



# Market of Olive Residues for Energy

Final publishable report



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*This document summarizes all the findings derived from the implementation of IEE project “MORE: Market of olive residues for energy”. The findings are fully described in many reports which are available online at website [www.moreintelligentenergy.eu](http://www.moreintelligentenergy.eu).*

*This summary was compiled by ARE Liguria and revised by project partners.*

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## Glossary

English	pits or stones
Spanish	huesco
Italian	nocciolino
Greek	κουκούτσι
Croatian	koštice maslina
Slovenian	koščice
English	<b>pomace or virgin pomace or olive pomace or crude olive cake (The residual paste after the olive oil extraction)</b>
Spanish	orujo
Italian	sansa vergine
Greek	ελαιοπυρήνας
Croatian	komina maslina
Slovenian	oljčne tropine (Ostanek oljčne drozge po ekstrakciji oljčnega olja)
English	<b>“traditional system” pomace (contains:pomace oil, pulp, pits, approx.25 % humidity)</b>
Spanish	orujo
Italian	sansa vergine
Greek	ελαιοπυρήνας παραδοσιακού συστήματος
Croatian	sirova komina maslina
Slovenian	oljčne tropine tradicionalne predelave (vsebnost: ostanek olja v oljčnih tropinah, meso ali pulpa (mezokarp), koščice (endokarp), približno 25 % vlage)
English	<b>“2-phase” pomace (contains:pomace oil, pulp, pits, approx.60 % humidity)</b>
Spanish	alperujo
Italian	sansa vergine
Greek	Διφασικός ελαιοπυρήνας
Croatian	komina maslina – produkt 2-faznog centrifugalnog sustava
Slovenian	oljčne torpine 2-faznega sistema (vsebnost: ostanek olja v oljčnih tropinah, meso ali pulpa (mezokarp), koščice (endokarp), približno 55 % vlage)
English	<b>“3-phase” pomace (contains:pomace oil, pulp, pits, approx.50 % humidity)</b>
Spanish	orujo
Italian	sansa vergine
Greek	Τριφασικός ελαιοπυρήνας
Croatian	komina maslina – produkt 3-faznog centrifugalnog sustava
Slovenian	oljčne torpine 3-faznega sistema (vsebnost: ostanek olja v oljčnih tropinah, meso ali pulpa (mezokarp), koščice (endokarp), približno 48 % vlage)
English	<b>pomace oil or olive kernel oil or olive pomace oil or crude pomace oil</b>
Spanish	orujo
Italian	Olio di sansa
Greek	πυρηνέλαιο
Croatian	ulje komine maslina
Slovenian	ostanek olja v oljčnih tropinah

English	<b>dried pomace</b> (contains: pomace oil, pulp, with or without pits, approx.10% humidity)
Spanish	orujo deshidrato
Italian	Sansa essiccata
Greek	ξηρή ελαιοπυρήνα
Croatian	suha komina maslina
Slovenian	suhe oljčne tropine (vsebnost: ostanek olja v oljčnih tropinah, meso ali pulpa (mezokarp), koščice (endokarp), približno 8 % vlage)
English	<b>exhausted pomace or depleted olive pomace or extracted olive pomace or exhausted (deoiled) olive cake</b> (contains: pulp, with or without pits, approx.10 % humidity)
Spanish	orujillo
Italian	Sansa esausta
Greek	πυρηνόζυλο
Croatian	iscrpljena komina masline
Slovenian	Suhe tropine brez ostankov olja (vsebnost: meso ali pulpa (mezokarp) z koščicami ali brez, približno 8 % vlage)



Pit



Dried pomace



Virgin pomace

## **Background**

Olive oil production chain is an important agro-alimentary branch in Europe. The EU is the biggest world producer of olive oil (1.9 million tons/y of olive oil - 80% of total) with about 12.000 olive mills<sup>1</sup>, most of which are SMEs. Olive cultivation is widespread throughout the Mediterranean mainly and is important for the rural economy, local heritage and the environment being the main source of employment and economic activity in many regions. Spain, Italy, Greece and Portugal together account for the 80% of world production and the EU globally accounts for 71% of world consumption<sup>2</sup>. Due to its nutritional, health and sensory properties, its consumption is expected to grow in the whole world.

Three broad types of production can be distinguished: 1) traditional groves, 2) more managed traditional plantations and 3) intensive, generally recent, more mechanised. The three use different industrial processing methods which besides olive oil, generate solid (olive pomace) and liquid (wastewater - OMW) residues in different quantities. But while up to a decade ago pomace used to be a no-cost resource for olive millers and used to be sold to pomace oil refineries with a revenue, today pomace oil has no market due to competition with other oils. Wastewater is abundant but since this is a combination of water and fat, it is difficult to recycle, highly polluting and negatively affects underground waters.

The polluting residues pose serious problems and the producing companies, very often conservative family based SMEs, with limited access to information on regular waste management, low investments possibilities and the need to be competitive against larger mills, are faced with increasingly restrictive environmental legislations (very hard to comply with) and might be forced to close due to their inability (both in terms of finance and skills) to treat properly their residues.

With the project MORE the partnership was aiming at addressing the problems of the market players in the olive oil sector, offering a way to

solve the problem of waste by using it for energy purposes, with olive pomace being an efficient fuel. Thus bringing in innovation, creating new revenues, increasing the quantity of renewable energy and improving the environment.

Core of the project has been the creation of **supply chains for energy from olive residues**, by involving the key public and private players, identifying the problems and the possible solutions, and promoting concrete actions.

The main objective was then the **creation of a stable olive-residues-to-energy market**. The main expected outcomes of the project were the **business plans** for energy facilities using olive solid residues and **guidelines** to identify and implement the best solutions for using olive residues for the production of energy.

The olive oil market is not very dynamic and presents the general characteristics below, which can lower its competitiveness against new and increasing overseas market, which are also using state-of-the-art technologies which minimise the production of waste and allow for a complete reuse of all the residues (eg. in California). Overall olive market problems:

- seasonality
- gathered quantity of highly polluting residues
- absence of a single feasible solution to the treatment of residues and waste
- attitude to use the residues as waste instead of a reusable resource
- small size of mills, often family based, which makes economically not feasible a proper treatment of waste with the need to find common solutions
- no technology and process innovation (new technologies allow for lower generation of waste waters)
- conservative attitude of operators
- lack of investments and of financing schemes.

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<sup>1</sup> UNCTAD based on data from the International Olive Oil Council (IOOC) 2005 + "The olive oil sector in the European Union", EC, DG for Agriculture

<sup>2</sup> UNCTAD based on data from the International Olive Oil Council (IOOC) 2005

## The present state: olive oil market in the partner countries

### Italy

Italy is the second producer of olive oil in the world with ab. 540.000 tons/year of production on 1.2 million ha and is the first consumer country. It also exports all over the world and the recent export trends have been constantly rising. More than 2 million farms and about 6000 olive mills operate in Italy. Olives are grown in 18 regions out of 20. 80% of oil production is located in southern Italy, where Puglia represents the most important region, with about 370.000 ha, followed by Calabria (about 186.000 ha) and Sicily (about 60.000 ha). These three regions account for more than 60 percent of Italian olive production. Olive oil production is characterized by alternate bearing. To sum it up, Italian olive growing is characterized by a great variety of factors: land dispersement; complex orography; high number of olive trees varieties (at least 100); different cultivation techniques, etc. Italy can count on the highest number of protected designations of origin in the sector of olive oil. According to the results of the annual survey carried out by ISMEA in 2001, many of the olive mill owners/managers interviewed declared to be actually interested in reducing the impact of olive oil extraction on the environment and to consider this aspect as a part of the greater concept of quality.

The main extraction systems in Italy are classic press, continuous centrifugation (two-phase and three-phase options) and various mixed systems plus the percolation system, which is statistically insignificant. Mixed systems can be defined as a whole group of possible combinations between the first two types and should represent about 9% of all extraction systems, though they are often identified with the continuous group. On national basis, the press and the continuous systems seemed to equal each other (44.8% the first and 45.6% the second) until the end of the '90 but today things have changed and the centrifugal technology prevails on the traditional. Giving a close look to the different regions, the continuous prevails remarkably in the south while the press system still plays a major role in the centre-north of the country. No data are available on the percentage incidence of two-phase and three-phase options within the continuous centrifugation category.

In the region of Liguria (ab. 14,000 ha) the transformation capacity of olive mills not only satisfies the needs of regional olive production but it also meets the needs of extra-regional producers, but this is not so economically beneficial. Most olive mills are family-based small size, characterised by little investment and process innovation. They are mainly considered

being part of the crafts sector instead of agriculture, which means lower chances to get accessible grants. Ligurian millers not only process the olives coming from many producers, but are a key player in the commercialization of olive oil and by-products. Ligurian olive oil can exploit the POD Riviera Ligure, but the many millers which collect olives from different producers do not use it, meaning that it does not match their needs. Big olive producers are starting to have a company mill, in the attempt to close the production chain within the framework of the agricultural sector. In this case the POD label is often used.

Most mills are located in "districts" on the already very polluted coastline or on the nearby hills. In the western Riviera most mills normally spread residues on the ground, while in the Eastern Riviera the mills usually give the residues to specialized companies. However pomace in Italy has not got much value anymore, therefore it is only a cost for the millers. There are many pilot actions to use biomass for composting and spread in woods burned, for addition to vegetable cultures, for addition with lime (calcium hydroxide) in order to dry it up and usable as fuels in extra regional plants and so on. Besides, in Italy there is a strong demand for olive nuts for heating due to their calorific power. Not experimented the olive oil biodiesel for automotive sector yet.

Distribution of olive cultivation areas with reference to climate



## Spain

Spain is the first producer of olive oil in the world, with its 40% of total production. Spain exports roughly 300.000 tons of olive oil a year.

The total current olive grove surface area is around 2.200.000 Hectares, which comprises 10% of the total arable land in Spain. In the last few years, there has been a noticeable increase in plantations as the previous total surface area, especially in Andalusia, was 200.000 Hectares of recent plantation.

The last few years has also seen an increase in the unit yields since specialised production and the professionalization of the sector's work force has improved (in both the agrarian and industrial phases) and investment destined to improve the agrarian and industrial structures (technological modernization, greater application of inputs, changes in irrigation, etc). In Spain, oil and olive production is around 5.2% of the Final Agricultural Production (this figure rises to 25% in Andalusia and 80% in the province of Jaén).

It is estimated that an additional 67,000 Hectares have been planted in the last few years (which would have to be added to the young olive groves), close to 74% of these correspond to

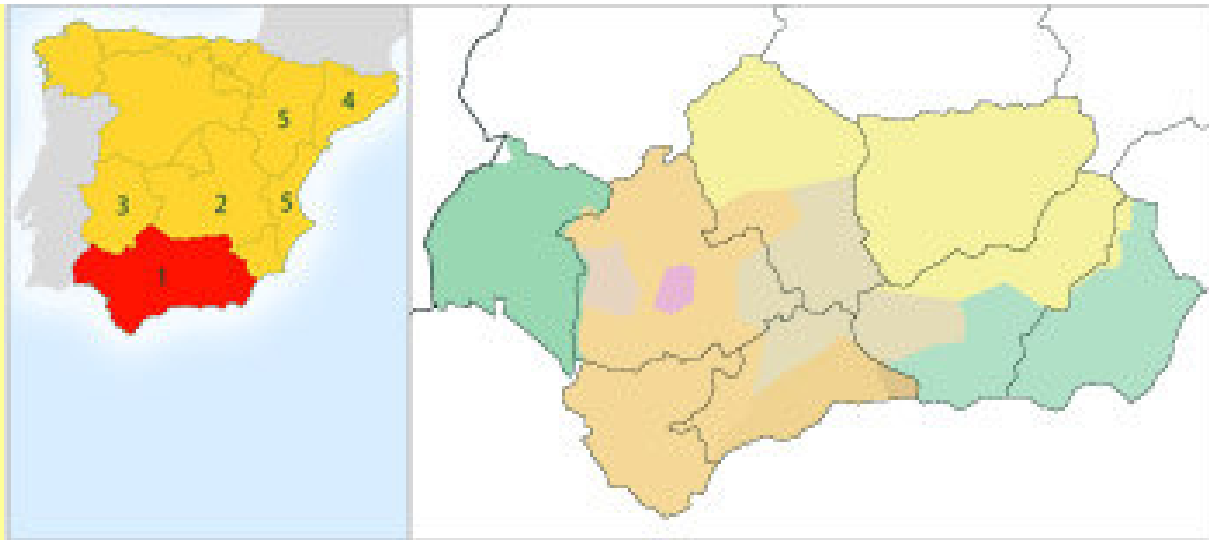
Andalusia, 9.5% to Castilla-La Mancha, 6.5% to Extremadura and 3.2% to the Community of Valencia. It is worth noting that in relation to the rest of the olive producing countries in the European Community, those in the Mediterranean basin and Portugal, the massive development of this crop registered in the last few years has only occurred in Spain.

In the olive oil industry family businesses predominate and the cooperative societies have been the preferred type of organization chosen by olive farmers.

A high number of olive mills exist in Spain. The majority of the olive mills uses two-phase extraction systems. Moreover, there are about 50 pomace oil extracting industries, only 20% of which are Cooperative Societies. They are characterised by the absence of public undertakings and foreign capital.

The province of **Jaén**, with approximately a quarter of the Spanish olive growing surface area, represents about 40-45% of the Spanish olive oil production and nearly 15-20% of the world production. The province of Jaén produces more olive oil than all of Greece.

### Spanish and Andalusia regions for olive growing



### Greece

Greece devotes 60% of its cultivated land to olive growing. Greece holds the third place in world olive production with more than 132 million trees, 520,000 olive growers, 3000 mills and 220 bottling companies which produce approximately 350,000 tons of olive oil annually, out of which 82% is extra-virgin. About 30% per cent of Greek oil is produced in island Crete, 26% in Peloponissos (southern peninsula), 10% in the Aegean island of Lesbos, 10% in the Ionian Islands (Adriatic Sea) and the remaining 24% is scattered around the rest of the country. Olive groves represent 20.5% of total farmland and olive oil production 14% of total plant production. In total approximately 1,200,000 hectares of land grow, over 140,000,000 trees. Only one sixth of those trees are intended for table olive production.

Consumption of olive oil in Greece is the highest in the world, 23 kilos per capita, compared to the E.U. average of 4.65 kilos, Spain's 13.68 and Italy's 12.41 (Source: International Olive Oil Council). In Greece there is no specific regulation regarding the management of olive processing waste. The olive oil producing prefectures have their own environmental requirements for olive mill wastewater (OMWW) management and on the gained local experience and the results of sponsored research projects they encourage different waste management approaches. Nowadays, the issuing of an olive-mill operation permit is subject to measures taken to treat the olive-mill waste.

The percentage of the olive mills depending on the extraction method used is: 80% olive mills using the three-phase method, 18% use the classical extraction method and a very small percentage use the two-phase or "ecological" two-phase method.

The large number of olive growers in relation to the cultivated land reveals that there is no large scale industrialised olive farming. 20% of the mills are cooperative ones while the rest belong to the private sector. Private mills are usually small family operations. The average mill employs

specialized personnel (1-2) and some 3-4 non specialized labourers.

The fact that olive mills are small to medium size enterprises (SMEs) employing less than ten persons, with limited financial abilities and managerial skills will be a serious barrier in adopting an entirely new technology

There are 35 olive pomace extraction plants in Greece with the largest number concentrated in Crete (11) and the Peloponnese oil (10).

The average production of olive groves is particularly high, 360 kilos/ hectare when the corresponding world average is 160Kg/ hectare. In certain areas such as Crete average production is even higher going up to 500Kg/ hectare.

In Greece oil refineries buy virgin pomace from olive millers, extract pomace oil from virgin pomace and they use the exhausted pomace either for their own energy needs or they sell it to the millers as a heating fuel.

### Olive oil production in Greece



### Slovenia

The tradition of olive growing in Slovenia is very long. The olive trees are cultivated in the coastline of Slovenia, the territory is called Slovene Istra and the olive trees are present there millenary. Nowadays Slovenia has 1400 hectares of orchards and Slovenian part of Istria has more than 1100 ha of them. Approximately 900 hectares are intensively cultivated (put in the last few years). The number of olive growers is 1639. The annual Slovenian production of olive oil is approx. 400 tons which gives about 1000 tons of olive residues. All olives are pressed in 12 olive mills in Slovenia. The predictions show the growth

of olive residues in the following years. Produced olive oil is fully consumed on Slovenian market. The import of olive oil in Slovenia is estimated to approximately 1000 tons, mostly coming from Italy, Spain and Greece.

Olive residues are now used as fertilizer for agriculture fields which is not a sustainable way of disposal.

Some olive millers have already bought special stoves for heating with olive residues. The barriers are lack of proper technologies, of ecological consciousness, of knowledge and (at the moment) too expensive infrastructure for broader use of olive residues as renewable energy source.

## Croatia

Production of olives and olive oils has long tradition in Mediterranean part of Croatia. Area of olives distribution in Croatia is Istria, coastal area of Kvarner and islands, and coastal area of Dalmatia with islands. In last few years, after long period of extensively way of production, olive growing becomes interesting agricultural sector (activity), and nowadays there is a trend of start-up new plantations of olives.

According to statistical data in Croatia in 2004 there were 3.743.000 olive trees (Statistical yearbook 2005) planted on 16.980 ha from which 16.685 ha own family farms and 295 ha are from legal entity, parts of legal entity and plantations on the state property. The majority of olive plantations are in County of Split-Dalmatia (27%), then County of Dubrovnik-Neretva (22%), County of Zadar (17%), County of Šibenik-Knin (12%), Istria County (9%), County of Primorje-Gorski kotar County (12%) and County of Lička-Senj (1%). Most of the olive plantations have between 0.5 and 2 ha (40%).

Plantations with less then 0.5 ha participated with 37% and plantation with more then 5 ha participated with 23%. Most of the production is organised by family farms and it is estimated that there is about 40.000 olive producers. Croatia has about 100 olive millers and production of table olives is almost insignificant. Average production in the last five years were 22.000 t olives (for example in 2002 - 32.955 t, and in 2003 - 9.482 t),

which were about 33.000 hl of olive oil (2002 - 44.815 hl, and in 2003 - 12.567 hl). Average annual consumption of olive oil in Croatia is about 1 kg per capita.

Olive oil residues are not used in some new useful product. To our knowledge there is only one example in which this remains, after one year, were put back to the plantation as material for soil quality improvement.

