PROJECT FINAL REPORT

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Project acronym: ALGATEC II

Project title: optimisation of the biological recycling solution for olive washing water

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1.1 Executive summary

The European Union is the most important producer of olives and olive oil in the world. Main producers are placed in the basin of the Mediterranean Sea, being Spain, Italy and Greece the biggest ones. In 2010/11 the world production of olive oil was approximately 3.08 million metric tonnes and Mediterranean countries accounted for almost 97.4% of this production (IOC, 2013). On the other hand, non-European countries enter the market and harden competition, threatening European Union producers' dominant position. Besides the market expansion, the sector in the EU has to solve some long-standing resource and environmental problems to keep its predominant situation.

During the olive processing, large amounts of drinking water are consumed, especially during the washing step, and highly pollutant liquid wastes are generated. This poses serious problems to the mills since waste management involves additional costs and logistical problems, especially for the SMEs. In average, about **50 litres of water are required to process 100 kilos of olives**. With IOC (2012) data stating that 17 million tonnes of olives are harvested every year and with 90% of them being used to produce olive oil, the potential of reuse is very high as approximately it will be necessary to treat 22.63 million tonnes (22.63 million m3) of washing water generated in the process.

Olive oil consumption is steadily growing worldwide thanks to its known benefits of on health. Although the EC is the main olive oil consumer, the demand in countries like United States, Canada, Russia, China and Brazil has increased significantly in recent years.

Within Spain, Italy and Greece there are 8,349 olive mills which in 2010/2011 produced more than 2 million of olive oil (IOC, 2013). These producers, mainly SMEs, are in urgent need to meet a growing part of their water demand from "unconventional" water supply sources, such as wastewater reuse, especially in water scarce countries. Therefore, it is very important to undertake any measures for the optimisation of the recycling of olive mills washing water as the system proposed in ALGATECII. In addition, the opportunity in this market in huge because olive oil producers are increasingly taking their water management seriously due to financial, reputational and legislative pressures and no efficient /affordable solutions are available in the market.

The ALGATECII project main activities were focused on the demonstration of a technology to treat the olive washing water generated in SME olive mills, with high pollutant content, by means of an innovative, affordable and easy to use technical solution composed by a photobioreactor (PBR) using biotechnological consortium, followed by a membrane technology module.

During the project, several improvements have been implemented to the system developed in ALGATEC in order to demonstrate, on the one hand its optimal performance with regards to the purification rate, and on the other hand the competitiveness of this solution in the market, opening new business opportunities to the participating SMEs.

The biotechnological ALGATECII system demonstrated in the project has showed to be technically effective producing drinking water quality after PBR and membrane module treatment. In addition, it shows many added values compare to current applied strategies for the treatment of the olive oil production washing water, being competitive – investment and O&M costs increased less than 0.01€/litter of olive oil, and sustainable as renewable energy sources such as solar energy have been used, and we are moving to Zero residues by producing a biomass (algae) that could be later valorised.

The project consortium is formed by five European small and medium enterprises from three EU countries, Spain, Germany and Italy. Three technology providers: BIOAZUL (membrane module), BIOT (inoculants and PBR) and ISITEC (automation and control), ENCO (market expert), and DESAM (SME olive oil producer, end user).

The consortium believes that the main objective of the project has been achieved: Promotion of a green technology in recycling and re-usage of washing water in olive oil production, consequently reducing the costs of water usage and eliminating the problem of disposal of polluted water.

1.2 Description of the project context and the main objectives.

The European Union is the most important producer of olives and olive oil in the world. Main producers are placed in the basin of the Mediterranean Sea, being Spain, Italy and Greece the biggest ones. In 2010/11 the world production of olive oil was approximately 3.08 million metric tonnes and Mediterranean countries accounted for almost 97.4% of this production (IOC, 2013).

On the other hand, non-European countries enter the market and harden competition, threatening European Union producers' dominant position. Besides the market expansion, the sector in the EU has to solve some long-standing resource and environmental problems to keep its predominant situation.

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The ALGATECII project started the 1st of January 2013 and lasted for 24 months. The project is based on the promising results of the ALGATEC project and its **overall objectives were**:

- To provide an affordable technical solution for reducing the consumption of drinkable water in the olives washing process by 90 % and increasing the overall water efficiency of the process by 80% based on the solution developed in ALGATEC.

