

AENEAM

Agri-food Efficiency with New Energy Audit Measures

Energy Audit Methodology Agri-food sector

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The AENEAM project aims to accelerate the transition of the EU agri-food industry towards a sustainable growth model by increasing the uptake of recommended measures from energy audits. The project will encourage companies, mainly SMEs, to undergo energy audits and subsequently implement the recommendations from these audits, promoting digital solutions.

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List of acronyms

| Abbreviation / acronym | Description |
|-------------------------------|---|
| AENEAM | Agri-food Efficiency with New Energy Audit Measures |
| WP | Work Package |
| BAT | Best Available Techniques |
| BREF | Best available techniques Reference document |

COMMON AUDIT METHODOLOGY FOR DETERMINING POTENTIAL ENERGY SAVING MEASURES IN SMEs OF THE AGRI-FOOD SECTOR APPLICABLE AT EU LEVEL

(NACEs 10 and 11)

1. Introduction

The aim of this document is to provide a common methodology for carrying out energy audits based on the European standard EN 16247, at EU level, but adapted to the partner countries and to the specificities of SMEs of the MMA subsectors, NACE Rev. 2 codes C10 and C11 corresponding to.

C10: MANUFACTURE OF FOOD PRODUCTS

C11: MANUFACTURE OF BEVERAGES

2. Energy audit definition, aims and fields application

2.1. Industrial energy audit, definition

An Energy Audit is defined as the inspection and systematic analysis of energy use and consumption in a location, building or organization, to identify and report on the energy flows, the factors that affect said consumption and the potential for energy efficiency improvement.

The Audit is the tool which allows companies to be aware of the situation regarding the use of energy and the energy consumption improvement potential.

2.2. Objectives of the energy audit

The main objective of an energy audit is to reduce energy consumption and costs associated with it, analysing the causes and factors affecting such consumption, without affecting the production or the quality of the service.

Therefore, with the energy audit we will achieve the following objectives:

- To obtain reliable knowledge of the energy consumption of the company and the cost, identifying the factors that influence the energy consumption and introducing energy performance indicators.
- To detect and evaluate the different opportunities for energy saving.

2.3. Scope of the energy audit

To define the scope of the energy audit is one of the most important initial tasks, because it will indicate the objects to be audited and the degree of detail that can be achieved.

In our case, the Energy Audit will comprise the production processes of the company, processes meaning all necessary steps to manufacture a product or provide a service. The audit will also include at least 85% of total energy consumption.

Therefore, the Audit will have to include the following analysis:

- Analysis of the energy supply system (electrical substation, fuel supply systems, renewable energy systems)
- Energy analysis of the equipment and/or operations of the productive process.
- Energy analysis of the auxiliary systems (production of heat and cold, compressed air systems, lighting systems, air extraction systems, combined heat and power generation).
- Analysis of energy cost (type of energy and billing)

3. Definitions

To understand better this document, we present a review of the most common energy terms.

Energy Audit: Inspection and systematic analysis of energy use and consumption in a location, building, system or organization with the aim of identifying and informing about the energy flow and the potential for improvement of energy efficiency.

Energy Auditor: Person or group of people and organization that carries out energy audits.

Audited object: Building, equipment, system, process, motor or service to be audited.

Organization: Person and institution that has, uses or manages the audited object or objects.

Energy consumption: Quantity of energy applied.

Energy efficiency: ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy.

Energy performance: measurable results related to energy efficiency, energy use and energy consumption.

Energy performance indicator (EnPI): Quantitative value or measure of energy performance, as defined by the organization.

Energy performance improvement action (EPIA): action or measure or group of actions or measures implemented or planned within an organization intended to achieve energy performance improvement through technological, managerial or operational, behavioural, economical, or other changes.

Energy use: Application of energy.

Significant energy use (SEU): Energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement.

Energy balance: Accounting of inputs and/or generation of energy supply versus energy outputs based on energy consumption by energy use.

Static factor: Identified factor that significantly impacts energy performance and does not routinely change (facility size, design of installed equipment, number of weekly shifts, range of products, etc.).

Relevant variable: Quantifiable factor that significantly impacts energy performance and routinely changes (weather conditions, operating conditions, etc.).

Energy: Electricity, fuels, steam, heat, compressed air and other similar media.

Energy management system (EnMS): Management system to establish an energy policy, objectives, energy targets, action plans and process(es) to achieve the objectives and energy targets

Energy target: Quantifiable objective of energy performance improvement.

Energy performance improvement: improvement in measurable results of energy efficiency, or energy consumption related to energy use, compared to the energy baseline.

Energy baseline (EnB): quantitative reference(s) providing a basis for comparison of energy performance.

Energy audit scope: Extent of energy uses and related activities to be included in the energy audit, as defined by the organization in consultation with the energy auditor (can include several boundaries).

Production process: All steps necessary to manufacture a product or provide a service.

Utility: Energy carrier necessary for the process and auxiliary.

Utility process: Set formed by the related equipment to the energy carrier and the distribution of said carrier.

System boundary: Boundary that includes within it all areas associated with the audited object (both inside and outside the audited object) where energy is consumed or produced.

Building: Construction as a whole, including its envelope and all technical building systems, for which energy may be used to condition the indoor climate, to provide domestic hot water and illumination and other services related to the use of the building and the activities performed within the building.

4. Energy auditor

The energy auditor must be suitably qualified (in accordance with local guidelines and recommendations or as defined in EN 16247-5:2015). Specifically for the countries involved in AENEAM project, based on following conditions:

FRANCE

Skills required:

- Auditors must demonstrate their ability to carry out energy audits in accordance with recognized standards (such as EN 16247).
- They must have in-depth knowledge of energy management, industrial energy systems and the relevant production processes.

Experience and training:

- Auditors must have significant and relevant experience in the energy field, including practice in carrying out energy audits.
- They must also undergo continuous training to keep abreast of the latest technologies, methods and regulations.

ITALY

General Requirements from UNI CEI EN 16247-5:2015. The energy auditor must demonstrate adequate education, work experience, and training that enable them to perform

an energy diagnosis. The competence of the energy auditor must be based on the combination of the following elements:

- Education contributing to the development of knowledge and skills in technical disciplines and sectors in which the energy auditor intends to operate;
- Work experience in a relevant technical, managerial, or professional position involving evaluation exercises, decision-making, problem-solving, and communication with managers, professionals, colleagues, clients, and other stakeholders;
- Training or experience in energy diagnoses acquired under the supervision of an energy auditor with appropriate skills in the same discipline or sector. The energy auditor must create and maintain a record of their technical skills and knowledge.

In Italy, as of July 19, 2016, energy diagnoses required by Legislative Decree No. 102 must be conducted by either Expert in Energy Management (UNI CEI 11339) or ESCo, Energy Service Company, (UNI CEI 11352) certified by accredited organizations. No other entities are specified by Legislative Decree No. 73 of July 14, 2020.

Qualifications to attain Expert in Energy Management status necessitate degrees, courses, or diplomas recognized or deemed equivalent to Italian standards. Candidates must demonstrate professional experience involving technical and/or managerial responsibilities in energy management. Relevant experiences include roles within consulting firms, independent consultancy work, feasibility study preparation, educational program design, and project management.

POLAND

The Energy Efficiency Act (consolidated text of October 14, 2021) specifies who may conduct energy efficiency audits in Poland.

An energy efficiency audit can only be prepared by a person who:

1) has at least two years of professional experience in the operation, service or assembly of a given type of technical equipment or installations, or in the operation or service of a given type of facilities covered by an energy efficiency audit,

or

2) completed:

a) higher education studies resulting in obtaining a professional title of MSc, MSc Engineer or an equivalent title confirming higher education at the same level,

or

b) postgraduate studies – whose program includes issues related to energy, electrical engineering, energy efficiency, energy audits of buildings, energy-efficient construction or renewable energy sources.

SPAIN

- a) Be in possession of an official university degree or other university degrees, or master's degrees that certify basic knowledge of energy, building installations, industrial processes, energy accounting, measurement equipment and data collection and energy saving techniques, or;

- b) Have theoretical and practical knowledge about energy audits, by owning a professional training degree or a professional certificate that includes subjects related to energy audits or work experience in this field.

5. Process of energy audit

To carry out an energy audit is considered important to proceed with the following seven stages:

1. Preliminary contact and initial meeting with the company.
2. Data collection.
3. Preliminary analysis.
4. Field work.
5. Energy analysis.
6. Decarbonization.
7. Report and final meeting.

5.1. Preliminary contact and initial meeting with the company

Once the company has decided to proceed with the energy audit, the first step is to arrange a meeting between the auditor and the company and establish the scope of the audit.

The Auditor will explain what an audit consists of and will ask for preliminary information to set the basis for preparing and organizing the work to be done later.

Moreover, the company will appoint a person responsible for the audit who will be in contact with the auditor to supply him with the information required during the process.

At this meeting agreement will be reached on the period and the planning of visits for the audit, as well as special requirements and safety where necessary to install measuring equipment.

At this first meeting the company shall provide a description of the company and its production process and the auditor will request preliminary information necessary for planning later works.

If possible, agreed will be reached with the company on energy performance indicators.

5.2. Data collection preliminary

A questionnaire for the collection of preliminary data has been prepared as set out in Annex I.

This questionnaire includes:

- General data of the company
- General data about raw materials, production, and mode of operation. (Monthly production over the last year).
- Description of the productive process and block diagram.

- General energy data (monthly consumption, power supply contracts and invoices over the last 12 months of every energy supply: electricity, including self-consumption, fuels, and other energy sources).
- Quarter-hour annual electricity load curve.
- Inventory of the process and auxiliary services equipment that consume energy (description, installed power capacity, operating conditions, energy consumption, existence of specific energy counters, established maintenance plan, revision, etc.).
- Building information regarding its energy characteristics:
 - Thermal envelope.
 - Normal operating and occupancy conditions.
 - Thermal comfort conditions.
 - Lighting comfort conditions.
 - Indoor air quality.

If possible, the company will be requested to present single-wire schemes of the installation and drawings with the different locations of existing counters, electric and non-electric, general and specific.

A factory plan with location of different manufacturing divisions and auxiliary services would be useful for the audit process.

5.3. Preliminary analysis

The data collected in the previous phase will be evaluated in the preliminary analysis. To this end, the following actions will be contemplated:

- Starting with the total energy consumption, shown in the bills or energy invoices, an energy distribution will be carried out, identifying systems and equipment of higher energy consumption. Tables and charts of energy distribution will be made, including absolute and percentage data and graphs of consumption throughout the period being considered.
- Energy performance indicator(s) and relevant factor(s) will be established.

An energy performance indicator (EnPI) is a crucial indicator for performance in relation to use, consumption and energy efficiency. An EnPI is a quantitative value which measures and gives information about the energy performance inside the organization.

The relevant factor is a quantifiable parameter that significantly impacts energy performance and routinely changes. Relevant factors are, for example: production, weather conditions, light level, working hours of a machine and its temporary uses, etc.

The most common EnPI in the industrial sector is:

Total energy consumption / equivalent unit of production

In accordance with the different Commission Implementing Decision (EU) establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the different subsectors that cover this project, the EnPI's proposed are the following:

Table 1: Indicators by subsectors

| Subsector | Indicator | Regulation |
|---|--------------------------------------|--|
| Animal feed | MWh/tonne of products | Commission Implementing Decision (EU) 2019/2031 of 12 November 2019 establishing best available techniques (BAT) conclusions for the food, drink and milk industries, under Directive 2010/75/EU of the European Parliament and of the Council |
| Brewing | MWh/hl of products | |
| Dairies | MWh/tonne of raw materials | |
| Fish and shellfish processing | MWh/tonne of products | |
| Fruit and vegetable sector | MWh/tonne of products | |
| Grain milling | MWh/tonne of products | |
| Meat processing | MWh/tonne of raw materials | |
| Oilseed processing and vegetable oil refining | MWh/tonne of oil produced | |
| Soft drinks and nectar/juice made from processed fruit and vegetables | MWh/hl. of products | |
| Starch production | MWh/tonne of raw materials | |
| Sugar manufacturing | MWh/tonne of beets | |
| Slaughterhouses | kWh/tonne of carcasses kWh/animal | Commission Implementing Decision (EU) 2023/2749 of 11 December 2023 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU on industrial emissions, for slaughterhouses, animal by-products and/or edible co-products industries |
| Installations processing animal by-products and/or edible co-products | kWh/tonne of raw materials | |

Depending on the numerator and denominator many different variations can be obtained:

Total electrical consumption / equivalent unit of production

Total thermal consumption / equivalent unit of production

Energy consumption of a single production line or equipment or installation / equivalent unit of production of the same production line or equipment or installation

Other indicators can be:

Total electrical consumption per unit of surface

Total electrical consumption per employee

Electrical consumption in lighting per unit of surface

Electrical consumption in lighting per unit of surface and per hours of working

Electrical consumption in lighting per employee

Thermal consumption for heating per unit of surface

Thermal consumption for heating per unit volume.

Thermal consumption for heating per day-degrees

The indicator that best suits the specificities of the audited company will be chosen.

- If possible, an energy baseline will be established. There will be a baseline for each indicator of energy performance adopted.

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

Saving = consumption according to baseline – real consumption

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

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

The form of the equation is of the type:

$$y = a + bx$$

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

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

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

To determine that the relation between "x" and "y" is significant and the baselines are correct it is necessary to take into account the R value which marks the degree of association between the dependent variable and the independent. A value greater than 0,85 is taken as valid.

As said previously, an energy baseline represents the energy behaviour in a determined period of time, therefore, to set the energy baseline and for these to be representative, the monthly energy data consumption and the independent variable from the last year (12 months) will be used.

- Data collection and subsequent measurements will be planned.

In the event that the previously obtained data were not coherent or had to be completed in order to identify and evaluate the opportunities of energy saving, the method to be used will be determined.

The different methods for obtaining these data are:

- Measurements: Carrying out in situ measurements with portable equipment.
- Calculations: by means of the power of the equipment and the equivalent time of use.
- Estimates: made from historical data, experience, studies, etc.

5.4. Field work

Once the preliminary analysis is done and in the event that more data are needed to carry out the energy analysis, in situ measurements will be made. To do this, it may be necessary to use measuring equipment such as:

- Combustion analyser
- Thermometers
- Air flow measurement devices
- Flow meter
- Portable power analyser
- Multimeter
- Clamp meter
- Light meter
- Infrared camera

In Annex II there is a description of the equipment.

When work is carried out that requires the manipulation of equipment and/or elements of the company such as boilers, electrical panels, compressors, etc., the company will designate those operators who have adequate training and can carry out the tasks. Corresponding measurements reliably and under conditions that are as representative as possible of normal operation.

In the case of the placement of equipment necessary for measuring electrical parameters such as portable power analyzer, multimeter, clamp meter, etc., whenever possible, it will be considered that operators with the necessary technical and safety training provided by the company will do.

When the company does not have the resources for these measurements and it is up to the personnel carrying out the audit to place this equipment, they must have adequate training, both at a technical level and occupational risks prevention.