### Olive oil production areas in Croatia



## What are we exactly talking about?

### The olive oil extraction processes

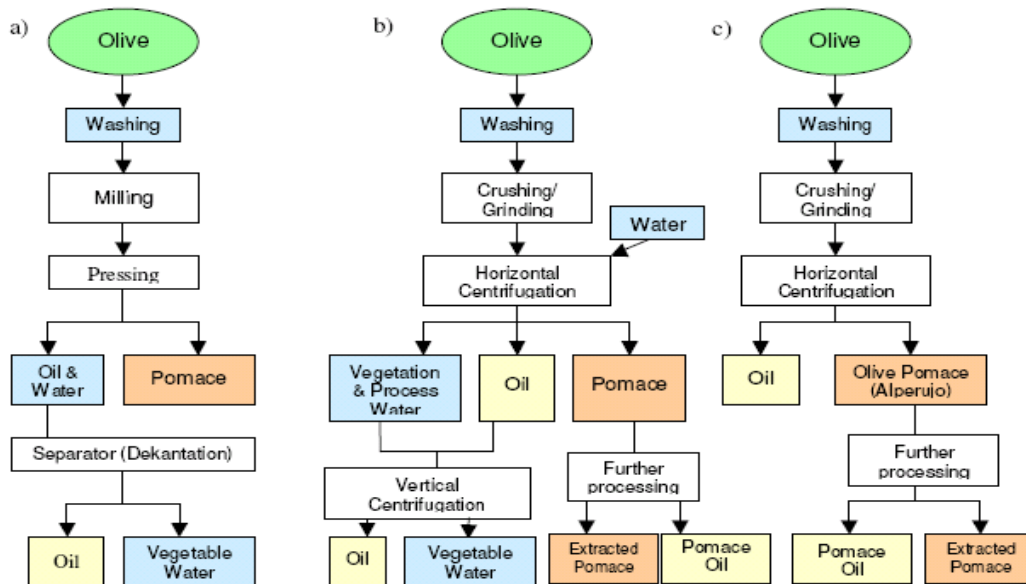
Four to ten kilos of olives are needed to produce just 1 litre of olive oil. The olive tree begins to produce olives between the ages of 5 to 10 years, reaching maturity at about 20 years. After 100 to 150 years, its production begins to decline. The age of the tree influences only the quantity produced, not the quality. The harvesting can be done by hand hitting the tree with a flexible pole so that the olives fall into canvas covers placed on the ground or by means of mechanical vibrations.

Some olive varieties may be picked in October when they are still green, while other varieties may be left until February when they are at the peak of ripeness and bursting with oil. Olives are usually pressed within 24 hours if the weather is hot. If the weather is cooler, the pressing may occur within 72 hours of harvesting.

Until about 30 years ago, almost all olive oil was obtained through traditional pressing. In the 70s, the mills gradually abandoned the traditional olive pressing process for economical reasons. Nowadays the traditional method is only used for processing small quantities of olive oil. The alternative method is the continuous system that works by means of the centrifugation of the pressed olive paste, producing three products: oil, pomace and residual water (wastewater), just like the pressing system. At present, three types of extraction system are used on the olives (shown in figure below):



Flow scheme of the 3 different olive oil production processes, a) traditional process, b) 3-phase decanter process, c) 2-phase decanter process. Source: TDC OLIVE “By product Reusing”



- The “**Traditional process**”, also known as “traditional method” or “press”. The ground paste is placed between pressing mats and is subject to pressure, to expel the oil mix (mixture of oil and water). The mixture is then poured into a vat or holding tank. This is allowed to rest so that gravity and different densities come into play, separating the oil from the water. It is also defined as “**discontinuous cycle**”, where milling, grinding, extraction and recovery are performed discontinuously, through the use of different machines.

2-phase and 3-phase processes are known as “CONTINUOUS CYCLE” (by centrifugation): where processing cycles are not interrupted, from when the fruit is crushed to when the oil is separated.

- The “**3-phase process**”. The process based on a 3-phase decanter: 1 litre of water is added per kilo of paste; it is then added to a horizontal centrifugal machine, where the solid is separated from the oil must. The must is then passed on to a vertical centrifugal machine, where the oil is separated from the vegetable water.
- The “**2-phase process**”. The process based on a 2-phase decanter: Same process as above, but instead of adding water for the horizontal centrifugation, the vegetable water is recycled.

The main differences between the extracted raw materials are due to water content. Two-phase pomace has moisture approximately 50-70% and contains a certain amount of sugars as a result of the presence of vegetation water, while traditional pomace has a moisture content of between 25- 30% in the pressing system, and 45-60% in 3-phase centrifugal systems.

Comparing the three processes:

- The main disadvantage of the “3-phase process” is the huge amount of water needed and consequently the production of vegetable water.
- The stream of the milled olives in “2-phase process” is separated in a 2-phase decanter. This system enables reduced fresh water consumption and the elimination of wastewater streams. Unfortunately, pomace which is produced comprises both, solids and water (OMWW) from the olives and poses again difficulties for disposal, as it is very difficult to handle, dries out very slowly and it is again very polluting.
- As a method of pressing, the traditional process entails high labour costs and has certain disadvantages due to the fact that the pressing devices used cannot prevent small pieces of paste from one batch remaining in the press to the next batch, thus contributing to an increase in acidity.

More specifically three-phase centrifugation has the following advantages:

- It enhances the subsequent drying process, since at least 25% of the residual water contained in the “2-phase process” is removed from the paste. This moisture decrease allows for the use of lower drying temperatures, which is favourable for obtaining an oil of better quality in the further chemical extraction.
- Major energy and financial savings are derived because the evaporation of the residual water in the evaporators/concentrators of the power plants takes place with zero net energy consumption. In fact, the process uses the residual energy of the exhaust steam from the turbine.
- It enables a residual water concentrate to be obtained, which is rich in mineral salts, sugars and polyphenols. This concentrate is of high commercial value due to its use as animal feed and organic-mineral fertilizer.
- The resulting residual water is the departure point for obtaining compounds of high added value because they are beneficial to human health.

## Possible current use of olive oil residues

Pomace with water content up to 48-54% can be sent to pomace units to extract residual oil with solvents, whereas pomace with 58-62% water content causes problems for extracting oil and since it has to be dried first it is difficult to place it on the market. In general, 5% oil and 65% waste pomace is obtained from wet pomace. There are several uses for the latter including agricultural uses (compost, amendments, fertilizers), energy generation in specially designed stoves or gasifiers, material recycling (cements, tiles, compressed wood) or even livestock feed or steam explosion treatment for obtaining hydroxytyrosol.

The traditional energy use of exhausted olive pomace is as fuel in drying ovens or steam boilers because of its thermal capacity. The pomace oil extraction industry is a high energy consumer, particularly at the pomace drying stage and during extraction with solvent. By exploiting the calorific potential of the exhausted olive cake or the pomace (biomass), it is possible to generate electrical energy and exploit the residual thermal energy for the stages of drying and extraction with solvent. Similarly, the ashes produced in combustion are used to manufacture manures, given their high soluble potassium content.

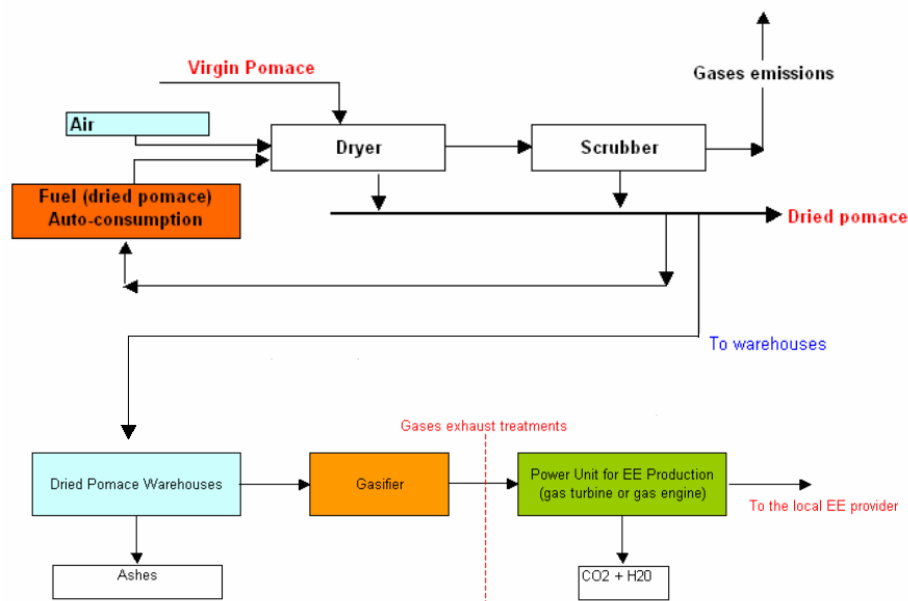
Pomace can also undergo Anaerobic digestion where organic material is transformed into biogas which can be used to generate electricity or

thermal energy. The main drawback is the production of small quantities of mud.

Gasification can be also used to produce thermal energy or for cogeneration. Gasification allows using virgin pomace which is transformed into syngas made of CO and H. This kind of plants has the advantages that pomace does not need to be dried and high performances, but they need big quantities of pomace.

The pit has very good properties as a fuel for heating, even for domestic installations. In addition to the use as fuel, pits are also used as abrasive material for cleaning walls, for example, in the manufacturing of furfural, and for the manufacturing of active carbon for the treatment of gases, water or other special applications.

What is perhaps the newest use of olive mill wastewater, complex agro industries are integrally exploiting the pomace with evaporators/concentrators capable of removing the olive mill wastewater and exploiting the residual energy of the exhaust steam from electricity generating turbines. The liquid generated in this process is used as cooling water in the capacitors and the resulting concentrate is excellent for use in the manufacturing of manures and fertilizers, and for its use as animal feed.



## The energy potential of solid olive residues

The average heating value of dry pomace (with pit, low moisture content) is 3,500-4,000 kcal/kg while for pits is 4,000-4,500 kcal/kg.

### Comparison of Heating Values of Olive by-products in each partner country

Kcal/kg	Spain	Italy	Greece	Slovenia	Croatia
Average heating value of <b>dry</b> pomace (with stones, low moisture)	3800	n.a.	3500 – 4000	4.216	n.a.
Average heating value of <b>virgin</b> pomace ( with pomace oil & pits, high moisture)	1800	1800	n.a.	4604 – 4974	4219
Average Heating value of <b>pit/stone</b>	4100	4750	4500	4805	4500

### Heating value of fossil fuels.

	Fuel	kcal/kg
1	Propane	11060
2	Butane	10940
3	LPG Mixture	10960
4	Diesel	10200
5	Fuel Oil	9600
6	Town Gas	9100
7	Coal	4498
8	Wood	3890
9	Natural Gas	8300 – 9700 kcal/m3

## ***The present state: Target areas***

The partners have selected the target areas, matching their regions of influence or part of them, where they concentrated their in depth analyses of present state assessment, potential definition, elaboration of business plans, involvement of local stakeholders.

- **Are Liguria and Unioncamere Liguria: the whole region, but in particular the provinces of Imperia and Savona, because of the highest amount of olive residues**
- **Agener. Province of Jaen**
- **Anatoliki. Area of Chania, in Crete**
- **UPZRS: Slovenian Istria**
- **IPTPO: Croatian Istria**

## ***The present state: current supply chains and end-uses of solid residues in each target region***

### **Liguria Region**

Liguria is a coastal region of north-western Italy, the third smallest of the Italian regions. Its capital is Genoa. Liguria borders France to the west, Piedmont to the north, and Emilia-Romagna and Tuscany to the east. It lies on the Ligurian Sea.

The ring of hills, lying immediately beyond the coast, together with the beneficial influence of the sea, account for the mild climate the whole year round. Population density in Liguria is high (almost 300 inhabitants per km<sup>2</sup> in 2008). Liguria is divided into four provinces: Province of Genoa, Province of Imperia, Province of La Spezia and Province of Savona. Ligurian agriculture has increased its specialisation pattern in high-quality products (flowers, wine, olive oil).

Ligurian millers are craftsmen who work third party's olives (imported olives) or their own's (local olives). The quantity of residues therefore depends on imports but it is not easily figured. Most Ligurian millers use the traditional system or the 3-phase system. Only 1 mill has the 2- phase system. Virgin pomace is dispersed on the ground or sent to pomace refineries at no cost (the refineries pay for transport). Most millers (over 60%) deliver pomace to pomace refineries: there is 1 small refinery in Liguria, but most pomace is sent to Tuscany or Latium (where there are big refineries) that pays very little money (more or less as much as the transport cost). Therefore, in Liguria there is only virgin pomace potentially

available. The other millers use pomace for agronomic use (10%) and the rest dispose of it in another way. Liguria has a pilot project for alternative disposal of pomace but there are environmental, procedural, legal or technical difficulties.

Olive pit separation from virgin pomace (pit recovery range amounts to 18-30%) seems to have the highest potential in terms of heating value and price. At the moment pits are not purchasable in shops, only some mills sell them directly. The remaining pomace is mostly dispersed on the ground. Waters are dispersed on the ground (very small quantities are dispersed due to the morphology of our territory) or treated in special depurators but the cost is really high.

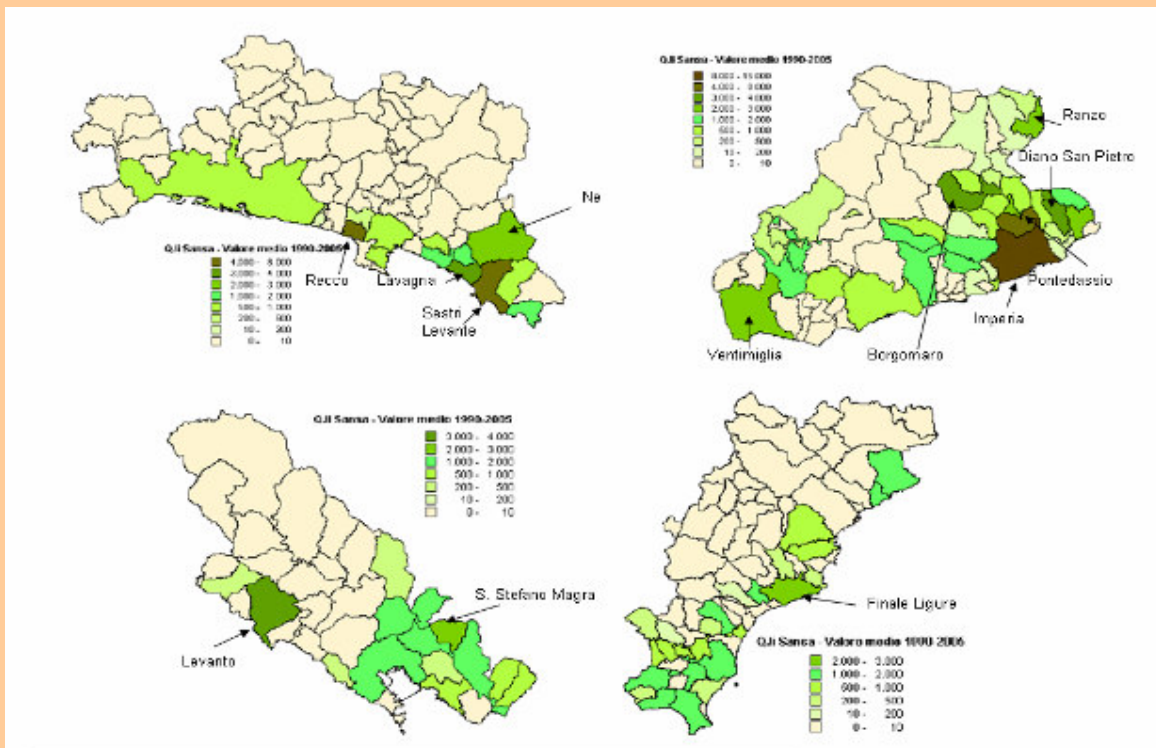
- In Liguria there are cases of pit separation and consequent use it as domestic fuel. It is also sold for the same aim.
- There is a case of use of calcium for pomace drying (UNIECO) at Lucchi & Guastalli mill with subsequent use as fuel in biomass boilers (in Tuscany and Lombardy)
- There is a small (70 kW – 64 mt length) district heating plant running with olive nut in the municipality of Arnasco. It heats up the church and the annexed building.

**Estimated Olive solid pomace residues produced between the years 1995-2007 in the region of Liguria**

Solid pomace residues (tn)													
(tn)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
virgin pomace	14.411	10.055	13.871	5.415	6.314	12.902	4.749	18.849	9.712	13.605	10.620	9.774	7.151
exhausted pomace	1.441	1.006	1.387	542	631	1.290	475	1.885	971	1.361	1.062	977	715

For the virgin pomace produced in the region of Liguria the actual data was not possible to be found due to the fact that there isn't a regional authority to keep in file this kind of figures. The data were estimated by ARE Liguria. For the estimation it was used the assumption given by the local olive millers that from 1kg of olives 0.450 kg virgin pomace is produced and from this amount 0.100kg is the final product that could be used as a fuel and is called exhausted pomace.

**Pomace production in the region of Liguria divided in province areas**



**Potential facilitating factors, opportunities or barriers concerning the energy exploitation of olive residues:**

- Green certificates for electrical energy
- Possibility to use heat for the many greenhouses in Liguria (flowers and farming)
- Funding opportunities for <1MW plants, coming from the Rural Development Plan 2007-2013
- Mills have a low energy demand (for electricity in the range 16-70 kW and for heat around 40.000 kcal) therefore there is a need for different potential users.
- Presence of virgin pomace only and absence of regional pomace refineries therefore, need to find a way to dry pomace in order to increase its heating value. Pelletising could be a solution?
- Presence of many scattered small mills, therefore the transport factor becomes crucial in the feasibility study. And transport in Liguria is particularly difficult due to orography
- Presence of different milling systems, which generate different kinds of pomace.
- Seasonality of residues.
- Different crop yield each year.

## Province of Jaen

**Jaén** is a region/province of southern Spain, in the eastern part of the autonomous community of Andalusia. It is bordered by the provinces of Ciudad Real, Albacete, Granada and Córdoba. Its capital is Jaén city. Its area is 13.484 km<sup>2</sup>. Its population is 657,387 (2003), of whom just about one-sixth live in the capital. It contains 97 municipalities.

Jaén is one of the larger producers of olive oil in the world. It produces around 60% of all Spanish production. Therefore the elimination of the waste is very important in this process. To eliminate the residues, the olive-mills use a 2-phase process, which does not generate waters. A by-product designated as virgin pomace is obtained (humidity 62-70%) that goes through a pitting machine - the pit is mainly used as fuel to produce heat for thermal use. Afterwards, the virgin pomace goes through a process of drying and extraction and new by-product results, designated dry pomace (humidity 10%). This by-product is mainly used as fuel to produce electricity.

Both of the following two types of energy applications of the olive grove solid residues are used in Spain:

### 1. Thermal application:

The biomass (olive solid residues) is used for the domestic sector, for heating and sanitary hot water (SHW); also at industrial level for steam process that comes from reused residues.

### 2. Electrical application:

The technology used for obtaining electricity is the Rankine vapour cycle, with generation or co-generation (heat + electricity) electrical plants (steam conventional cycles). Another alternative is the electricity generation through gasification processes.

