	60,174
May	2,536,548	1,924,644
June	2,110,036	2,142,923
July	2,099,076	2,122,697
August	285,559	1,055,426
September	2,113,407	2,086,737
October	2,372,059	2,474,642
November	2,371,250	2,599,643
December	1,927,687	2,109,339
TOTAL	**26,277,727**	**23,706,058**

4.4.4.3. Proposed solution and EE action plan

- **Replacement of turbodissolutor engines with more efficient engines**: the total cost related to the life cycle of the engine (typically over 10 years) is composed of 98% of its electricity consumption, while only 2% is given by the initial cost (purchase plus installation) and maintenance. In the light of these considerations, in most cases it will be more profitable to adopt technologically advanced engines and control systems rather than to focus solely on the incidence of the costs of purchase or replacement of the existing.
- **Thermal recovery from tunnel furnace**. The present opportunity for energy efficiency provides heat recovery on the cooling air circuit at the exit from the tunnel furnace. The cooling air of the workpieces inside the furnace comes out at a temperature of 180-200 ºC and, being clean air, it can be conveyed and sent, by means of appropriate fans, to the departments where it can be used, in particular to the furnace department, dryers and room heating. It will be necessary to double the cooling stack and to intercept with special cutting valves the current at higher temperature (possibly higher than 200^{0}C). Three pipes will start from the furnace cooling air outlet, which will lead the hot air to the departments and dryers.
- **Cogeneration**. It is recommended to install a cogeneration system. This is the combined production of electricity and heat through a single process. Cogeneration lies precisely in the lower consumption of primary energy compared to the separate production of the same quantities of electricity and thermal energy. By recovering part of the thermal energy produced in the energy transformations and that would otherwise be dissipated, we obtain a much more efficient use of primary energy, with savings of up to 30%.

Table 163 Pilot 4 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 4						
Proposed solution - description	**Investment**	**Energy saving Type:**	**Cost saving**	**Payback period**	**NPV**	**IRR**
	[EUR]		[EUR/year]	[years]	[EUR]	[%]

Replacement of turbodissolutor engines with more efficient engines	4,000	5,728.30 kWh/year (Electric energy)	716.04	5.59	839.00	10.8
Thermal recovery from tunnel furnace	230,000	136,000 smc/year (Thermal energy)	34,952.00	6.58	117,207	6.8
Cogeneration	520,000	330,961.03 smc/year (Thermal energy)	324,220.53	1.60	2,468,621	61.5

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	

4.4.4.4. Energy management plan

A systematic and strategic approach to energy management can lead to a significant reduction in costs and the need for resources in daily energy management.

It is suggested to adopt an Energy Management System (SGE) according to ISO 50001:2011 in order to achieve a continuous and constant improvement in energy efficiency and a reduction in operating costs through an identification process, consumption measurement and management.

It is recommend the training of technical and managerial staff, so as to implement such awareness to energy savings within the organization.

With regards to the economic assessments of the energy efficiency measures identified, it will be necessary to always update the estimates, when it is intended to proceed with the implementation of the proposed solutions. This is done by means of a punctual estimate (materials and labour) resulting from a detailed design of the works to be carried out.

Finally, it is recommended to integrate the current energy monitoring system with meters that allow, where possible, greater coverage of consumption and better control of the energy performance of plants with significant energy use.

4.4.5. Pilot site 5

4.4.5.1. Introduction for data and current situation

Number of employees: 12

NACE Code: 10.51.2 Dairy industry

- Description of the technological process(es):

The activity object of this diagnosis is a cheese factory aimed at the production of Grana Padano. The proposing Subject is outside the company and a freelance engineer. For the analysis site are currently carried out consultancy activities for the management of the water treatment plant. The dairy treats milk from local producers and through a process that combines tradition and modern techniques, a high-quality product is obtained.
The production process consists of the following phases:
1) Outcrop
2) Stopover
3) Milk transfer to boiler (tapping)
4) Cooking and extraction
5)Drying
6) Salting
7)Seasoning

For the implementation of the energy audit, the consumption data related to 2019 and 2020 annuities were analyzed. In particular, the 2019 annual data were used for the definition of baselines while the 2020 data as a control period.

Table 164 Pilot 5 – Production data

Production – Pilot 5 Milk			
	2018	**2019**	**2020**
Month	Production Kg	Production Kg	Production Kg
January	1,794.00	1,724.76	1,904.14
February	1,670.16	1,650.47	1,839.05
March	1,866.02	1,857.86	2,020.25
April	1,812.70	1,817.28	1,932.33
May	1,821.20	1,828.80	1,982.04
June	1,648.41	1,695.50	1,755.86
July	1,648.31	740.92	1,766.51
August	1,542.20	1,444.03	1,592.31
September	326.59	1,570.74	152.81
October	1,537.92	1,671.74	1,582.50
November	1,548.82	1,709.31	1,580.56
December	1,653.27	1,863.96	1,733.17
TOTAL	**18,870**	**19,575**	**19,842**

4.4.5.2. Energy analysis

Auditing methodology

The methodology of this energy diagnosis is divided into three macro - phases:

1. Collection and initial analysis of the cooperative's data and reconstruction or estimate of information not available by thermal and/or electrical breakdown.

2. Implementation of statistical models, elaboration and analysis of results;

3. Identification of efficiency opportunities.

Global energy consumption

To compare the distribution of current energy consumption, the consumption pie is adopted, below.

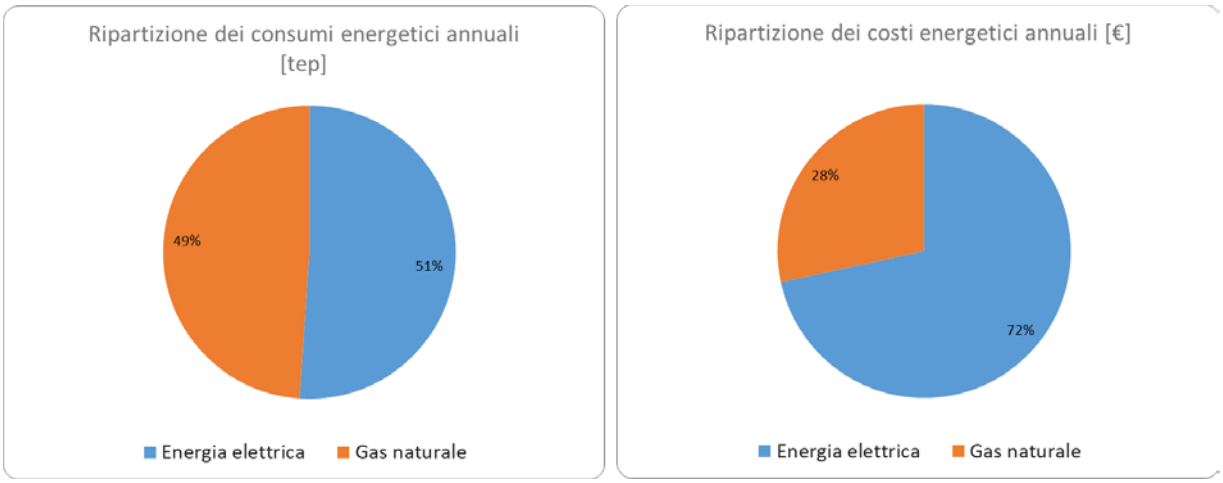


Figure 95 Ditribution of current energy consumption

From the point of view of the costs it is possible to notice that 71% of the costs have as a source of energy that electricity.

Energy consumption by electricity: the consumption of electricity constitutes 51% of the total consumption of the plant. The machines that make use of electricity are different: pumps, compressors, CIP washing, evaporative tower, refrigeration systems, agitators. The general assessment also includes indoor and outdoor lighting.
Gas energy consumption: the gas consumption represents 49% of the total consumption of the plant. The machines that use gas are steam generators and gas radiators. The thermal breakdown below shows that office heating is a negligible part of the thermal power station.
Consumption of raw materials: the raw material used for production purposes is milk, which is processed into grana cheese. The monthly production is reported below.

Table 165 Pilot 5 – Electricity consumption

Electric energy consumption – Pilot 5		
	2019	**2020**
Month	Consumption [KWh]	Consumption [KWh]
January	53,730	71,200
February	53,563	70,406
March	64,092	76,640

April	71,048	76,135
May	83,450	86,392
June	99,473	85,438
July	71,460	95,788
August	93,174	93,627
September	89,928	39,083
October	81,107	64,191
November	70,191	59,472
December	71,804	62,337
TOTAL	**903,020**	**880,709**

Table 166 Pilot 5 – Gas consumption

Gas consumption – Pilot 5			
	2018	**2019**	**2020**
Month	Specific consumption [Smc]	Specific consumption [Smc]	Specific consumption [Smc]
January	17,445	20,617	20,724
February	16,074	18,867	18,142
March	18,133	20,803	18,987
April	17,234	20,731	17,172
May	16,945	19,983	16,886
June	14,467	17,100	16,199
July	15,045	7,597	15,460
August	15,098	13,509	14,695
September	5,492	16,949	1,528
October	16,283	16,524	15,740
November	17,120	16,524	15,905
December	19,121	18,409	17,283
TOTAL	**188,457**	**207,613**	**188,721**

Specific consumption

Table 167 Pilot 5 – Specific gas consumption

Specific gas consumption – Pilot 5			
	2018	**2019**	**2020**
Month	Specific consumption [Kwh/Kg]	Specific consumption [Kwh/Kg]	Specific consumption [Kwh/Kg]
January	0.092	0.114	0.103
February	0.091	0.109	0.094
March	0.092	0.106	0.089
April	0.090	0.108	0.084
May	0.088	0.104	0.081
June	0.083	0.096	0.088

July	0.087	0.097	0.083
August	0.093	0.089	0.088
September	0.160	0.103	0.095
October	0.101	0.094	0.094
November	0.105	0.092	0.096
December	0.110	0.094	0.095

Table 168 Pilot 5 – Specific electric consumption

Specific electric consumption – Pilot 5		
	2019	**2020**
Month	Specific consumption [Kwh/Kg]	Specific consumption [Kwh/Kg]
January	0.031	0.037
February	0.032	0.038
March	0.034	0.038
April	0.039	0.039
May	0.046	0.044
June	0.059	0.049
July	0.096	0.054
August	0.065	0.059
September	0.057	0.256
October	0.049	0.041
November	0.041	0.038
December	0.039	0.036

4.4.5.3. Proposed solution and EE action plan

- **Installation of 4 meters** (warehouse, production, refrigeration units).
  Measure: given that the situation in question is currently without dedicated meters for users, this action is proposed as a priority. A first survey with the potential supplier identified the cost of a meter, equal to about 200€, and the cost of the intervention that in some cases requires a local change to the framework due to lack of space. The total amount of the investment was thus estimated to be around 9.000€. The installation of the first 4 meters on the most significant users has been planned.
  Calculation of energy savings: from the examination of similar measures, it was possible to establish a range of reduction of consumption that is between 1 and 5%, as a precautionary measure it was considered a value of 2.5% for the intervention in question. The resulting savings amount to 22,000kWh/year.

Economic savings: the dairy pays on average €0.2/kWh in the bill, so the corresponding annual savings are around 4,400€. Below is the NPV, assuming a discount rate of 2% and a useful life of the intervention of 10 years
Complementarity: there is no complementarity with the other envisaged measures.

- **Steam generator flow meter**
  Measure: to monitor thermal consumption, almost exclusively linked to the production of steam, it is assumed to install a flow meter. The expense includes the modification of the line, through the installation of the meter and the cost of the same. Assuming as manufacturer Hendress & Houser the total cost is around 7.000€.
  Calculation of energy savings: in this case too, the saving comes from an estimate deriving from similar interventions, which is between 1 and 5%, as a precautionary measure was considered a value of 2.5% for the intervention in question. The resulting savings are 4720 smc/year.
  Economic savings: the dairy pays on average € 0.37/Sm3 in the bill, so the corresponding annual saving is around 1750€.
  Complementarity: there is no complementarity with the other envisaged measures.

- **Recovery of condensation**
  Measure: one of the measures that is certainly recommended for the sector in question is the recovery of condensation. Currently a system is already installed but is not in use due to frequent soiling related to the fact of serum leaks from double funds.
  To avoid this, it is necessary to install a recuperator that allows then exploit the heat of condensation (54 C) and be able to heat the water in the inlet to the steam generator.
  Calculation of energy savings: from the recovery obtained from the dairies reported in the bibliography it has been possible to estimate a specific value according to the treated milk, the resulting savings is equal to 9000smc/year.

  Economic savings: the dairy pays an average of €0.37/smc in the bill, so the corresponding annual saving is around €3.300.
  Complementarity: this intervention has a certain complementarity with the installation of flow meters, therefore the energy saving has been reduced due to the fact that the installation of the meter reduces the overall steam consumption.

- **Installation of a photovoltaic system**
  Measure: another possible source of savings is the installation of photovoltaic system on the roof of the warehouse. Because of its conformation, only the southern part is exploitable (693mq), 334 modules were assumed to be 405 W peak each. There are no accumulations because the power will be returned to the network.
  Calculation of energy savings: the savings were identified from the equivalent hours per year, which for the Lombardy region averaged 1044 he/y. The resulting plant has a rated output of 135kW.

Economic savings: the dairy pays an average of €0.2/kWh in the bill, so the corresponding annual savings are around €28.198.
Complementarity: there is no complementarity with the other envisaged measures.
Grants or subsidies: there are incentives for the installation of photovoltaic panels equal to about 200€/kWh, so in reality the return time of the investment is considerably lower than currently assumed.

Table 169 Pilot 5 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 5						
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**	**Payback period**	**NPV**	**IRR**
	[EUR]		[EUR/year]	[years]	[EUR]	[%]
Installation of 4 meters (warehouse, production, refrigeration units)	9,000	22,000 kWh/year electricity	4,400	2	37,531.50	48.46
Steam generator flow meter	7,000	4,720 smc/year (gas)	1,700	4	-	-
Installation of a new condensate recovery unit	12,000	9,000 smc/year (gas)	3,300	3.6	-	-
Installation of photovoltaic system (warehouse)	270,000	130,000 kWh/year electricity	28,400	10	-	-

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	

4.4.5.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Table 170 Proposed financial resources

Type	Description
Incentives for digitization of SMEs	The possibility of further reducing the return time through access to incentives for digitisation of SMEs is being assessed.
Incentives for the installation of photovoltaic panels	There are incentives for the installation of photovoltaic panels equal to about 200€/kWh, so the return time of the investment is considerably lower than currently assumed.

4.4.5.5. Energy management plan

There is not a specific energy management plan for this pilot case. However, some useful conclusions can be shared.

There are several sources and solutions to obtain substantial energy savings. The greatest limit to a precise identification of the savings before-work lies in the absence of punctual measures that will be the first necessary step to a series of possible following improvements. There are also cultural barriers: operators are often accustomed to using methods of operation and techniques that are often random and not the result of rationality. It is precisely the latter that should be used to engage in a process of identifying waste and reducing consumption.

4.5. Romania

4.5.1. Pilot site 1

Number of employees: 60

NACE Code: 811 – Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate

Total energy consumption: 1,418 toe/year (16,491.34 MWh/year)

4.5.1.1. Short description of the pilot site

The pilot site is the global producer of industrial minerals, mainly fillers and pigments derived from calcium carbonate and dolomite, and a global distributor of specialty chemicals. The company offers a variety of product solutions that contribute to the competitiveness and productivity of its customers in several industries, such as:

- Constructions;
- Paper;
- Technical polymers;
- Packaging;
- Food;
- Pharmaceuticals;
- Agriculture and Forestry;
- Water and Energy.

In Romania, the company has a micronized calcium carbonate production and marketing unit in operation. The production unit consists of modern manufacturing technologies, physico-chemical laboratory with high performance measuring and control equipment, modern packaging technologies.

4.5.1.2. Technological processes

The diagram below shows the development of the technological process in the factory, from the raw material - stone to the realization of the final product - powder.

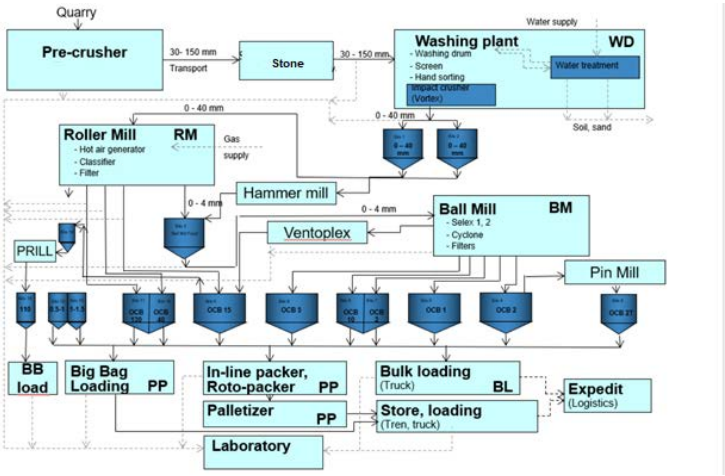


Figure 96 Pilot 1 - Technological Process

Table 171 Pilot 1 – Production data

Production – Pilot 1 Final product			
	2017	**2018**	**2019**
Month	Production [tons]	Production [tons]	Production [tons]
January	6,956	10,712	9,108
February	11,256	11,935	14,273
March	18,109	16,544	18,316
April	16,336	15,426	18,585
May	18,170	18,490	16,665
June	15,827	16,853	17,247
July	17,162	19,647	19,409
August	18,341	17,302	16,874
September	16,717	16,968	18,049
October	12,550	13,070	15,981
November	9,470	9,540	12,016
December	4,496	5,417	6,424
TOTAL	165,390	171,904	182,947

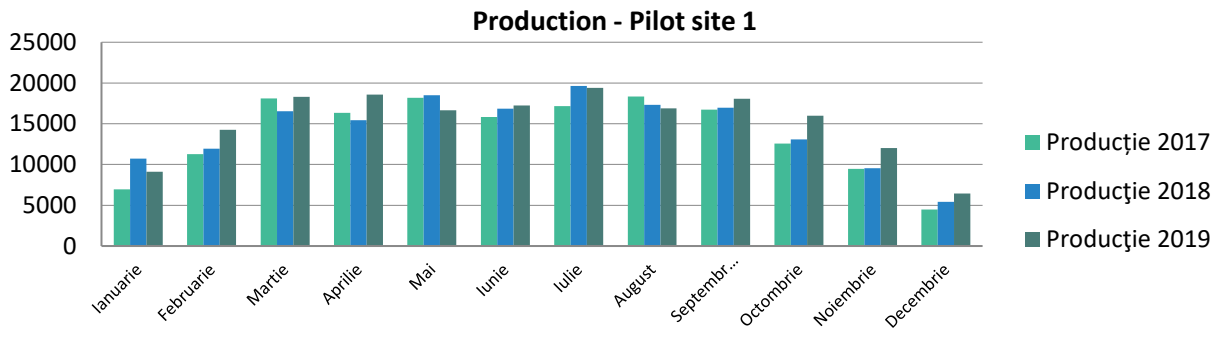


Figure 97 Production data for 2017-2019

4.5.1.3. Energy analysis

- Referring to 2019, from the information specified by the beneficiary, it is estimated a number of **275 working days**. Thus, a number of approximately **6,600 operating hours / year** is quantified at the global level of the factory. During the weekend there is no constant work activity and there are stops only when some defects appear on certain consumers or when revisions are made during the holidays.
- In 2019, a final production of 182,947 tons was registered. In December 2019 the registered electricity consumption is 722 MWh with a production of 6,424 tons compared to November 2019 where the electricity consumption is 803 MWh and the production is double of 12,016 tons.

Table 172 Electrical energy consumption

Energy consumption – Pilot 1 Electrical energy			
	2017	**2018**	**2019**
Month	Consumption [MWh]	Consumption [MWh]	Consumption [MWh]
January	827	1,130	893
February	998	1,110	1,326
March	1,703	1,442	1,547
April	1,354	1,231	1,442
May	1,360	1,265	1,321
June	1,184	1,260	1,455
July	1,327	1,786	1,551
August	1,515	1,314	1,411
September	1,228	1,431	1,568
October	955	1,089	1,571
November	785	878	803
December	489	507	722
TOTAL	**13,725**	**14,442**	**15,609**

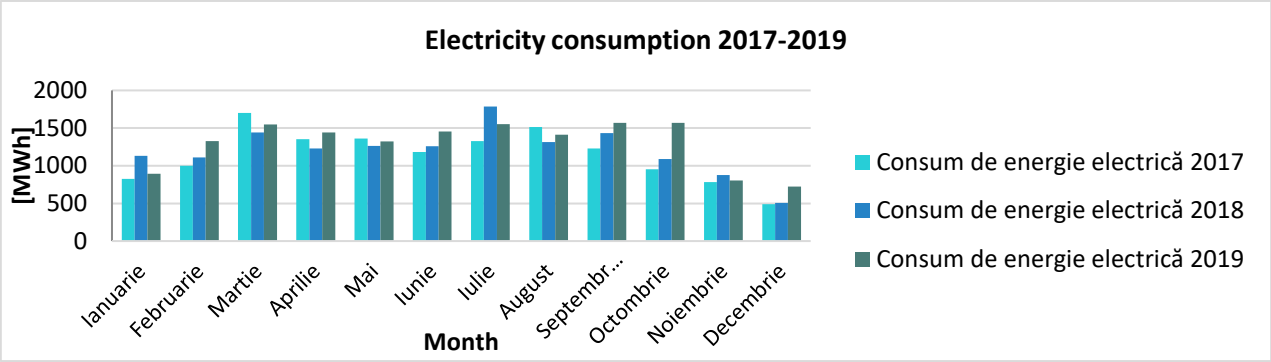


Figure 98 Electricity consumption 2017-2019

Table 173 Pilot 1 – Methane gas consumption

Methane gas – Pilot 1			
	2017	**2018**	**2019**
Month	Specific consumption [MWh]	Specific consumption [MWh]	Specific consumption [MWh]
January	225	63	103
February	242	53	53
March	39	63	23
April	28	11	16
May	18	8	14
June	5	6	7
July	3	5	40
August	5	4	27
September	20	8	86
October	38	18	160
November	67	34	160
December	61	0	189
TOTAL	**752**	**273**	**879**

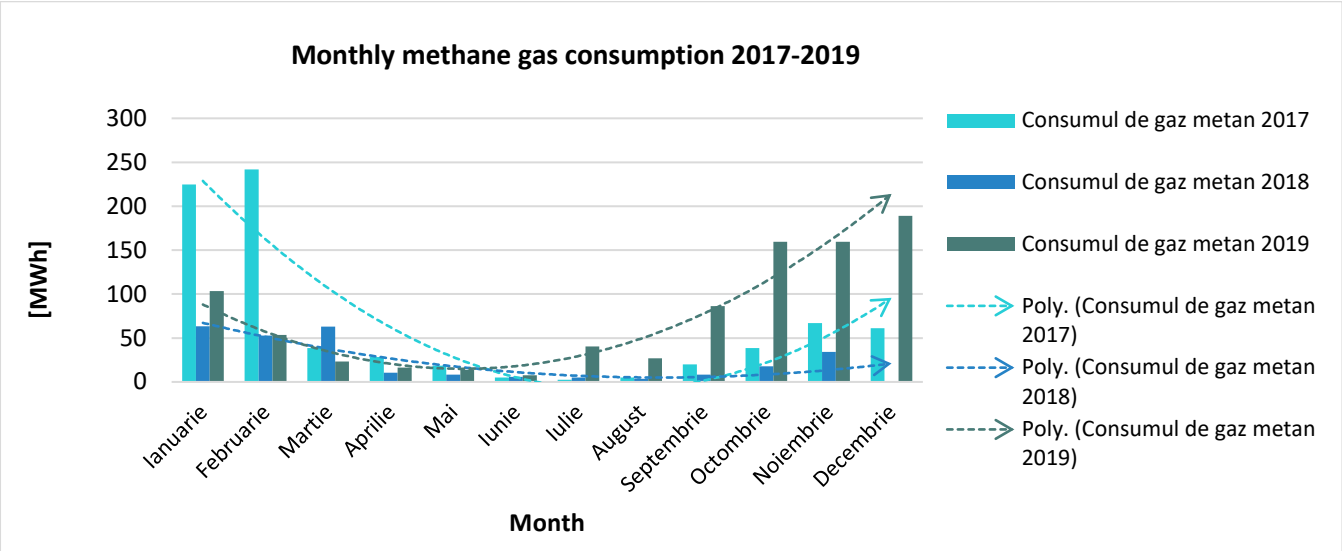


Figure 99 Methane gas consumption 2017-2019

The energy is taken from the supplier through 2 medium-low voltage transformation stations 20 / 0.4 kV, and the distribution through a low voltage station, located in the building where the control room is located.

Transformers supply electricity consumers such as:

- Consumers of the technological process factory;
- Indoor lighting;
- Outdoor lighting;

- Air compressors;
- Office consumers (computers, printers, AC devices, etc.);

The methane gas supply of the factory is made from the distribution network to several thermal points serving the whole factory and all the equipment consuming methane gas.

The thermal energy used in the factory is used in three main directions:

- For technological purposes
- Domestic hot water preparation;
- Preparation of thermal agent to ensure space heating during the cold season.

There is a thermal energy consumption at the company level of 879 MWh / year, of which approximately 46% of the thermal energy consumption is used in the production plant. The remaining 54% is represented by the space heating in halls / warehouses, respectively for the preparation of domestic hot water.

The following tables and graphs show the share of electricity and methane gas consumption and the share of costs:

Table 174 Share of energy consumption and cost

2019				2019		
Consumption	**[MWh]**	**[%]**		**Cost**	**[euro]**	**[%]**
Electrical energy	15,609	95%		Electrical energy	1,198,460	94%
Methane gas	879	5%		Methane gas	29,009	2%
				Diesel	46,616	4%
TOTAL	**16,488**	**100%**		**TOTAL**	**1,274,085**	**100%**

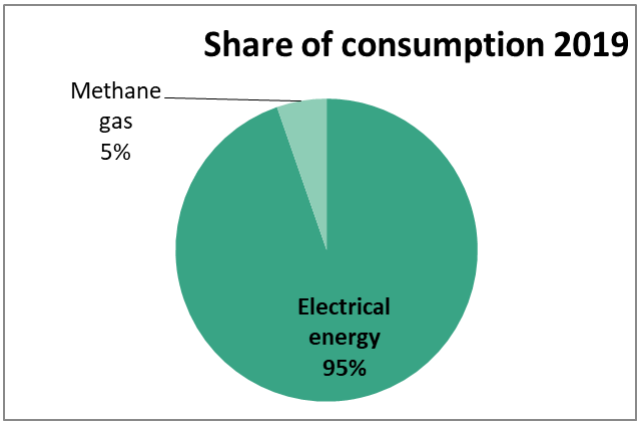


Figure 100 Share of energy consumption in 2019

Table 175 Main electrical energy thermal energy consumers

Electricity		Yes/No/DK
	Technological process	Yes
	Lighting	Yes
	Compressed air	Yes
	Ventilation	Yes
	Pumps	Yes
	Automation	Yes
	Electrical heat	No
	Air conditioning	Yes
	Offices: PCs, printer, copier etc.	Yes

Heat		Yes/No/DK
	Technological process	Yes
	Room heating	Yes
	Domestic hot water preparation	Yes

Lighting System	
Partially LED Technology	X

4.5.1.4. Proposed solution and EE action plan

Proposed solutions & EE action plan for Pilot 1							
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Lighting system retrofit to LED technology	11,254	42	3,249	13.2	3.5	9,042	25%
Reactive power compensation	700	-	196	-	3.6	524	23.9%
Reduction of the compressed air losses	5,000	52	4,012	16.3	1.2	20,063	79.8%
Centralized air compressor control system	18,000	45.2	3,478	14.2	5	3,727	12.8%
Replacement of air compressor with variable speed compressor	25,000	106	8,159	33.3	3	25,968	29.4%
Installation of photovoltaic system	430,560	537	41,349	168.6	10.4	172,257	-2.8%
Energy monitoring system	200,000	-	1,160	-	-	-	-
Hot air recovery from the compressors – hot air	10,000	495	16,329	101	0.6	92,007	163.3%
Hot air recovery from the compressors – hot water	10,000	412	13,608	84	0.7	75,006	136%
Production of thermal energy with solar collectors	1,540	5	157	1	9.8	-558	-1.7%
Cogeneration micro turbine	173,164	-	9,189	-	-	-	-
TOTAL	502,054*	808**		-	-		

*Not all the measures were included in total investment cost.
**Not all the measures were included in the total energy saving.

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.5.1.5. Measurement and verification of the results

The tools were not used.

4.5.1.6. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Table 176 Pilot 1 – Financial resources

Type	Description
Grant scheme	POIM 6.4 and POIM 6.2
Grant scheme	EEA Norway Fund – Programme for Romania – SME Growth Programme
Support instrument	ESCO Funding
Support instrument	Romanian Fund for Energy Efficiency - FREE

4.5.1.7. Energy management plan

- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures; In this way, the body of employees / collectives / groups / work teams will be motivated to directly address the issue of energy consumption efficiency, to pursue the achievement of optimal conditions in the consumption-production ratio. It is also recommended to monitor and train staff on the impact of their energy behavior, through specific training, information and awareness actions.
- Initiation of a bonus system for the proposals / implementations in which the Energy Manager, the Utilities Manager and the Technical and Maintenance Managers of the company are engaged; giving an important role to those mentioned above; establishing joint meetings on energy efficiency between: General Manager, Technical Director, Logistics Manager, Maintenance Manager, Energy Manager, Utility Manager, heads of production departments;
- Monitoring of energy quality indicators, so as to identify in advance possible problems, due to disturbances in the RED, or associated with the operation of equipment / machinery in the energy environment of the company;
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards. Equipping the electrical panels with updated single-wire electrical diagrams that correspond to the labels of each circuit;
- Periodic renegotiation of the price for electricity and methane gas is recommended.

4.5.2. Pilot site 2

4.5.2.1. Introduction for data and current situation

Number of employees: 35

NACE Code: 1082 Manufacture of cocoa, chocolate and sugar confectionery

Production: 800 tons of chocolate/year

4.5.2.2. Energy analysis

The main energy suppliers are electricity and gas.

Electric energy is procured from the 10kw grid by medium voltage connection thought own transformation post. Gas is procured from the low-pressure grid with adjustment station.

Table 177 Pilot 2 – Electrical energy consumption

Energy consumption – Pilot 2 Electrical energy				
2020				
	Active	Reactive		
Month	Consumption [MWh]	Consumption [kVAR]	Cost [RON]	Cost [Euro]
January	43.3	9,100	24,670	5,100
February	39.6	8,400	23,060	4,767
March	42.8	10,700	27,070	5,596
April	39.1	9,200	22,570	4,666
May	35.1	6,300	20,440	4,226
June	41.9	8,100	24,230	5,009
July	40.6	8,500	23,490	4,856
August	40.4	8,700	23,060	4,767
September	44.3	13,200	26,040	5,384
October	41.9	10,500	24,380	5,040
November	39.1	9,400	22,350	4,621
December	35.7	5,900	21,330	4,410
TOTAL	**488.8**	**108,000**	**282,690**	**58,443**

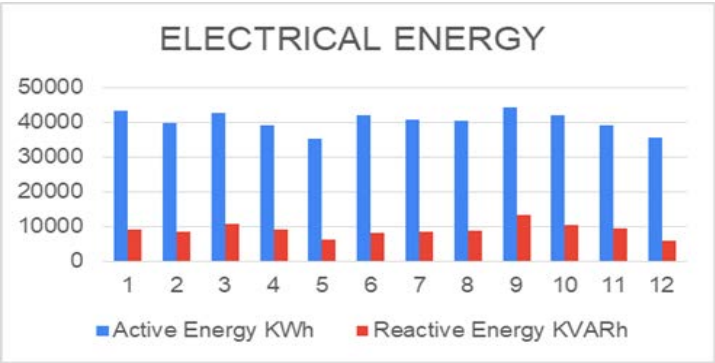


Figure 101 Active and reactive consumption

Table 178 Methane gas consumption

Energy consumption – Pilot 2 Methane gas			
	2020		
Month	Consumption [MWh]	Cost [RON]	Cost [Euro]
January	11.8	2,006	415
February	9.7	1,649	341
March	8.24	14,001	2,895
April	6.26	1,064	220
May	5.50	944	195
June	4.85	825	171
July	4.79	814	168
August	4.79	814	168
September	5.42	921	190
October	6.91	1,175	243
November	7.55	1,284	265
December	10.44	1,775	367
TOTAL	**86.3**	**27,272**	5,638

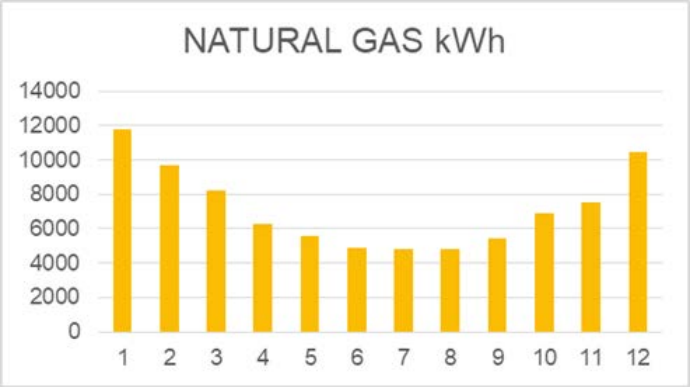


Figure 102 Methane gas consumption

Annual global energy consumption indicators

Total energy (electric+gas)	86,300 kWh + 488,800 kWh	= 575,100 kWh
Primary gas energy	86,300 kWh x 1.17	= 100,971 kWh
Primary electric energy	488,800 kWh x 2.62	= 1,280,656 kWh
Primary total energy	100,971 kWh + 1.280.656 kwh	= 1,381,627 kWh
Specific cons./product unit	575,100 kWh: 900.000 kg choc	= 0.63 kWh/kg choc
Primary total energy /toe	1,381,627 kWh: 11.630 toe/kw	= 118.8 toe
Primary energy intensity	118.8 toe/1300 mii euro	= 0.09 toe/1.000 euro

Electrical energy consumers

- office lighting system with fluorescent lamps
- exterior lighting system with mercury-vapor lamps
- hall lighting system with mercury-vapor lamps
- office climate chiller
- office and catering - electric equipment
- main gate - electric motor
- Technology - motors, heating resistors.

Thermal energy consumers

Two boilers with the power of 35 kW located in the thermal power plant.

Energy assessment

Thermal energy production for heating and domestic water using methane gas

The two boilers form the thermal power plant

- are using condensation method;
- are interconnected;
- technical inspection;
- pumps have adjustable flow;
- they are isolated correctly;

Lighting

- lamps aren't energy-economic;
- the level of illumination in the production hall isn't adequate;
- the production hall doesn't have enough natural light, windows are located at +6m elevation;
- there isn't direct vision with the exterior.

Heating, cooling and ventilation of the building

- there isn't any temperature control in the building
- passive solar protection has a low efficiently
- there aren't any methods of air recirculation, with the exception of toiles
- there isn't any humidity control
- healing and cooling system (VRV) is out of use

Technological flux

- They are using electrical resistance for heating the water (40-800) in the four homogenization tanks.
- The equipment and the transportation pipes aren't isolated; the heat is released in the interior of the hall. In the winter the situation is acceptable by compensating some of the thermal energy needed for heating the hall. In the summer the temperature is over the limit, being necessary to cool the hall.

- The two compressors that produce compress air have different parameters;

Other information

- There isn't any previewed energy audit;
- There isn't any previews industrial energy audit
- There isn't a dedicated technical person for energy efficiency.

4.5.2.3. Proposed solution and EE action plan

Lighting

- Lowering the windows from the production hall in order to receive more natural sunlight and visual contact with the exterior;
- Retrofitting the lighting system with LED technology;
- Redesign the lighting system, lowering the lamps, in order to achieve better lighting level at production hall.

Heating, cooling & ventilation

- Energy performance certificate for the buildings;
- Implementing measures resulting from the certification;
- Installing temperature control in each location;
- Implementing heating pumps for producing heating and cooling using thermal agent;

Technology

- Isolation of the tanks and transportation pipes;
- Using thermal energy form the existing system to heat the water in electrical resistance.
- Heat recovery from the cooling system by heat exchangers;
- Heat recovery from the compressors.

Renewable energy sources

Solar potential

- Number of sunny days: 76
- Number of partial clouded days: 160
- Number of clouded days: 130
- Available are: rooftop – 1,330 sqrm, north façade – 240 sqrm, south façade – 550 sqrm, green zone – 2,500 sqrm;

It is recommended to use photovoltaic panels for electrical energy production.

Geothermal potential

Given the fact that there is a groundwater and permeable layer we can use the potential of the groundwater by implementing a system that can extract the heat from the closed water circuit. This is possible by digging two wells at a depth of 5m and measuring the closed-circuit debit of them.

Wind potential

The building is located in a wind zone that doesn't justify investments in this type of energy.

4.5.3. Pilot site 3

Total energy consumption: ~7,768 toe/year

NACE Code: 4673

4.5.3.1. Introduction for data and current situation

The company has been on the market since 1994 and has a regional presence in Romania, Moldova, Ukraine and Bulgaria. The company has 38 shopping centers, of which 23 in Romania. The Romanian team has over 3,200 employees and the logistical force is provided by the over 1,000 specialized trucks.

The company's object of activity is the trade in construction materials, so the company has developed continuously, at a very fast pace, becoming today the largest distributor of construction materials and finishes in Romania, with a complete portfolio of products and services, with operations both internally as well as externally.

Technological processes

The services provided range from specialized technical advice, shaping and cutting of steel and most notably retailing and transporting of construction materials.

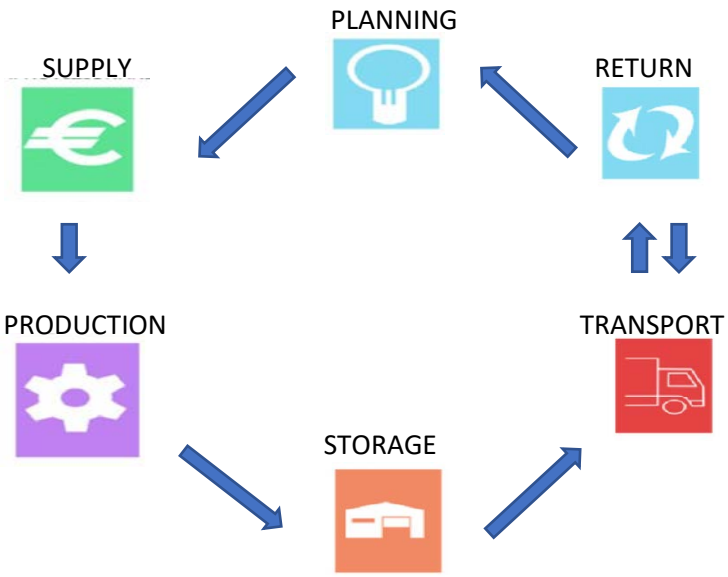


Figure 103 Technological process diagram

The logistical strength of the company is confirmed by the logistics park that includes an impressive number of specialized trucks that ensure maximum efficiency in transport, delivery and unloading, within 24 hours from the date of order, anywhere in Romania.

4.5.3.2. Energy analysis

The data presented is based on the energy balances of the company as well as the annual declarations sent to ANRE/ MEEMA, for the years 2017, 2018 and 2019.

Table 179 presents the data on energy consumption of the company for 2017, 2018 and 2019. It was found that diesel use has the highest share in the total energy consumption, and is almost constant each year, respectively 86.42% in 2017, 84.28% in 2018 and 85.68% in 2019.

Table 179 Data on energy consumption of the company for 2017, 2018 and 2019

Nr.	Energy Source	Year					
		2017		2018		2019	
		toe	%	toe	%	toe	%
1	Electricity	544	6.69	594.6	7.95	597	7.76
2	Natural Gas	440	5.41	491.2	6.57	443.67	5.77
3	Petrol	135	1.66	89.42	1.20	61.09	0.79
4	Diesel	7,012	86.24	6,304	84.28	6,592	85.68
Total		8,131	100	7,479	100	7,694	100

As the company's main object of activity is the transport of goods and their sale for which diesel trucks are decisive, the use of diesel as a main energy source was expected. At the time of this energy audit, the company used trucks, vans, lifting equipment and cars as means of transport. The vehicles are used both for the transport of goods and materials from suppliers to their own warehouses and from warehouses to customers.

