



tesla^o

Transferring
Energy Save
Laid on Agroindustry

Final Results Oriented Report



Co-funded by the Intelligent Energy Europe
Programme of the European Union



THE MISSION OF TESLA



TESLA Consortium was promoted by European associations of cooperative agro-food businesses for the main purpose of leveraging the energy efficiency in their processes and facilities. The project has extended the best available practices for the evaluation of the energy situation and for the adoption of improving measures amongst SMEs of the agro-food sector.

Within this sector, TESLA project has focused on agro-industry cooperatives of wineries, olive oil mills, animal feed factories, and fruit and vegetables processing plants. In these agro-industrial processes the main input, besides the raw material, is energy consumption.

The project implementation entailed the direct involvement of 110 cooperatives, belonging to the above mentioned sectors, and the execution of an energy audit in each one of these cooperatives. These audits were executed by a multidisciplinary team, including experts in energy efficiency and in agro-food engineering, set up for the project and trained during it.

The tools and knowledge acquired in the project have been spread through a dissemination and consciousness-raising campaign amongst the 7.372 cooperatives associated to the promoters. TESLA has carried out a large plan of regional brokerage events, involving important agro-food supplies enterprises, and has also made a wide use of computer technologies, like web 2.0 and the existing chil.org agro-food knowledge-base platform.

The challenge has been -and will be- to maintain or increase the competitiveness of our businesses and their environmental performance, through extending the efficient and accurate use of energy in its facilities.

COOPERATIVES THAT HAVE ACTIVELY PARTICIPATED IN THE PROJECT:

Olive oil mills

- San Isidro de Castillo de Locubín (Andalucía-ES)
- La Bética Aceitera de Quesada (Andalucía-ES)
- S.C.A San Juan de la Cruz de Beas de Segura (Andalucía-ES)
- San Isidro de Loja (Andalucía-ES)
- San Francisco de Asís de Montefrío (Andalucía-ES)
- S.C.A. Olivarera del Trabuco de Villanueva del Trabuco (Andalucía-ES)
- Montes Norte (Castilla-La Mancha-ES)
- Oleificio OLMA (Toscana-IT)
- UPAL - Oleificio (Puglia-IT)
- Agricola Latianese - Oleificio (Puglia-IT)
- Progreso Agricolo - Oleificio (Puglia-IT)
- Produttori agricoli di Molfetta (Puglia-IT)
- Nuova Generazione-Martano (Puglia-IT)
- Nuova Generazione-Corigliano D'Otranto (Puglia-IT)
- Oleificio Montalbano (Toscana-IT)
- Coop De Deo (Puglia-IT)
- Terre dell'Etruria - Oleificio (Toscana-IT)
- Olivicoltori Toscani Associati, OTA (Toscana-IT)
- Coop. Agricola Beja e Brinches (Alentejo-PT)

- Coop. Olivicultores de Fátima (CENTRO-PT)
- Coop. Viticultores e Olivicultores de Freixo de Numão (Norte-PT)
- Cooper-Coop. Agrícola do Concelho de Portalegre (CENTRO-PT)

Wineries

- S.C.A Nuestra Señora de la Aurora (Andalucía-ES)
- S.C.A La Unión de Montilla (Andalucía-ES)
- COVIÑAS (Comunidad Valenciana-ES)
- Bodegas La Purísima (Murcia-ES)
- Bodegas San Isidro-BSI (Murcia-ES)
- BACO (Castilla-La Mancha-ES)
- Bodega Cooperativa Unión Campesina Iniestense (Castilla-La Mancha-ES)
- Coop. del Campo Ntra. Sra. de Manjavacas (Castilla-La Mancha-ES)
- Vignerons de Buxy (Bourgogne-FR)
- La Chablisienne (Bourgogne-FR)
- Cellier des St-Etienne (Rhône-FR)
- Caves Cooperatives de Jales (Ardèche-FR)
- Cave coopérative de Juliéna (Rhône-FR)
- Cave de Tursan Chalosse (Landes-FR)
- Caves de Montbazillac (Dordogne-FR)
- Cave de Fronton (Groupe Vinotalie) (Midi Pyrénées-FR)
- Cave de Vic Fezensac (Groupe Vivadour) (Midi Pyrénées-FR)
- Vignerons de Gerland (Midi Pyrénées-FR)
- Arnaud de Villeneuve (Languedoc-Roussillon-FR)
- Cave coopérative de Frontignan (Languedoc-Roussillon-FR)
- Cave coopérative de Puilacher (Languedoc-Roussillon-FR)
- Nuova Generazione-Seclì (Puglia-IT)
- UPAL - Vitivinicola (Puglia-IT)
- Agricola Latianese - Vitivinicola (Puglia-IT)
- Santa Maria La Palma S.C. (Sardegna-IT)
- Le Chiantigiane-Tavarnelle V. di Pesa (Toscana-IT)
- Le Chiantigiane-Grosseto (Toscana-IT)
- Viticoltori dei Colli Cimini (Lazio-IT)
- Cantina Sociale Paglieta (Abruzzo-IT)
- Coop. Agric. St. Isidro de Pegões (Alentejo-PT)
- Adega Coop. de S. Mamede da Ventosa (CENTRO-PT)
- Ad. Coop. Cantanhede (CENTRO-PT)
- Ad. Coop. Palmela (Alentejo-PT)
- Caves Vale do Rodo (Norte-PT)
- Terras de Felgueiras (adeaga) (Norte-PT)
- Ad. Coop. Ponte Lima (Norte-PT)
- Ad. Coop. Vidigueira, Cuba e Alvito (Alentejo-PT)
- Ad. Coop. Valpaços (Norte-PT)
- Caves Santa Marta (Sede) (Norte-PT)