The optimal electrical energy plant size is between 10 to 25 MW, the normal size is 25 MW so that it is the most profitable.

Since some years ago, the Spanish Government began to promote thermal installations. However, the development of the sector (of biomass installation) depended on Logistics & Distribution. That's why a lot of companies related to this sector create new distribution companies that supply biomass to all the thermal installations.

Spanish biomass electricity producers receive a premium on top of the normal price for electricity; however this premium is not high enough to make biomass attractive to most investors so it is necessary to increase the premiums for the biomass sector.

The implementation of the biomass electricity installations mainly depends on government policy. In the years 2004-2007, the price of which was established by government, were not profitable for implementation of olive-pomace installations. Finally in May 2007 the prices changed and investments in the biomass sector helped to develop old projects and start new ones.

In the following table and figures is presented the situation regarding the pomace produced in the region of Jaén.

### Estimated Olive solid pomace residues produced between the years 1995-2007 in the region of Jaén

Solid pomace residues (tn)													
(tn)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
virgin pomace	2.861.512	3.485.600	3.522.407	2.694.089	3.419.902	3.419.902	4.680.542	2.843.173	4.686.853	3.344.862	2.553.713	3.765.965	3.961.565
exhausted pomace	429.227	522.840	563.585	431.054	547.184	547.184	748.887	454.908	749.896	535.178	408.594	602.554	633.850

### Potential facilitating factors, opportunities or barriers concerning the energy exploitation of olive residues:

Biomass energy is increasingly popular as an alternative energy source for a variety of reasons:

- It is widely available in the region (Jaen).
- It can provide solutions to the climate change issue.
- When utilizing the 2-phase system the fresh water consumption is reduced and also the wastewater streams are eliminated.
- When the refined oil is extracted, the leftover fibrous material is primary lignin and cellulose. This residue has still a high calorific value, and it can be composted, burned, use for heating, for animal feed supplement or returned to the olive trees as mulch.

- The remaining leaves and stone can be pyrolysed under non-oxidative atmosphere or gasification can take place with energy or alternative fuel production. It can be a solution to the environmental problems that their land filling or combustion could create.

### Chania Region

In the prefecture of Chania according to the data of the General Secretariat of the National Statistical Service of Greece (ESYE) there are cultivated about 7.000.000 olive trees (only for olive oil production) each year. In the area there are 112 active mills and three pomace oil refineries. The majority of the olive mills (94.4%) use the 3-phase olive oil extraction system and the remaining 5-6% uses traditional pressing and the 2-phase extraction system (3.2% and 2.4% correspondingly).

The virgin pomace derived after the olive oil extraction is delivered to the pomace oil refineries usually as exchange of the exhausted pomace that they use in their boilers for heating process water. In the market, the price of virgin pomace is approx. 15€/tn and the price of the exhausted pomace is approx. 50-60€/tn. In this sense the olive millers get 1kg of exhausted pomace for each 3.5 kg of virgin pomace that they give. Pomace oil refineries collect most of the virgin pomace produced in the region approx. 95-99% and they dry it in order to extract the pomace oil using a solvent (usually hexane). The final product contains humidity around 13%, pits and pulp and is called exhausted pomace or depleted pomace or olive kernel wood. Pomace oil in Greece is used as an animal feed but it can also be found at the super markets for human consumption. The wholesale price of the pomace oil is currently 650€/kg.

For the virgin and exhausted pomace produced in the region of Chania the actual data was not possible to be found due to the fact that neither the ESYE nor a regional authority keep in file this kind of figures. For the estimation it was used the assumption given by the local olive millers that

from 1kg of olives 0,4 kg virgin pomace is produced and from this amount 0,205Kg is the final product to be used as a fuel and is called exhausted pomace.

Olive millers in Greece do not extract pits from the virgin pomace as most of the Spanish millers do because of the high cost of the technology required for this process. Moreover, in old times olive pulp was used as animal feed and for this reason pomace oil refineries were separating the pit from the pulp after the pomace oil extraction. Nowadays pulp which isn't used as animal feed, is burned together with the pit as exhausted pomace.

Dried or exhausted pomace is mainly used for heating purposes today on Crete for:

- Houses
- Greenhouses
- Various small-sized industries

In the future, pomace has very good prospects in power generation and/or heat and power cogeneration. Since a large proportion of power in Crete is generated today from wind energy, it is likely that, in the future, biomass will also contribute to the generation of green electricity

Pomace's heating value is 3500-4000 Kcal/ kg (with a moisture content of 12%) and its price is approximately 0,05 Euros/ kg; thus, it is a very attractive option as a fuel in comparison to oil. Also, it is used in various industries for drying purposes and/or for hot water heating. The required machinery for the dried or exhausted pomace combustion is the boiler (including the burner), which is quite simple to use and not expensive. These boilers are reliable and made locally.

### Estimated Olive solid pomace residues produced between the years 1994-2006 in the region of Chania

Solid pomace residues (tn)													
(tn)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
virgin pomace	56.758	59.523	79.024	73.122	77.890	81.889	72.728	70.396	72.033	71.998	65.381	76.177	75.298
exhausted pomace	28.379	29.762	39.512	36.561	38.945	40.945	36.364	35.198	36.016	35.999	32.690	38.088	37.649

### Potential facilitating factors, opportunities or barriers concerning the energy exploitation of olive residues:

Dried or exhausted pomace can be used for power generation or cogeneration of heat and power in Crete, since it presents many advantages, such as:

- There is no need for harvesting of raw materials and transportation because it is produced in the dried or exhausted pomace processing plants.
- Its moisture content is very low and its heating value is high.
- Its price is rather low in comparison with its heating value.
- The combustion technology is well known. Since it is granular, either fixed bed reactors or fluidized bed reactors can be used.
- The generated power can be consumed either inside the plant or can be sent to the grid.
- The Greek Government offers good subsidies for investments in the field of Renewable Energy Sources and, of course, in Biomass.
- The use of Biomass for power generation in Crete will reduce the CO2 emissions on the island.
- In the case that such a plant should be created, various other solid agricultural residues can be used together with the Olive Kernel Wood as raw materials.
- The creation of such a plant will help in power generation to and from small-decentralized plants instead of larger centralized power plants that exist today in Crete.
- The sulphur content of dried or exhausted pomace is minimal.
- The efficiency of small-sized combustion plants is very low. The dried or exhausted pomace processing plants operate seasonally. The produced heat from dried or exhausted pomace should be used at the time that cogeneration of the heat and power is obtained (during its operational period which is from November – April), or outside the plant for nearby heat-requiring operations.
- Initially, the price of the dried or exhausted pomace may rise, due to an initial local deficit of this Biomass source.
- Nowadays, fewer people work in agriculture. There are no incentives or opportunities to the farmers to exploit olive residues in order to produce energy from them.
- People should be informed about the environmental and energy benefits of the olive residues exploitation.
- Cretan's admitted that they would like to exploit olive residues only if they had a financial incentive.
- Most millers are at a senior age and lack knowledge about new possibilities and procedures for olive residues exploitation.

The island of Crete (left) and the area of Chania (right)



### Istria Region

The Slovenian Littoral is a historical region of Slovenia. The region comprises two traditional provinces: Goriška and Slovenian Istria. In Slovene Istria, olive residues are usually (95.4 % of residues) composted and returned to the olive groves as fertilizer. The composting of olive residues is integrated in the processing cycle of each oil mill. After the 3-6 month composting period, the olive residues are spared on the surface as fertilizer, returning nutrients to the soil. Only 4.6 % of olive residues are used for energy purposes, to generate heat. This amount of residues produces enough green energy for

heating two households. Until now there is no any supply chain in Slovene Istria region. The end users of olive residues are now mainly olive millers which use olive residues for composting. Two of them use olive residues for their private energy purposes (heating). Both of them have around 60 tons of residues per year. If they would use all of residues, it would be enough energy for heating at least 5 more households. In Slovenia pit separators, which separate olive pits from olive pomace are not used. There are also no drying facilities and refineries to dry wet pomace in order to make them more appropriate for burning or

further processing. Planned development of electricity generation from renewables does not include the energy exploitation of olive residues, because of their small quantities. In Slovenia olive

residue is treated as waste and not as secondary product. They don't use olive residue for energy most of them are thrown away or use like fertilizer in olive fields.

#### Olive mills location in Slovenia

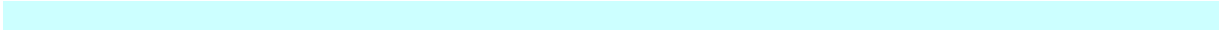


#### Olive mills data

Št.	Mill name	Address	ZC	Town	Technology
1	Oljarna TORKLA	Obrtna ulica 11	6310	Izola	2
2	Kocijančič	Frenkova 5	6276	Pobegi	2
3	Oljarna Torkla Šalara	Obrtniška ulica 26a, Šalara	6000	Koper	2
4	Oljarna Torkla Krkavče	Krkavče 97	6274	Šmarje	2,5
5	Oljarna Prinčič	Sv. Peter 18	6333	Sečovlje	2
6	Oljarna Krožera	Srgaši 40	6274	Šmarje	2,5
7	Oljarna Peroša	Nova vas nad Dragonjo 8	6333	Sečovlje	3
8	Oljarna Čok	Plavje 10	6281	Škofije	traditional
9	Oljarna Oljka	Vanganel 40	6000	Koper	traditional
10	Oljarna Hrvatini	Ul. 15 maja 10b	6000	Koper	2
11	Oljarna v Brdih	Zadružna cesta 9	5212	Dobrovo v Brdih	2
12	Oljarna Agapito	Spodnje Škofije 15	6281	Škofije	traditional

Technology	Olive residues (t)	Waste water (t)
Traditional	122,3	183,45
2 phase	536,1	122,54
2,5 /3 phase	167,5	334,98
<b>SUM</b>	<b>825,9</b>	<b>640,97</b>

For the virgin pomace produced in the region of Istria the actual data was not possible to be found due to the fact that there isn't a regional authority to keep in file this kind of figures For the estimation it was used the assumption given by the local olive millers that from 1kg of olives 0,7 kg virgin pomace is produced.



## Estimated Olive solid pomace residues produced between the years 1994-2006 in the region of Istria

Solid pomace residues (tn)													
(tn)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
virgin pomace	915	930	169	747	1.055	871	615	1.751	603	1.502	718	815	739

### Potential facilitating factors, opportunities or barriers concerning the energy exploitation of olive residues:

- Based on upward trend of petrol prices on global markets and breakthrough of new technologies, which use alternative / renewable sources of energy (for instance wood biomass in Slovenia), the use of olive residues could be an alternative source of energy, in first place for heating / production of heat and later for production of electricity.
- Since the quantity of olive residues in Slovenia is very small, the exploitation of these is not suitable for larger energy plants, such as large heating stations or power plants. Their use is most suitable for heating individual olive mills and private households, which are in direct proximity of olive mills. These conclusions are based on calculation of ratio between yearly energy potential of olive residues, comparing to yearly energy needs for energy in Slovenia, which is very low.
- Use of olive residues has very important impact on the environment.

### Istrian region

The Istrian region (Croatia) has a long olive growing and oil producing tradition. According to the latest official statistical data, a total of 600,000 olive trees are cultivated in Istria. Lately, traditional extensive olive cultivation methods were replaced with intensive modern growing technology, and olive growing has become attractive trend in agriculture. Moreover, the olive oil is one of the most important typical food products in Istria. The olive oil market has recently improved especially since the consumers pay more attention to both health and nutritional aspects of food.

Olive sector in Istrian Region (Croatia) is organized as follows: Olive producers use services of 18 olive mills, mostly SME's. Olive mills produce olive oil and they are responsible for olive mill waste management. The treatment of olive milling residues in the region encompasses different treatments. During the few last years 2-phase centrifugation technology is replacing both the traditional press technology and the relatively recent 3-phase centrifugation in the olive-oil extraction industry.

Olive mill owners manage waste waters mostly using physical treatment processes in their own organization or by means of waste management companies. There are also some cases of OMWW releasing in the environment. In Croatia, olive residues are treated as a waste and not as secondary products. But, there are some cases of virgin pomace treating as an organic fertilizer, usually placed back to the olive fields (with or without composting). Some mills deposit pomace in the mill vicinity or release it in the environment.

There are a very few cases of using pomace for energy purposes (as furnace fuel).

At the moment in Croatia there is a lack of successful energy exploitation of olive residues. Quantities of residues are relatively low in Croatia but in the following period significant increasing could be foreseen.

Since in the region of Istria exhausted pomace is not produced and according to their regional situation it won't be possible to be produced in the near future due to the small quantities of the olives treated in the area.

### Location of olive mills in Croatia



### Olive mills in Croatia

Št.	Mill name	Name	Surname	Address	Zip code	Town	Technology
1	Agro Millo	Valter	Smilović	Baredine 16	52460	Buje	2
2	Agrofin	Boris	Vekić	Zambratija bb	52475	Savudrija	3
3	Al Torcio	Tranquilio	Beletić	Ulica Torci 18	52466	Novigrad	2
4	Baiocco	Andrej	Đurić	Galižana 8a	52216	Galižana	3
5	Brist d.o.o.	Silvano	Puhar	Ušičevi dvori bb	52203	Medulin	-
6	Kraljević – CUI	Danijel	Kraljević	Farnežine	52470	Umag	2
7	Olea d' oro	Germano	Kraicer	Partizanski put bb	52100	Pula	3
8	Pastorvicchio	Antonio	Pastorvicchio	Istarska 28	52215	Vodnjan	2
9	Pavlović	Alojzije	Pavlović	Crveni vrh bb	52475	Savudrija	-
10	Pilar – Stella Maris	Pilar family		Stella Maris	52470	Umag	2
11	Torač	Franko	Vladišković	Žbandaj bb	52440	Poreč	2
12	Babić	Ante	Babić	Stancija Vineri bb	52466	Novigrad	3
13	Bronzi	Sergio	Černeka	Bronzi 51	52420	Buzet	2
14	Brtonigla	Šišot family		Ronko bb	52474	Brtonigla	Traditional
15	Pašutići	Miljenko	Prodan	Pašutići bb	52420	Buzet	2
16	Agrolaguna	Agrolaguna d.o.o.		M. Vlašića 34	52440	Poreč	2
17	Rovinjnsko selo	Miro	Pokrajac	Rovinjnsko selo 50	52210	Rovinj	2
18	Agroprodukt d.o.o.	Agroprodukt d.o.o.		Trgovačka 135	52215	Vodnjan	3

### Estimated Olive solid pomace residues produced between the years 1995-2007 in the region of Istria

Solid pomace residues (tn)													
(tn)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
virgin pomace	22.613	10.655	6.899	13.630	23.338	10.751	12.871	21.849	6.287	n.d.	24.267	18.252	22.891

For the virgin pomace produced in the region of Istria the actual data was not possible to be found due to the fact that there isn't a regional authority to keep in file this kind of figures. For the estimation it was used the assumption given by the local olive millers that from 1kg of olives 0,5 kg virgin pomace is produced.

#### Potential facilitating factors, opportunities or barriers concerning the energy exploitation of olive residues:

One of the main goals of Croatian energy development sector is to increase the use of renewable energy sources.

The advantages of energy end-uses of these residues are:

- The improvement of olive waste management
- Not increase atmospheric levels of carbon dioxide, a primary greenhouse gas and at the same time it can also decrease the amount of methane, another greenhouse gas, which is emitted from decaying organic matter. Biomass is a renewable, CO<sub>2</sub> –neutral, fuel making it a valuable technology in efforts to reduce CO<sub>2</sub> emissions in order to curb global warming and climate change.

Creation of supply olive-residues-to-energy chains could be the optimal solution for olive residues management in the region but some problems for the energy exploitation could arise:

- In Istria (and Croatia) there is no olive cake collecting centres or facilities for their drying and energy producing.
- Generally, limited access to information on regular and appropriate waste management

- Existing producer's attitude of non profitability on pomace use in energy purposes (results of feasibility studies).
- High percentage of olive oil in pomace in Croatia (no pomace oil extraction) requires a special approach in energy production.
- Crucial factor for the feasibility study are transport expenses, due to olive mills dislocation
- Presence of different milling systems and different residues content
- Seasonality of olive residues production and different crop yield each year

## ***The present state: figures***

### Type of Olive solid residues

Country	Data	Type of solid residues					Number of olive-mills	Olive cultivation area (in ha)
		virgin pomace	dried pomace	leaves	pruning	pits		
Spain	National	x	x	x	x	x	1722	2.509.677
	Regional -Jaen-	x	x	x	x	x	327	n.a
Italy	National	x	x	x	x	x	6000	1.200.000
	Regional -Liguria	x		x	x	x	180	13.500
Greece	National	x	x	x	x	x	2500	1.125.000
	Regional -Crete-	x	x	x	x	x	124	41.759
Croatia	National	x		x	x	x	125	30.000
	Regional -Istria -	x		x	x	x	18	3.600
Slovenia	National	x		x	x		12	1470
	Regional -Istrian -	x		x	x		11	1420

### Type of Olive oil production methods

Country	Data	Production methods used			
		Traditional	2 phase centrifugal system	3 phase centrifugal system	Other
Spain	National		100%		
	-Jaen-		100%		
Italy	National	37.5%	0.7%	47.5%	Mixed (2.5): 9,6 %. Other: 4,2 %
	-Liguria-	52%	0,005%	30%	Mixed (2.5): 13 %. Other: 0,02%
Greece	National	5%	7%	88%	
	-Crete-	1%	5%	94%	
Croatia	National	43%			57% (both 2-3 phases)
	-Istria -	6%	63%	31%	
Slovenia	National	33,3%	33,3%		33,3%
	-Istrian	36%	27%		36%
	-				

### Olive oil residues

Country	Data	Quantity of (tn/year)			
		produced olive oil	virgin pomace	dry pomace (with pits)	pit/stone
Spain	National	1.230.000	4.920.000	4.222.000	2.500.000
	-Jaen-	544.555	2.058.221	1.770.378	1.050.000
Italy	National	721.418	n.a	n.a	n.a
	-Liguria-	5.500	12.000	Not existing	3.240 potentially (27% of virgin pomace)
Greece	National	352.000		598.000	53.800-161.500
	-Crete-	33.300	n.a	56.500	5.100-15.400
Croatia	National	5.000	18.200	n.a	3.640
	-Istria -	810	3.509	n.a	710
Slovenia	National	275	1100	n.a	281
	-Istrian	255	1000	n.a	258

## The present state: Best practices

In Spain, Greece and Italy project partners identified 13 best practices in total, while Slovenia and Croatia selected 4 practices in their countries. In total, 17 best practices were chosen.

### Best practices in Spain

Selected best practices are located in provinces of Córdoba and Jaén Andalusia region on the south of Spain.