Analysis of energy fluid consumption for the three reference years

Figure 104 shows the share for the energy fluids in the structure of the company's consumption for the three years, based on data provided by the beneficiary.

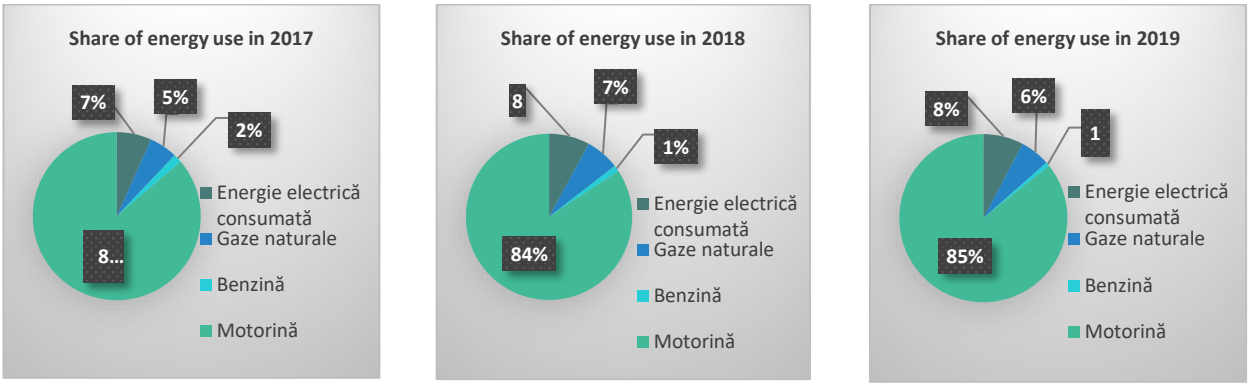


Figure 104 Share of energy use in 2017, 2018, 2019

Figure 105 presents the total energy usage and the turnover for the same time interval.

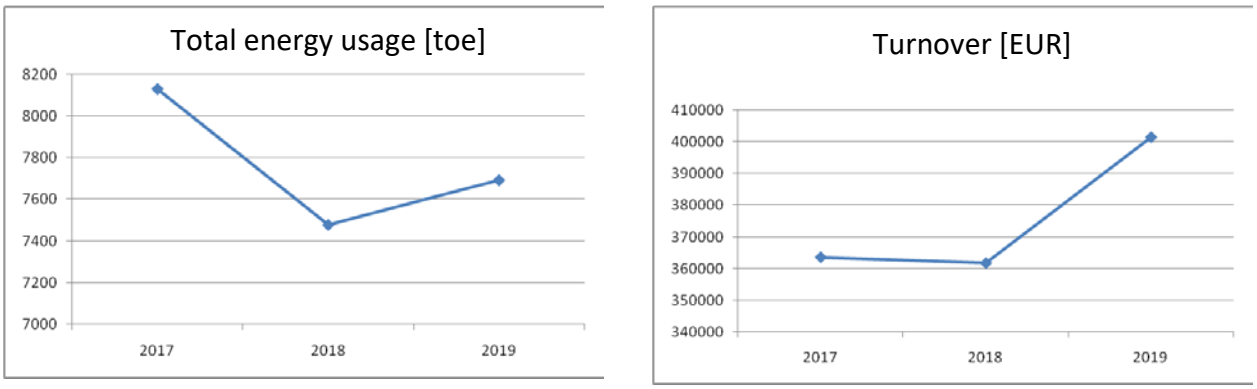


Figure 105 Yearly energy usage and yearly turnover variation

The company's total consumption has four components, and diesel consumption represents over 80% of total consumption, the other three types of energy fluids each having a share between 1% and 8% of total consumption, for the three years under analysis.

Diesel is used predominantly, according to the data provided, by goods vehicles such as DAF CF, DAF LF, DAF FAR and IVECO. DAF FAR trucks have the same engines and construction features as DAF CF, but are also equipped with a crane for loading and unloading operations.

The endowed cars run on average 30,000 km/ year. At an average consumption of 6 l/ 100 km it results that the car fleet consumes 300 x 971 x 6 = 1748800 liters of diesel/ year. At an average density of 0.85 kg/ liter it results that the car fleet on diesel consumes at the level of one year 1,748,800 x 0.85 / 1,000 = 1,486 tons of diesel, respectively approximately 1,500 toe/ year.

For the analyzed period, the center of energy consumption, in proportion of over 65%, is on the fleet of transport vehicles. Therefore, the audit outline consisting of the company's truck fleet has a share of over 65% of the total annual consumption of 7,694 toe/ 2019, fulfilling the conditions of an audit on the entire outline, as presented in the Energy Efficiency Law no. 140/2014, amended by Law no. 160/2016.

Monthly diesel costs are shown in figure below:

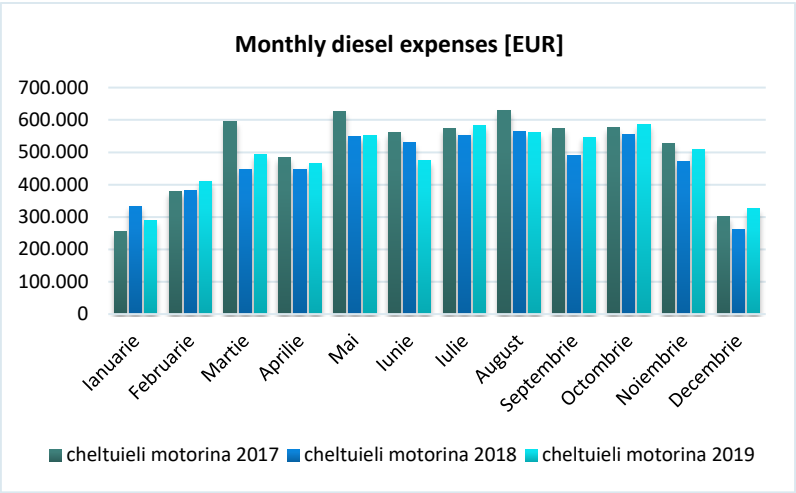


Figure 106 Monthly diesel expenses for the years 2017-2019

For 2019, the distances covered and diesel consumptions for each class of consumers in the audit outline are presented in figure 107.

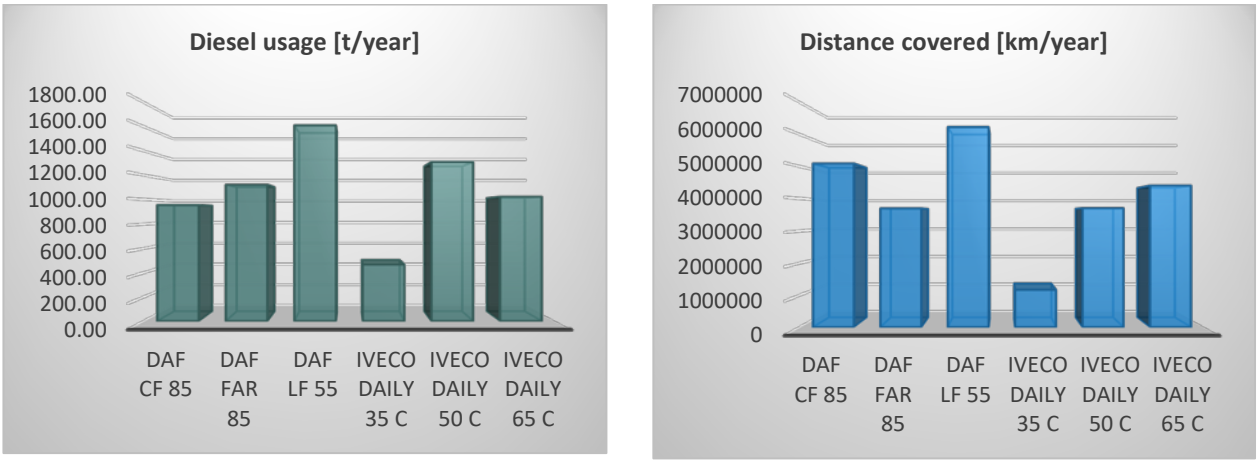


Figure 107 Diesel usage by fleet in 2019 and distance covered by fleet in 2019

Regarding the share of expenditures on energy fluids in total expenditures, the value for this company is between 2% and 2.02%. Even if this share of energy consumption is very small, much lower than the national and European average, the company has complied with the provisions of the energy efficiency law proving concern for the efficient use of energy fluids. The evolution of the share of energy consumption in production costs is represented in figure 108.

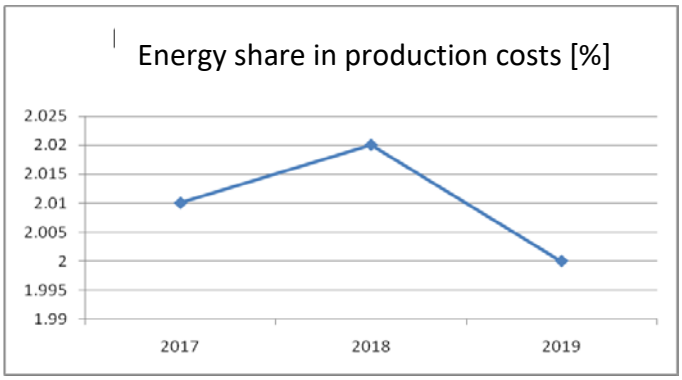


Figure 108 Share of energy consumption in production costs

Energy intensity decreased from 0.0048 toe/ thousand RON in 2017 to 0.0044 toe/ thousand RON in 2018 and then to 0.0040 toe/ thousand RON in 2019. And this indicator shows the company's concern to reduce consumption and avoid wasting energy needed to carry out business.

In conclusion, the company being part of the category of large consumers, the predominant consumption being the fuel, of which diesel has the largest share, has a very low share of energy consumed in production costs, respectively about 2%, compared to the national average of 19-17%, the company being concerned with keeping these consumptions under control.

Table 180 shows the main indicators of the transport activity in the company, for the years 2017, 2018 and 2019. If we take into account the fact that for this company the freight transport activity is the largest energy consumer, the following average values are obtained yearly.

Table 180 Main indicators of the transport activity in the company

Reference year	2017	2018	2019
Total value of annual production [thousant RON]	1,663,293	1,683,363	1,905,618
Quantity of goods transported [t]	1,211,002	1,052,476	1,092,346
Turnover for freight vehicles [km]	25,934,829	2,297,6751	24,373,707
Turnover per tonne of material transported [km/t]	21.42	21.83	22.31
Turnover for thousand RON produced [km/thousant RON]	15.59	13.65	12.79

Completing those presented above, it is outlined that the car fleet represented in 2019 over 65% of the total energy consumption of the company, as detailed in table 181.

Table 181 Breakdown of diesel usage by the fleet in 2019

Vehicle Model	DAF CF	DAF FAR	DAF LF	IVECO	Total
Km run in 2019	5,090,455	3,690,667	6,229,155	9,269,115	24,279,392
Diesel used [l]	829,187	974,872	1,433,899	2,462,147	5,700,105
Average fuel economy per vehicle model [l/100km]	16.29	26.41	23.02	26.56	23.48
No. of vehicles	119	106	148	245	618
Average annual vehicle run [km]	42,777	34,818	42,089	37,833	39,287
Average annual fuel consumption [l]	6,967.96	9,196.91	9,688.51	10,049.6	9,223.47
Average run per vehicle per month [km]	3,565	2,901	3,507	3,153	3,274
Average consumption per vehicle per month [l]	580.66	766.41	807.38	837.46	768.62

4.5.3.3. Proposed solution and EE action plan

Table 182 Proposed efficiency measures for the vehicle fleet

Nr.	Proposed Solutions	Investment	Projected savings				ROI [y]
		[EUR]	[EUR]	[MWh/y]	[toe/y]	[t CO_2/y]	
1	Compliance with the maintenance program about engine overhauls and repairs	120,000	418,440	3,837,900	330.00	679,308.3	0.3
2	Periodic inspection and replacement of tires	80,000	190,200	1,744,500	150	308,776.5	0.42
3	Use of a telemetry monitoring system	150,000	253,600	2,326,000	200	411,702.0	0.6
4	Periodic driver training sessions	0	25,360	232,600	20	41,170.2	0.0
5	Remuneration of disciplined drivers	50,000	25,360	232,600	20	41,170.2	2.0
6	Improving transport routes and avoiding idling	0	19,020	174,450	15	30,877.7	0.0
7	Reducing the waiting time for deliveries	0	6,340	58,150	5	10,292.6	0.0

8	Use of trailers to supplement the load	200,000	190,200	1,744,500	150	308,776.5	1.1
TOTAL		**600,000**	**875,174**	**10,350,700**	**890**	**1,832,074**	**0.7**

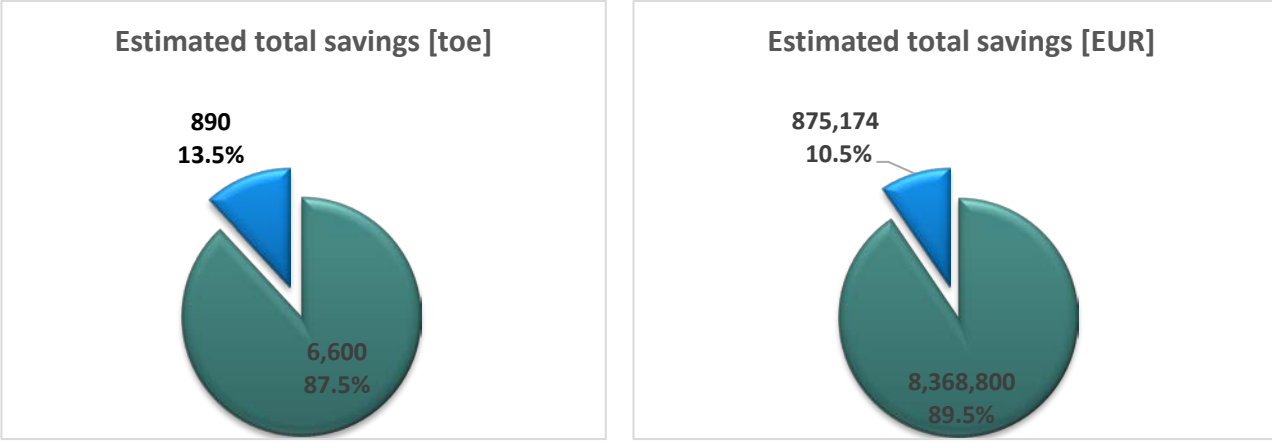


Figure 109 Estimated total savings [toe] and total cost saving [EUR]

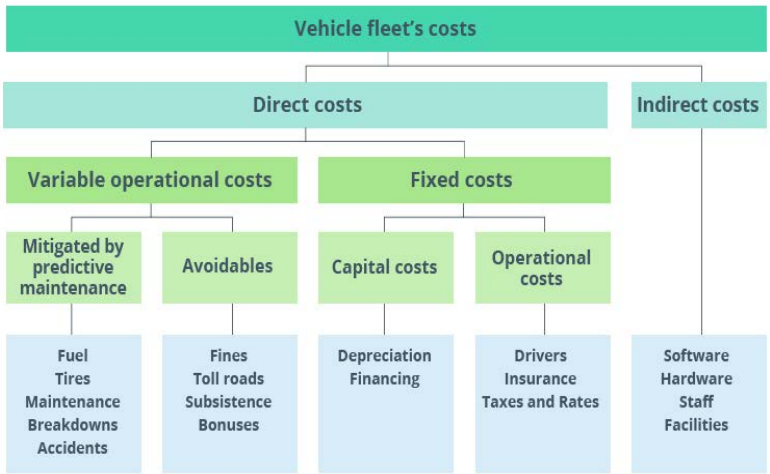


Figure 110 Direct and indirect expenses of a car fleet

Car Fleet General Efficiency Measures

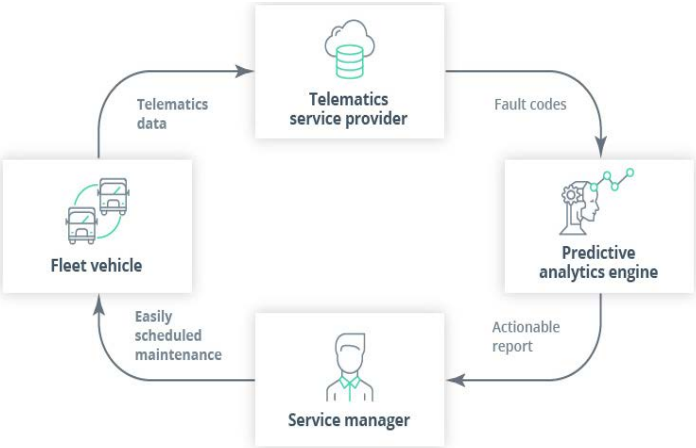


Figure 111 Use of telemetry fleet monitoring systems

4.5.3.4. Energy management plan

The maintenance activities for the means of transport of goods are carried out in specialized workshops, on a contractual basis, according to a rigorous program, which follows each means of transport endowed by the company.

There is a program for monitoring repairs/ overhauls, which is observed and which monitors the state of wear of the machines and their active parts. At the end of each repair activity, a bulletin is issued in which the recommendations of the workshop for the operation of the machine are mentioned until the next planned overhaul.

From the analysis of the findings made by the workshops, the following were identified:

- the maintenance program is observed with a maximum deviation of 10%, given the specifics of the company that has equipment in operation country wide, and they cannot be brought to the workshop exactly on the date or number of hours/ km provided;
- there is no component of maintenance activities dedicated exclusively to the concern for reducing consumption, although some evaluations are related to it (checking fuel quality, recommendation on tire wear, wear of active parts that leads to increased consumption during technological activities); this is due to the fact that maintenance services are outsourced at the company level;
- the qualification level of the operators of the means of transport is not always the best, and the fuel consumption depends on the way in which they are exploited; in the company there is an internal provision by which all consumption exceedances are borne by the operator of the respective means of transport;
- there is a need to introduce awareness-raising activities for operators in order not to exceed the standard consumption of means of transport, given their very large number and relative mobility of staff in this department;
- the action of intensifying the smoke/gas analysis to the endowment means and the correlation of the results with the framing in their consumption norms is required.

4.5.4. Pilot site 4

Number of employees: 113

NACE Code: 2059, Manufacture of other chemical products

Total energy consumption: 19,997 MWh

4.5.4.1. Introduction for data and current situation

Inaugurated in 2008, the factory produces hard gelatin capsules for pharmaceutical use.

A state-of-the-art factory that produces high-quality gelatin capsules for top customers in Europe and other major markets. The modernization process and the expansion of the factories in Bucharest considered all three management pillars: technology, economy and sustainability.

4.5.4.2. Building characteristics

Total gross surface		7,783	sqm
Total surface (buildings + outdoor premises)		25,000 m2	sqm
Number of the administrative buildings	Number of the buildings for production	Number of the buildings dedicated for warehouses	Total number of the buildings
1	2	2	5

4.5.4.3. Energy analysis

Reference Year: 2019	Electricity	Heating
Consumption (MWh)	13,018	6,927
Cost (euro)	808,216	212,342

Table 183 Main electricity and thermal energy consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	Yes
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	Yes
Room heating	Yes
Domestic hot water preparation	Yes

Lighting System	
Partially LED Technology	X

4.5.4.1. Proposed solution and EE action plan

Table 184 Pilot 4 – Propsoed EE action plan

Proposed solution - description	Investment	Energy saving
	[EUR]	[MWh/year]
Closing the coupling between the electrical panels of production buildings	100	433

Implementing a maintenance planning	6,800	8,878
Setting up smart electrical meters	17,000	6,954
Installation of twilight and moving sensors for outdoor lighting	630	116
Photovoltaic panels	288,000	29,186
Dry coolers	10,000	50,883
Adjustment of excess air coefficient to the boiler burner	210	1,560
Adjustment of excess air coefficient to the boiler burner	210	2,467
Insulation of heat exchanger	150	100
Setting up smart natural gas meters	4,500	2,985
Adiabatic cooling system of chillers condensers	1,000	2,250

4.5.5. Pilot site 5

Number of employees: 24

NACE Code: 2511 Manufacture of metal structures and parts of structures

Total energy consumption: 67 toe/year = 779.21 MWh/year

4.5.5.1. Energy analysis

In the following table the list of consumers is described.

Table 185 Pilot 5 – List of consumers

Equipment	Power	Number of pieces
Plasma cutting installation	400 W	1
Exhausted installation	7.5 kW	1
Welding machine	350 W	5
Mill	3 W	1
Lathe	2.8 kW	2
Column drilling machine	2.8 kW	2
Column drilling machine	2 Kw	2
Compressor	7.5 kW	2
Heat plant	45 kW	1

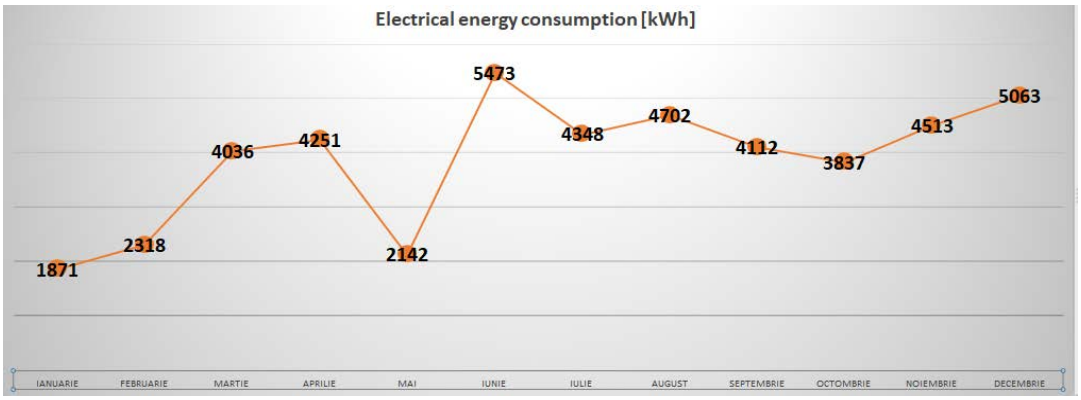


Figure 112 Electrical energy consumption

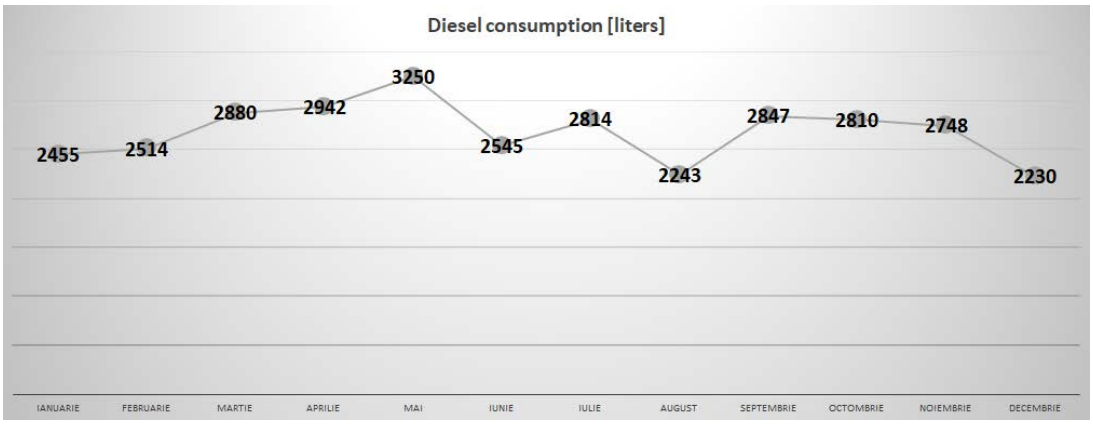


Figure 113 Diesel consumption

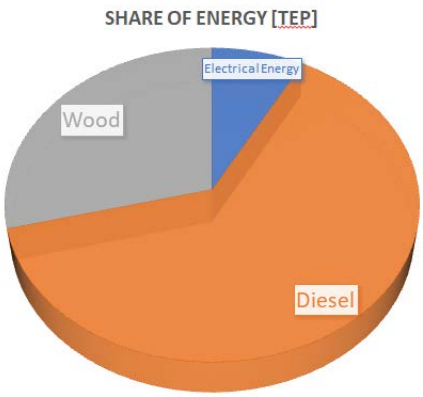


Figure 114 Pilot 5 – Share of energy

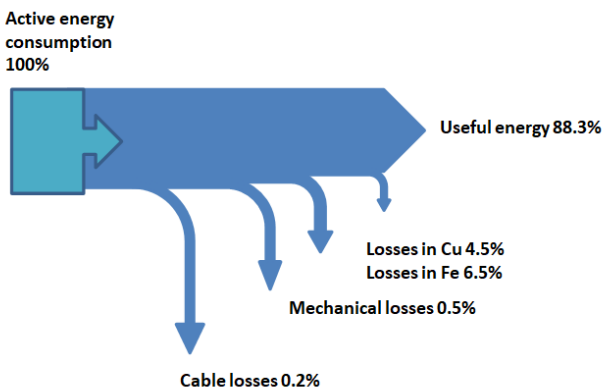


Figure 115 Pilot 5 – Sankey diagram for electrical enery consumption

4.5.5.2. Technological processes

Raw materials: 420 tons/year

Final product: 398 tons/year

The production process takes place in a rented industrial hall with an area of approx. 451 sqm and includes the following operations:

- cutting with oxy-acetylene flame for sheet metal and with the help of chainsaws for profiles;
- the obtained parts are debarred with the help of manual angle grinders;
- assembly of parts by welding
- the painting is done by spraying with a gun or with the help of a roller. After painting, the pieces are left in the painting booth for drying. Drying is done freely, in the painting booth, at ambient temperature;

- Machining: some parts such as different axes and flanges are obtained by machining. The processing is performed on machine tools and consists of: milling, turning, bending, punching, and drilling.

4.5.5.3. Energy analysis

Reference year	Electricity	Wood
Consumption (MWh/year)	27	131
Cost (Euro/year)	31,235	29,879

4.5.5.4. Energy characteristics of the analyised building

- The structure of the construction consists of bushing foundations with foundation beams, the structure made of beams, pillars and metal panels and the roof is made of leather.
- The perimeter closure is with 60mm facade sandwich panels.
- IFor the creation of the technical space, the partitioning is with 20 cm non-thermally insulated brick walls.
- The access in the area destined to the metallic confections is made through 3 sectional doors.
- PVC windows and doors with double glazing.
- The heating of the production and administrative spaces and the production of acc is done from a 72kw CT - solid fuel – pellets

Following the energy performance analysis, the building is in the E energy class, 42.

- Specific annual energy consumption: 451.26kWh/sqm year
- CO_2 emssions: 24.75 kgCO_2/sqm year

Following the proposed measures, energy class C, 88 can be reached.

- Specific annual energy consumption: 208.71kWh/year
- CO_2 emssions: 10.932 kgCO_2/sqm year
- Energy saving of 54% following the application of the measures
- CO_2 emission reduction of 56% following the application of the measures.

4.5.5.5. Proposed solution and EE action plan

- **Heating source** - geothermal heat pump, with a maximum load of 60% of the heating requirement, SCOPnet = min.3.8 (SREN 14825) and CT - solid fuel
- **Domestic heat water** - produced with the help of solar collectors with vacuum tubes to be in the summer months 85% of the necessary, yield 0.785, mounted on roofs, S facade, inclination angle 45%, restoration of the distribution network with thermal insulation pipes and replacement of batteries with sensors (toilet)

- Polycrystalline photovoltaic panels, efficiency min = 14%, S orientation, inclination angle 45% - ensuring consumption - to ensure a percentage of 26.4% of electricity consumption of building utilities, respectively 9,800kWh / year.

Description	Investment [EURO]	Energy saving [MWh/year]	Year of implementation
Heating source	150,000	5.8	2021
Photovoltaic panels Solar thermal collectors Heat pump	72,000	81.27	2022
Purchase of new welding machines, which have superior efficiencies to the old ones	5,000	6	2022
LED technology for the lighting system	2,000	3	2024

4.5.5.6. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant scheme	EEA and Norway Fund
Grant Scheme	Regional Operational Program 2020

4.5.5.7. Energy management plan

- Optimization of the work schedule so as to reduce the number of starts and stops of the welding machines
- Elimination of over-welding, retouching, scrap and bad welding
- Purchase of new welding machines, which have superior efficiencies to the old ones
- Informing employees about energy saving
- Correct understanding of how the building should function both as a whole and in detail
- Encourage occupants to use the building correctly, being motivated to reduce energy consumption
- Regular registration of energy consumption and energy supply contracts
- Analysis of energy bills
- Use of energy consulting services by specialized companies

4.5.6. Pilot site 6

Number of employees: 245

NACE Code: 2712 Manufacture of electricity distribution and control apparatus

Total energy consumption: 60.57 toe/year = 704.43 MWh

4.5.6.1. Introduction for data and current situation

The company's activity is organized on the following sections / warehouses / functional services / compartments:

- An electrical panel manufacturing section;
- Warehouses;
- Functional services (design; automation; installation; commissioning);
- Departments (Human Resources; Procurement & Logistics; Administrative; IT; Quality-Environment-OSH; Sales & Commercial; Financial).

The pilot site no. 6 operates in two locations:

Location A: the central administrative headquarters, where the administrative building with the related offices is located, a storage room for parts and materials with several offices, a warehouse attached to a set of container type offices, employee's locker room, dining room and a park / cable warehouse with a workshop mechanically attached;

Location B: an electrical panel manufacturing, with the materials warehouse, the bathroom and the related offices.

4.5.6.2. Technological processes

Raw materials of the process of making electrical panels:

- Metal box which may be of aluminum or stainless steel;
- Electrical components;
- Circuit breakers;
- Protection;
- Contactors;
- Relee;
- Coils;
- Electrical cables for making connection strips for connections;

Final products: Electrical panels – approxiamtly 1700 pieces/ year

4.5.6.3. Energy analysis

Table 186 Pilot 6 – Energy analysis

No.	Building	Electrical energy consumption [toe]	Natural gas consumption [toe]	Diesel and gasoline consumtions [toe]	Total energy consumption [toe]
1	Administrative office	3.03	-	-	**3.03**
2	Warehouse and related offices	0.54	10.71	-	**11.25**

3	Warehouse, social group and office	2.21	3.60	-	**5.81**
4	Production hall	6.19	8.82	-	**15.01**
5	Car park	-	-	25.47	**25.47**
	Total [toe]	**11.97**	**23.13**	**25.47**	**60.57**
	Total [MWh]	**139.2**	**269**	**296.2**	**704.4**
	Total [%]	**19.76**	**38.19**	**42.05**	**100**

The share of energy costs in turnover for 2019 was about 0.12%, an insignificant share of energy costs per company.

The total amount of energy consumed for 2019 is 60.57 toe.

The specific electricity consumption calculated for each consumption point is presented in the table below:

Table 187 Pilot 6 – Specific consumption

No.	Building	Specific consumption [kWh/mp/an]	Specific consumption [kWh/cm/year]	Specific consumption [toe/mp/an]	Specific consumption [toe/cm/an]
1	Administrative office	35.56	14.23	0.0031	0.0012
2	Warehouse and related offices	14.42	2.41	0.0012	0.0002
3	Warehouse, social group and office	51.42	20.57	0.0044	0.0018
4	Production hall	39.92	7.99	0.0034	0.0007
	Total	**37.35**	**9.08**	**0.0032**	**0.0008**

4.5.6.4. HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

The main consumers within the SME by energy type:

Table 188 Pilot 6 – Electricity and thermal energy consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Ventilation	Yes
Drives	Yes
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	Yes
Room heating	Yes

Domestic hot water preparation	Yes

Lighting System	
No LED Technology	X

4.5.6.5. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

Table 189 Pilot 6 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 6			
Proposed solution - description	**Investment**	**Energy saving**	**Cost saving**
	[EUR]	[toe/year]	[EUR/year]
Awareness of employees about the switching off of light sources, heating and cooling in certain areas at the end of the activity	-	0.35	227.8
Monitoring energy consumption by managers	-	0.35	227.8
Temperature control and regulation in workspaces	-	2.31	915.67
Setting all computers to enter standby mode after a period of non-use	-	0.52	587.63
Ensuring a minimum of weekly maintenance by cleaning the air filter on the indoor unit	-	0.05	58.76
Removal of impurities from the outdoor unit by blowing air	-	0.025	29.3
Checking the freon pressure in the installation at the beginning of each hot season	-	0.025	29.8
Modernization of the lighting system through the use of motion sensors in spaces without permanent occupation	206.19	0.06	70.52
The use of solar panels for the production of domestic hot water during the summer	907.22	0.29	111.34
Replacement of existing classic air conditioning systems (on / off) with Inverter type equipment	247.42	0.332	391.75
Installation of an automatic power factor compensation system	515.56	-	-
TOTAL		4.31	2,650
		50.13 MWh/year	

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X

4.5.6.5.1. Financial resources

Table 190 Pilot 6 – Financial resources

Type	Description
Grant scheme	EEA and Norway Grants – Energy Programme Romania – Call 3
Support mechanism	Modernisation Fund
Other	National Recovery and Resilience Plan

4.5.6.5.2. Energy management plan

Energy management measures proposed:

Table 191 Proposed energy management plan

Nr. cr.	Proposed measures	Responsible
1	Awareness of employees about the switching off of light sources, heating and cooling in certain areas at the end of the activity	Internal department
2	Monitoring energy consumption by managers	Internal department
3	Temperature control and regulation in workspaces	Internal department
4	Setting all computers to enter standby mode after a period of non-use	Internal department
5	Ensuring minimal maintenance weekly, by cleaning the air filter on the indoor unit	Internal department
6	Removal of impurities from the outdoor unit by blowing air	Internal department
7	Checking the freon pressure in the installation at the beginning of each hot season	Internal department
8	Modernization of the lighting system through the use of motion sensors in spaces without permanent occupation	External service - design and execution company
9	The use of solar panels for the production of domestic hot water during the summer	External service - design and execution company
10	Replacement of existing classic air conditioning systems (on / off) with Inverter type equipment	External service - design and execution company
11	Installation of an automatic compensation system a power factor	External service - design and execution company

4.5.7. Pilot site 7

4.5.7.1. Introduction for data and current situation

NACE Code: 2611

Total energy consumption: 552.73 toe/an

The main activities of the factory, representing Pilot 7, are the following: production of electronic components and systems for industrial equipment as well as low voltage electrical equipment: sources, control modules, compact electronic assemblies.

Technological processes:

- Logistics (component inputs / electronic assemblies' output);
- Manufacturing, mounting, gluing, baking, cooling, washing dedicated boards with electronic components;
- Verification, testing, packaging, shipping of finished products;
- Product development, optimization for the global market.

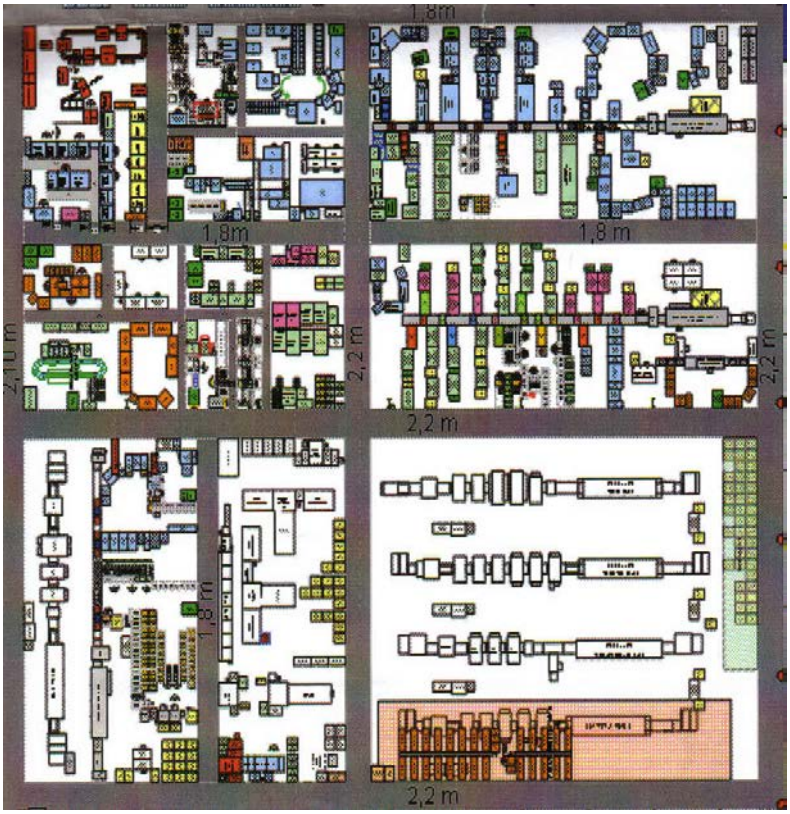


Figure 116 Pilot 7 - Emplacement plan

4.5.7.2. Energy analysis

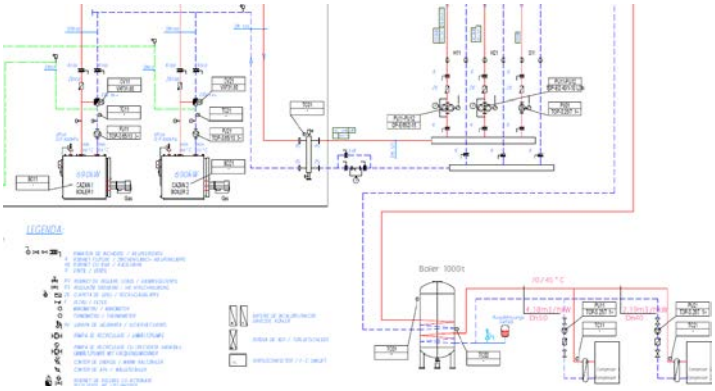


Figure 117 HVAC system of the pilot 7

Table 192 Energy consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	Yes
Drives	Yes
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	No
Room heating	Yes
Domestic hot water preparation	Yes

Lighting System	
Entirely LED Technology	X

Table 193 Pilot 7 – Energy consumption

Energy consumption – Pilot 7	
	2019
Month	Consumption [MWh]
January	324.9
February	321.1
March	341.3
April	313.5
May	355.9
June	350.4
July	370.8
August	356
September	301
October	304.5
November	359.9
December	296.8
TOTAL	**3,996.18**

Table 194 Pilot 7 – Methane gas consumption

Methane gas consumption – Pilot 7	
	2019
Month	Consumption [m³]
January	13,351
February	15,679
March	6,527
April	1,645
May	1,469
June	0
July	0
August	0
September	0
October	2,468
November	10,990
December	9,362
Total	**61,491**

Table 195 Pilot 7 – Water consumption

Water consumption – Pilot 7	
	2019
Month	Consumption [m³]
January	1,017
February	393
March	170
April	680
May	73
June	690
July	877
August	761
September	736
October	644
November	297
December	577
Total	**7,555**

4.5.7.3. Proposed solution and EE action plan

In the follsing table, the existing EE measures are detailed:

Table 196 Pilot 7 - Existing energy efficiency measures

Measure	Cost [Euro]	Energy saving	Implementation year
960 LED lamps	23 Euro/piece	40%	2020
4 heat exchangers	-	75%	2012
1 x 630 kVA Trafo	8300	3%	2018

4.5.7.4. Measurement and verification of the results

The tools were not used.

4.5.7.5. Financial resources

No financial resurces have been identified, rather than own resources.

4.6. Slovenia

The companies in the region do not have the history and experiences in energy management. There are very few SME companies with implemented good energy managements system or ISO related standards. According to the energy law they are not obliged to make energy audits. Therefore, some data about production is still missing. It will be collected and analyzed in next months. Not all pilot site has developed the whole action plan yet. The training finished in March 2021 and some of them still develop the energy action plan. It will be finalized in May 2021. Energy data for 2019 and 2020 was used, because such data were already collected and analyzed for pilots. Data for 2021 is still collected. Not all pilots are very active. Due to the epidemic situation, they have had difficult times and cooperation within the project were not their priority. The awareness about the energy management is low therefore they do not see the potential savings or the rise of their competitiveness when working on energy use and CO_2 emission reduction. They do not use such information in their marketing activities.