Fruit and vegetables processing plants

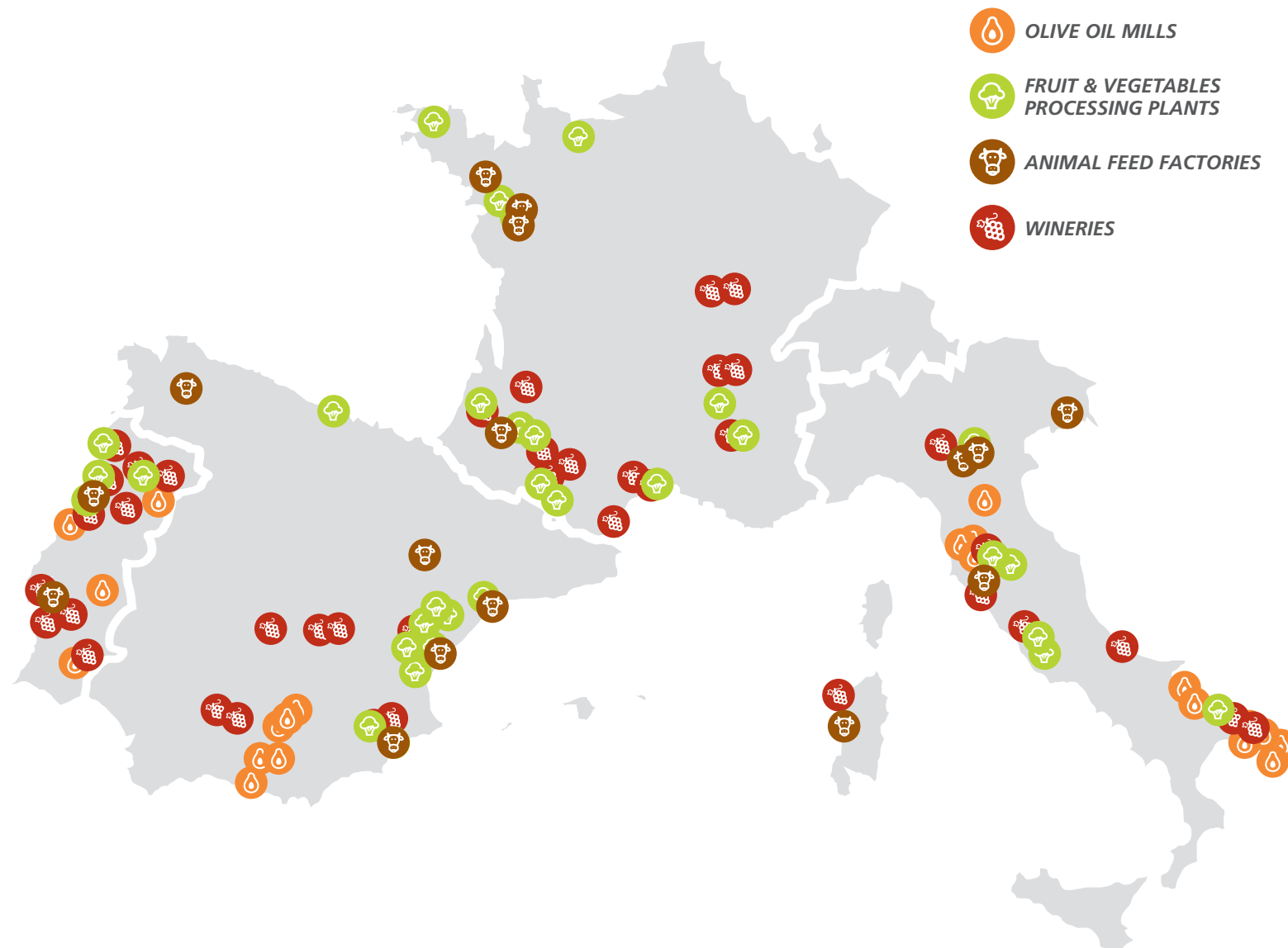
- GARAIA S.COOP (País Vasco-ES)
- SANALF (Comunidad Valenciana-ES)
- Cooperativa Vinícola de Liria (Comunidad Valenciana-ES)
- COHOCA (Comunidad Valenciana-ES)
- Cooperativa Agrícola Sant Bernat (Comunidad Valenciana-ES)
- COAGRI (Comunidad Valenciana-ES)
- Rural San Vicent Ferrer (Comunidad Valenciana-ES)
- COPAL (Comunidad Valenciana-ES)
- GREGAL (Murcia-ES)
- SACOJE (Murcia-ES)
- Lunor, Groupe coopératif CAPSEINE (Hte Normandie-FR)
- Terrena, Elaris (Pays de la Loire-FR)
- Gie Hermitage (Drôme-FR)



- Rhoda-Coop (Ardèche-FR)
- S.C.A.A.P. Kiwifruits (Landes-FR)
- Trois Domaines S.C.A. (Lot-&-Garonne-FR)
- S.C.A. de Lamouthe (Lot-&-Garonne-FR)
- Coopérative de Stanor (Midi Pyrénées-FR)
- Coopératives des 2 Vallées (Midi Pyrénées-FR)
- Teraneo (Languedoc-Roussillon-FR)
- Les Vergers d'Anjou (Pays de la Loire-FR)
- Terres de Saint-Malo (TSM) (Bretagne-FR)
- SAVEOL (Bretagne-FR)
- Fruttage (Emilia Romagna-IT)
- Progresso Agricolo - Ortofrutta (Puglia-IT)
- Il Forteto (Toscana-IT)
- San Lidano (Lazio-IT)
- Soc. Agricola C.O.P.A. (Lazio-IT)
- Terre dell'Etruria - Ortofrutta (Toscana-IT)
- Cooperativa Agrícola Oliveira do Bairro e Vagos - CALCOB (CENTRO-PT)
- Coop. Agríc. Esposende (Norte-PT)
- Terras de Felgueiras-kiwi (Norte-PT)
- Coop. do Távora Moimenta-da-Beira (Norte-PT)

■ Animal feed factories

- AIRA (Galicia-ES)
- GUCO (Aragón-ES)
- Cooperativa Agraria San Miguel (Aragón-ES)
- COAVRE (Comunidad Valenciana-ES)
- ALIA (Murcia-ES)
- MAIS ADOUR (Aquitaine-FR)
- TRISKALIA (Bretagne-FR)
- CAVAC (Pays de la Loire-FR)
- TERRENA (Pays de la Loire-FR)
- Progeo-San Vito (Friuli V. G.-IT)
- Progeo-Masone (Emilia Romagna-IT)
- Progeo-Sorbara (Emilia Romagna-IT)
- Profenda Srl (Sardegna-IT)
- Mangimificio Consorzio Maremma (Toscana-IT)
- Coop. Agríc. Vila do Conde (Norte-PT)
- Alirações, Rações para Animais (Grupo ALIS) (Lisboa e Vale do Tejo-PT)



- OLIVE OIL MILLS
- FRUIT & VEGETABLES PROCESSING PLANTS
- ANIMAL FEED FACTORIES
- WINERIES

THE WAY WE DID IT



THE TRAINING

37 professionals of agro-food sector were trained in auditing skills in the courses that took place in Madrid, Florence, Lisbon and Paris. The courses also included a practical session auditing the facilities of a real company.

The TESLA project got underway on springtime of 2013. The first task was to align the capacities of all the teams' members with the challenges of the project. After an accurate planning of the activities for the following three years, the **training sessions** were carried out between September and November of 2013.

In an intense first phase of the project, an **Audit Guide** was also issued seeking both to facilitate the tasks execution by auditors and to homogenize the assessment of the 110 cooperative businesses, bearing in mind the multinational and multisectorial scope of the project.



AUDIT GUIDE

Following the EN 16247:2012 rules, an adjusted Audit Guide was developed to facilitate, step-by-step the auditing works. It includes technical annexes, composed by useful calculators and checklists for the visits to the facilities, specifically designed for each sub-sector of TESLA.

Inputs from private Key Actors were compiled in a **Best Practices document**. It has been profusely used by the auditors for proposing specific measures supported by market based criteria. Meanwhile, the national teams of auditors arranged with the cooperative businesses the best moment to do the audits. Of course it meant to take advantage of the short production seasons of some sectors: autumn for wineries, winter for olive oil mills, etc.

Once the teams of auditors were trained, and all the procedures were established and the useful tools were developed, it was the moment to start with the core of the project: the in-depth analysis of the energy behaviour of the agro-industries and the proposal of cost effective measures. The first audits started last weeks of 2013 but the majority of the audits were carried out during 2014.

The teams gathered the information during preliminary visits, collecting, among others, the energy bills and the preliminary equipments' inventories. They checked the inventories and the overall processes of the industry, as well as



BEST PRACTICES

In close contact with important European providers of technology, they provided the project with the most updated cutting-edge technologies aimed at reducing the energy consumption in the agro-food industries.



GRID ANALYZERS

One of the premises of the auditing work in TESLA was to use real data for assessing the energy behavior. The grid analyzer is a portable device that can be easily connected to a machine or group of machines in a particular food process, and so it can provide reliable information about the energy consumed by them. The auditors obtained million of data since the measurements were registered every few seconds and during several days.

its performance. This information was relevant to decide where to put the measurement devices **-grid or gas analyzers-**, and which motors, devices or electrical panel should be measured. Once it was decided, records for around one week were collected, registering real consumptions in each short fraction of time.

The information obtained from the grid analyzer records was completed with additional data from the maintenance technicians about the performance of the equipments: number of operating hours, working load, no-load moments, etc.

