# *IEE/12/758/SI2.644752*

D 3.1: Audit Guide



Transfering Energy Save Laid on Agroindustry

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#### About this report

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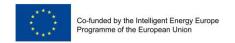




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#### 0. Introduction

This deliverable has been elaborated with the aim of support auditors in their task of audit the agro-food cooperatives included in the project: olive oil mills, wineries, fruit and vegetable processing plants, and animal food factories. These auditors must be previously trained by CIRCE as indicated in the task 2.2, 2.3, and 2.4 of TESLA project. This guide will support them to remember and clarify key points of the courses at the moment they have to execute their audits, and will also help any other person interested in developing audits for the agro-food sub-sectors of the project.

This guide is available in the four languages of the project (English, Spanish, French, Portuguese, and Italian) and as a public document of the project it can be downloaded from the project webpage <a href="https://www.teslaproject.org">www.teslaproject.org</a>

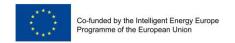
The present document is the core of the audit guide, but it is also complemented by the following annexes:

- Annex I: Audit Report template
- Annex II: Commitment Letter template (to be signed by the cooperative's responsible person)
- Annex III: D 3.2 Audit questionnaires
- Annex IV: Check list Excel template (for the four sub-sectors of the project)
- Annex V: Inventory Excel template
- Annex VI: User's guide for the grid analyzer and measuring methodology
- Annex VII: D 6.1 Software tools report
- Annex VIII: D.5.3 Best practices list (for the four sub-sectors of the project)
- Annex IX: Investment analysis tool (Excel file)
- Annex X: D.2.2 Power Point presentations of the training course (in the four languages of the project)

This guide will be elaborated taking into account the available resources of TESLA project. Therefore, number of visits to the cooperatives, measuring time for grid analyzer, and working hours for the execution of the audit report calculations will be determined by the limited economic and human resources of the project.

The result of this guide will be the audit reports edited by the auditors of the four countries to the 110 agro-food cooperatives audited in the project. These reports will be gathered in the deliverable D 3.4

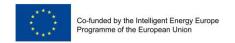




Audit Reports. Besides that, after reviewing the reports, an Audits Quality Report will certify their execution quality.

This Audit Guide has been elaborated taking into account the instructions of the European Standard UNE-EN 16247:2012, as well as the recommendations obtained by this TESLA project under the task 5.2 Proposals to audit plan (quantification and monetizing criteria in Best practices) and task 6.2 Proposals to audit plan. It will also include lessons learnt by another projects like CO2OP, EINSTEIN, ENGINE, BESS and EXBESS.





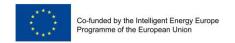
# 1. First step of the audit: Previous conversations and Commitment Letter

Once the list of cooperatives to be audited has been defined (in the case of TESLA project, they have been chosen taking into account their annual energy consumption), the auditor should maintain some conversations with the responsible personnel of the cooperative. In order to save money for the coming trips, these conversations can be by phone and/or email. By these conversations the auditor will explain them TESLA general objectives, scope and boundaries of the audit, and should take note about the expectations of the cooperative's personnel about the results of the audit.

After these detailed information about the project and the auditing process, the auditor and the cooperative's responsible personnel should sign a **Commitment Letter** (see **Annex II**) expressing the commitment of the cooperative to help the auditor in the execution of the audit. It will be signed by the responsible person of the cooperative (president, director or manager). Therefore, this letter will help the auditor to obtain the necessary information he will have to ask for to the overall cooperative's personnel, and will determine the person (technician, maintenance personnel) designated by the responsible of the cooperative to help the auditor, place the grid analyzer, and explain all the process in detail, from the energy point of view. It won't be necessary to bring this letter personally to the cooperative, but in the presentation of this letter the auditor should explain in detail to the responsible person of the cooperative the context of the energy audit he is going to develop in their cooperative: the TESLA project, the steps of the energy audit process, the conclusions and steps forward. Likewise, the **definition of the scope of the** energy audit should be clearly explained at this step, since it will be crucial to establish the range, degree of thoroughness required, level of detail and limits of the audit, and to avoid false expectations on the results of the audit. Besides that, the auditor and the cooperative will agree the timescale of the energy audit in order to execute it disturbing as less as possible, but always coinciding with the full performance of the processes.