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The scientific and technological specific objectives were:

- Optimisation of the PBR operation and production of inoculants (WP2) to:
    1. Avoid problems of WW leakage from the PBR tubes
    2. Reduce the Hydraulic Retention Time (HRT) of the PBR
    3. Demonstrate the possibility of having commercial formulation of the inoculants
    4. Introduce a disinfection procedure for the tubes and the tanks
- Optimisation of the membranes technology (WP3) to improve:
    1. The control system of the trans-membrane pressure (TMP)
    2. The membrane tank design and use cheaper material
- To increase the competitiveness of the solution (WP2, WP3 and WP4) by:

1. Reducing the HTR as well as the energy consumption of the membrane modules
2. Knowing in detail the market needs and future requirements
3. To know the state of another new and potential markets (outside Europe)
4. To know the market strategy to penetrate with the ALGATECII system

- To meet the end-user needs and to disseminate the functionally results of the solution ALGATECII (WP5) by:
    1. Identifying end-user needs
    2. Tailor-made competitive solutions for each final user
    3. Showing the project results to the end-user and science community

In order to achieve the expected results, the work to be performed in the 24 months that lasted the ALGATECII project, has been organised in five work packages.

- WP1: Project management
- WP2: Optimisation of the PBR operation and conservation of microbial inoculants
- WP3: Membrane module optimisation and validation
- WP4: Business Plan and Market analyses
- WP5: Dissemination and exploitation of the project results

The following figure shows how the work has been organised in the 24 months of the project, within each work package and the tasks of each of them, and the foreseen deliverables.

Project duration: 24 months	Length	Month																							
		1st RP									2nd RP														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP 1 Project management	**9,50**																								
Task 1.1:General, administrative and financial project coordination	7,00		D1.4				D1.1																		
Task 1.2: IPR management	2,50									D1.2															D1.3
WP2: Optimisation of the PBR operation and conservation of microbial inocula	**69,50**																								
T 2.1: Optimisation of the operation of PBR	51,50												D2.1				D2.2								
T 2.2: Conservation of pure cultures and microbial inoculants for production of PBR	18,00																		D2.3						
WP3:Membrane modules optimisation and validation	**34,50**																								
Task 3.1: Demonstration of the performance of the selected membrane module configuration under real conditions	24,50												D3.1				D3.2								
Task 3.2: Energy consumption optimisation of the selected membrane module configuration under real conditions	10,00												D3.1				D3.2								
WP4: Business Plan and Market Analyses	**32,00**																								
Task 4.1: Definition of Business Planning	23,00												D4.2												D4.3
Task 4.2: Development of Market Analyses	9,00										D4.1														
WP5: Dissemination activities	**24,50**																								
Task 5.1: Creation of project website	6,25			D5.1																					
Task 5.2: Training and disemination activities	9,25						D5.4															D5.5			D5.7 D5.8
Task 5.3: Development of materials project dissemination	4,50						D5.2 D5.3															D5.6			D5.9
Task 5.4: Further dissemination activities	4,50																								
TOTAL	170,00																								

Fig 1 - *ALGATEC II Gantt chart*

The first and main objective was to optimise the ALGATEC II system – PBR and membrane module- and validated and demonstrated during the project.

BIOT has leaded WP2 whose work has been focused on optimizing the biological solution for recycling the washing water from olives, developed in the previous project ALGATEC. Therefore, improvements that would help to achieve a greater efficiency in the purification system, and therefore a higher performance in the process, while reducing the associated costs have been implemented.

With this aim, growth curves of the microorganism have been performed looking at the key issues influencing their growth: nutrients and light. In addition, work has been done in the new PBR design

in order to solve the technical problems (leakages, heating and lighting systems, and energy production alternatives). DESAM, BIOAZUL and ISITEC have supported BIOT in these activities. In parallel, measures for the preservation of the pure cultures have been carried out by BIOT as well as the production at several scales, including the preparation of semi-industrial one.

BIOAZUL has leaded WP3 focused on the membrane module – UF+NF- optimisation, including the redesign of the module, development of the process and instrumentation diagram giving key process parameters to be controlled, type of sensors needed, interaction between sensors and process equipment, and their location in the system. The control philosophy has been elaborated for the control panel development by ISITEC. The new design allows the reduction of the energy consumption, O&M costs and its usability. BIOAZUL and DESAM have updated the former pilot plant and arrange location and supply of WW, and the electrical connections.

The ALGATECII system, the PBR and the membrane module, have been constructed, installed, started up and tested during the olive campaign 2013-2014. Performance evaluation has been carried out based on the results obtained and against the project objectives.