The four national teams of auditors in Italy, Spain, France and Portugal began to draft individual audit reports at the end of 2014. They presented all this analyzed information and proposed a set of measures adapted to the specific features of each audited company. This set of measures included market available technologies but also many cutting-edge technologies which are not yet commonly implemented. The balance between innovative but proven technologies has been crucial in this project.



HANDBOOKS

4 handbooks about energy efficiency have been issued, one per sub-sectors of TESLA, that are: Olive oil mills, Fresh fruit and vegetables processing plants, Wineries, and Animal feed factories. The target group for this dissemination material has been the managers and the staff of the agro-food businesses. These handbooks include the state-of-art in each sub-sector from the energy efficiency point of view.

At the same time as TESLA teams of auditors were working in the field with cooperative business, another dimension of the project was being developed. The academic and scientific world -represented in the project by the partners of the consortium working on Industrial Processes- summarized the main current knowledge about energy efficiency in the targeted sectors through specific **handbooks**. It allowed the project to start soon disseminating this knowledge, beyond the cooperative business directly involved and audited by the project. This work was continued during 2015, and more thoroughly analyses



LEAN&GREEN

Production systems designed for improving continuously the business potential taking into account the three components of value (Profit, Planet, People). Lean & Green methodologies and tools are used for reducing systematically eight Lean wastes and eight Green wastes.

were done, built up from the handbooks. In these analyses, a more exhaustive assessment was done about the potential impact -in TESLA sub-sectors- of other techniques, procedures and technologies, successfully implemented in other kind of industries.

A modelisation with software was executed to virtually test **Lean&Green** management techniques in wineries and in other agro-food businesses. The complexity of the food processing sector, with very intensive working periods followed by long idle ones, has been an important challenge for this task.



SECTORIAL BEST PRACTICES FOR IMPROVING ENERGY EFFICIENCY

An upgrading of the previously issued documents was edited as a compiling document, including knowledge from the project and from diverse scientific sources. In contrast to the handbooks, these documents have been conceived for its dissemination within the universities and the scientists world.

The real and updated data from the already carried out audits and the assessment of information from other sources eventually underpin the compilation of the **sectorial Best Practices for improving energy efficiency**. These sector specific documents target the designers of future facilities and processes in the agro-food sub-sectors of TESLA.

In the last third of the project, all the actions were addressed to obtain real results from the previously executed tasks. Each audit report was presented to its corresponding cooperative business, in order to improve it and to identify which ones -from the proposed measures- were positively considered by business managers. Then, the auditor matched the selected measures with the optimal Key Actors providing the necessary technology.

Around a hundred specific meetings have been held between **Key Actors** and cooperative businesses, most of them in the cooperative's facilities. With the intermediation of the TESLA auditor, those meetings were focused on dealing with specific measures, not only



KEY ACTORS

During these 3 years, project partners have being in contact with more than 30 companies. Some of them have been crucial for the success of the project, thanks to their involvement and availability, namely: Siemens, CIAT, Pieralisi, ABB, Schneider Electric, SNC Lavalin, Clauger, Manar Consulting, and others.



THE BROKERAGE EVENTS

The brokerage events were aimed at the extension of the results and tools of the project, and were addressed to the businesses involved in the sub-sectors of TESLA. More than 500 attendants have benefited from the information and business contacts in the 20 regional meetings organized.

from the technical point of view but also from the commercial perspective. By this win-win strategy the project improved its impact in terms of real implemented measures. Thus, the cooperative business become more efficient and reduced its energy costs, and the Key Actors sold its products and services.

Beyond these business-to-business meetings, the project deployed a plan for extending the results and tools of the project to other agro-food industries not directly involved in the project. In total, **20 brokerage events** have been carried out in different European regions, some of them focused on a sub-sector, and some others with a horizontal perspective.



TESLA TOOL

Any person using this easy-to-manage tool will be able to obtain an energy diagnosis for the studied agro-industry. A PDF Report will be issued at the end including the results of the diagnosis, representative graphs, comments about the situation of the energy consumption of this agro-industry compared with other European agro-industries, and also including an analysis of the potential energy saving measures.

In both approaches (Key Actors-cooperative businesses meetings and brokerage events) and in the overall project the financing of investments has played a very relevant role. Some banks and financial bodies have been engaged in the project, facilitating the investments to the cooperatives. In addition, the possibilities of obtaining funds and public aids to finance the implementation of measures were mandatory for the auditors in the economic assessment of each proposed measures.

Since lasts months of 2015 the **TESLA tool** is available and downloadable from the project webpage. It compiles a great part of the knowledge gained in the project, structured by sectors and aimed at obtaining a self-diagnosis. This tool is user friendly and has been designed to help managers of the agro-food businesses or professionals of the energy efficiency sector in their energy analysis. The TESLA tool has been showed in the dissemination events of the project, i.e. last brokerage events and other more academic and scientific events.



OLIVE OIL MILLS

The current situation of the European olive oil mills shows that there is still a margin for improving their energy consumption. Some olive oil mills have already implemented cutting-edge technologies, but some others could reduce considerably their energy consumption -and so their energy costs- after analyzing their weak and strong points.

Energy consumption in olive oil mills is determined by a short working period with very high energy demand. Olives are collected from October to January, and olive oil is produced during these four months plus one or two more. The rest of the year the agro-industry has to bottle, to store and to sell the production.

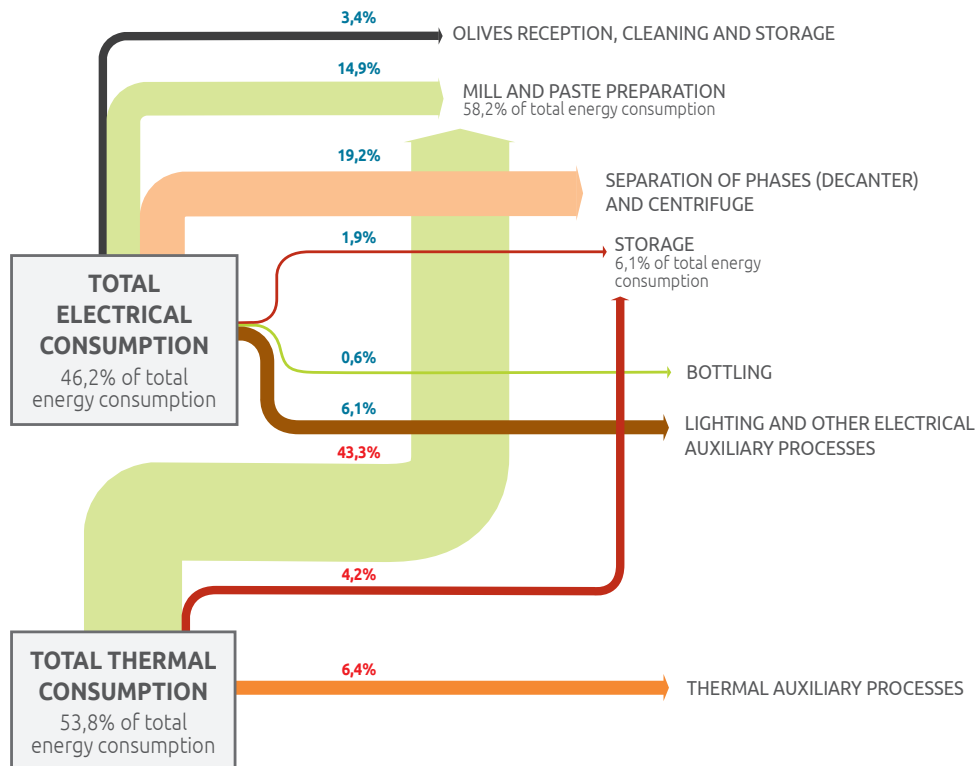


Figure 1: Sankey diagram for an standard olive oil mil (1.600 tons of olive oil per year).