The scope of energy audits executed under TESLA project will include only energy consumptions (non CO2 emissions, nor carbon footprint), and the proposed improvement measures will only be commercial machines and devices (not pilot equipments or machinery under developments). The scope of each specific cooperative should be defined by the auditor considering the buildings, facilities and working processes of each cooperative. The audit will include only the industrial process, so transports will not be included in it (only indoors transports by forklifts).





# 2. Second step of the audit: Collecting data before the first visit

After the signature of the Commitment Letter the auditor will be ready to be in contact with the technical personnel designated by the cooperative and ask for all the information needed for the audit. This information could be obtained by telephone conversations or by emails, although it could be obtained personally by visiting the cooperative in the case that the allocated budget for each audited cooperative is enough for more than 4 visits (the four estimated visits).

The information needed at this first contact with the technical personnel of the cooperative is the one included in the following **Annexes**:

#### Annex III-Audit questionnaires

Fill in the overall questionnaire, and ask the cooperative for the complementary documentation (plans of the cooperative, circuit diagram, user's guide of some machines and equipments...)

Please, pay special attention to the figure of "power installed [kW]", which is different from available power in the cooperative. It is very common that maintenance technician of the cooperative understand "installed power" like "transformer power capacity (kVA)". However "power installed" refers to the kW resulting from the sum of each devices power, and "transformer power capacity" refers to the power capacity of the transformer connected to the grid, it is the electricity available from the connection of the cooperative to the general grid, measure in kVA.

#### Annex IV-Checklist

Fill in all the <u>blue boxes</u>, except the ones in the "industrial process" sheet, which will be filled after the Annex V-Inventory and after measurements done using the grid analyzer to complete the data.

#### Annex V-Inventory

Fill in the table as much as possible, although some information requested on it will be obtained in the first visit to the cooperative (specially the column referred to "estimated hour/day" and "estimated day/year"). A first draft of the inventory could be obtained from the Register of Industries (in Spain) where the governmental institutions control each company's facilities.





When mentioning lighting in the Inventory, remember to include balasts from the discharge lamps, and check its performance during the audit.

All the gathered information in these three Annexes regarding cooperative's production, energy consumption, etc must be referred to a complete productive year (one campaign), or if possible, two years/campaigns. So, depending on the analyzed sub-sector the data collection will start as follows:

- In the case of Olive Oil Mills: from October-2011 to September-2013
- In the case of Wineries: from August-2011 to July-2013
- In the case of Fruit and Vegetable Processing Plants: from January-2012 to December-2013 since their activity will be continuous during the whole year.
- In the case of Animal Feed Factories: from January-2012 to December-2013, due to their continuous activity throughout the year.

In order to obtain the above mentioned information for the Annexes, it will be necessary to ask the cooperative for the following **Documents**:

#### Electricity bills received during a whole year (12 months) or two years:

The auditor must ask specifically to the cooperative's personnel to make sure that electricity bills correspond to the overall factory and that no other factories' consumptions (other processing plants for other products of the cooperative) are included on these bills.

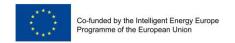
When calculating the average electricity price per kWh, remember to NOT include taxes, or penalties for reactive energy consumption, or other extra costs added to kWh cost in the bills. However, a weighed average could be calculated jointly for the different contracted tariffs.

**NOTE**: if possible, it will be very useful to obtain also the breakdown of total consumptions of the cooperative (in Spanish it is called "CURVA CUARTOHORARIA" and includes the cooperative's electricity consumption every 15 minutes).

#### Other energy bills (gasoil, petrol, biomass, natural gas...)

The auditor should gather all the bills regarding the cooperative's energies consumptions. It will be very important especially for the calculations related to the "lower calorific power" (specified in the bill),





which depends on the fuel's producer, and on the type of biomass. Likewise, it will be important for the conversion of consumed liters or kilograms into kWh, to sum up and compare all energy consumptions.

#### Plans and drawing

It will be also very useful to have in advance the plan of the facilities, the building and the distribution of machines and equipments, as well as the electricity drawings. It will allow the auditor to study and decide, before the *in situ* visit, the most appropriated places to measure using the grid analyzer and to check the list of equipments of the cooperative.