**BP1: GEOLIT CLIMATIZACIÓN S.L. District heating and cooling central system with biomass. Mengíbar (Jaén), Spain**

**GEOLIT** is the name of science and technology park devoted to the olive industry in Jaén. This park has a district heating and cooling network to provide air conditioning to all the park buildings. The heat is provided by two biomass boilers with a total capacity of 6.000 kW. The cooling capacity using absorption chillers is 4.000 kW. The Council of Innovation (Consejería de Innovación) has approved one requests of subvention for its construction by an amount to 2,3 millions Euros. By now plant investment is 5,2 millions Euros. More information can be found at

<http://www.geolit.es> and <http://www.agener.es>.



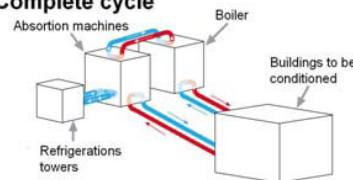
### GEOLIT CLIMATIZACIÓN S.L. District Heating and Cooling Central System with Biomass

La Cal Herrera, J.A.; Muñoz Jiménez, J.; Heredia Galán, B.

#### CENTRAL HEATING AND COOLING



#### Complete cycle



#### Absorption machines

By means of three simple effect absorption machines cool water with 5 – 6° C is produced and distributed to the final users through a red of pipes. In the process is necessary a refrigeration tower



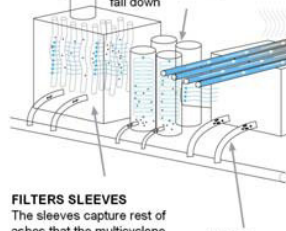
#### Boiler



**CHIMNEY**  
Cleaning air go out

**MULTICYCLONE FILTER**  
The air from the boiler is placed here and form small cyclones which crash with the walls, and the ashes fall down

**BOILER**  
Inside the boiler take place the combustion of the biomass



**FILTERS SLEEVES**  
The sleeves capture rest of ashes that the multicyclone don't capture. Afterwards, with compressed air the ashes fall, and the air go out clean

**PIPES**  
Through those pipes go out the ashes generated in the boiler. The ashes is used to produce cement and fertilizers.

**STORAGE PIT**  
Place to store the biomass. It's filling outside the building



**WATER**  
The water pipes past on the top where the water is heating and leave to the Park



**BP2: ENERGÍA LA LOMA S.A. Villanueva del Arzobispo (Jaén)**

**ENERGÍA LA LOMA S.A.:** Endesa Cogeneración y Renovables has promoted and built this plant (Figure below) for energy production through combustion of depleted olive pomace.

The main elements are: a kind grade combustion boiler and a condensing steam turbo-alternator set, formed by a steam turbine (using Rankine cycle) connected to an alternator. The plant is planned to function 24 hours a day, during all year, except an annual stopping for plant maintenance. The plant works in total 7.884 hours/year, estimating an unavailability of 10% above a total of 8.760 hours/year of theoretical functioning.

**Type of biomass (fuel):**

Depleted olive pomace

**Power installed in the plant:** 16 MW

**Biomass processes:**

100.000 tons/year

**Energy production:**

126.144.000 kWh/year

**Energy export:** 113.201.620

kWh/year



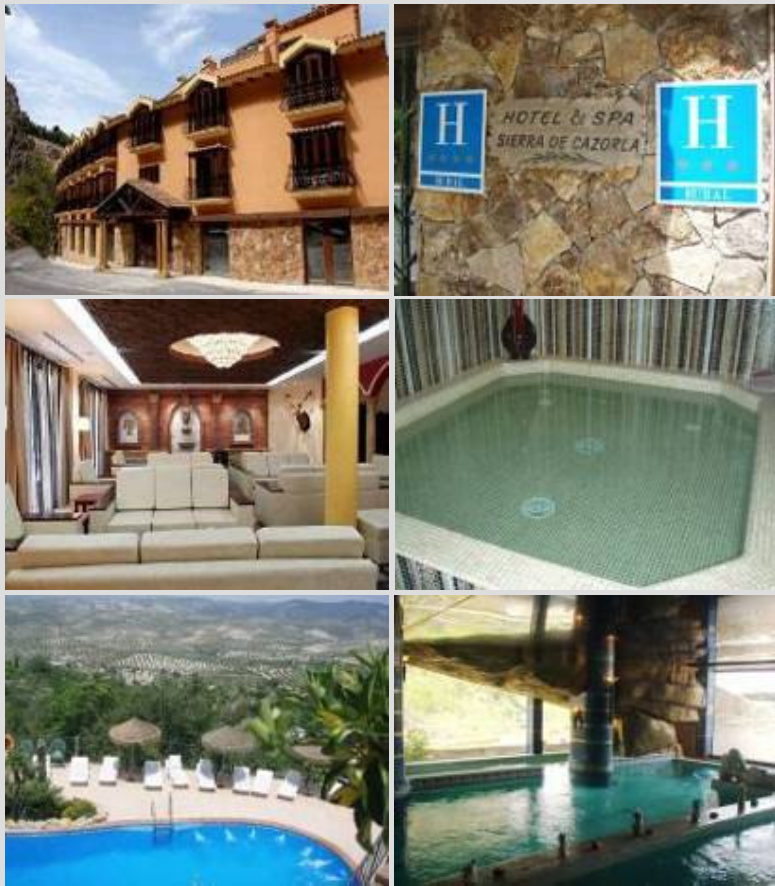
**BP3: BIOMASA PUENTE GENIL, Puente Genil (Córdoba)**



The biomass plant (Figure aside) generates electricity from olive pomace (orujillo) in Córdoba, the technology used for obtaining electricity is the vapour cycle. The electrical power is 9,7 MW that is produced by means of steam turbine. The consumption of biomass is 71.000 tons/year. The Council of Innovation (Consejería de Innovación) has approved two requests of subvention for its construction by an amount superior to 800.000 Euros each. Total plant investment 46 million Euros.

**BP4: HOTEL & SPA SIERRA CAZORLA, La Iruela (Jaén)**

Hotel (Figure aside) uses biomass (pit/stone) for heating and producing sanitary hot water (thermal application). The technology used for obtaining thermal energy consists of two boilers (400 kW) (Figure below). The Council of Innovation (Consejería de Innovación) has approved one request for subvention for its installation by an amount 100.800 Euros. Total installation investment costs are 230.000 Euros. This installation is unique in Andalucía (España).



**BP5: PUBLIC BUILDINGS (SCHOOLS) BOILERS, province of Jaén**

PUBLIC BUILDINGS (SCHOOLS) BOILERS: The biomass (olive waste) is used for thermal energy production used for heating in public buildings. This application is a result of the initiative aimed at changing gas-oil boilers with biomass boilers (Figure 7), and is supported by The Provincial Deputation in Jaén, Counselling and Education (Junta de Andalucía) and the City Council of township. It is funded by The Provincial Deputation (60%) and the Andalusia Energy Agency (Junta de Andalucía 40%).



From the economic point of view, a boiler of 200 kW of power that works with splinters of olive trees has an energetic cost of 47,9 €/MWh. For 1500 working hours/year, the total cost is 14.366,49 €/year including cost of investment, maintenance and operation. While the same boiler but with gasoil, which has a total cost of 26.416,55 €/year, with energetic cost of 88,1 €/MW, which is 83,92% of costs more. Not considering any public support, all money spent can be regained within two years.

## Best practices in Greece

Selected best practices in Greece are located in the region of Chania on the island of Crete.

### BP6: ABEA - heating system with biomass and oil extracting system from pomace. Chania / Agrokipio (Greece)

**ABEA** is the company which extracts oil from pomace, located in Chania / Agrokipio (Figure 9). At first, pomace has a relative humidity of 50 – 65 %. After oil extraction, the pomace is dried to obtain pits used in pomace oil extraction process as heat source and for heating facilities.

More information could be found at [www.abea.gr](http://www.abea.gr).



### BP7: BIOMEL pomace oil extracting system using pits and pits trade to the UK. Chania / Achlades, Keramia (Greece)

**BIOMEL** is the company which uses olive pits/stones for heating and also trades olive pits to London, in the UK. This company purchases 80.000 t/year of pomace from olive mills and produces cca 35.000 – 50.000 t/y olive pits used for heating the factory building. Part of it is also traded to the UK.

### BP8: GIANNOULIS CRAFT – BASED UNIT. District heating central system in buildings with pits. Chania / Chania (Greece)

District heating system based on pits, for heating factory buildings, for boiling water and for pomace drying.

From 1972 the company

established a factory for refining olive oil and olive pomace oil. In the early nineties the company shifted to packaging and selling olive oil products and pits for heating.



## Best practices in Italy

### Location of chosen best practices in Italy



### **BP 9: DISTRICT HEATING ARNASCO, LIGURIA, ARNASCO (ITALY)**

It is a small district heating system running with olive nut separated at source by the local cooperative olive mill. It's the only of the kind in Liguria. The district heating is made of a olive nut fuelled high temperature 69,8 kW boiler and a 60 mts pipeline. Quantity of nut used each year is 14,3 tons to heat up 700 m<sup>3</sup> (Church and annexed building). Nut is supplied by the local cooperative mills. There is also a gas fuelled 28 kW boiler which may be used during the maintenance of the main boiler or if a problem occurs.

**Nut cost:** 180 €/ton.

**Total cost of plant:** € 9.500.

**Year cost:** 2.500 €/y.

<http://www.coopolivicolarnasco.it/>

### **BP 10: LUCCHI & GUASTALLI MILL, LIGURIA, SANTO STEFANO MAGRA (ITALY)**

**LUCCHI & GUASTALLI MILL** disposes 2-phase mill pomace through innovative systems which adds calcium oxide in the pomace to dry it up.

The mill uses a new technique invented in 2005 by Unieco, an Italian waste treatment company. This technique only applies to 2 phase pomace with 65% humidity and consists in pouring some quantity (ab. 5%) of calcium oxide into pomace to make it basic, stable, no-odor and with 55% humidity. Then it can be used as compost or as fuel in a biomass plant (apparently it has a calorific value of 4700 kcal/kg). The described solution comprises the problem of waste waters.

The revenue deriving from pomace selling to the biomass plant, deducted of transport costs, is shared between Unieco and the miller.

This system requires a specific technology (silo, pourer and mixer) which, for treating 1800 kg/h, had a cost of 100.000 € (+, in this case, the miller's cost of conversion from a 3-phases system to a 2-phases system). More information's could be found at <http://www.unieco.it/> from the company which has invented the technique of calcium adding and which collects the dried pomace to be delivered to a biomass power plant. <http://www.frantoiolg.com>.

**BP11: ASSOCIAZIONE LAZIALE FRANTOI OLEARI (MILLERS ASSOCIATION OF LATIUM REGION), LATIUM, CAMPODIMELE - LATINA (ITALY)**

It is the millers association of Latium region.

The plant consists of a pomace dryer (thermal capacity, 1.1 MW at about), a pomace gasifier and a power unit for electrical energy production (power: 1 MW). Referring to the last one, a careful analysis is being carried out to evaluate the most streamlined and economical solution between a gas engine and a gas turbine employment.

The electric energy produced is reintroduced in the network of the local provider (ACEA). The plant can work either with 3 phases pomace or two phases pomace; Latium is promoting the system conversion from 3 phases to 2 phases because this technique does not imply vegetable waters. Their spreading is difficult because of the property segmentation.

Dried pomace (15 % humidity) coming from the dryer is stocked by proper warehouses for two months: a small part (250 kg/h at about) is burnt to supply heat for the dryer (auto-consumption), while the remaining part fuels the gasifier. A technical scheme of the plant is reported in the figure aside.

The plant testing has been scheduled by autumn 2010; if expected results are reached, Latium will realize new four similar plants, one for each province.

In the future, photovoltaic modules will be installed on the roofs of the warehouses to increase electrical energy production. <http://www.frantolazio2080.com/>

**BP12: MATRAIA MILL, TUSCANY, LUCCA (ITALY)**

**MATRAIA MILL** has been testing the production of pellets from pomace (nut and pulp together). It is an interesting solution. More information could be given at <http://www.frantiodimatraia.it/>.

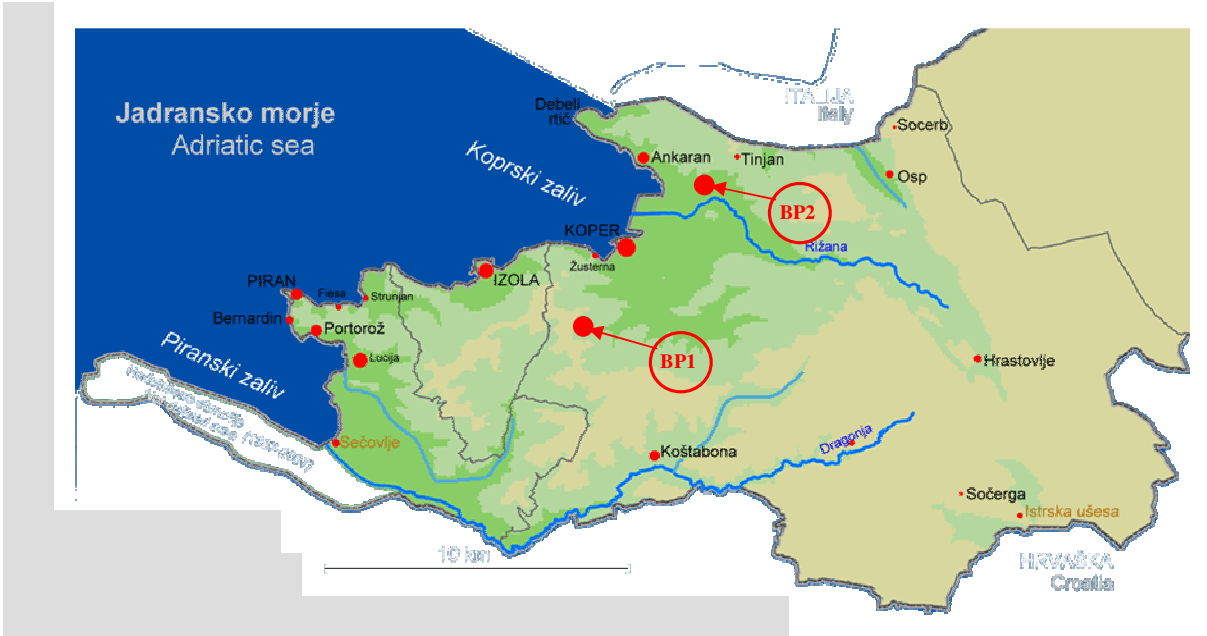
**BP 13: ROSSANO CALABRO POWER PLANT, CALABRIA, ROSSANO CALABRO (ITALY)**

It is a pomace gasifier + CHP plant (4,2 MWe, 23 MWth), running with 8571 t/MWe year. The pomace is supplied by the surroundings (Puglia and Calabria). The objective of the plant is to reach a conversion ratio of 1.05 kWh per 1 kg of biomass. This will be translated into a global electric efficiency of 24 % (currently efficiency is 17 %).

## Best practices in Slovenia

Two best practices are identified in SLO Istria region

### Location of chosen best practices in Slovenia



### **BP14: AGAPITO OLIVE MILL, PRODUCTION OF HEAT FOR HIS PRIVATE HOUSE HEATING AND WATER HEATING**

**AGAPITO OLIVE MILL** - Olive miller uses olive residues mostly for production of heat for his private house heating and water heating (cca. 140 m<sup>2</sup>)

**Mill type:** 3-phase mill

**Technology used:** ALFA LAVAL

**Amount of olive residues produced:** approx. 60 tons/year

**Use of olive residues:** Olive miller uses olive residues mostly for production of heat for his private house heating and water heating.

After olive oil extraction (3-phase mill) olive residues are too wet to burn immediately and therefore disposed to the field/meadow behind the house. Olive residues are left to dry on the open space. Olive residues are mixed up/turned up side down several times to speed up the drying process. After certain time they are collected and loaded into big wooden containers and stored in the shed next to boiler room. Dried olive residues are used directly for burning/combustion in the stove.

The rest of olive residues is used for dunging/fertilisation of his olive fields / oliveyards.

**Stove:** D'Alessandro Termomeccanica, model CS 40, nominal power of the stove is 40KW, heating power is 47 KW. The company D'Alessandro Termomeccanica is an Italian firm with thirty years of experience in manufacturing heating generators that utilize solid combustibles.

**Olive residues consumption and energy value:** Official data about average consumption of the stove at maximum regime is 12 kg/h of olive residues. In everyday practice actual consumption is 170 dm<sup>3</sup> (0,17 m<sup>3</sup>) of olive residues in 3-4 days. Annual consumption of the olive residues is between 10 and 11 m<sup>3</sup>. With this quantity they heat 140 m<sup>2</sup> of the apartment with the temperature 23°C and they heat also 300 l water boiler through the whole year. **Purchase costs:** 3.000 €+costs of installation. Stove was bought 2 years ago.

### **BP15: KROŽERA OLIVE MILL, PRODUCTION OF HEAT FOR HIS PRIVATE HOUSE**

#### **HEATING AND WATER HEATING**

**KROŽERA OLIVE MILL** - Olive miller uses olive residues only for energy purposes; production of heat for heating private house and olive mill (ca. 250 m<sup>2</sup>).

**Mill type:** traditional

**Technology used:** PIERALISI traditional system

**Amount of olive residues produced:** approx. 60 tons/year

**Use of olive residues:** In past they have been putting olive residues back in olive fields. Today they put them directly to wooden box in order to dry them on open air (but under roof) and use them only for energy purposes; production of heat for heating private house and olive mill (ca. 250 m<sup>2</sup>).

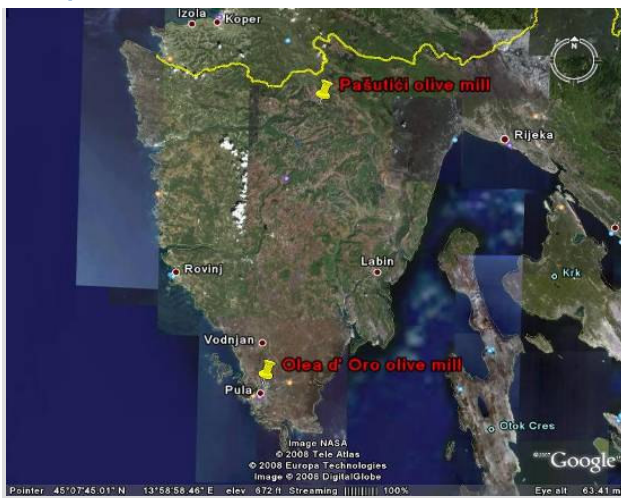
**Stove:** Kondor, Casacalendia, Italy

**Olive residues consumption and energy value:** In everyday practice actual consumption is 200 dm<sup>3</sup> of dry olive residues in 2 days. Annual consumption is approx. 18 m<sup>3</sup> of dry olive residues per season (from beginning of November to the end of April). With this quantity they produce heat for 250 m<sup>2</sup> of the apartment and olive mill and water heating.