SELF-SUFFICIENT

Olive oil mills produce biomass (olive pit) and consume biomass (thermal energy)

A key point in olive oil mills is the generation of a by-product which is biomass (olive pits) in the olive oil production process itself. And moreover, the olive oil mills demand thermal energy in the olive oil production process which can be supplied by this by-product.

Besides that, the **distribution in percentage of energy consumption per process** (see **Sankey diagram** on the left) is very useful to focus the attention on the most energy consuming processes, in which improvements will achieve the higher energy savings.

However, some other important considerations must be taken into account when analyzing the energy behaviour of an olive oil mill:

- the **quality of the olive oil** should not be affected.
- the **environmental impact** has to be considered when chosen certain technologies (i.e. some processes generates more sewages than other, and these sewages will have to be managed afterwards -due to its risk for the environment- by energy consuming processes).

Considering an average olive oil mill, it is easily observed that around 50% of the energy consumed by the olive oil mill is electric energy, and the other 50% is thermal energy.

1. Optimization of biomass consumption

From the studies developed by TESLA project it has been found out that **thermal energy consumption could be reduced** considerably, but usually it is not tackled because olive pit is obtained by the production process itself, and is not considered as a value-added product, although it can be sold.

In spite of this, thermal energy consumption can be optimized by some means:

- Controlling humidity level of olive pit entering in the boiler. Some producers do not pay attention to it, and olive pit is transported or stored without a cover, so pits get wet when it rains.
- Implementing heat recovery systems, in which exhaust gases can preheat water before entering in the boiler.
- Improving insulation, by sealing doors and windows for avoiding heat losses in the industry unit and the storehouse.

2. Extraction process: two-phases system VS. three-phases system

Apart from the environmental benefits of the two-phases extraction process (less water consumption and less sewage production), energy savings can be up to 20%, compared with the three-phases extraction process.

TWO-PHASE EXTRACTION PROCESS	
Advantages	Disadvantages
Less liquid waste produced.	Still some sewage production. Waste water treatment needed.
Water savings (less water to be heated).	The water content of the solid is higher. More energy for drying.
Less production costs.	Higher costs for storage and transport of solid waste.
More olive oil produced (higher yield).	Higher costs of drying the solid waste.

3. Installation of Listellos grind

Compared with the usually installed sieve grind (right one in the picture) the Listellos grind (left one) can save up to 23% of the energy consumed by the mill.

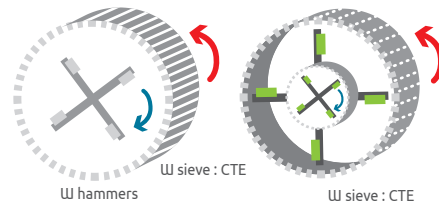
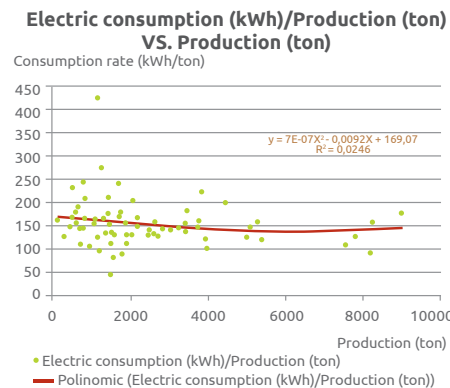


Figure 2: Listellos grind (left) and sieve grind (right).

4. Olive oil mill size

It is known that most of the production processes are more profitable when more raw material is processed. In the case of olive oil mills, the critical point is 4.000 tons of olive oil produced. Olive oil mills producing less olive oil usually have higher kWh/ton ratio than the bigger ones. However, there also small factories that are well dimensioned, and consequently, are more efficient.



5. Energy Management

Big machines with high energy consumption should never be functioning without load, or should modulate their energy consumption to the amount of processed product. This is the case of mills, mixer, and centrifuges (decanter and vertical centrifuge), although Energy Management should be implemented in the overall agro-industry. There are two ways to manage it:

- Automation: It is implemented by installing load sensors that stop the machine when no load is entering. This measure is usually paid off in 1-2 years.
- Variable speed drives: These devices modulate the energy consumption to the energy demand, considering the amount of product that is being processed or carried every moment.

Apart from reducing energy consumption, this modulation benefits the performance of the machines and their lifetime.

When a mill has automation installed together with a variable speed drive, softer starts and stops can be carried out to avoid no-load work.

As a general rule, when an olive oil mill has mill, mixer, decanter and vertical centrifuge dimensioned for managing similar amount of paste, machines can work on non-stop, and fewer stops and starts have to occur.

6. Humidity sensor in decanter

The humidity level of the paste entering in the decanter determines the amount of water that should be added to the process. Instead of adding always the same amount of water, the sensor will decide it, so water needs (and heating water needs) will be adjusted.



Picture 1: Humidity sensor installed in the entrance of the decanter.

7. Decanting process instead of vertical centrifuge

There are some masters of olive oil mills in favour of changing vertical centrifuges by decanting tanks. It could entail a clear energy saving, while the quality of the olive oil will be kept.

FRUIT AND VEGETABLES PROCESSING PLANTS



European fruit and vegetables processing plants are characterized by several different processes, settings, quality restrictions, and storage needs (for example, lettuce has to be placed in the supermarket in 48 h after harvesting, while potatoes can be stored for 1 year). Notwithstanding, the more common processes are cleaning (with warm water), classification and packaging, and storage (in cooling chambers).

At a glance, the Sankey diagram shows which processes are more energy consuming: in the first place there is the cooling system, after it there is the heating system (to heat washing water), and finally the processing (including drying, among others). Thus, all issues related to cooling requirements will be crucial in order to achieve a reduction of energy costs in a fruit and vegetables processing plant. However, the different characteristics of each type of fruit and vegetable, its harvesting season, its size, its maturity at harvesting time, its perishable nature, etc. will determine the best energy saving measures that could be implemented in each company.