Fig 2 - *ALGATEC II system*

WP4, leaded by ENCO, was devoted to business plan and market analyses. The market analysis report, included an introduction with the most relevant data regarding olive oil market, global olive oil industry, consumption/production statistics, environmental and social impacts, water use, olive oil mills type and waste water, competitors, and specific sections for main olive oil producers analyses. In addition, the Business Plan Strategy and the Business Plan Final Report were developed to push the market penetration of the ALGATECII system considering market analysis results, competitors' analysis and IPR issues. Furthermore, the Market Analyses Report was updated and the ALGATECII survey results were analyzed to better understand economic and environmental problems olive oil mills are facing with.

The partners have been very active at disseminating ALGATECII projects and its results within WP5. One of the main outcomes is the ALGATECII website in English, Italian and Spanish, www.algatec2.eu. A logo was also developed to be included in all ALGATECII dissemination material.

Fig 3 - *ALGATEC II Logo*

In addition, dissemination material has been developed as the project poster and leaflet available in English, Italian and Spanish, as well as the promotional video in English and Spanish.

Moreover, the ALGATECII database was prepared, including almost 350 entries from which the expert group was appointed. A very relevant outcome is the ALGATECII manual which is available in English, Italian and Spanish.

Several training sessions took place for the SME participants in the frame of the project, as well as 3 workshops for relevant stakeholders, two in Spain and one in Italy.

1st Spanish Workshop, 19th June 2014, Puente Genil (Córdoba)

Italian Workshop, 18th November 2014, Bari

2st Spanish Workshop, 11th December 2014, Huelva

Last but not least, the project has been widely disseminated by the media through webpages, videos, online-newspapers and magazines, TV, etc.

Within WP1, management activities have been carried out in parallel to the other activities, ensuring the smooth running of the project, communication and cooperation between the partners. Seven project meetings have taken place: KoM in Málaga, 1st technical meeting in Puente Genil, Midterm meeting and Review meeting in Granada, 2nd technical meeting in Naples, and final meeting in Huelva. The 1st and 2nd periodic reports have been submitted in November 2013 and February 2015 together with the final report. In addition, the Consortium Agreement and the Quality Assurance Plan and eight assessments have been prepared by the partners. Within task 1.2 devoted to IPR issues, the contents of any dissemination material have been checked in order to avoid any IPR conflict and the protection measures for the project results have been revised. The 1st PUDF and the Final PUDF have been prepared.

1.3 **Description of the main S & T results/foregrounds.**

The ALGATECII project main activities were focused on the demonstration of a technology to treat the olive washing water generated in SME olive mills, with high pollutant content, by means of an innovative, affordable and easy to use technical solution composed by a photobioreactor (PBR) using biotechnological consortium, followed by a membrane technology module.

During the project, several improvements have been implemented to the system developed in ALGATEC in order to demonstrate, on the one hand its optimal performance with regards to the purification rate, and on the other hand the competitiveness of this solution in the market, opening new business opportunities to the participating SMEs.

The final main S&T outputs of the ALGATECII project have been the **pilot plant constructed, installed and tested at DESAM facilities (Spanish end user) and the ALGATECII technology optimised and validated for the treatment of olive washing waters** allowing its safe reuse as process water. In addition, the conservation and production of the inoculant have been optimized as well in the frame of the project.

The biotechnological ALGATECII system demonstrated in the project has showed to be technically effective producing drinking water quality after PBR and membrane module treatment. In addition, it shows many added values compare to current applied strategies for the treatment of the olive oil production washing water, being competitive – investment and O&M costs increased less than 0.01€/litter of olive oil, and sustainable as renewable energy sources such as solar energy have been used, and we are moving to Zero residues by producing a biomass (algae) that could be later valorised.

This development of the ALGATECII technology provided a solution for the treatment of the olives washing water, so the high volumes of polluted water from olive processing are reduced, and the treated washing water with drinkable quality can be recycled for olives washing prior to olive oil extraction.

In order to develop such technology, 5 SMEs proposers, from three EU countries, Spain, Germany and Italy, have worked in close cooperation within the ALGATECII project. Three technology providers: BIOAZUL (membrane module), BIOT (inoculants and PBR) and ISITEC (automation and control), ENCO (market expert), and DESAM (SME olive oil producer, end user).