In April 2021 11 pilot sites are running, they were able to collect energy use data for 2019 and 2020. Not all of them have prepared the action plan for EE and RES measures. They are working on them.

Table 197 Pilot sites in Slovenia

			Pilot sites
N.	**NACE CODE**	**No. of employees**	**Short description**
1	**27.120**	**9**	Manufacture of electricity distribution and control apparatus, servicing and production of compensation devices, construction of transformer stations, production of all types of switchgear, electrical installation services and electricity quality measurements.
2	**25.990**	**216**	Manufacture of other fabricated metal products, European manufacturer of permanent metal magnets, paste magnets and magnetic systems with a long tradition of production since 1951
3	**35.220**	**86**	Distribution of gaseous fuels through mains, provision of services in the field of gas technology, distribution of natural gas and liquefied petroleum gas
4	**23.320**	**100**	Manufacture of bricks, tiles and construction products, in baked clay, production of wall bricks, facade bricks and brick tiles
5	**71.129**	**9**	Other engineering activities and related technical consultancy, energy monitoring, energy management, design, implementation and maintenance of automation
6	**35.111**	**5**	Production of electricity in HE generation facilities, production of electricity from renewable sources (solar power plants, hydroelectric power plants)
7	**08.990**	**266**	Other mining and quarrying, production and processing of quartz sand, production of cores, production of auxiliary foundry means for foundries and ironworks
8	**29.320**	**52**	Manufacture of other parts and accessories for motor vehicles - manufacture of pneumatic, hydraulic brake units, clutch boosters for trucks, trailers, buses and tractors
9	**56.290**	**4**	Other food service activities, installing

			and assembling product lines in the automotive industry, setting up solar power plants and wood dryers

4.6.1. Pilot site 1

4.6.1.1. Introduction for data and current situation

Number of employees: 9

NACE Code: 27.120 Manufacture of electricity distribution and control apparatus, servicing and production of compensation devices, construction of transformer stations, production of all types of switchgear, electrical installation services and electricity quality measurements.

- Characteristics of the buildings: built in 1990, more owners and users: offices 72, 4 m^2, production process 55.8 m^2, depo 123.9 m^2, not energy efficient building.
- Energy use data not correlated to the production yet.

4.6.1.2. Energy analysis

- Energy bookkeeping is based on energy bills.
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for 2 years.
- The M&T and M&V tools were not used yet.
- Total cost for energy in 2020 is 3,088 EUR per year 2020, 38 % for electricity.
- Specific consumption was not calculated.

Table 198 Pilot 1 – Electricity consumption

Energy consumption – Pilot 1 Electricity		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	0.812	0.804
February	0.719	0.717
March	0.612	0.632
April	0.702	0.491
May	0.536	0.368
June	0.474	0.469
July	0.543	0.629
August	0.722	0.629
September	0.553	0.609
October	0.481	0.629
November	0.554	0.609
December	0.686	0.629
TOTAL	**7.39**	**7.22**

Table 199 Pilot 1 – Natural gas consumption

Energy consumption – Pilot 1 Natural gas		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	1.69	0.804
February	1.16	0.717
March	0.91	0.632
April	0.54	0.491
May	0.42	0.368
June	0.06	0.469
July	0.03	0.629
August	0.01	0.629
September	0.01	0.609
October	0.41	0.629
November	0.78	0.609
December	1.20	0.629
TOTAL	**7.23**	**7.22**

4.6.1.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Complete energy audit was not done yet.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - New heating system – energy efficient gas burner
  - Insulation of the building
- The measures have not been specified yet, only approximately costs and saving were calculated.
- Payback period for building insulation is much too long and costly.
- Payback period for new gas burner is acceptable.
- NPV and IRR were not calculated yet.

Table 200 Pilot 1 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 1					
Proposed solution - description	**Investment**	**Energy saving Type: (gas)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
New gas burner	4,000	2	600	0.4	6.7
Building insulation	25,000	0.7	195	0.14	128

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR		X
CO_2 emission	Tones eq.	X	

4.6.1.4. Measurement and verification of the results

M&T and M&V tools were not used yet.

4.6.1.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.1.6. Energy management plan

Energy management plan:

- Basic step of energy management will be developed: energy monitoring, action plan, indicators, regular checking of the results, educational activities;
- Energy book-keeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff on the impact of their energy behavior, through specific training, information and awareness actions will be organized;
- Periodic renegotiation of the price for energy will be done;
- Influence of the energy use on maintain works will be studied.

4.6.2. Pilot site 2

Number of employees: 216

NACE Code: 25.900

4.6.2.1. Introduction for data and current situation

- European manufacturer of permanent metal magnets, paste magnets and magnetic systems with a long tradition of production since 1951.
- Characteristics of the buildings: built in 1980, industrial building 1,841.4 m^2, not energy efficient building.
- Energy use data not correlated to the production yet.

4.6.2.2. Energy analysis

- Energy monitoring was performed via measurement units. The measurements of the heat use are done on 3 locations. Only 4 months energy data for heating in 2019 is available.
- Cost monitoring was done through energy bills.
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for 2 years.
- Total cost of energy is 1.12 mio EUR per year 2020, 71 % for heat and 28 % for electricity, 1 % for water.
- Specific consumption was not calculated.

Table 201 Pilot 2 - Electricity consumption

Energy consumption – Pilot 2 Electricity		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	1,031.83	923.89
February	1,050.70	1,045.84

March	1,145.25	1,094.21
April	1,047.97	983.89
May	1,120.01	820.35
June	977.61	762.05
July	1,066.59	851.54
August	992.87	860.85
September	1,097.44	1,026.07
October	1,149.86	1,007.88
November	1,005.77	1,019.81
December	882.43	1,071.16
TOTAL	**12,568.33**	**11,467.56**

Table 202 Pilot 2 – Thermal energy consumption

Energy consumption – Pilot 2 District heating		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	-	133.89
February	-	83.04
March	-	57.87
April	-	25.76
May	-	3.40
June	-	0.10
July	-	0.00
August	-	0.00
September	0.20	0.40
October	8.83	20.34
November	30.40	89.96
December	78.07	12.94
TOTAL	**117.50**	**427.70**

4.6.2.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Complete energy audit was not done yet.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - Use of waste heat
- The measures have not been specified yet, only approximately costs and saving were calculated.
- NPV and IRR were not calculated yet.

Table 203 Pilot site 2 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 2					
Proposed solution - description	**Investment**	**Energy saving Type: (Heat)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Use of the waste heat via heat pump	35,000	40	7,000	12,800	5

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.6.2.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.2.5. Energy management plan

Energy management plan:

- The company has implemented basic step of energy management: energy monitoring and regular checking of the results; due to the lack of human resources and time good management is not implemented yet
- Energy book-keeping data will be upgraded with some process variable; analytics will be performed separately on each measurement units and correlated to the process variable;
- KPI will be developed for management decision making process;
- Periodic renegotiation of the price for energy will be done;
- Influence of the energy use on maintains works will be studied.

4.6.3. Pilot site 3

4.6.3.1. Introduction for data and current situation

Number of employees: 86

NACE Code: 35.220

- Company is natural gas distributor and operator of natural gas grid in the region. They offer the services in the field of gas technology, distribution of natural gas and liquefied petroleum gas.
- Characteristics of the buildings: built in 1989, 2,231.4 m^2 in 3 parts: administrative 899 m^2, processes 511m^2, depo 821.4 m^2), medium energy efficient.
- Energy use data not correlated to the production yet, production data not selected yet.

4.6.3.2. Energy analysis

- Energy audit of the administrative building was performed.
- Energy analytics: presentation of the monthly energy consumption (for each energy type) only for 2019 due to the lack of time.
- Energy and cost were read from energy bills, the cost for electricity is 53,409 EUR per year 2020, the cost for natural gas is not monitored, it is treated as self-consumption.
- Specific consumption was not calculated.

Table 204 Electricity consumption

Energy consumption – Pilot 3 Electricity	
	2019
Month	Consumption [MWh]
January	38.59
February	29.32
March	31.33
April	26.06
May	25.01
June	26.46
July	29.97
August	29.30
September	30.48
October	27.20
November	30.37
December	34.39
TOTAL	**358.48**

Table 205 Natural gas and liquid petroleum gas consumption

Energy consumption – Pilot 3 Natural gas and liquid petroleum gas	
	2019
Month	Consumption MWh]

January	184.82
February	129.95
March	101.49
April	76.23
May	63.96
June	20.30
July	20.25
August	19.12
September	30.49
October	65.96
November	112.46
December	163.09
TOTAL	988.13

4.6.3.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Complete energy audit was done for building, for the whole process not yet.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - Insulation of the building
  - Reduction and optimization of electricity use
- The measures have not been specified yet, only approximately costs and saving were calculated.
- Payback period for building insulation is not calculated because they do not collect the cost for gas supply – it their own use.
- NPV and IRR were not calculated.

Table 206 Pilot 3 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 3					
Proposed solution - description	**Investment**	**Energy saving Type: (electricity)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Reduction and optimization of electricity use	60,000	70	10,500	34	5.7

KPI	U.M	Calculated	Estimated
Investment	EUR		X

Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.6.3.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.3.5. Energy management plan

Energy management plan:

- Basic step of energy management will be developed: energy monitoring, action plan, indicators, regular checking of the results, educational activities;
- Energy book-keeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff will be organized and information and awareness actions implemented;
- Periodic renegotiation of the price for energy will be done.

4.6.4. Pilot site 4

Number of employees: 100

NACE Code: 23.320 Production of wall bricks, facade bricks and brick tiles.

4.6.4.1. Introduction for data and current situation

- Process is presented on the picture bellow.

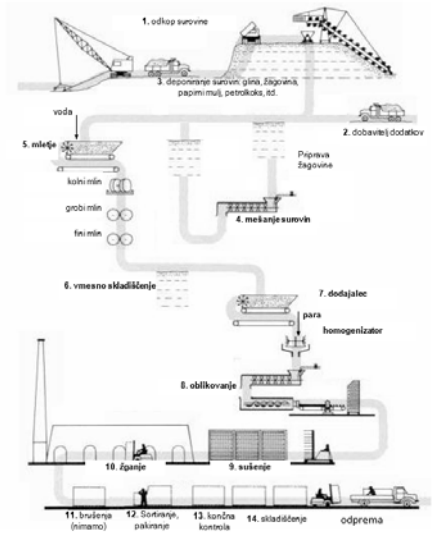


Figure 118 Technological process

- Characteristics of the buildings: built in 1979, 2 parts: administrative 423.4, m^2, depo 41 m^2, not energy efficient building.
- Energy use data not correlated to the production yet.

4.6.4.2. Energy analysis

- The company has energy bookkeeping in place; some energy measurement units are set but not linked to the cost, the costs are read from energy bills as a whole.
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for 2 years.
- Total cost of energy is 1.98 mio EUR per year 2020, 28 % for electricity, 71 % for heat and 1 % for water.
- Specific consumption was not calculated.

Table 207 Pilot 4 Electricity consumption

Energy consumption – Pilot 4 Electricity		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	256.16	644.67
February	228.92	715.41
March	645.31	662.18
April	653.07	610.51
May	660.85	607.71
June	661.25	621.27
July	716.80	652.49
August	749.59	629.96
September	728.84	621.33

October	745.06	655.30
November	749.84	643.14
December	714.60	625.10
TOTAL	**7,510.28**	**7,689.9**

Table 208 Pilot 4 – Natural gas consumption

Energy consumption – Pilot 4 Natural gas		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	2,754.40	5,208.97
February	2,461.99	5,730.65
March	5,404.79	5,428.68
April	4,582.77	4,962.10
May	4,603.97	4,596.85
June	4,280.41	4,534.70
July	4,703.59	4,735.97
August	5,436.09	4,481.17
September	5,609.94	4,324.73
October	5,100.91	4,631.56
November	5,272.58	4,599.19
December	5,425.20	4,516.09
TOTAL	**55,636.64**	**57,750.64**

4.6.4.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Complete energy audit was done.
- According to energy data and known situation from energy team at the site, following measures should be implemented in very near future:
  - Optimization of energy use in drying room with new ventilation system
  - Optimization of drying room with new frequency regulators
  - Installation of PV system
- The measures were specified, special measures were done to find optimal solution, costs and saving were calculated.
- Payback period for building insulation is much too long and costly.
- Payback period for investments in drying room are very favorable and will be implemented very soon.
- The calculation for PV system were done but the payback period is long but it is dropping, they will wait another year or two and then invest.
- NPV and IRR were calculated.

Table 209 Pilot 4 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 4					
Proposed solution - description	**Investment**	**Energy saving Type: (electricity)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Optimization of energy use in drying room with new ventilation system	73,047	256.67	18,587	125.44	3.93
Optimization of drying room with new frequency regulators	122,988	168.58	15,568	82.60	7.9

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.6.4.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.4.5. Energy management plan

Energy management plan:

- Basic steps of energy management are developed: energy monitoring and action plan, indicators, regular checking of the results and educational activities will be further developed;
- Energy book-keeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff will be organized;
- Periodic renegotiation of the price for energy will be done;
- Influence of the energy use on maintains works will be studied.

4.6.5. Pilot site 5

4.6.5.1. Introduction for data and current situation

Number of employees: 9

NACE Code: 71.129 Engineering company specialized for energy monitoring, energy management, design, implementation and maintenance of automation.

- Characteristics of the buildings: built in 1942, more parts together 502 m^2, more users, not energy efficient building.
- For the calculations in pilot 2 zone within the building were defined as presented on the picture bellow.

Figure 119 Buildings

Energy use data not correlated to the production yet because the production parameter was not defined yet.

4.6.5.2. Energy analysis

- The energy bookkeeping system use energy bills for data collection. The users are only in buildings.
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for 2 years.
- Total cost of energy 2.423 EUR per year 2020, 44 % for heating.
- The M&T and M&V tools were not prepared yet.
- Specific consumption was not calculated.

Table 210 Pilot 5 – Electricity consumption

Energy consumption – Pilot 5 Electricity		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	0.74	0.77

February	0.64	0.76
March	0.70	0.55
April	0.57	0.54
May	0.67	0.58
June	0.57	0.50
July	0.76	0.62
August	0.75	0.64
September	0.60	0.53
October	0.61	0.67
November	0.86	0.73
December	0.68	0.68
TOTAL	**8,16**	**7,56**

Table 211 Pilot site 5 – Natural gas consumption

Energy consumption – Pilot 5 Natural gas		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	5.84	6.84
February	4.47	3.90
March	2.88	0.00
April	1.19	0.00
May	2.06	4.49
June	0.00	0.00
July	0.00	0.00
August	0.00	0.00
September	0.00	0.00
October	1.38	1.92
November	2.74	3.71
December	3.25	4.51
TOTAL	**23.80**	**25.37**

4.6.5.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Complete energy audit for the building was prepared.
- According to energy data and known situation from energy team at the site, following measures should be implemented in very near future:
  - Insulation of the building
  - New heating system – energy efficient gas burner 25 kW was installed in 2020
- Payback period for building insulation is much too long and costly; they will perform some work to make it less expensive.

- NPV and IRR have not been calculated yet.

Table 212 Pilot 5 – Porposed EE action plan

Proposed solutions & EE action plan for Pilot 5							
Proposed solution - description	**Investment**	**Energy saving Type: (gas)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Building insulation	2,010	7.3	300	1.46	6.7	-	-

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.6.5.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.5.5. Energy management plan

Energy management plan:

- Basic step of energy management will be developed: energy monitoring, action plan, indicators, regular checking of the results, educational activities;
- Energy bookkeeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff will be organized;
- Periodic renegotiation of the price for energy will be done.

4.6.6. Pilot site 6

Number of employees: 5

NACE Code: 35.111 Production of electricity from renewable sources (solar power plants, hydroelectric power plants).

4.6.6.1. Introduction for data and current situation

- Characteristics of the buildings: they have only 4 offices in bigger building and are not able to influence the energy efficient measures.
- Their production units are in the field and they use only electricity to run RES production units.

4.6.6.2. Energy analysis

- The electricity use is only to run RES production units and is less than 0,0001 % of their production. The installments are quite energy efficient and not old. In 2019, under average weather conditions, they produced 12,660 MWh of RES electricity with own production facilities.
- Energy analytics: presentation of the monthly energy consumption for electricity for 2 years;
- The cost of the electricity is 5,900 EUR per year 2020.
- Specific consumption was not calculated.

Table 213 Pilot 6 – Electricity consumption

Energy consumption – Pilot 6 Electricity		
	2019	**2020**
Month	Consumption MWh]	Consumption [MWh]
January	0.54	0.95
February	0.50	1.12
March	5.37	0.66
April	1.16	0.78
May	0.34	0.86
June	0.65	0.81
July	0.65	0.89
August	0.85	0.91
September	0.80	0.92
October	1.12	1.01
November	0.94	1.04
December	0.97	2.88
TOTAL	**13.88**	**12.81**

4.6.6.3. Proposed solution and EE action plan

Company is still searching for potential energy efficient measures. They are very specific company with good energy efficient production and they produce and use 100 % RES.

The activities will be oriented towards the promotion of EE and RES.

4.6.7. Pilot site 7

Number of employees: 266

NACE Code: 08.990 - Mining and quarrying n.e.c

4.6.7.1. Introduction for data and current situation

- Established in 1960, is a mining company for the production and processing of silica sands and the production of auxiliary casting material for foundries and ironworks.
- Characteristics of the buildings; built in 1980, 1,152 m^2, energy inefficient.
- Monthly production data has not been collected yet.

4.6.7.2. Energy analysis

- The energy data was collected from monitoring system and from energy bills.
- Energy analytics: presentation of the monthly energy consumption for electricity for 2 years.
- Total costs of energy are 455,001 EUR per year 2020, 97 % for electricity and 3 % for water.
- Specific consumption is not calculated.

Table 214 Electricity consumption

Energy consumption – Pilot 7 Electricity		
	2019	**2020**
Month	Consumption [MWh]	Consumption [MWh]
January	563.23	536.98
February	586.99	551.27
March	631.48	506.32
April	572.49	330.70
May	578.97	404.24
June	539.10	393.40
July	656.53	522.65
August	440.85	396.74
September	534.39	541.09
October	533.48	554.70
November	481.25	544.43
December	366.88	447.59
TOTAL	**6,485.63**	**5,730.12**

4.6.7.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Energy audit was done.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - Reduction of the air loses
  - New heating system sources – from heating oil to gas boiler
  - New indoor lighting

Table 215 Pilot 7 – Propsoed EE action plan

Proposed solutions & EE action plan for Pilot 7					
Proposed solution - description	**Investment**	**Energy saving Type: (electricity, heating oil)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
Reduction of the air loses	12,600	151.2	12,600	74.1	1
New heating system sources – from heating oil to gas boiler	4,940	4.5	2,600	6.95	1.9
New indoor lighting Co-generation unit	35,268	90.3	10,193	44.25	3.46

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.6.7.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.7.5. Energy management plan

- Basic step of energy management will be developed: energy monitoring, action plan, indicators, regular checking of the results, educational activities;
- Energy bookkeeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff will be organized and awareness raisin activities implemented;
- Periodic renegotiation of the price for energy will be done;

4.6.8. Pilot site 8

Number of employees: 52

NACE Code: 29.320 Manufacture of pneumatic, hydraulic brake units, clutch boosters for trucks, trailers, buses and tractors.

4.6.8.1. Introduction for data and current situation

- Characteristics of the buildings; built in 1948; administrative building 180 m^2, energy inefficient.
- Monthly production data has not been collected yet.

4.6.8.2. Energy analysis

- Data was collected via measuring points and from energy bills.
- Energy analytics: presentation of the monthly energy consumption for electricity and heat for 2 years.
- Total costs of energy are 271,840 EUR per year 2020, 71 % for electricity and 29 % for heat.
- Specific consumption was not calculated.

Table 216 Electricity consumption

Energy consumption – Pilot 8 Electricity			
	2018	**2019**	**2020**
Month	Consumption [MWh]	Consumption MWh]	Consumption [MWh]
January	148.09	154.02	142.00
February	134.31	142.74	139.34
March	154.63	142.06	154.37
April	137.59	147.15	142.21
May	156.49	139.71	133.34
June	152.18	135.41	136.69
July	138.16	149.40	136.07
August	142.28	116.73	138.76
September	138.35	143.53	164.02
October	144.57	152.58	186.51

November	133.56	145.08	180.03
December	116.48	125.63	165.04
TOTAL	**1,696.68**	**1,694.04**	**1,818.37**

Table 217 Natural gas consumption

Energy consumption – Pilot 8 Natural gas			
	2018	**2019**	**2020**
Month	Consumption [MWh]	Consumption MWh]	Consumption [MWh]
January	198.73	227.24	263.96
February	219.04	200.93	179.77
March	241.24	169.15	174.58
April	145.00	123.05	132.08
May	151.24	112.37	102.86
June	121.83	65.68	103.33
July	106.73	98.75	83.89
August	93.67	60.57	84,52
September	118.10	103.60	134.11
October	137.19	92.53	185.66
November	170.50	150.44	207.30
December	175.13	159.94	160.00
TOTAL	**1,878.41**	**1,564.24**	**1,812.04**

4.6.8.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Revision of the existing energy audit has not been done yet.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - Installation of co-generation unit using natural gas
  - Installation of FV system for self-consumption

Table 218 Pilot 8 –Proposed EE measures

Proposed solutions & EE action plan for Pilot 8					
Proposed solution - description	**Investment**	**Energy saving Type: (electricity, natural gas)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]

Co-generation unit	125,000	600	63,600	294	1.96
Photovoltaic system	100,000	200	21,200	98	4.71

KPI	U.M	Calculated	Estimated
Investment	EUR		X
Energy saving	MWh		X
Cost saving	EUR		X
CO_2 emission	Tones eq.		X

4.6.8.4. Measurement and verification of the results

M&T and M&V tools were not used.

4.6.8.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.8.6. Energy management plan

Energy management plan:

- Basic step of energy management will be developed: energy monitoring, action plan, indicators, regular checking of the results, educational activities;
- Energy bookkeeping data will be upgraded with some process variable;
- KPI will be developed for management decision making process;
- Training of staff will be organized;
- Periodic renegotiation of the price for energy will be done.

4.6.9. Pilot site 9

Number of employees: 9

NACE Code: 56.290 Installing and assembling product lines in the automotive industry, setting up solar power plants and wood dryers

4.6.9.1. Introduction for data and current situation

- Characteristics of the buildings; built in 1978, 377,2 m^2, more users, energy inefficient.
- Monthly production data has not been collected yet.

4.6.9.2. Energy analysis

- Energy data was collected from energy bills.
- Energy analytics: presentation of the monthly energy consumption for electricity and heat only for 2020.
- Total costs of energy are 5,341 EUR per year 2020, 73 % for electricity and 27 % for heat.
- Specific consumption is not calculated.

Table 219 Pilot 9 – Electricity consumption

Energy consumption – Pilot 9 Electricity	
	2020
Month	Consumption [MWh]
January	1.00
February	1.07
March	1.19
April	1.74
May	1.26
June	9.79
July	1.82
August	2.15
September	1.84
October	1.44
November	2.04
December	1.00
TOTAL	**26.51**

Table 220 Pilot 9 – Natural gas consumption

Energy consumption – Pilot 9 Natural gas	
	2020
Month	Consumption [MWh]
January	4.87
February	3.16
March	2.53
April	1.04
May	0.00
June	0.00

July	0.00
August	0.00
September	0.00
October	1.16
November	2.96
December	2.09
TOTAL	**17.80**

4.6.9.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Energy audit has not been done yet.
- According to energy data and know situation from energy team at the site, following measures should be implemented in very near future:
  - New indoor lighting

Table 221 Pilot 9 – Proposed EE action plan

Proposed solutions & EE action plan for Pilot 9					
Proposed solution - description	**Investment**	**Energy saving Type: (electricity)**	**Cost saving**	**CO_2 emission reduction**	**Payback period**
	[EUR]	[MWh/year]	[EUR/year]	[tones eq. CO_2/year]	[years]
New indoor lighting	8,000	10	2,000	4.9	4

KPI	U.M	Calculated	Estimated
Investment	EUR		x
Energy saving	MWh		x
Cost saving	EUR		x
CO_2 emission	Tones eq.		x

4.6.9.4. Measurement and verification of the results

M&T and M&V tools were not used.

4.6.9.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description

Grant/Subsidy scheme	Slovene Ecological Fund – public national fund has financial schemes for SME usually 20 % grants or subsides interested rate are possible

4.6.9.6. Energy management plan

- Due to the lack of human resources and time, only start of the energy management will be implemented – they will start with regular energy data collection.
- Energy book-keeping data will be upgraded with some process variable.
- KPI will be developed for management decision making process.

4.7. Spain

4.7.1. Pilot site 1

4.7.1.1. Introduction for data and current situation

Number of employees: 210

NACE Code: 15130 – Food industry

Total energy consumption: Over 11,630 MWh/year

Energy profile of the SME

Table 222 Pilot 1 – Energy consumption

Year: 2018	Electricity	Purchased Liquid fuel
Consumption (MWh)	14,200	19,180
Cost (euro)	1,208.616	655,903

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	DK
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes
Other	-

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK
Other	-

Lighting System	
Partially LED Technology	X

Table 223 Production data

Production – Pilot 1 Meat		
	2018	**2019**
Month	Production [ton]	Production [ton]
January	1,997	2,207
February	2,296	2,478
March	2,099	2,341
April	2,069	2,290
May	1,904	2,089
June	1,505	1,732
July	1,731	1,915
August	1,748	1,932
September	1,672	1,862
October	1,673	1,856
November	1,592	1,777
December	1,842	2,020
TOTAL	**22,128**	**24,500**

4.7.1.2. Energy analysis

Electricity

Table 224 Electricity consumption

Energy consumption – Pilot 1 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	1,139	1,279
February	1,333	1,436
March	1,216	1,357
April	1,204	1,327
May	1,102	1,211
June	894	1,004
July	996	1,110
August	1,008	1,120
September	967	1,079
October	949	1,076
November	923	1,030
December	1,030	1,171
TOTAL	**12,761**	**14,200**

Specific consumption

Table 225 Specific consumption

Specific consumption – Pilot 1		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.57	0.58
February	0.58	0.59
March	0.58	0.58
April	0.58	0.59
May	0.58	0.59
June	0.59	0.58
July	0.58	0.58
August	0.58	0.58
September	0.58	0.59
October	0.57	0.58
November	0.58	0.59
December	0.56	0.58
AVERAGE	**0.58**	**0.58**

Methane gas

Table 226 Methane gas consumption

Energy consumption – Pilot 1 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	1459	1609
February	1352	1508
March	1566	1708
April	1535	1700
May	1458	1609
June	1257	1408
July	1444	1609
August	1449	1602
September	1561	1702
October	1453	1616
November	1560	1701
December	1263	1408
TOTAL	**17,357**	**19,180**

Specific consumption

Table 227 Specific consumption

Specific consumption – Pilot 1		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.73	0.73
February	0.59	0.61
March	0.75	0.73
April	0.74	0.74
May	0.77	0.77
June	0.84	0.81
July	0.83	0.84
August	0.83	0.83
September	0.93	0.91
October	0.87	0.87
November	0.98	0.96
December	0.69	0.70
AVERAGE	**0.79**	**0.78**

4.7.1.3. Proposed solution and EE action plan

Lighting and ventilation of work areas

It is proposed to turn off the lighting during rest periods. The breaks are considered to be 15 minutes long.

Compressed air

It has been observed that on weekends, the air compressors are left on, which could be managed more efficiently.

It is proposed that unused compressors be turned off on weekends and that the valves on unused ducts be closed.

Adjustment of outdoor lighting schedule

It has been observed that the plant has two twilight clocks that each control half of the exterior lighting. Each one is oriented in a different direction, causing a mismatch in the switching.

It is proposed to adjust the lighting as restrictively as possible in order to save unnecessary consumption, since the outdoor conditions allow it.

Disconnection of exhaust fans in work rooms

It has been observed that the exhaust fans in the workrooms are left on during weekends.

It is proposed to shut down the extractors during weekends (from 2:30 p.m. on Saturday to 0:00 a.m. on Monday).

Disconnection of exhaust fans in attics

It has been observed that the attic exhaust fans are left on during weekends.

It is proposed that the extractors be shut down on weekends.

Replacement of interior lighting ballasts

It has been observed that the existing electromagnetic ballasts are being progressively replaced by electronic ballasts.

It is proposed to replace the remaining magnetic ballasts. The energy saved will be 288,204 kWh/year.

LED Luminaires

It has been observed that the luminaires used for interior lighting are fluorescent.

It is proposed to change to LED type luminaires in the rooms that are kept on 24 hours a day. The installation of LED tubes is proposed, giving priority to luminaires without electronic ballast, since they have a higher consumption. A total of 186 58 W tubes would be replaced. The 58 W tubes would be replaced by 22 W LED tubes.

Free cooling

It has been observed that there are periods of time when the ambient temperature outside the building is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a "free-cooling" system to take advantage of the enthalpy of the outside air when the environmental conditions are favorable, as in winter, and thus be able to disconnect the production of cold.

Use of a hydroscopic fluid for dehumidification

It has been observed that in the slicing rooms, refrigeration consumption can be reduced by performing a more exhaustive humidity control.

It is proposed to install a dehumidification system in the slicing rooms.

Door of the refrigeration chambers

It has been observed that during the sausage and bacon manufacturing process, the doors of the four cold rooms for bacon stock and sausage stock remain open for long periods of time, with consequent energy losses and reduced performance.

It is proposed to install rapid access doors to the chambers in order to reduce thermal transfers between the chambers and the work rooms.

Inflatable shelters on the docks

It has been observed that during the loading process of the product in the transport trucks, the sealing docks lack the adequate airtightness to avoid thermal losses.

It is proposed to install inflatable shelters to reduce infiltrations and thermal transfers between the shipping dock and the exterior.

Utilization of boiler exhaust gases

It has been observed that the plant's boilers release all the exhaust gases into the atmosphere without taking advantage of their enthalpic state for use in other processes.

It is proposed to install a water preheater at the outlet of the exhaust gases to preheat the mains water that goes to the boilers, reducing the required thermal jump, thus achieving energy savings in steam production.

Compressor unloading

It has been observed that there is no use of the thermal state of the refrigerant at the discharge of the compressors.

It is proposed to install a heat exchanger at the inlet of the evaporative condensers and thus preheat the inlet water to the boilers achieving energy savings by a reduction of the necessary temperature jump. In this way, the thermal jump of the condensers is also reduced.

Air conditioning in work rooms

It has been observed that the air conditioning in the work rooms (packaging, sausage production, bacon injection, etc.) is left on during weekends, when there are no people working on these processes.

It is proposed to interrupt the air conditioning during the weekends. This will result in net energy savings.

Forklift loading

It has been observed that there are three groups of forklifts working in 8-hour shifts. These are powered by batteries that are replaced and recharged at the end of each shift.

It is proposed to shift the charging of the batteries to periods of lower energy cost.

Proposed solutions & EE action plan for Pilot 1										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[kg eq. CO_2/year]	[years]	[EUR]	[%]
Turning off lighting during breaks	0	6,985	0	6,985	0.60	523	1,607	0	3,267.12	-
Turn off compressors and close valves that are not in use	0	54,340	0	54,340	4.67	3,296	12,498	0	20,589.74	-
Setting the clocks	0	2,911	0	2,911	0.25	205	670	0	1,280.61	-
Turning off exhaust fans during the weekend	0	69,067	0	69,067	5.94	4,186	15,885	0	26,149.47	-
Turning off exhaust fans during the weekend	2,014	20,214	0	20,214	1.74	1,043	4,649	1.93	4,501.50	50%
Replacing magnetic ballasts with electronic ballasts	13,802	288,204	0	288,204	24.78	19,500	66,287	0.71	108,012.31	141%

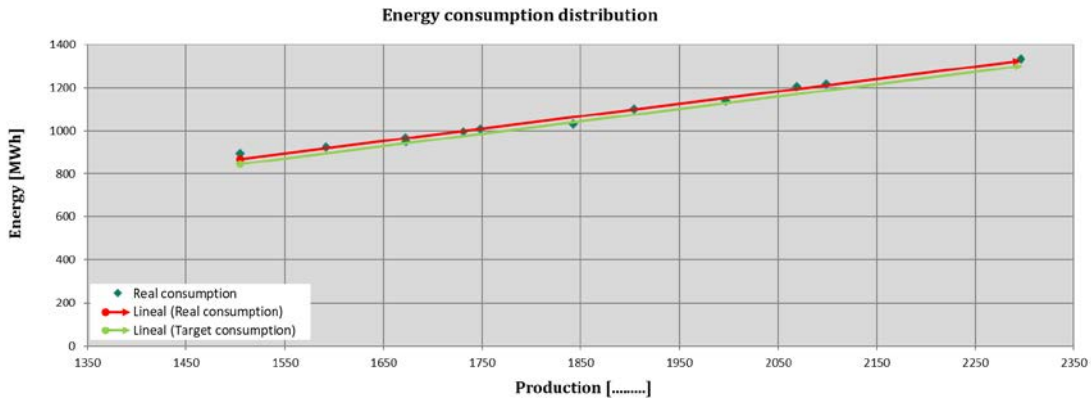
Replacement of metal halide lamps with VSAP lamps	2,090	20,310	0	20,310	1.75	1,400	4,671	1.49	6,655.64	66%
Installing a flow regulator	2,970	11,921	0	11,921	1.03	545	2,742	5.45	434.55	11%
Replacing halogen tubes with LED tubes	16,276	89,696	0	89,696	7.71	6,512	20,630	2.50	2,4403.73	38%
Free-cooling	16,301	116,623	0	116,623	10.03	7,582	26,823	2.15	31,062.90	45%
Installing a dehumidifier	79,310	130,917	0	130,917	11.26	10,691	30,111	7.42	-12,524.52	4%
Installation of high-speed doors	4,800	50,063	0	50,063	4.30	4,357	11,514	1.10	22,417.69	90%
Installation of inflatable docks	15,600	99,166	0	99,166	8.53	9,056	22,808	1.72	4,0971.82	57%
Installing a preheater	90,500	0	922,870	922,870	79.35	31,377	0	2.88	105,508.60	32%
Installing a condenser heat exchanger	223,300	0	2,151,325	2,151,325	184.98	73,145	0	3.05	233,628.62	30%
Interruption of the air-conditioning system at weekends	0	186,207	0	186,207	16.01	14,043	42,828	0	0	-
Recharge batteries at	0	0	0	0	0	1,156	0	0	0	-

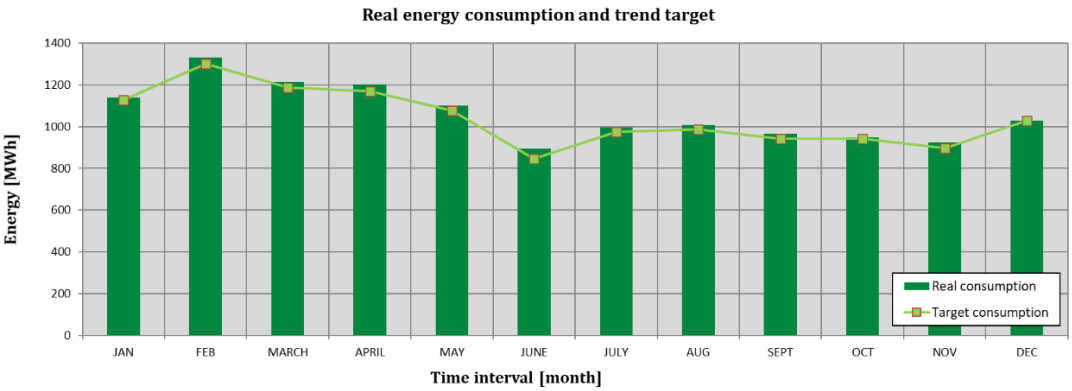
recommended times										
Outsource more batteries and chargers and recharge them all in P6.	0	0	0	0	0	4,108	0	0	0	-
Switch off circuit -10ºC during recommended hours	0	44,892	0	44,892	3.86	5,974	10,325	0	0	-
Turn off circuit -35ºC during recommended hours	0	11,897	0	11,897	1.02	1,583	2,736	0	0	-
TOTAL	466,963	1,203,413	3,074,195	4,277,608	367.81	200,282	276,785	2.33	616,359.81	51%

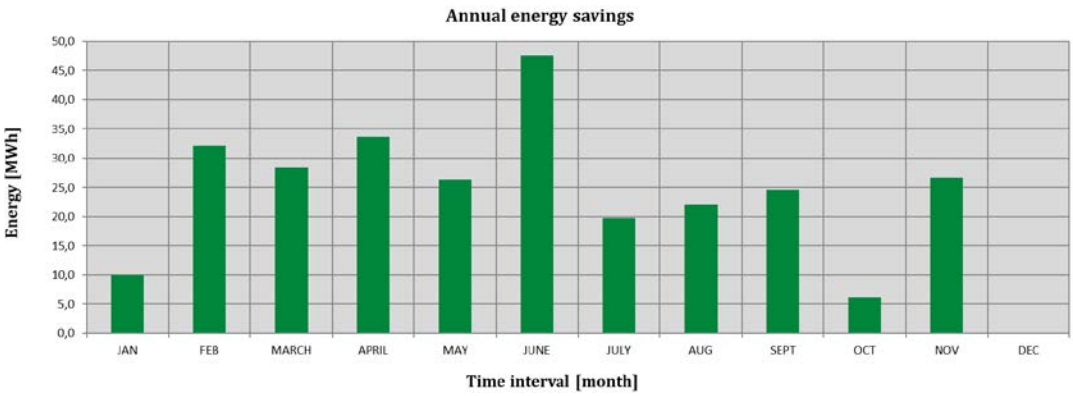
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.7.1.4. Measurement and verification of the results

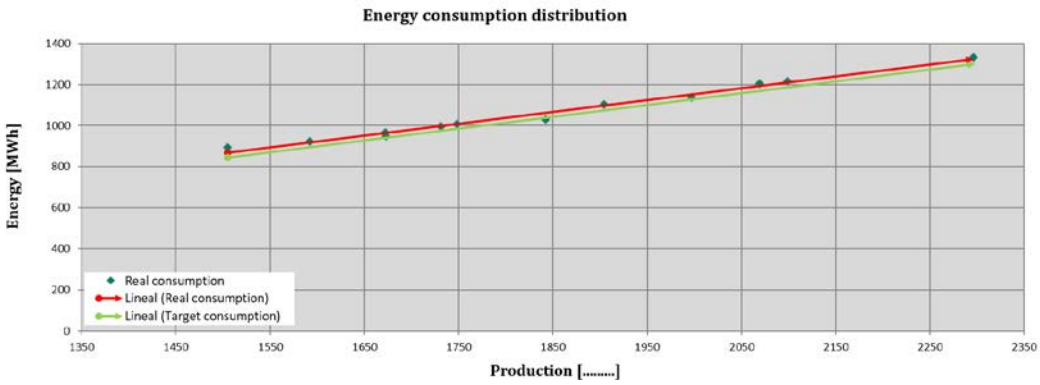
Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below.