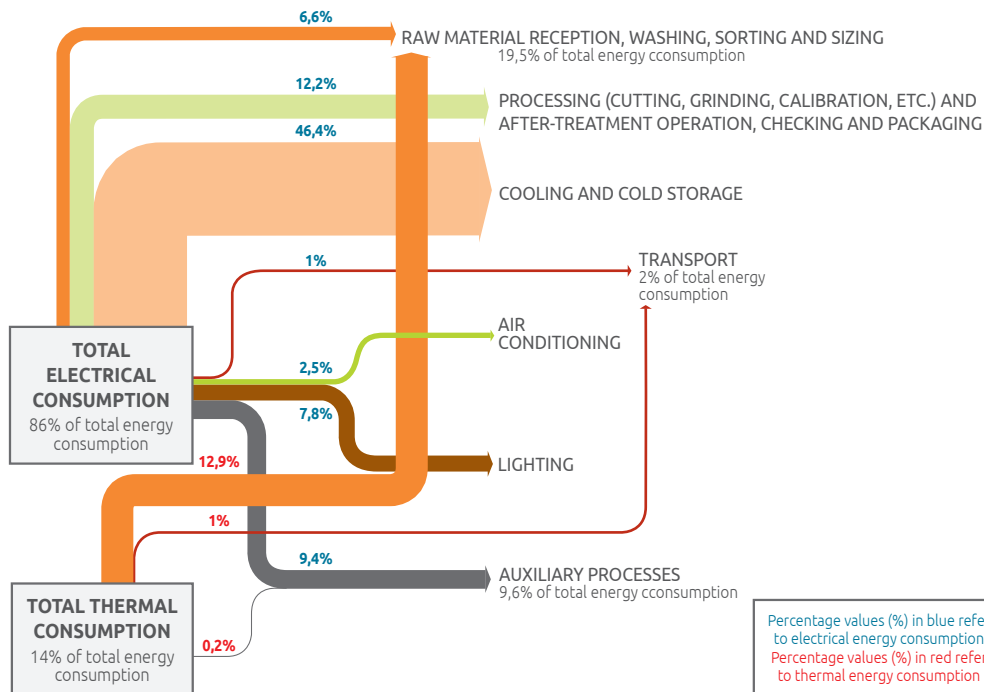
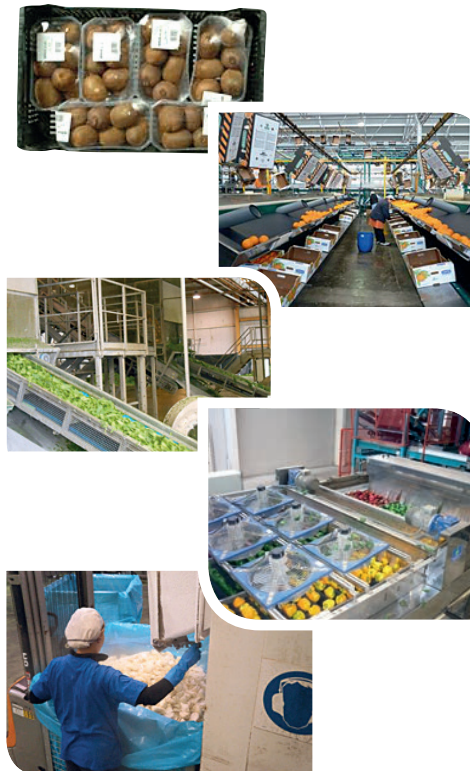


Figure 3: Sankey diagram for an standard fresh fruit and vegetables processing plant.

As a result, the more a company adjusts its facilities to the processed products (type and amount), the more efficient it will be. For example, as showed by some companies analyzed by TESLA, the energy cost of oversized cooling chambers, or wrongly designed cooling installation, will be paid in every energy bill.

THE VARIETY OF PRODUCTS IS HUGE...



Picture 2: Different fruit and vegetables being processed.

7 Advices for achieving Energy Efficiency in fruit and vegetables processing plants:

(some of them seem logical, but they are not implemented in some real agro-industries visited)

1. Place cooling chambers and cooling machines in coolest area of the agro-industry (North). If it is not possible, just shade the machines.
2. Place warm areas of the agro-industry (washing, drying, and even offices) in the warm area of the industry (South). And take advantage of the sun placing solar panels on the roof.
3. Reduce as much as possible the way a vegetable has to go over the factory.
4. Install different cooling systems that will work at different ranges of temperature (minimum two). They will work more efficiently.
5. Pre-cool fruit and vegetables before entering in the cooling chamber.
6. Do not forget maintenance operations. A pipe losing heat or a compressed air system losing pressure will be "leaking money" (as energy costs) every moment.
7. Recover heat, re-circulate warm water, and retrofit processes, when possible.



1. The most efficient cooling system

This is the one getting in the coolest air, working within its temperatures range, and being supported by other equipments when cooling needs are higher.

An efficient cooling system will also take advantage of night temperatures:

- by free cooling systems (useful from the moment when ambient temperature is 1°C below the set value).
- by night (or early morning) harvest, specially for big fruit, with a great mass of product that should be chilled (watermelon, pumpkin, khaki, etc.) in which biodegradation processes have to be stopped very quickly.
- by cooling storage systems, which is a commercialized system consisting in freezing a fluid during the night (more efficient process and during cheaper electricity tariffs) and in using it during the peak cooling demand of the day.

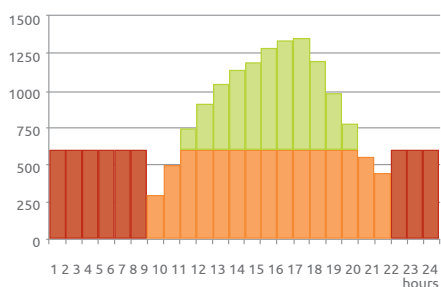


Figure 4: Cooling storage during night time.

According to the seasonality of each processed product, a detailed logistic plan for cooling chambers should be done.

2. Lighting: no more no less

In the fruit and vegetables sub-sector, the maturity level of the products plays a crucial role. Maturity is strongly influenced by light, and maturity level is perceived by subtle differences in colour. For this reason lighting level is essential and has to be planned according to the specific products.



Picture 3: Manual triage in fruit.

In this sense, energy efficiency measures can be implemented by installing LED technology. LEDs consume less electricity for the same luminous intensity.



3. Electric resistance VS. Thermal heating

Heating is usually needed in agro-food industries for example for washing or drying processes. Normally, it is more efficient to heat the water or air by a combustion process (by a boiler, or especially by a biomass boiler) than by an electric resistance.

However, the characteristics of each processing plant, its heating needs, and the availability of fuels, will always guide the decision.

4. Recommendations for optimizing performance of Compressed Air Systems (CAS)

Every agro-industry, but specially fruit and vegetables processing plants, has conveyors, elevators, packers, etc. These are hundreds of motors, which are pushed by compressed air systems. The good performance of the CAS will result in the overall industry performance, and it can be achieved by the following considerations:

- Optimize the design: overloaded or oversized systems will always affect the energy consumed per compressed air generated.
- Install a baseline systems (satisfying 95% of all needs) plus an additional one (small pressure increasing device).
- No leaks, no losses. Maintenance operations are crucial for avoiding it. In this sense, a good practice will be to close pipes of the system during the night, so the decrease of

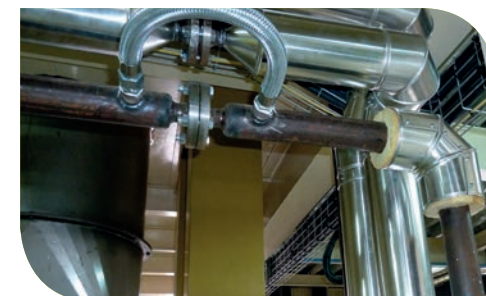
pressure in the CAS during no-working hours, will not affect the overall system.

- Modulate its power demand in accordance with the working load, usually by variable speed drives.
- Provide cool air for a better performance. Instead of compressing warm air, if the machine has to compress cool air, the process will be more efficient.

5. Insulation, in chambers and pipes

Energy savings of a 350 m³ chamber with 80mm polystyrene panels (U=0,4W/m²°C) can reduce in 20% its energy consumption by changing to polyurethane 100mm panels (U=0,25W/m²°C).

In the same way, agro-industries having long pipes going over the long industrial sites (and sometimes by external walls) can decrease their energy consumption drastically by implementing good insulation systems, and these investments are usually paid off in a few years.



Picture 4: Installation of good insulation in pipes.

WINERIES

Wineries constitute a widespread agro-industry sector in the Mediterranean Basin countries, such as Italy, France, Spain and Portugal, which have participated in TESLA project. Large and small facilities can be found in these countries, and all of them face the same problem: seasonality. Energy demanded by the production processes is concentrated in the four months of the year corresponding to the wineries season. In this scenario, negotiations between the winery and the energy company can be a crucial point for reducing its energy costs, apart from implementing energy efficiency measures in the most energy demanding processes.

The Sankey diagram shows the main processes to which energy efficiency measures must be addressed to. These main processes are: refrigeration (which is essential to decrease temperature during fermentation and stabilization processes), and bottling (when carried out in the agro-industry).