The ALGATECII is a Demonstration activity under the“Research for SMEs” projects; therefore the project foreground belongs to the participating SMEs. They will benefit from the outcomes, increasing their products range and thus making them more competitive in the wastewater treatment market.

The information provided below described the main work done in ALGATECII and their outputs of this work. The information disclosed could not be very detailed as most of the results produced have been classified as confidential. The main reason is to avoid any conflicts with the SMEs interest in the further protection and exploitations of the project results.

In order to achieve the expected S&T project results, the work had been organised in the 24 months duration in three DEMO work packages.

WP2: Optimisation of the PBR operation and conservation of microbial inoculants. This WP took place during the 24 months of the project and leaded by the coordinator BIOT. Its main aims were:

- To improve and optimize the operation of the photobioreactor (PBR), increasing the biological performance of the microbial consortium and decreasing the hydraulic retention time of the washing water (WW) in the PBR. (Task 2.1)
- To solve technical problems and contamination detected in ALGATEC Project. (Task 2.1)
- To preserve and produce the microalgae consortium. (Task 2.2)

WP3: Membrane module optimisation and validation. This WP leaded by BIOAZUL run from month 1 until the end of the project. Its main aims were:

- To optimase the selected membrane module that will produce the final effluent that should have drinkable water quality. (Task 3.1 and Task 3.2)
- To demonstrate the performance of the selected membrane module configuration under real conditions after implementing improvements. (Task 3.1)
- To reduce as much as possible the energy consumption of the selected membrane module configuration under real conditions. (Task 3.2)

WP4: Business Plan and Market analyses: This WP leaded by ENCO run from month 6 until the end of the project. Its main aims were:

- to map the olive industry, and to understand Europe's leading markets in order to offer them the innovative wastewater treatment technology and, consequently, to as many surrounding regions as possible.
- To produce a business plan for designing the business strategy to commercially introduce of the ALGATEC II system in the market.

The following table shows the deliverables resulted from each of the ALGATECII work packages.

Table 1 *- Running workpackages during the project period and deliverables submitted*

WP no.	Workpackage title	Lead beneficiary	Start month	End month	Deliverable number
WP1	Project management	BIOAZUL	1	24	D1.1 D1.2, D1.3
WP2	Optimisation of the PBR operation and conservation of microbial cultures	BIOT	1	24	D2.1, D2.2, D2.3
WP3	Membrane module optimisation and validation	BIOAZUL	1	16/24	D3.1, D3.2
WP4	Business Plan and Market Analysis	ENCO	6	24	D4.1, D4.2, D4.3
WP5	Exploitation and dissemination activities	BIOAZUL	1	24	D5.1, D5.2, D5.3, D5.4 D5.5; D5.6; D5.7, D5.8, D5.9

In order to achieve the expected S&T results/foreground, the project partners have worked in cooperation in the different DEMO work packages with the following outcomes:

WP2: Optimisation of the PBR operation and conservation of microbial inoculants.

In the ALGATECII project, the purpose has been to optimize the biological solution for recycled the wash water from olives, developed in the previous project ALGATEC.

After ALGATEC project, it was already detected the need to implement improvements that would help to achieve a greater efficiency in the purification system, and therefore a higher performance in the process, while reducing the associated costs.

To achieve this objective, a list of tasks, organized in work packages, have been developed. Some of them are described below.

Maintaining of pure culture of the consortium microorganisms

Tasks related with conservation and maintaining of biologic material of the project have been carried out by BIOT, on the one hand to preserve and maintain the consortium used from the project

ALGATEC, and on the other hand to start the inoculants production, necessary for the project ALGATECII.

To address the ALGATECII project and start to grow, it was necessary to keep and maintain the consortium of microorganisms in recent years, in the period from the finalization of ALGATEC. This conservation has been carried out in BIOT facilities with the company staff.

***Fig. 1**. Detail of strains preserved in Petri plates and tubes, and culture chamber used by BIOT for conservation of microorganisms.*

Knowing more about the consortium of microorganisms

Initially it was necessary to deepen the knowledge of the consortium of microorganisms in which the biological purification system is based.

It was necessary to determine optimal growth conditions in the laboratory, which then could be extrapolated to an industrial scale. Some parameters, mainly related to the optimum development of the consortium such as conditions of lighting, temperature and nutrients were assayed. These parameters were identified as the key to the growth and therefore the efficiency of the debugging process. The knowledge obtained during this stage was crucial for the later optimisation of ALGATECII system at industrial scale.