All these information gathering should be developed in two working days in order to follow TESLA requirements.





# 3. Third step of the audit: First in situ visit to the cooperative

This <u>first visit</u> should be mainly to check all the information gathered previously, and obtain the rest of the information needed that could not be obtained by telephone or by email. Besides that, the most important task for this visit will be to measure energy consumptions of the most important equipments of the cooperative, working in full performance, and finally leave the grid analyzer placed to measure some working days' energy consumption.

The technical personnel should be previously informed about the inconveniences that the measurements could produce, and that this day the cooperative should be working in full performance. Likewise, as established in the Commitment Letter, the technical personnel should help the auditor in his/her tour around the cooperative's facilities, explaining the auditor all the process, operating routines, working times, biggest energy consumption, and also identifying preliminary energy improvements.

It will be very important to remember that the **grips of the grid analyzer would be placed by the technician of the cooperative, not by the auditor**. It will be especially important in those cases where national legislation ask for specific certification to the person managing the electricity installations (France and Italy).

In order to execute correctly the audit, it will be necessary to bring the following equipments and information to the visit:

- Grid analyzer
- Camera (to take pictures that will have to be included in the reports)
- Completed annexes (see Second step of the audit)
- Thermographic camera (optional)
- Gas analyzer (optional)

The instructions for auditor to remember how to use the grid analyzer are included in **Annex VI-User's** guide for the grid analyzer and measuring methodology.

During this visit, the following measurements should be done. For the measurements indicated as "at least 1 day" the grid analyzer will be placed in this first visit, and will be removed during the second visit to the cooperative. In those subsectors in which more than one process is indicated as "at least 1 day", the





auditor should decide which one will be measured during more than one day, or when possible, use more than one grid analyzer, or visit the cooperative more times.

It will be also important for the auditor to take the corresponding decisions when, for example, it will be impossible to separate wires from different equipments, or the equipment we want to measure take its electricity from the same source as another we do not want to measure,... In all these particular cases the auditor should take the best decision for the quality of the audit.

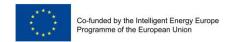
In all the following lists of processes, it will be necessary to set/configure the grid analyzer to measure every 5 seconds, except for measurements longer than 2 hours (or "at least one day" processes) where grid analyzer should be set to measure, for example, every 1 minutes.

#### Olive oil mills cooperatives:

Process	Measuring unit	Time
Reception	kWh/ton	At least 2 h
Grinding	kWh/ton	At least 2 h
Churning and mixing	kWh/ton	At least 2 h
Horizontal Centrifugation**	kWh/ton	At least 1 day
Vertical Centrifugation**	kWh/ton	At least 1 day
Storage**	kWh/m³	At least 1 day
Lighting***	kWh	Inventory
Other	kWh	From the difference between measurement and electricity bill
Thermal production	kWh/m³	From energy bill (natural gas, diesel or biomass)*

<sup>\*</sup>Energy bills: It is easy to see biomass boilers in olive oil cooperatives. These boilers use olive pit that is produced by the cooperative itself, so there will not exist bills. However, the auditor should ask to





cooperative's manager about what is the amount of olive pit consumed and multiply this value by biomass Low Calorific Power (around 4000 - 4500 kcal/kg).

\*\* In the case of olive oil mills it is important to clarify what do these terms included in this audit guide mean, in order to avoid misunderstanding in the terminology and language uses in the four countries:

- "Horizontal centrifugation" is referred to the first machine in the centrifugation process which separates the solid phase of olive paste and the liquid phase (oil and vegetation water). It is done by a machine sometimes called "decánter". It can also be executed in three or two phases, depending on whether the products disposed are three (oil, vegetation water and solids), or two (oil and wet pomace) respectively.
- "Vertical centrifugation" is referred to the machine that will separate oil and vegetation waters.



Picture 1. Decánter



Picture 2. Vertical centrifugation

- "Storage" is referred to the process where the liquid is storage and decanted in big tanks to separate the pure liquid and the grounds (dregs, lees). In Portuguese, the machine doing it is called "silo". Picture 3. Olive oil tanks.