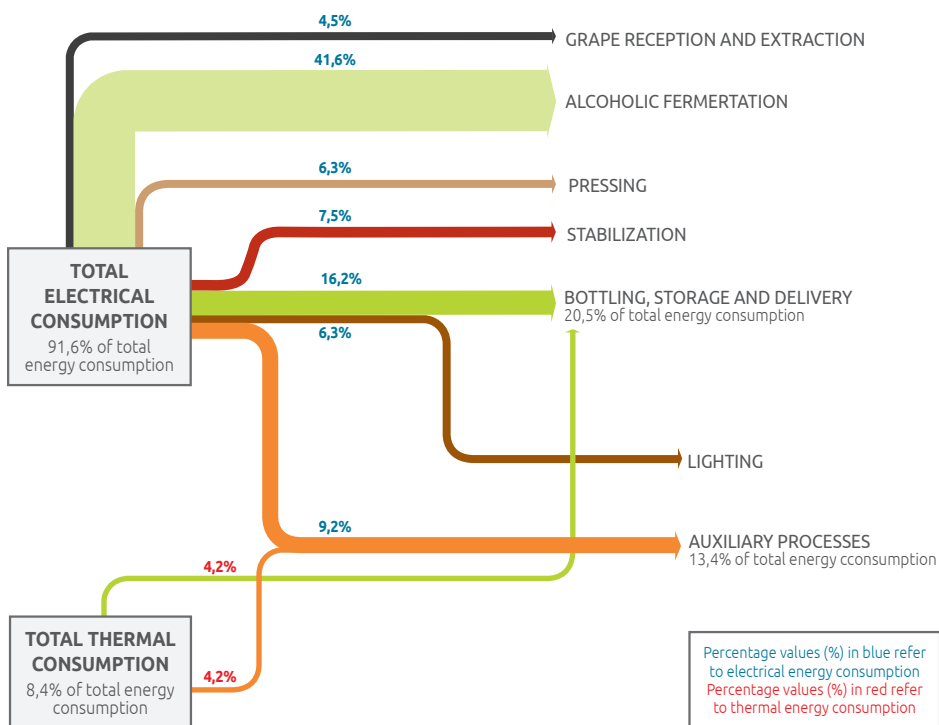


Figure 5: Sankey diagram for an standard winery (30.000 hl/year).



2. Cooling tanks

Wine production is based on the fermentation of grapes' sugar by yeast, which is an exothermic process. But if the temperature of the must go over 25-30°C, the yeast will die, and the fermentation process will be stopped. Therefore, a cooling system is always implemented to keep temperature in an appropriate range.

A typical way of maintaining must temperature under 25°C is by refrigerated tanks. The refrigeration is usually accomplished by a circulating refrigerant fluid inside a cooling coil that runs through the must. This fluid is chilled by a cooling machine.



Picture 5: Refrigeration tanks in a winery.

Refrigeration is more efficient when tanks are placed in the shade, but it is not always possible or affordable.

Due to the nature and characteristics of the wine production, energy efficiency measures will be aimed at reducing, or balancing out, peaks of energy demand, for example:

- by accumulating, during night-time, the energy needs that will be used during the peaks of energy demand at daytime. It is usually done by **cooling storage systems**.
- by installing auxiliary equipments such as **generators**, which provides electricity during peaks of demand (in wineries season).

1. Cooling demand: Underground cellars VS. Well insulated walls

The first energy efficiency measure in wineries is related to building design of facilities for aging wines. Some winemakers prefer underground wine cellars, but when it has to be dug, insulated walls are usually a cheaper solution.

However, it will always depend on the surface of the aging room, the existing underground areas (total or partially), and the annual outside conditions (temperature and humidity).





3. Efficient cooling machines

A good practice is to install **different cooling machines** that operate at different ranges of temperature; it is, at their optimal performance conditions.

Another good measure is to install **high energy efficiency components**, such as new pipe evaporators, fans with speed drivers, screw compressors, aluminium condensers, and soft starters.



Picture 6: Cooling machines.

Cooling machines can achieve even better performance indicators when air entrance (the cooler the better) is separated from air exit (which is hot air).

4. Cooling storage systems

These systems take advantage of the cooler night temperatures (when cold production is more efficient) and the cheaper electricity tariffs, to produce cold and store it.

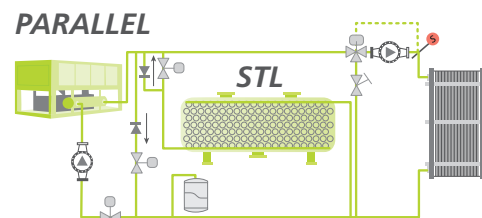


Figure 6: Scheme of a cooling storage system (Source: CIAT).

Stored cold is used during the peaks of cooling demand, and so the electricity consumed by the cooling machines can be reduced.

5. Insulation, for avoiding cooling losses

As explained for the fruit and vegetables processing plants, well insulated pipes can decrease heat or cold losses, and so energy demanded for heating or cooling will be more accurate.



Picture 7: Damaged insulation in pipes.

6. Thermal consumption

In some wineries, bottling processes are responsible of a high thermal energy consumption, which can be optimized by:

- Installing solar panels for pre-heating washing water;
- Using biomass or natural gas boilers, instead of diesel boilers;
- Installing heat exchange systems, for example, taking advantage of hot exhaust gases;

7. Efficient pumps and motors

A considerable portion of energy consumption is due to the pumps propelling must or wine from one tank to another. These pumps, as well as the rest of motors, can be new and efficient ones, or old and less efficient pumps or motors.

In some cases, substitution of old pumps or motors (IE1) by more efficient pumps or motors (IE3 or higher) can be very profitable, specially taking into account the number of working hours per year of each motor.

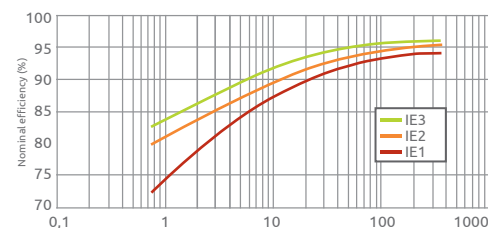


Figure 7: Nominal efficiency in different motors.

8. Variable speed drives

The performance indicator of pumps and motors can be also optimized by installing variable speed drives that adjust energy demand to production needs, and avoid machines working with no-load.



Picture 8: Variable speed drives installed.

It is especially relevant regarding energy consumed by the presses of the winery. For this process, high efficient motors and variable speed drives are usually recommended.



Picture 9: Group of presses in a winery.

ANIMAL FEED FACTORIES

This kind of agro-industries are characterised for working many hours per year (normally 16h per day, every working day), and for having to mix different raw materials. For energy reasons, modern factories are almost all built "upwards". It means that raw materials are stored in high tanks (around 10 floors high) and mixtures are done in the way they come down by dispensers. These mixtures are usually determined by different formulas or recipes depending on the animals they will feed.

Animal feed factories are great energy consuming agro-industries. In these factories, electric energy is consumed by large machines (grinds and pelletizers) and thermal energy is consumed by the boiler – steam is needed, among others, for compacting feed pellets and making them palatable for farm animals.