***Fig 2**. BIOT facilities detail during the tests performed with the consortium of microorganisms.*

Improving ALGATEC system

In addition to this stage of study the necessary conditions to get the maximum culture growth as possible, was carried out an additional study to identify all improvements that were considered important to increase the ALGATECII photo-bioreactor (PBR) performance. These improvements, related to the fluid dynamics of process and control and monitoring of main parameters involved in culture growth (pH, T, dissolved oxygen, carbon dioxide, turbidity and nutrients concentration), was detailed, designed and implemented.

Therefore, the improvements finally implemented for the PBR system optimisation has been focused on: revision, repairing and updating of ALGATEC system installed components; installation of heating system; greenhouse coverage; artificial lighting powered with solar energy source.

***Fig 3**. Improvement works carried out during ALGATECII project.*

Once all the assembly, installation and start-up works were finalized, an industrial pilot plant located at the oil mill Cooperative DESAM (Puente Genil – Córdoba – Spain), was fully operational and ready to work since the beginning of the olive harvest campaign. The final installed system is composed of four modules of methacrylate vertical columns and two tanks acting as degassers, allowing the removal of dissolved oxygen generated in the photosynthetic process and accumulated over the course of the culture through the tubes. These tanks are also suitable for heat exchange, because they have a heating jacket through which hot water circulates. This hot water is provided by the solar thermal modules installed and were working in automatic mode to maintain the culture temperature at considered optimal for culture growth, by solar energy.

***Fig 4**. a) ALGATEC system before improvements. b,c) ALGATECII system after improvements.*

Producing the inoculum needed to start

Once the plant ready to treat water from washing of olives, must be inoculated. This involves producing the amount of inoculum (biomass) enough to start the culture that will treat wash water. For inoculum production, was necessary to have a parallel installation of smaller volume, with capacity to supply industrial plant. It was decided to locate the plant production of inoculum in Granada, next to the BIOT Company facilities, where its operation and use certainly could be more efficient from an operational point of view for the BIOT staff.

Once the initial design performed by BIOT Company staff, it was proceeded to with land development for the installation of the plant, fixation of the structure and assembly works.

***Fig 5.** Works during installation and finished Inoculum Production Plant at BIOT facilities.*

The final configuration of the installed system can be seen in the figures 5 and 6. It has two benches of vertical methacrylate tubes, equal to those used in the facility at the olive mill. It has a degasser tank where the removal of dissolved oxygen accumulated during the photosynthetic process occurs,

with a water jacket connected to the heating system solar thermal to provide the optimum temperature for culture growth. The system further has a buffer tank for the harvested culture and a system for collecting biomass based on a filter bed with the ability to progressively concentrating harvesting, and finally sends it to a solar dryer designed by BIOT. The installation is completed with solar photovoltaic panels that provide energy to power artificial lighting based on LED technology. This lighting has been installed with the quantity and quality of light needed in terms of wavelength that has previously been studied in lab to identify those parts of the spectrum that shows higher performance on use of supplied light.

Fig 6. *Detail of Inoculum Production Plant during day and night, with illumination Led on.*

The facility has an automatic control and monitoring system to the main parameters involved in culture growth as pH, temperature, flow, pressure, CO_2 injection, dissolved oxygen and irradiance. This control is extends to the automatic injection of nutrients and culture medium and may be performed remotely via mobile devices.

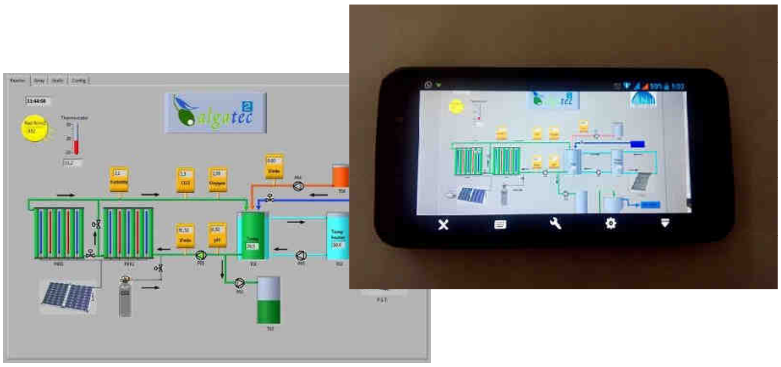

Fig 7. *Details of control system and monitoring screen in Smart-phone with remote control of inoculum production plant.*

As a result, the inoculums production plant is an ideal system for controlled culture need in the industrial plant production as well as an excellent tool to test possible improvements in the process that can be implemented in the industrial plant. Once produced the inoculum, this was moved up to the plant in Puente Genil to inoculate the system and begin testing in the facility of oil mill.