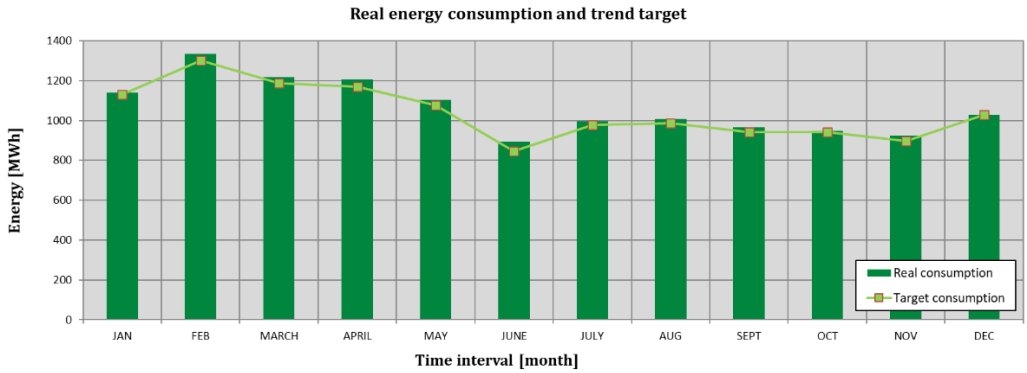


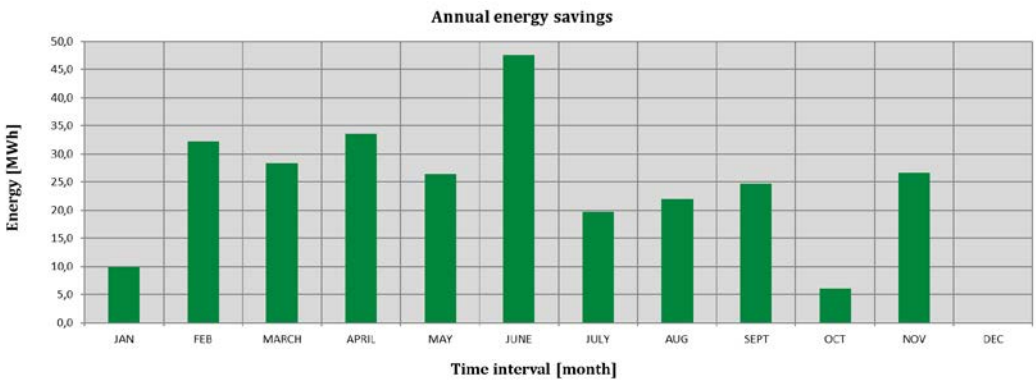




a) Before (2018)







b) After (2019)

Figure 120 M&T & M&V results

The results obtained by implementing the values in the tool are presented below:

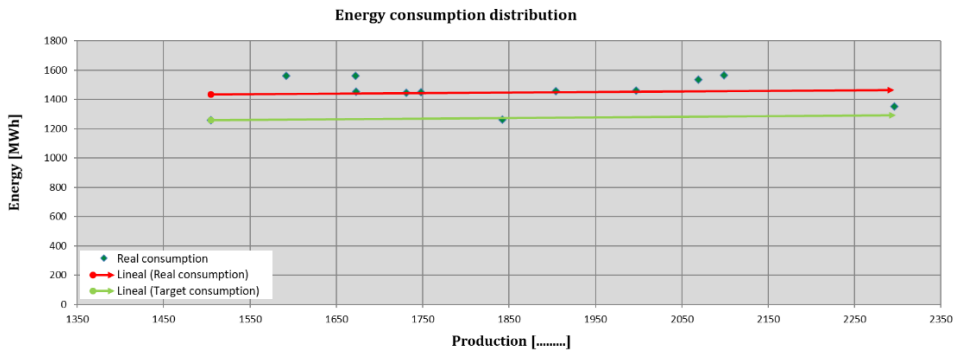
Table 228 Results

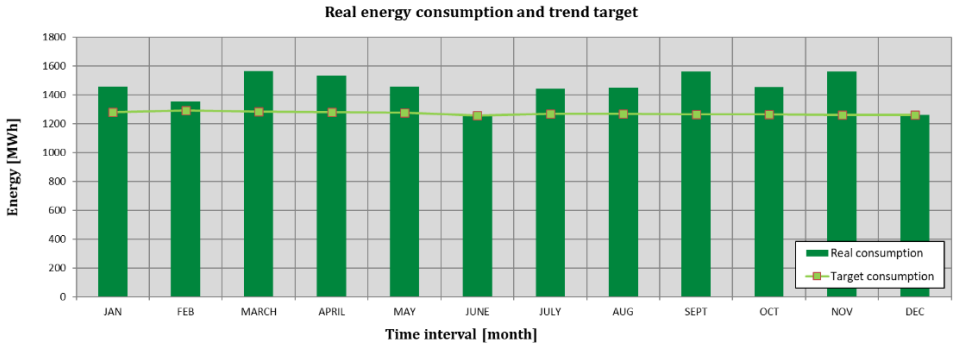
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	22128	[Ton]	12,761	[MWh]	120	**277**	**33,266**

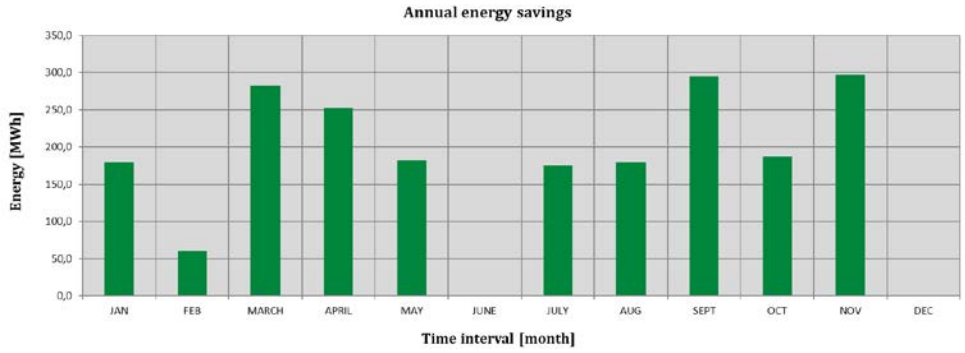
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	24,500	[Ton]	14,200	[MWh]	115	**0**	**0**

Measured and verified achieved energy saving								
Utility type	**Before the energy efficiency implementation**							
	Specific energy use			**Total energy use**				
	0.6	[kWh/[...]]		12,761	[MWh/yr.]		**Achieved energy savings**	
Energy	**After the energy efficiency implementation**						**-0.1**	**[MWh/yr.]**
	Specific energy use			**Total energy use**			**Achieved cost savings**	
	0.6	[kWh/[...]]		14,200	[MWh/yr.]		**-8**	**[euro/yr.]**

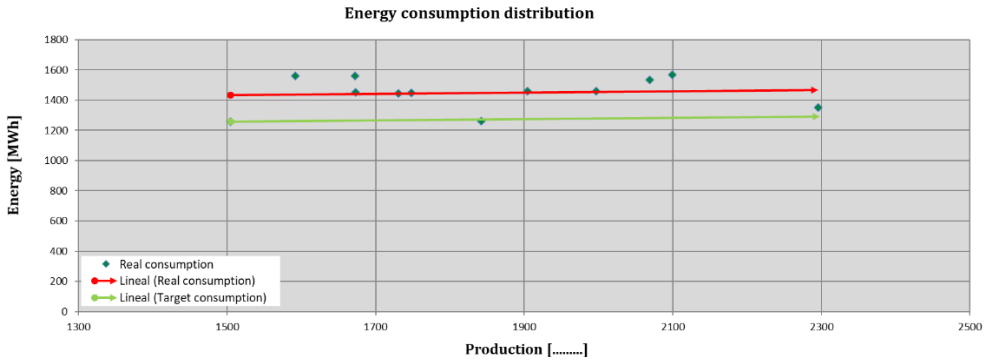
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:

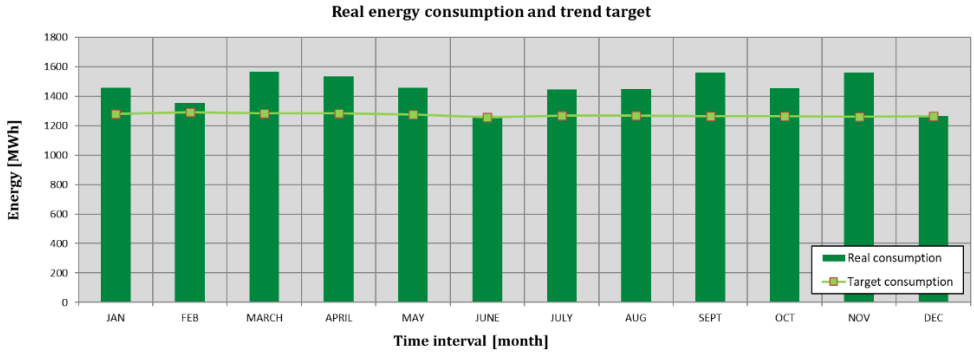


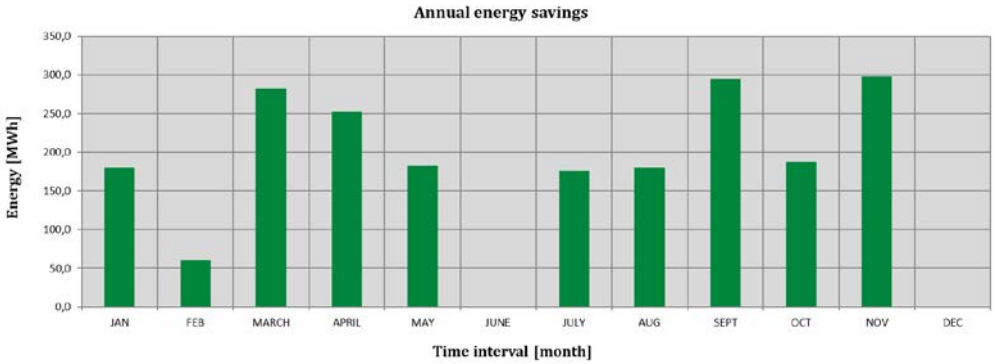




a) Before (2018)







b) After (2019)

The results obtained by implementing the values in the tool are presented below:

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	22,128	[Ton]	17,357	[MWh]	55	**2,092**	**115,049**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	24,500	[Ton]	19,180	[MWh]	45	**2,161**	**97,229**

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use			Total energy use					
	0.8	[kWh/[...]]		17,357	[MWh/yr.]		Achieved energy savings		
Energy	After the energy efficiency implementation							0.0	[MWh/yr.]
	Specific energy use			Total energy use			Achieved cost savings		
	0.8	[kWh/[...]]		19,180	[MWh/yr.]		4	[euro/yr.]	

4.7.1.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, Action plan

4.7.1.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;

- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance.

4.7.2. Pilot site 2

Number of employees: 49

NACE Code: 15130 – Food industry

Total energy consumption: Over 11,100 MWh/year

4.7.2.1. Introduction for data and current situation

Energy profile of the SME

Table 229 Energy profile

Year: 2018	Electricity	Natural gas
Consumption (MWh)	39,050	22,000
Cost (euro)	3,577,395	680,740

HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	Yes
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

Lighting system	
Partially LED Technology	X

Table 230 Production data

Production – Pilot 2 Meat		
	2018	**2019**
Month	Production [tons]	Production [tons]
January	4,057	4,661
February	4,261	4,827
March	4,508	4,994
April	4,475	5,077
May	5,018	5,493
June	5,215	5,826
July	5,560	6,159
August	5,352	5,826
September	5,382	5,992
October	5,178	5,659
November	4,771	5,243
December	4,670	5,243
TOTAL	**58,447**	**65,000**

4.7.2.2. Energy analysis

- Define the energy contour on which the evaluation is made;
- Energy analytics: presentation of the monthly energy consumption (for each energy type) for at least 2 years;
- The M&T and M&V tools can be used & presented.
- The share of different type of energy, in terms of consumption and cost. Enumeration of the consumers: electric and thermal.
- Specific consumption

Table 231 Electricity consumption

Energy consumption – Pilot 2 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	2,431	2,800
February	2,586	2,900
March	2,644	3,000
April	2,690	3,050

May	2,983	3,300
June	3,151	3,500
July	3,397	3,700
August	3,186	3,500
September	3,238	3,600
October	3,060	3,400
November	2,863	3,150
December	2,828	3,150
TOTAL	**35,057**	**39,050**

Table 232 Specific consumption

Specific consumption – Pilot 2		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.60	0.60
February	0.61	0.60
March	0.59	0.60
April	0.60	0.60
May	0.59	0.60
June	0.60	0.60
July	0.61	0.60
August	0.60	0.60
September	0.60	0.60
October	0.59	0.60
November	0.60	0.60
December	0.61	0.60
AVERAGE	**0.60**	**0.60**

Table 233 Natural consumption

Energy consumption – Pilot 2 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	1,977	2,121
February	2,090	2,200
March	1,942	2,117
April	2,149	2,293
May	1,575	1,724
June	912	1,044
July	1,669	1,849

August	1,386	1,565
September	1,502	1,699
October	1,608	1,788
November	1,795	1,982
December	1,400	1,618
TOTAL	**20,005**	**22,000**

Table 234 Specific consumption

Specific consumption – Pilot 2		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.49	0.46
February	0.49	0.46
March	0.43	0.42
April	0.48	0.45
May	0.31	0.31
June	0.17	0.18
July	0.30	0.30
August	0.26	0.27
September	0.28	0.28
October	0.31	0.32
November	0.38	0.38
December	0.30	0.31
AVERAGE	0.49	0.46

4.7.2.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

Lights and fans

It has been observed that the lights and fans in certain rooms are left on during breaks.

The power to be disconnected from the fans amounts to 140.4 kW. If it is considered that the lights and fans are turned off during breaks, the power to be disconnected amounts to 202.77 kW.

Air conditioning

It has been observed that the air conditioning in the work rooms is left on during the workers' breaks, causing unnecessary consumption throughout the year.

It is proposed that the air conditioning be turned off for 15 minutes during the different rest periods throughout the day, since there is no activity in the rooms and the interruption period is so short, the temperature increase would be minimal.

Conservation chambers

It has been observed that the lights in the conservation chambers are permanently on, as the operators are constantly entering and leaving.

It is proposed that motion sensors be installed in 15 of these chambers to detect the presence of people and turn on the lights. This measure will result in considerable savings on the electricity bill.

Internal lighting. Ballasts

It has been observed that the existing ballasts are being progressively replaced by electronic ballasts.

It is proposed to replace the rest of the magnetic ballasts located in the cooking plant.

The calculated savings from the replacement of ballasts is 23%. Considering the total installed power, the luminaires without ballasts represent 58.7% of the total installed internal lighting. A 13% saving is applied on the total lighting load curve.

LED Luminaires

It has been observed that the luminaires used for interior lighting are fluorescent.

It is proposed to change to LED type luminaires, which would provide a savings of 65% of the energy consumed for lighting in the areas where they are installed. It is proposed to install LED tubes, giving priority to luminaires without electronic ballast, since they have a higher consumption. The savings calculation has been made for the replacement of the tubes of 400 2x58W luminaires that are kept on 24 hours a day.

Cold storage chambers

It has been observed that during the manufacturing process of the different products, the doors of the cold rooms and processing rooms remain open for long periods of time, with consequent energy losses and reduced performance.

It is proposed to install high-speed doors between rooms with a high temperature jump to reduce heat transfers.

Shipping dock

It has been observed that during the process of loading the product onto the transport trucks, the docks lack adequate airtightness to prevent thermal losses to the outside of the plant, especially in summer.

It is proposed to install inflatable shelters to reduce losses and thermal transfers between the shipping dock and the outside.

Free-cooling

It has been observed that there are periods of time when the outside ambient temperature is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a "free-cooling" system to take advantage of the enthalpy of the outside air when the ambient conditions are favorable, as in winter, and thus be able to disconnect the cooling production.

Packaging machines

It has been observed that the bottling plants use 23,500 m3/year of water from the network at 20ºC for cooling, and this water is discharged to the drain. The cost of the water is 0.7 €/m3.

It is proposed to install a closed water recirculation circuit, including recirculation pump, water purifier and tanks on the roof where the water leaving the machine at 30 ºC would be cooled by the environment. It is known that the outside temperature is 10ºC in winter and 17ºC in summer. This proposal will entail a significant investment, but it also has a reduction in water consumption and thus an appreciable economic saving.

Hot water washing machines

It has been observed that hot water is used uninterruptedly in the washing machines. The consumption of the washing machines is 79.85 m3/day and 20,761 m3/year. The cost of water is 0.7 €/m3.

It is proposed that a detector be installed so that when no parts pass through the washing machine, the hot water transfer stops. A parts counter could also be installed so that the water in the washing machine is renewed from time to time.

Forklifts

It has been observed that the forklifts are subcontracted and that no forklift loading program is followed. The number of forklifts in regular use is 66 to 68, discounting those in reserve and some under repair.

It is proposed to subcontract more batteries and chargers for overnight charging. This would allow charging the batteries for each of the shifts on P6 (from 00:00), when the price of energy is cheaper.

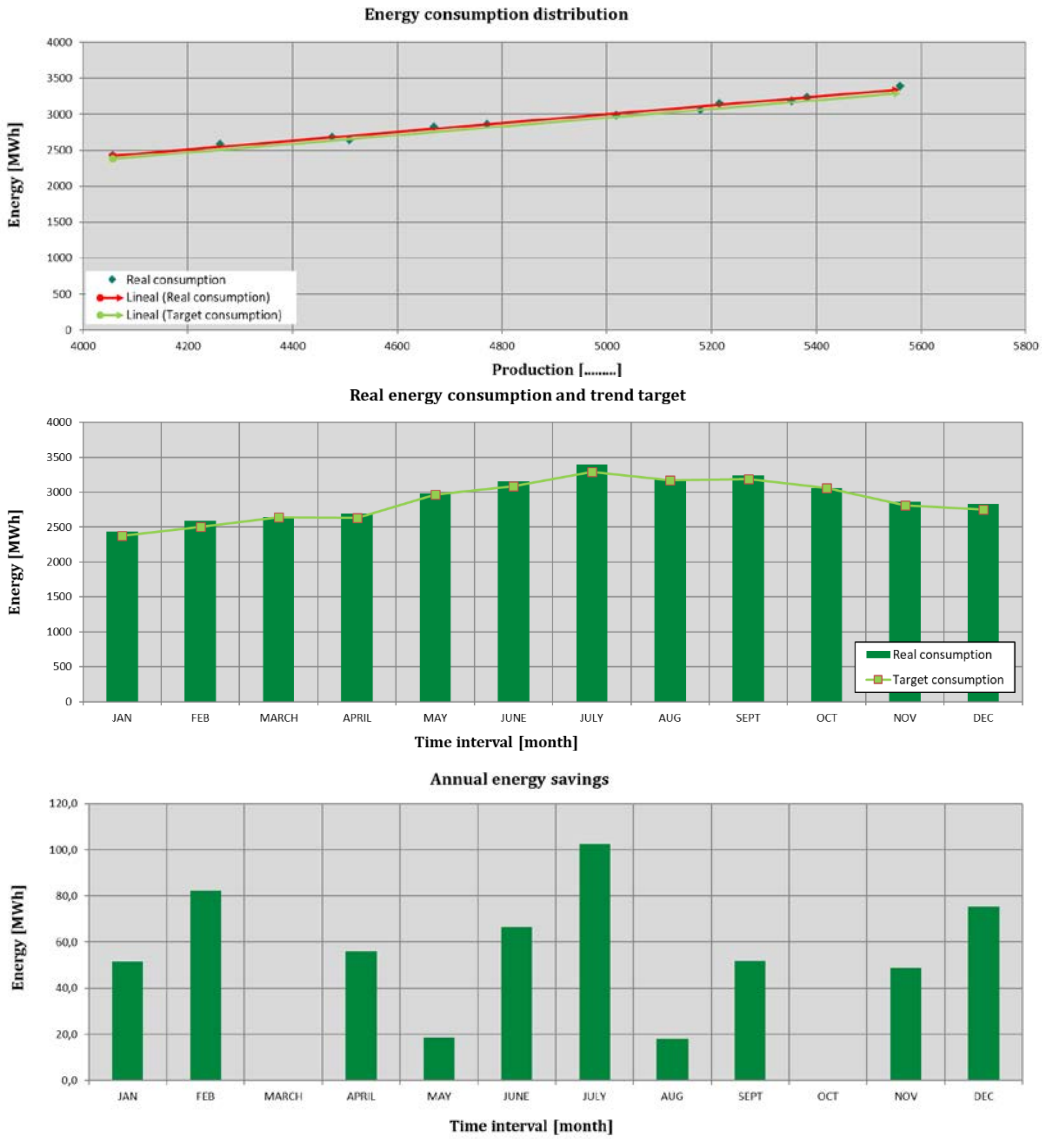
Proposed solutions & EE action plan for Pilot 2										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[kg eq. CO_2/year]	[years]	[EUR]	[%]
Switch off lighting and ventilation during breaks	0	111,778	0	111,778	9.61	7,416	25,709	0	46,326.92	
Turn off air conditioning during breaks	0	130,960	0	130,960	11.26	11,944	30,121	0	74,612.83	
Avoid unnecessary consumption	0	34,870	0	34,870	3.00	2,855	8,020	0	17,834.86	
Turn off luminaires	3,840	188,946	0	188,946	16.25	12,131	43,458	0.32	71,941.00	316%
Replacing magnetic ballasts with electronic ballasts	60,982	369,063	0	369,063	31.73	22,610	84,884	2.70	80,260.14	35%
Replace T8 fluorescent with T5	88,758	953,886	0	953,886	82.02	58,438	219,394	1.52	276,297.64	65%

Installation of flow regulator	3,500	18,288	0	18,288	1.57	985	4,206	3.55	2,653.18	24%
Replace fluorescent tubes with LEDS tubes	81,931	1,619,319	0	1,619,319	139.24	112,561	372,443	0.73	621,224.95	137%
Installation of high-speed doors	31,200	185,126	0	185,126	15.92	16,104	42,579	1.94	69,399.88	50%
Installation of inflatable docks	46,800	146,054	0	146,054	12.56	46,800	33,592	1.00	245,554.35	100%
Use free cooling	49,897	397,285	0	397,285	34.16	49,897	91,376	1.00	261,803.97	100%
Water recirculation circuit	7,210	0	0	0	0	7,210	0	1.00	37,830.06	100%
Installation of recirculation circuit	6,790	0	0	0	0	6,790	0	1.00	35,626.37	100%
Replacement of vacuum pumps	0	0	0	0	0	0	0		0	
Installation of parts detector	0	482,116	0	482,116	41.45	0	110,887		0	
Recharge batteries at recommended times	0	0	0	0	0	0	0	0	0	
Outsource more batteries and charge them in P6	15,000	0	0	0	0	15,000	0	1.06	4,154,952.22	
Use hot water instead of steam	30,000	0	843,955	843,955	72.57	30,000	0	0	0,00	

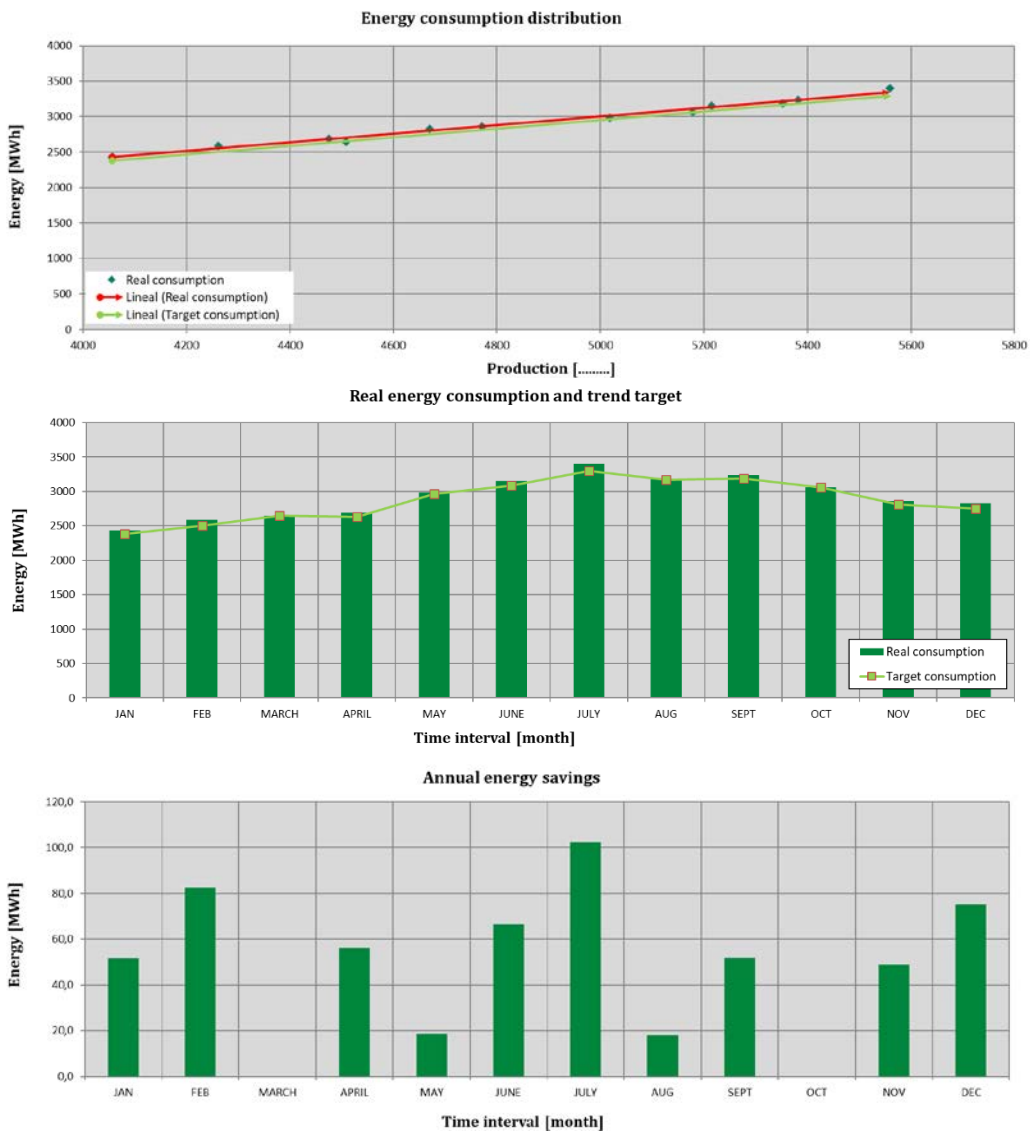
Disconnecting the circuit during peak hours	0	84,121	0	84,121	7.23	0	19,348	0	0	
Transfer consumption in dryers to P6	0	0	0	0	0	0	0	0	0	
TOTAL	425,908	4,721,812	843,955	5,565,767		400,741	1,086,017	1.06	5,996,318.37	103%

KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.7.2.4. Measurement and verification of the results



a) Before (2018)



b) After (2019)

Figure 121 M&T & M&V tools

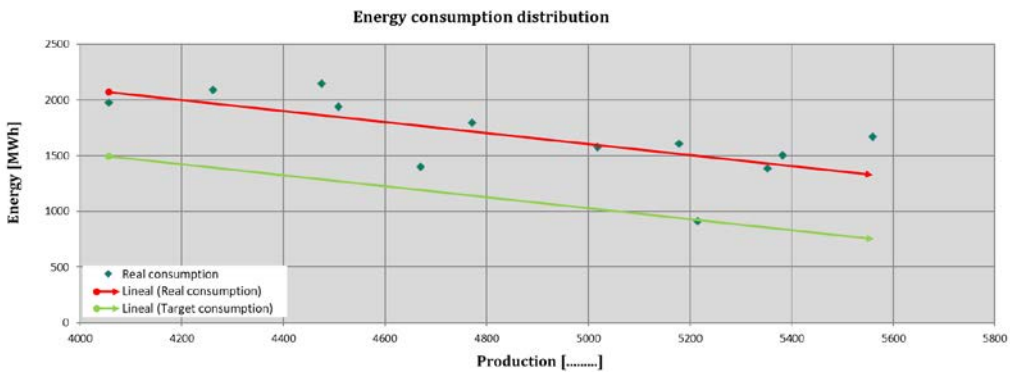
The results obtained by implementing the values in the tool are presented below:

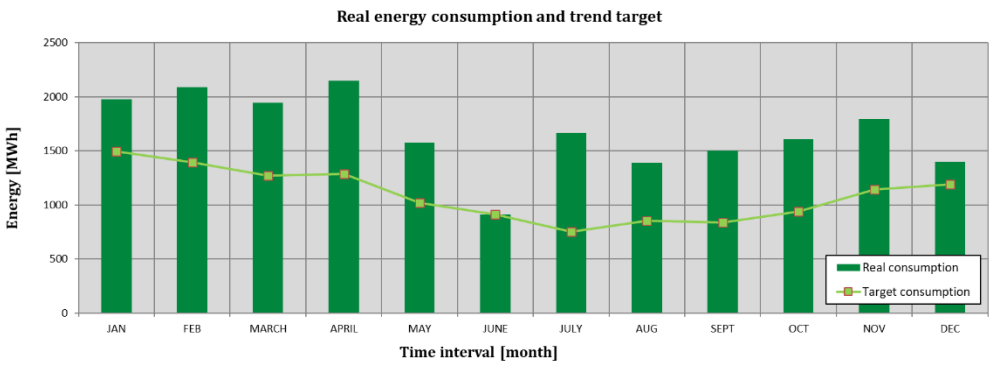
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	58,447	[Ton]	35,057	[MWh]	120	**572**	**68,581**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		

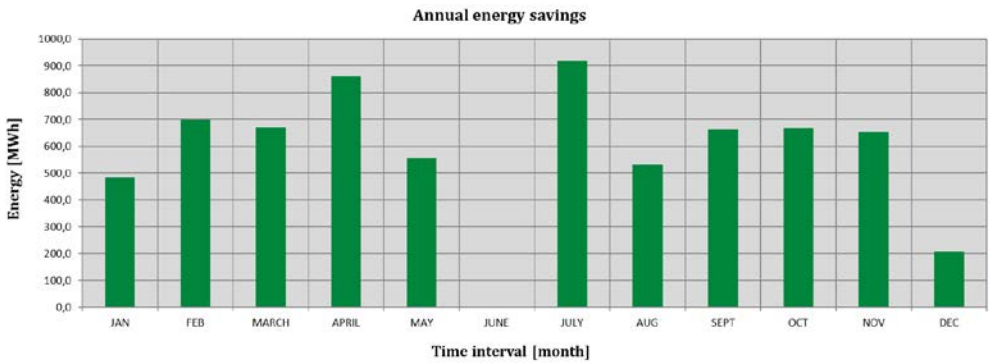
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	65,000	[Ton]	39,050	[MWh]	115	**0**	**0**

Measured and verified achieved energy saving								
Utility type	**Before the energy efficiency implementation**							
	Specific energy use			**Total energy use**				
	0.6	[kWh/[...]]		35,057	[MWh/yr.]	**Achieved energy savings**		
Energy	**After the energy efficiency implementation**						**-0.1**	**[MWh/yr.]**
	Specific energy use			**Total energy use**		**Achieved cost savings**		
	0.6	[kWh/[...]]		39,050	[MWh/yr.]		**-7**	**[euro/yr.]**

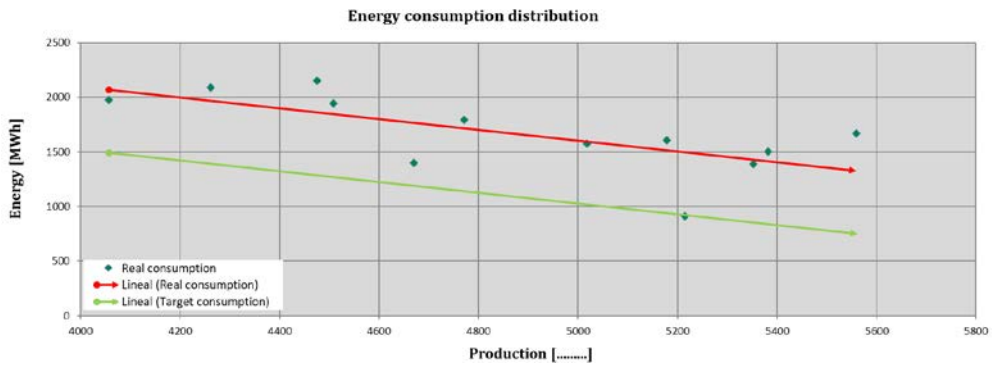
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:

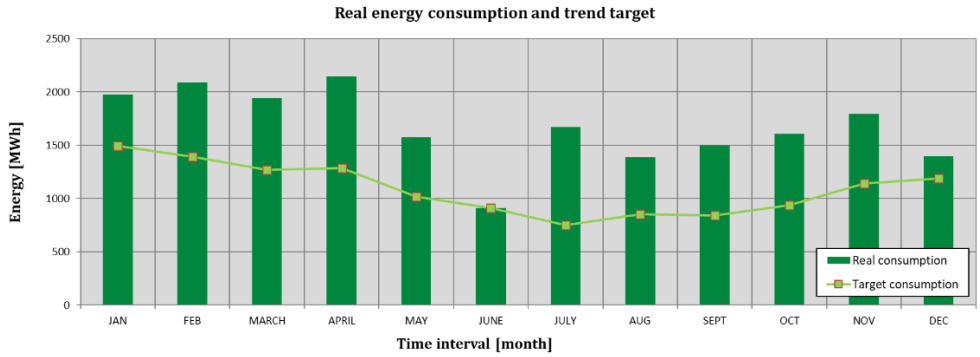


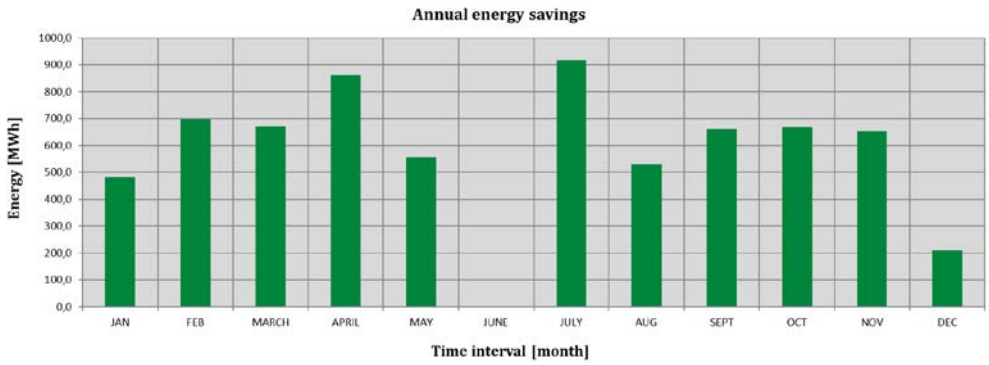




a) Before (2018)







b) After (2019)

The results obtained by implementing the values in the tool are presented below:

Utility type	Before the energy efficiency implementation				Potential energy savings - M&T
	Interval analysis	Production	Energy	Unit price	

	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	58,447	[Ton]	20,005	[MWh]	55	**6,913**	**38,0226**
Utility type	**After the energy efficiency implementation**							**Potential energy savings - M&T**	
	Interval analysis		**Production**		**Energy**		**Unit price**		
	Start	**Stop**	**Value**	**U.M.**	**Value**	**U.M.**	**[euro/MWh]**	**[MWh/yr]**	**[euro/yr]**
Energy	JAN	DEC	65,000	[Ton]	22,000	[MWh]	45	**7,025**	**316,129**

Measured and verified achieved energy saving									
Utility type	**Before the energy efficiency implementation**								
	Specific energy use				**Total energy use**				
	0.3	[kWh/[...]]			20,005	[MWh/yr.]	**Achieved energy savings**		
Energy	**After the energy efficiency implementation**							**0.2**	**[MWh/yr.]**
	Specific energy use				**Total energy use**		**Achieved cost savings**		
	0.3	[kWh/[...]]			22,000	[MWh/yr.]		**11**	**[euro/yr.]**

4.7.2.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy Action plan

4.7.2.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;

- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.7.3. Pilot site 3

Number of employees: 54

Total energy consumption: less than 11,100 MWh/year

NACE Code: 15130 – Food industry

4.7.3.1. Introduction for data and current situation

HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Table 235 Electricity consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	No
Pumps	Yes
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

	No LED Technology	-
	Partially LED Technology	X
	Entirely LED Technology	-

Table 236 Production data

Production – Pilot 3 Meat		
	2018	**2019**
Month	Production [ton]	Production [ton]
January	577	639
February	535	596
March	556	620
April	560	620
May	551	618
June	565	625
July	546	607
August	586	647
September	539	599
October	614	678
November	548	615
December	576	636
TOTAL	**6,753**	**7,500**

4.7.3.2. Energy analysis

Table 237 Electricty data

Energy consumption – Pilot 3 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	218	242
February	201	226
March	212	235
April	211	235
May	210	234
June	213	237
July	207	230
August	222	245
September	204	227
October	234	257
November	210	233
December	218	241
TOTAL	**2,560**	**2,842**

Specific consumption

Table 238 Specific consumption data

Specific consumption – Pilot 3		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.38	0.38
February	0.38	0.38
March	0.38	0.38
April	0.38	0.38
May	0.38	0.38
June	0.38	0.38
July	0.38	0.38
August	0.38	0.38
September	0.38	0.38
October	0.38	0.38
November	0.38	0.38
December	0.38	0.38
AVERAGE	**0.38**	**0.38**

Methane gas

Table 239 Metahne gas consumption

Energy consumption – Pilot 3 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	239	266
February	182	204
March	198	222
April	248	274
May	233	259
June	219	240
July	253	279
August	205	228
September	224	245
October	203	224
November	203	228

December	213	236
TOTAL	**2,620**	**2,905**

Specific consumption

Table 240 Specific consumption data

Specific consumption – Pilot 3		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.41	0.42
February	0.34	0.34
March	0.36	0.36
April	0.44	0.44
May	0.42	0.42
June	0.39	0.38
July	0.46	0.46
August	0.35	0.35
September	0.42	0.41
October	0.33	0.33
November	0.37	0.37
December	0.37	0.37
AVERAGE	**0.39**	**0.39**

4.7.3.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

Common areas

It has been observed that the offices, locker rooms and break room keep the air conditioning on throughout the day on weekdays.

It is proposed to modify the scheduling of the air conditioning in the different rooms.

Compressed air

It has been observed that the compressed air compressor does not have any type of speed regulator. Since it always operates at the same speed, there is an excess of electrical energy consumption that could be eliminated.

It is proposed to install a variable speed drive on the compressed air compressor so that its operation can be adjusted to demand.

Pumps

It has been observed that the cooling circuit pumps do not have speed controllers.

It is proposed to install a variable speed drive in each of the pump groups of the -9 ºC and -13 ºC refrigeration circuit and in the primary pumps of the refrigeration system. In this way, the speed of the pumps will be adjusted to the system requirements.

Free-cooling

It has been observed that there are periods of time when the outside ambient temperature is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a "free-cooling" system to take advantage of the enthalpy of the outside air when the ambient conditions are favorable, as in winter, and thus be able to disconnect the cooling production.

Exterior lighting. Luminaires

It has been observed that the lamps of the exterior lighting are VSAP lamps and these allow the regulation of the luminous intensity.

It is proposed to regulate the luminous flux of the VSAP lamps by means of a flux regulator.

Interior lighting. LEDs

It has been observed that the luminaires used in the illumination of the following rooms are fluorescent:

- Kneading and laminating
- Distribution of ingredients
- Packaging
- Packaging and palletizing

It is proposed to replace the fluorescent tubes with LED type luminaires, which can save up to 70% of the energy consumed for lighting. The savings have been calculated for the replacement of all fluorescent tubes.

Internal lighting. Ballasts

It has been observed that the ballasts currently in the factory are magnetic.

It is proposed to replace the rest of the ballasts.

Solar thermal panels

It has been observed that the plant uses domestic hot water (DHW) which is heated in the boilers using propane.

It is proposed to install solar thermal panels on the roof of the plant, thus obtaining part of the plant's daily consumption and thereby reducing propane consumption.

Lighting

It has been observed that there are periods of time when lighting is kept on unnecessarily.

It is proposed to turn off rooms reducing consumption during the estimated time by using presence sensors.

Shipping and palletizing dock

It has been observed that during the plant operation process, the doors to the shipping chambers, cartoning room and the door to the carton warehouse remain open for long periods of time when the refrigeration equipment is on, with the consequent energy losses and reduced performance.

It is proposed to install rapid access doors to the chambers and rooms to reduce thermal transfers between the chamber and work areas.

Fermentation chambers

It has been observed that during the plant operation process, the fermentation chamber door remains open for long periods of time, during which the refrigeration equipment is on, with consequent energy losses and reduced performance.

It is proposed to install a quick access door to the chamber to reduce thermal transfers between the chamber and the work areas.

Forklifts

It has been observed that the forklifts are subcontracted and that no forklift loading program is followed. The number of forklifts in regular use is 3.

It is first proposed that a forklift reloading schedule be drawn up to include charging during periods of lower electricity costs.