**Purchase costs:** 4.500 € + costs of installation. Stove was bought 1 year ago.

## **Best practices in Croatia**

### **Best practices in Croatia**



**BP16: PAŠUTIČI - OLIVE MILL, production of heat for private house**

Olive miller uses olive residues mostly for production of heat for his private house heating and for sanitary water heating.

**Mill type:** 2-phase mill

**Technology used:** PIERALISI 250

**Amount of olive producing capacity:** Approx. 400 kg/hour, yearly production 70 tons.

**Use of olive residues:** Olive miller uses olive residues mostly for production of heat for his private house heating and water heating. After olive oil production, olive residues are pressed and left to dry on the open space. Dried olive residues are used directly for burning/combustion in the stove.

**Stove:** TVT Maribor d.d., nominal power of the stove is 33KW. These installed stoves are 8 year old.

**Technology of the stove:** Unknown, insufficiently data from the owner.

**Olive residues consumption and energy value:** The miller heats 120 m<sup>2</sup> of the house with the temperature 21°C and he heats also 120 l water boiler through the major part of the year.

**Purchase costs:** All costs are approx. 3.000 € with costs of installation.

**BP17: OLEA D' ORO - OLIVE MILL, production of heat for private house and for soil fertilization**

Olive miller uses olive residues mostly for production of heat for his private house heating and for sanitary water heating.

**Mill type:** 3-phase mill

**Technology used:** Vitone V2 (max. production 2 tons/hour)

**Amount of olive producing capacity:** Approx. 1500 kg/h, yearly production 400 tons.

**Use of olive residues:** Olive miller uses olive residues mostly for production of heat for his private house heating and water heating. After olive oil extraction (3-phase mill), olive residues are stored 10 kilometres from the olive mill to dry on the field. Olive residues are mixed up/turned upside down several times to speed up the drying process.

**Stove:** It is Italian stove. Nominal power of the stove is 100.000 cal.

**Technology of the stove:** Unknown, insufficiently data from the owner.

**Olive residues consumption and energy value:** The miller heats 500 m<sup>2</sup> of the house with the temperature 22°C and heats also 1000-l water boiler through the major part of the year.

**Purchase costs:** 10.000 € in total. The stove is new. It is in the process of import from Italy.

## ***The present state: SWOT analysis***

*The project partners have developed SWOT analyses of the olive-residues-to-energy market in each region. Below we list the common issues:*

- A major common strength is that pomace is a reliable, renewable, relatively inexpensive and readily available energy source of high calorific value.
- Technology for pomace exploitation is mature and is already being implemented in some scale (in Spain primarily, in Italy and Greece are rising) while in Slovenia and Croatia residues are still not fully exploited.
- Problems due to transportation, unawareness and seasonality exist.
- Because of different olive treatment procedures pomace is not a homogeneous sub-product in all regions, therefore a standardized exploitation methodology cannot be implemented.
- Incentives and legislation are needed in order to overcome some of the identified barriers (eg. Green certificates for electricity generation can be made available).
- The development of olive-residues-to-energy chains can provide solutions to the cultivating regions and to olive solid waste management.
- Unpredictable weather conditions may affect annual production of pomace.
- Pomace is a suitable replacement of fossil fuels and a promising source for the creation of new job opportunities.
- Lack of administrative support and dissemination efforts.

## The potential: Should be scenario

The partners, in order to proceed with the development of the olive residues to energy chain, defined the energy potential of residues to 2020 according to current market production in each of the involved areas and application of regression statistics. Then the BAU scenario and the potential scenario have been compared. Here below the a summary of findings for each area. Full details available on [www.moreintelligentenergy.eu](http://www.moreintelligentenergy.eu)

### Italy, Liguria

#### Forecast of the virgin and exhausted pomace production for the years 2009-2020 in the region of Liguria

Forecast for the Solid Residues (tn)												
(tn)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
virgin pomace	11.615	11.689	11.762	11.836	11.909	11.982	12.056	12.129	12.203	12.276	12.349	12.423
exhausted pomace	1.213	1.225	1.237	1.249	1.261	1.273	1.285	1.297	1.309	1.321	1.333	1.345

The energy content of the exhausted pomace potentially produced in the area is approx. 4.000-4.500 kcal/kg. The table and the figure below present the equal energy content of the projected exhausted pomace production in Kcal and in GWh for the years 2009-2020.

#### The energy content of the projected exhausted pomace produced in the region of Liguria

The energy content of the exhausted pomace in 10 <sup>6</sup> Kcal												
(10 <sup>6</sup> Kcal)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	5.155	5.206	5.257	5.308	5.359	5.410	5.462	5.513	5.564	5.615	5.666	5.717

#### The energy content of the projected exhausted pomace produced in the region of Liguria

The energy content of the exhausted pomace in GWh												
(GWh)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	6,135	6,195	6,256	6,317	6,378	6,438	6,499	6,560	6,621	6,681	6,742	6,803

## Comparing Fossil fuels to exhausted pomace

#### Equivalent energy content in Toe, "Handbook of Mechanical Engineering"

1tn	exhausted pomace	"="	0,425 toe
1tn	Natural Gas	"="	1,3865 toe
1tn	Heating Oil	"="	1 toe
1tn	Coal	"="	0,3328 to max of

			0,8319 toe
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For the projected amounts of the exhausted pomace (in toe and in MWh), the equivalent quantities of natural gas, heating oil and coal are given in the tables and figure below.

### Energy content of exhausted pomace in toe

Energy content of exhausted pomace (in toe)												
(toe)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	516	521	526	531	536	541	546	551	556	561	567	572

### Energy Content of exhausted pomace in MWh

Energy content of exhausted pomace (in MWh)												
(MWh)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	6.135	6.195	6.256	6.317	6.378	6.438	6.499	6.560	6.621	6.681	6.742	6.803

### Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)

Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)												
(tn)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	1.213	1.225	1.237	1.249	1.261	1.273	1.285	1.297	1.309	1.321	1.333	1.345
Natural Gas	372	375	379	383	387	390	394	398	401	405	409	412
Heating Oil	516	521	526	531	536	541	546	551	556	561	567	572
Coal	620	626	632	638	644	650	657	663	669	675	681	687

## Potential production of Electrical Power

The energy available from exhausted pomace is calculated at an average value for the period 2009-2020

### Yearly average Energy Content in MWh of exhausted pomace for the years 2007-2020 (from data in Table 10)

Average Energy Content (in MWh/year)	
exhausted pomace	6.469

The net electrical power that can be produced from an input source of 6.469 MWh/year (corresponding to the average exhausted pomace energy content) is shown below, comparing different energy sources

### Net Electrical Energy produced from an input of 6.469 MWh/year (in MWh)

Energy input source	Power generation technology		Net Electrical Energy produced (MWh)	
Natural gas	Open Cycle Gas Turbine (GT)		2.458	
	Combined Cycle Gas Turbine (CCGT)	-	3.752	
		CCS	3.170	
Oil	Internal Combustion Diesel Engine	-	2.911	
	Combined Cycle Oil-fired Turbine (CC)	-	3.428	
Coal	Pulverised Coal Combustion (PCC)	-	3.040	
		CCS	2.264	
	Circulating Fluidised Bed Combustion (CFBC)		-	2.588
	Integrated Gasification Combined Cycle (IGCC)	-	2.911	
CCS		2.264		
Biomass	Solid biomass	-	1.714	

### Potential production of Heating

The energy available from exhausted pomace is calculated at an average value for the period 2007-2020

### Yearly average Energy Content in toe of exhausted pomace for the years 2009-2020 (from data in Table 9)

Average Energy Content (in toe/year)	
exhausted pomace	544

With a net efficiency of 90% of 544 toe as input (corresponding to 489 toe) for direct combustion.

### The “Should Be” scenario in comparison to “Business as Usual” scenario

#### Energy content of the projected exhausted pomace of the SB scenario (in toe)

Energy content of the projected exhausted pomace of the SB scenario (in toe)												
(toe)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	516	521	526	531	536	541	546	551	556	561	567	572

#### Energy content of the projected exhausted pomace of the BAU scenario (in toe)

Energy content of exhausted pomace of the BAU scenario (in toe)												
(toe)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	27	27	28	28	28	28	29	29	29	29	30	30

## Energy content of the non exploited exhausted pomace comparing the SB and the BAU scenario (in toe)

Energy content of the non exploited exhausted pomace comparing the SB and the BAU scenario (in toe)												
(toe)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	488	493	498	503	508	513	517	522	527	532	537	542

## Spain, province of Jaen

### Forecast of the virgin and exhausted pomace production for the years 2008-2020 in the region of Jaén

Forecast for the Solid Residues (tn)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
virgin pomace	3.789.116	3.833.275	3.877.433	3.921.592	3.965.751	4.009.909	4.054.068	4.098.226	4.142.385	4.186.543	4.230.702	4.274.860	4.319.019
exhausted pomace	614.682	623.649	632.615	641.581	650.548	659.514	668.480	677.446	686.413	695.379	704.345	713.311	722.278

## The energy content of the exhausted pomace produced in the area

The energy content of the exhausted pomace produced in the area is approx. 4.000-4.500 kcal/kg. The table and the figure below present the equal energy content of the projected exhausted pomace production in Kcal and in GWh for the years 2007-2019.

### The energy content of the projected exhausted pomace produced in the region of Jaén

The energy content of the exhausted pomace in 10 <sup>6</sup> Kcal													
(10 <sup>6</sup> Kcal)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	2.612.401	2.650.507	2.688.614	2.726.720	2.764.827	2.802.934	2.841.040	2.879.147	2.917.254	2.955.360	2.993.467	3.031.574	3.069.680

### The energy content of the projected exhausted pomace produced in the region of Jaén

The energy content of the exhausted pomace in GWh													
(GWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	3.109	3.154	3.199	3.245	3.290	3.335	3.381	3.426	3.472	3.517	3.562	3.608	3.569

## Comparing Fossil fuels to exhausted pomace

### Equivalent energy content in Toe, "Handbook of Mechanical Engineering"

1 tn	exhausted pomace	"="	0,425 toe
1 tn	Natural Gas	"="	1,3865 toe

1tn	Heating Oil	"="	1 toe
1tn	Coal	"="	0,3328 to max of 0,8319 toe

For the projected amounts of the exhausted pomace (in toe and in MWh), the equivalent quantities of natural gas, heating oil and coal are given in the tables and figure below.

### Energy content of exhausted pomace in toe

Energy content of exhausted pomace (in toe)													
(toe)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	261.240	265.051	268.861	272.672	276.483	280.293	284.104	287.915	291.725	295.536	299.347	303.157	306.968

### Energy Content of exhausted pomace in MWh

Energy content of exhausted pomace (in MWh)													
(MWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	3.108.757	3.154.104	3.199.450	3.244.797	3.290.144	3.335.491	3.380.838	3.426.185	3.471.532	3.516.879	3.562.226	3.607.573	3.652.920

### Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)

Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
exhausted pomace	614.682	623.649	632.615	641.581	650.548	659.514	668.480	677.446	686.413	695.379	704.345	713.311	722.278
Natural Gas	188.417	191.165	193.914	196.662	199.411	202.159	204.907	207.656	210.404	213.153	215.901	218.649	221.398
Heating Oil	261.240	265.051	268.861	272.672	276.483	280.293	284.104	287.915	291.725	295.536	299.347	303.157	306.968
Coal	314.028	318.609	323.190	327.770	332.351	336.932	341.512	346.093	350.674	355.254	359.835	364.416	368.996

## Potential production of Electrical Power

The energy available from exhausted pomace is calculated at an average value for the period 2008-2020

### Yearly average Energy Content in MWh of exhausted pomace for the years 2007-2020 (from data in Table 10)

Average Energy Content (in MWh/year)	
exhausted pomace	3.380.838

The net electrical power that can be produced from an input source of 3.380.838 MWh/year (corresponding to the average exhausted pomace energy content) is shown below, comparing different energy sources

### Net Electrical Energy produced from an input of 3.380.838 MWh/year (in MWh)

Energy input source	Power generation technology		Net Electrical Energy produced (MWh)
Natural gas	Open Cycle Gas Turbine (GT)		1.284.718
	Combined Cycle Gas Turbine (CCGT)	-	1.960.886
		CCS	1.656.611
Oil	Internal Combustion Diesel Engine	-	1.521.377
	Combined Cycle Oil-fired Turbine (CC)	-	1.791.844
Coal	Pulverised Coal Combustion (PCC)	-	1.588.994
		CCS	1.183.293
	Circulating Fluidised Bed Combustion (CFBC)	-	1.352.335
	Integrated Gasification Combined Cycle (IGCC)	-	1.521.377
CCS		1.183.293	
Biomass	Solid biomass	-	895.922

### Potential production of Heating

The energy available from exhausted pomace is calculated at an average value for the period 2008-2020

Yearly average Energy Content in toe of exhausted pomace for the years 2007-2020 (from data in Table 9)

Average Energy Content (in toe/year)	
exhausted pomace	284.104

In this case the SB scenario of the region coincides with the BAU scenario.

### Greece, area of Chania in Crete

Forecast of the virgin and exhausted pomace production for the years 2007-2019 in the region of Chania

Forecast for the Solid Residues (tn)													
(tn)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
virgin pomace	76.069	76.692	77.315	77.938	78.560	79.183	79.806	80.429	81.052	81.675	82.297	82.920	83.543
exhausted pomace	38.017	38.331	38.645	38.958	39.272	39.586	39.900	40.214	40.528	40.841	41.155	41.469	41.783

The energy content of the exhausted pomace produced in the area is approx. 3.500-4.000 kcal/kg, (16 MJ/kg), (4,4 kWh/kg). The table and the figure below present the equal energy content of the projected exhausted pomace production in Kcal and in GWh for the years 2007-2019.

### The energy content of the projected exhausted pomace produced in the region of Chania

The energy content of the exhausted pomace in 10 <sup>6</sup> Kcal													
(10 <sup>6</sup> Kcal)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	142.563	143.740	144.917	146.094	147.271	148.448	149.625	150.802	151.979	153.156	154.332	155.509	156.686

### The energy content of the projected exhausted pomace produced in the region of Chania

The energy content of the exhausted pomace in GWh													
(GWh)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	169,650	171,051	172,451	173,852	175,252	176,653	178,053	179,454	180,855	182,255	183,656	185,056	186,457

## Comparing Fossil fuels to exhausted pomace

### Equivalent energy content in Toe, "Handbook of Mechanical Engineering"

1tn	exhausted pomace	"="	0,375 toe
1tn	Natural Gas	"="	1,3865 toe
1tn	Heating Oil	"="	1 toe
1tn	Coal	"="	0,3328 to max of 0,8319 toe

For the projected amounts of the exhausted pomace (in toe and in MWh), the equivalent quantities of natural gas, heating oil and coal are given in the tables and figure below.

### Energy content of exhausted pomace in toe

Energy content of exhausted pomace (in toe)													
(toe)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	14.256	14.374	14.492	14.609	14.727	14.845	14.962	15.080	15.198	15.316	15.433	15.551	15.669

### Energy Content of exhausted pomace in MWh

Energy content of exhausted pomace (in MWh)													
(MWh)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	169.650	171.051	172.451	173.852	175.252	176.653	178.053	179.454	180.855	182.255	183.656	185.056	186.457

### Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)

Fossil fuel quantities corresponding to the energy content of exhausted pomace (in tonnes)													
(tn)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>exhausted pomace</b>	38.017	38.331	38.645	38.958	39.272	39.586	39.900	40.214	40.528	40.841	41.155	41.469	41.783
<b>Natural Gas</b>	10.282	10.367	10.452	10.537	10.622	10.707	10.792	10.876	10.961	11.046	11.131	11.216	11.301
<b>Heating Oil</b>	14.256	14.374	14.492	14.609	14.727	14.845	14.962	15.080	15.198	15.316	15.433	15.551	15.669
<b>Coal</b>	17.137	17.279	17.420	17.561	17.703	17.844	17.986	18.127	18.269	18.410	18.552	18.693	18.835

The electrical energy available from exhausted pomace is calculated at an average value for the period 2007-2020

### Yearly average Energy Content in MWh of exhausted pomace for the years 2007-2020 (from data in Table 10)

Average Energy Content (in MWh/year)	
<b>exhausted pomace</b>	178.754

The net electrical power that can be produced from an input source of 178.754 MWh/year (corresponding to the average exhausted pomace energy content) is shown below, comparing different energy sources

### Net Electrical Energy produced from an input of 178.754MWh/year (in MWh)

Energy input source	Power generation technology		Net Electrical Energy produced (MWh)
Natural gas	Open Cycle Gas Turbine (GT)		67.926
	Combined Cycle Gas Turbine (CCGT)	-	103.677
		CCS	87.589
Oil	Internal Combustion Diesel Engine	-	80.439
	Combined Cycle Oil-fired Turbine (CC)	-	94.739
Coal	Pulverised Coal Combustion (PCC)	-	84.014
		CCS	62.564
	Circulating Fluidised Bed Combustion (CFBC)	-	71.501
	Integrated Gasification Combined Cycle (IGCC)	-	80.439
CCS		62.564	
<b>Biomass</b>	Solid biomass	-	47.370

### Potential production of Heating

The energy available from exhausted pomace is calculated at an average value for the period 2007-2020

### Yearly average Energy Content in toe of exhausted pomace for the years 2007-2020 (from data in Table 9)

Average Energy Content (in toe/year)

exhausted pomace	15.021
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## The “Should Be” scenario in comparison to “Business as Usual” scenario

### Energy content of the projected exhausted pomace of the SB scenario (in toe)

Energy content of the projected exhausted pomace of the SB scenario (in toe)													
(toe)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	14.256	14.374	14.492	14.609	14.727	14.845	14.962	15.080	15.198	15.316	15.433	15.551	15.669

### Energy content of the projected exhausted pomace of the BAU scenario (in toe)

Energy content of exhausted pomace of the BAU scenario (in toe)													
(toe)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	8.982	9.056	9.130	9.204	9.278	9.352	9.426	9.501	9.575	9.649	9.723	9.797	9.871

### Energy content of the non exploited exhausted pomace comparing the SB and the BAU scenario (in toe)

Energy content of the non exploited exhausted pomace comparing the SB and the BAU scenario (in toe)													
(toe)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
exhausted pomace	5.275	5.318	5.362	5.406	5.449	5.493	5.536	5.580	5.623	5.667	5.710	5.754	5.797

## Slovenia, region of Istria

### Forecast of the virgin and exhausted pomace production for the years 2007-2019 in the region of Istria

Forecast for the Solid Residues (tn)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
virgin pomace	987	1.002	1.018	1.033	1.048	1.064	1.079	1.095	1.110	1.126	1.141	1.156	1.172
Dried pomace	493	501	509	517	524	532	540	547	555	563	570	578	586

### The energy content of the dried pomace produced in the area

The energy content of the dried pomace produced in the area is approx. 4.000-4.500 kcal/kg. The table and the figure below present the equal energy content of the projected dried pomace production in Kcal and in GWh for the years 2008-2020.