5.5. Energy analysis

The energy analysis will include the following:

- *Breakdown of the energy consumption by use and source (both absolute and percentage terms).*

Once the data and energy consumption have been collected, this will be distributed between the different equipment and consuming processes. The following distributions will be obtained:

- Distribution electrical consumption between the different equipment and processes. Both absolute and percentage terms.
- Distribution consumption of each thermic source (natural gas, diesel oil, fuel,...) among the different equipment and processes. Both absolute and percentage terms.

- Distribution total energy consumption between the different equipment and processes. Both absolute and percentage terms.

At the end of this process, the significant energy use (SEU) will be identified, both in equipment and facilities.

- *Making mass and energy balance.*

The mass and energy balance of the equipment or processes which have presented an energy saving potential will be carried out, calculating performance and evaluating energy losses (Sankey diagram).

If possible, the energy consumption when there is no production or activity will be determined.

- *Quantification of energy performance indicators.*

Once energy performance indicators are set, they will be calculated each month for the last year. A monthly graph with the trend over time of these indicators will be a precious tool for a clearer observation of their evolution.

- *Baseline establishment.*

As said previously, a baseline for each energy performance indicator specified will be established.

- *Identification and evaluation of energy efficiency improvement opportunities.*

The analyses carried out in the previous points are preparatory for the main objective of each energy audit:

"To identify and propose energy saving actions"

All recommended measures and opportunities for improvement can be organized into the following categories:

- Decreasing energy losses
- Recovery of energy losses. Use of waste energy
- Replacement of out-dated equipment by other more efficient
- Modifying the operating conditions to improve the efficiency of equipment
- Maintenance improvement
- Thermal envelope of the building improvements
- Changes in staff behaviour
- Improvements in energy measuring and monitoring plan

To propose different energy saving measures, what is indicated in Annex III Energy Saving Measures will be taken into account.

Once the energy saving measures and efficiency improvement have been identified, it is necessary to work out an economic evaluation of each one, so as to guarantee the economic return. The saving and improvement measures will be ordered following this profitability criterion, from a lower rate of return on investment to higher. The procedure described in Annex V will be followed in order to evaluate and order them.

- *Analysis and evaluation of a change in energy sources.*

A study will be carried out to analyse the possibility of changing energy source, both at general level and at specific processes or equipment, whose energy can be supplied from other energy sources or by waste energy recover and/or renewable energy.

To propose different changes in energy sources, what is indicated in Annex IV Alternative energy sources will be taken into account. The procedure described in Annex V will be followed to evaluate and order them.

- *To study tariff changes to lower the cost of energy.*

A study will be made of energy tariffs that are being applied and the possibility of a change in them that may bring about a reduction in energy costs. To do so, both monthly invoices (last year) and supply contracts must be available.

The following ratios must be controlled:

- Average price (€/kWh) = Total amount of invoice (without VAT)/Consumption
- Hours of use = consumption (kWh) / Contracted power (kW)
- Distribution of energy consumption per period in %
- Distribution of energy cost per period %
- Invoicing excess power required or daily flow
- Invoicing excess reactive energy demanded
- Other items of the invoice

The trading companies make offers to the clients to hire the energy supply. The price and kind of offer will depend on the characteristics of the energy consumption of the client (consumers of flat load curves, consumers in valley hours, etc.), so that the trading company can control their costs and risks.

The offers normally include:

- Contract period and validity of the offer
- Power to be contracted, annual consumption hired in energy, expected annual consumption and daily volume of flow in natural gas to be hired
- Treatment of excesses and regulated concepts
- Price structure: single price, price in 3 or 6 periods, indexed price, etc. in electricity and fixed term, unique variable price, indexed variable price, etc. in natural gas
- Price and other terms, for example electricity tax
- Definition of the profile of consumption and penalizations/bonuses
- Price review for subsequent years contracted, conditions for automatic contract renewal and required notice for termination
- Penalties for early withdrawal of the agreement (if applicable)
- Conditions of payment
- Quality of supply
- Measuring and measurement equipment (rental)
- Access to information, i.e. specify if the trading company is required to supply information and what information is available

The description of energy markets is attached in Annex VI as well as different possibilities of hiring.

5.6. Decarbonization

At this point, knowledge of the current environmental status of the company in terms of its energy performance is proposed, which also allows to draw up the implementation plan for energy efficiency measures in order to reduce its energy consumption, a mitigation strategy for its Greenhouse Gas (GHG) emissions.

This strategy could help the company set its decarbonization objectives in the most efficient way possible, in the short, medium and long term in order to:

- Align in the current context of the EU, which has set the goal of having an economy with net zero greenhouse gas emissions by 2050, through the European Green Deal and in accordance with the community's commitment to increasing global climate action, in line with the commitments of the Paris Agreement.
- Remain competitive in the market, with profitability as a key factor.
- Provide knowledge, collaboration and commitment within the value chain.
- Incorporate the "CO₂ cost" into product accounting.

To do this, the following points will be developed in the framework of the energy audit:

- Calculation of the Carbon Footprint in its direct emissions (scope 1) derived from its energy consumption and indirect emissions (scope 2) resulting from its energy supply by third parties (electric energy, steam, hot water, etc.).
- GHG reduction derived from the implementation of the energy efficiency measures and change of energy sources provided for in the audit.
- Proposal of other possible measures such as purchasing green energy, for decarbonization purpose.

5.7. Report

The report will include the following aspects:

- Introduction and applicable regulations
- Objectives, limits and phases of the energy audit
- General data of the company: production and activities
- Description of productive process: Block diagram
- Energy consumption and costs
- Energy facilities (receiving facility, auxiliary and process facilities)
- Energy distribution
- Energy analysis
- Decarbonization
- Good practice
- Summary of savings and investments

Attached in Annex VII is an index and a brief description of each of the aspects to be reflected in the final summary of the Energy Audit.

6. Information sources

For the preparation of this document, the following sources of information have been taken into account, mainly:

- European Standard EN 16247:2022. Part 1, Part 2 and Part 3
- A3E organization. www.asociacion3e.org
- IDAE. www.idae.es

ANNEX I DATA COLLECTION

It is necessary to collect preliminary data to carry out the audit. The template prepared for this is shown below.

| GENERAL DATA OF COMPANY | | |
|---|--|----------------|
| Company name | | |
| NIF (tax number) | | |
| Address | | |
| City | | |
| Region | | |
| Postcode | | |
| Country | | |
| Contact person | | |
| Phone number | | |
| e-mail | | |
| web | | |
| Nace code (2009) | | |
| Activity sector | | |
| Main activity of the company. Description | | |
| Age of the company | | age |
| Number of employees | | people |
| Plant surface | | m ² |
| Annual energy consumption 2023 | | kWh/year |
| Annual energy cost 2023 | | €/year |
| Percentage energy cost over total cost 2023 | | % |
| Production value 2023 | | € |

| OPERATION MODE | | |
|----------------|--|-----|
| Working hours | | |
| Hours / day | | h/d |
| Days / week | | d/w |
| Days / year | | d/y |
| Hours / year | | h/y |

PRODUCTION DATA

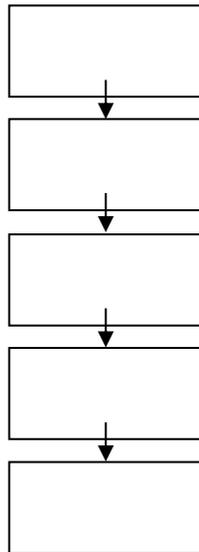
| | | 2023 | | | | | | | | | | | | |
|-----------------------|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|-------------------------|
| Type of raw materials | Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Annual consumption 2023 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

| | | 2023 | | | | | | | | | | | | |
|--------------------------|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------------------|
| Type of finished product | Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Annual production 2023 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

DESCRIPTION OF PROCESS

Description of manufacturing process:

Process diagram: Block diagram with the most important operating phases of the manufacturing process



ENERGY SOURCES

IMPORTANT NOTE:

It is essential that the company provide the contract and energy bills over the last 12 months. One of the points of energy analysis will be energy billing. A possible change in the energy tariff will be studied to obtain a lower cost of energy.

NATURAL GAS

Energy distribution company:

Energy supplier company:

Main uses:

Type of tariff

Supply pressure

Consumption range

| | 2023 | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

DIESEL

Energy supplier company:

Main uses:

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

OTHER

Energy supplier company:

Main uses:

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

HARD COAL

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Energy supplier company:

Main uses:

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

HEATING OIL

Energy supplier company:

Main uses:

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

ELECTRICAL ENERGY

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Energy distribution company:

Energy supplier company:

Main uses:

Type of tariff

Voltage

Contracted power

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| Power max. | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

BIOMASS

Energy supplier company:

Type of biomass:

Main uses:

Net Calorific Value (NVC) kWh/Kg

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

BIOFUELS

Energy supplier company:

Type of biofuel:

Main uses:

Net Calorific Value (NVC) kWh/l

| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

PHOTOVOLTAIC SOLAR ENERGY

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Type of installation (alone or grid-connected)

Main use:

Rated power photovoltaic plant (kW)

Pick power photovoltaic plant (kWp)

Rated voltage (AC) (V)

Grid connection (single-phase or 3-phase)

Type of photovoltaic modules

Number of photovoltaic modules

Number of inverter

| | 2023 | | | | | | | | | | | | |
|---------------------------------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| Expected electricity production (kWh) | | | | | | | | | | | | | |
| Actual electricity production (kWh) | | | | | | | | | | | | | |
| Performance Ratio | | | | | | | | | | | | | |

THERMAL SOLAR ENERGY

Main use:

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Total surface area of solar gain (m²)

Thermal maximum power (kW)

Total accumulation volume (m³)

| | 2023 | | | | | | | | | | | | |
|--|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| Thermal energy demand (kWh) | | | | | | | | | | | | | |
| Energy covered by solar thermal collectors (kWh) | | | | | | | | | | | | | |
| Average solar fraction | | | | | | | | | | | | | |

GEOTHERMAL ENERGY

Type of installation (low, medium or high temperature):

Main use:

| | 2023 | | | | | | | | | | | | |
|---------------------------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| Thermal energy production (kWh) | | | | | | | | | | | | | |
| Electricity consumption (kWh) | | | | | | | | | | | | | |

TOTAL ENERGY CONSUMPTION

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| 2023 | | | | | | | | | | | | | |
|--------------|---------|----------|-------|-------|-----|------|------|--------|-------|------|------|------|------------|
| Type of unit | January | February | March | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Total 2023 |
| kWh | | | | | | | | | | | | | |
| EUROS | | | | | | | | | | | | | |
| c€/kWh | | | | | | | | | | | | | |

| ENERGY PERFORMANCE INDICATORS (EPis) | | | |
|--------------------------------------|-----------------------|-----------|-------|
| INDICATORS | | | |
| Nº | Energy use identified | Indicator | Units |
| | | | |
| | | | |
| | | | |

PROCESS EQUIPMENT - AUXILIARY FACILITIES

| FLUID PRODUCTION (STEAM, HOT WATER) | |
|--|--|
| Functional description | |
| Type of generator: | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€/year) | |
| Brand: | |
| Model: | |
| Capacity of equipment | |
| Technical efficiency | |
| Safety pressure: | |
| Working temperature: | |
| Regulation type | |
| Equipment control | |
| Maintenance | |
| Maintenance description | |
| Comments | |

| | |
|---|--|
| STEAM DISTRIBUTION (LAGGING AND LEAKAGE) | |
| Comments | |
| CONDENSATE RECOVERY (IF APPLICABLE) | |
| % Recovery: | |
| Network condition (lagging and leakage): | |
| Comments | |

PROCESS EQUIPMENT - AUXILIARY FACILITIES

| FURNACE | |
|-------------------------------|--|
| Functional description | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€/year) | |
| Brand | |
| Model | |
| Power | |
| Type | |
| Capacity of equipment | |
| Technical efficiency | |
| Process time | |
| Cycle/day | |
| Working temperature | |
| Material per cycle | |
| Regulation type | |
| Equipment control | |
| Maintenance | |
| Maintenance description | |
| Comments | |

PROCESS EQUIPMENT - AUXILIARY FACILITIES

| COGENERATION (CHP) | |
|---------------------------------|--|
| Functional description | |
| Type of instalation: | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€/year) | |
| Brand: | |
| Model: | |
| Electrical power (kW) | |
| Electrical efficiency (%) | |
| Electrical generation (kWh) | |
| Self-consumed electricity (kWh) | |
| Heat recovered_gases (kWh) | |
| Heat recovered_water (kWh) | |
| Maintenance | |
| Maintenance description | |
| Comments | |

PROCESS EQUIPMENT – AUXILIARY FACILITIES

| COOLING SYSTEMS | | |
|------------------------------------|------------|--|
| Functional description | | |
| Cooling systems production | | |
| Cooling capacity (kW): | | |
| Characteristics of the compressor: | Type | |
| | Brand | |
| | Model | |
| | Power (kW) | |
| Type of energy consumed | | |
| Energy consumption (kWh/year) | | |
| Energy cost (€/year) | | |
| Capacity of system | | |
| Technical efficiency | | |
| Regulation type | | |
| Equipment control | | |
| Condensation system | | |
| Maintenance | | |
| Maintenance description | | |
| Comments | | |

AUXILIARY SERVICES

COMPRESSED AIR

| | | |
|--|--|--|
| Functional description | | |
| Type of compressors (piston engine, screw engine, etc.) | | |
| Characteristics of compressors: | Brand | |
| | Model | |
| | Power (kW) | |
| | Working pressure (bar) | |
| | Functioning conditions (loaded, empty) | |
| Type of energy consumed | | |
| Energy consumption (kWh/year) | | |
| Energy cost (€/year) | | |
| Capacity of equipment | | |
| Technical efficiency | | |
| Network pressure (bar) | | |
| Regulation type | | |
| Compressors control | | |
| Maintenance | | |
| Maintenance description | | |
| Comments | | |

| AUXILIARY SERVICES | |
|--|--|
| AIR CONDITIONING | |
| Functional description | |
| Heating system | |
| The heating system (Fan heaters, Radiant tube heaters, etc.) | |
| Power and characteristics of the heating equipment. | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€/year) | |
| Capacity of equipment | |
| Technical efficiency | |
| Regulation type and Equipment control. | |
| Working temperature. | |
| Maintenance | |
| Maintenance description | |
| Comments | |

| | |
|--|--|
| Cooling system | |
| Cooling system (Air conditioning, heat pump equipment, etc.) | |
| Power and characteristics of the cooling equipment. | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€/year) | |
| Regulation type and Equipment control. | |
| Working temperature. | |
| Maintenance | |
| Maintenance description | |
| Comments | |

| AUXILIARY SERVICES | |
|---|--|
| DOMESTIC HOT WATER | |
| Functional description | |
| Domestic Hot Water system (Natural Gas Boiler, Electricity Accumulators, etc.) | |
| Power and characteristics of the Domestic Hot Water equipment. | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€) | |
| Capacity of equipment | |
| Technical efficiency | |
| Regulation type and Equipment control. | |
| Working temperature. | |
| Maintenance | |
| Maintenance description | |
| Comments | |