Testing the ability ALGATECII Purification System at the oil mill

Once obtained the necessary inoculum to feed the ALGATECII industrial plant, the trials to evaluate the performance of the biological system in debugging have been initiated when the campaign to collect olives started and there was wash water availability. To obtain results, an experimental strategy was designed and the debug phase with real wastewater from mill started.

During the assays, BIOT displaced its own personnel for analysis and monitoring "in-situ" the main parameters related to culture growth and debugging process. Besides, to have some reference on the quality of water obtained from the PBR system, it was decided to analysing those included in Spanish law with a discharge limit values, completing its analysis with the additional analysis with a reference laboratory. Therefore, were analysed the cell number evolution, optical density,

temperature, pH, phosphate and nitrate concentration, BOD, COD, fat and oils, phenolic compounds, suspended solids and colour.

Fig 8. *ALGATECII System during debug phase at oil mill in the campaign to collect olives.*

After the results obtained from these tests and analyses performed during the course of the campaign to collect olives, between the months of December to March, the ALGATECII system based on the developed microalgae-bacteria consortium, showed an excellent ability to debug on pollutants present in the olives wash water. Next conclusions drawn by the project team could be inferred:

- It has been found a decrease well above 90% and 85% of the BOD and COD respectively, of initial values, after one day.

-It has been found a rapid decrease in the concentrations of phosphate and nitrate, because of the metabolic activity of the consortium. However, these parameters are function of the composition of the wash water, and may be even necessary to supplement these nutrients externally. Therefore, we consider essential to have a system of monitoring of these nutrients to adapt the addition thereof to possible deficiencies that could compromise culture growth.

-It has been found that an effective decrease of suspended solids, fats and oils, and colour, occurs.

-It was found that the purification system reduce by more than 99% the concentration of phenolic compounds, primary toxic pollutant derived from this industrial activity.

As a general conclusion, for the tested capacities, PBR water outlet parameters after one day are into the discharge limit values for Spanish legislation in this field, and with drinking water quality after pass across membrane module.

All these results clearly demonstrate the potential of the purification system ALGATECII based on this consortium and its important pollutant treatment capacity.

Therefore, the ALGATECII photo-bioreactor ability to debug, coupled with membrane module activity, leads us to consider that have been achieved reasonable results to consider that technical objectives of the project has been reached, and therefore the success of the project.

Although test results have demonstrated the technical feasibility of the project, it must be also feasible from an economic point of view. Therefore was evaluated the total cost of ALGATECII system, to check if the implementation is a viable alternative. In this sense, and based for a suitable treatment plant to the needs of the oil mill chosen for testing, the cost (referred to prices in Spain) of treatment for the ALGATECII system is estimated between 2.40 €/m^3 of the most basic configuration which only includes the PBR system and 10.40 €/m^3 for the complete system, including the membrane module. This cost is competitive with around of 16 €/m^3 which is the cost of the traditional system.

This cost of treatment affects the price of the final product (olive oil) in amounts well below the euro cents. Specifically from 0.0048 to 0.0012 euros per liter of oil on the market depending on the system configuration chosen, referred to the Spanish market price.

Relocation of ALGATECII System

Once the olives collection campaign was finished, and therefore the phase of trials with ALGATECII system, and obtained the results that have been described, it was decided by the project partners, move the entire system to a better location. The new location allows to have the plant demonstrative as part of the dissemination activities and available for possible visits and events for its future operation and commercial exploitation.

The location chosen was CIDERTA, a Research Centre belonging to the University of Huelva, specializing in Algae Biotechnology, with an active group of researchers and companies involved in biotechnology of microalgae, international reference in this field of science.

Thus were initiated the works of dismantling and relocation of the plant from oil mill and was proceeded to complete installation of A ALGATECII system and all accessory elements in its new location in Huelva (south-west of Spain).

The ALGATECII system is now therefore fully demonstrative and has already received several visits from companies belonging to the olive sector, researchers, students, staff from different public administrations and regional government, and other groups with interest in the ALGATECII technology developed in the project.