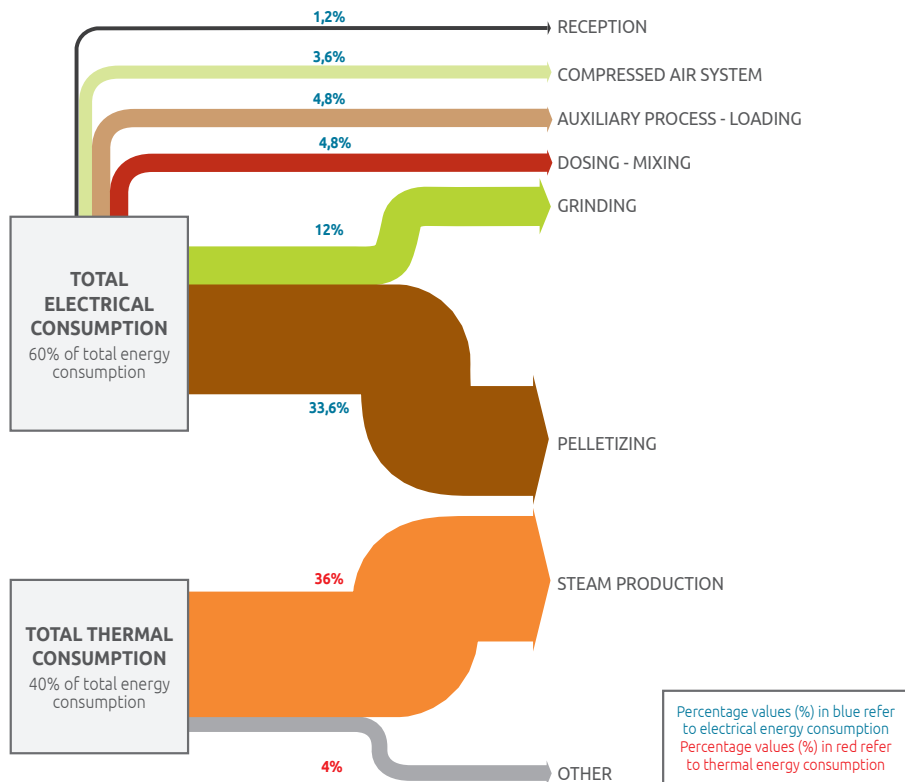
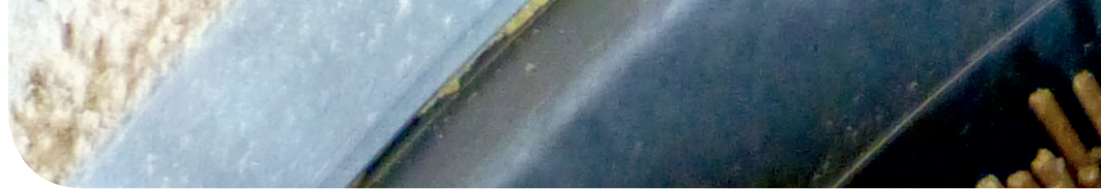


Figure 8: Sankey diagram for an standard French animal feed factory.



1. Thermal energy considerations and the Steam Boiler

Being thermal energy consumption almost half of the total energy consumed by the factory, some considerations should be taken into account for improving its efficiency:

a) Heat recovery systems

We can make the most of the heat coming from every heated air, water or surface that is going to be thrown away. This heat can be recovered to pre-heat cold inputs (air or water), and so, energy needs for heating can be reduced. In this sense, exhaust gases from boiler can be used for pre-heating water by the so called "economizers".

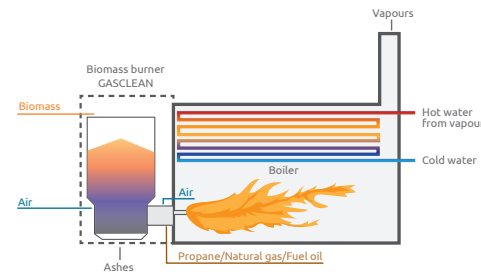


Figure 9: Scheme of a heat recovery system.

b) Solar panels for pre-heating

By implementing solar panels, the water will enter into the boiler at 30°C (or higher), instead of entering at 4°C (usual water temperature from water net). Therefore, fuel requirements for heating water will be reduced.



Picture 10: Solar panels for pre-heating water.

c) Optimizing air (oxygen) entrance in boiler

Low air flow rate in the burning chamber provoke unburned fuel, fuel losses, and contaminating emissions. Therefore, "excess air" is always needed, but too much excess air provokes lower calorific power and lower boiler efficiency. An "excess air" control system is always recommended to adjust the quantity of air and fuel in the burner.

Excess air effects on efficiency for natural gas

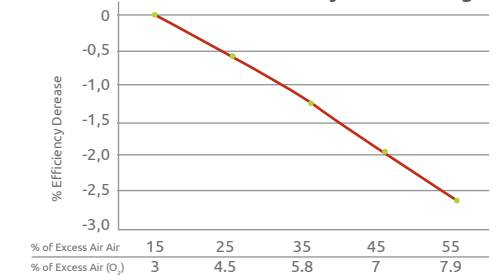


Figure 10: Effects of excess air in boilers.

d) Biomass > Natural gas > Fuel-oil

Since the steam boiler is needed in animal feed factories, the best option is to choose the best fuel.

Biomass: In terms of CO₂ emissions and for environmental issues, biomass is the best option, apart from being a very efficient source of thermal energy, although it depends on the nature of the burned biomass.

Natural gas: It has a high calorific power and usually is cheaper than diesel or fuel-oil. However, natural gas is not available in every location.

Fuel-oil or diesel: Sometimes is the only option for the factory. In this case, saving measures should be always taken into account.



Picture 11: Diesel boiler.

2. Compressed air system

Many different processes are run by the compressed air systems in these factories, for example conveyors, screws, pneumatic gates, dispensers for adding liquids, pelletizer, packaging machines, etc.



Picture 12: Compressed air system in a feedstuff factory.

These systems must be checked periodically, and the following recommendations will help to obtain the best energy performance of the systems:

- Adjust the design to the needs. Usually, the best option is to have one main compressor for the baseline needs and some other auxiliary compressors for peaks of demand.
- Feed the compressor with cold air (from outside, or from the coolest area of the factory). It will improve energy performance of the air compression process.
- Minimize compressed air leaks. It can be ensured by maintenance operations, and by switchers turning off sectors and/or devices during night-time.

3. Maintenance operations

A good maintenance management will have an effect on the lack of losses and in energy efficiency. It is especially important in boilers and compressed air systems, but actually in all equipments. Maintenance operations and periodical checks will:

- reduce leaks (fuel leaks, compressed air leaks, etc.),
- reduce heat losses due to damaged coating or badly insulated pipes,
- optimize boiler performance (analyzing flue gases content).



Picture 13: Measuring flue gases composition in the chimney.

4. Motor sizing

After pelletizer, grinding is the second largest energy consuming process. The grinds or mills are powerful machines with a large number of working hours. Thus, the best energy efficiency measure is to install a very efficient machine, and to install the more accurate machine taking into account the

factory needs. Any device processing the load determined by its design specifications is more efficient than if it works with a lower or upper load. It happens to grinds, but also to conveyors, pumps, etc.

Besides that, variable speed drives will help to adjust energy consumed to working load. These devices are crucial for avoiding consumptions in no loading moments and to decrease consumption in low loading moments, and so, matching consumptions with needs.

5. Total Productive Management

This global measure could be considered one of the best, and it is applicable to any agro-food sector. It manages all variables of the overall factory and help in making the best decision at each moment, apart from optimizing each process performance individually. Energy savings up to 12% have been achieved when implementing this measure.



Picture 14: Control panel of the management systems.

THE IMPACT OF TESLA



In the audit reports 680 energy efficiency measures were identified in a preliminary way. The most promising measures were accurately considered and prioritized, and specific visits were carried out to deal with them. By the early 2016, as a result of the post-audit work and the close collaboration with both cooperative businesses and Key Actors, almost 20 GWhour of primary energy will be saved yearly due to the already implemented measures. It is envisaged that during the present year (2016) the total amount of savings will raise up to 36 GWhour yearly. These savings imply a reduction in greenhouse gases emissions of 4.300 tCO_{2e}/year.