AUXILIARY SERVICES

LIGHTING

| Functional description | | | | | | | | | | |
|------------------------|-------------------------------------|----------------|---------------|--------------------------------|--------------------|-------------------------|-----------------------------------|--------------------|----------------------|-------------|
| Dependency | Dimensions L x W x h (meters) | Type luminaire | Power (kW) | Energy consumption (kWh) | Energy cost (€) | Number of luminaires | Operation mode (hours/year) | Regulation type | Equipment control | Maintenance |
| Industrial plant | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Comments | | | | | | | | | | |

AUXILIARY SERVICES

| |
|--|
| |
|--|

MAIN ELECTRIC MOTORS

| Description | Power (kW) | Operation mode (hours/year) | Energy consumption (kWh/y) | Energy cost (€/y) | Age or Efficiency Level | Variable speed drive (Yes/No) | Average percentage of speed variation | Constant load | Medium load (%) | Maintenance and Operation | | Maintenance |
|-------------|------------|-----------------------------|----------------------------|-------------------|-------------------------|-------------------------------|---------------------------------------|---------------|-----------------|-------------------------------------|---|-------------|
| | | | | | | | | | | The motor has been repaired? Yes/No | How many times has the motor been repaired? | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Comments | | | | | | | | | | | | |

OTHER FACILITY

| NAME: | |
|-------------------------------|--|
| Functional description | |
| Type of energy consumed | |
| Energy consumption (kWh/year) | |
| Energy cost (€) | |
| Installed power (kW): | |
| Technical efficiency | |
| Other features | |
| | |
| | |
| Maintenance | |
| Maintenance description | |
| Comments | |

BUILDINGS

| General information | |
|----------------------------|--|
| Name | |

BUILDINGS

| | | | |
|--|-------------|--|--|
| Functional description | | | |
| Construction/technology of structure | | | |
| Year built | | | |
| Building Regulation in force when the building was designed | | | |
| Climate zone | | | |
| Weekly operating hours | | | |
| Number of floors | | | |
| Net heated area [m ²] | | | |
| Heated volume [m ³] | | | |
| Ventilation (ren/h) | | | |
| DHW daily demand (l / day) | | | |
| Tightness of the building tested | | | |
| <ul style="list-style-type: none"> - Yes. Q50 (l/s) - No | | | |
| Internal partitions mass (L/M/H) | | | |
| Characteristic of building partitions | | | |
| Façades / External walls | Description | | Thermal transmittance [W/m ² K] |
| Roof/floor slab | Description | | Thermal transmittance [W/m ² K] |
| Ceiling structure | Description | | Thermal transmittance [W/m ² K] |
| Partitions with no heated spaces | Description | | Thermal transmittance [W/m ² K] |
| Windows | Description | | Thermal transmittance [W/m ² K] |
| External doors | Description | | Thermal transmittance [W/m ² K] |
| Thermal bridges | Description | | Thermal transmittance [W/mK] |
| Characteristic of ventilation system | | | |
| Type of ventilation system | | | |

BUILDINGS

| | |
|--------------------------------------|--|
| Method of supplying and removing air | |
| Type of energy consumed | |
| Energy consumption [kWh/year] | |
| Energy cost [EUR/year] | |
| Comments | |

ANNEX II MEASURING EQUIPMENT FOR FIELD WORK

To carry out the consumption measurements on site, the following measurement equipment can be used:

- **Combustion analyser.**

Combustion analysers are portable devices which estimate the combustion efficiency of furnaces, boilers and other fossil fuel burning machines. Their application is based on taking a sample of the gases that flow through the chimney or flue pipe, by suction through a hole and obtaining the concentration of their components by electronic analysers with electrochemical sensors which are fitted to these analysers. Moreover, these devices are supplied with a thermocouple probe for taking gas temperature and software which, depending on the analysis of gases, temperature and room temperature, provide the combustion efficiency.

- **Thermometers.**

Thermometers are needed to measure temperatures in offices and other working areas, and to measure the temperature of operating equipment. Knowing the process temperatures allows the auditor to determine process equipment efficiencies, and also to identify waste heat sources for potential heat recovery programs. Some common types include an immersion probe, a surface temperature probe and a radiation-shielded probe for measuring true air temperature. Other types of infra-red thermometers and thermographic equipment can measure line or equipment temperatures that are not accessible without a ladder.

- **Air flow measuring devices.**

Measurements of energy efficiency of air flow heating, air conditioning or ventilating ducts, compressed air systems or other sources of air flow is one of the energy auditor's tasks. Airflow measuring devices can be used to identify problems with air flows. Typical airflow measuring devices include pressure transmitters, flow meters, anemometers or air flow hoods, an ultrasonic device for finding losses in compressed air distribution network.

- **Flow meter.**

The flow meters are instruments designed to measure the flow of fluid circulating through a pipe, usually water and air.

In an energy audit, the type of flow meter to be used is normally a portable ultrasonic flow meter, not intrusive, for measuring the volume flow without contact with the liquid. Basically ultrasonic flow meters can be used in all places where the liquid flowing through the pipes allow the propagation of sound.

- **Portable power analyser.**

Electrical network analysers are measuring instruments that measure directly or calculate different electrical parameters of a network, usually at low voltage: voltage, current, power and active and reactive power, power factor, etc. All this type of equipment also have the possibility of registering these parameters through various programming functions.

Usually, the results of the measurements are presented in the form of computer files in a specific format that can only be handled by the software manufacturer, or in standard ASCII format that can be handled with any conventional software applications (EXCEL, ACCESS , etc.).

- **Multimeter.**

A digital multimeter (DMM) is an advanced electrical meter used in electrical and electronic work to measure several critical electrical parameters. Its primary function is measuring voltage (AC and DC), current (AC and DC), and resistance. Advanced digital meters can also measure capacitance, frequency, duty cycle, and temperature. Some models include additional features like diode testing and continuity checking, making them indispensable tools for various electrical diagnostic tasks...

- **Clamp meters.**

Clamp meters are electrical tools designed for measuring electrical current without direct contact with the conductor in various environments, including industrial and residential settings. They use a clamp that opens and surrounds a conductor, enabling safe and efficient current measurement, especially in tight or difficult-to-reach areas.

- **Light meter.**

The light meter is an instrument that measures the illumination or lighting level (lux) on a given surface. Normally it is a very simple and light piece of equipment, consisting of the analyser and the photosensitive probe.

- **Infrared camera.**

The infrared camera is a device, similar to a common camera, that detects infrared energy (heat) and converts it into an electronic signal, which is then processed to produce a thermal image and perform temperature calculations. Heat detected by an infrared camera can be quantified, allowing you to identify and evaluate heat-related problems (heat leaks, poor insulation, overheating in electrical systems, etc.).

- **Other measuring equipment.**

Depending on the scope of the Energy Audit it may be interesting (or even essential) to use other portable measuring equipment. Thus, for the comprehensive study of the environmental conditions and the functioning of the facilities, it may be necessary to have room temperature and fluid (air and water) probes in ducts, anemometers and flow probes, static and dynamic pressure (pitot), pyrometers optical, infrared cameras etc.

- **Tools.**

Apart from more or less specialized equipment, and other materials commonly used tools, such as screwdrivers, pliers, scissors, tape measure, flashlight, extension cords, adapters, electrical cables, terminals, tape, etc., may be necessary in an energy audit.

- **Safety Material.**

Professional work requires the adoption of safety measures to protect oneself and others, especially when carrying out measurements.

During the development of an energy audit, the main physical hazards are often of an electrical origin, but there are others such as falls or burns.

The minimum personal protective equipment recommended is listed below (used to be homologated).

- Helmet
- Safety footwear
- Dielectric gloves Class "0" up to 1,000V.
- Safety glasses
- Dielectric Mat

ANNEX III ENERGY SAVING MEASURES

Below are some suggested energy saving measures for industrial equipment/systems that consume energy, both thermal and electricity, as well as for the thermal envelope of the building.

THERMAL ENERGY CONSUMERS

Steam, thermal fluid and superheated water boilers.

- Reduction of heat loss in boilers and hot circuits due to defects in the insulation.
- Reduction of heat loss due to leaks in the flanges, valve presses, etc.
- Heat recovery from combustion gases:

Depending on the temperature of the combustion gases, we can have the following heat recovery applications:

500 – 1000°C

- Preheating of the feed in furnaces
- Generation of high pressure steam
- Reheating of steam

300 - 500°C

- Preheating of the combustion air
- Production of medium pressure steam

150 – 300°C

- Preheating of the feed water in boilers
- Preheating of the combustion air
- Generation of low pressure steam

<150°C

- Absorption cooling
- Application of a heat pump

The equipment most commonly used is:

- Boiler economisers
- Heat recovery boilers
- Combustion air heaters

Furnaces.

- Reduction of heat loss due to defects in the insulation.
- Heat recovery from combustion gases through the following systems:

Combustion air heaters:

- Heat regenerators. In a regenerator, the transfer of heat between two currents is transported by the alternating passing of hot and cold fluids through a bed of solids, which has an appreciable heat storage capacity.
- Heat recovery units. In a recovery unit, the two fluids are separated by an internal partition which enables the heat to be directly transferred.

- Convection recovery units. This generally consists of one or more bundles of tubes through which the air to be heated flows whilst the gases bathe the outside of the tubes.

Hot gas temperature < 1,000 °C, gases that do not contain corrosive compounds or a large amount of solid particles.

Applications: Forging furnaces, Iron and steel industry, Calcining furnaces, Waste recovery, Cooling of gases or air.

- Radiation recovery units. This type of recovery unit is especially suitable for cases where the temperature of the gases is very high and constant. Radiation recovery units cannot be used with batch-type furnaces, where the temperature of the gases is very low during the furnace heating periods. Jacketed radiation recovery units offer reduced fuel consumption of 40% or more thanks to preheating the combustion air and a compact design which facilitates their installation into the chimney flue.

Hot gas temperature: > 1,000 °C, gases that contain aggressive compounds or a large amount of particles.

Applications: Forging furnaces, Frit smelting, Glass manufacturing, Aluminium smelting

- Mixed convection-radiation recovery unit

Product pre-heaters: The heat from the gases is applied directly to preheat the product, so the consumption of fuel needed to reach the product's heating temperature is reduced.

- Recovery of the product's waste heat through:

Preheating the product entering the furnace. The energy exchange between hot and cold products can be carried out in the furnace itself or in a separate heat exchange chamber.

Heating of combustion air. This method allows the use of the product's heat when leaving the furnace or the hot parts of the furnace to heat the air that will be used as a combustion agent in the combustion.

Driers.

- Reduction of heat loss due to defects in the insulation.
- Heat recovery from the output vapours, preheating the drying gases.
- Recovery of the product's waste heat: These driers are also known as regenerative, as they try to recover the product's heat whilst also drying it.

Other energy saving measures.

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- Minimise purges in steam boilers.
- Recovery of condensates and hot waters: The waste heat from circuits of condensates and hot water coming from the steam used in processes can be recovered in two forms:
- Direct form: introducing the condensates and hot water into the feed tank and mixing them with the feedwater to the boiler, provided that they are not contaminated.
- Indirect form: transferring the residual heat to another fluid through exchangers.
- Heat recovery from the cooling circuits of refrigeration machines, for example through a heat pump.
- Replace pieces of equipment with others that are more efficient.

Energy saving measures in combustion.

- Suitable control of combustion.
- Change of energy source, i.e., the combustible used.

Other sectoral energy efficiency measures (BAT)

Brewing

- a) Mashing-in at higher temperatures. The mashing-in of the grain is carried out at temperatures of approximately 60 °C, which reduces the use of cold water.
- b) Decrease of the evaporation rate during wort boiling. The evaporation rate can be reduced from 10% down to approximately 4% per hour (e.g. by two-phase boiling systems, dynamic lowpressure boiling).
- c) Increase of the degree of high-gravity brewing. Production of concentrated wort, which reduces its volume and thereby saves.

These measures may not be applicable due to the product specifications.

Dairies

- a) Partial milk homogenisation. The cream is homogenised together with a small proportion of skimmed milk. The size of the homogeniser can be significantly reduced, leading to energy.
- b) Energy-efficient homogeniser. The homogeniser's working pressure is reduced through optimised design and thus the associated electrical energy needed to drive the system is also reduced.
- c) Use of continuous pasteurisers. Flow-through heat exchangers are used (e.g. tubular, plate and frame). The pasteurisation time is much shorter than that of batch systems.
- d) Regenerative heat exchange in pasteurisation. The incoming milk is preheated by the hot milk leaving the pasteurisation section.
- e) Ultra-high-temperature (UHT) processing of milk without intermediate pasteurisation. UHT milk is produced in one step from raw milk, thus avoiding the energy needed for pasteurisation.

- f) Multi-stage drying in powder production. A spray-drying process is used in combination with a downstream dryer, e.g. fluidised bed dryer.
- g) Precooling of ice-water. When ice-water is used, the returning ice-water is pre-cooled (e.g. with a plate heat exchanger), prior to final cooling in an accumulating ice-water tank with a coil evaporator.

Fruit and Vegetable sector

To cool fruit and vegetables before deep freezing. The temperature of the fruit and vegetables is lowered to around 4 °C before they enter the freezing tunnel by bringing them into direct or indirect contact with cold water or cooling air. Water can be removed from the food and then collected for reuse in the cooling process.

Oilseed processing and vegetable oil refining

To generate an auxiliary vacuum. The auxiliary vacuum used for oil drying, oil degassing or minimisation of oil oxidation is generated by pumps, steam injectors, etc. The vacuum reduces the amount of thermal energy needed for these process steps.

Soft drinks and nectar/juice made from processed fruit and vegetables

- a) Single pasteuriser for nectar/juice production. Use of one pasteuriser for both the juice and the pulp instead of using two separate pasteurisers.
May not be applicable due to the pulp particle size.
- b) Hydraulic sugar transportation. Sugar is transported to the production process with water. As some of the sugar is already dissolved during the transportation, less energy is needed in the process for dissolving sugar.
- c) Energy-efficient homogeniser for nectar/juice production. The homogeniser's working pressure is reduced through optimised design and thus the associated electrical energy needed to drive the system is also reduced.

Sugar manufacturing

- a) Pressing of beet pulp. The beet pulp is pressed to a dry matter content of typically 25-32 wt-%.
- b) Indirect drying (steam drying) of beet pulp. Drying of beet pulp by the use of superheated steam.
May not be applicable to existing plants due to the need for a complete reconstruction of the energy facilities.
- c) Solar drying of beet pulp. Use of solar energy to dry beet pulp.
May not be applicable due to local climatic conditions and/or lack of space.
- d) Recycling of hot gases. Recycling of hot gases (e.g. waste gases from the dryer, boiler or combined heat and power plant).
- e) Low-temperature (pre)drying of beet pulp. Direct (pre)drying of beet pulp using drying gas, e.g. air or hot gas.