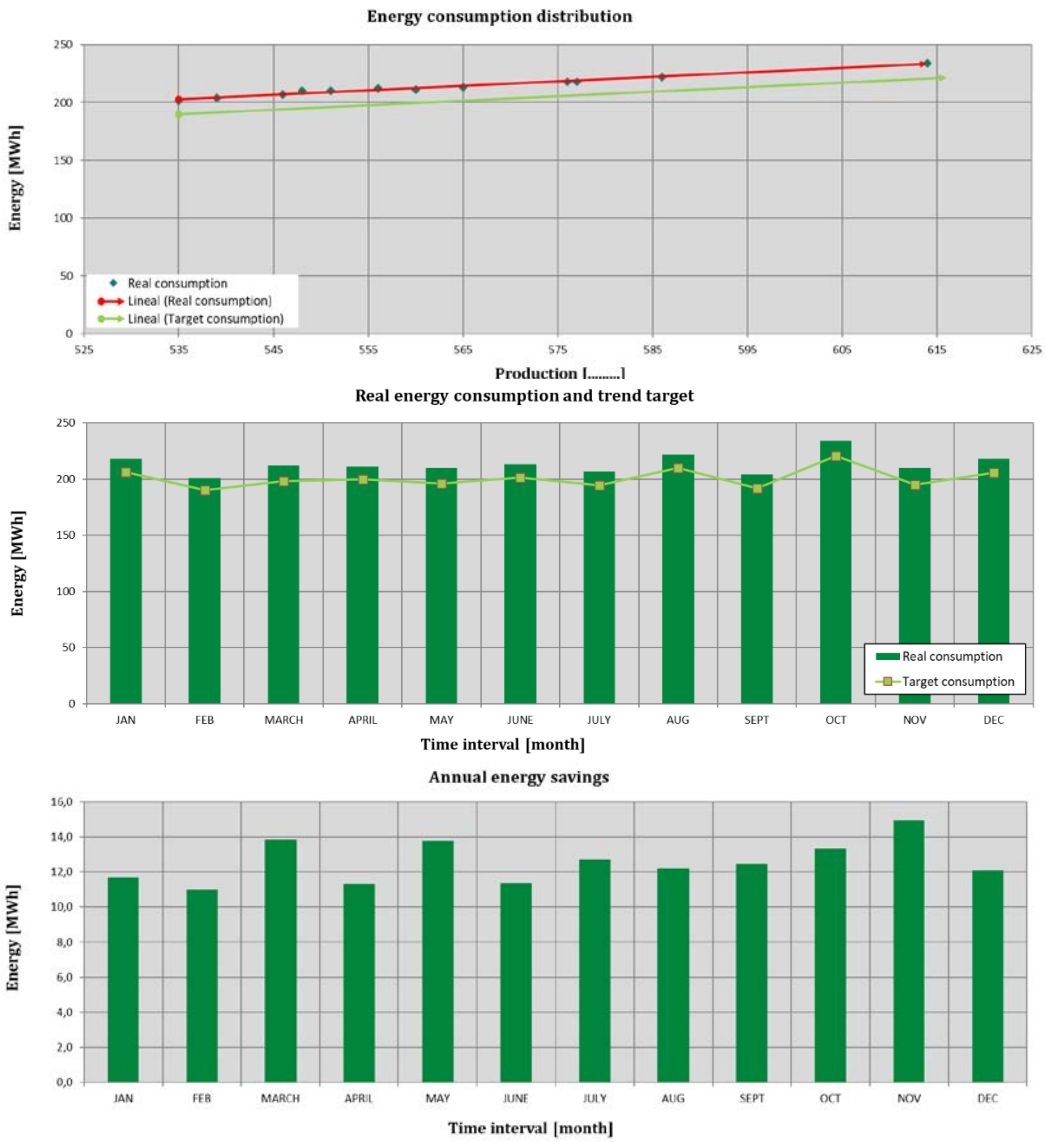
Proposed solutions & EE action plan for Pilot 3										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[kg. eq. CO_2/year]	[years]	[EUR]	[%]
Modify the climate control programming	0	17,823	0	17,823	1.53	1,532	4,099	0	9,570.23	
Install variable speed drive	10,788	49,067	0	49,067	4.22	4,134	11,285	2.61	15,036.63	36%
Install variable speed drive	9,315	24,885	0	24,885	2.14	2,049	5,724	4.55	3,484.87	16%
Install free cooling system	19,328	67,963	0	67,963	5.84	5,369	15,631	3.60	14,211.54	24%
Installing a flow regulator	3,034	22,945	0	22,945	1.97	1,704	5,277	1.78	761,070	55%
Replacement of interior luminaires with LEDs.	55,053	151,278	0	151,278	13.01	13,255	34,794	4.15	27,749.50	19%
Replacing magnetic ballasts with electronic ballasts	8,450	51,201	0	51,201	4.40	4,478	11,776	1.89	19,523.56	52%

Installation of DHW panels	64,474	0	545,915	545,915	46.94	13,647	0	4.72	20,777.28	15%
Turning off unnecessary lighting loads	448	14,048	0	14,048	1.21	1,213	3,231	0.37	7,129.48	271%
Installation of skylights in some rooms	41,992	40,231	0	40,231	3.46	3,919	9,253	10.71	-17,510.45	-3%
Fast door installation	1,200	64,849	0	64,849	5.58	5,867	14,915	0.20	35,450.49	489%
Installation of inflatable docks	15,600	37,371	0	37,371	3.21	3,421	8,595	4.56	5,770.60	16%
Installation of quick access door to the chamber	1,200	24,227	0	24,227	2.08	2,110	5,572	0.57	11,980.93	176%
Disconnect the -9 ºC line	0	15,202	0	15,202	1.31	1,604	3,496	0	10,020.01	
Recharge batteries at recommended times	0	0	0	0	0	324	0	0	2,023.99	
Outsource more batteries and charge them in P6	1,500	0	0	0	0	1,952	0	0.77	0	
Optimize contracted power	0	0	0	0	0	1,668	0	0	0	
TOTAL	232,382	581,090	545,915	1,127,005	96.90	68,246	133,651	3.41	172,829.38	97%

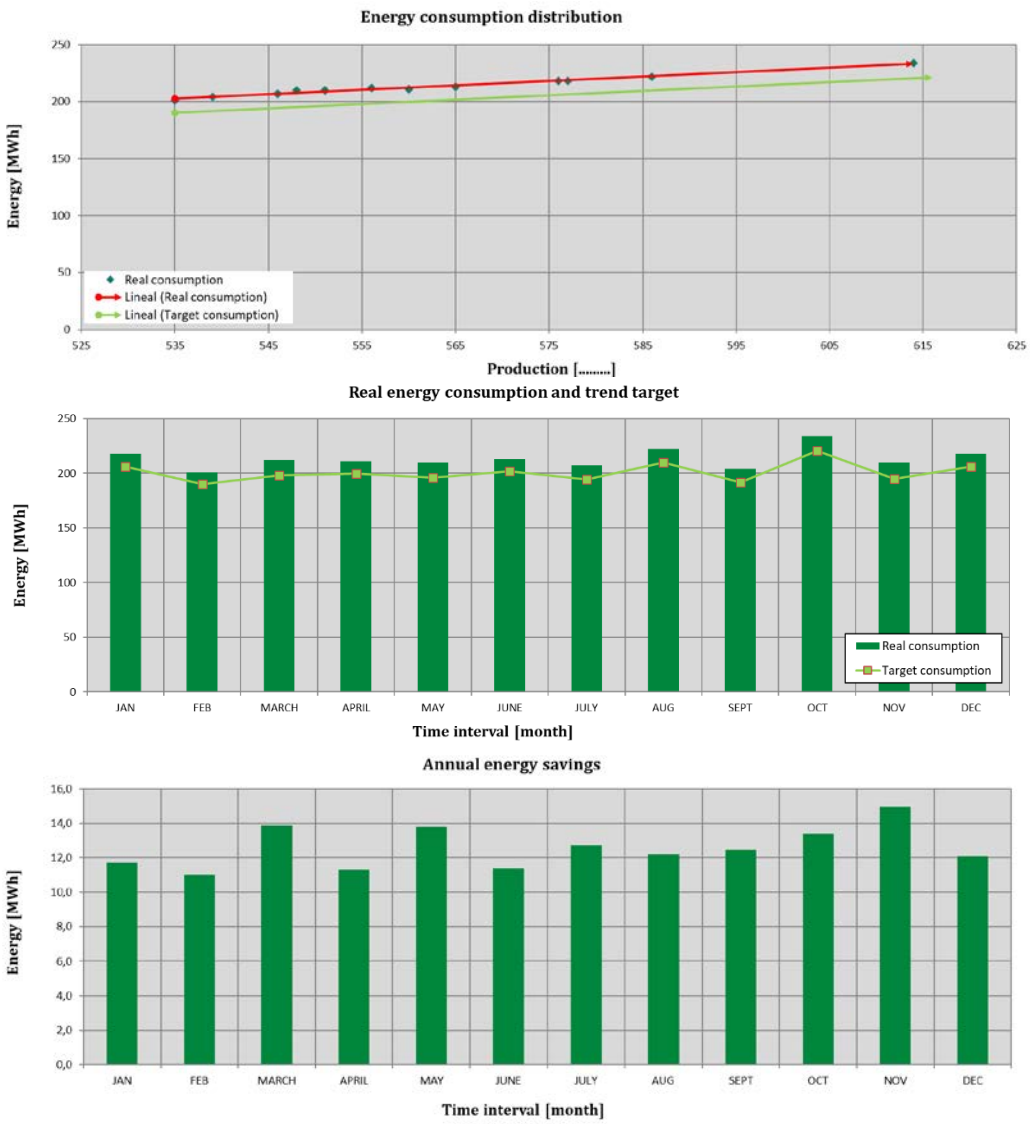
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.7.3.4. Measurement and verification of the results

Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)

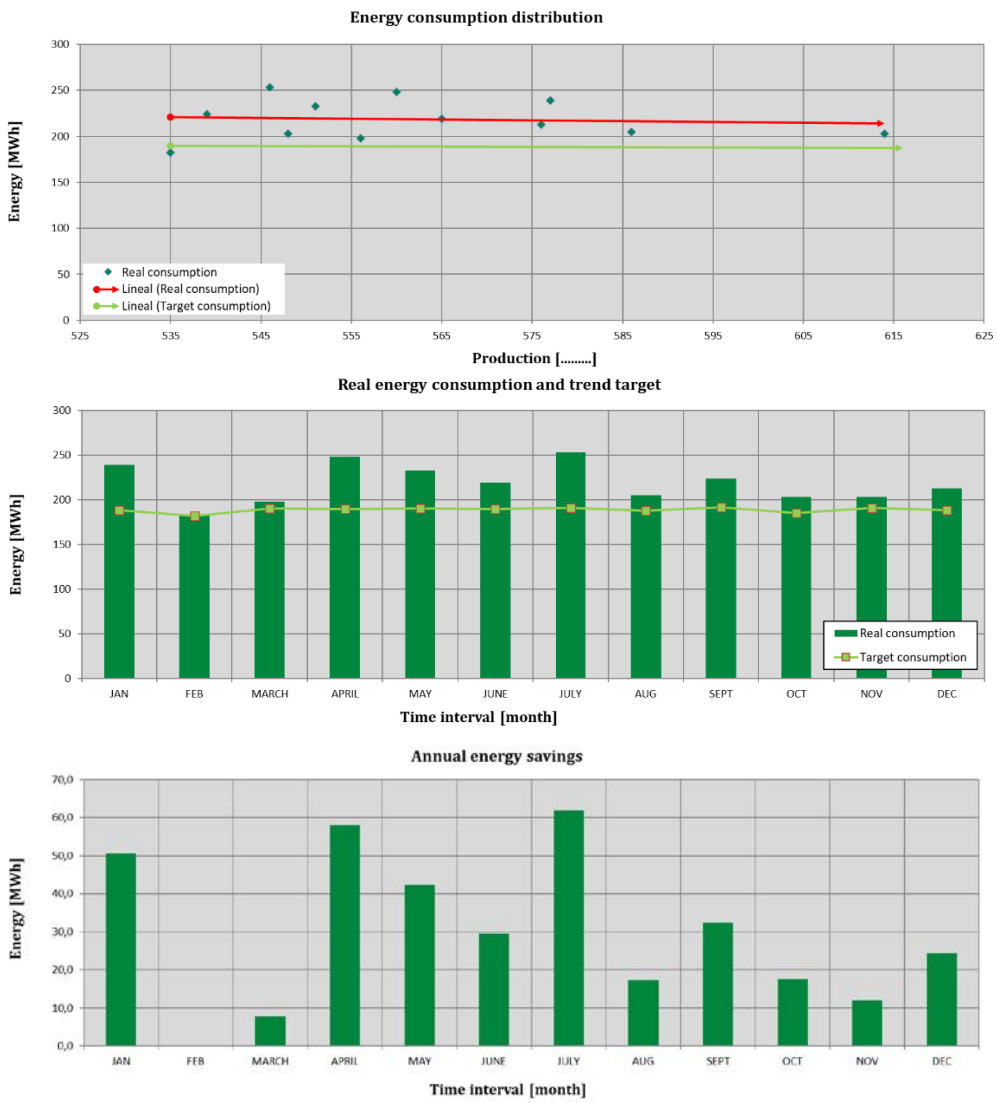


b) After (2019)

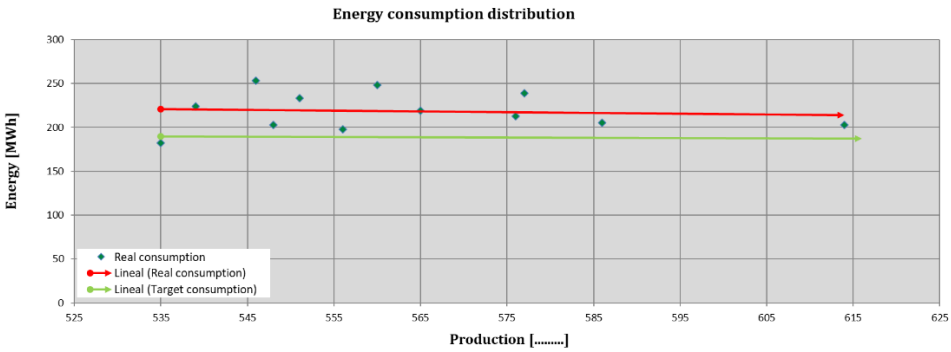
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	6,753	[Ton]	2,560	[MWh]	120	**0**	**0**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	7,500	[Ton]	2,842	[MWh]	115	**0**	**0**

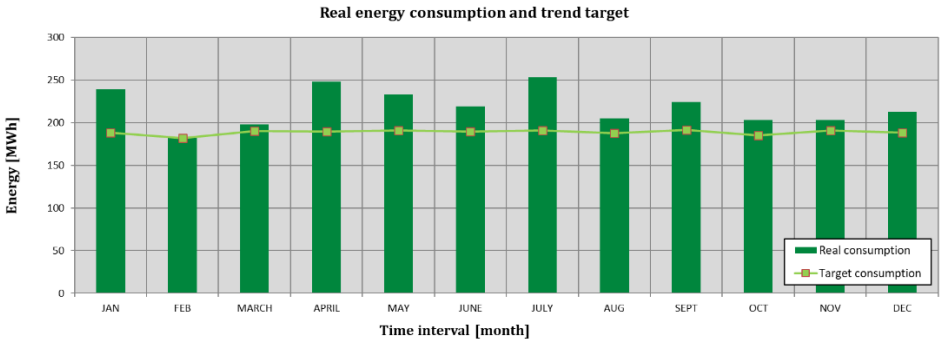
Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use				Total energy use				
	0.4	[kWh/[...]]			2,560	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation							0.0	[MWh/yr.]
	Specific energy use				Total energy use		Achieved cost savings		
	0.4	[kWh/[...]]			2,842	[MWh/yr.]		0	[euro/yr.]

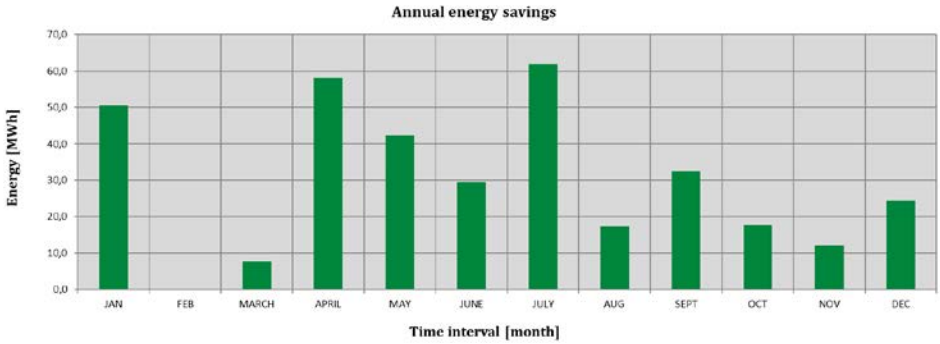
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)







b) After (2019)

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	6,753	[Ton]	2,620	[MWh]	55	**354**	**19,468**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	7,500	[Ton]	2,905	[MWh]	45	**390**	**17,540**

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use			Total energy use					
	0.4	[kWh/[...]]		2,620	[MWh/yr.]		Achieved energy savings		
Energy	After the energy efficiency implementation						0.0	[MWh/yr.]	
	Specific energy use			Total energy use			Achieved cost savings		
	0.4	[kWh/[...]]		2,905	[MWh/yr.]		1	[euro/yr.]	

4.7.3.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, Action plan

4.7.3.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.7.4. Pilot site 4

Number of employees: 68

NACE Code: 15130 – Food industry

Total energy consumption: Less than 11,630 MWh/year

4.7.4.1. Introduction for data and current situation

HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

- Short description about the HVAC system;
- For the main consumers please fill the following table, indicating where the specific energy type is used. Answer with Yes, No or Don't Know (DK).

Table 241 Electricity consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	Yes
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

Lighting system	
Partially LED Technology	X

Table 242 Production data

Production – Pilot 4 Meat		
	2018	**2019**
Month	Production [ton]	Production [ton]
January	350	398
February	364	406
March	402	448
April	384	437
May	455	501
June	482	542
July	568	625
August	557	602
September	540	599
October	482	543
November	436	481
December	365	418
TOTAL	**5,385**	**6,000**

4.7.4.2. Energy analysis

Electricity

Table 243 Electricity consumption

Energy consumption – Pilot 4 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	280	316
February	289	323
March	315	356
April	302	347
May	350	397
June	388	431
July	450	497
August	445	478
September	439	476
October	384	431
November	339	382
December	296	332
TOTAL	**4,277**	**4,766**

Specific consumption

Table 244 Specific consumption

Specific consumption – Pilot 4		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.80	0.79
February	0.79	0.79
March	0.78	0.79
April	0.79	0.79
May	0.77	0.79
June	0.80	0.79
July	0.79	0.79
August	0.80	0.79
September	0.81	0.79
October	0.80	0.79
November	0.78	0.79
December	0.81	0.79
AVERAGE	**0.79**	**0.79**

Table 245 Methane gas consumption

Energy consumption – Pilot 4 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	163	181
February	174	186
March	188	200
April	175	186
May	164	175
June	86	105
July	144	163
August	145	157
September	114	133
October	162	180
November	143	160
December	190	206
TOTAL	**1,848**	**2,032**

Table 246 Specific consumption

Specific consumption – Pilot 4		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.47	0.46
February	0.48	0.46
March	0.47	0.45
April	0.46	0.43
May	0.36	0.35
June	0.18	0.19
July	0.25	0.26
August	0.26	0.26
September	0.21	0.22
October	0.34	0.33
November	0.33	0.33
December	0.52	0.49
AVERAGE	**0.36**	**0.34**

4.7.4.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

Workrooms and lighting

It has been observed that in the following work rooms, the lighting remains on during breaks: Reception, Stuffing, Packaging, Offices

It is proposed to turn off the lighting in the listed rooms during break periods.

Free-cooling

It has been observed that there are periods of time when the outside ambient temperature is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a free cooling or "free-cooling" system that allows to take advantage of the enthalpy of the outside air when the environmental conditions are favorable, as in winter, and thus to be able to disconnect the production of cold. One of the appropriate places to apply free-cooling is in the three dough and stuffing rooms.

Installation of high-speed doors in refrigeration chambers and work rooms.

It has been observed that during the plant operation process, the doors of several cold rooms and work rooms remain open for long periods of time, and it has also been detected that the window of the forklift loading area is broken; all of the above causes increased energy losses and reduced performance.

It is proposed to install fast access doors to the chambers and rooms to reduce thermal transfers between the chamber and work areas, as well as repair the damaged window.

Inflatable shelter installation

It has been observed that during the process of loading and unloading products onto the transport trucks, the dock remains completely open since the truck does not park on the dock, resulting in large air infiltrations from outside the plant.

It is proposed that the truck use the dock for loading and unloading of material, as well as the installation of an inflatable dock to reduce infiltrations and thermal transfers between the dock and the outside.

Interior lighting. LEDs

It has been observed that the luminaires used for interior lighting are fluorescent.

It is proposed to change to LED type luminaires, which would provide a savings of 69% of the energy consumed for lighting in the areas where they are installed. It is proposed to install LED tubes, giving priority to luminaires without electronic ballast, since they have a higher consumption. The savings calculation has been made for the replacement of the tubes of 387 2x58W luminaires.

Unnecessary luminaire

It has been observed that the lighting in the different work rooms of the factory is turned on most of the time outside working hours or at times when it is possible to take advantage of the outside light, thus causing unnecessary consumption.

It is proposed to turn off the lighting when not working in the rooms or at times when outside light can be used.

Internal lighting. Fluorescent lamps

It has been noted that the tubes in the plant are T-8 technology fluorescent tubes.

It is proposed to replace the T-8 tubes with existing T-5 tubes on the first floor and second floor. With this type of tubes, a saving of 32% is achieved with respect to the current ones, while maintaining the magnetic ballasts. The number of tubes to be replaced was calculated on the basis of the W/m2 ratio. A total of 908 T8 tubes of 58 W will be replaced by T5 tubes of 35 W with adapter and mirror aluminum reflector.

Internal lighting. Ballasts

It has been observed that the existing ballasts are being progressively replaced by electronic ballasts.

It is proposed to replace the rest of the magnetic ballasts located in the cooking plant.

External lighting. Luminaires

It has been noted that the outdoor lighting lamps are high-pressure sodium vapor lamps and allow for dimming of the luminous intensity.

It is proposed to reduce the luminous flux of the lamps by means of a flux regulator.

Covers

It has been observed that water is used at the plant for washing carts, washing crates and cleaning services. The water is heated in the boilers using C diesel.

It is proposed to install solar thermal panels on the roof of the plant, thus obtaining part of the plant's daily consumption and thereby reducing energy consumption.

Compressed air

It has been observed that there is machinery in the facility that requires a constant supply of compressed air. These machines are concentrated in one area of the plant. The compressed air service is provided by a 75 kW Atlas Copco compressor which has the capacity to meet the compressed air demand of the entire plant. Outside working hours (nights and weekends), the only compressed air consumption point is at the packaging machines. There are three other compressors that are not currently in operation.

It is proposed to use one of the 20 kW compressors that are not in use to meet the consumption of the packaging machines outside working hours. It is estimated that the average load state of the compressor will be 60%, counting the time it will be idle and on load. The compressor needs to be installed in the area of the packaging machines to supply air from 10:00 p.m. to 6:00 a.m. on weekdays and throughout the weekend.

Traction Equipment

It has been observed that the traction equipment, such as forklifts or pallet trucks, do not follow any type of load scheduling. During the morning shift, 22 different types of equipment are used, and during the afternoon shift, 18 are used.

First of all, it is proposed to carry out a battery recharging schedule that contemplates charging during the periods with the lowest cost of electricity.

Contract optimization

It has been observed that the contracted power is higher than the optimum required for the installation.

It is proposed to contract a power that optimizes the payments for excess power with the payment for contracted power.

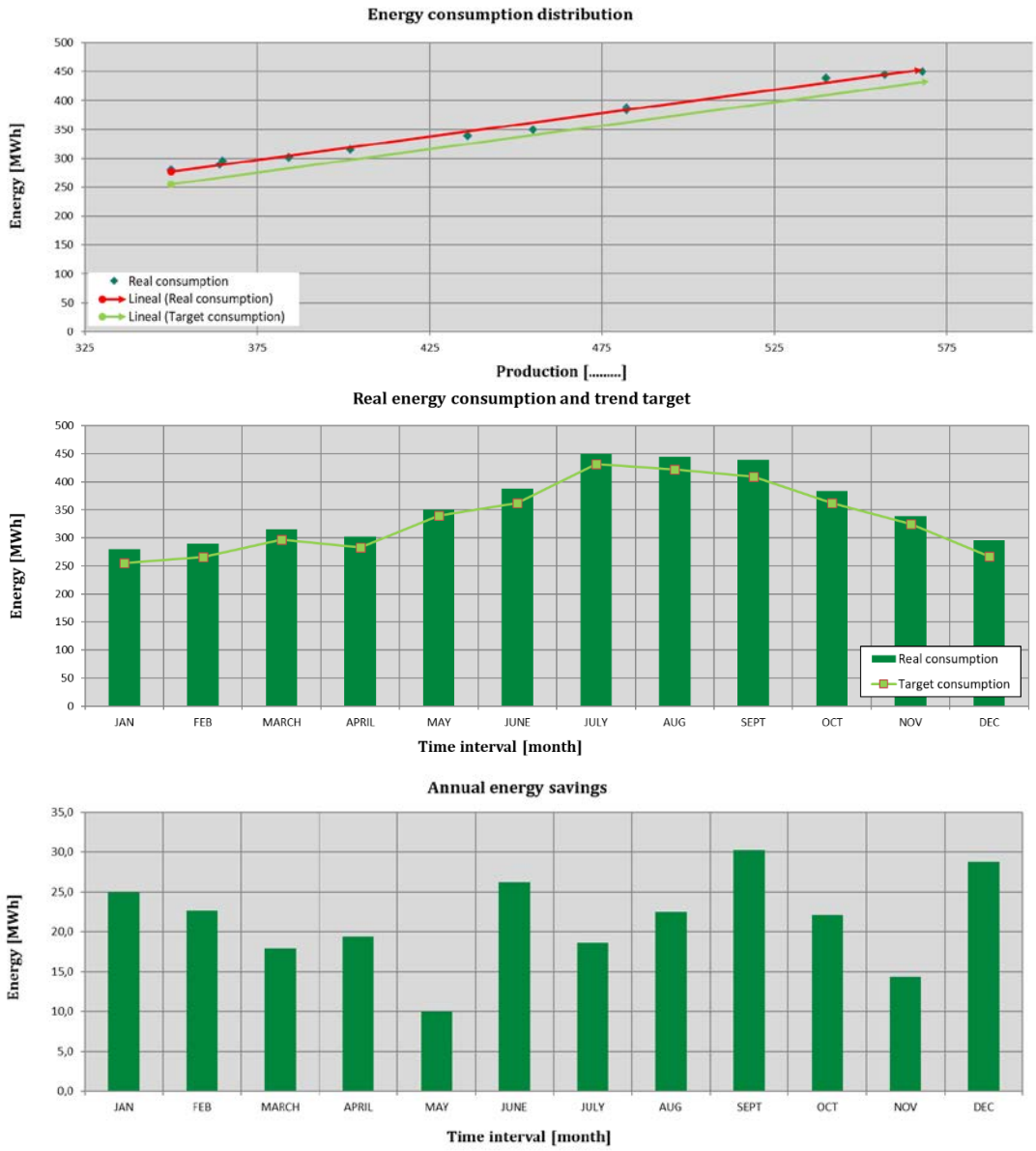
Proposed solutions & EE action plan for Pilot 4										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Turn off lighting during breaks	0	10,185	0	10,185	0.88	973	2,343	0	6,078.22	-
Install a free cooling system	0	25,490	0	25,490	2.19	1,602	5,863	0	10,007.51	-
Repair window and raise staff awareness	0	3,659	0	3,659	0.31	245,5	842	0	1,533.61	-
Quick door installation in the peeling and packaging room.	2,150	7,556	0	7,556	0.65	425	1,738	5.06	504.93	13%
Inflatable dock installation	4,440	19,511	0	19,511	1.68	1,048	4,488	4.24	2,106.74	18%
Replacement of fluorescent tubes with LEDs	39,634	140,832	0	140,832	12.11	11,346	32,391	3.49	31,243.19	25%

Turn off unnecessary lighting	210	10,523	0	10,523	0.90	877	2,420	0.24	5,268.52	418%
Replace T8 fluorescent tubes with T5	13,150	70,416	0	70,416	6.05	5,672	16,196	2.32	22,282.35	41%
Replacing magnetic ballasts with electronic ballasts	5,307	31,658	0	31,658	2.72	2,597.3	7,281	2.04	10,918.04	47%
Installation of a flow regulator	3,034	30,594	0	30,594	2.63	2,105	7,037	1.44	10,115.70	69%
Solar thermal panels	237,916	0	1,479,893	1,479,893	127.25	97,643	0	2.44	372,048.88	39%
Closing compressed air lines	1,000	273,643	0	273,643	23.53	15,304	62,938	0.07	94,602.37	1,530%
Interrupt refrigeration of the chambers	0	10,103	0	10,103	0.87	864	2,324	0	5,397.31	-
Recharge batteries at the recommended times	0	0	0	0	0	1,802	0	0	11,256.89	-
Subcontract batteries and chargers	0	0	0	0	0	1,246	0	0	7,783.62	-
Contracting the optimum power	0	0	0	0	0	238	0	0	0	-
	306,841	634,170	1,479,893	2,114,063	181.78	143,987.8	145,859	2.13	591,147.89	245%

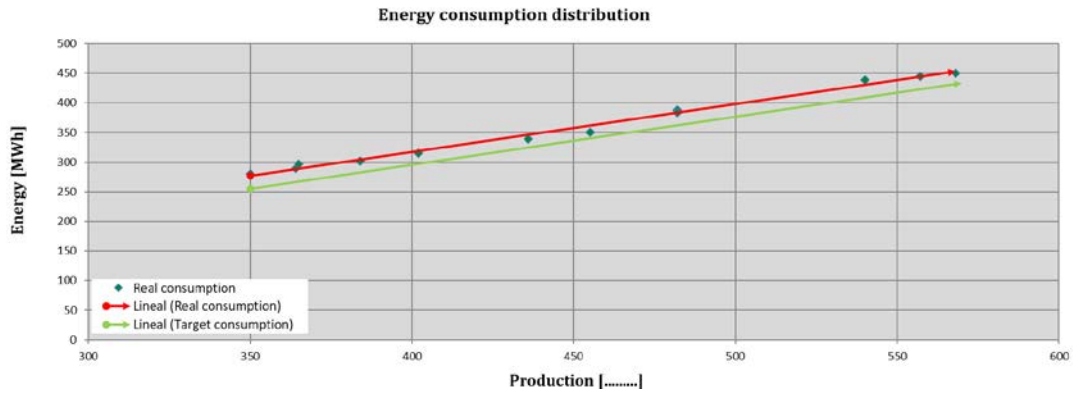
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

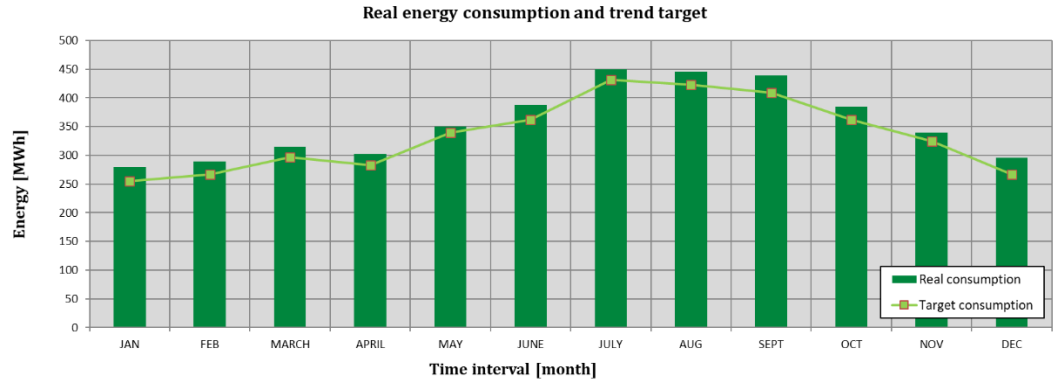
4.7.4.4. Measurement and verification of the results

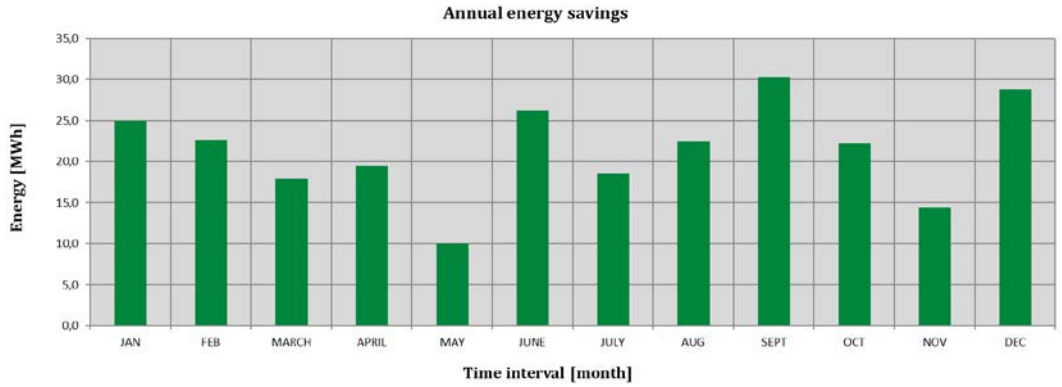
Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)





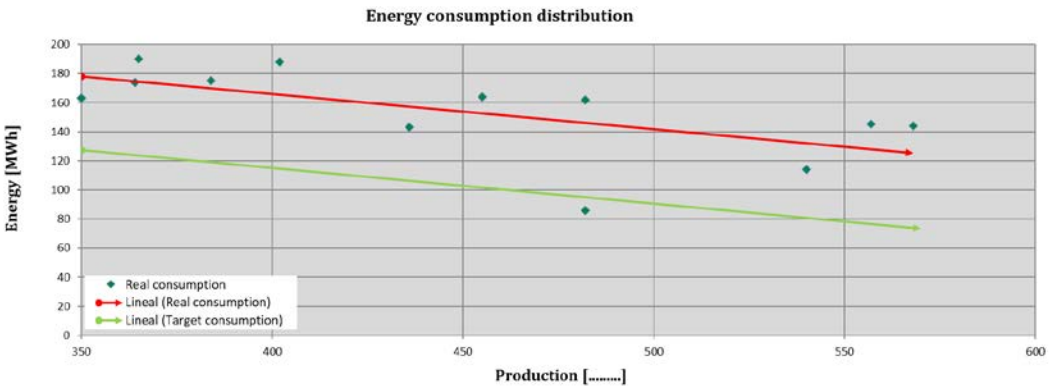


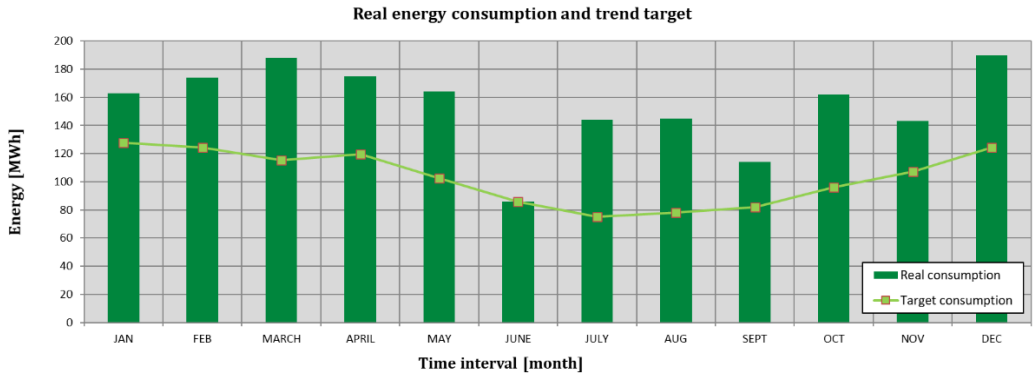
b) After (2019)

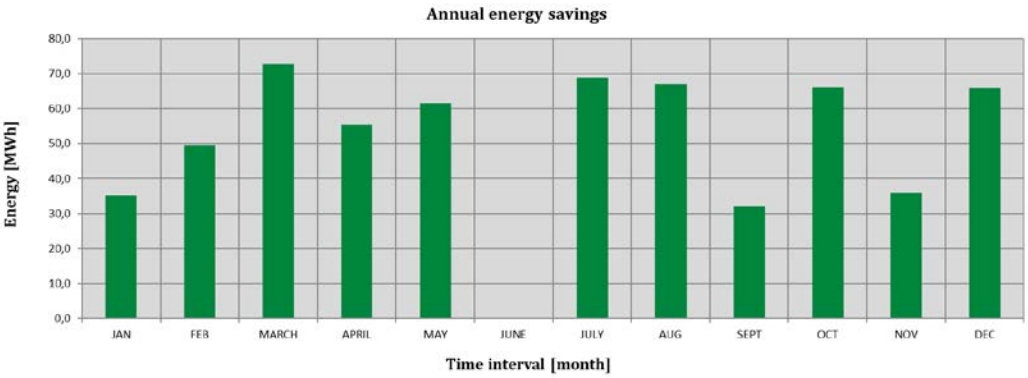
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	5,385	[Ton]	4,277	[MWh]	120	**37**	**4,489**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	6,000	[Ton]	4,766	[MWh]	115	**0**	**0**
Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								

	Specific energy use				Total energy use				
		0.8	[kWh/[...]]			4,277	[MWh/yr.]	Achieved energy savings	
Energy	After the energy efficiency implementation							0.0	[MWh/yr.]
	Specific energy use				Total energy use			Achieved cost savings	
		0.8	[kWh/[...]]			4,766	[MWh/yr.]	0	[euro/yr.]