### The energy content of the projected dried pomace produced in the region of Istria

The energy content of the dried pomace in 10 <sup>6</sup> Kcal													
(10 <sup>6</sup> Kcal)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	1.850	1.879	1.908	1.937	1.966	1.995	2.024	2.053	2.081	2.110	2.139	2.168	2.197

### The energy content of the projected dried pomace produced in the region of Istria

The energy content of the dried pomace in GWh													
(GWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	0,826	0,839	0,852	0,864	0,877	0,890	0,903	0,916	0,929	0,942	0,955	0,968	0,980

## Comparing Fossil fuels to dried pomace

### Equivalent energy content in Toe, “Handbook of Mechanical Engineering”

1 tn	dried pomace	"="	0,375 toe
1 tn	Natural Gas	"="	1,3865 toe
1 tn	Heating Oil	"="	1 toe
1 tn	Coal	"="	0,3328 to max of 0,8319 toe

For the projected amounts of the dried pomace (in toe and in MWh), the equivalent quantities of natural gas, heating oil and coal are given in the tables and figure below.

### Energy content of dried pomace in toe

Energy content of dried pomace (in toe)													
(toe)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	185	188	191	194	197	199	202	205	208	211	214	217	220

### Energy Content of dried pomace in MWh

Energy content of dried pomace (in MWh)													
(MWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	826	839	852	864	877	890	903	916	929	942	955	968	980

## Fossil fuel quantities corresponding to the energy content of dried pomace (in tonnes)

Fossil fuel quantities corresponding to the energy content of dried pomace (in tonnes)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	493	501	509	517	524	532	540	547	555	563	570	578	586
Natural Gas	133	136	138	140	142	144	146	148	150	152	154	156	158
Heating Oil	185	188	191	194	197	199	202	205	208	211	214	217	220
Coal	222	226	229	233	236	240	243	247	250	254	257	261	264

## Potential production of Electrical Power

In Slovenia, currently the olive pomace residues are not exploited due to the legislation restrictions. Such kind of residues are considered as waste and are not allowed to be burnt. However, as the legislation is about to change, it would be an opportunity to use these residues as an energy source. The limited quantities may be not suitable for power generation but they could be used as a heating source.

## Potential production of Heating

The energy available from dried pomace is calculated at an average value for the period 2008-2020

### Yearly average Energy Content in toe of dried pomace for the years 2007-2020

Average Energy Content (in toe/year)	
dried pomace	202

## The Business as usual (BAU) scenario of expected trends to 2020 for the region of Istria

According to the survey taking place in the Slovenia, only two olive mills were found to use the olive pomace residues as an energy source (approx. 120 tn/year) for space and water heating. For this reason for the case of Slovenia the BAU scenario is not applicable.

## Croatia – area of Istria

### Forecast of the virgin and exhausted pomace production for the years 2008-2020 in the region of Istria

Forecast for the Solid Residues (tn)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
virgin pomace	19.800	20.315	20.831	21.346	21.862	22.377	22.892	23.408	23.923	24.439	24.954	25.470	25.985
dried pomace	10.484	10.768	11.052	11.336	11.620	11.904	12.188	12.472	12.756	13.040	13.324	13.608	13.892

## The energy content of the dried pomace produced in the area

The energy content of the dried pomace to be produced in the area is approx. 3.500-4.000 kcal/kg. The table and the figure below present the equal energy content of the projected dried pomace production in Kcal and in GWh for the years 2008-2020.

### The energy content of the projected dried pomace produced in the region of Istria

The energy content of the dried pomace in 10 <sup>6</sup> Kcal													
(10 <sup>6</sup> Kcal)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	39,314	40,379	41,445	42,510	43,575	44,640	45,705	46,771	47,836	48,901	49,966	51,032	52,097

### The energy content of the projected dried pomace produced in the region of Istria

The energy content of the dried pomace in GWh													
(GWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	46,784	48,051	49,319	50,587	51,854	53,122	54,389	55,657	56,925	58,192	59,460	60,728	61,995

## Comparing Fossil fuels to dried pomace

### Equivalent energy content in Toe, "Handbook of Mechanical Engineering"

1tn	dried pomace	"="	0,375 toe
1tn	Natural Gas	"="	1,3865 toe
1tn	Heating Oil	"="	1 toe
1tn	Coal	"="	0,3328 to max of 0,8319 toe

For the projected amounts of the dried pomace (in toe and in MWh), the equivalent quantities of natural gas, heating oil and coal are given in the tables and figure below.

### Energy content of dried pomace in toe

Energy content of dried pomace (in toe)													
(toe)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	3.931	4.038	4.144	4.251	4.357	4.464	4.571	4.677	4.784	4.890	4.997	5.103	5.210

### Energy Content of dried pomace in MWh

Energy content of dried pomace (in MWh)													
(MWh)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	46.784	48.051	49.319	50.587	51.854	53.122	54.389	55.657	56.925	58.192	59.460	60.728	61.995

### Fossil fuel quantities corresponding to the energy content of dried pomace (in tonnes)

Fossil fuel quantities corresponding to the energy content of dried pomace (in tonnes)													
(tn)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
dried pomace	10.484	10.768	11.052	11.336	11.620	11.904	12.188	12.472	12.756	13.040	13.324	13.608	13.892
Natural Gas	2.835	2.912	2.989	3.066	3.143	3.220	3.296	3.373	3.450	3.527	3.604	3.681	3.757
Heating Oil	3.931	4.038	4.144	4.251	4.357	4.464	4.571	4.677	4.784	4.890	4.997	5.103	5.210
Coal	4.726	4.854	4.982	5.110	5.238	5.366	5.494	5.622	5.750	5.878	6.006	6.134	6.262

### Potential production of Electrical Power

In Croatia, the limited quantities may be not suitable for power generation but they could be used as a heating source.

### Potential production of Heating

The energy available from dried pomace is calculated at an average value for the period 2008-2020

#### Yearly average Energy Content in toe of dried pomace for the years 2008-2020

Average Energy Content (in toe/year)	
dried pomace	4.571

The SB scenario clearly demonstrates the potential use of pomace as a heating source either in free form or transformed into pellets, especially if it can be combined with other biomass sources (wood chips etc).

### The Business as usual (BAU) scenario of expected trends to 2020 for the region of Istria

According to the survey taking place in Croatia, only two olive mills were found to use the olive pomace residues as an energy source (approx. 470 tn/year) for space and water heating. For this reason for the case of Croatia the BAU scenario is not applicable.

## ***The tools: roadmap for future development***

*Thanks to the analyses carried out in the partner regions and to the experience developed with the pilot projects, the following general conditions for a sustainable market growth of olive residues for energy use were identified.*

### **AWARENESS**

Given the fact that Europe is energetically heavily dependent on more and more expensive fossil fuels and that it does contribute the share to global warming, it is necessary to set up a serious scenario for the future use of alternative energy sources. Among the alternative biomass energy sources the primary role goes to wood biomass, but olive residues could be considered as biomass with great potential in some EU regions. Currently there is lack of broader awareness of their energy potential and the potential yield.

Lack of awareness of the olive residues energy potential is shown at several different levels:

- Political and legislative level - resulting in the absence of a legislative/regulatory basis for the management of olive residues (lack of awareness and policies at national levels-ministries, regional levels and local levels-municipalities); in some countries olive residues are not treated as a secondary product;
- The level of potential suppliers/customers - olive millers do not recognize olive residues as potential biomass for energy use and as possibility for secondary profit; olive millers do not have a capacity to address and inform potential customers about the advantages of their product in a similar way like large utilities (oil companies, etc.) There is a big lack of awareness also in broader society.
- Level of professional public - lack of awareness by relevant professional communities (olive mills associations, energy planners, installers, researchers) and conflict of interests between those who promote use of olive residues for

composting and those who promote use of olive residues for energy purposes.

### **INCENTIVES**

it is necessary to introduce specific initiatives that will support and stimulate the use of solid residues. It is important to introduce appropriate financial subsidies at regional levels to attract users to replace the existing fossil fuel furnace for the new biomass stoves. Such initiatives are already in place in some regions and have in recent years become well established. Since the use of olive residues (pits) for heating require the same technology as already developed for heating with wood biomass (pellets), only further extension of the existing programs and financial incentives is needed to continue the promotion and the use of olive residues as biomass.

### **LEGISLATIVE SUPPORT**

Legislative support is a prerequisite for successful implementation of the market of olive residues for energy purposes. Some countries such as Spain, Italy and Greece are already partially implementing it. It is important that olive residues are legally recognized as biomass, which can be used for energy purposes and get legal status of by-product. On this assumption olive residues may deliver an important contribution to advancing the use of "non-wood" biomass for energy purposes and can ease the fulfilling of the requests of new legislation in many EU countries which require that all new buildings provide a certain proportion of energy supply from renewable energy sources.

## QUALITY OF PRODUCTS AND SERVICES

Ensuring quality products and services brings an important contribution to the sustainable development of olive residues for energy market and distribution chain. It is necessary to take into consideration the provision of quality product - olive residues, which are to be sold as biomass for energy, should have stable average energy value, low moisture content and enable easy managing in order to avoid problems in the heating process.

In order to ensure the quality of services it is important to assure continuity of the quantities through the whole heating season and quality of olive residues on demand of the market and consumer needs. This will create a long-term consumer confidence and finally make olive residues in respective regions a competitive energy source able to deliver high quality renewable energy with competitive prices related to other energy sources (fuel oil, gas, pellets).

### ***The tools: Policy recommendations at partners' levels***

*Below a summary of the policy recommendations developed by each partner region of its own area.*

#### **Italy – developed by ARE Liguria**

In Liguria and in Italy the most critical issue has resulted being the regulatory framework which can characterise olive residues as “waste”. A specific study on applicable norms has then been carried out and led to the following legal recommendations to facilitate the management of olive mill pomace and to provide incentives for producing energy from biomass starting from this (by-)product:

- ❖ The EC Commission should provide technical specifications, pursuant to art. 5 of directive 2008/98, on the conditions for using olive pomace as a by-product regardless of their economic value and regardless of the possible need of a drying phase and/or pot removal. In the meantime this could also be provided for in national law (albeit with less space to work in and a lower degree of "reliability");
- ❖ national law should be brought in line with this the new concept of by-product by amending art. 183(p) of legislative decree no. 152/2006, namely the part that still provides for the economic value of by-products as a requirement (however, without providing regimes

that can make operations particularly burdensome and/or complex, or delay application, which is the risk of “traceability” during transposition *en route*, with regards to residues from agricultural processing, without prejudice to the fact that olive pomace does not fall under this category since it is a residue from the agro-food industry);

- ❖ if olive pomace is considered as waste, national law should allow it to be treated as municipal waste when produced by smaller olive mills;
- ❖ furthermore, the prohibition against transporting waste with vehicles that are not specially equipped for that purpose should be dropped when the materials to be transported are natural and non-hazardous;
- ❖ more favourable national laws should be introduced for obtaining permits for facilities producing energy from biomass, especially when they are small;
- ❖ national law should expressly provide that, in the absence of adequate private initiative, municipalities are able to build such facilities (or

have them built) and operate them (at least during the start-up phase) within the scope of their local public services and with corresponding forms. Economic incentives should also be provided to ensure this actually happens (or at least the regions can be oriented to that effect, in collaboration with local "pilot" bodies within the scope of regional plans providing incentives for energy from renewable sources).

Other recommendations at regional policy level are:

- establish a (regional) monitoring system able to record olive residues quantities produced each year
- promote a joint interest in this issue by Energy, Environment and Agriculture departments of regional government
- promote the legal recommendations above at the national level on the occasion of the normal regions-state meetings
- fund a pilot project.

## Spain – developed by Agener

1. Establish a specific Andalusian plan orientated to encourage in a decisive way the promotion of olive biomass as an alternative within rural environment thus obtaining a different energy to that generated by fossil fuels.

2. Promote research and support for the establishment of a competitive industrial supply chain system centred on olive biomass in the province of Jaén.

3. A commitment to work in this sense at all levels of the system - starting with the administration and reaching farmers and industry, promoting it in a specific way:

- a) Establishing adequate rules which regulate, in an independent manner, this sector, taking into account its specific nature.
- b) Putting into effect studies and / or research projects, development and innovation (I+D+I) aimed to improve and transfer the knowledge in this field.
- c) Carrying out information activities.
- d) Promoting all the proposed measures already mentioned by establishing and

formalizing agreements with competent Official Bodies and associated industries.

e) Boost in establishing companies in the service sector associated with the use of olive biomass.

4. Promote with Official Bodies and Industries the development of projects and experiences related to the use of biomass, through informative actions.

6. Reach a necessary diversification in olive farming, through the development and execution of projects.

7. Review the price system for the production of electric energy using olive biomass.

*We must not forget that olive farming is the only woods which can be 100 % managed because the number of olive trees in the territory is known.*

## Greece – developed by Anatoliki SA

In Greece, olive residues have been widely used in the past for space heating in the domestic sector (and still remain an important fuel type for rural areas) and as fuel for process heat requirements in a large number of small-scale industries (i.e. olive mills, greenhouses, cotton ginning factories, sawmills, etc.).<sup>3</sup>

However, it should be stressed out that the traditional use of biomass energy has its own problems: inefficient energy production, sharp temperature rises, prolonged drought periods, decreased crop productivity are some of the most important ones that Greece already faces. Increasing oil prices, awareness for climate change and its adverse effects have recently brought biomass to the front stage along with the other renewable energy technologies.

The rural areas present certain characteristics which favour the potential development of an olive-to-energy chain:

- the agricultural sector is one of the most important economic activities of the region of Chania (Crete) which itself is facing significant difficulties. The unemployment rate is higher than the national average, especially among young people (National Statistics on Employment and Unemployment, 2004),
- additional economic activity is offered to the local community. The development of community-based bio industries often results in strengthening the community support services, providing additional jobs in the local government and service sectors.
- Provides a green label to the energy user differentiating it from other competitors

- mitigating rural depopulation

### Public awareness

The following aspects should be addressed:

- There is a lack of data for specific quantities of the olive-mill solid residues produced.
- Dissemination of information relating to the disposal and recycling techniques of olive-mill waste in an efficient and economic way.
- Elaboration of common rules about the management of olive-mill solid residues.
- Economic evaluation.

### Institutional framework

It is generally acknowledged that biomass lies across the borders of several policy sectors, the most important ones being agriculture, energy, environment and international trade. Each of them has a major effect on the successful development of biomass systems and efficient interaction is expected to be critical for future development. Ideally, a platform should be created linking the relevant policy sectors and using biomass in an overall climate change strategy by the following key areas:

- Effectively linked policy framework
- Harmonise support mechanisms to improve the overall effectiveness of biomass supply chains.
- Favourable national laws should be introduced for obtaining permits for facilities producing energy from biomass

<sup>3</sup> Bioenergy in Greece: Policies, diffusion framework and stakeholder interactions, Calliope Panoutsou, Available online 13 August 2008

### Public funding

The lack of measures providing public funding could likely be offset by:

- The alleviation of the bureaucratic burden through the simplification of procedures and the overcoming of administrative constraints in using pomace as energy source.
- The consolidation and stabilisation of the investment environment by means of broader development and favourable taxation policies.
- The continuation of the feed-in price regime of the renewable energy on a permanent and stable base.
- The announcement of the new Development law with special measures on biomass plants.

### Economic viability of the project

Two main conditions are needed for the viability of bioconversion projects and concern both sides, first of all the investors (responsible for the realization and the operation of the biomass units) and the farmers-producers (providers of the primary sources in the conversion units):

- The olive millers should provide their primary sources to the plants and keep the agreement with the investors in maintaining steady prices.
- The investors should have a minimum percentage of profit, which is expressed with the Internal Rate of Return (IRR) and is set equal to 15%.

### Investors/energy plant owners

Investors/energy plant owners involved in the olive-to-energy schemes are greatly concerned

about biomass availability, feedstock properties and the economic viability of such energy systems. Their focus lies on:

- feedstock quality and year-round security of supply,
- current feedstock prices and projected increases,
- efficient technologies,
- governmental support to ensure successful take-off of bioenergy schemes.

Current policies, provide some subsidies for investors. Others believe that the best way to increase competitiveness of biomass to energy schemes is through environmental taxes on fossil fuels.

State-of-the-art technologies, advanced combustion systems and co-generation schemes seem to be the most economically attractive solutions for heat and electricity generation at the moment

A reliable source of energy (heat and/or power) requires long term guaranteed contracts with primary source suppliers. Therefore in the development of local bioenergy schemes it would be advisable to encourage local agricultural cooperatives or other local businesses to participate as contract coordinators. Cooperatives could indeed act as independent power producers, producing the feedstock and using it locally for heat and/or electricity production. Such a role for cooperatives would be consistent with their existing roles with respect to conventional crops. Local cooperatives could join bioenergy schemes in order to raise their income and keep their interest in the subject.

### Decision-making groups

Politicians, who constitute the most important decision-making group, raise a great number of questions, which can be categorised as follows:

- Environmental impacts:
  - of exploiting residues for energy purposes,
  - of feedstock production/handling schemes, and
  - of their use as a fuel.

- Competitiveness of biomass in the market (compared to the alternative market demands);
- Agriculture's role within an appropriate energy policy;

Current subsidy programmes for the energy industry and for agriculture should be evaluated and perhaps integrated to support this opportunity. Olive pomace energy production has the potential to benefit not only the power industry and the agricultural community, but the public and environment as well.

## **Slovenia – developed by UPZRS**

### *Recommendations for changes in the current legislation*

The current Slovene legislation treats olive residue as waste and does not determine its management. Therefore we propose several recommendations for its alteration. The system proposed is only the first step towards the preparation of relevant Slovene regulation in the field of pomace treatment. Slovenia needs to conceive and implement a more detailed decision-making system and scheme:

- By introducing the monitoring of quantities and manner of pomace land application/spreading. Inappropriate discharge of vegetable water into the environment (lakes and other bodies of water) can give rise to the process of eutrophication.
- By exempting the activities related to olive processing (oil millers) from the Decree on the Emission of Substances and Heat during Waste Water Discharge from Plants for the Production of Vegetable and Animal Oils and Fats (*OJ RS No. 45, 25 May 2007*). In accordance with the Directive 2006/11/EC of the European Parliament and of the Council

of 15 February 2006 on the Pollution Caused by Certain Dangerous Substances Discharged

into the Aquatic Environment of the Community (OJ L No. 64 of 4 March 2006, p. 52), the Decree stipulates the following conditions for plants for the production of vegetable and animal oils and fats (hereinafter: fat production plants) as regards the emission of substances and heat during the discharge of industrial waste water (hereinafter: waste water):

- Limit values for waste water related parameters and
- Special measures for substance emission decrease.