#### Wine cooperatives:

Process	Measuring unit	Time
Reception	kWh/ton	At least 2 hours
Pressing	kWh/ton	Two complete pressing processes
Cooling production for fermentation	kWh/m³	At least 1 day
Pumping*	kWh/m³	One filling tank process
Bottling	kWh/bottle	At least 2 hours
Lighting***	kWh	Inventory
Other	kWh	From the difference between measurement and electricity bill

\*Pumping: it is clear that there are several types of pumpings in cooperatives: from trailer to tank, from tank to tank, from underground tank to overground tank, with different kinds of wines or must (grape-juice) and each one has different energy consumption. However due to it is not possible to measure indepth all of them it is recommended that the auditor selects most typical pumping operation in each cooperative and measure energy consumption on it.

#### Fruit and vegetables processing plants cooperatives:

Process	Measuring unit	Time
Reception	kWh/ton	At least 2 h
Cleaning and Drying	kWh/ton	At least 2 h
Packaging	kWh/ton	At least 2 h





Process	Measuring unit	Time
Cooling conservation	kWh/ton	At least 1 day
Lighting***	kWh	Inventory
Other	kWh	From the difference between measurement and electricity bill

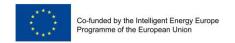
# Animal feed factories cooperatives:

Process	Measuring unit	Time
Raw materials storage	kWh/ton	At least 2 h
Elevation of raw material to begin of the process	kWh/ton	At least 2 h
Grinding	kWh/ton	At least 1 day
Pelleting	kWh/ton	At least 1 day
Thermal production	kWh/ton	Inventory
Packaging	kWh/ton	At least 2 h
Lighting***	kWh	Inventory
Other	kWh	From the difference between measurement and electricity bill

\*\*\*Lighting: in case old light bulbs exist, it would be necessary to check what the real energy consumption is, by measuring with grid analyzer in lighting line, due to energy consumption usually increases very fast after exceeding its lifetime.

Also, regarding lighting, balasts from discharge lamps could be taking into account by checking their performance. A typical, and cheap, improvement measure could be to change electromagnetic balasts by electronic balasts.





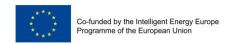
**IMPORTANT NOTE**: please use ALWAYS and ONLY the above mentioned terminology for the processes. It will facilitate the comparisons between cooperatives and between countries, and also to check developed audits for the quality control.

Remember that not all cooperatives have the same processes, so the following instructions have to be taken into a count in auditing phases:

- In the cooperatives, all types of pumpings will be considered as the same pumping process so the auditor will measure the most typical pumping process in the cooperative.
- In transport processes, energy consumption of transports done by conveyor belts that are very common fruits and vegetables processing plants will be considered inside packing process.
- All the rest of processes that have not been considered before may be included like "Other".

This first visit to the cooperative will be developed in **one working day** in order to follow TESLA requirements.





# 4. Fourth step of the audit: Second visit to the cooperative to remove the grid analyzer

During this second visit to the cooperative the auditor will remove the grid analyzer (remembering that the grips should be always managed by the technical personnel of the cooperative, not by the auditor). This visit will also be very useful for checking the information gathered and obtaining the missing data needed for the analysis. It can be used as well to make other measurements with the grid analyzer that could not be done in the first visit.

The measurements obtained by the grid analyzer will be downloaded in the auditor's computer as an Excel sheet. The data of this Excel sheet should be managed to obtain (from each device or equipment measured) the following figures:

- Real electricity consumption in kWh
- Maximum power demanded (kW)\*
- Minimun power demanded (kW)\*

With this information the auditor will take the decisions to make the calculations for obtaining the average power demanded in each process by means of dividing energy consumption (kWh) by total measuring time (h).

These data, and the information obtained from the interview with the maintenance technician of the cooperative, will give the auditor the estimations for the value of "load factor", "estimated hours/day" and "estimated days/year" to be included in Excel sheet "calculations" of Annex V-Inventory.

For the measured equipments, the value for "load factor" will be obtained by: the average electricity consumed during the measuring time divided into the total installed power of the equipment multiplied by the measuring time.

$$Load\ factor\ (\%) = \frac{power\ of\ the\ machine\ (kWh)}{total\ installed\ power\ (kW)*measuring\ time\ (h)}*100$$

Load factor will be useful to know, how much oversized the power of certain process is, or how much variable a process is.