The cooperative businesses have taken advantage of the TESLA project to boost their investment efforts in order to enhance the efficiency in their industrial sites. Up to now (February 2016) they have spent 10,8 M€ in measures and technologies directly or indirectly linked with TESLA. It means that the ratio between money funded by the EU for the project and money invested by businesses is 1 to 7.

Other results achieved by the project have been, among others:

- Twenty two events carried out, involving near to 500 attendants, most of them SMEs;
- Project website with more than 10.000 downloads plus visits by early 2016. The most visited section is the "Project Documents and Deliverables";
- 50 companies, from big European corporations to local SMEs, have been contacted to act as Key Actors. Most of them have collaborated with the project under a win-win strategy;
- 37 professionals developing its careers in the food sector have been trained in energy efficiency and will be able to extend the outputs of TESLA in the coming years.

TOTAL ENERGY CONSUMPTION OF 110 INDUSTRIAL SITES. GWHOUR/YEAR



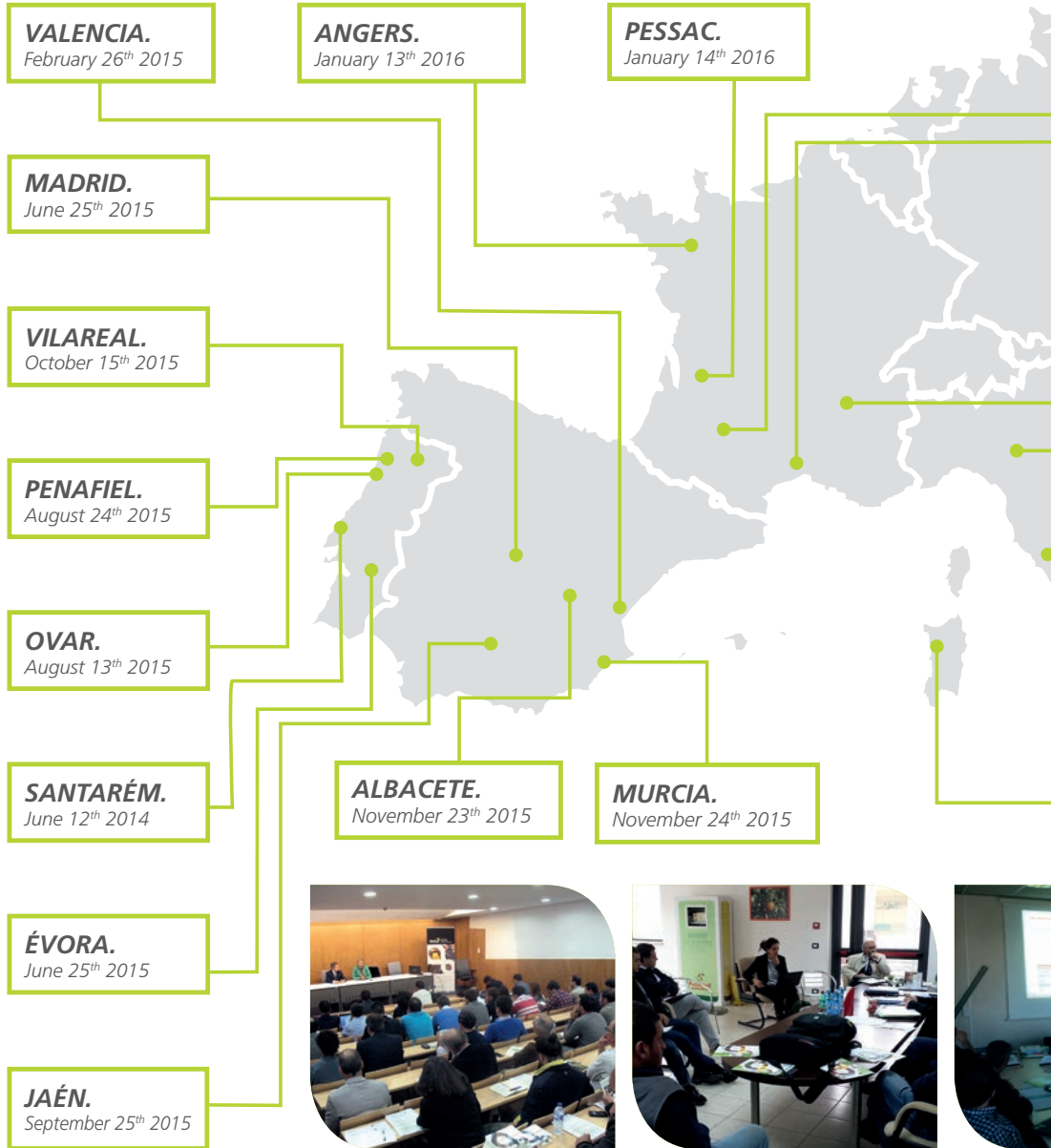
PROPOSED SAVINGS IN 110 AUDIT REPORTS. GWHOUR/YEAR



ACHIEVED SAVINGS IN JANUARY 2016. GWHOUR/YEAR



ACHIEVED INVESTMENTS IN JANUARY 2016. €





CASTANET-TOLOSAN.
December 15th 2015

MONTPELLIER.
January 28th 2016

LYON.
June 5th 2015

TOSCANA.
May 14th 2015

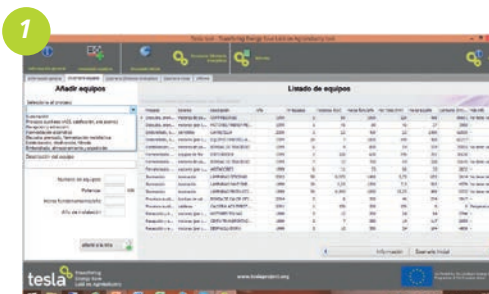
BOLOGNA.
March 3rd 2014

LAZIO.
January 12th 2016

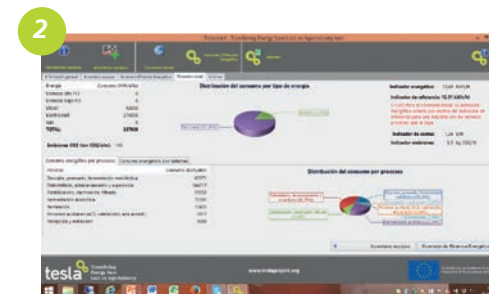
SARDEGNA.
December 10th 2015

PUGLIA.
November 13th 2015

TESLA TOOL – CREATED FOR THOUSANDS OF EUROPEAN AGRO-INDUSTRIES



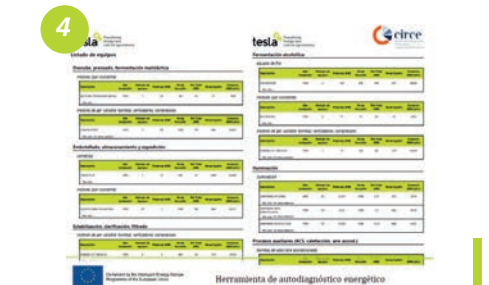
Introduce your data



Obtain a self diagnosis



Check the ways to improve your energy behaviour



Obtain the final report



www.teslaproject.org

All the useful information regarding TESLA project is freely available in the web page, including the TESLA tool.

Everyone can join the virtual network in the page so that be informed about updates and information on events. The blog has broadcasted the performance of the project during the project life cycle.



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Transferring
Energy Save
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About this document:

This document has been prepared by Cooperativas Agro-alimentarias de España in collaboration with the rest of partners of TESLA project:



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