Slaughterhouses

- a) Refrigeration management plan. A refrigeration management plan is part of the environmental management system and entails:
 - monitoring of energy consumption of the refrigeration system;
 - operational measures such as inspection and maintenance of equipment, closing of doors when possible; equipment operation by experienced staff;
 - monitoring of refrigerant losses.
- b) Techniques for efficient scalding of pigs and/or poultry. These include techniques such as:
 - steam scalding of pigs;
 - immersion scalding of pigs and/or poultry with optimised water flow systems.
- c) Applicability to existing plants may be restricted by the plant layout/lack of space.

Installations processing animal by-products and/or edible co-products

Multiple-effect evaporators. Multiple-effect evaporators are used to remove water from liquid mixtures generated for example in fat melting, rendering, and fishmeal and fish oil production. Steam is introduced in a series of successive vessels, each one exhibiting a lower temperature and pressure than the previous one.

ELECTRICITY CONSUMERS

Industrial cooling.

Industrial cooling can be achieved through the following systems:

- Compression: cooling machine
- Absorption: absorption machine
- Evaporation: evaporative cooling

The energy saving measures that can be considered in the different systems are:

Cooling machines:

- Replace the compressors with others with a better performance.
- Centralise equipment, compared to having independent and split equipment
- Install multi-stage compressors to meet cooling demands at different temperatures.
- Recovery of cooling heat from the compressors, for heating or hot water.
- Adjust the evaporation temperature to the highest possible.
- Defrost using hot fluid, not electricity.
- Adjust the condensation temperature to be as low as possible.
- Use the condensation heat for other uses.

Absorption machines:

- Use of thermal waste heat as recovery of heat from boilers, recovery of condensates, solar thermal panels, etc. to generate cooling and avoid the use of electricity in systems with compression.

Evaporative cooling (cooling towers):

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- Replace constant flow water pumps with variable flow pumps.
- Stop ventilators or adjust their speed.

Compressed air.

As energy saving measures, we can:

- Reduce the air pressure to the minimum permitted level.
- Section the distribution lines: by pressure, production line, equipment, etc.
- Reduce leaks in the compressed air networks.
- Take the suction air from the compressor at the lowest possible temperature.
- Prevent the compressors from working on empty.
- Recover the cooling heat from the compressors.
- Replace the pieces of equipment with others offering a better performance.

Lighting.

- Adjust the lighting levels to the needs of the area.
- Replace lights with a poor light performance with others that are more effective.
- Replace lights with louvres that are badly deteriorated, or those that do not fit the characteristics of the premises.
- Take advantage of natural light.
- Install regulation and control systems.
- Implement a suitable management and maintenance system.

Electric motors.

- Adjust the motors to the power needed. (Motor size appropriate to the work to be done).
- Use high efficiency motors.
- Regulate the motor's speed.

Pumps and ventilators.

- Adjust the operating points of the pumps.
- Prevent the motor from overheating. Place in a ventilated location.
- Correctly place the motor to prevent its premature wear.
- Regulate the flow.
- Perform the proper maintenance and cleaning of the hydraulic circuits, valves and accessories.

Transformers.

- Adjust the power factor.
- Adjust the transformer's load factor.
- Reduce the effect of harmonics.
- Reduce the temperature in the transformer's enclosure.
- Replace old transformers with new ones.

BUILDING THERMAL ENVELOPE

Thermal isolation

Insulation is a key aspect to save energy in buildings. As energy saving measures, we can:

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- Increasing the thickness of thermal insulation reduces heat losses in winter and heat gains in summer.
- Exterior enclosures with low thermal transmittance.
- Optimize the thickness of thermal insulation.

Thermal envelope tightness

- Ensure tightness of the building envelope, avoiding holes and air flows between the interior and exterior through cracks and gaps.

Thermal bridges

- Elimination of thermal bridges since they harm the energy efficiency of the construction element (junctions of enclosure walls with carpentry and installation steps).

High performance windows and doors

- Provide very high quality carpentry and glass in order to limit energy leakage through them as much as possible.
- Correct location and execution, using windows with double or triple glass and low-e glass.

ANNEX IV RENEWABLE ENERGY SOURCES

Some alternative energy sources suggested for industrial equipment/systems that consume energy of fossil origin, both thermal and electrical, are shown below.

ELECTRICITY CONSUMERS

Photovoltaic solar energy.

Photovoltaic solar energy takes advantage of solar radiation to transform it directly into electrical energy using photovoltaic panels. Photovoltaic solar energy, as a renewable source, represents a radically more environmentally friendly formula than conventional energies, because inexhaustible resources are available, on a human scale, to cover energy needs.

Given the availability of significant roof surfaces in industrial buildings, and the reduction in the costs of these installations in recent years, the installation of photovoltaic systems is seen as a suitable technology for decarbonization.

The current photovoltaic panels, with performances greater than 20%, provide the opportunity to implement 1 kWh for every 5 m² of deployable roof on the roof of buildings and provide the possibility of substituting a significant percentage of the company's electrical needs for self-consumption.

This self-consumption technology with photovoltaic solar can be complemented in the case of industries located in rural areas with the implementation of some wind equipment, although this requires stricter environmental procedures as they are implementations outside the industrial land.

Wind power.

This technology takes advantage of the kinetic energy of the wind (renewable source) to transform it directly into electrical energy using wind turbines.

For its application in the decarbonization of organizations, there is small power wind technology (horizontal or vertical axis wind turbines) for its integration in urban, semi-urban, industrial and agricultural environments and take advantage of its capacity to provide renewable energy in a distributed manner. These small power installations have their own characteristics, which entail a series of advantages, such as a potential greater overall efficiency due to the losses avoided in the transmission and distribution networks and the integration of renewable generation without the need to create new electrical infrastructures.

THERMAL ENERGY CONSUMERS

Aerothermal.

This energy source can obtain heat from the energy contained in the ambient air using aerothermal heat pumps for use in the production of cold, heat and hot water to cover the thermal needs of air conditioning installations and low temperature processes of the industry.

The heat pump extracts energy from the air through a compression refrigeration cycle, with a small contribution of electrical power to the compressor and transports this useful heat in a highly efficient manner from a "cold" source to a "hot" source.

It is one of the most efficient generation systems since it can take advantage of up to 75% of the energy from the air with 25% electrical consumption, which means that it can provide 4 kW of thermal energy with only 1 kW of electrical energy, while 3 kW come from outside air (renewable). The operation and its performance depends on factors, such as the outside temperature, the supply temperature, the thermal difference, the climatic zone, etc.

In the case of aerothermal energy captured by a heat pump, it is recognized as renewable energy under certain conditions, in accordance with Commission Delegated Regulation (EU) 2022/759 of 14 December 2021, which modifies the annex VII of Directive (EU) 2018/2001 of the European Parliament and of the Council proposing a methodology for calculating the amount of aerothermal, geothermal or hydrothermal energy captured by heat pumps used for cooling and urban cooling systems that should be considered energy from renewable sources.

It should be noted that the use of aerothermal energy, although it requires higher initial installation costs, can be used without supply problems, is economical in its exploitation, renewable, reliable since it does not have the intermittency of solar or wind energy. Energy can be produced throughout the day.

Biomass.

Biomass is a renewable fuel capable of reaching high temperatures. Thermal applications with heat and Domestic Hot Water (DHW) production are the most common within the biomass sector, and their use is increasingly widespread in the production of steam in boilers. The use of pellets, food waste or forest chips has had a low volatile price environment in recent years.

The main drawback is the need for ample space for storage, and that its use cannot be adapted to any process, such as direct combustion in ovens.

It should be noted that biomass, as a renewable source in its energy use, is considered neutral in CO₂ emissions, when it is obtained from the sustainable management of available resources as it is not an inexhaustible source of energy.

Solar thermal energy

The solar energy captured through collectors is used thermally, transferring it to a fluid to supply the different heat demands existing in the building, industrial and agricultural sectors and is one of the most efficient and economical ways to take advantage of an abundant and indigenous, free, and available at the same point of consumption.

This is a mature technology with significant implementation in the building sector in recent years that, due to its technological development and high reliability, is easy to integrate into buildings and industries, with minimal maintenance and control systems for remote monitoring. Thus, offering all the guarantees in terms of safety and comfort of use.

From the point of view of decarbonization, the use of this type of facilities implies a reduction in primary energy consumption and CO₂ emissions corresponding to the energy source that it replaces and that supplies these demands.

In this type of installations, a conventional support system is necessary to supply with the energy needs not covered by the solar installation.

Geothermal

Geothermal energy is the heat energy that the earth transmits from its inner layers to the outermost part of the earth's crust. Applications range from electricity production, when dealing with high temperature reservoirs (above 100-150°C), to thermal uses in the industrial, service, and residential sectors, for temperatures below 100°C, either directly or through a geothermal heat pump (heating and cooling) for very low temperatures (below 25°C).

Like aerothermal energy, geothermal energy captured by a heat pump is recognized as renewable energy under certain conditions, in accordance with Commission Delegated Regulation (EU) 2022/759, of 14 December 2021, already mentioned. In the same way, the use of geothermal energy, although it also requires high initial installation costs, in addition to elaborate terrain studies, it can be used without supply problems, is economical in its exploitation, renewable, reliable since it does not have the intermittency of solar or wind. Energy can be produced throughout the day.

H₂ green

Green Hydrogen is an alternative, clean and sustainable fuel that facilitates the use of renewable energies. Currently, it is proposed as an energy vector that will contribute to the decarbonization of the economy in coexistence and combination with other technologies and energies. It is produced through a process of water electrolysis, a chemical process in which water is decomposed into oxygen and hydrogen, using electricity that, if obtained from renewable sources, produces energy without emitting CO₂ into the atmosphere. The hydrogen production circuit from biogas could also be considered green hydrogen.

H₂ is used as a raw material in different industries, but it has a series of advantages that can boost it as an energy vector, such as:

- It serves as storage for surplus renewable energy, which would be very useful to guarantee supply in a context of greater weight of renewables in the electricity generation mix.
- It can be transformed into different forms of energy (electricity, synthetic gas or heat) and has multiple applications in the industrial, domestic, commercial and mobility sectors.
- It can be used in key sectors that do not have clear decarbonization solutions, such as high-temperature process-intensive industry and heavy transportation.

Currently, green H₂ as an energy vector is being promoted worldwide through policies and initiatives to support this source.

The European Commission presented, through the communication "A hydrogen strategy for a climate-neutral Europe" (2020), its new hydrogen strategy under a plan called: "Boosting a climate-neutral economy: an EU strategy for the integration of the energy system". Furthermore, Hydrogen and fuel cell technologies have been identified as a strategic sector in R&D&i, and constituted one of the five Joint Technological Initiatives in this field, unique in energy.

Biogas and biomethane

Biogas, as well as biomethane obtained from biogas itself, can be used in different economic sectors (mobility, electricity generation or heat and energy systems), replacing energies of fossil origin, and play a relevant role in the energy transition due to its capacity to integrate the circular economy in the generation of renewable energy.

Biogas is a gas composed mainly of methane (CH₄) and carbon dioxide (CO₂), in variable proportions depending on the composition of the organic matter from which it was generated. The main sources of biogas are livestock and agro-industrial waste, sludge from urban wastewater treatment plants (WWTPs) and the organic fraction of domestic waste (MSW).

Biogas is the only renewable energy that can be used for any of the major energy applications (electrical, thermal or as fuel), from its channeling for direct use in a boiler adapted for combustion, to its injection, after purification to biomethane, in existing natural gas infrastructure, both transportation and distribution.

In the field of decarbonization, the appropriate use of biogas has great potential to contribute to reducing GHG emissions, not only by replacing fossil fuels, but also by avoiding the emission of CH₄ generated, in the aforementioned sources, to the atmosphere.

ANNEX V PROCEDURE FOR ASSESSMENT OF ENERGY SAVING MEASURES

As mentioned previously, the economic cost of the different energy saving measures will be carried out as described in this procedure.

We take as a basis the following input data:

1) input data:

- Investment, I (€). Economic valuation at market prices, the purchase of equipment and work to be done to carry out the energy saving measure.
- Annual reduction of energy costs, ARE (€). Evaluation of the saving in energy costs as a result of implementing the energy saving measure.
- Annual increase in maintenance/operation costs, AIMO (€). Evaluation of the annual increase in maintenance and operation costs related to energy improvement.
- Annual economic saving, AES (€). Evaluation of the resultant annual economic saving.

$$AES = ARE - AIMO$$

- Lifetime of equipment, Lt (years)
- Present value, PV. Present Value describes the process of determining what a cash flow, to be received in the future, is worth in today's Euros . It is calculated using the formula below:

$$PV = FV / (1+r)^n$$

Where:

FV = future value

r = interest or discount rate

n = number of years

And as indices of economic evaluation:

2) Profitability Ratios:

- Gross amortization period (return time of the investment), **GP** (years):

$$GP = I / AES$$

- Gross return of the investment, **GRI** (%). It expresses the percentage of profit obtained on investment throughout the life of the installation resulting from the improvement:

$$GRI = (AESn - I) / I \times 100$$

- Annual Gross return of the investment, **AGR** (annual %). The annual benefit is calculated with this indicator. It is usually more operative than the GRI:

$$AGR = GRI / Lt$$

- Annual depreciation of equipment, D (€, linear):

$$D = I / Lt$$

- Net present value, **NPV**. It is the difference between the present value of cash inflows and the present value of cash outflows.

$$NPV = I_1 / (1+r) + I_2 / (1+r)^2 + \dots + I_n / (1+r)^n - C_0 - C_1 / (1+r) - C_2 / (1+r)^2 - \dots - C_n / (1+r)^n$$

In our case:

$$NPV = AES/(1+r) + AES/(1+r)^2 + \dots + AES/(1+r)^{Lt} - (I/Lt + AIMO) - (I/ Lt + AIMO)/(1+r) - (I/ Lt + AIMO)/(1+r)^2 - \dots - (I/ Lt + AIMO)/(1+r)^{Lt}$$

Where:

AES = Annual economic saving

Lt = Lifetime of equipment

I = Investment

AIMO = Annual increase in maintenance/operation costs

r = interest or discount rate

Example:

$$I = 200 \text{ €}$$

$$Lt = 5 \text{ years}$$

$$AES = 75 \text{ €}$$

$$AIMO = 5 \text{ €}$$

$$r = 10\%$$

| Time period (Lt) | Cash inflow (AES) | PV where r=10% | Cash outflow (I/Lt+AIMO) | PV where r=10% |
|------------------|-------------------|----------------|--------------------------|----------------|
| 0 | 0 | 0 | 45 | 45 |
| 1 | 75 | 68 | 45 | 41 |
| 2 | 75 | 62 | 45 | 37 |
| 3 | 75 | 56 | 45 | 34 |
| 4 | 75 | 51 | 45 | 31 |
| 5 | 75 | 47 | 45 | 28 |
| TOTAL | | 284 | | 216 |
| NPV | 68 | | | |

The savings measures identified and evaluated will be sorted in descending order, from higher NPV to lower.