<sup>\*</sup> This information allows us to know what processes are suitabled to install a speed driver on it.





For the rest of equipments and devices, not measured by the grid analyzer, the following values of "load factor" could be used as estimations, although maintenance technician will know it better and the auditor should have to take decisions for each case:

- Reception and transport's machinery: 80-90%

- Washing equipments:50-60%

- Electric fans: 90-100%

- Compressed air equipments: 60%

Packaging machines: 60-90%

- Computers: 70%

- Computer's screen: 100%

Fax and printers: 100%

Using these data and filling in completely the Excel sheets of Annex IV-Check list and Annex V-Inventory, will be obtained the energy consumption of each machine and device, and the energy consumption of each process. At this point, the difficulties will arise from the differences between real electricity consumption (obtained by the electricity bills) and virtual electricity consumption (estimated by the auditor and included in the sheet "industrial process" of the Annex IV-Check list Excel file). These differences will decrease by including the percentage of "Other" referred to small devices or consumptions that were not taken into account, and will be automatically corrected in this Excel sheet to obtain the "REAL" ENERGY CONSUMPTION of each process.

However, <u>REAL</u> ENERGY CONSUMPTION will be impossible and will always be estimations and assumptions that the auditor will have to make about the working hours per day of each machine, and the working days per year, but especially due to estimations about the real working power (each device has a nominal power, which is the maximum power of the device, but very often the machines work less, using lower power than their nominal power)

In this sense, for those devices measured directly with the grid analyzer, the real used power will be closer to be real annual consumption; and for those devices and equipments not directly measured estimations should be made, and mentioned in the audit report.

This second visit to the cooperative will be developed in **one working day** in order to follow TESLA requirements.





# 5. Fifth step of the audit: Analyze all the gathered information

The main targets of this step will be:

- Describe the existing energy performance situation, breaking down the energy consumptions of the different processes.
- Identify inefficiencies and the consequent improvement measures that could be implemented to reduce energy consumption of the cooperative.

The first analysis of the existing situation will be executed with the help of Annex IV-Check list and Annex V-Inventory Excel sheets, and so with the data obtained by the grid analyzer measurements. This analysis will be included in the Energy analysis of the Audit Report, including graphs and charts obtained by "data report" Excel sheet of Annex IV-Check list. Therefore, it will mention:

- Analysis of energy consumption
  - Energy consumption per source (classified as: electricity, liquid fuel, natural gas, and biomass)
  - Energy consumption during the year (mentioning the seasonality)
  - o Energy consumption during the hours of the day (to find gaps or losing times)
  - Energy consumption per process (breakdown of processes)
- Performance indicators
- Identification of inefficiencies regarding energy consumption
- Criteria for ranking the energy efficiency improvement measures.

When analyzing the proposed improvement measures, remember to take into account working hours of the equipment or devices that will be changed by a better one: engines working less than 1.000 hours per year will not be profitable to be substituted by a new one.





The lessons learned during the Audit course (see power point presentations in Annex X) will help the auditor in the calculations for the analysis. At the course was mentioned:

- Lower Calorific Power to express all the energy sources consumptions in the same units: kcal/kg
- Use as units kWh for measuring energy and kW for measuring power.
- Grid analyzer will measure power consumption (W or kW), during the specific time of measure (h), so electricity consumption will be these W or kW multiplied by the time: kWh.
- Pay attention to heat generation processes, mainly in animal feed factories in which it is one of the biggest energy demanding process.
- Pay attention to cooling generation, especially in wineries and in cooling chambers of fruit and vegetables processing plants.
- Remember that maybe lighting is not the most energy consuming process. However it will be very feasible and easy for cooperatives to implement improvement measures in this field.

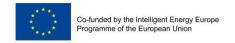
Moreover, there is also the Annex VII-D.6.1 Software tools report which explains five different software programs. These software programs can be downloaded for free and will help a lot in analyzing the energy data of the cooperative. Some of them provide a report with the results, the payback or the energy or CO2 savings achieved.

All this information will provide the auditor with the necessary knowledge about the energy performance of the cooperative, its main consumptions, and processes and routines of the cooperative while it is working.