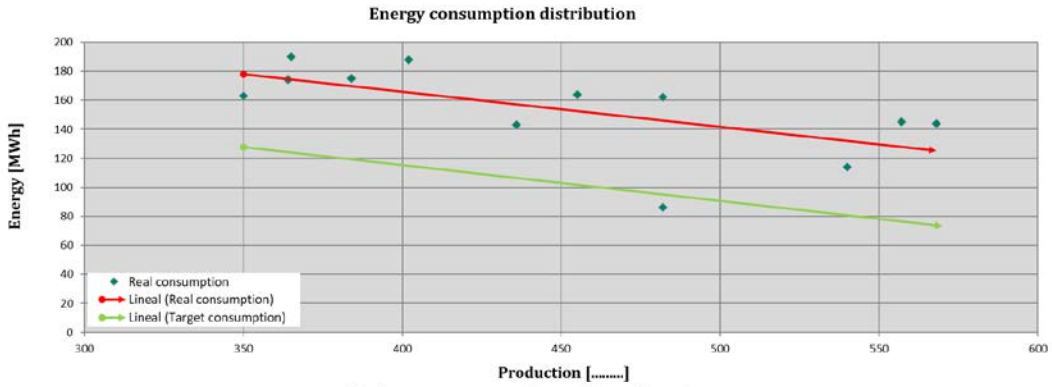
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:

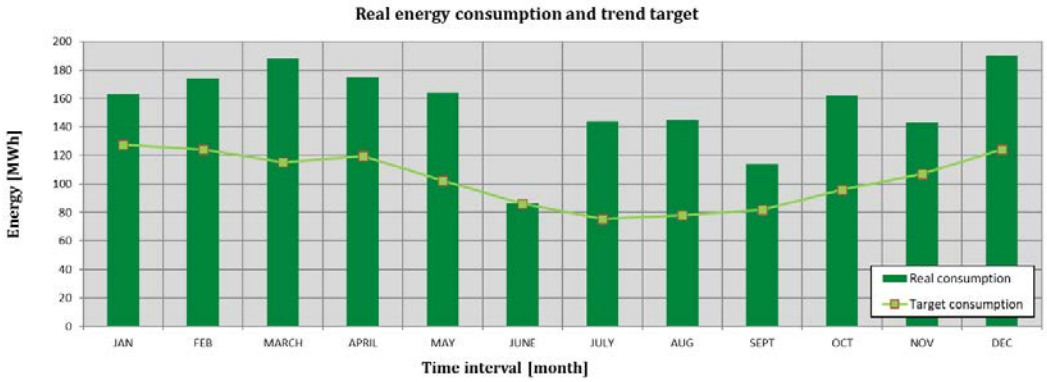


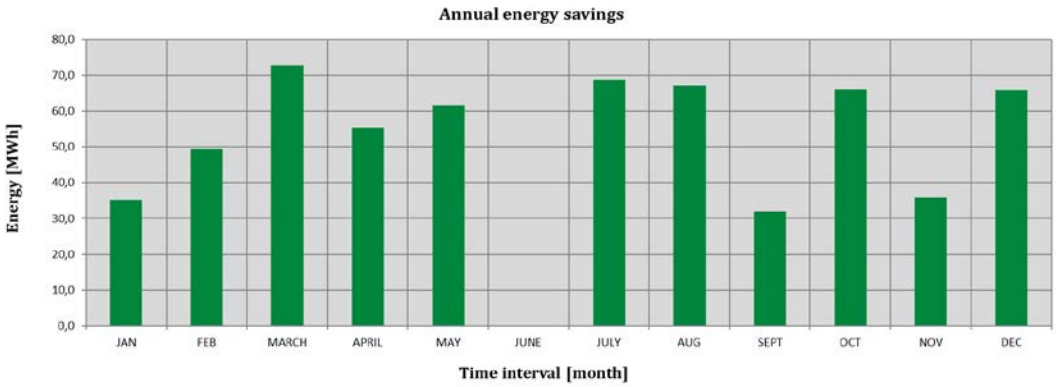




a) Before (2019)







b) After

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	5,385	[Ton]	2,032	[MWh]	55	**572**	**31,437**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	6,000	[Ton]	2,032	[MWh]	45	**549**	**24,696**

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use			Total energy use					
	0.4	[kWh/[…]]		2,032	[MWh/yr.]		Achieved energy savings		
Energy	After the energy efficiency implementation						0.2	[MWh/yr.]	
	Specific energy use			Total energy use			Achieved cost savings		
	0.3	[kWh/[…]]		2,032	[MWh/yr.]		10	[euro/yr.]	

4.7.4.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, action plan

4.7.4.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.7.5. Pilot site 5

4.7.5.1. Introduction for data and current situation

Number of employees: 154

NACE Code: 15130 – Food industry

Total energy consumption: Over 11,630 MWh/year

4.7.5.2. HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Table 247 Energy consumers

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	DK
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

Lighting system	
Partially LED Technology	X

Table 248 Production data

Production – Pilot 5 Meat		
	2018	**2019**
Month	Production [tons]	Production [tons]
January	302	337
February	275	312
March	302	337
April	340	375
May	356	394
June	390	423
July	411	447
August	403	438
September	340	381
October	352	389
November	285	327
December	303	340
TOTAL	**4,059**	**4,500**

4.7.5.3. Energy analysis

Electricity

Table 249 Electricityy consumption

Energy consumption – Pilot 5 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	681	781
February	637	734
March	716	792
April	788	869
May	847	925
June	885	982
July	941	1038
August	944	1026
September	794	883
October	809	900
November	679	770
December	716	800
TOTAL	**9,437**	**10,500**

Specific consumption

Table 250 Specific consumption

Specific consumption – Pilot 5		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	2.25	2.32
February	2.32	2.35
March	2.37	2.35
April	2.32	2.32
May	2.38	2.34
June	2.27	2.32
July	2.29	2.32
August	2.34	2.34
September	2.34	2.32
October	2.30	2.32
November	2.38	2.35
December	2.36	2.35
AVERAGE	**2.33**	**2.33**

Gas

Table 251 Methane gas consumption

Energy consumption – Pilot 5 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	341	379
February	341	379
March	341	379
April	341	379
May	341	379
June	341	379
July	341	379
August	341	379
September	341	379
October	341	379
November	341	379
December	341	379
TOTAL	**4,092**	**4,550**

Specific consumption

Table 252 Specific consumption

Specific consumption – Pilot 5		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	1.13	1.13
February	1.24	1.22
March	1.13	1.13
April	1.00	1.01
May	0.96	0.96
June	0.87	0.90
July	0.83	0.85
August	0.85	0.87
September	1.00	1.00
October	0.97	0.98
November	1.20	1.16
December	1.13	1.11
AVERAGE	**1.03**	**1.01**

4.7.5.4. Proposed solution and EE action plan

Lighting

It has been observed that some luminaires remain on in areas where they are not necessary, as they are connected to circuits that turn on other luminaires that should be on.

It is proposed to separate the circuits to isolate the 4 screens in the work area of warehouse 7. Thirteen luminaires would be disconnected from the ones that are now on during working hours.

Outdoor lighting

It has been observed that the exterior illuminated sign is on all night long (from approximately 8:00 p.m. until 8:00 a.m. the following day).

It is proposed to turn off the lighting of the exterior sign from 2:00 a.m. onwards, since it is considered that after this time this consumption is not necessary. The load consists of 19 projectors of 150 W each.

Compressed air

A residual demand of 30 kW electrical power has been observed during the weekend in compressed air production. Since air consumption during this period is minimal, most of this demand is due to leakage. It is proposed to shut off unused ductwork during the weekend using valves to eliminate these leaks.

Free-cooling

It has been observed that there are periods of time when the ambient temperature outside the building is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a "free-cooling" system to take advantage of the enthalpy of the outside air when the environmental conditions are favorable, as in winter, and thus be able to disconnect the production of cold.

Cold Storage

It has been observed that there are systems for the production of cold that are used continuously throughout the year. Some of these systems do not require very low temperature (0ºC).

It is proposed to install a cold storage system based on the production of ice blocks during off-peak hours (from 0:00 to 8:00) to consume the stored cold during peak hours (autonomy: 8 hours during the day).

Optimum power contracting

It has been observed that the power contracted by the plant is much higher than the power actually demanded during most of the year. Likewise, it must be taken into account that the maximum annual demand is reached in August, when electricity prices are the cheapest.

It is proposed to adjust the contracted power value to minimize the sum of contracted power and excess power payments.

Proposed solutions & EE action plan for Pilot 5										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Interruption of air-conditioning on weekends	0	139,916	0	139,916	12,03	10,548	32,181	0	65,892.17	-
Interruption of cold production during working hours	0	54,412	0	54,412	4,68	4,102	12,515	0	25,624.73	-
Separation of circuits to make luminaires independent	0	3,456	0	3,456	0,30	432	795	0	2,698.66	-
Switching off of the exterior sign illumination	2,150	6,245	0	6,245	0,54	470	1,436	4.57	786.04	16%

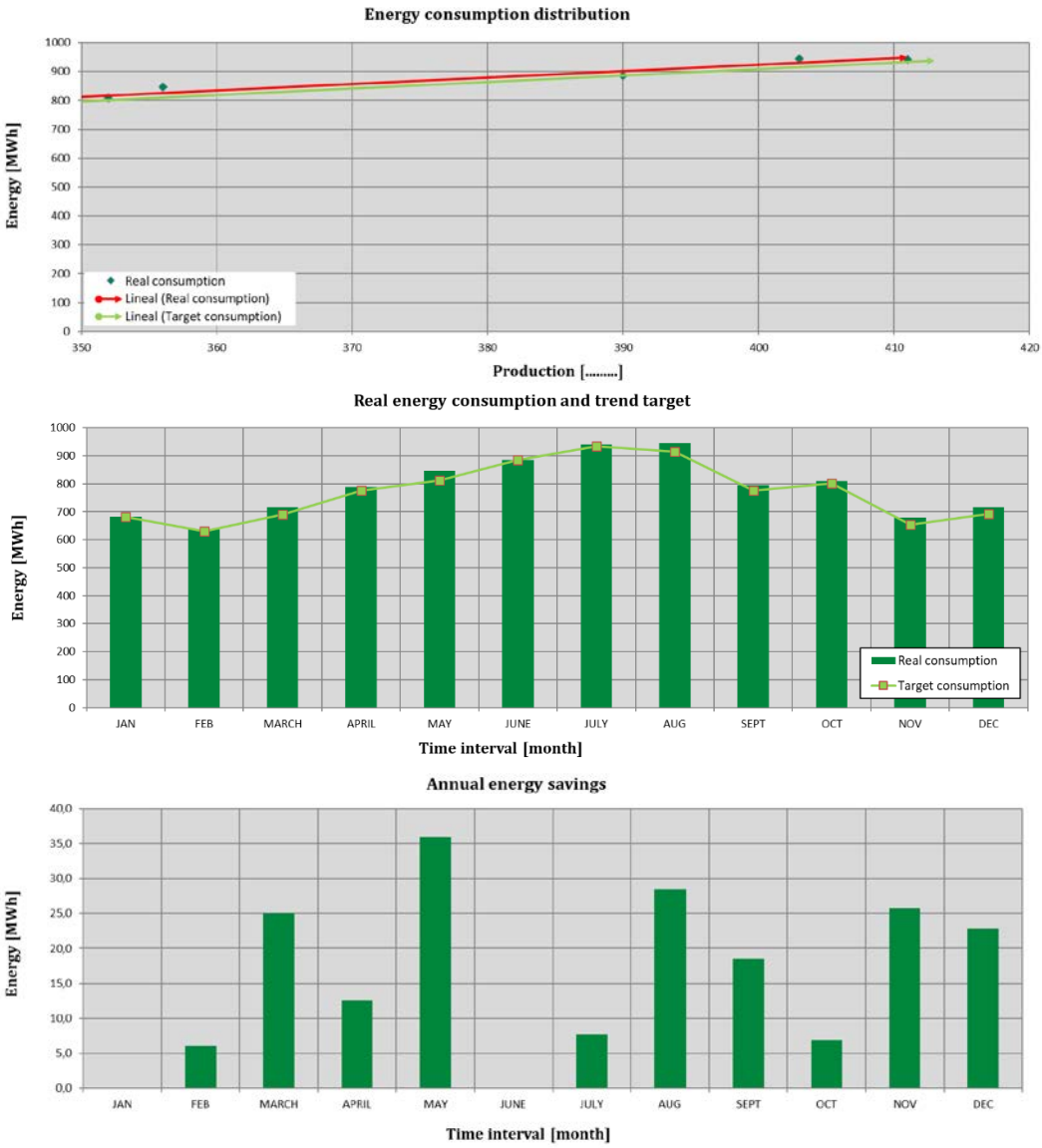
Interruption of air-conditioning during the described periods	4,440	49,347	0	49,347	4,24	5,615	11,350	0.79	30,636.28	126%
Closing of unused pipelines	39,634	103,680	0	103,680	8,91	7,770	23,846	5.10	8,904.32	13%
Improving window insulation	210	16,750	26,705	43,455	3,74	3,853	3,853	0.05	23,859.26	1835%
Free-cooling	13,150	213,768	174,458	388,226	33,38	28,787.28	49,167	0.46	166,680.91	219%
Ice storage	5,307	0	0	0	0,00	16,260.43	0	0.33	96,270.08	306%
Interruption of air-conditioning during the described periods	3,034	12,080	0	12,080	1,04	1,370	2,778	2.21	5,524.24	43%
Interruption of air conditioning during the periods described above.	237,916	167,430	0	167,430	14,40	18,560	38,509	12.82	-121,973.76	-7%
Speed control of refrigeration units	1,000	172,458	0	172,458	14,83	13,642	39,665	0.07	84,220.04	1364%

Division and optimization of its use	0	142,597	0	142,597	12,26	13,119	32,797	0	81,952.92	-
Review and detection of errors in electric invoices	0	0	0	0	0	5,000	0	0	31,234.44	-
Optimum power contracting	0	0	0	0	0	4,240	0	0	26,486.80	
TOTAL	306,841	1,082,139	201,163	1,283,302	110.34	133,768.71	248.892	2.29	528,797.14	435%

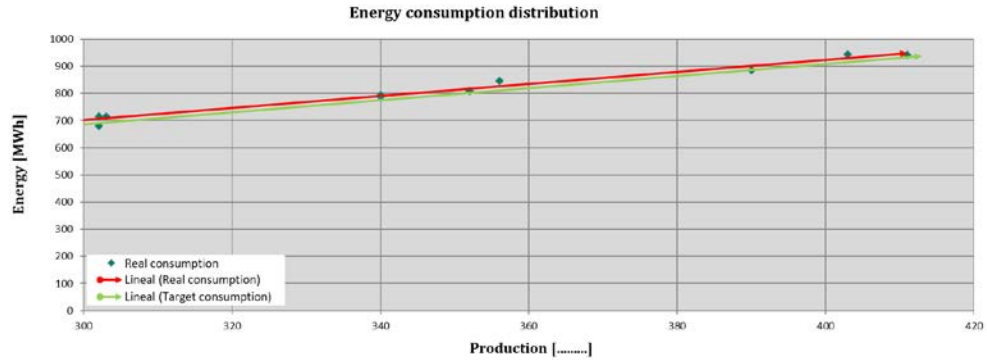
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

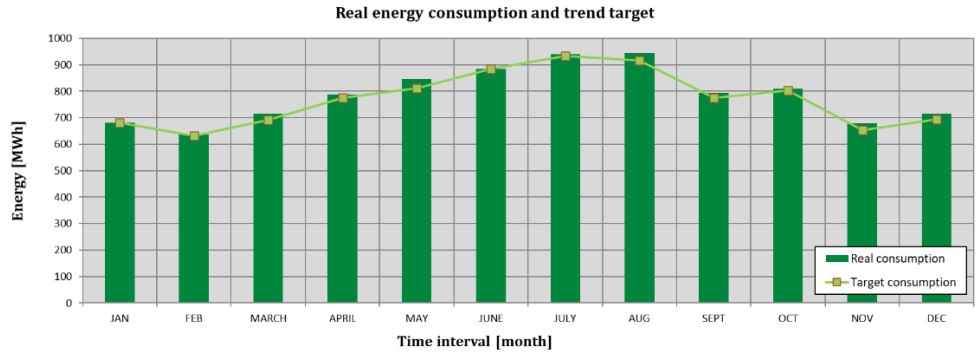
4.7.5.5. Measurement and verification of the results

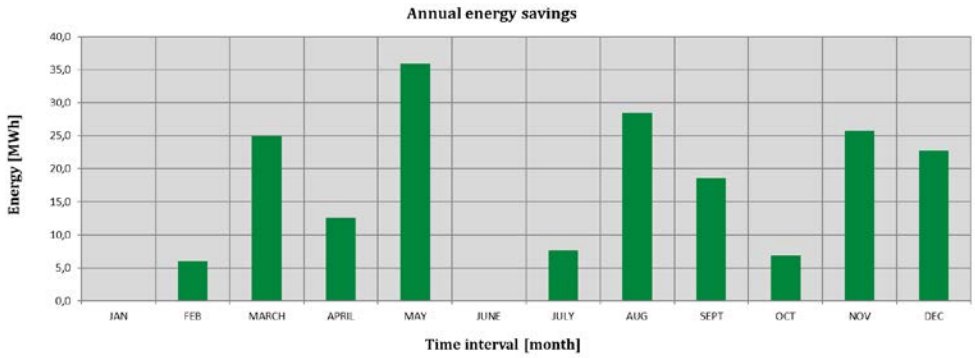
Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)





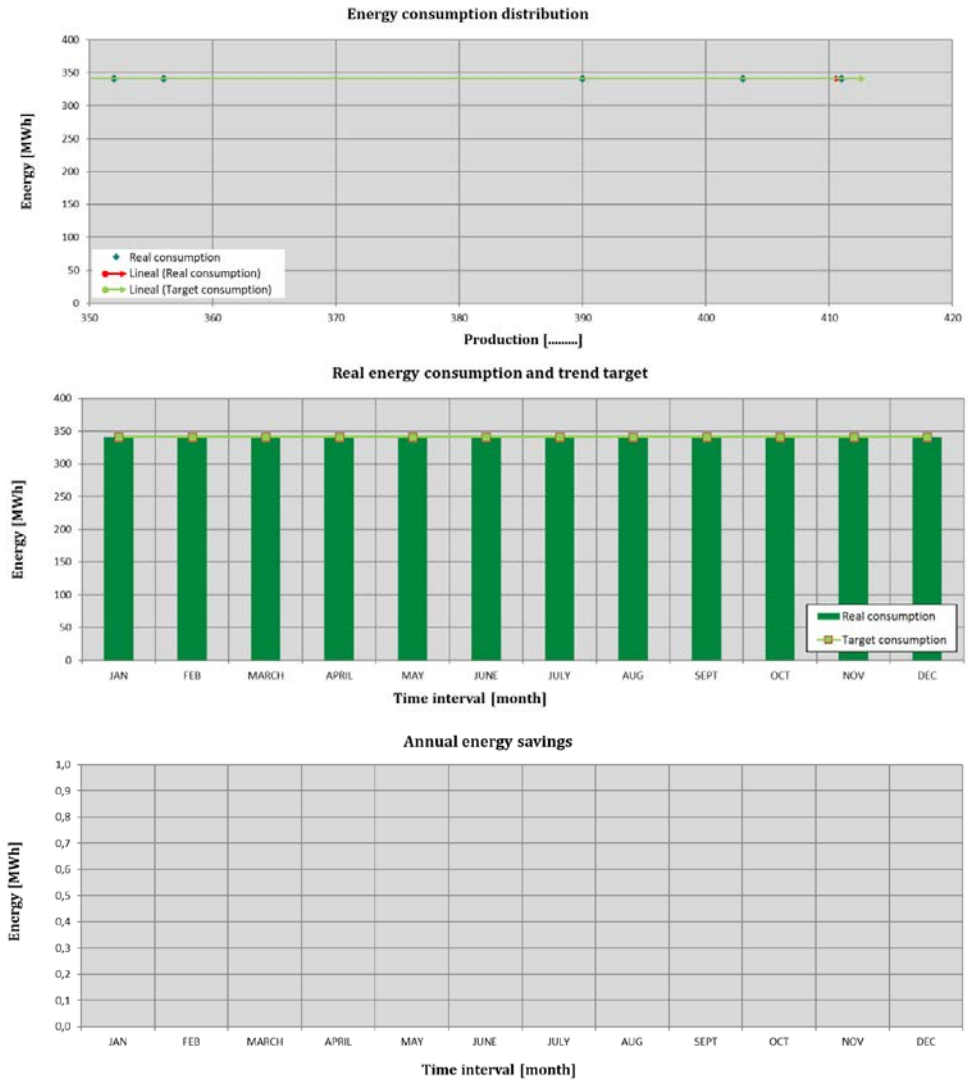


b) After (2019)

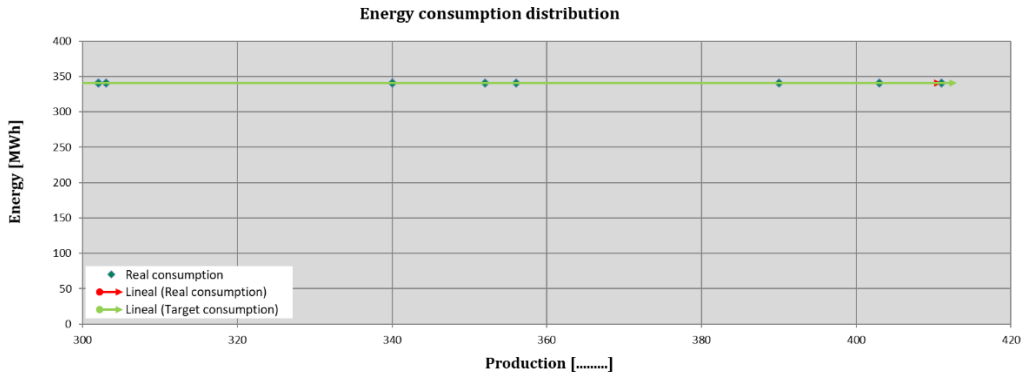
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	4,059	[Ton]	9,437	[MWh]	120	**190**	**22,745**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	4,500	[Ton]	10,500	[MWh]	115	**8**	**957**

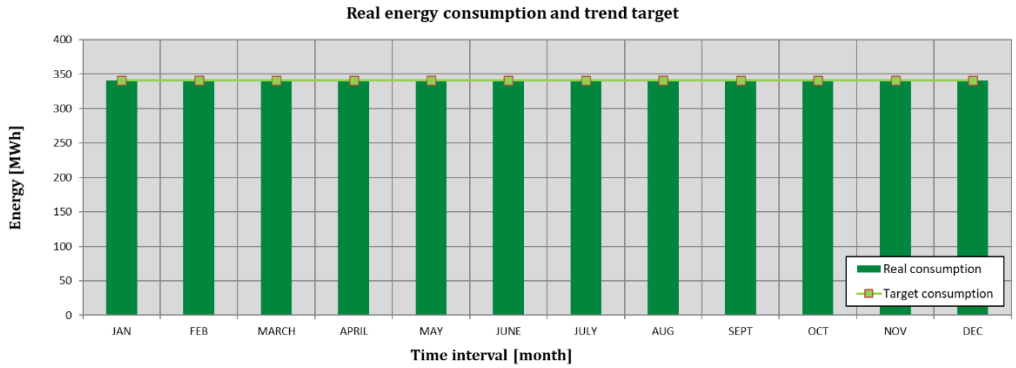
Measured and verified achieved energy saving										
Utility type	Before the energy efficiency implementation									
	Specific energy use				Total energy use					
		2.3	[kWh/[...]]			9,437	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation								0.0	[MWh/yr.]
	Specific energy use				Total energy use			Achieved cost savings		
		2.3	[kWh/[...]]			10,500	[MWh/yr.]		-4	[euro/yr.]

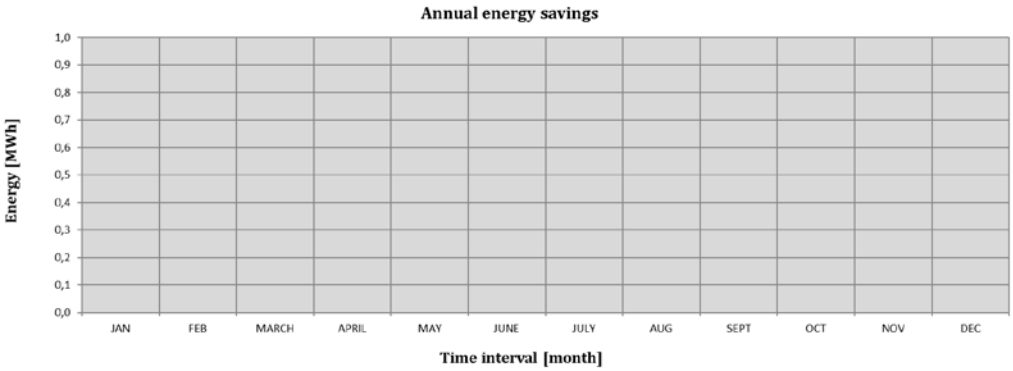
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)







b) After (2019)

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	4,059	[Ton]	4,092	[MWh]	55	0	0
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	4,500	[Ton]	4,550	[MWh]	45	0	0
Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								

	Specific energy use				Total energy use					
		1.0	[kWh/[...]]			4,092	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation								0.0	[MWh/yr.]
	Specific energy use				Total energy use			Achieved cost savings		
		1.0	[kWh/[...]]			4,550	[MWh/yr.]		-1	[euro/yr.]

4.7.5.6. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, action plan

4.7.5.7. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.7.6. Pilot site 6

Number of employees: 152

NACE Code: 15130 – Food industry

Total energy consumption: 10,500 ton/year

4.7.6.1. Introduction for data and current situation

HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes

Ventilation	Yes
Pumps	DK
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

Lighting system	
Partially LED Technology	X

Table 253 Production data

Production – Pilot 6 Meat		
	2018	**2019**
Month	Production [ton]	Production [ton]
January	802	890
February	717	797
March	779	869
April	742	828
May	775	859
June	786	872
July	822	911
August	825	911
September	781	870
October	863	951
November	860	949
December	702	793
TOTAL	**9,454**	**10,500**

4.7.6.2. Energy analysis

Electricity

Table 254 Electricity consumption

Energy consumption – Pilot 6 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	1,331	1,484
February	1,175	1,328
March	1,293	1,444
April	1,248	1,381
May	1,289	1,432
June	1,306	1,454
July	1,381	1,518
August	1,373	1,519
September	1,297	1,450
October	1,429	1,586
November	1,425	1,582
December	1,180	1,322
TOTAL	**15,727**	**17,500**

Specific consumption

Table 255 Specific consumption

Specific consumption – Pilot 6		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	1.66	1.67
February	1.64	1.67
March	1.66	1.66
April	1.68	1.67
May	1.66	1.67
June	1.66	1.67
July	1.68	1.67
August	1.66	1.67
September	1.66	1.67
October	1.66	1.67
November	1.66	1.67
December	1.68	1.67
AVERAGE	**1.66**	**1.67**

Gas

Table 256 Methane gas consumption

Energy consumption – Pilot 6 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	459	501
February	457	498
March	490	533
April	437	490
May	407	457
June	327	377
July	341	384
August	328	381
September	329	374
October	384	433
November	395	444
December	392	433
TOTAL	**4,746**	**5,305**

Specific consumption

Table 257 Specific consuamption

Specific consumption – Pilot 6		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.57	0.56
February	0.64	0.63
March	0.63	0.61
April	0.59	0.59
May	0.53	0.53
June	0.42	0.43
July	0.41	0.42
August	0.40	0.42
September	0.42	0.43
October	0.44	0.46
November	0.46	0.47
December	0.56	0.55
AVERAGE	0.57	0.56

4.7.6.3. Proposed solution and EE action plan

Proposed solutions and energy efficiency action plan:

- Revision of the existing energy audit and the proposed solutions, if any.
- Proposing other energy efficiency measures and RES, based on the energy analytics, presenting estimated investment, savings (both energy and cost), simple payback period, and if possible net present value (NPV – in euro) and internal rate of return (IRR – in %).

Work rooms. Air conditioning

It has been observed that currently the cold is switched off manually in the workrooms when there are no hams inside, but only on weekends, not at night.

It is proposed to automate this process to also consider nights and holidays. To do this without investment, the team leader of each shift should be responsible for turning the equipment on and off. There is a possibility to do this manually through the existing SCADA system. An average day has 7 working hours. The rest up to 24 hours could be shut down.

Dryers

It has been observed that during the transfer of products from the dryers, the air conditioning systems continue to operate, causing energy losses and reduced yields.

It is proposed that the air conditioning systems be turned off while the dryers are being filled or emptied.

Fans. Evaporative condensers

It has been observed that the condensers of the refrigeration lines are evaporative. Each condenser has one fan of 22 kW and two fans of 11 kW each. These fans do not have any speed regulation system.

It is proposed to install a variable speed drive for each of the evaporative condensers, thus making more efficient use of the system.

Cooling pumps

It has been observed that the pumps of the refrigeration lines and of the glycol circuit at +35 ºC do not have speed controllers.

It is proposed to install a variable speed drive in each of the groups of pumps of the refrigeration circuits and in the glycol circuit at +35 ºC. In this way, the speed of the pumps is adjusted to the real demand of the system.

Free-cooling

It has been observed that there are periods of time when the outside ambient temperature is lower than the required temperature inside some of the refrigerated rooms inside the building.

It is proposed to install a "free-cooling" system to take advantage of the enthalpy of the outside air when the ambient conditions are favorable, as in winter, and thus be able to disconnect the cooling production.

Internal lighting. LEDs

It has been observed that the luminaires used in the lighting of several rooms are fluorescent.

It is proposed to replace the fluorescent tubes with LED type luminaires, which can save up to 70% of the energy consumed for lighting. The savings calculation has been made for the replacement of all fluorescent tubes.

Internal lighting

It has been observed that the luminaires used in the lighting of several rooms are fluorescent.

It is proposed to replace the fluorescent tubes with LED type luminaires, which can save up to 70% of the energy consumed for lighting. The savings calculation has been made for the replacement of all fluorescent tubes.

Solar thermal panels

It has been observed that the water is heated in the boilers (there are three, although only two of them are currently on, each of 1,150,000 kcal/h using diesel oil C).

It is proposed to install solar thermal panels on the roof of the plant, thus obtaining part of the daily hot water consumption, and with it a reduction in the consumption of diesel oil.

Compressed air

It has been observed that the compressed air compressors do not have speed variation.

It is proposed to install a compressor with speed variation to adjust to the demand, with start selector so that the variator can serve, optionally, for one motor or another.

Contract optimization

It has been observed that the contracted power is higher than the optimum required for the installation.

It is proposed to contract a power that optimizes the payments for excess power with the payment for contracted power.

Proposed solutions & EE action plan for Pilot 6										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[kg. eq. CO_2/year]	[years]	[EUR]	[%]
Interruption of air-conditioning on weekends	0	139,916	0	139,916	12.03	10,548	32,181	0	65,892.17	
Interruption of cold production during working hours	0	54,412	0	54,412	4.68	4,102	12,515	0	25,624.73	
Separation of circuits to make luminaires independent	300	3,456	0	3,456	0.30	432	795	0.69	23,98.66	144%
Switching off of the exterior sign illumination	0	6,245	0	6,245	0.54	470	1,436	0	29,36.04	

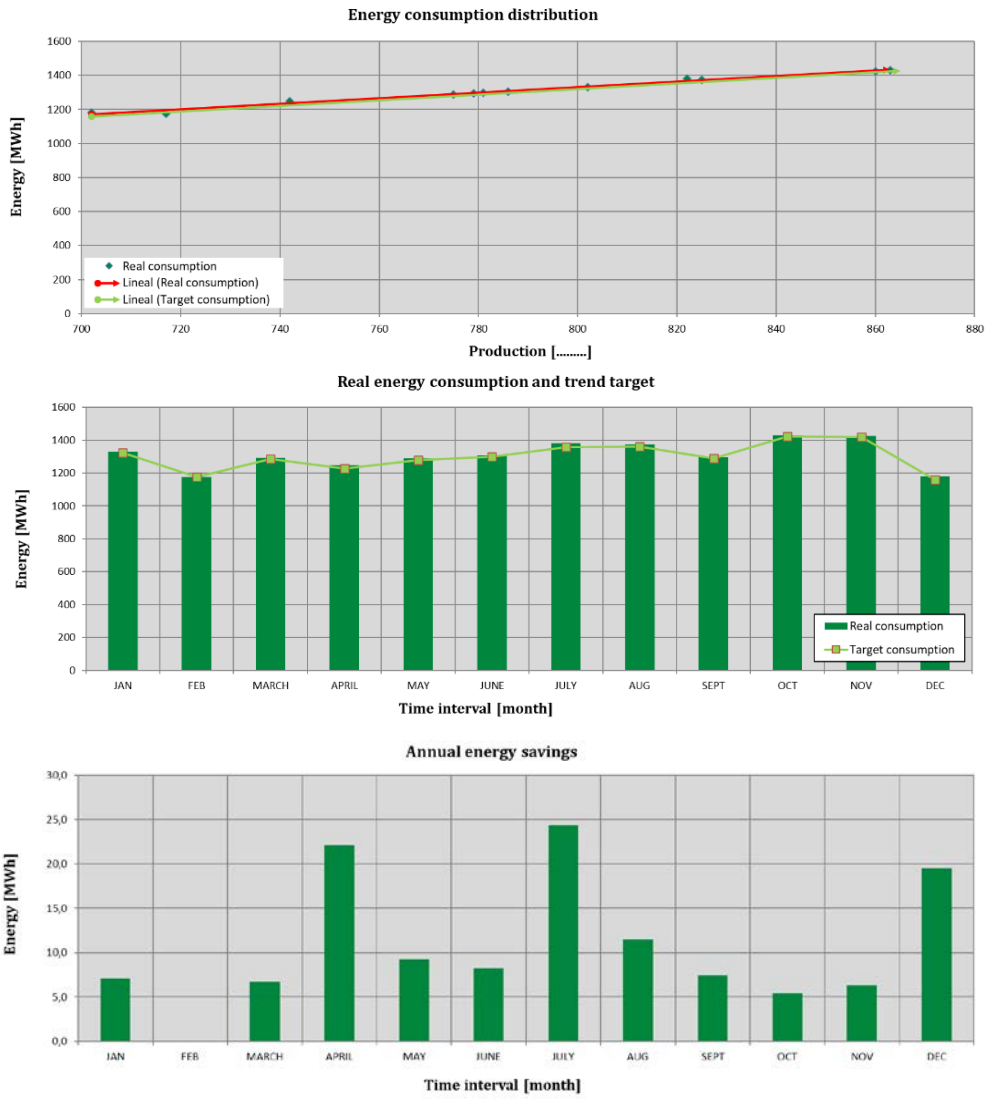
Interruption of air-conditioning during the described periods	0	49,347	0	49,347	4.24	5,615	11,350	0	35,076.28	
Closing of unused pipelines	12,000	103,680	0	103,680	8.91	7,770	23,846	1.54	36,538.32	64%
Improving window insulation	12,300	16,750	26,705	43,455	3.74	3,853	3,853	3.19	11,769.26	28%
Free-cooling	65,750	213,768	174,458	388,226	33.38	28,787	49,167	2.28	114,079.16	42%
Ice storage	127,576	0	0	0	0	16,260	0	7.85	-26,001.60	3%
Interruption of air-conditioning during the described periods	0	12,080	0	12,080	1.04	1,370	2,778	0	8,558.24	
Interruption of air conditioning during the periods described above.	0	167,430	0	167,430	14.40	18,560	38,509	0	115,942.24	
Speed control of refrigeration units	37,250	172,458	0	172,458	14.83	13,642	39,665	2.73	47,970.04	34%

Division and optimization of its use	58,500	142,597	0	142,597	12.26	13,119	32,797	4.46	23,452.92	17%
Review and detection of errors in electric invoices	0	0	0	0	0	5,000	0	0	31,234.44	
Optimum power contracting	0	0	0	0	0	4,240	0	0	26,486.80	
	313,676	1,082,139	201,163	1,283,302	110.34	133,768	248,892	2.34	521,957.70	47%

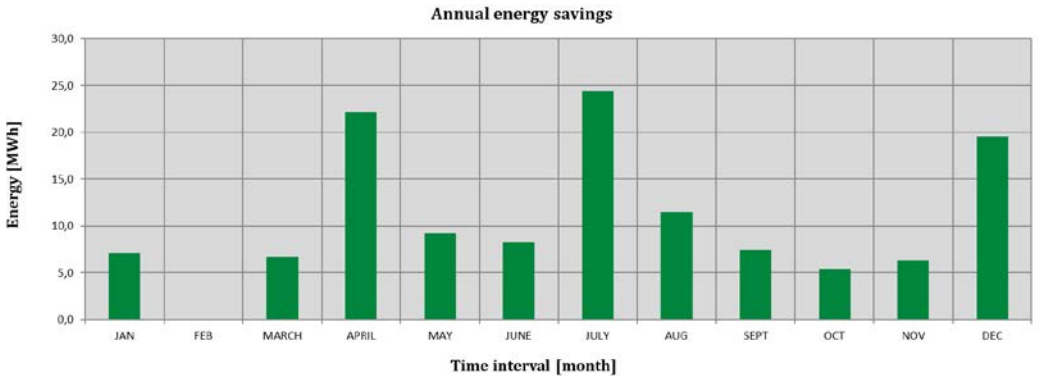
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

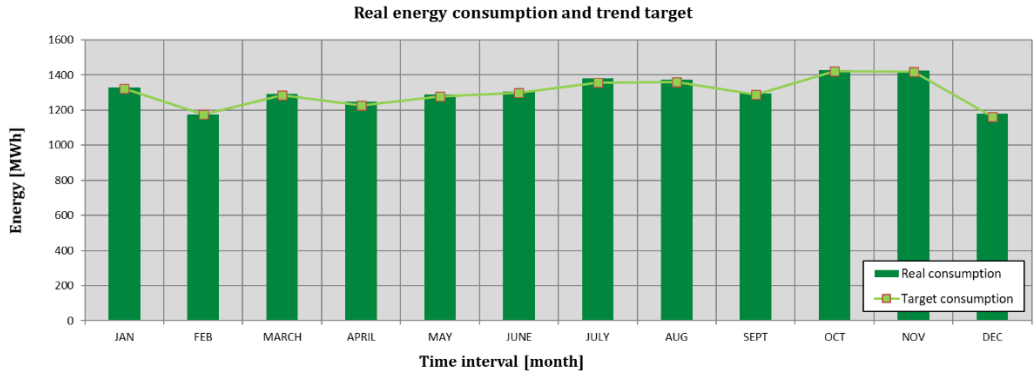
4.7.6.4. Measurement and verification of the results

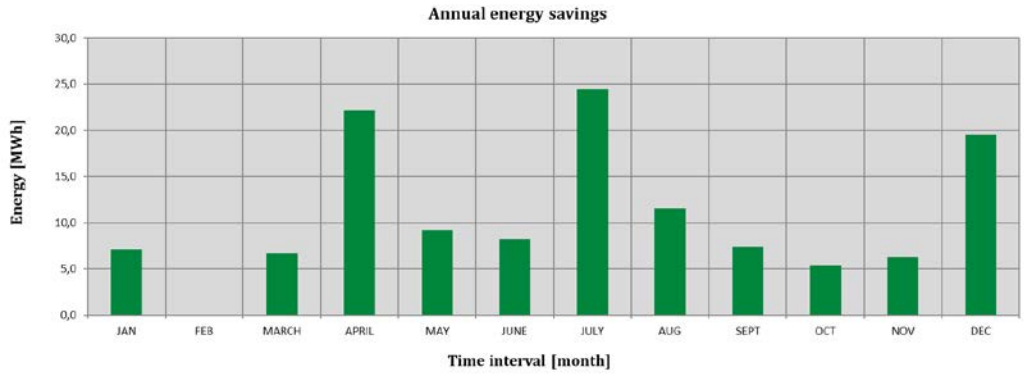
Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)







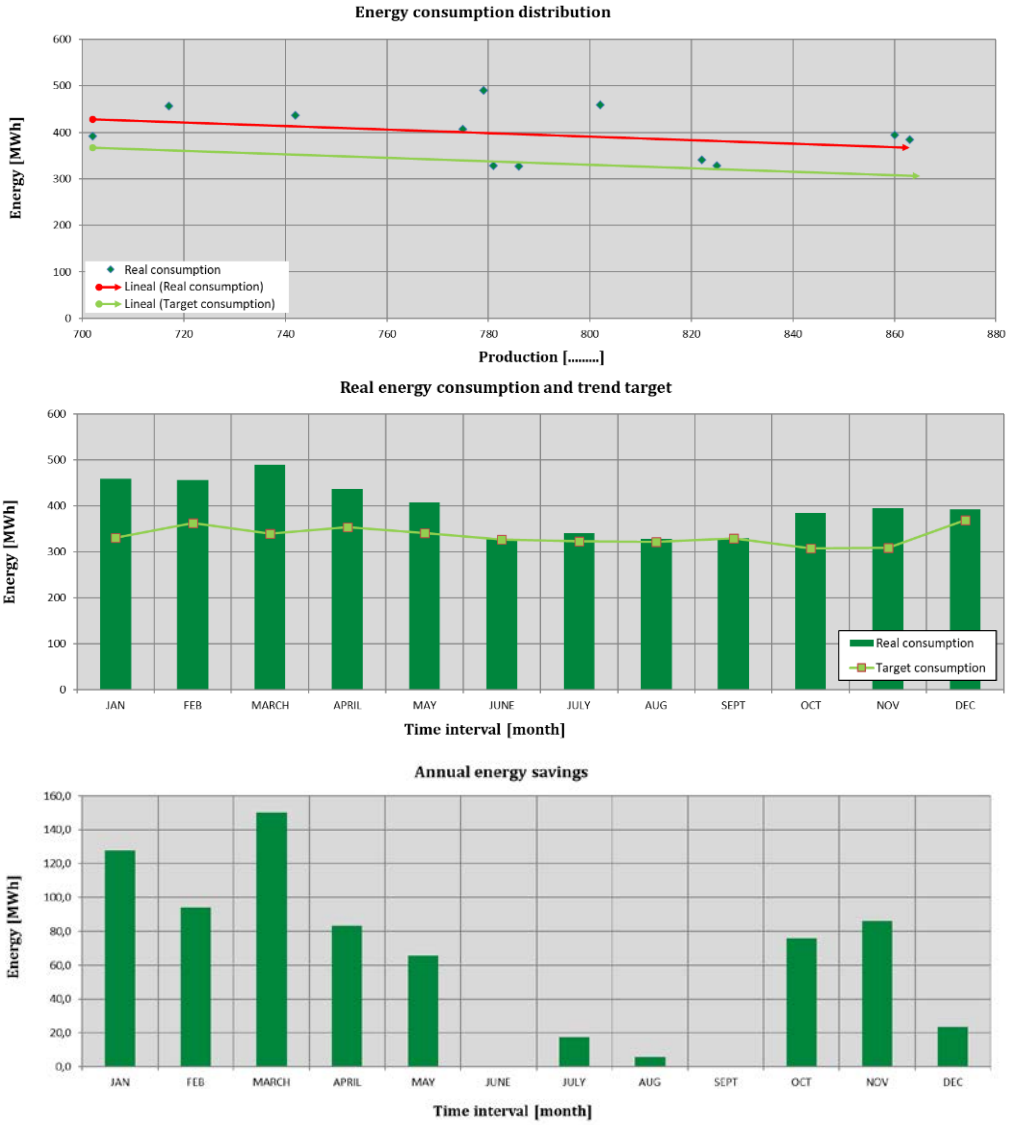
b) After (2019)

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	9,454	[Ton]	15,727	[MWh]	120	**838**	**100,554**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	10,500	[Ton]	17,500	[MWh]	115	**655**	**75,281**

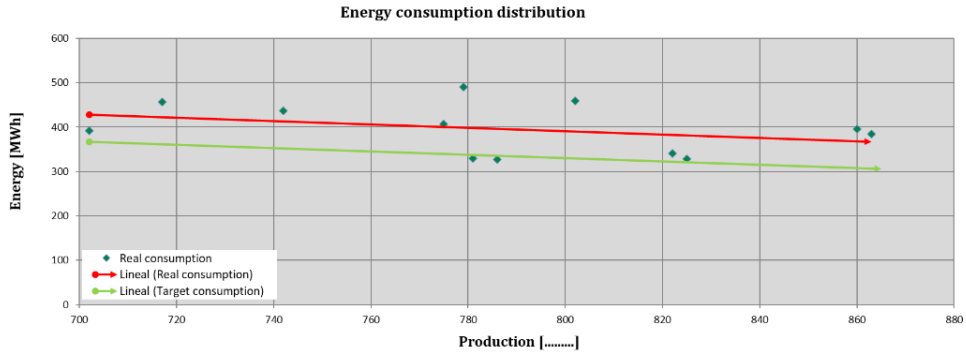
Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use				Total energy use				
		1.7	[kWh/[...]]			15,727	[MWh/yr.]	Achieved energy savings	

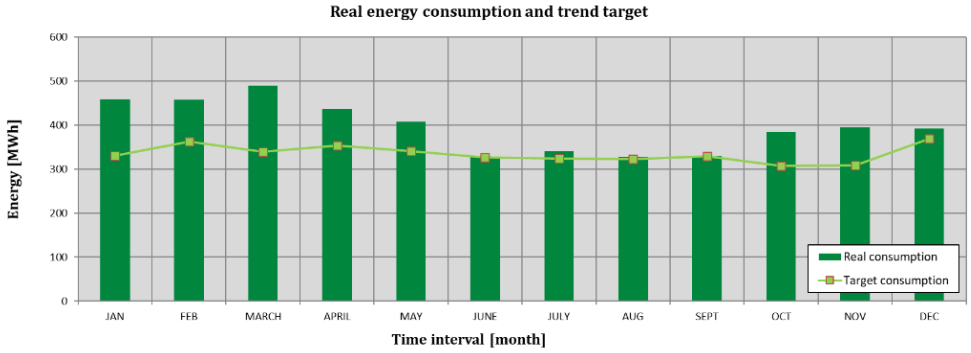
Energy	**After the energy efficiency implementation**							**0.0**	**[MWh/yr.]**
	Specific energy use				**Total energy use**			**Achieved cost savings**	
		1.7	[kWh/[...]]			17,500	[MWh/yr.]	**-4**	**[euro/yr.]**

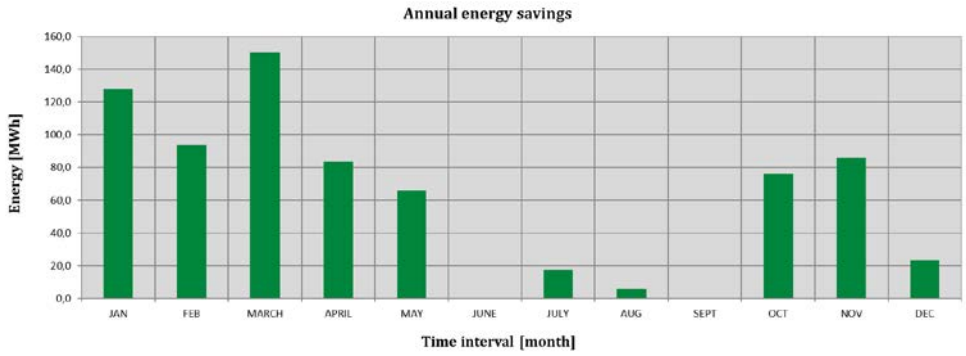
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)







b) After (2019)

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	9,454	[Ton]	4,746	[MWh]	55	**1,430**	**78,667**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	10,500	[Ton]	5,305	[MWh]	45	**1,438**	**64,693**

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use			Total energy use					
	0.5	[kWh/[...]]		4,746	[MWh/yr.]		Achieved energy savings		
Energy	After the energy efficiency implementation						0.0	[MWh/yr.]	
	Specific energy use			Total energy use			Achieved cost savings		
	0.5	[kWh/[...]]		5,305	[MWh/yr.]		-2	[euro/yr.]	