The issues related to the emission of substances and heat during the discharge of waste water from plants for the production of vegetable and animal oils and fats that are not regulated by the above-mentioned Decree are regulated by the decree on the discharge of waste water into water and the public sewage system. The issues related to

waste water monitoring are regulated by the rule on first measurements and operational monitoring of waste waters and conditions of their execution. The provisions of this Decree also apply to fat production plants conducting the following processes:

- Production of raw vegetable oils and fats and semi-finished products from oilseeds;
- Refining including extraction of mucilage, neutralization, bleaching, deodorization, hydrogenation and esterification, packaging of vegetable oils and fats;
- Production of margarine and similar edible fats; and
- Production and packaging of animal fats.

The provisions of this Decree also apply to the production of biofuels from raw vegetable or animal fats.

- By exempting the olive growers from the Decree since olive processing is a seasonal activity yielding very small quantities of products as it was established by the Kranj Institute of Public Health in 2002. Between 2001 and 2002, the Institute carried out operational monitoring of waste water generated during olive oil processing in Slovenia (continuous method) and established that the following limit value were exceeded during the discharge of waste water into the public sewage system: pH and contents of sedimentary substances and hardly-volatile sedimentary substances (Kranj Institute of Public Health, 2002). Even if the exceeded limit values of the above-mentioned parameters were expected, it was for the first time that the monitoring company

stated that vegetable water could be treated as a by-product and that the quantity of products and seasonal operation of olive oil mills should be taken into account when implementing the measures prescribed. The report also pointed out that waste water produced during olive oil processing created industrial waste water whose parameters could exceed legally permitted values if no water purification process had been carried out. With the quantity of waste water generated in olive oil processing being as a rule extremely small, the purification costs cannot be justified from the point of view of volume and duration of individual production. According to the Kranj Institute of Public Health, olive processing generates only industrial waste water as a by-product and no municipal or cooling waste water. Permanent monitoring of waste water discharge would be economically justifiable if the quantity of waste water at the outflow exceeded 100,000 m<sup>3</sup>. Therefore it is not sensible to compare operational monitoring of waste water in plants whose annual waste water discharge surpasses 500,000 m<sup>3</sup> with that in seasonal plants where the annual discharge amounts to a few 10 m<sup>3</sup>.

- By introducing a register of olive residue (vegetable water, olive pomace, olive pits) at the national level, which would be kept by an office within the Ministry of Agriculture or the Ministry of the Environment and Spatial Planning and would record data on the quantity of olive residue produced and the quantity of olive residue used for secondary purposes (energy production, composting, land spreading) for each olive oil miller.

#### *Recommendations on financial mechanisms*

With regard to the existing financial mechanisms at national and local levels, there is a complete absence of mechanisms to promote the utilization of olive residue as biomass for energy purposes. The EKO SKLAD mechanism introduced by the Republic of Slovenia at national level provides subsidies and co-financing for various projects of natural persons and legal entities (companies) that are aimed at efficient use of energy and renewable energy sources. Whereas most such programs are directed towards utilizing renewable energy sources like wood biomass, as well as solar and water energy, no support has been found for the use of other types of biomass. Therefore we propose:

- the extension of financial subsidies awarded by EKO SKLAD on the basis of an invitation for “grants to natural persons for the utilization of RES and RUE in residential buildings” under Point D – installment of wood biomass boilers in single-family homes and multi-occupied buildings – by also taking into account the applications of natural persons who wish to use olive residues as biomass (and not only wood biomass);
- that olive residue be treated on equal terms as wood biomass and be listed under development priority 6. Sustainable use of energy (Cohesion Fund), or more accurately, within the framework of the priority policy 6.3 Innovative Measures for Local Energy Supply under the Operational Program for the Development of Environment and Transport Infrastructure. Such initiatives can primarily enable the establishment of an appropriate olive residue treatment plant (pitting, drying, pelletizing) for energy purposes and, secondly, facilitate the setting-

up of remote heating systems at micro local level that will make use of the strong local potential of olive residue as biomass.

- At municipal level (city municipalities of Koper, Izola and Piran) the introduction of an additional financial mechanism (parallel to the invitations by EKO SKLAD) for additional/parallel co-financing of investments of natural persons and legal entities that wish to replace the existing heating systems by those using olive residue as an energy vector.

#### *Recommendations to support promotional and awareness-raising activities*

With a view to ensuring support and large-scale promotion of olive residue as a local energy source we propose that, in line with the development priority 6. Sustainable use of energy (Cohesion Fund), or more accurately, the priority policy 6.4 Demonstrative Projects, Consulting and Information within the framework of the Operational Program for the Development of Environment and Transport Infrastructure, support be extended to projects aimed at informing and promoting olive residue as biomass which can be put to beneficial use for the production of heat if subject to appropriate treatment (drying, pelletizing, pitting).

## Republic of Croatia – developed by Institute of agriculture and tourism Poreč

### Fact 1

With regard to the existing financial mechanisms defined through measures organized by Fund for environmental protection and energy efficiency at national and local levels, we must mention that in this moment in Croatian market lots of co financing possibilities exist. One of the biggest is 70% co financing for quality business plans for implementing a RES plant (including biomass – olive residues) and replace existing heating system or electrical facilities. But the problem is that in Croatia tariff regulations for renewable energy in Croatian energy act (NN 68/2001) and in Regulation on fees are not defined. (NN 33/2007). Tariffs would be important in order to let local governments implement and promote small electricity producers and plant producers in local areas.

### Recommendation:

Improve circulation of basic information to potential users of those co financing programs so they could invest into a new energy facility. Also tariff regulations must be defined for renewable energy sources to encourage all potential small investors to invest into those energy facilities.

### Fact 2

In the Republic of Croatia every county has its own energy agency which has duty to implement conclusions defined in Strategy of energy development of Republic of Croatia (NN 38/2002). One of the main activities in those agencies is dissemination about renewable energy sources through EU directives and plan to reach 20 – 20 – 20 measure.

### Recommendation:

Improve contacts with local governments, public bodies, schools, students, small and medium enterprises, agricultural companies, associations. This is one of the main activities based on “Rural

development plan 2007 – 2013” by Ministry of agriculture and rural development. Associations and those agencies must take care about environmental development in rural areas on every platform (ecological, economical and field of energy). Local resources must be used to satisfy local needs for energy, clean environment and economic sustainability.

### Fact 3

In the Republic of Croatia there is no biomass market so there are no prices, transport calculations, etc. In same time almost all biomass is being exported to Austria and Germany for their biomass plants and energy facilities. Olive residues still have not got a defined clear purpose.

### Recommendation:

To stop with this practice and establish biomass market inside Croatian territory so we could reach our energy objectives.

### Fact 4

In Croatia there is a "Regulation on the use of renewable energy sources and congregations". Regulation was adopted 15.06.2007. the problems of all forms of renewable energy sources, except for biomass, are defined. Biomass is mentioned in only one short paragraph. Olive pits are not mentioned. Following the Regulation this source of renewable energy is defined as solid biomass from forestry and agriculture (lop, straw, seeds) and solid biomass from wood processing industry (bark, sawdust, chaff).

### Recommendation:

This issue should be further promoted and developed. Fund for Energy Efficiency of Republic of Croatia is formed in parallel with the adoption of this regulation and has not yet really started with quality work. In Regulation there are no defined

rules on how to manage biomass as a renewable source of energy.

#### **Fact 5**

Residues of agricultural production have an important role. Agricultural SMEs are not stimulated to use renewable sources of energy. There is a highly complex procedure of acquiring the status of eligible producers of energy (equal to 100 kW and 100 MW). In Croatia, the primary energy obtained from biomass and wood is 0.00025% and is now used exclusively for the individual examples of heating homes or smaller spaces of certain manufacturing facilities. Only one big furniture factory uses their own biomass to close the energy circle and in Croatia are more than 150 producers in wood industry. A problem is that Croatian basic strategy of biomass promotion is primarily focused on stimulation to use wood biomass (wood pellets, wood chips etc.) due to high percentage of Croatian territory covered by forests. On whole territory is almost 60% covered by forest.

#### **Recommendation:**

There is political support nor legislation that would motivate people to invest in systems of producing energy from renewable sources.

**For Republic of Croatia the main recommendation is to develop such market and resolve olive residues problem through:**

1. Increasing levels of knowledge and awareness about the need for olive producers to use new technologies.
2. The establishment of olive cadastre.
3. Increase the area of olive groves.
4. Increase the quantity of Olive production.
5. Revitalization of old and abandoned olive trees.
6. Make business plans where olive pits, and wooden residues are mixed.
7. Organize co-financed transport supply.
8. Make a control management to organize market for olive residues.
9. Better control of process disposal of olive residues.
10. Control of all acts and regulations.
11. Establish new co financing positions for small investors.
12. Define popular tariff for selling electricity to national electrical system.
13. Encourage potential investors to invest not only in energy but also in other kinds of olive residues by-products.
14. Try to do everything so the problem of olive residues could become one of the basic biomass resources.

### ***The tools: the guidelines***

The project final outcome has been the guidelines for the evaluation of the feasibility conditions for the realisation of an olive pomace-to-energy plant based on a local supply chain, replacing the fossil fuels (mainly diesel oil and natural gas).

Particularly, the guidelines help in delineating the project characteristics in terms of technological,

economic and environmental aspects as well as in evaluating the sustainability under the entrepreneurial profile.

The guidelines make reference both to consolidated methodologies, exploited at an international level, and to the testing, carried out during the MORE Project, through the elaboration

of Business Plans in the partner regions (Liguria in Italy, Province of Jaen in Spain, Istria in Slovenia and Croatia, Crete in Greece). The guidelines represent an operating tool for non-specialised people to identify, plan and evaluate economically sustainable supply chain initiatives to exploit pomace for energy purposes. Particularly, they can be useful for:

- Public Bodies willing to promote and support in their territory the development of ventures giving potentially large scale advantages for the community, both in terms of employment and product added value as well as economic saving and environmental protection;
- Operators in the energy or agricultural-food sectors wanting to develop and/or integrate their economic activities, seizing the opportunity offered by biomass energy exploitation (e.g. Olive-millers to better manage their solid residues and use them as a renewable energy source);
- New entrepreneurial entities wanting to start economic initiatives in the energy sector.

The guidelines document consists of two sections:

1. The first deals with the process used to identify, plan and evaluate the economic and financial sustainability of the initiative concerning the construction of a pomace plant for energy purposes. It goes step by step through a logical path made of analysis, identification of solutions and final evaluation. The methods used are also described in this part.
2. The second section contains the technical sheets displaying the contents and useful tools for the development of each step in which the process is articulated.

In particular, the proposed process consists of 5 steps, which respond to key for the *decision maker* to take a rational choice:

- 1) How much pomace is available, where and when? (context analysis);
- 2) Who could be interested in using pomace as fuel? (demand analysis);
- 3) Which kind of plant? (technology analysis);
- 4) What can be implemented in our territory? (design of the alternatives);
- 5) Which is the best solution? (alternatives analysis and evaluation).

*The full document is available in each partner's language both in printed copies and online on the website [www.moreintelligentenergy.eu](http://www.moreintelligentenergy.eu)*

### **The tools: the business plans**

The partners have developed business plans for the establishment of facilities to generate energy through exploitation of pomace. These business plans refer to public or private plants and refer to a variety of situations.

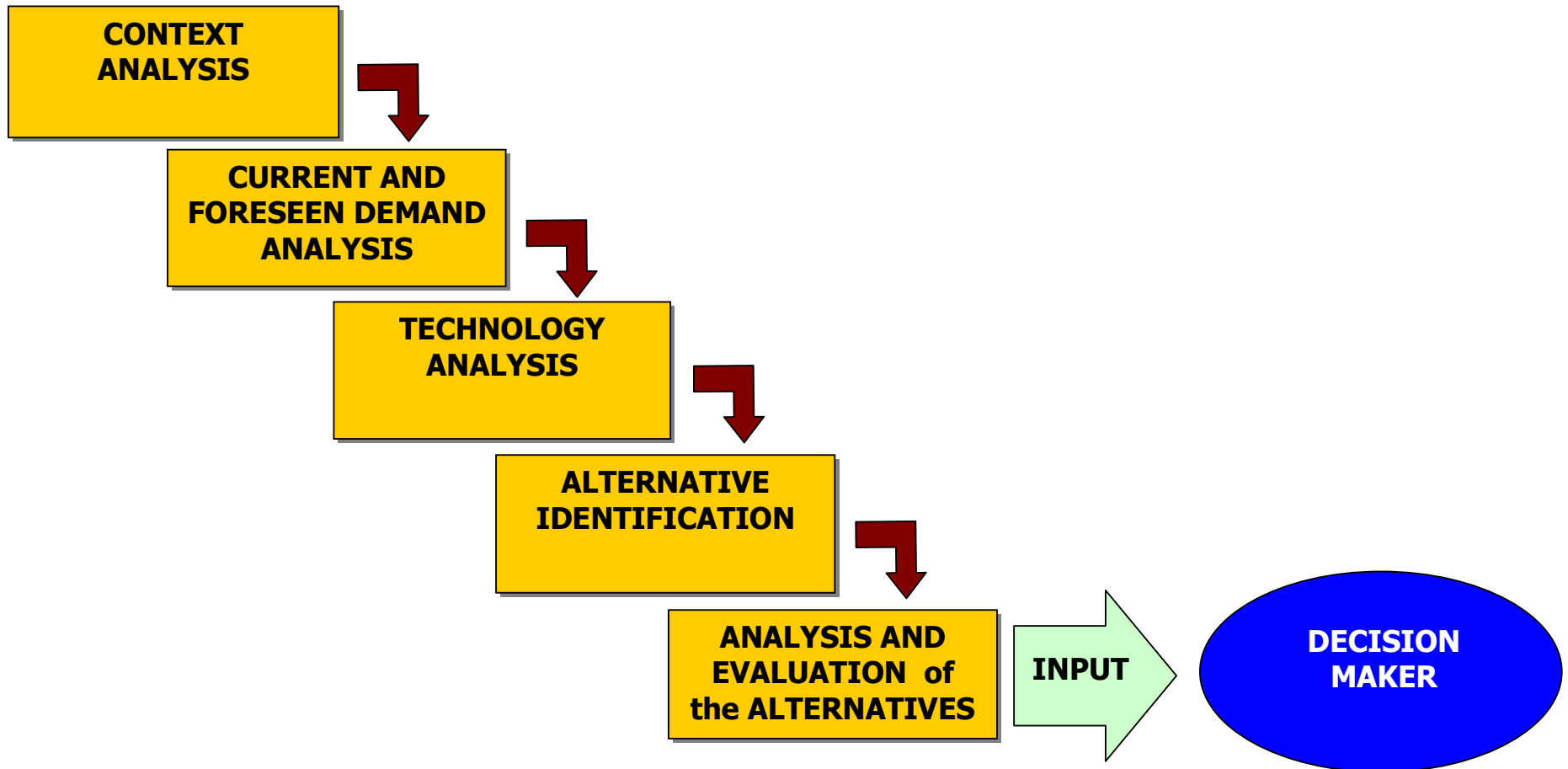
- \_ Liguria (Italy): pomace drying unit + heating plant
- \_ Istria (Croatia): hot water pomace boiler system for district heating
- \_ Province of Jaén (Spain): combined solar thermal and biomass heating and

- \_ Crete (Greece): pomace heating plant and pelletizing plant
- \_ Istria (Slovenia): olive pitting plant and olive pit fuelled heating plants

Some of them have already been implemented, some are in course of implementation or of funds search. The table in the Focus at page 58 summarizes the business plans characteristics.

*For full details on business plans see [www.moreintelligentenergy.eu](http://www.moreintelligentenergy.eu)*

The process steps



## Focus: Summary of business plans characteristics and features

			size	investment	quantity of pomace used	quantity of energy generated	saved money	saved fuel	CO2 saved	payback year
1	Italy	Pomace drier	907 kg/h	€ 170.000	1075200 kg/y	n.a.				10 (with 50% financing)
1bis	Italy	heating plant	130 kW	€ 60.000	34000 kg/y	171600 kWh	12000 €/y		30030 kg/y	7
2	Greece	Direct combustion of depleted pomace for greenhouse heating	180 kW boiler	€ 27.000	34000 kg/y	154705 kWh/y	6580 €/y	12 toe/y	38 ton/y	4,1
3	Greece	Pellet plant	4,999 kg/hr	€ 1.874.552	17995699 kg/y			6.351 toe/y	20179 ton/y	9
4	Slovenia	Smarje Primary School heating	400 kW boiler	€ 88.300	54 t/y	238 MWh/y	8189 €/y	26000 lt/y of fuel oil	71 ton/y	8
5	Slovenia	Trutske inn heating (pit)	90 kW boiler	€ 7.000	9,6 t/y pit	34 MWh/y	1180 €/y	4400 lt/y of fuel oil	12 ton/y	4,5
6	Slovenia	Hrvatins Olive mill heating (pit)	65 kW boiler	€ 10.500	3600 kg/y pit	17500 kWh/y	1397 €/y	16000 kWh/y electricity	84,8 ton/y <sup>4</sup>	7,5
7	SPAIN	Local council and police building heating and cooling system	120 kW	€ 88.000	81836 kg/y pit	295680 kWh/y	22778,83 €/y	38.871,72 lt/year of diesel oil	172.084,16 kg/year	4
8	Croatia	boiler for district heating of IPTPO premises + high school	1,3MW	4700000 kn (€ 648.000,00)	250000 kg/y pit	9090 MWh/y	1095000 kn/y	1,006,645 lt/y fuel oil	3273000 kg/y	4,3

<sup>4</sup> conversion for electricity Slovenia for year 2009 equal to 530 kg of CO2 per MWh

## **Stakeholders involvement**

Stakeholders have been involved throughout project implementation in various ways and at various levels.

**At local/regional level**, they have been directly invited to take part in the Regional Steering Committees (RSCs), sort of advisory board for the local implementation of project activities. Each region has set up one Committee which has met at least 4-5 times to get information on project results and take strategic decisions. Members have also been involved in project dissemination and they have been invited to events and activities; they have also been asked to commit for project success, which means to take direct action to promote the use of pomace for energy.

Overall, more than 30 stakeholders are members of our 5 RSCs, this is the list of members.

Liguria:

- Corefli, regional association of provincial millers associations;
- CIA, agricultural business association;
- Coldiretti, agricultural business association;
- Confagricoltura, agricultural business association.