After these in-depth analyses, the auditor will be ready for the identification of inefficiencies regarding energy consumption, which will be analyzed following the scheme of Annex I: Audit Report template. This analysis will include:

- List of identified inefficiencies.
- Improvement measures to correct each identified inefficiency.
- Energy analysis for each proposed improvement measure (energy savings obtained by implementing each proposed improvement measure) and implementation of the measure (installation and works needed). A new calculation of the overall energy situation of the cooperative, supposing that the measure has been adopted, should be done. The same graphs as





the one obtained by the "data report" Excel sheet of Annex IV-Check list should be included to compare current and future situation.

- Financial analysis for each proposed improvement measure:
  - Economic savings obtained by implementing each improvement measure.
  - Needed investment
  - Payback of the proposed measure.
  - Probable grants and subsidies OR expected penalties or taxes (current or future¹)
- Other improvements obtained by the proposed measure (more productivity, less maintenance operations, etc.)
- Comparison of different measures and technical analysis of their interaction.

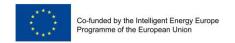
In order to help the auditor in his/her task of proposing improvement measures and analyzing its expected results, there is a list of best practices and improvement measures, specifics for the four different subsectors, included in Annex VIII-Best practices list. Besides that, for helping the auditor in the calculations for the financial analysis, the Annex IX-Investment analysis tool is also available. As explained in each document, its information will be considered in a case by case analysis, taking into account each cooperative's particular energy situation. In this economic analysis, the auditor should remember to include the depreciation value, especially for the important equipments and machines.

In the development of this step's tasks, the most important one will be to ask the Key Actors for market offers for the proposed equipments and devices. It will provide the auditor with realistic and updated prices, characteristics, models, etc. that will be analyzed and included in the report.

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<sup>&</sup>lt;sup>1</sup> In Spain, it is expected a tax for buyed biomass (not for self-produced) which will be approved by law in 2 years, more or less.





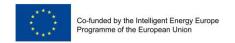
# 6. Sixth step of the audit: Edit the audit report

In this step the audit report will be written, including the analysis of the data done in the step 5, and the graphs and flows obtained from these data, as well as the writing of the conclusions about the functioning, the current performance, and the proposed measures.

The edition of the audit report must follow conscientiously the Audit Report template, in order to maintain the uniformity in the documents executed by the four countries-of the project.

This step, together with the previous one (analyze the gathered information) should be developed in ten working days in order to follow TESLA requirements.





# 7. Seventh step of the audit: Quality control

As specified in the Grant Agreement of the project, a quality control will be done to a representative amount of audit reports. It is,  $\sqrt{n}$  of cooperatives audited in each country (5 or 6 audit reports per country; 4 or 5 in the case of Portugal).

Once all the audit reports are finished in each country, the subcontracted entity will review the above mentioned number of reports to check them.





# 8. Eighth step of the audit: Audit Report presentation and Key actors meeting

These activities could be executed jointly during the same visit to the cooperative, or separately in two different visits to the cooperative (depending on the available budget and available time)

This will be the most important step of the overall auditing process. In the presentation of the audit report to the cooperative's responsible personnel the auditor must emphasizes about the implementation of the improvement measures, and its benefits.

After it, or in the same meeting, the auditor must intermediate between the cooperative and the Key Actors to recommend the best options of improvement measures to be implemented by the cooperative.

The auditor should remember that after this meeting a report about it should be presented, as specified for the deliverable **D.5.4 of TESLA** project Gran Agreement.

This third, and last, visit to the cooperative will be developed in **one working day** in order to follow TESLA requirements.





#### 9. References

The following documents were consulted to execute this Audit Guide. When the auditors edit the Audit Report for each cooperative, reference of the **consulted documents**, obtained **data sources**, and used **software tools (5<sup>th</sup> step)** should be included.

TESLA IEE/12/758/SI2.644752 Grant Agreement.

BREF - Energy Efficiency (E.C.)

UNE-en 16247-1:2012 Standard for Energy Audits

**EINSTEIN Project** 

**ENGINE Project** 

**CO20P** Project documentation

Task 5.2 Proposals of Best practices

Task 6.2 Proposal of software