4.7.6.5. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, action plan

4.7.6.6. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.7.7. Pilot site 7

Number of employees: 183

NACE Code: 15130 – Food industry

Total energy consumption: Over 11,630 MWh/year

4.7.7.1. Introduction for data and current situation

- Final products: 30500 ton/year

4.7.7.2. HVAC (Heating, Ventilation and Air Conditioning) and Lighting System

Electricity	Yes/No/DK
Technological process	Yes
Lighting	Yes
Compressed air	Yes
Ventilation	Yes
Pumps	DK
Drives	DK
Electrical heat	No
Air conditioning	Yes
Offices: PCs, printer, copier etc.	Yes

Heat	Yes/No/DK
Technological process	DK
Room heating	Yes
Domestic hot water preparation	DK

Lighting system	
Partially LED Technology	X

Table 258 Production data

Production – Pilot 7 Meat		
	2018	**2019**
Month	Production [tons]	Production [tons]
January	2445	2695
February	2170	2424
March	2221	2482
April	2184	2432
May	2396	2657
June	2175	2422
July	2312	2573
August	2253	2499
September	2246	2512
October	2448	2716
November	2132	2383
December	2453	2706
TOTAL	**27,435**	**30,500**

4.7.7.3. Energy analysis

Electricity

Table 259 Electricity consumption

Energy consumption – Pilot 7 Electricity		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	1475	1640
February	1319	1476
March	1363	1511
April	1335	1481
May	1457	1617
June	1329	1475
July	1403	1565
August	1360	1521
September	1373	1529
October	1502	1653
November	1303	1451
December	1486	1647
TOTAL	**16,705**	18,565

Specific consumption

Table 260 Specific consumption

Specific consumption – Pilot 7		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	0.60	0.61
February	0.61	0.61
March	0.61	0.61
April	0.61	0.61
May	0.61	0.61
June	0.61	0.61
July	0.61	0.61
August	0.60	0.61
September	0.61	0.61
October	0.61	0.61
November	0.61	0.61
December	0.61	0.61
AVERAGE	**0.61**	**0.61**

Gas

Table 261 Methane gas consumption

Energy consumption – Pilot 7 Gas		
	2018	**2019**
Month	Consumption [MWh]	Consumption [MWh]
January	2,460	2,668
February	2,357	2,593
March	1,919	2,171
April	2,181	2,443
May	2,186	2,442
June	2,025	2,270
July	2,162	2,407
August	2,032	2,264
September	1,888	2,153
October	2,044	2,241
November	1,691	1,928
December	1,810	2,043
TOTAL	**24,755**	**27,623**

Specific consumption

Table 262 Specific consumption

Specific consumption – Pilot 7		
	2018	**2019**
Month	Specific consumption [kWh/kg]	Specific consumption [kWh/kg]
January	1.01	0.99
February	1.09	1.07
March	0.86	0.87
April	1.00	1.00
May	0.91	0.92
June	0.93	0.94
July	0.94	0.94
August	0.90	0.91
September	0.84	0.86
October	0.83	0.83
November	0.79	0.81
December	0.74	0.75
AVERAGE	**0.90**	**0.91**

4.7.7.4. Proposed solution and EE action plan

Lighting

It has been observed that the lights in the warehouse corridor and the large warehouse are kept on during working hours. There are 16 luminaires in the corridor and 42 in the warehouse with 2x58W.

It is proposed to turn off the lights normally during working hours, turning them on only when necessary.

Packaging machines

It has been observed that currently the cooling of packaging machines is done with water from the network, which displaces the hot water by overflow.

It is proposed to install a closed cooling water circuit (including recirculation pump, purifier and water cooler) in the packaging machines, thus obtaining a reduction in water consumption and thus a significant economic saving.

Capacitor bank

It has been observed that the plant penalizes almost every month for excess reactive energy. Although the penalty is not usually significant, there have been months in which it has reached almost 1,500 euros. As the reactive power generation capacity is so tight, any unforeseen event in any of the capacitors of the existing battery would cause an immediate penalty, as the power factor obtained hardly ever exceeds 0.9, while penalties occur for values below 0.95.

It is proposed that the capacitor banks be expanded to avoid incurring excesses. It would be necessary to increase the capacitor bank capacity by 150 kVAr.

Interior lighting. Luminaires

It has been noted that the exterior lighting fixtures are VSAP fixtures and these allow for dimming.

It is proposed to install a flux regulator to reduce the consumption of the exterior lighting.

Solar thermal panels

It has been observed that the hot water used in the plant is produced with natural gas boilers.

It is proposed to install solar thermal panels on the roof of the plant, thus obtaining part of the plant's daily hot water consumption. This water can be used to reduce the consumption of steam used to heat process water.

Cold storage

It has been observed that during the plant operation process, the doors of the C2 fresh reception chambers, C4 finished product chamber and C115s finished product chamber remain open for long periods of time, with the refrigeration equipment on, resulting in energy losses and reduced performance.

It is proposed to install fast access doors to the chambers to reduce thermal transfers between the chamber and the corresponding docks.

Compressed air

It has been observed that on weekends there is a residual compressed air consumption due to leaks that is not necessary, exceeding the 55 kW of the small compressor at many times.

It is proposed to shut down the compressed air lines that are not used on weekends and meet the air demand only with the small compressor that has speed control.

Electric heating

It has been observed that currently the electric stoves that provide heating to the entire plant are kept on all the time in winter. The total stoves account for approximately 50 kW.

It is proposed to replace the heat input from the electric heaters, using the thermal state of the glycol circuit at 70 ºC, either with the current capacity or by increasing the glycol production to 70 ºC if necessary.

Contract optimization

It has been observed that the contracted power is often lower than the power demanded by the installation.

It is proposed to contract a power that optimizes the payments for excess power with the payment for contracted power.

Proposed solutions & EE action plan for Pilot 7										
Proposed solution - description	Investment	Energy saving Type: Electricity	Energy saving Type: Thermal	Total energy saving	Total energy saving	Cost saving	CO_2 emission reduction	Payback period	NPV	IRR
	[EUR]	[kWh/year]	[kWh/year]	[kWh/year]	[Tep/year]	[EUR/year]	[tones eq. CO_2/year]	[years]	[EUR]	[%]
Interrupt air conditioning when no hams are present	0	341,603	0	341,603	29.37	24,637	78,569	0	153,904.58	
Switch off air conditioning during filling and emptying	0	21,545	46,883	68,428	5.88	2,026	4,955	0	12,656.19	
Use glycol at -2 ºC instead of -4 ºC.	0	562,238	0	562,238	48.34	49,364	129,315	0	308,371.37	
Install variable speed drives	29,443	242,028	0	242,028	20.81	16,677	55,666	1.77	74,736.35	56%
Install variable speed drives	74,410	716,340	0	716,340	61.59	49,360	164,758	1.51	233,936.39	66%
Install free cooling system	26,724	100,898	0	100,898	8.68	6,748	23,207	3.96	15,430.00	21%

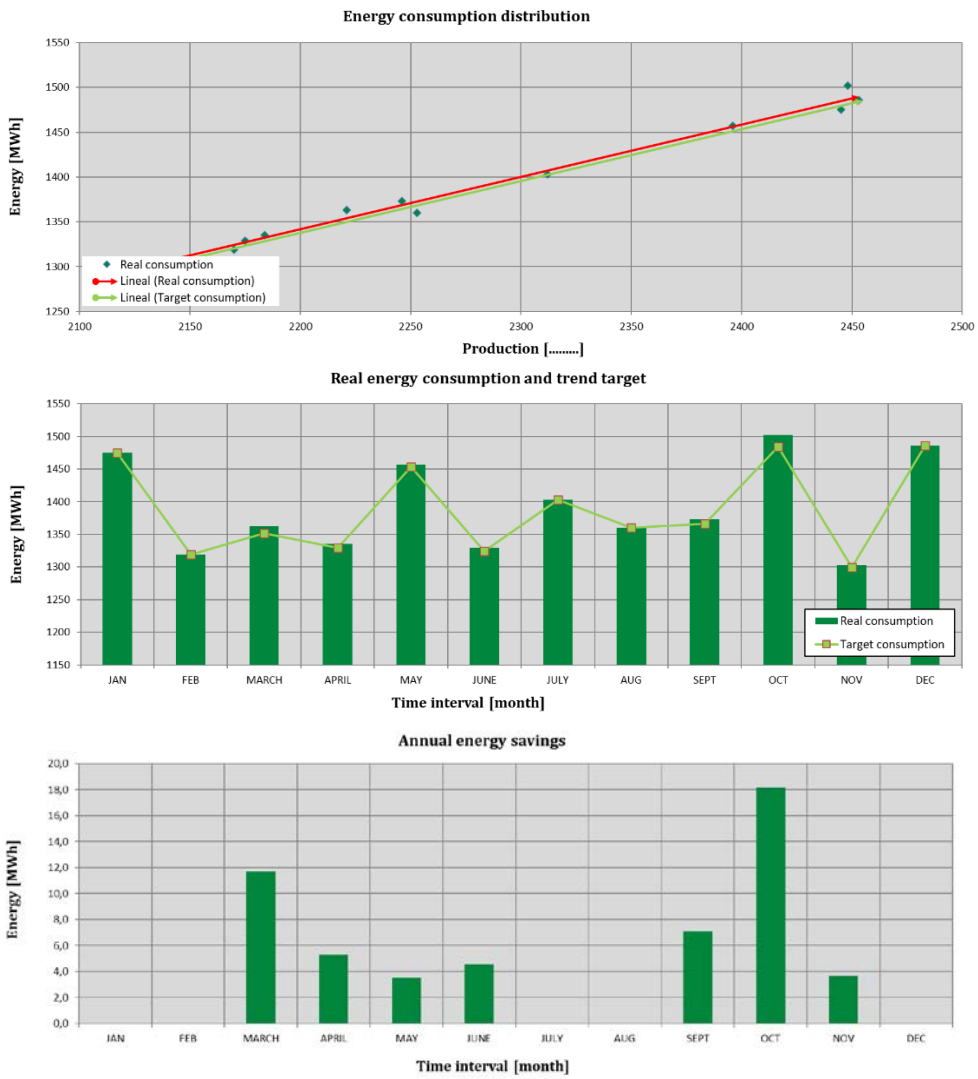
Replacement of lighting fixtures with LEDs	134,571	227,870	0	227,870	19.59	17,582	52,410	7.65	-24,738.22	3%
Replacing magnetic ballasts with electronic ballasts	24,145	86,563	0	86,563	7.44	9,875	19,909	2.45	37,543.02	39%
Replace fluorescent T-8 with T-5	2,365	45,575	0	45,575	3.92	4,586	10,482	0.52	26,283.23	194%
Installing Panels for ACS	305,890	0	2,609,522	2,609,522	224.38	65,238	0	4.69	101,644.47	15%
Installation of an inflatable shelter	3,800	8,549	0	8,549	0.74	774	1,966	4.91	1,035.09	14%
Closing compressed air lines	10,500	59,817	0	59,817	5.14	3,512	13,758	2.99	11,439.07	30%
Compressed air compressor	19,790	37,881	0	37,881	3.26	2,702	8,713	7.32	-2,910.91	4%
Replace damaged insulation	28,971	236,452	0	236,452	20.33	21,156	54,384	1.37	103,188.16	72%
Brine dehydration	0	0	0	0	0	182,520	0			
Avoiding simultaneous dryers	0	0	0	0	0	16,819	0			
Disconnect the -4 ºC line in dryers.	0	240,985	0	240,985	20.72	22,506	55,427			

Disconnect the -11 ºC line in chambers.	0	8,690	0	8,690	0.75	812	1,999			
Recharge batteries at recommended times	0	0	0	0	0	1,554	0			
Recharge batteries in P6	0	0	0	0	0	1,769	0			
Contracting the optimum power	0	0	0	0	0	4,357	0			
TOTAL	660,609	2,937,034	2,656,405	5,593,439	480.95	504,574	675,518	1.31	1,052,518.80	47%

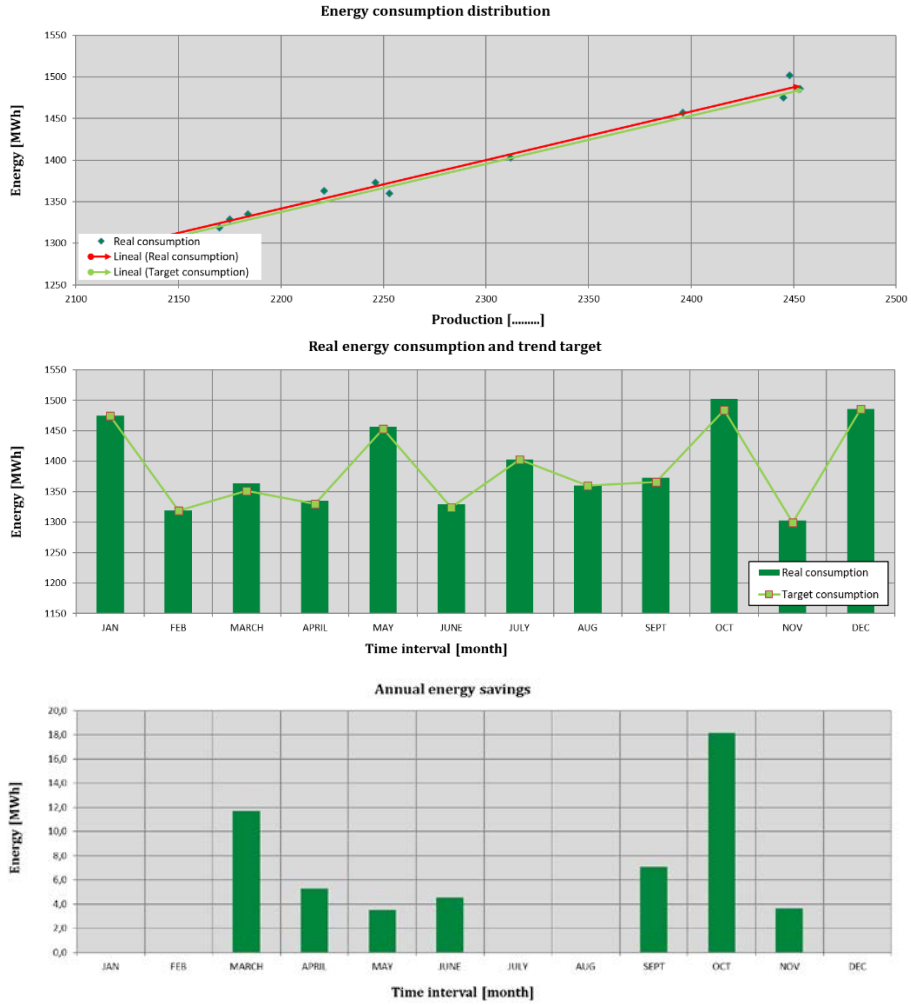
KPI	U.M	Calculated	Estimated
Investment	EUR	X	
Energy saving	MWh	X	
Cost saving	EUR	X	
CO_2 emission	Tones eq.	X	

4.7.7.5. Measurement and verification of the results

Electricity-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)

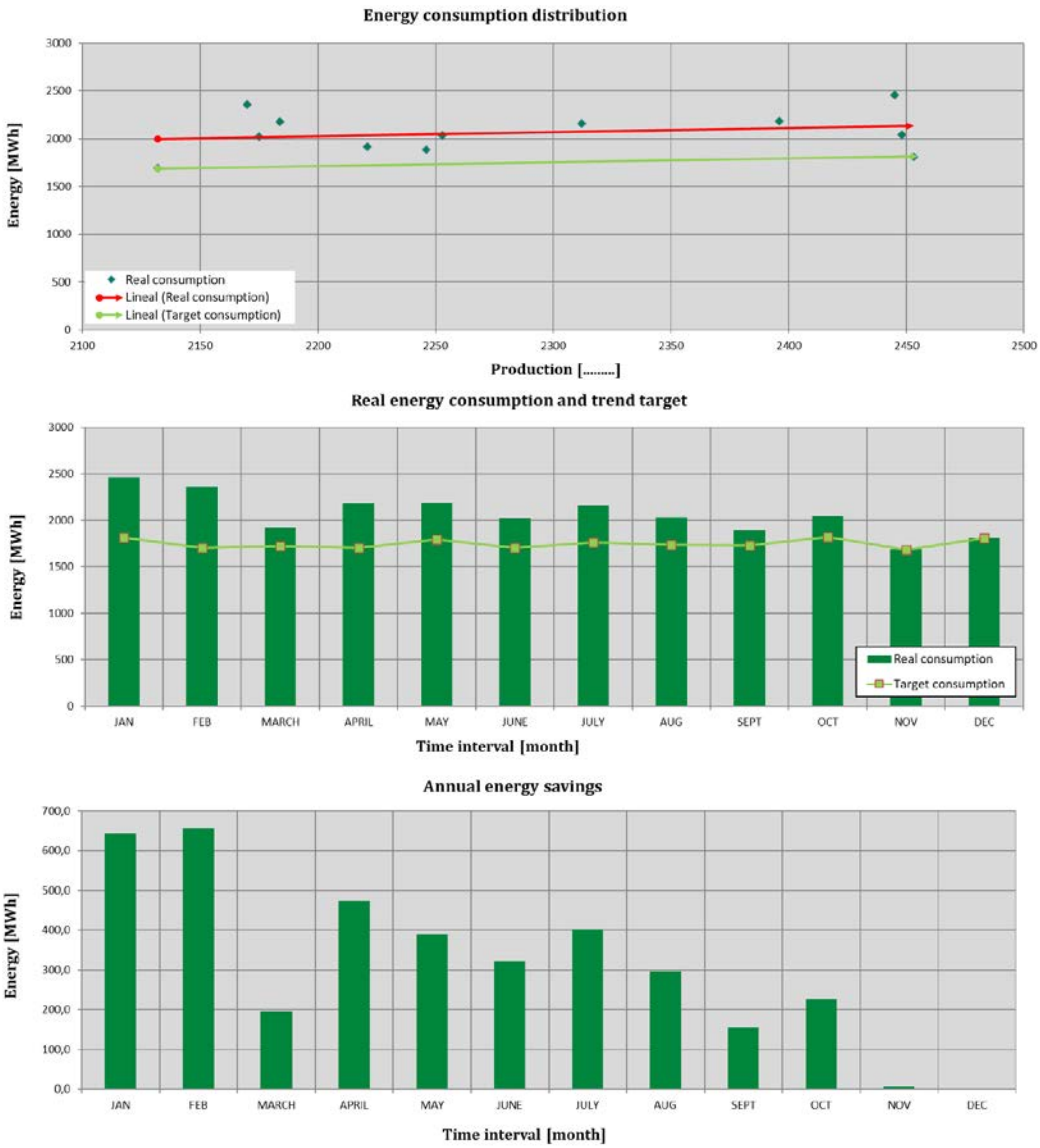


b) After (2019)

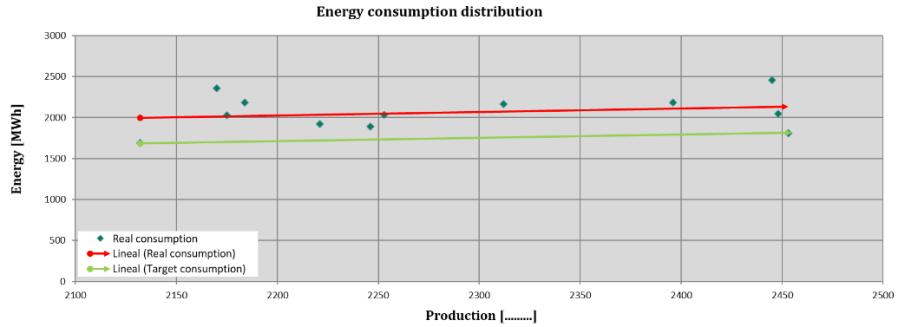
Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	27,435	[Ton]	16,705	[MWh]	120	**752**	**90,245**
Utility type	After the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	30,500	[Ton]	18,565	[MWh]	115	**610**	**70,150**

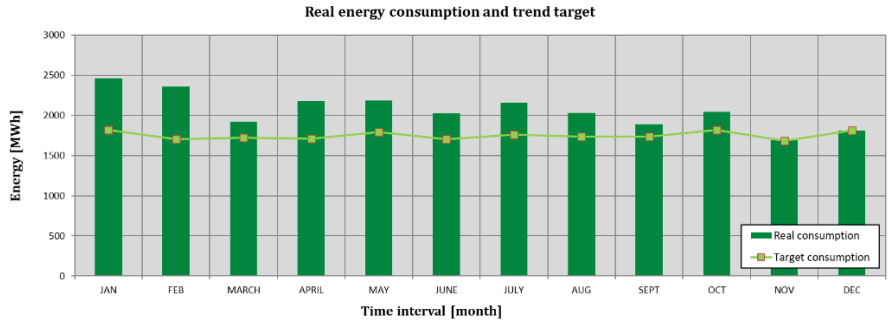
Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use				Total energy use				
	0.6	[kWh/[...]]			16,705	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation							0.0	[MWh/yr.]
	Specific energy use				Total energy use		Achieved cost savings		
	0.6	[kWh/[...]]			18,565	[MWh/yr.]		0	[euro/yr.]

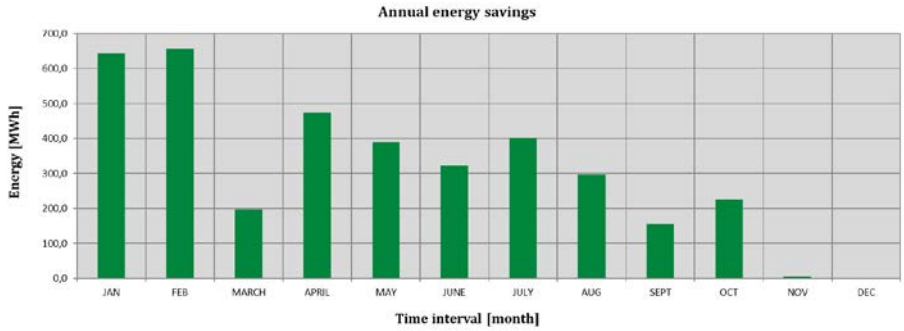
Gas-related data for the years 2018 and 2019 using the tools developed in the SMEmPower project are presented below:



a) Before (2018)







b) After (2019)

Utility type	Before the energy efficiency implementation							Potential energy savings - M&T	
	Interval analysis		Production		Energy		Unit price		
	Start	Stop	Value	U.M.	Value	U.M.	[euro/MWh]	[MWh/yr]	[euro/yr]
Energy	JAN	DEC	27,435	[Ton]	27,623	[MWh]	55	**4,482**	**246,536**
Utility type	**After the energy efficiency implementation**							**Potential energy savings - M&T**	
	Interval analysis		**Production**		**Energy**		**Unit price**		
	Start	**Stop**	**Value**	**U.M.**	**Value**	**U.M.**	**[euro/MWh]**	**[MWh/yr]**	**[euro/yr]**
Energy	JAN	DEC	30,500	[Ton]	27,623	[MWh]	45	**4,525**	**203,607**

Measured and verified achieved energy saving									
Utility type	Before the energy efficiency implementation								
	Specific energy use				Total energy use				
	1.0	[kWh/[...]]			27,623	[MWh/yr.]	Achieved energy savings		
Energy	After the energy efficiency implementation							3.1	[MWh/yr.]
	Specific energy use				Total energy use		Achieved cost savings		
	0.9	[kWh/[...]]			27,623	[MWh/yr.]		139	[euro/yr.]

4.7.7.6. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Support mechanism	Energy savings and efficiency strategy, action plan

4.7.7.7. Energy management plan

Energy management plan: Propose organizational & behavioral advices based on the identified needs.

- Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;
- Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;
- Periodic renegotiation of the price for electricity and methane gas is recommended.
- Labeling and keeping up to date of equipment labels and departures from electrical switchboards;
- Monitoring of energy quality indicators, so possible problems can be identified in advance;

4.8. United Kingdom

4.8.1. Pilot site 1

4.8.1.1. Current situation

The pilot site is a small, family run company with two employees working from home.
Our main activity is advising organizations on the development of professions and definition of occupations. Most of the time we are based at home, but we have a branch independently existing overseas and occasionally that requires us to travel overseas. These days we conduct most of our contracts for our overseas clients and we use a variety of online technology - mostly Zoom, to coordinate with widely dispersed team of experts.

Most of the time we spend online working on our laptops, there is no “production” involved in our processes. We used to travel a lot but it is no longer possible.

The business premises are an end of terrace semi-detached and was built in 1958. It used to be a council house with 4 bedrooms, two stories and a loft. It has been bought by the previous owner and modernized by her and by us when we bought it in 2015. The house is built with brick with cavity which has already been insulated. All of the windows on the ground and first floor are PVC double glazed, there is an addition of a porch which encloses more space and creates an additional separation area.

List of upgrades we have made is as follows:

- Loft conversion – north side of the double slope roof was lifted to 11 degree angle creating dormer window. Loft was fitted with triple glazed windows with U-Value 0.7 W/(m^{2}K) on the north side, three roof lights on the south side and insulated all over with 10cm of insulation. Former loft became a bedroom and a bathroom. The entire house is now 3 stories high with 4 bedrooms and a study, 3 bathroom, kitchen and a large sitting/dining room.
- We have installed 16 solar panels generating power (4 on the South, sloped roof and 12 in the North almost flat roof). We had one failure of inverters, which is reflected in lack of data for a period of time in the summer 2019.
- We also had to replace the concrete slab under the house as the material used originally – it was “red ash” which made the concrete crack so it needed to be removed to avoid further damage. We have replaced that with an insulating membrane and new concrete slab which works as thermal mass – we have decided to invest in under floor heating (water based) as we use the house during the day and that creates comfortable ambiance for work and living.
- To improve air circulation around the house – we have installed MVHR which takes the air from the kitchen and bathrooms and recovers heat warming up the inflow of air coming from outside, blown to bedrooms.
- We have applied 10 cm of rockwool on all three available sides of the house
- We have insulated walls between our house and neighbors (in the cavity) and added 10cm of insulation on the top level of the house where our loft conversion would share a wall with empty loft in the neighboring house.

- We have removed internal walls – especially the one which had two fireplaces back to back – we don't have a chimney in our house. Air circulation is conducted through MVHR.
- Our recent addition to green measures at home is addition of a battery installed in March 2020.
- We try to opt for energy efficient appliances in the kitchen including an induction hob which is quick and cheap (the only equipment which uses gas is a combi-boiler, which provides hot water for taps and under-floor-heating in the winter).
- At the moment we are on an agile price contract with our electricity supplier.

4.8.1.2. Energy usage

Table 263 below shows the combined heat demand of the building from 2018 to 2020.

Table 263 Combined heat demand of the building from 2018 to 2020.

	2018				
	Gas	**Electricity**			
Month	Consumption (total annual) [kWh]	Generation (from **PV**) [kWh]	Import (from **Grid**) [kWh]	Export (PV to Grid) [kWh]	Consumption [kWh]
January	-	41.301	260.77	10.285	291.786
February	-	104.87	208.59	38.07	275.39
March	-	229.48	184.35	132.88	280.95
April	-	325.45	156.47	220.4	261.52
May	-	631.29	110.74	484	258.03
June	-	687.41	91.88	520	259.29
July	-	707.52	94.78	557	245.3
August	-	476.48	91.04	377.34	190.18
September	-	300.99	116.2	214.63	202.56
October	-	119.55	200.51	54.13	265.93
November	-	51.32	197	14	234.32
December	-	36.72	274	4	306.72
Annual gas use	9,694				3,071.976
Total Annual Heat demand	**Annual Gas demand + Electricity demand**				12,765.976

Table 264 Electricity and methane gas consumption

	2019				
	Gas	**Electricity**			
Month	Consumption (total annual) [kWh]	Generation (from **PV**) [kWh]	Import (from **Grid**) [kWh]	Export (PV to Grid) [kWh]	Consumption [kWh]
January	-	48.97	237.70	9.90	276.78
February	-	108.15	184.26	44.77	247.64
March	-	278.17	177.67	179.78	276.06
April	-	444.12	133.72	317.44	260.40
May	-	541.77	114.43	398.49	257.71
June	-	47.36	222.94	35.00	235.30
July	-	0.00	269.29	0.00	269.29
August	-	0.00	230.93	0.00	230.93
September	-	178.86	162.25	187.94	153.17
October	-	124.56	217.38	48.49	293.45
November	-	52.84	248.51	10.47	290.88
December	-	39.57	305.82	3.05	342.34
Annual gas use	10,556.79	-	-	-	3,133.94
Total Annual Heat demand	Annual Gas demand + Electricity demand				13,690.73

	2020				
	Gas	**Electricity**			
Month	Consumption (total annual) [kWh]	Generation (from **PV**) [kWh]	Import (from **Grid**) [kWh]	Export (PV to Grid) [kWh]	Consumption [kWh]
January	-	44.90	281.26	5.38	320.78
February	-	96.60	221.09	31.81	285.89
March	-	296.09	98.21	59.43	334.87
April	-	536.19	15.38	247.24	304.33
May	-	731.99	2.51	431.05	303.45
June	-	565.30	5.52	271.67	299.15
July	-	528.63	4.89	271.67	261.85
August	-	434.21	14.14	148.09	300.26
September	-	308.11	15.58	68.68	255.01
October	-	145.47	156.25	2.70	299.01
November	-	42.78	286.10	2.17	326.72

December	-	32.74	311.75	2.68	341.81
	4,839	3,763.02	1,412.68		3,633.12
Total Annual Heat demand	Annual Gas demand + Electricity demand				8,472.12
Average Heat demand for 2 years	Year 3 ignored due to incomplete gas readings		-	-	**13228.35**

4.8.1.3. Proposed solution and EE action plan

The three options proposed for the scheme are as follows:

I. Installation of Air-to-water heat pump (ASHP)
II. Installation of ground source heat pump (GSHP)
III. Installation of PV Tree.

Use of heat pumps to maximize energy efficiency of a building is especially suitable under the following conditions (www.greenmatch.co.uk):

1. There is an already existing efficient insulation for the walls, roofs, and floors
2. Wet underfloor heating is already installed
3. Energy generation can be shared with existing Photovoltaics

The building as previously described in section 4.1.1 fulfills these conditions which informed the selection of the options. The selection of air-to-water heat pumps over air-to-air heat pumps better performance of the former because water as a heat-carrying medium can store heat for much longer better than air (www.greenmatch.co.uk). Table 265 below shows the proposed energy efficiency measures based on the estimated investment, savings (both energy and cost), simple payback period, net present value (NPV – in GBP) and internal rate of return (IRR – in %).

Underlying assumptions used in developing the proposed heat pump alternatives

The underlying assumptions below informed the figures obtained for the computation in Table 265.

- Energy demand for the building is augmented with generation from existing photovoltaics.
- The heat pumps will only be used for space heating while existing condensing combi boiler will meet hot water demands for the building
- The combi boiler is 90% efficient (https://energysavingtrust.org.uk/)
- The ASHP has a CoP of 3.0 https://energysavingtrust.org.uk/)
- The GSHP has a CoP of 4.0 https://energysavingtrust.org.uk/)
- Hot water demand is 3.488kWh/day/person (www.greenmatch.co.uk)
- Carbon intensity for domestic gas is 0.215 $kgCO_2$ (www.designbuildings.co.uk)
- The price of solar panels (https://tradesmencosts.co.uk/solar-panels/)
- Design of solar tree (https://archello.com/project/smart-solar-tree-in-ludbreg-with-tem-modular-sockets-and-usb-charger)

- The price of Electricity (https://www.energyswitching.co.uk/uk-electricity-prices-per-kwh-2021/)
- Carbon emission, PV Panels energy production (https://www.renewableenergyhub.co.uk/)
- The ASHP will benefit from the Domestic Renewable Heat Incentive (RHI) for the first 7 years which is £1,856/year (https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi)
- The GSHP is eligible for RHI (£1,856 for 7 years) and the Green Homes Grant scheme (lesser of 2/3 of installation cost or £5,000) (https://www.gov.uk/guidance/apply-for-the-green-homes-grant-scheme)
- Energy bills are assumed constant over the lifespan of the heat pumps.

Table 265: Proposed Solutions and EE Plan for the alternatives

Proposed solutions & EE action plan							
Proposed solution - description	**Investment**	**Energy saving Type:**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[GBP]	[kWh /year]	[GBP/year]	[tons eq. CO_2/year]	[years]	[GBP]	[%]
Use of Air Source Heat pump for underfloor heating	10,000	5,046.07 **(gas)**	42	1.08	5	-551	8.00
Use of Ground Source Heat pump for space heating	30,000	5,676.82 **(gas)**	137	1.22	6	-6,066	2.00
Installation of PV Tree	10,000	3,800 **(Electricity)**	875.14	14.4	9-12	-1,869.38	7.00

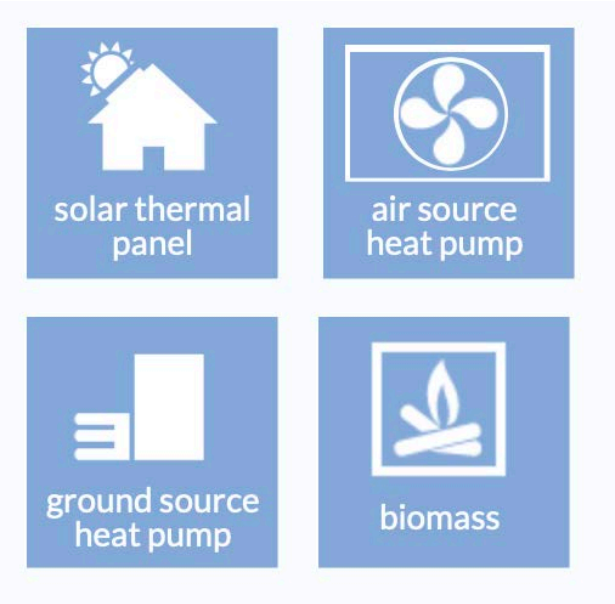
Table 266 below shows how the KPIs from table were obtained.