***Fig 9**. Detail of Plant installed and fully operational in CIDERTA (University of Huelva).*

WP3: Membrane module optimisation and validation

The main result of ALGATEC project was a system able to efficiently treat olive washing water in order to be reused in the process. Technical performance complied with all project expectations but the economic analyses showed that still more efforts should be done in order to make it competitive. Therefore, during ALGATECII several improvements have been implemented to the membrane module.

- Transmembrane Pressure (TMP) control. Three possible options:
  - Replace manual by-pass for an Automatic By-pass controlled by a motorized valve and a pressure sensor
  - Install a security valve to release pressure in the permeate suction line at P>0.3 bar.
  - Install a variable speed pump with a frequency variator controlled by a pressure sensor
- Energetic optimization
  - Select motors (pumps and blower) with a performance curve adapted to its real working conditions.
  - Re-design the ultrafiltration tank in terms of geometry
  - Improve control system
- Hidraulical network improvement
  - Improvement of the piping network connection

Redesign ALGATEC system membrane module

The designed membrane module has two filtration steps: the first one through an ultrafiltration membrane (UF), and the second through a nanofiltration membrane (NF).

Re-design the geometry of the ultrafiltration tank was necessary in order to optimize the permeate process by reducing the permeate pressure. It was selected a membrane module which let the

system work at low pressures, resulting in a lower energy demanding process. The geometry of the tank where the membrane is submerged was designed to use the water column pressure into the tank to achieve a permeate process without the use of an electrical pump, being the tank taller than usual

The NF concept remains as it was but new hydraulic distribution has been included in the design to optimize the plant performance, therefore specific pipes with solvent socket accessories to eliminate the leaks in the network were implemented. It implies that the system performs at 100% reducing the energy waste in events of water leakages

Regarding the TMP control, BIOAZUL implemented the automatic by-pass option, comprised by a motorized valve controlled by a pressure sensor and transmitter, as this option is the most suitable one for such sensible membranes.

Then, the motors to be used were selected in order to optimize the energy consumption considering the real performance conditions. Different performance curves and technical specifications where compared in order to select the most suitable units. It must be considered that a motor working on its optimal performance range make the process more energetically efficient.

Furthermore, the control system was improved by the implementation of different possibilities to make the process more energetically efficient, as well as increase the performance of the Filtration Plant of ALGATEC II with respect of ALGATEC.

The main output of the work done during the redesigning was to produce a module easy to operate and maintain and with low energy demand to decrease also the operation and maintenance costs. The modifications proposed also include the re-organization of the module part that has led in a less area needed for the module.

The entire membrane filtration module was built into the warehouse of DESAM and later at the greenhouse (definitive location) being ready to work under normal conditions.

***Fig 10**. Detail of Plant installed at DESAM warehouse*

***Fig 9**. Detail of Plant installed and fully operational in the greenhouse*

Testing the ability ALGATECII Purification System at the oil mill

The membrane module has been working during the 2013-2014 campaign treating the effluent as it was provided by the PBR.

The quality of the final effluent required according to the project was the one for drinkable water in order to be reused in the washing step. The Spanish legal framework has been taken as the reference for the evaluation of the results. Therefore, the limits are those included in the Royal Decree 140/2003 of 7th of February, which establishes the health criteria for water quality for human consumption.

An external certified laboratory performed the analyses of the final effluent to verify its drinkable water quality. The analyses were performed according to the analytical methods stated in the legal framework. Only flavour has not been analysed for safety reason by the laboratory staff as this was in fact treated wastewater. Apart from the parameters requested in accordance to the RD 140/2003, also Total Suspended Solid (TSS), Biochemical Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD) have been analysed.

It can be concluded, that the drinkable water quality values were achieved according to current legislation in all cases but for those related to the nitrogen compounds such as nitrites and ammonia.

Two possible reasons have been identified as those causing these unexpected results. The first one is based on the nutrients that have been added in the PBR to maintain the right nutrients concentration for the optimum growth of the microorganisms. This has lead in an over concentration of these nitrogen compounds in the PBR effluent. As the membrane module has no treatment capacity, it is just a filtration unit, it has not been possible to degrade these compounds to the limits stated by the legislation, but it has reduced almost completely the TSS, BOD5, COD, and all the bacteria that are bigger than the size of the pore of the NF module.

Another possibility that could have lead in the final high concentration of the Nitrogen compounds could have been caused by the nitrate reduction in the storage tank due to the anoxic conditions created as the filtration has been done in batches and not continuously. Most of the nitrogen compounds have been turned into ammonia.