ANNEX VI ENERGY MARKETS. SUPPLY CONTRACT

FRANCE

ELECTRICITY MARKET IN FRANCE.

- INTRODUCTION.

Since the electricity markets were fully opened up in 2007, regulated tariffs, set by the government and offered by incumbent suppliers, have coexisted with market offers freely set by all suppliers (incumbent and alternative). The end of 2015 marked a turning point, with the abolition of regulated tariffs for large and medium-sized consumers (subscribed power greater than 36 kVA) in mainland France.

The market share of incumbent suppliers (EDF and local distribution companies) remains high, at over 63% by volume, but is gradually declining. Regulated access to historical nuclear electricity (ARENH) and current market conditions ensure that alternative suppliers can offer competitive prices in all market segments.

The retail price of electricity in France is one of the lowest in Europe. The reform of the contribution to the public electricity service (CSPE) should help stabilize this component of the bill, which had risen significantly in recent years. In addition, the competitiveness of electro-intensive consumers remains a point of vigilance, and several measures in their favor were decided in 2015.

Consumers with subscribed power less than or equal to 36 kVA

With the opening up of markets to competition, residential and business customers can choose between :

- regulated sales tariff (TRV) offers, available only from EDF and local distribution companies (such as Electricité de Strasbourg)
- market offers, available from all energy suppliers, including the incumbent ones.

The principle of reversibility means that there is no limit to the number of times you can switch from TRV to market offers, and vice versa.

At June 30, 2019, 77% of residential consumers were covered by TRV tariffs. Nearly 40 alternative suppliers offer market deals to this customer segment.

Consumers with contract power greater than 36 kVA

For medium- and large-scale professional consumers, regulated tariffs were abolished on December 31, 2015, marking another important step in the opening up of markets.

Article 25 of French consumer law no. 2014-344 of March 17, 2014 provided for several measures to accompany this abolition:

- information letters were sent to the consumers concerned;
- consumers who had not spontaneously opted for a market offer on January¹, 2016 were automatically switched to a "transition offer" proposed by the incumbent supplier, the duration of which is limited to 6 months.

Customers who had not opted for a market offer by July 1, 2016 were assigned to suppliers selected through a competitive procedure (launched on March 17, 2016), organized by the Commission de Régulation de l'Energie (CRE), in accordance with order no. 2016-129 of February 10, 2016.

Regulated access to nuclear electricity (arenh)

Since the NOME law (New Organization of the Electricity Market) came into force in 2010, alternative suppliers have been able to benefit from regulated access to historical nuclear electricity (ARENH). This source of electricity is supplied under cost conditions equivalent to those of the incumbent operator. ARENH is an option for alternative suppliers, who can also choose to source their electricity entirely from the wholesale market when market prices are lower than ARENH.

Parliament introduced a provision in the Energy-Climate Act giving the Government the power to raise the ARENH ceiling to 150 terawatt-hours (TWh), and to change its price, unchanged since 2012.

The conditions for exercising this option have been discussed with the European Commission. Any change in the ARENH parameters, such as raising the volume to 150 TWh, even without changing the price, would require an amendment to its 2012 decision approving the ARENH scheme.

- TYPE OF CONTRACTS

Market offers are available from all suppliers, both alternative and incumbent.

Consumers can opt for :

- **indexed-price offers**, which may be indexed to regulated sales tariffs or to various products (spot prices, ARENH, etc.), or evolve according to a formula specific to the supplier.
- **fixed-price offers**, which cover a wide range of contractual terms and conditions. While some offers leave only the energy component of the price, excluding taxes, unchanged for the duration of the contract, other offers leave the price of kWh and subscription, excluding taxes, constant for the duration of the contract.

Green" electricity refers to electricity generated from renewable energy sources (hydro, wind, solar, geothermal, etc.) or cogeneration. **Green** electricity offers electricity from renewable sources, certified by guarantees of origin.

NATURAL GAS MARKET IN FRANCE.

- INTRODUCTION.

At December 31, 2017, the natural gas retail market represented 11.3 million end-consumer sites supplied with gas, for a volume of around 480 TWh/year.

Since July 1, 2007, the gas market has been fully open to competition : all end consumers can sign a natural gas supply contract at a market price with the supplier of their choice.

Residential and small business consumers can choose between two types of price:

- **regulated tariffs** , set by the ministers responsible for energy and the economy, after consultation with the Commission de régulation de l'énergie (CRE), and offered by incumbent suppliers;
- **market offers**, freely available from all suppliers (incumbent and alternative).

Regulated sales tariffs for large and medium-sized non-domestic consumers have been abolished since December 31, 2015 (with the exception of small professionals whose consumption level is less than or equal to 30 MWh/year and small collective residential), in accordance with an agreement with the European Commission endorsed in January 2013 :

- **January 1, 2016 - July 1, 2016**. Approximately 17400 consumers had not opted for a market offer on January 1, 2016: in accordance with French consumer law n°2014-344 of March 17, 2014, **they switched to a transitional offer** proposed by their incumbent supplier, the duration of which is limited to 6 months ;
- **since July 1, 2016**: to avoid any disruption in supply, consumers who had not taken the necessary steps by July 1, 2016 have been allocated to a default supplier designated through a tender procedure organized by the CRE.

The opening up of the gas market to competition is now well advanced, particularly in the non-domestic consumer market. Market offers are by far the majority in terms of volume (88% of consumption volume), covering more than 56% of sites at the end of 2017. The market share of alternative suppliers reaches 26% in consumption volume on the residential customer segment and 41% on the non-residential market. Market offers are driving prices down, with discounts of up to 10% on the offer price compared with regulated tariffs.

Natural gas suppliers

There are some 190 authorized suppliers in France (incumbents and alternative suppliers combined, including industrial suppliers who buy gas directly from the market). Around 40 suppliers are authorized to supply gas to residential customers.

These suppliers must comply with a number of public service obligations, notably to ensure continuity of delivery.

There are 24 **historical suppliers**:

- ENGIE (formerly GDF SUEZ) ;
- and 22 local distribution companies (ELD).

They offer regulated tariffs, and can also propose market offers to their customers. **Other suppliers, known as alternative suppliers**, offer their customers market offers.

• TYPE OF CONTRACTS

Market offers are available from all suppliers, both alternative and incumbent.

Consumers can opt for :

- **fixed-price offers**, which cover a wide range of contractual terms and conditions. While some offers leave only the energy component of the price, excluding taxes, unchanged for the duration of the contract, other offers leave the price of kWh and subscription, excluding taxes, constant for the duration of the contract.
- **price-indexed offers**, which may be indexed to price references set by the CRE (benchmark natural gas sales price, CRE supply cost reference) or to various products (spot prices, oil or gas products, etc.), or may evolve according to a formula specific to the customer.

ITALY

ELECTRICITY MARKET IN ITALY.

- INTRODUCTION.
- The establishment of the electricity market in Italy dates back to Legislative Decree No. 79 of March 16, 1999, aligning with the European directive aimed at fostering an internal energy market (Directive 96/92/EC). Like in other global contexts, the creation of this market responds to two primary objectives:
 1. Fostering competition in electricity production and trading activities based on principles of neutrality, transparency, and objectivity, achieved through the establishment of a designated marketplace.
 2. Ensuring the economic management of adequate availability of dispatching services.

With the Legislative Decree n. 79 of 16th March 1999 the access to the free market of electricity was granted to large consumers (considered as single company or also as a consortium) at first (over 30 GWh of annual consumption), with progressive decrease of this threshold during the following years (20 GWh from the 1st of January 2000, 9 GWh from the 1st of January 2002). Law n. 239 of the 23th of August 2004 admitted to free electricity market from the 1st of July 2004 every customer, except for residential customers, who were eligible only from the 1st of July 2007.

Then regulatory framework introduced progressive deadlines for the end of protected market: the 1st of July 2021 for small enterprises, the 1st of April 2023 for microenterprises and the 1st of July 2024 for residential customers.

- The Italian electricity market operates through two main segments: the Spot Electricity Market (MPE) and the Forward Electricity Market (MTE). The MPE facilitates the exchange of energy for immediate or short-term delivery, while the MTE enables transactions for future delivery, allowing participants to set prices and quantities of energy beforehand (Source: GME website).
- Electricity Pricing
- The PUN (Prezzo Unico Nazionale – National Unique Price) serves as the wholesale reference price of electricity purchased on the Italian Power Exchange (IPEX). This price regulates transactions between electricity producers and suppliers, representing the national weighted average of zonal electricity sales prices for each hour and day.
- Key Participants
- Several entities play pivotal roles in the Italian electricity market ecosystem:
- Ministry of Environment and Energy Security (MASE): Ensures safety in energy and geomineral infrastructures, procurement, efficiency, competitiveness, and promotion of renewable energies.
- Regulatory Authority for Energy Networks and the Environment (ARERA): Issues regulations for energy markets and conducts control, inspection, and sanctioning activities.

- Terna/Snam Rete Gas: Manages primary transport networks, ensuring fundamental dispatching services and network balance.
- Energy Markets Operator (GME): Responsible for managing energy markets, notably the energy exchange.
- Energy Services Operator (GSE): Manages, promotes, and incentivizes renewable sources and energy efficiency.
- Single Buyer: A public entity supplying electricity to domestic customers and SMEs yet to transition to the liberalized market.
- Energy and Environmental Services Fund (CSEA): Collects system charge proceeds and administers the "energy-intensive bonus" mechanism.

(Source: slide Corso EM & EGE, ISNOVA – I mercati Liberalizzati di elettricità e gas)

- TYPE OF CONTRACTS

Customers operating in the open electricity market sign an electricity purchase contract with the supplier. The agreement can affect only economic conditions about cost of energy. Other additional items that are included in the bill refers to taxes, network charges, distribution and dispatch costs, measurement charges etc. and cannot be negotiated. Value of these items is set and periodically updated by Governmental and Authority dispositions and can depend on type of customer, level of voltage, available power and hourly discrimination.

The most common types of electricity supply contracts are:

Offer price-indexed "pool" (EQUIVALENTE AL PUN)

Electricity price in these agreements is variable and depends on the purchase price of energy in the wholesale market (the single national price, or PUN) upon which the supplier apply a fee. Usually contracts are indexed on hourly value of PUN (electricity price changes every hour) or on monthly average values of PUN referred to three different time slots (F1, F2, F3) defined by Authority (ARERA) with Decision n° 181/2006:

- F1 is the peak time slot: from 8 AM to 7 PM on weekdays;
- F2 is the medium load time slot: from 7 AM to 8 AM and from 7 PM to 11 PM on weekdays; from 7 AM to 11 PM on Saturday;
- F3 is the off-peak time slot: from 11 PM to 7 AM on weekdays and Saturday, 24 hours a day on Sunday and Public Holidays.
- This way, the risk is totally transferred from the trading company to the customer. Normally penalties due to variations in daily forecast demand are price-included in the contract.

Fixed price offer and fixed price offer with hourly discrimination

Supplier and customer reach an agreement about the expected volume of consumption and a fixed-price of kWh. Usually a fixed-price can be set for each different time slots according to the abovementioned Three-Time Band Scheme (F1, F2, F3) or according to other alternative structures. One of the most common is the Two-Time Band Scheme (Peak – Off Peak) where:

- Peak band includes all hours from 8 AM to 8 PM on weekdays;

- Off-Peak band includes all hours from 8 PM to 8 AM on weekdays and all 24 hours of Saturdays, Sundays and Public Holidays.

The electricity cost in fixed-price agreements is not affected by market price fluctuations. The customer can forecast the energy cost for the whole duration of the purchase agreement with less difficulties and uncertainties than a variable-price agreement.

In this type of contract the supplier assumes all the risks. Anyway a mechanism of cost compensation is usually established in the agreement in case some difference between the annual real consumption and the estimated value occurs.

Mixed price offer

In order to reduce the market-price risk and optimize the average final price of electricity, fixed-price mechanism can be combined with variable-price in the same offer, according to a defined sharing criteria of electricity or power withdrawal. Lots of complex schemes are possible in this sense, with combination of different solutions for price distribution.

1

NATURAL GAS MARKET IN ITALY.

- INTRODUCTION.

The European Directive 98/30 / EC for the creation of the European internal market in natural gas set out the principles for the liberalization process of natural gas sector.

Facilities related to the natural gas system consist of national transport network, distribution networks, regasification plants, underground storage and other complementary facilities.

The activities related to regasification, basic storage, transportation and distribution must follow Governmental and Authority dispositions while procurement and market selling of natural gas are developed in a free competition scheme.

The 10th of January 2024 the protected market of natural gas ended for all customers (except for vulnerable customers). Purchase agreement for natural gas supply is established between consumer and supplier under terms freely agreed by the parties.

The natural gas offer includes the following cost components:

- Cost of gas purchases in the wholesale market, managed by the trading companies in the wholesale acquisition (buying gas directly from producers, other traders, etc.)
- Cost of access tolls (specifically referred to the daily capacity defined between customer and supplier) for use of gas transport and distribution networks, regulated by law.
- Other costs and charges (rental of measuring equipment, VAT, etc.) included in the bill are defined and regularly updated by Governmental and Authority stipulation.

Each consumer pays the corresponding access tolls, depending on their pressure connection to the network and their annual consumption.

The GME organizes and manages the natural gas market, within which operators, authorized to carry out transactions on the Virtual Trading Point (PSV), can buy and sell quantities of natural gas for immediate delivery, functional also to the balancing of the gas system, as well as quantities of gas for future delivery.

In this market, the GME acts as the central counterparty for transactions concluded by the operators.

MGAS is structured as follows:

Spot Gas Market (MPGAS), consisting of the following markets. Day-Ahead Gas Market (MGP-GAS). Negotiations on the MGP-GAS are conducted through continuous trading, and for the sole compartment for system gas supply (AGS compartment), whose session takes place on gas day G-1, through auction trading. For negotiations on the MGP-GAS, which are conducted through continuous trading, bids for the purchase and sale of gas related to the three subsequent gas days to the one in which the trading session opens are selected. For negotiations on the AGS compartment, which are conducted through auction trading, bids for the purchase and sale of gas related to the subsequent gas day to the one in which the trading session takes place are selected.

Intraday Gas Market (MI-GAS). Negotiations on the MI-GAS are conducted through continuous trading, and for the sole compartment for system gas supply (AGS compartment), whose session takes place on gas day G, through auction trading. For negotiations on the MI-GAS, which are conducted through continuous trading, bids for the purchase and sale of gas related to the gas day corresponding to the one in which the trading session opens are selected. For negotiations on the AGS compartment, which are conducted through auction trading, bids for the purchase and sale of gas related to the same gas day in which the trading session takes place are selected.

Locational Products Market (MPL). The MPL is conducted through auction trading. MPL sessions are held solely upon request by Snam Rete Gas. In this market, Snam Rete Gas sources quantities of gas necessary to manage localized physical needs within the balancing area or any discrepancies between overall network injections and withdrawals.