Slovenia:

- 3 olive millers,
- 2 olive growers,
- 2 researchers from Institute of Mediterranean Agriculture and Olive Growing,
- energy agency
- Municipality of Koper

Croatia

- 4 olive millers,
- 1 olive grower,
- 2 researchers from Technical university of Rijeka and Medical university Rijeka,
- energy agency
- 3 representatives of local community-Municipality (Istiran county, city of Poreč and City of Vodnjan),
- 2 from Croatian national Institutions (Chamber of economy and Croatian fund for environmental protection and energetically efficiency)
- local waste disposal company.

Jaen

- Scientific Park Jaen,
- Federation of Agriculture Cooperatives
- Innovation Centre,
- University of Jaen, Regional financial fund,
- Union of small farmers
- Agenda 21-Diputacion de Jaen.

Crete (Greece)

- Technical University of Crete “Laboratory of Renewable & Sustainable Energy Systems”,
- Association of Cretan Olive Municipalities,
- Olive mill “BIOLEA-Astrikas Estate” Organic olive products,
- Olive oil industry “Anatoli S.A-ABEA”,
- Aristoteles University of Thessaloniki – Biomass group of the Laboratory of Chemical Technologies,
- ABEA – oil refinery company.

More than 20 of them signed a commitment letter, that is, declared to be willing to take concrete actions towards the promotion of pomace as energy fuel.

Other stakeholders have been involved at regional level in training courses, organised in 3 modules where project partners have given information on the project, its aims, on pomace energy potential, on business plans, on opportunities of investment and funding. Overall 331 stakeholders took part in training sessions, mainly from olive oil mills and trade associations. Interesting enough, in Greece (Crete) only, many attendants were coming from R&D sector or were investors.

**At national level**, stakeholders have been involved thanks to newsletters and final national conferences as well as to participation to third party events. 360 people overall attended the final national conferences which took place in spring 2010 in each partner region. These occasions have been important to give visibility to the project and its results. We saw the impact of these wider dissemination activities at the end of the project, when people from around involved nations started calling project partners for main information. In Italy this has especially happened with millers and private investors from the South of Italy.

**At international level**, the project has been disseminated through European networks such as FEDARENE or EEN and has been presented at 2 international events and 1 French event:

- Montpellier, France – 9<sup>th</sup> December 2009 Unioncamere Liguria presented MORE project at a dedicated workshop within “ENERGAIA” Exhibition. About 40 local stakeholders took part to the event.
- Hamburg: 17th European Biomass Conference&Exhibition “From Research to Industry and Markets” took place in Hamburg (DE) from 29<sup>th</sup> of June – 3rd July 2009, Agener presented the MORE project with a Visual Presentation entitled “The chain of Values of the Olive Trees Biomass for Final Thermal Uses: Key Aspects and Challenges”.
- “Renexpo Aebiom Bioenergy” conference & fair: More presented by partner AGENER at the event which took place in Bruxelles on 30<sup>th</sup> June-1<sup>st</sup> July 2010 (Eubionet III workshop on “Emerging biomass resources” see <http://www.renexpo-bioenergy.eu/index.php?id=workshops>)

ARE Liguria received a request for a meeting by a delegation of millers from Chile. They want to know more about pomace for energy. The meeting will take place in mid-June in Genoa.

## ***Success stories***

### **Business plan follow up**

**CROATIA:** During the last period Institute for agriculture and tourism and high school “Mate Balote” have decided to invest into a heating facility with fuel from olive residues and other kind of biomass from their own 28 hectare of olives and vineyards. They have filled in forms for a loan equal to 4.700.000,00 Croatian kunas and another copy of this business plan was sent to the Fund for Environmental Protection and Energy Efficiency for approval so we could ensure co-financing in level of 70%.

**SLOVENIA:** 1 of 3 business plans elaborated has already been realised. In Slovenia 2 local stakeholders committed to invest in energy use of olive residues.

Mr. Marinko Hrvatin, owner of Olive mill “Hrvatin” has already invested more than 30.000 EUR into new energy plant (new pit separator, biomass boiler (using olive pits) and new central heating system for olive mill and business premises).

Mr. Fulvio Marzi, owner of Olive mill “Krožera” plans to invest 17.000-20.000 EUR next year into upgrading his current private energy heating system using olive residues as biomass for energy (for production of heat for olive mill, 2 private apartments). He plans to purchase olive pit separator and small pelletiser for production of pellets out of olive residues.

The third project “Renovation of energy plant of Primary school Šmarje pri Kopru” will be realised in next years. The municipality of Koper is partner in project co-financed from Swiss fund and is now preparing open call for tenders for renovation of energy plant and implementation of new equipment (biomass boiler).

**SPAIN:** In Jaén, the Provincial Council, together with the Junta de Andalusia are going to install a biomass boiler with olive pit, in 95 of the 97 municipalities of Jaén. To this aim, they will use our business plan as basis.

### Success stories

- 1) Slovenian miller Marinko Hrvatin was invited by University of Primorska, Science and Research Centre of Koper to collaborate in Regional Steering Committee. Mr. Marinko Hrvatin responded positively and signed RSC Declaration. During the project life cycle he participated actively in RSC meetings and contributed several ideas, suggestions to the documents and deliverables produced within MORE project and made first steps towards the establishment of olive-residues-for-energy market in Slovenia. He attended 3 training sessions performed by UP ZRS, participated at international excursion to Liguria where olive millers visited some best practices, collaborated by writing business plan and bought necessary technology for the separation (pit separator) and use (installation of heating plant using olive pits) of olive pit for production of heat for olive mill and his business facilities. In next heating season he will start supplying 3-4 customers with olive pits.
- 2) the Final Conference in Thessaloniki was greatly attended (138 people).
- 3) IPTPO is participating into the establishment of a cluster for renewable energy sources in one municipality near Poreč where the idea is to build storage, palletizing facilities, small plant based on biogas from biomass, two greenhouses. The idea was born during Module 3 Training for market operators when they met one guy who grows lavender and who's presented his interest to organize

storage centre for biomass anywhere. After few meetings they decided to establish one small spin off consortium for education on using biomass for energy in cooperation with Municipality of Tinjan because according to Croatian law they can establish any cluster. So we're waiting now to receive signed permission by Ministry of economy. All plans are finished, some loans are realized and till today in the consortium there are 11 small and medium enterprises and one association.

- 4) More was invited in autumn 2009 to participate in the EEP Award. The EEP Award is organised every year by the European Environmental Press (EEP) in collaboration with Pollutec, the leading French environmental trade show, with the support of EFAEP, the European Federation of Associations of Environmental Professionals. The purpose of the EEP Award is to recognise the efforts of those European companies that are improving the environment with their innovative environmental technologies. The winners will receive: the award itself (gold, silver, bronze); an extensive covering in all 17 EEP member-magazines, covering in the fortnightly electronic EEP Newsletter and on the EEP website; as well as a free equipped stand at Pollutec Lyon The winners will be known in December 2010. [www.eep.org](http://www.eep.org).
- 5) University of Florence (Italy) asked for project results in order to insert them in a research done for another IEE project called "EUBIONET III".

### Facts and figures

• Nr of stakeholders involved in Regional Steering Committees	<b>38</b>
• Nr of best practices identified	<b>17</b>
• Nr of business plans prepared	<b>8</b>
• Nr of newsletters elaborated	<b>4</b>
• Nr of people trained	<b>331</b>
• Nr of people participating in field trips	<b>66</b>
• Nr of people participating to the 5 in national conferences	<b>360</b>
• Nr of events in which More was presented	<b>34</b>

## **Lessons Learnt**

In SPAIN the biggest problem in supply chain system is the distribution of biomass. This market is under development, because companies want to install biomass boilers but at the same time, they also want to assure the supply of biomass. One of the main objectives for further development of this market is an increase in the number of private companies and also an increase of people trust in this source of energy. The main problem with biomass electricity power plants is related to electricity connection in the grid and to certain extent the management of high quantity of biomass. In order to solve current problems, possible solutions are:

- companies have to carry out a distribution grid to supply biomass in similar ways as they do with traditional fuel supply;
- as biomass managing companies they have to develop and offer to the customers different logistic services;
- market operators have to establish a distribution trading network with strategic nodes in each region;
- increase awareness which would improve the use of olive residues as biomass for thermal use.

In ITALY the main problems identified are the following:

- need for long term investments with a rather long pay-back period, which makes the realization of the pilot implantation not much economically attractive;
- scarce political support to the pilot action;
- scarce predisposition of small local private actors to invest in the olive residues to energy facility;

- a too wide localization of olive oil production sites in the region;
- lack of public incentives schemes to thermal solutions
- lack of updated figures on pomace quantities.

In GREECE (CHANIA) the problems for establishment of a good supply chain are mainly due to:

- physical form of olive residues which are not easily transported;
- need for big storage areas which make it more attractive for heating big facilities rather than homes.

For CROATIA and SLOVENIA the main problem is the same – non-existence of energy supply chain. For development of such a market some preconditions need to be fulfilled:

- bigger quantities of olive production
- the establishment of olive residues cadastre on regional/national level
- better control of disposal process of the olive residues
- increased level of knowledge and awareness about the existing and used technologies for management and use of olive residues for energy purposes
- established financial incentives within ERDF for funding the creation of such energy facilities/power plants
- giving subsidies to developers of olive residues market or co-financing supply chain (transport costs)

## Conclusions

1. Olive solid residues represent a **great biomass energy potential for Europe** – in the Mediterranean every year more than 7 million tons of virgin pomace are produced but there is little awareness of this
2. **legislative aspects** are a main issue, not only because of their diversity among the partner regions, but also because in each region olive-residues-to-energy is affected by different, sometimes conflicting, norms, such as those on waste, on biomass, on environmental pollution, on chemicals, etc. It is therefore quite difficult to handle situations
3. **international cooperation** is very important to learn from foreign best practices and the enthusiasm of newly entered or accessing countries is very useful for the whole partnership
4. the project topic is only fully known in Spain so far; even though Greece and Italy are two major producers, **up to now it has been difficult to find interesting plants there**. However, the momentum is right because MORE has become very well-known and all the partners receive calls and emails from people around Europe and in their countries to get info
5. in some of the regions involved the available limited pomace quantities need **public co-financing** in order for the business plans to be sustainable – therefore, political support is absolutely key for the success of the whole operation
6. extreme **market fragmentation** in many small family based mills as well as the use of different milling appliances (which generate different kind of residues) make it harder to organise a stable supply chain in many Mediterranean regions.

## Annex I: The partners



ARE Liguria is a joint-stock company established in 1996 within the framework of the EU PERU Programme: "Creation of regional and local energy agencies". It has been formally recognised by the Regional Law N. 18/99 as a tool for the regional energy policy on sustainable development. ARE Liguria is held at 95% by F.I.L.S.E. S.p.A. (Ligurian institution financing economic development). Since 1997 the Agency has been member of FEDARENE (European network of energy agencies) as well as part of the steering committee of the RENAEL, the national network of energy agencies (since 1999). The institutional aim of the Regional Energy Agency is the promotion of energy saving policies, the exploitation of renewable energy sources and the rational use of energy within Liguria Region. ARE Liguria works in the institutional field, supporting the regional authority and other local administrations to elaborate and implement

energy plans, promoting the local acquisition of laws, founding a consortium to jointly buy electricity, offering training on energy matters as much as information on new fuels and technologies. ARE has also elaborated feasibility studies applying energy efficiency rules according to the EU directive and business plans for RES plants in Liguria. ARE Liguria is now running a monitoring & control structure for energy and infrastructure projects for all the hospitals of Liguria.

ARE Liguria is also working hard at international level, taking part in many EU projects dealing with European energy policy priorities, such as buildings and communities energy certification, energy management in the health system, promotion of new contractual and management models, energy education.



The Regional Chamber of Commerce is the association (as foreseen by the D. Lgs. N. 23/2010) of the four Chambers existing in Liguria, providing a series of services, such as:

- statistical reports on the trend of the regional socio-economic development;
- observatory of the tourism sector, in cooperation with Regione Liguria;
- analysis of the industrial sector on a six monthly basis;
- Chambers steering committee on agricultural matters, liaising with the Regional Minister for agriculture;
- promotion of food products' quality.

In addition, Unioncamere Liguria hosts the Enterprise Europe Network, the business support network created by DG Enterprise and Industry of the European Commission in 2008 in order to improve the competitiveness of EU companies and, in particular, of SMEs. Our EEN Office, named ALPS Liguria, plays an intermediary role between the European Institutions and the local business actors. ALPS Liguria assists companies

and above all SMEs to facilitate their access to opportunities at European level and to prepare them on topical themes such as innovation, technology transfer, RTD, internationalisation.

EEN mission consists in:

- Providing information about European legislation, public bids and programmes;
- Supporting SMEs in the identification of the most suitable funding opportunities;
- Detecting new market opportunities and help SMEs in finding new business partners;
- Leading them in the field of research and technological development;
- Informing them about environmental management and certification;
- Organizing workshops to spread information and deepen the most relevant EU policies.

EEN is made up of more than 500 members all across EU and beyond.



The Region of Central Macedonia and the Local Development Agency «ANATOLIKI S.A.» established the Regional Energy Agency of Central Macedonia (REACM) in 1997, through the European Union’s SAVE programme.

The main activities of REACM include: Data Acquisition for Energy Production & Consumption in the Region, Support to the Region’s Local Authorities in energy policy planning, Dissemination and Promotional Activities for RES and RUE Technologies, Training and Continuing Education, Support to Local Industry, SMEs & Commercial, Pilot application of EMAS in four heavy industries in Thessaloniki (Hellenic Petroleum, Hellenic Sugar, Hellenic Vehicles and Hellenic Steel), Training of personnel in the industrial sector in ECO – Energy Audits, Promotion of RES Technologies to the Agricultural Sector, Definition of a Regional Energy Plan, Promote Collaboration with Neighbouring Countries in the Field of Energy Savings, Participation in the committee of Regional Planning for the development and management of Geothermal Fields, Evaluation of RES and RUE Investment Proposals for Industrial and Residential applications.

On regional level, REACM is closely cooperating with the Regional Authority of Central Macedonia as well as with the other six prefectures of the Region, in RES and RUE projects such as: “Detailed Study of Energy Planning for the Region of Central Macedonia”, “Feasibility Study for Geothermal Agricultural Applications in the region of Tragilos (Serres)”, “Extended Energy Audit in the General Hospital of the Prefecture of Pella”, “Development of the Geothermal Field and Biomass Livestock Utilization in the Prefecture of Pella”, “Utilization of Geothermal Energy for Olympic-size swimming pool heating in the Municipality of Thermi (Thessaloniki)”. REACM operates as a department within the structure of the local development agency ANATOLIKI S.A. and it is supervised by a Steering Committee. REACM through ANATOLIKI S.A. holds strong ties with the region of Central Macedonia in matters of Energy Policy and Environmental Activities. The operation of REACM and ANATOLIKI S.A. includes a multi-scientific personnel of a wide range of educational backgrounds with strong economic capabilities which provide the best credentials of professional and financial capacity.



AGENER is the Energy Management Agency of the Province of Jaén, a non-profit making association, governed by the Spanish Organic Act 1/2002. It is linked to the Tourism and Local Sustainable Development Area of the Provincial Council of Jaén, whose main aim is to contribute to the energy sustainability in the province of Jaén by promoting rational use of energy and diversification towards less polluting indigenous energy sources. AGENER was created in 1998, within the framework of SAVE II, the European Union programme for the promotion of Energy Efficiency, through a collaboration agreement signed by the Provincial Council of Jaén, the electricity supply company Sevillana de Electricidad, the company for the Energy Development of Andalusia (SODEAN) and the Sierra de Cazorla, Sierra Mágina and Sierra de Segura regions Rural Development Associations.

AGENER is a tool at the service of citizens from the province of Jaén: consumers, professional and community associations, organisations, companies, etc; although it mainly focuses its actions on the provincial public sector, the Provincial Council of Jaén and the Town & City Councils of the province of Jaén.

The activities that AGENER develop include the following areas:

- \* Power planning.
- \* Rational use of the energy.
- \* Fomentation of the renewable energy.
- \* Citizen cooperation.
- \* Advising, consultancy and technical support.
- \* Integral management of supplies of energy.
- \* By-laws.

- \* Fossil fuel substitution.
- \* Town planning and bio climatic.
- \* European Project

Agener has carried out analysis study on the potential and cost of Olive Tree pruning in the province of Jaén and in the same field has

organized conferences and training course. The Province of Jaen has, over the years, participated in projects for the exploitation of olive biomass for energy generation.

The Science and Research Centre of the Republic of Slovenia, Koper (SRC Koper), was founded on 1st December 1994. For the Government of the Republic of Slovenia the Ministry of Science and Technology carries out the rights of the founder, co-founders were further the Community of the Communes of the Littoral area and the Slovenian Academy of Science and Arts.

The sphere of activity of SRC Koper are Mediterranean studies with an emphasis on the research of Slovenian Istria with interdisciplinary approach of humanistic, social and natural sciences or more precisely: basic and applied research, expert advising and consulting, education, organising meetings of scientists and

Institute of Agriculture and Tourism is a national research body, founded in 1875, during Austro-Hungarian period. It is mostly financed by the Croatian Ministry of Science, Education and Sports, but also by other national, regional and local entities, as well as by its own commercial activities such as laboratory work or advisory services. Institute is organised in five fundamental structure units: Board, Department of Agriculture and Food Science, Department of Economics and Agriculture Development, Department of Tourism and Experimental agricultural holding.

**DEPARTMENT OF AGRICULTURE AND FOOD SCIENCE**

Department performs permanent scientific-research activities and professional work in the framework of biotechnological sciences. Researches are mostly orientated to viticulture, wine-production, production of olives and olive oil and vegetable growing. Experimental plantations and laboratories (pedological, enological, genetic and food testing) are the base for these researches.



experts, advertising and publishing, documentation and librarianship. Staff members of the SRC Koper are about 50 researchers and associates.

Basic Research activities of SRC Koper:

- Institute for Mediterranean Humanities and Social Studies
- Institute for Biodiversity Studies
- Institute for Mediterranean Agricultural and Olive Growing

- 6 infrastructural units of SRC Koper: Publishing house Annales SRC Koper, Library SRC Koper, Information resource centre, Public opinion Centre SRC Koper, Laboratory SRC Koper and Euro Info Centre Koper.



**DEPARTMENT OF ECONOMICS AND AGRICULTURE DEVELOPMENT**

In this department, scientific and professional work in the fields of economics, development and organisation of agricultural-nutritional system, as well as of planning and land protection is performed. The researches are applied to agricultural family householdings.

**DEPARTMENT OF TOURISM**

Department of tourism performs scientific and research activities, as well as professional jobs in tourism. Development, economics and organisation of tourism in Istria are the most studied subjects.

**EXPERIMENTAL AGRICULTURAL HOLDING**

Experimental agricultural holding is organisational unit in function of scientific research work for realisation of permanent scientific projects in agriculture. Its components are: wine cellar with minivinification, mini oil refinery, mini brewery and meteorological station. Institute has the modern information equipment and library with 12.000 titles that are refer on Institute activities.