Table 266. Indication of how KPIs were obtained

KPI	U.M	Calculated	Estimated
Investment	GBP		X
Energy saving	MWh	X	
Cost saving	GBP	X	
CO_2 emission	tons eq.	X	

4.8.1.4. Financial resources

Financial sources (national, international grants from which the proposed solutions can be financed): enumeration of financial schemes, grants which are suitable for the proposed solutions and for the analyzed SMEs;

Type	Description
Domestic Renewable Heat Incentive	Types of heating You can claim for: - biomass boilers - solar water heating - certain heat pumps Payments are made for 7 years and are based on the amount of renewable heat made by your heating system.  www.ofgem.gov.uk/environmental-programmes/domestic-rhi/applicants
Project 3D (Birmingham and West Midlands)	*Data to help Decarbonise in a Decade* Grants up to £10K criteria will be announced soon www.cse.org.uk/projects/view/1374

4.8.1.5. Energy management plan

Energy management plan actions:

- *Explore the possibility of decarbonising completely by using the heat pump for hot water as well as space heating.*
- *GSHP effectively provides annual heat storage in the ground: heat that is removed during winter is replenished by solar gain during the summer. By using a horizontal 'slinky' under the*

paved lane beside the house, maximum solar gain will be achieved. Alternatively a vertical borehole GSHP could be shared with adjacent properties.

- *Explore the use of a reversible heat pump to provide cooling during summer months.*
- *Explore the use of hydrogen to provide annual heat storage: use the excess PV power to generate hydrogen by hydrolysis during the summer months, and use the hydrogen to generate electricity from a fuel cell during winter months.*
- *Monitoring and training of staff on the impact of their energy behavior, through specific training, information and awareness actions;*
- *Initiation of a system of rewards / bonuses for employees who propose / apply energy efficiency measures;*
- *Use Agile pricing in combination with electric battery storage to ensure that electricity is drawn from the grid at times when the price is lowest (even negative). This helps load spreading, peak reduction and cost reduction;*
- *Periodic renegotiation of the price for electricity and gas is recommended.*
- *Labeling and keeping up to date of equipment labels and departures from electrical switchboards;*
- *Monitoring of energy quality indicators, so possible problems can be identified in advance;*

4.8.2. Pilot site 2

4.8.2.1. Current situation

A small business that comprises of little private eco campsite and lodge located in Southwest of Wales. The eco campsite and lodge is in a smallholding in the Welsh countryside surrounded by hills and beaches. The business is run on a sustainable environmental and ethical basis. Over the last 10 years, the business has carried out steps to reduce their carbon footprint gradually and so that their visitors enjoy a low carbon holiday.

The business uses green electricity tariff and solar water heating (SHW) system combined with a Rayburn wood fuelled heating system for heating and hot water. The SHW is a three panel system, so that it can be utilised throughout the whole year. In Winter, the SHW heats the water to a warm temperature before getting heat from the Rayburn. The use of wood before and after the SHW installation was measured, and it was found that after the SHW installation, the use of wood decreased by 50%. There is also an immersion into the hot water tank, but it is only used once or twice a year, maximum. There are therefore three sources of energy for the hot water tank: three coils: the bottom is solar, mid-Rayburn, top immersion. The Rayburn is a multi-fuel stove with nine radiators. Most of the fuel is locally sourced wood; however, coal is usually used in the Rayburn when it is exceptionally cold weather and cloudy/night time. Yearly, around 50 x 10 bags are used, accounting for (0.65 kg x 500) 325 kg CO_2 per year. That is the only use of carbon fuel, but it is more efficient than using it in other ways as it is directly used in the Rayburn. There is also a small wood burner in the snug used instead of the Rayburn both in Autumn, spring, and sunny days in Winter when the solar is working.

There are three different types of construction in the site and the office building/residence; a solid wall, which was the original 1840's stonewalled construction lodge, it has dry lining insulation but little roof insulation. Shutters have been installed in the two-rooms, and in the shower room insulation has been added to the walls, roof, and floor. As it is a small room it does not require heating. The shower is a venturi shower (uses mains water pressure) so does not use electricity. The two extensions consist of a flat-roofed extension and pitch roof. Cavity wall insulation was installed in the walls and pitch roof. All the rooms have oakwood flooring, except the kitchen, which is tiled. The most significant issue and loss of heat are from the heating system laid by the previous owners. Bare pipes were directly laid on the concrete underneath the wood floors, therefore the concrete floor absorbs the heat before it reaches the radiators. In colder seasons the concrete floor absorbs most of the heat. All the system pipes meet in the hallway, therefore, by insulating the pipes in that area, the time taken for the radiators to heat up was reduced from nearly two hours to an hour or less. Since insulation installation is a costly and disruptive process, insulation in other areas still needs installing. The business hopes to insulate other places in the future.

On site there are three glamping units all off grid, "Cabin A", "Cabin B", and "Cabin C" which is a converted horse lorry. All three have PV systems for lighting, however, B's and C's are larger systems with battery and could operate more than lights, but it is only used for lighting, as customers cannot be relied on to curb their usage. B Cabin's PV is smaller as there is quite a bit of tree cover around the cabin so only really space for small panel and battery with lights for the toilet and kitchen sheds.

Measurements and wood burners for the Cabins and lorry are:

- A - largest is 7m by 5m and the wood burner is 5kW.
- B - is 6.4m x 4.6m and the wood burner is 7.5kW.
- C - is 5.48m x 2.43m and the wood burner is 4kW.

- As above, all three units have wood burners, and the wood supply comes from locally sourced suppliers.
- All three have either compost or caravan style toilets (using biodegradable fluid). On-site, there are three compost toilets.
- The showers for each of the units are at the top of the site (marked S). There is also a 4th shower for campers.
- Two additional showers were constructed due to COVID-19 restrictions.
- Each shower is heavily insulated so they can be used in all weathers as the units are rented throughout the year. The unit comprises of small heaters on frost setting for pipework just in case for Winter but not for space heating.

4.8.2.2. Energy usage

The electrical energy consumption for 2017, 2018, 2019 and 2020 is show in Table 267.

Table 267: 2017-2020 Energy Consumption - Electricity

Energy consumption Electricity				
	2017	**2018**	**2019**	**2020**
Month	Consumption [KWh]	Consumption [KWh]	Consumption [KWh]	Consumption [KWh]
January	515	523	421	445
February	496	245	248	274
March	644	723	513	781
April	621	622	539	952
May	530	848	491	993
June	602	602	422	881
July	612	630	594	812
August	653	650	613	801
September	595	568	688	600
October	520	325	331	550
November	432	432	452	442
December	562	580	509	421
TOTAL	**6,782**	**6,749**	**5,721**	**7,952**

Figure 122 shows the electrical energy consumption described in Table 267 in form of a bar chart.

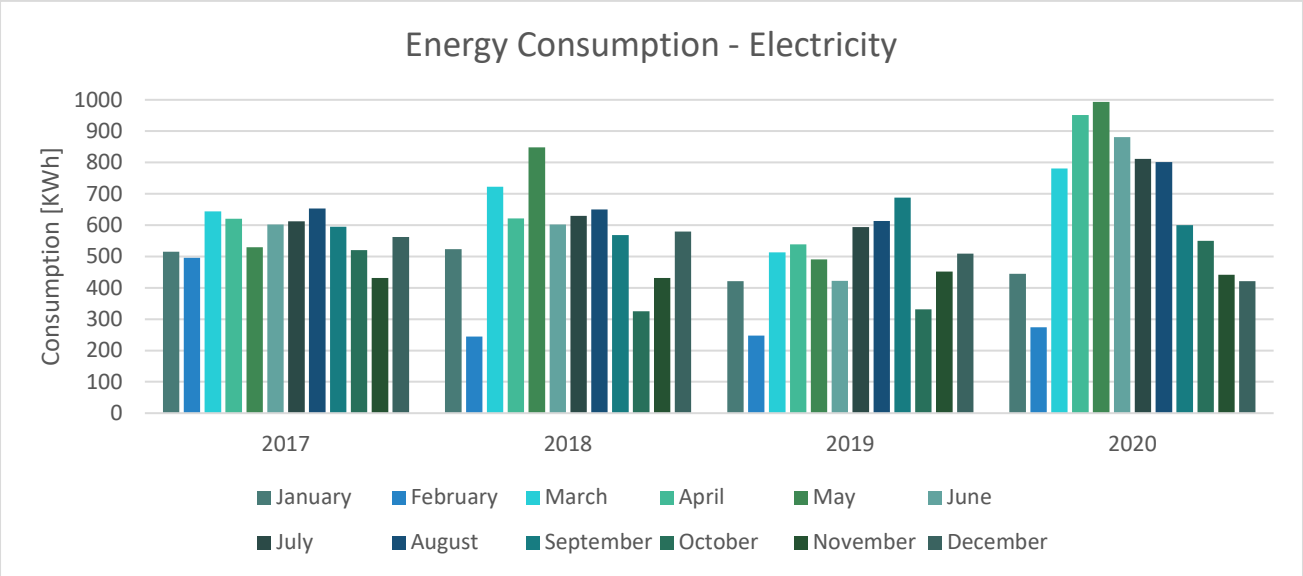


Figure 122: Summary of Electrical Consumption

Electricity consumption has been monitored since 2009, with a reduction over time due to insulation, installation of SHW and other measures. All lights are low energy or LED (mainly LED). LED are also used for the Solar PV systems.

The Energy Consumption shown on the bar chart demonstrates a typical year which is 2019 for consumption. 2017 and 2018, work was being carried out on site, mainly the refurbishment of the new horse lorry unit. 2020 shows the impact of CoVid19 with the highest recorded use of electricity since the business began in 2008. This is due to works being carried out to add facilities and other measures for CoVid19.

The wood consumption has been recorded from September to August next year. Summary of wood consumption is as illustrated in Figure 123. A reduction in the usage of wood in 2017-18 can be seen, this is due to summer 2018 hot weather and use of own wood supply from coppicing and fallen tree. The owners have planted a small coppice of willow and planted a variety of trees including a new orchard further down on the site.

Figure 123: Wood Consumption 2016-2020

4.8.2.3. Proposed solution and EE action plan

The lodge is a Green Keys accredited site (green tourism accreditation run by Keep Wales Tidy https://www.keepwalestidy.cymru/greenkey) since 2009. The energy and environmental assessment for the Green Keys accreditation (reviewed on an annual basis) indicates:

- **Main impacts** - No major impacts, visual amenity the site is hidden from the road by hedges and trees. All activities rely on some or all the following resources: mains electricity is sourced from a 'green' energy supply, heating from wood for the bungalow. Property has mains water although rainwater is harvested around the bungalow for crops use, water is discharged to a soakaway pit.
- **Commitment to pollution prevention** - The Owners seek to use natural, recycled, or low impact products where possible and appropriate. There are no polluting processes conducted at the site. All waste is sorted before the weekly refuse is put out for collection.
- **Energy Use** - The Energy use of the site and its impact on the environmental are integral to the sustainable approach. Heating and electricity are kept to a minimum, heating is from sustainable wood supplies via a wood burner and rayburn/solar heating system. The use of energy will be managed as effectively as possible all steps will be undertaken to keep energy use to a minimum

including, using all white goods as efficiently as possible: washing machine, dishwasher, microwave, cooker, and others. When not in use all equipment will be switched off and not left in standby mode. All equipment currently owned is at least a 'B' rated appliance and any that needs replacing will be replaced with same.

The proposed solutions in Table 268 describe the possible measures that can be implemented to reduce energy use and increase efficiency. Table 269 provides the KPI estimations for the proposed solutions.

Table 268 Proposed solutions

Proposed solutions & EE action plan							
Proposed solution - description	**Investment**	**Energy saving Type:**	**Cost saving**	**CO_2 emission reduction**	**Payback period**	**NPV**	**IRR**
	[GBP]	[KWh/year]	[GBP/year]	[tons eq. CO_2/year]	[years]	[GBP]	[%]
Silicone Wall insulation	600	24	460	0.8	3	489.30	45
DIY Solar installation	7,000	213	2,125	-	5	1,985.88	14
Cellular glass pipe insulation or foam glass insulation[1]	400	8	150	0.52	3	8.49	6

[1] https://www.foamglas.com/en-us/download

Table 269 KPI estimation

KPI	U.M	Calculated	Estimated
Investment	GBP		£8,000
Energy saving	KWh		245
Cost saving	GBP		£2,735
CO_2 emission	tons eq.		1.32

4.8.2.4. Financial resources

The identified possible financial sources are as described in Table 270.

Table 270 Financial resources

Type	Description
On-street Residential ChargePoint Scheme (ORCS) (OZEV / OLEV)	OZEV can fund up to a maximum of £13,000 per charge point installation, where connection costs are high. Evidence of high connection costs will be required where applicants apply for over £7,500 per charge point. OZEV will now pay 75% of any successful bid upfront, while the remaining 25% can be claimed on completion of the project. All capital costs associated with the installations must be individually evidenced.
Business Fund for Non-Domestic Rate Grant (Tourism Grants)	Grant 1: £4,000 cash grant payment for hospitality, tourism and related supply chain businesses, including some retail businesses with Small Business Rate Relief (SBRR) qualifying hereditaments with a rateables value of £12,000 or less. Grant 2: £5,000 cash grant payment for hospitality, tourism and related supply chain businesses, including some retail businesses occupying hereditaments with a rateables value between £12,001 and £500,000. Businesses registering for the first time will be asked to self-declare whether they have experienced a 40% reduction in turnover for January 2021 and February 2021 as compared to January 2020 and February 2020.
Pembrokeshire Insulation Grants	Under the scheme, homeowners are set to receive vouchers worth thousands of pounds to help make their properties more energy-efficient and potentially save hundreds on bills each year. According to the Treasury office, the government will cover the cost of at least two-thirds of insulation and other energy efficiency measures up to £5,000. The scheme will fully fund energy efficiency measures of up to £10,000 per household for those on the lowest incomes.

4.8.2.5. Energy management plan

The business already has an action plan and management plan generated for the Green Key accreditation and is continuously updated (reviewed by Green Key staff once a year). However, due to the effects of COVID-19 in hospitality businesses, some part of the management plan requires adapting to the current situation considering the current restrictions. The management plan illustrated in Table 271 has been adapted from the previous management plan. The energy-related and other actions have been updated to the current situation.

Table 271 Management plan

Criteria	Objective	Action	Date complete
Environmental Management	Highlight the green keys project to our visitors	As well as displaying the green key award and explaining the projects aims, add to information packs for cabins and lorry	End of November 2018/ongoing
Staff Involvement	The owners will continue to improve their knowledge and network across the local area to promote the eco work	To attend at least 4 local events and any relevant training opportunities	June 2019
	Continuous learning and training on energy efficiency measures.	To attend at least 1 energy efficiency webinars and 5 hours of personal research.	June 2022
Guest Information	Improve the guest information on the surrounding area	Look to update all the guest information on walks, events etc. Highlight local markets There is no central guest information at present folders are provided for each unit/group. Information is kept to a minimum due to CoVid19, i.e., difficult to predict availability and also need to keep paperwork to a minimum for health and safety.	Review March 2022
Water	Continue to monitor the water use and continue to improve on the use of recycled grey water	Divert gutter water from Cabin B to fruit trees.	End of Sept 2021
Ecology	Provide further diversification for habitats on site	Orchard trees fruit numbers improving require Winter trimming. Ad hoc planting of wildflowers has been taking place, need to focus on identified areas around Cabins and horse lorry. Also improve pond area at horse lorry.	Yearly management and improvements/trimming review Nov 21.

Waste	Strive to increase the recycling amounts up to 80%	Continue to engage with visitors informing them of the 80% target. Separate nappy and composting bins are working well, require additional ones for busy season in summer. CoVid19 has meant that each unit/group are provided with a set of bins and instructions so they sort and keep separate all their waste i.e. there is no central collection point	Review March 2022
Energy	With the increase in site use of the cabins out of season, aim to keep the wood and energy use at 2015 amounts or lower.	Continuous monitoring and analysis of energy use and energy use behaviour. Update energy use spreadsheets regularly.	Monthly
	Fair cost of energy	Periodic renegotiation of the price for electricity and wood.	–
	Labelling the equipment and appliances.	Check and update equipment labels and departures from electrical switchboards on a yearly basis.	Yearly
	Monitoring of energy quality indicators so possible problems can be identified in advance	Analyze and determine power quality of energy systems.	Every 2 years
	Covid19 had a large impact on the energy use for the site in 2020, mainly due to increase in facilities i.e. no longer any shared facilities for any customers. Measures included increase number of showers and taps on site.	Difficult to predict the electricity use increase over time due to new facilities this will require monitoring once all improvements have been completed, by the end of 2021.	Continuously monitor for next 2 years
	Due to increase in EV vehicle use the owners wish to install an EV charge point, there is a financial cost to this so the impact	A grant source was identified for an EV charge point this will be pursued and determine when a charge point will be installed.	Research grants and cost of EV system End of September 2021

	of Covid19 on the business in 2021 will effect when the business can afford to install this. It will also depend on availability of grants.		
Food & Beverage	Promote local suppliers	Review the information to visitors on where to purchase organic and seasonal veg. Promote own surplus veg to visitors. Increase number of chickens to sell surplus eggs to visitors Due to CoVid 19 no longer supplying to visitors.	Review March 2022
Environment	To enhance the wildlife flowers around the site	Add in cut flower/wildflower beds in growing area and next to horse lorry	ongoing
Green Activities	Promote activities in the local area	Ongoing updates for the information area and cabins. Look where possible to involve visitors in own growing plots Due to CoVid 19 no longer engaging visitors	Ongoing Review March 2022
Administration	Review environmental management policy	Review monitoring and assess energy and other impacts during 2021	Nov and February 2022

4.8.3. Pilot site 3

4.8.3.1. Current situation

- The company is an insulation installation/contractor company. At present, there is only one staff member working at the company in a home office. The main business is energy conservation using thermal insulation. One of the services the company offers is 'TIPCHECK' (Technical Insulation Performance Check) which is an energy audit where energy wastage due to lack of insulation due to poor maintenance / incorrect application in existing buildings is calculated. Following this, remedial action is recommended, or we make recommendations for new-build assets at FEED or EPC phase, or on a bespoke basis. The company is licensed to conduct TIPCHECK audits by the EiiF (European Industrial Insulation Foundation);

- As the company is currently operating from a domestic dwelling the following assignment is based on data provided by Teesside University, and is focused on the Clarendon building.
- Built in 1973, Clarendon Building is part of a block of buildings at Teesside University campus that are managed by a single owner. According to (Sylvia Breukers 2019) the net floor area of the building is 5562.63m^2 with an energy use intensity (EUI) of 182.71 kWh/m2/yr. (Sergio Rodriguez 2017). Under normal operating conditions it is occupied by 1040 people comprising of staff and students. The building has two chillers which are enabled on demand against temperature conditions and time schedule. Additionally, there are four air handling units (AHU) which are also enabled on demand. Both the AHU's and chillers are on record to have been installed in 1998. However, one of the chillers was replaced in 2016 at the time of the implementation of the DR-BOB project.
- The building is operated using a centralized Satchwell Sigma building management system (BMS). The system is intended to adapt effortlessly to the shifting demands of buildings thus making it flexible to work with new advances in technology (Electric 2008). Furthermore, the system is equipped with control and visibility which allows for historical data extraction and analysis. Strategies such as plant operation mode, zone control, logging and even alarms are integrated into the user interface. Importantly, Satchwell Sigma BMS conforms to the CEN TC 247 standards which stipulate definitions, requirements, functionality, and test methods of building automation systems.

4.8.3.2. Energy usage

Clarendon building uses both gas and electricity as power sources. According, to the energy use data for gas and electricity collected for the years 2019 and 2020, there was a significant drop in electricity consumption from 515.18 MWh to 395.87 MWh respectively. Whilst the gas consumption dropped from 86.92 MWh to 83.07 MWh (see Table 272). Not only was the gas consumption drop not as significant as the electricity consumption drop, from August to December the consumption for 2020 was notably higher than that of the previous year. This peculiarity will perhaps require further investigation by the facility management team to determine its causes.

Due to the DR-BOB project carried out between 2016 and 2019 the building underwent optimization of the scheduling. Consequently, the pre-COVID consumption figures reflected in the 2019 dataset, are actually representative of the lowest levels of energy consumption that the building can achieve with the current building fabric (Sergio Rodriguez 2017). Accordingly, the 2020 levels of energy consumption are only demonstrative of the effect that the pandemic has had on the normal operation of the building.

Table 272 2019 and 2020 energy consumption data.

Energy consumption Clarendon building				
	2019	**2019**	**2020**	**2020**
Month	Electricity Consumption [MWh]	Gas Consumption [MWh]	Electricity Consumption [MWh]	Gas Consumption [MWh]
January	49.14	13.41	45.63	12.29
February	47.95	10.57	43.56	12.65
March	49.06	11.38	38.20	9.19
April	40.87	8.08	18.12	0.09
May	41.19	5.52	17.47	0.09
June	37.53	3.51	16.85	0.09
July	40.45	1.15	20.55	0.14
August	37.45	0.55	28.52	0.91
September	41.96	3.34	33.51	3.76
October	47.93	8.92	48.81	14.66
November	45.05	11.59	49.12	17.33
December	36.61	8.91	35.53	11.88
TOTAL	**515.18**	**86.92**	**395.87**	**83.07**

4.8.3.3. Proposed solution and EE action plan

As Clarendon building has already been retrofitted with a BEMS already, the objective of this action report therefore is to present a proposal of an energy efficiency plan to ensure that future purchasing, retrofits and daily management, all support best practices in energy efficiency. The building is a mixture of teaching spaces and staff offices; hence, it can be argued that the major end use equipment is mostly for the thermal comfort of the occupants. Energy consumption is essentially a function of 'use' of power over time, conversely power is equipment oriented therefore any equipment related proposal would require capital injection. Thus, within the framework there needs to be an alignment of the useful life of equipment and budgetary allowance for timely retrofitting.

With regards to the time portion of energy consumption, time is basically an operations-oriented activity in which case soft measures will have to be employed when executing the action plan. Accordingly, activities such as periodic assessment of equipment run-time schedules, systems monitoring; data loggers, submetering, software programs updating will be incorporated into the

organizational policy framework. Further recommended actions to be employed in the practical action proposal include the following:

- Setting up of metrics to assign responsibility to a single energy manager. This measure does not negate the existence of a facility management team it merely places accountability to a single point of contact.
- Revision of previous temperature set points for occupied and unoccupied spaces, including a function for seasonal thermostat setting adjustment, to suit new occupancy schedules due to COVID.
- Closing of doors and windows when HVAC systems are in operation.
- Provision of on demand water heating, where hot water storage system is still in use within the building.
- Setting up of mandatory shut down procedures for end of day and vacation time to be managed by the facilities team and applicable to all staff.

Lastly, it is proposed that a framework for future purchasing to include specification of efficiency levels of new equipment be drafted by the building owners. Renovation and retrofits should also include addendums to standard contract documents to ensure that efficiency level requirements for new installations are part of the client's expectations to be met by service providers.

4.8.3.4. Financial resources

As the business has already invested in energy efficiency measures, through the DR-BoB project, it will benefit from the UK government's 'capital allowances on energy efficient items' scheme. The resulting cost savings accrued from the tax reduction can then be put aside for future retrofitting projects which may include replacement of equipment that has reached the end of its useful life (Table 273).

Table 273 Financial resources

Type	Description
Tax incentive:	**Capital allowances on energy-efficient items** Businesses can claim capital allowances when they buy energy efficient, or low or zero-carbon technology for their business. This reduces the amount of tax you pay.

4.8.3.5. Energy management plan

In conclusion, based on the findings of this action plan, it is recommended that the organization adopt the following proposals to ensure the effectiveness of the measures employed in Clarendon building:

- The installed BEMS needs to be maintained, as per manufacturers specs, to ensure optimal functionality and keeping up with system improvements through updates.
- Training and programs for employee awareness, to be availed and possibly be made mandatory, in order to improve end-user's responsiveness and thus encourage a reduction of energy consumption in the building.

- Regular energy audits using standardized guidelines to ensure consistency in data collection and analysis to be done (Augenbroe and Park 2005, Pérez-Lombard, Ortiz et al. 2009, ISO 2018, Vergerio, Becchio et al. 2018, Geraldi and Ghisi 2020).
- Implementation of predictive maintenance; this is a data driven degradation modelling technique used to approximate the trend of facility performance degradation and assume the ideal maintenance policy that reduces the overall operational, maintenance, or repair cost. (Himeur, Alsalemi et al. 2021, Mariano-Hernández, Hernández-Callejo et al. 2021, Xie, Lu et al. 2021)
- Solution based applications, (Hauge, Thomsen et al. 2011, Yan, O'Brien et al. 2015, Wei, Xia et al. 2020)

To this end, should all these measures be incorporated into the existing facility management plan, continued optimal building energy efficiency will be achieved during the building lifecycle.

4.8.3.6. References

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4.8.4. Pilot site 4

This section provides the results from the technical report developed by the group composed solely of post-graduate students. The report is based on the theoretical case study, using data from Teesside University's Clarendon building.

4.8.4.1. Introduction for data and current situation

- Building energy use is a key consideration in energy efficiency and building management. The Clarendon Building is one of Teesside University's buildings, and it hosts lecture events and student services. Due to their unique set of specifications, energy conservation in commercial buildings presents a difficult challenge. Numerous challenges come with managing the energy of a university building, including class schedules, faculty availability, and classroom space.

Table 274 Energy consumption

Energy consumption				
	2019	**2020**	**2019**	**2020**
Month	Electricity Consumption [MWh]	Electricity Consumption [MWh]	Gas Consumption [MWh]	Gas Consumption [MWh]
January	49.14	45.63	13.41	12.29
February	47.95	43.56	10.57	12.65
March	49.06	38.20	11.38	9.19

April	40.87	18.12	8.08	0.09
May	41.19	17.47	5.52	0.09
June	37.53	16.85	3.51	0.09
July	40.45	20.55	1.15	0.14
August	37.45	28.52	0.55	0.91
September	41.96	33.51	3.34	3.76
October	47.93	48.81	8.92	14.66
November	45.05	49.12	11.59	17.33
December	36.61	35.53	8.91	11.88
TOTAL	**515.18**	**395.87**	**86.92**	**83.07**

Table 274 above shows the average electricity and gas consumption from January 2019 to December 2020. Internal or external temperature, as well as building activity and dormancy periods, all affect energy consumption. In 2020, as compared to 2019, the consumption of electricity and gas decreased. Gas consumption in the winter increased compared to the summer. A heating system will be used extensively throughout the winter. Many factors, in addition to the external environment, may affect the internal temperature. Due to Covid 19 the university closed the Clarendon building from April 2020 onwards. Covid 19 Lockdown and vacation time have also affected energy usage. This is reflected in the reduction of energy use in 2020 as compared to 2019.

4.8.4.2. Proposed solution and EE action plan

Solar Thermal Collectors

Installation of solar thermal collectors to provide hot water for the building - Solar thermal systems heat water by absorbing heat from the sun, and they can replace other energy sources such as natural gas and electricity. As compared to traditional water heating using a gas, oil, or electrically heated boiler, a commercial installation of 43m2 ETL specified glazed flat plate collector with an annual yield of 350kWh/m2 could save the following annually (Table 275).

Table 275 Proposed solution – solar thermal collector

	Solar thermal replacing gas boiler	Solar thermal replacing electric water heating
Fuel savings (£/yr.)	390	1,340
Energy saving(kWh/yr.)	15,000	12,000
Carbon Dioxide Savings(kgCO_2e/yr.)	2,760	4,220
Payback period	20 Years	6 Years

1. **Lighting**

Modern lighting options such as T5 fluorescent tubes or LEDs, Dimmable fittings and various building infrastructural updates can enhance energy conservation.

- High frequency T5 Fluorescent tubes can save up to 45% of the energy cost as compared to older light systems.
- LED can save up to 90% of the energy saving as compared to traditional lamps.
- Dimmable fittings are now available with LED light which operates in accordance with the daylight sensor switch and automatically dim to emit less light thus it consumes less energy when natural light levels increase.
- The effective use of natural light by installing double glazed skylights will reduce the usage of artificial lighting.
- Effective installation of reflectors will direct the light to specified areas which can improve the efficiency up to 20%.

2. **Office equipment**

- Replacing old monitors, desktop PCs with Laptops provides a flexible working environment. Laptops emits less amount of heat and thereby result in better efficiency.
- Replacement of any cathode ray tube (CRT) monitors with modern flat screen technology. They will reduce monitor running costs by at least 50% and are less damaging to the eyes.
- Printers play an important role in any office and educational facility. The number of printers available should be checked to see if the use of common commercial printers is viable, instead of using a number of printers in each office. Also, it is important to check the age of the printer and replacing it with more efficient versions, which can reduce energy consumption.
- Fridges/ freezers should be purchased according to energy ratings. If old equipment is being used, their energy rating should be checked to see if they should be upgraded to newer more energy efficient models.

4.8.4.3. Financial resources

As Clarendon building is a part of Teesside University, it receives income from diverse sources: students, business, government, charities and from both domestic and international sources. Through careful and responsive financial management, universities use this income to:

- Deliver an outstanding learning experience to students, with high quality teaching.
- Generate world-class research.
- Maximize their contribution to the economy and society

Universities' income is affected by government policies on the system of undergraduate and postgraduate student funding, and funding for research and innovation. Therefore, these policies need to consider their impact on the long-term financial sustainability of universities.

4.8.4.4. Energy management plan

The following actions are proposed for the energy management plan:

- Raise environmental consciousness among students, staff, and all those with whom we interact, as well as the consequences of energy generation and consumption.
- Maximize the use of renewable energies and on-site production of energy.
- Increase energy efficiency and create a smart energy network; ensure that environmental and energy best practices are fully considered and implemented in all new construction and renovation projects.
- Maintain a legal registry and conduct effective monitoring and audits to ensure compliance with all relevant environmental legislation and other criteria.
- Work to recognized environmental and energy standards such as 'ISO 50001' to continuously develop processes and procedures, as well as set annual goals and targets.
- Develop a Purchasing Policy that encourages the use of products and services that are less energy and carbon intensive, and more environmentally friendly, and socially responsible.
- A review of environmental and energy efficiency should be included in an annual Environmental Report.
- As part of an overall sustainability policy, Teesside University is committed to responsible energy and water management. The Environmental Sub-Committee is charge of updating the energy policy and strategy and monitoring implementation and progress against annual goals.

4.8.4.5. References

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5. Analysis of the evaluation reports

In the report, the main KPIs are highlighted at almost each pilot site:

- Size of investment [Euro]
- Energy saving from the proposed measure [MWh/year]
- Cost saving from the proposed measure [Euro/year]
- CO_2 reduction from the proposed measure [Tons CO_2. Eq./year]
- Paypack period of the measure

In the following figure, another KPI (KPI1) is introduced for analyzing globally the proposed measure: investment for one tone of CO_2 reduction per year.

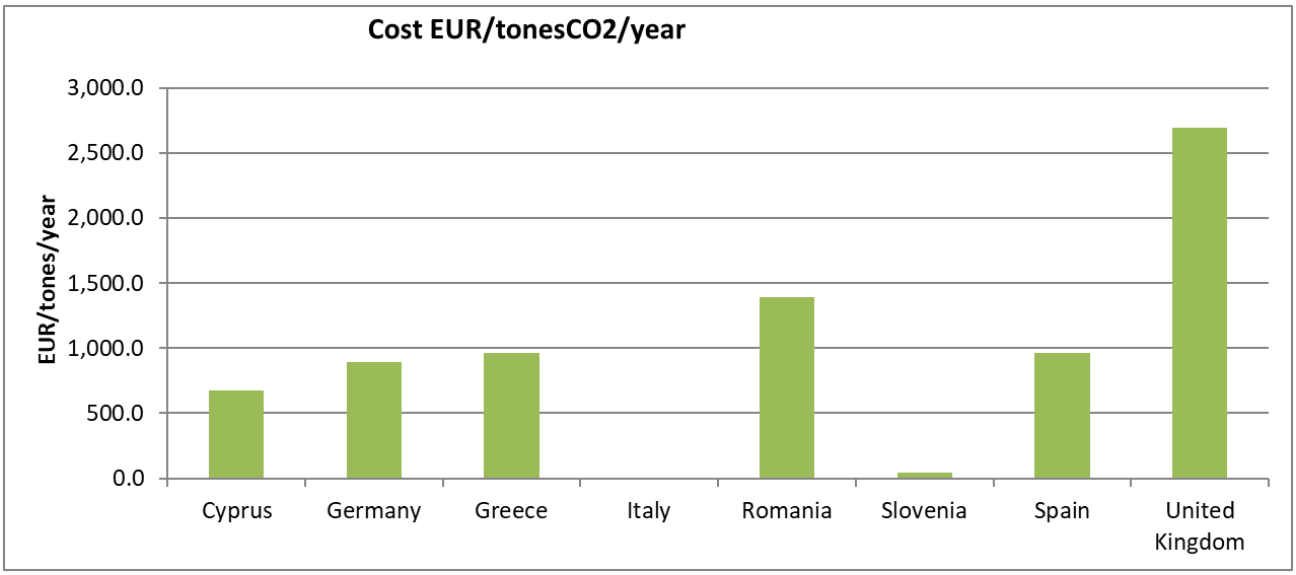


Figure 124 Investment for one tone of CO_2 reduction per year

The figure shows that some countries (United Kingdom, Romania) proposed investments with low reduction of CO_2 emissions. Note that some countries did not calculated the CO_2 emission KPI (Italy) and some did not include it for all pilots (Greece, Romania, Slovenia, United Kingdom). Also, in some cases the investment in Euro was missing.

Similarly, another KPI was calculated based on the Investment for one MWh energy reduction. The results are shown in the following table, and figure, respectively.

Table 276 Investment for one MWh energy saving per year

No.	Country	Investment/MWh saved
		EURO/MWh
1	**Cyprus**	473.8
2	**Germany**	475.0
3	**Greece**	52.4
4	**Italy**	287.3
5	**Romania**	455.3
6	**Slovenia**	379.6
7	**Spain**	127.7
8	**United Kingdom**	1,610.8
	AVERAGE	482.7

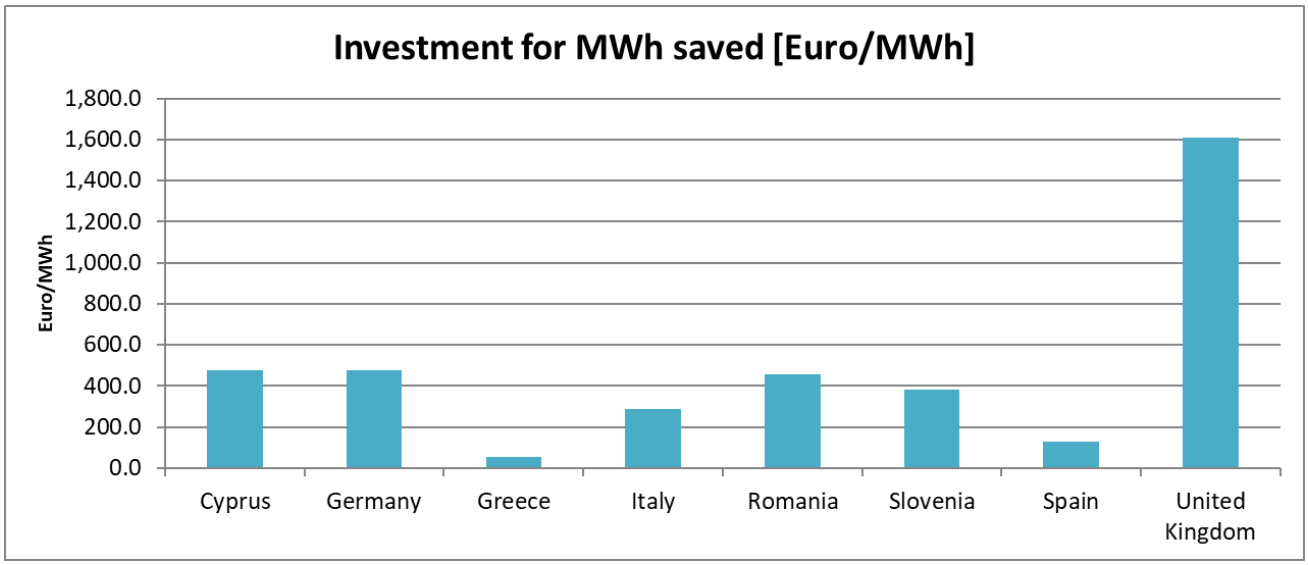
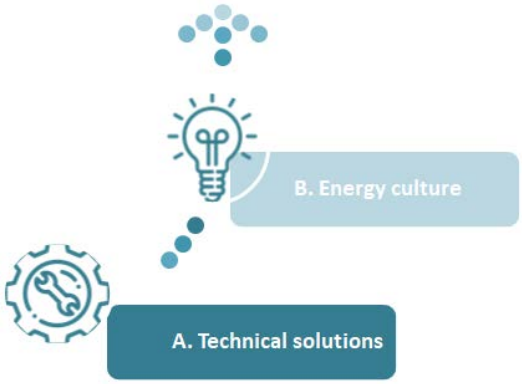


Figure 125 Investment for one MWh energy saving per year

Note that not all the pilots have the investment included or the energy saving concluded for the proposed measures.

6. Conclusion

The first stage of SMEmPower Efficiency's training program encountered more than 269 trainees with various professional backgrounds and 50 SMEs as pilot sites. Based on a rigorous energy assessment procedure, the students have successfully developed comprehensive future energy action plans which contain the financial effort, required for the investment, the energy savings considering MWh/year and Euro/year units, the CO_2 emission reduction, and the payback period. Based on analysis processes two categories of solutions and future actions can be highlighted, as follows:



A) Technical solutions (renewable energy technologies and direct energy efficiency solutions)

On one hand, adopting energy efficiency technical solutions and implementing renewable energy technologies will provide immediate benefits for the SME and the planet which can be easily quantified in both financial savings and reduction of CO_2 emissions. Several such solutions have been identified by the students:

- BMS systems
- Pilots sites and action plan
- Biogas generators
- Cogeneration units
- Lighting system retrofit with LED technology
- Lighting control systems
- Air compression machines
- State of the art electrical machines

B) Improvement the energy culture of the company

On the other hand, it was discovered that at the level of SME employees' indirect energy efficiency improvements can be achieved through implementing energy organizational culture measures. In this regard, the SMEmPower consortium highlights several best practices implemented among the pilot sites, based on the students' assessments and conclusions:

- Training and energy culture actions: yearly training for employees on climate and energy efficiency;
- Include climate and energy efficiency criteria when choosing upstream and downstream partners;
- Employees are encouraged to suggest improvements in energy efficiency and other environmentally impactful areas;
- Increasing the use of climate-friendly production inputs;
- Suppliers and service providers are chosen based on strict environmental standards;
- Greater decision-making power to the energy/environmental management officer;
- Work with suppliers to reduce carbon footprint of supply chain.

In Table 277 the aggreagated energy efficiency measures' KPIs are presented:

- Total proposed investments;
- Total proposed energy savings;
- Total proposed cost saving;
- Total CO2 emission reduction;
- KPI1 – Investment per ton CO_2 reduced;
- KPI2 – Investment per MWh saved.

Table 277 Aggregation of the proposed energy efficidncy measures and their KPIs

No.	Country	Number of SMEs	Total proposed investments	Proposed total energy savings	Proposed total cost savings	Proposed total CO2 emission reduction	Investment/Ton CO2	Investment/MWh saved
			[EURO]	[MWh/year]	[EUR/year]	[tones eq. CO2/year]	Eur/ton CO2	EURO/MWh
1	**Cyprus**	5	2,494,018.0	5,264.2	1,029,018.9	3,706.0	673.0	473.8
2	**Germany**	7	549,408.0	1,156.7	182,573.0	614.9	893.4	475.0
3	**Greece**	5	263,704.0	5,036.7	96,859.0	272.8	966.6	52.4
4	**Italy**	5	1,541,585.0	5,364.9	476,409.7	*	*	287.3
5	**Romania**	7	1,462,909.0	3,213.1	100,886.0	1,048.0	1,395.9	455.3
6	**Slovenia**	9	607,853.0	1,601.3	164,943.0	13,370.0	45.5	379.6
7	**Spain**	7	2,713,220.0	21,244.5	1,585,366.0	2,815.6	963.6	127.7
8	**United Kingdom**	4	67,280.0	41.8	6,402.0	25.0	2,691.2	1,610.8
	TOTAL	49	9,699,977.0	42,923.0	3,642,457.8	21,852.3	443.9	226.0

*Data was not available or was not calculated.

List of figures

List of tables