Organized Market for Gas Storage Trading (MGS). The MGS is conducted through auction trading. In the MGS, authorized users and Snam Rete Gas can negotiate bids for the purchase and sale of gas in storage.

Forward Gas Market (MT-GAS). The MT-GAS operates through continuous trading. Multiple trading books are organized within the MT-GAS, each for different tradable products, referring to various delivery periods. Bids for the purchase and sale of gas are selected within these trading books. The types of tradable products are defined in the DTF (Delivery Terms and Conditions).

(Source: GME website)

- TYPE OF CONTRACTS

The most common types of gas contracts available in Italy are:

1. Variable or Indexed Price Contracts:

- The gas price varies monthly or daily based on the performance of the wholesale market, often following the PSV index.
- The total gas expense comprises the PSV plus a spread representing the supplier's profit.
- Typically, there's an annual fixed cost to be paid monthly.
- Sometimes other market index such as TTF (Title Transfer Facilities) can be used.

2. Fixed or Locked Price Contracts:

- The cost of gas remains fixed for a period generally of 12 or 24 months and does not follow market fluctuations.
- Similarly, there's usually an annual fixed cost to be paid monthly.

Regardless of the contract type, the cost for gas raw material adds up with the charges and taxes set by Governmental or Authority dispositions and which cannot be negotiated or modified by the supplier.

POLAND

ELECTRICITY MARKET IN POLAND.

- INTRODUCTION.

Electric energy production

System power plants are the main producer of electricity in Poland. These power plants use hard coal and brown coal to generate electricity. Such power plants produce 61% of the energy consumed in Poland. The largest producers are: PGE, Tauron, Enea, Energa.

Thermal power plants produce approximately 20% of energy. They are mainly fueled by hard coal, methane gas and brown coal, sometimes biomass.

Smaller producers are: wind power plants (10,8%), photovoltaics (4,5%), water power plants (1,7%), biomass plants.

Electric energy sales

Trading companies purchase electric energy from producers and then sell it to end customers. Trading companies have been separated from energy producers in 2007 and sell on the basis of comprehensive contracts (sales + distribution of energy).

The largest sellers are: TAURON Sprzedaż, PGE Obrót, Enea, Energa Obrót, RWE Polska S.A. Sellers must sign a contract with a local distributor.

Energy distribution

Electricity is transported from the power plant via two types of networks:

- transmission network - energy is transmitted from the power plant to Main Power Supply Points (MPSP). Their administrator is Polskie Sieci Elektroenergetyczne,
- distribution network - energy is transmitted from the (MPSP) to the final recipient. Here, the administrator is the DSO - Distribution System Operator.

Forms of energy trade

The domestic electricity market is divided into three basic segments:

- contract market,
- stock market,
- balancing market.

In addition, electricity can be purchased via the POEE Electricity Trading Platform.

- TYPE OF CONTRACTS

Electricity purchase models in Poland - from the buyer's and seller's perspective:

1) FIX – involves the seller setting a fixed price for electricity, which does not change until the end of the contract with the seller. The final price depends on the historical and planned electricity consumption profile of a given company and the specific length of the contract.

2) Purchase in tranches - involves purchasing energy in volume batches.

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3) SPOT – day-ahead market, where energy is purchased at wholesale prices currently quoted on the Polish Power Exchange. Trades are processed within two business days of being placed and the basic trading period is one hour.

4) Mixed models – combine the features of several other models.

5) CPPa – contracts for the sale of electricity concluded by the recipient directly with its producer. The contract offers a fairly long period, which may be up to 15-25 years. During this time, the renewable energy producer sells electricity directly to the end user at a previously agreed price.

Different types of electricity purchase contracts are available to different customer groups, including households, small and medium-sized enterprises and large industrial customers. The main types of electricity purchase agreements are:

Contract for an indefinite period (standard tariff): This is the basic form of contract offered by local electricity suppliers. Customers who do not choose another option will automatically be included in this contract. Electricity prices are set by the supplier and may change depending on market conditions.

Fixed-term contract: Customers can also sign a contract for a specific period of time, for example one or two years. Under this contract, the price of electricity is usually fixed for a specific period of time and is not subject to change, which gives the customer certainty about the amount of their energy bills.

Fixed price contract: Under this contract, the customer pays a fixed price for electricity throughout the contract period, regardless of price changes in the market. This is a form of protection against sudden increases in electricity prices, which may be attractive to customers who prefer price stability.

Renewable energy contract: More and more suppliers are offering contracts that guarantee that some or all of the electricity comes from renewable energy sources such as wind, solar or hydropower. Such deals may be attractive to customers looking for greener options.

Agreement for large industrial consumers: Large industrial consumers of electricity can negotiate contracts on special terms, taking into account their specific needs and energy consumption.

Alternative supplier contract: In addition to traditional electricity suppliers, there are also alternative suppliers who offer different types of electricity purchase contracts. These may include companies specializing in renewable energy, suppliers offering customized pricing options or additional services such as energy management.

NATURAL GAS MARKET IN POLAND.

- INTRODUCTION.

The structure of the gas market is still highly monopolized. This is due to the dominance of one natural gas supplier on the market - the PGNiG Capital Group (belongs to the larger Orlen capital group) - which conducts all activities directly or through its subsidiaries, covering 98% of the market. The Polish gas market is practically a market of one natural gas supplier. In the

absence of competition, market prices are subject to tariffs and approval by the President of the Energy Regulatory Office.

On July 1, 2007, the PGNiG Group legally and technically separated its activities, i.e. the technical separation of gas transmission from its sale. This is the result of the implementation of the provisions of the Energy Law. The creation of one virtual gas purchase point in Poland by Gaz-System and the launch of gas sales on the Polish Power Exchange created the basis for its liberalization. As a result of the commercial separation of customer service, Gas Companies are currently involved in the technical distribution of gas, acting as Distribution System Operators. Gas Trading Branches (Lower Silesia, Carpathia, Greater Poland, Pomerania, Upper Silesia and Masovia) constitute a separate organizational structure of PGNiG, which operates 23 gas plants and over 300 Customer Service Offices throughout the country.

Transmission System Operator

The owner of the Transmission Network Operator is Gaz-System, whose task is to transport gas through high-pressure networks. The company operates a network of transmission pipelines with a length of approximately 9,853 km, gas storage facilities and reduction and measurement stations.

Distribution System Operators

In the distribution area, there is one distribution operator - PSG and several dozen smaller distribution system operators operating locally, whose networks are connected to PSG or the Transmission Network Operator - Gaz-System.

- TYPE OF CONTRACTS

There are several dozen entities operating in the trading area, but as in the case of distribution, it is dominated by one large entity - PGNiG. Despite this fact, each customer connected to the PSG distribution network has the right to change the gas fuel supplier to any company that has a General Distribution Agreement with the Distribution System Operator located on the distributor's areas. In the case of the gas market, it is most often one of the PGNiG companies. The change is free of charge. It does not mean gas breaks or replacement of installations. The Distribution System Operator is still responsible for the continuity of supplies.

Agreement with a new seller

The seller must have a license to sell natural gas issued by the Energy Regulatory Office. If the customer decides to change the gas supplier, it is recommended to sign an authorization for the new selling entity to act on customer's behalf. It will inform the relevant Distribution System Operator about the change of supplier and terminate the comprehensive agreement with PGNiG. The seller will also pay a deposit to the Distribution System Operator, which guarantees gas delivery. Changing the seller usually takes about 3 to 4 weeks from the moment the contract is signed.

Natural gas exchange

The sale and purchase of gas fuels on the Polish wholesale market takes place primarily on the exchange market operated by the Polish Power Exchange (Exchange Commodity Market) and, from May 1, 2020, through the Organized Trading Platform.

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The participants of the exchange market are mainly companies trading in gas fuels and the largest end users, who can operate independently after concluding an appropriate agreement with the Polish Power Exchange.

Exchange trading takes place by concluding sales agreements (transactions) between Exchange members.

The Polish Power Exchange operates the following markets for the sale of gas fuels:

- Intraday Market

The subject of trading is the supply of gas in the same quantity during all hours of the delivery period in accordance with the instrument standard (weekly, monthly, quarterly, seasonal and annual).

- Day Ahead Market

The subject of trading is the supply of gas in the same quantity at all hours of the delivery day. It is a base instrument, and one contract corresponds to the delivery of 1 MWh of gas in each hour of the delivery day. Trading is conducted for one day preceding the delivery date, in a continuous quotation system.

- Futures Market with real delivery.

SPAIN

ELECTRICITY MARKET IN SPAIN.

- INTRODUCTION.

With liberalization of the electricity market, starting in 1997 with the 54/1997 electricity sector law, greater efficiency in investments and operation of the electrical systems are being sought. The aim is to reduce costs and, therefore, the price that final users pay for electricity, and increase the quality and reliability of supply.

The Electricity Industry Law 24/2013 (available only in Spanish) of 26 December is the main regulation governing Red Eléctrica's activities. Said Law confers on Red Eléctrica the functions of transmission and system operator (TSO) in Spain, as well as the role of highvoltage transmission grid manager. Although Law 24/2013 repeals practically all of the previous electricity industry law, it upholds the current corporate structure for these activities since it does not repeal the twentythird additional provision. This provision makes specific reference to the Group's holding company, Red Eléctrica Corporación, S.A., and assigns to the subsidiary Red Eléctrica de España, S.A.U. the functions of sole transmission agent, system operator and transmission grid manager, the latter activity being conducted through a specific organisational unit that is sufficiently segregated from the transmission activity for accounting and functional purposes.

The remuneration for electricity transmission and system operation activities is also subject to regulation. Royal Decree-Law 1/2019 (available only in Spanish), of 11 January, on urgent measures to bring the competencies of the Spanish National Markets and Competition Commission (CNMC) in line with the requirements of EU law in relation to Directives 2009/72/EC and 2009/73/EC, modifying Law 24/2013, assigning to the Spanish National Markets and Competition Commission among other things, the powers to approve the methodology, the remunerative parameters, the asset regulatory base and the annual remuneration of power transmission activity and system operation.

Within the scope of these competencies, the CNMC approved Circular 5/2019 (available only in Spanish), of 5 December, establishing the methodology for calculating the remuneration of the electricity transmission activity, which together with Circular 2/2019 (available only in Spanish), dated 12 November, establishing the methodology for calculating the rate of financial return for those activities related to the electricity transmission and distribution, regasification and natural gas transmission and distribution, and Circular 7/2019 (available only in Spanish), of 5 December, approving the standard facilities and the benchmark unit values for operation and maintenance per asset that are to be used in calculating the remuneration for companies that own electricity transmission facilities, establish the current regulatory remuneration framework for the electricity transmission activity in Spain.

In accordance with the aforementioned Royal Decree-Law 1/2019, the methodology for calculating the remuneration for the operation of the electricity system is also established by the CNMC. Circular 4/2019 (available only in Spanish), of 27 November, establishing the methodology for the remuneration of the electricity system operator, sets out the methodology for remunerating the electricity system operator from 2020 onwards.

Also relevant to Red Eléctrica's business activities is Law 17/2013 (available only in Spanish), on security of supply and increased competition in the Spanish insular and non-peninsular

systems, which establishes that Red Eléctrica, in its capacity as operator of these electricity systems, be the owner of all new pumped-storage facilities, provided that it is determined that said facilities have as a main purpose the guarantee of the electricity supply, the security of the system and the integration of nonmanageable renewable energy.

Consumers who are engaged in the open electricity market sign a contract with the marketing company they choose, which includes the contractual conditions that are agreed and the prices to be paid for the supply. The concepts included in the agreed prices are:

- Price freely agreed with the marketing company for the purchase of electricity in the wholesale market.
- Access tolls. The consumers may hire the access to the networks with the marketing company (including this, therefore, in the invoice) or keep it with the distribution company (having to pay the toll concept, and therefore not included on the invoice). In any case the holder of the contract for access to networks is the consumer.
- Hiring the measuring and meter reading equipment. This concept may be on the invoice in the event it is hired. If the consumer opts to buy it, it will not appear on the invoice.
- Special electricity tax, established by law, is expressed as 4.864% of the total amount (supplements included). The taxable amount is made up of the result of multiplying the invoice amount by the coefficient 1.05113 (recovered recently -July 2024-, from reduced tax of 0.5%).
- VAT. Applied on the concepts of the invoice.

In the open market the trading company has the freedom to choose the terms included in the contract and, therefore, on the invoice/bill, so it will be very important to be clear about what concepts are included in the offer of the trading company.

Access tolls are regulated by the level of voltage and hourly discrimination. The tariff periods are defined according to the Royal Decree 1164/2001 of 26 December and subsequent updates, including the Order IET/2444/2014 of 19 December and the more recent Order TED/1247 /2021.

- TYPE OF CONTRACTS

The more common types of contract are:

Fixed price offer

Both parties reach an agreement about the price of kWh. The contract must state not only the price but the volume of energy consumed. Settlement of energy, tolls, surcharges, etc., are the responsibility of the trading company.

Many clients choose this option because it is simple. However, the trading company offer this price based on estimated annual consumption and energy consumed during different periods, so deviations in the consumption profile can lead to penalisation.

These contracts generally incorporate two clauses. These clauses, common in this type of contract, are called "complement for consumption volume" and "deviations from the load curve".

- The complement for volume is the result of estimating a volume consumption (estimate of consumption for a fixed time period). The client undertakes to consume at least a percentage of the consumption during the period the contract is valid. In the case of deviations a surcharge or a bonus may be received, depending on the direction of the variation.
- The complement for load curve: the contracted price is the result of the assessment of a consumer profile in hours Period 6 (sometimes also Period 1), which reaches a certain percentage of consumption during the contract period. Alterations in the time profile change the relative weight of consumption in each period, resulting in a percentage different from the one valued and therefore affecting the average price of the energy supplied. It may involve a surcharge or a bonus, depending on the direction of change.

Fixed-price offer with hourly discrimination

The price for each tariff period is fixed. Periods can be the traditional: peak, plain and valley hours, the 6 periods of the access toll, or anything established between the parties. It is also, as in the above type, a fixed-price contract.

The access tolls, including the power, in this case are included in the price. The liquidation of energy, tolls, surcharges, etc... are the responsibility of the trading company.

Additional terms that are indicated in the contract must be taken into account.

Offer of binomial per period

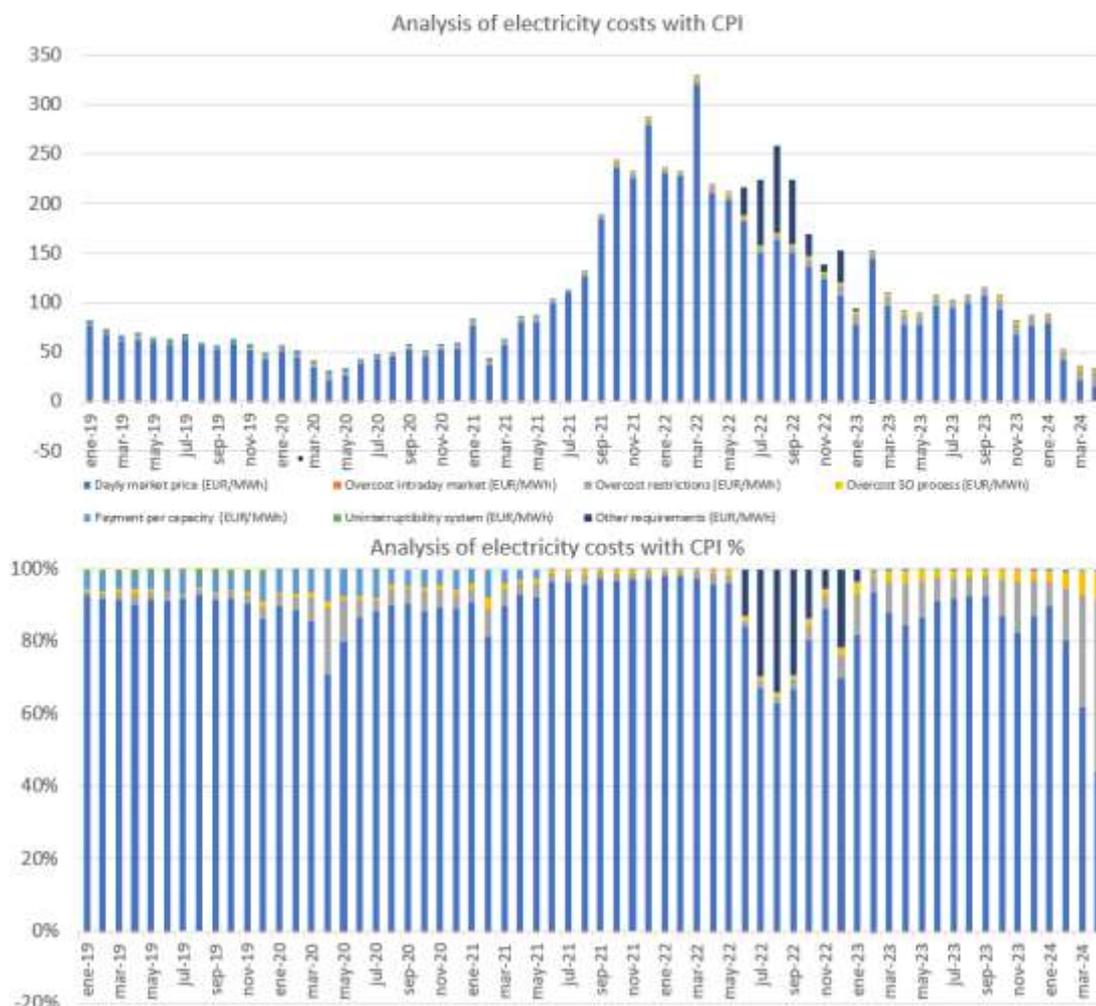
The price per kWh of energy and the price per kW of power is fixed for different periods.

It is targeted at customers with variation both in the consumption profile and the volume of consumption. The average price may be different for each month. This enables the customer to optimize the cost of energy.

Offer price-indexed "pool"

In these contracts, the price is variable and depends on the purchase price of energy in the wholesale market. In this way the risk, instead of being assumed by the trading company, is partially transferred to the client. The customer must report their daily forecasts of electricity demand, and pay the penalties stipulated in the contract for deviations incurred between the electricity requested and what is really consumed.

Electricity prices are highly uncertain due to various factors. While the integration of renewable energy sources generally tends to lower prices, the final price is determined by the last technology that bids into the market. This can significantly drive up prices due to the high costs associated with natural gas. As seen in 2022 with the Ukraine-Russia conflict, fluctuations in gas prices can lead to considerable volatility in electricity costs, making it challenging to predict future price trends accurately. Additionally, although the integration of renewables sensibly reduces bid prices, it comes with other market regulation costs that must be accounted for.



Source: Own elaboration based on data from OMIE

Multiclick Contracts in the Electricity Market:

Multiclick contracts are innovative agreements designed to provide flexibility and cost optimization for electricity consumers. Under these contracts, consumers can lock in different electricity prices at multiple points in time, rather than committing to a single fixed price for the entire contract duration. This strategy allows consumers to benefit from lower prices when market conditions are favorable and manage their electricity costs more effectively. Multiclick contracts typically include the following features:

- Multiple Price Locks: Consumers can secure electricity prices at various points during the contract period, taking advantage of dips in market prices.
- Quantity Flexibility: These contracts may allow consumers to lock in prices for different quantities of electricity, tailoring their supply to match anticipated demand.
- Hedging Against Price Volatility: By locking in prices at multiple times, consumers can mitigate the risk of price spikes, especially in volatile markets influenced by factors such as natural gas costs or geopolitical events.
- Regulatory Compliance: Multiclick contracts are structured to comply with market regulations, ensuring transparency and fairness in pricing and supply arrangements.

- **Cost Management:** These contracts provide a strategic approach to managing electricity expenses, enabling consumers to budget more effectively and avoid sudden increases in energy costs.

Overall, multiclick contracts offer a dynamic and responsive solution for consumers in the electricity market, balancing the benefits of renewable energy integration with the need for cost stability and market compliance.

NATURAL GAS MARKET IN SPAIN.

- **INTRODUCTION.**

The process of liberalization of the natural gas sector is parallel to the process of the electricity sector. The principles set out in European Directive 98/30 / EC for the creation of the European internal market in natural gas were incorporated into Spanish law by Law 34/1998 on the Hydrocarbons Sector, with last modification on 28 December 2023 to adapt to current market and new environmental laws.

The natural gas system includes facilities of the transport network, distribution networks, regasification plants, underground storage and other complementary facilities.

As in the case of the electricity sector, some activities are considered natural monopolies. These activities (regasification, basic storage, transportation and distribution) are subject to a system of regulated income by the Spanish government, while activities such as procurement and marketing of energy are developed in a regime of free competition.

The natural gas market in Spain operates through a combination of regulated and liberalized mechanisms, overseen by regulatory bodies such as the CNMC (National Commission of Markets and Competition) and managed by infrastructure operators like Enagás.

Natural Gas Market Structure:

- **Regulated Segment:** In the regulated segment, tariffs and prices are set by the government or regulatory authority to ensure fair access and pricing for consumers.
- **Liberalized Segment:** The liberalized segment allows for competition among suppliers and consumers, with prices determined by market forces. Consumers can choose their gas supplier and negotiate contracts based on their needs.

Role of CNMC (National Commission of Markets and Competition):

- **Regulation:** The CNMC regulates and supervises the natural gas market, ensuring compliance with laws and regulations, promoting competition, and protecting consumer interests.
- **Tariff Regulation:** CNMC sets tariffs for access to natural gas infrastructure, ensuring fair and transparent pricing for all market participants.
- **Market Oversight:** CNMC monitors market behavior, investigates anti-competitive practices, and enforces regulations to maintain a level playing field in the gas market.

Role of Enagás:

- Infrastructure Management: Enagás operates and maintains Spain's natural gas transmission and storage infrastructure, including pipelines and storage facilities.
- System Operation: Enagás ensures the safe, reliable, and efficient operation of the natural gas transmission system, coordinating supply and demand to meet market needs.
- Market Facilitation: Enagás facilitates market transactions by providing access to its infrastructure for gas transportation and storage, enabling suppliers and consumers to trade gas efficiently.

In summary, the natural gas market in Spain operates through a combination of regulated and liberalized segments, with oversight from regulatory bodies like the CNMC and management of infrastructure by companies like Enagás. Their roles include regulation, tariff setting, market oversight, infrastructure management, and system operation to ensure a fair, competitive, and reliable natural gas market for consumers and suppliers alike.

In free retail market, trading companies sell natural gas to their customers (domestic, commercial and industrial and power plants using natural gas) under terms freely agreed by both parties.

Consumers of natural gas with more than 50,000 kWh / year annual consumption must be supplied by a trading company at free pricing.

Consumers with annual consumption below 50,000 kWh / year voluntarily have the possibility of contracting in the free market instead of last resort tariff (established by Government).

The cost components that the trading company allocates in their offers to consumers are:

- The cost of gas purchases in the wholesale market, managed by the trading companies in the wholesale acquisition (buying gas directly from producers, other traders, etc.)
- The cost of access tolls for use of gas transport and distribution networks, regulated by law. The consumer may contract directly the access to the network and pay access tolls for their supply or may authorize the trading company to manage this on their behalf.
- Rental of measuring equipment.
- VAT. Applied to the concepts included in the bill.

In the liberalized market, the trading company is free to choose the terms included in the contract and therefore the invoice/bill, so it will be important to be clear what items are included in the offer of the trading company.

The access tolls for the transport and distribution of natural gas are regulated by RD 949/2001 (updated in December 2020), and economic values are regularly updated by the government.

Each consumer pays the corresponding access tolls, depending on their pressure connection to the network and their annual consumption.

- TYPE OF CONTRACTS

The more common types of contracts are:

Fixed price Supply contracts

It is usually format for customers with small and medium consumption. Both parties reach an agreement on a single price per kWh and agree on the billing terms determined by the daily amount contracted.

Indexed Supply contracts

Similar to the case of electricity supply, in these contracts, the costs of hedging the risk of changes in prices of natural gas supply, which are usually indexed to variable indices of energy markets, are distributed.

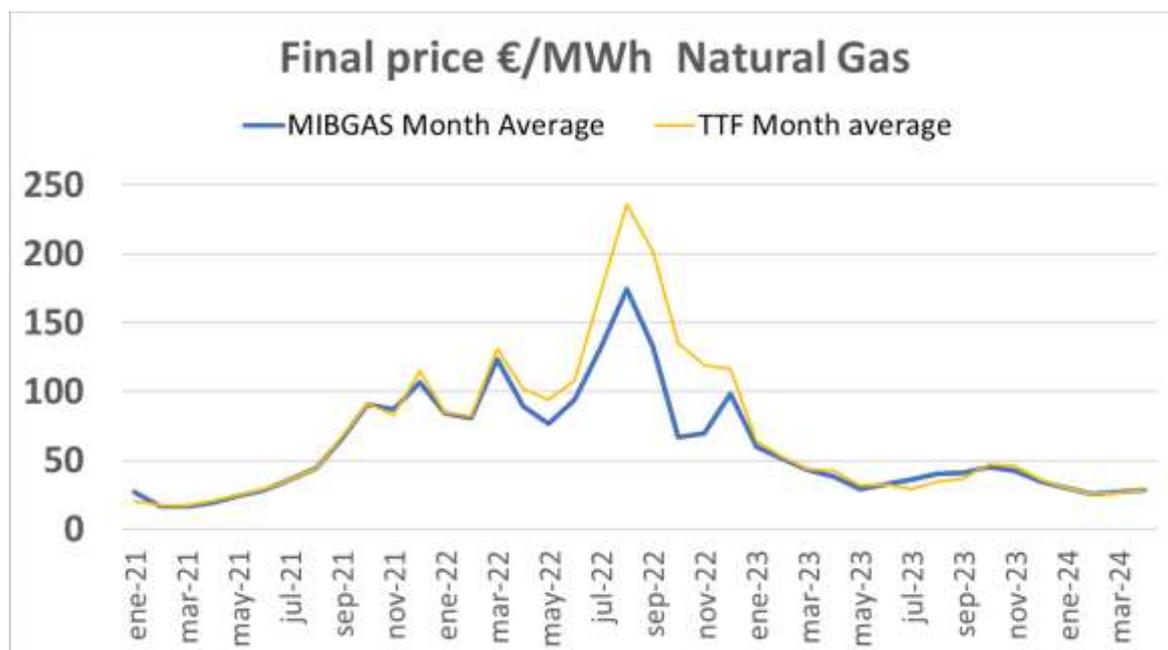
In this way, the part of the supply price corresponding to the purchase of gas is not a fixed term, but rather the real cost or its variation with respect to the value of one or more of the following benchmarks is transferred to the consumer.

Historically, these markets were the referred ones:

- CMP: Cost of Raw Materials for the tariff market in Spain, Spanish border.
- HH (Henry Hub): gas prices on the spot market NYMEX US
- NBP (National Balancing Point): gas prices on the spot market in the UK
- Brent: Brent crude international quote

However, in recent years, the referred markets have also included (and have displaced other markets) the followings:

- MIBGAS (Mercado Ibérico del Gas): The Iberian Gas Market, which reflects gas prices in Spain and Portugal.
- TTF (Title Transfer Facility): Dutch gas prices, serving as a benchmark for natural gas prices in Europe.



Source: Own elaboration based on data from TIB and MIBGAS

Indexed contract with maximum price limit (price cap)

It is a variant of contract indexed to energy market values (oil prices, gas prices in spot markets, etc.) but with a maximum price limit, which gives some assurance to consumers on upward price fluctuations in international oil and gas markets.

Indexed contract with maximum price and minimum price

It is a variant of contract indexed to energy market values (oil prices, gas prices in spot markets, etc.) but with a maximum price limit and a price floor, which gives some assurance to consumers on upward price fluctuations in international oil and gas markets, but it does not allow you to fully benefit from a significant drop in prices.

Long term gas supply contracts

In Spain the information of the duration of the individual long-term gas supply contracts is not public. However, historically most of the gas supply contracts of all Spanish marketers have been long-term contracts with producing countries. That applies for both, LNG and pipelines supply contracts. Long term gas supply contracts don't hinder competition, since there is available entry capacity in Spain, with the exception of France and Morocco interconnections; in addition, LNG can be diverted to other markets.

SOURCES:

- Ministerio transición ecológica y reto demográfico
<https://www.miteco.gob.es/es/energia.html>
- OMIE. <http://www.omie.es/inicio>
- IDAE. <http://www.idae.es/>
- Comisión nacional de los mercados y la competencia. CNMC.
<https://www.cnmc.es/ambitos-de-actuacion/energia>

OTHER EU COUNTRIES

For other countries of the EU, it is possible to check the following website:

http://eur-lex.europa.eu/summary/chapter/energy.html?root_default=SUM_1_CODED=18

ANNEX VII ENERGY AUDIT REPORT

In drawing up the Energy Audit Report you are recommended to follow the index as outlined below:

1. Introduction and applicable legislation

The AENEAM project aims to accelerate the transition of Agri-food EU industry towards a sustainable growth model by increasing the up taking of the recommended measures form Energy Audits, encouraging companies (C10 - C11) to undergo energy audits and the subsequent implementation of the recommendations from these audits, promoting digital solutions.

One of the actions included in the technical tools is to carry out an energy audit.

In this sense, the company XXXXXXX S.L., has been selected to carry out an energy audit at the plant that it has in XXXXXXX XXXX, and whose activity is XXXXXXX (NACE XX).

The energy audit was made according to the specific methodology developed in the project AENEAM. This methodology is based on the UNE EN 16247 Part 1 "Energy audits: General Requirements", Part 2 "Energy audits: Buildings" and Part 3 "Energy audits: Processes"

This audit includes energy analysis of plant facilities, both auxiliary and process, in relation to the use of energy and efficiency, to propose improvement actions, with assessment of profitability based on the generated energy savings.

The development of the energy audit is framed as an initial action, within the scope of the AENEAM project to reduce energy consumption.

2. Objectives, boundaries and phases of an energy audit

Objectives

The main objective of an energy audit is to reduce energy consumption and costs associated with it, analysing the causes and factors affecting such consumption, without affecting the production or the quality of the service.

Therefore, with this audit we intend to achieve the following objectives:

- To obtain reliable knowledge of the energy consumption of the company and the cost, identifying the factors that influence energy consumption and introducing energy performance indices;
- To detect and evaluate different energy saving opportunities.

Boundaries

Boundaries of the energy audit in each company will be established. At this point, the systems and/or equipment included in the audit will be listed and described, as well as energy analyses performed.

Phases

To carry out this energy audit we performed the following steps:

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1. Preliminary contact and initial meeting with the company.
2. Data collection
3. Preliminary analysis
4. Field work
5. Energy analysis
6. Decarbonization.
7. Report and final meeting

3. General Company. Production and operation mode.

It will include the following elements:

| GENERAL DATA OF COMPANY | | |
|--|--|----------------|
| Company name | | |
| NIF (tax identification number) | | |
| Address | | |
| City | | |
| Region | | |
| Postcode | | |
| Country | | |
| Contact person | | |
| Phone number | | |
| e-mail | | |
| web | | |
| Nace code (2009) | | |
| Activity sector | | |
| Main activity of the company. Description | | |
| Age of the company | | age |
| Number of employees | | people |
| Plant surface | | m ² |
| Annual energy consumption 2023 | | KWh/year |
| Annual energy cost 2023 | | €/year |
| Percentage of energy cost on total cost (2023) | | % |
| Production value 2023 | | € |

| OPERATION MODE | | |
|----------------------|--|-----|
| Working hours | | |
| Hours / day | | h/d |
| Days / week | | d/w |
| Days / year | | d/y |
| Hours / year | | h/y |

| PRODUCTION DATA | | | | | | | | | | | | | | |
|-----------------------|--------------|------|------|------|------|-----|------|------|------|-------|------|------|------|-------------------------|
| | | 2023 | | | | | | | | | | | | |
| Type of raw materials | Type of unit | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual consumption 2023 |
| | | | | | | | | | | | | | | |
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| | | 2023 | | | | | | | | | | | | |
|--------------------------|--------------|------|------|------|------|-----|------|------|------|-------|------|------|------|------------------------|
| Type of finished product | Type of unit | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual production 2023 |
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4. Description of production process. Block diagram.

- A) Description of the production process of the company, including energy consumption equipment, power of equipment, operating mode, temperatures of flue / gases, etc.
- B) Description of auxiliary facilities, including energy consumption equipment, power of equipment, operating mode, etc.
- C) Preparation of block diagram with the sequence of the most important phases. Included in each phase is the type of energy consumed, amount, %, etc.

5. Consumption and energy costs

- A) Analysis of the electricity and fuels used in the company and its monthly energy distribution as well as usage points. Monthly data for the year 2023.
- B) Study of billing and hiring of different energy sources.

Obtaining the following consumer graphics

- Graph of monthly consumption of each energy source. Line chart or column chart.
- Graph of annual consumption with percentage distribution of each energy source (% , pie chart).
- Graph of annual energy cost with percentage distribution of each energy source (% pie chart).
- In the case of electricity consumption, if possible, a graph of hourly consumption during a typical week. Line graph.

In addition, the following annual data will be obtained, relating production to consumption and energy costs:

- Specific thermal cost and consumption:

| | |
|-------------------------------|-----------------------|
| Annual production: | t, piece, ... |
| Annual thermal consumption: | GWh |
| Hours of use: | h |
| Annual thermal cost: | € |
| Specific thermal consumption: | GWh/t, GWh/piece, ... |
| Specific thermal cost: | €/t, €/piece, ... |
- Specific electrical cost and consumption:

| | |
|--|----------------|
| Annual production: | t, piece, |
| Annual electrical consumption (including self-consumption from renewable sources): | GWh |

- | | |
|----------------------------------|-----------------------|
| Hours of use: | h |
| Annual electrical cost: | € |
| Specific electrical consumption: | GWh/t, GWh/piece, ... |
| Specific electrical cost: | €/t, €/piece, ... |
- Specific energy consumption and cost:

| | |
|----------------------------------|-----------------------|
| Annual production: | t, piece, |
| Total annual energy consumption: | GWh |
| Total annual energy cost: | € |
| Specific energy consumption: | GWh/t, GWh/piece, ... |
| Specific energy cost: | €/t, €/piece, ... |
 - Quantification of energy performance indicators.

Once energy performance indicators are set, they will be calculated each month for the last year. A monthly graph with the trend over time of these indicators will be a precious tool for a clearer observation of their evolution.
 - Baseline establishment.

A baseline for each energy performance indicator specified will be established.

6. Energy facilities (Reception facilities, auxiliaries and process)

In this section, a tour of all the facilities where there is energy consumption is carried out, describing the main consumption equipment and their characteristics.

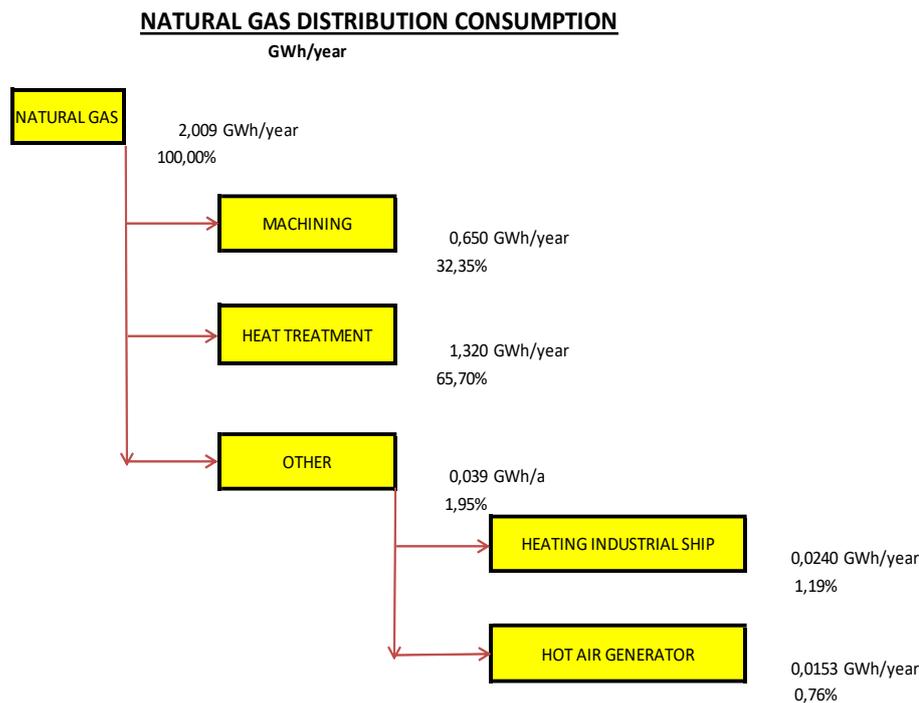
- 6.1. Reception facilities: equipment or systems directly involved in energy supply (example: transformers, electrical substation, fuel supply systems, renewable energy systems, etc.)
- 6.2. Auxiliary facilities (horizontal technologies and services): equipment supporting one or more manufacturing process (example: compressed air system, boilers for steam production, air extraction system, electric motors, etc.) and systems that indirectly affect manufacturing process (example: office, lighting, indoor heating and cooling etc.)
- 6.3. Process facilities: equipment directly involved in a specific manufacturing process (example: transfer machines, press, furnaces, dryers, etc.).

7. Energy distribution

In this section, the energy distribution of each type of energy among the various consuming equipment is carried out.

To this end, flow charts of use are performed with absolute and percentage data.

e.g.



A graph of hourly distribution of electricity consumption during a typical week will be carried out. In this graph, day and night consumption on weekdays and on Saturdays and Sundays will be shown.

8. Energy Analysis

In this section, an analysis of the facilities subject to improvement, based on the data provided by the company and the measurements and the study of possible energy improvements is carried out.

e.g.

Energy analysis of furnaces

Machining energy analysis

Heating energy analysis of plant

Energy analysis of heating generator

Study of main electric motors, more efficient, variable speed use

Study of lighting system

Study of automation facilities

Possibility of changing energy source

Energy contracting optimization

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9. Decarbonization

This section proposes knowledge of the current environmental state of the company in terms of its energy performance, considering the following points:

- Calculation of the Carbon Footprint in its direct emissions (scope 1) derived from its energy consumption and indirect emissions (scope 2) resulting from its energy supply by third parties (electric energy, steam, hot water, etc.).
- GHG reduction derived from the implementation of the energy efficiency measures and change of energy sources provided for in the audit.
- Proposal of other possible measures such as purchasing green energy.

10. Good Practices

A series of best practices for energy savings will be established.

11. Summary of savings and investments

11.1. Energy savings measure

A chart-summary, where savings and necessary investments is shown in order to carry out saving measures described above, and the period of return on such investments.

The energy saving measures will be arranged in descending order of NPV

| Saving measure | Final energy saving (GWh/year) | Primary energy saving (GWh/year) | Primary energy saving (Tep/year) | Cost savings (€) | Investment (€) | Gross amortization period_GP (years) | Net Present Value NPV | CO ₂ emissions reduction (Kg CO ₂) |
|----------------|--------------------------------|----------------------------------|----------------------------------|------------------|----------------|--------------------------------------|-----------------------|---|
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Note:

The total annual primary energy saving of the company will be calculated by each partner in their own country.

FRANCE

| type of energy imported by the building | Energy transformation coefficients energy entering the building into non-renewable | Energy transformation coefficients energy entering the building into primary energy |
|---|---|--|
| Wood | 0 | 1 |
| Electricity | 2.3 | 2.3 |
| District heating network (heat) | 1- Ratio of renewable or recovered energy (heat) | 1 |
| District heating network (cooling) | 1 | 1 |
| Renewable energy captured on the building or plot | 0 | 0 |

RE 2020 modifies the transformation conventions used in RT 2012 and distinguishes 2 categories of conversion:

For example, wood energy is considered 100% renewable, so the conversion coefficient of wood energy to non-renewable will be equal to 0. For district networks, the value of the coefficient Coef EPnr depends on the network's renewable or recovered energy ratio.

Depending on the energy mix (the more energy mix, the more renewable energy, such as biomass, the lower the coefficient will be). For cooling networks, the non-renewable primary energy conversion energy is equal to 1.

Renewable energies captured on the building or plot of land are not taken into account in the consumption calculations. RE 2020 takes into account self-consumption, which covers part of needs. Consumption is calculated energy vectors used to cover the remaining to cover the remaining needs after self-consumption. This calculation method results in a value of zero for both coefficients EP and EPnr.

1 Source : Réglementation environnementale RE2020, Minister of ecological Transition and cohésion of territories

ITALY

To obtain total annual primary energy saving (GWh), the following conversion factors will be used according to specified in section 5.1 of document "The EE Benchmarking and Energy criteria selection":

- ✓ Electricity from the grid: 2,42
- ✓ Natural gas: 1,05
- ✓ Diesel and fuel oil: 1,07
- ✓ Solid Biomasses: 1,00
- ✓ Coal: 1,10
- ✓ GPL: 1,05

Source: Interministerial decree 26 June 2015 - Application of energy performance calculation methodologies and definition of the requirements and minimum requirements of buildings.

On the other hand, the conversion factors of the most common operating units of each type of energy to the reference energy unit to be used (kWh) will be the following:

- ✓ Electricity from the grid: 2,175 kWh/kWhE
- ✓ Natural gas: 9,723 kWh/Smc
- ✓ Diesel and fuel oil: 11,863 MWh/t (9,965 kWh/l)
- ✓ Solid Biomasses: 4,652 MWh/t (for biomass pellets)
- ✓ Gasoline: 8,897 kWh/l
- ✓ Coal: 7,917 MWh/t
- ✓ GPL: 12,793 MWh/t

Source: Ministerial Circular 18th of December 2014 of Ministry of Economical Development, FIRE conversion factor (Italian Federation for Rational use of Energy).

POLAND

To obtain primary energy from final energy the following conversion factors will be used:

- ✓ Electricity: 2,5
- ✓ Natural gas: 1,1
- ✓ Diesel oil: 1,1
- ✓ Benzine: 1,1
- ✓ Biomass: 0,2
- ✓ Biogas: 0,5
- ✓ PLG: 1,1
- ✓ Hard coal: 1,1
- ✓ Heating oil: 1,1

Source: The Minister of Climate and Environment announcement from May 22, 2023 - the consolidated text of the Minister of Energy regulation regarding the detailed scope and method of preparing an energy efficiency audit and methods of calculating energy savings

SPAIN

To obtain total annual primary energy saving (GWh), the following conversion factors will be used according to specified in section 5.1 of document "The EE Benchmarking and Energy criteria selection":

- ✓ Electricity: 2,403
- ✓ Natural gas: 1,195
- ✓ Diesel oil: 1,182
- ✓ Biomass pellets: 1,113
- ✓ Non-densified biomass: 1,037
- ✓ PLG: 1,204

Source: *CO₂ Emission Factors and conversion coefficients to primary energy from different sources of final energy consumed in the buildings sector in Spain (Joint resolution of the Ministries of Industry, Energy and Tourism, and the Ministry of Public Works), published in January 2016.*

On the other hand, the conversion factors of the most common operating units of each type of energy to the reference energy unit to be used (kWh) will be the following:

- ✓ Natural gas: 10,494 kWh/Smc.
- ✓ Diesel oil: 11.944 kWh/t (10,033 kWh/l)
- ✓ Biomass pellets (humidity < 15%): 5.000 kWh/t
- ✓ Biomass chips (humidity < 40%) 3.600 kWh/t
- ✓ PLG: 13.139 kWh/t

Sources: For natural gas, diesel oil and PLG *National inventory of GHG, 2023*. For biomass pellets *Lower heating values of the main energy sources, IDAE*.

11.2. Benchmarking

At this point, the EnPI calculated in section 5 will be analyzed in comparison with the reference values of said indicator given in the sectoral BAT present in the documents:

- Commission Implementing Decision (EU) 2019/2031 of 12 November 2019 establishing best available techniques (BAT) conclusions for the food, drink and milk industries, under Directive 2010/75/EU of the European Parliament and of the Council
- Commission Implementing Decision (EU) 2023/2749 of 11 December 2023 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU on industrial emissions, for slaughterhouses, animal by-products and/or edible co-products industries.

Furthermore, these reference values have been extracted in section 7 of document "The EE Benchmarking and Energy criteria selection".

In a second step, after proposing the energy efficiency measures and implementation of renewables, the new value of this EnPI will be calculated and its comparison with the reference values.