Reducing the amount of extra nutrients added and/or working in a continuous flow pattern will allow the effluent fully meeting drinking water standards and therefore be safely reusable in the washing process.

Another solution identified would be the installation of a denitrification tank working with the UF tank, converting the UF system into a Membrane Biological Reactor (MBR) with the capacity of Nitrogen removal.

The membrane unit of the ALGATEC II plant is the result of a conscientious work done during the design process, in order to obtain a compact unit able to cope with the needs of the olive mills as DESAM with regards to water reuse. The technical results obtained are in line with those expected in the project and only the Nitrogen compounds found at the final effluent prevent for using the water in the process. The cause of this anomaly has been identified and is easy to overcome without extra investment and/or O&M costs.

A high level technology to achieve a fully automated system has lead to a significantly reduction of the energy consumption and the manpower for O&M, making the system a cost-effective option for the olive industry in case their demand is focused on recycling the water in the process.

The reduction of the environmental impacts associated to better practices on the washing water management should be also taking into account for choosing a system as the ALGATECII one.

In case of a client demanding the complete ALGATECII system (including membrane module), the cost would be 10.40€/m^3 which seems to be cost is competitive compare to the 16 €/m^3 associated to the traditional system.

WP4: Business Plan and Market analyses

The activities carried out in WP4 aimed at map the olive industry, understanding Europe's leading markets in order to offer them ALGATECII innovative wastewater treatment technology and then fostering the technology in surrounding regions, especially in MENA (Middle East and North Africa) countries. In addition, a business plan was elaborated, designing ALGATECII business strategy to commercially introduce the system in the market.

Whereas the EU is the world leader in olive oil production, it entails a significant amount of drinking water consumed and highly pollutant liquid wastes generated, during the olive processing. Some of the data analyzed show that within Spain, Italy and Greece there are 8,349 olive mills which in 2010/2011 produced more than 2 million of olive oil (International Olive Council, 2013).

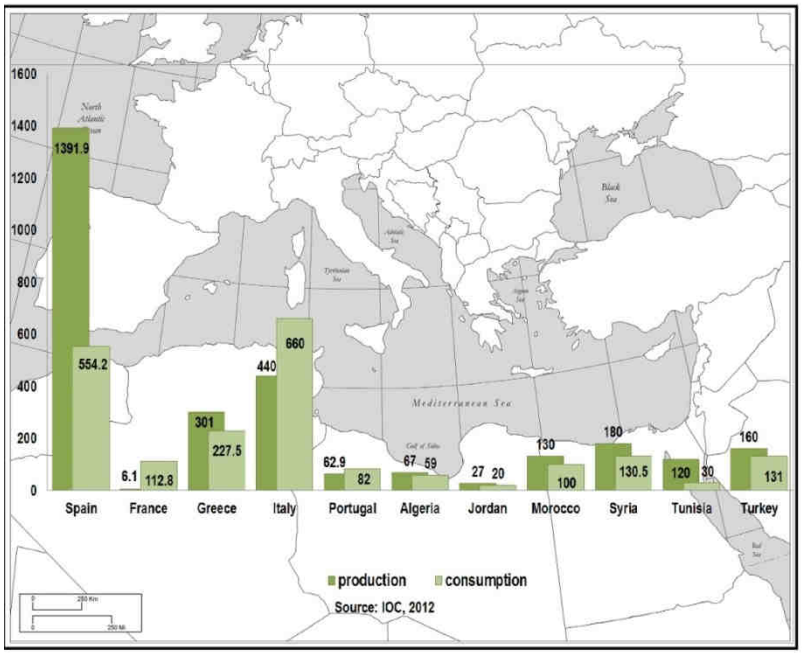

***Fig 10**. Olive oil production and consumption in Mediterranenan regions 2010/2011*

With an increased production of olive oil globally, consequently higher level of OMWW especially in water scarce countries, it is very important to undertake any measures for the optimisation of the recycling of olive mills washing. Furthermore, IOC (2012) data stating that 17 million tones of olives are harvested every year and with 90% of them being used to produce olive oil it would approximately be necessary to use 22.63 million tonnes (22.63 million m3) of washing water. Therefore it would result in a creation of 24.48 million tonnes (24.48 million m3) of wastewater.

***Table 2** - Amount of water used for washing and its associated costs*

YEAR	Amount of processed (washed) olives	Amount of washing water	Water cost €/m^3	Total water costs €
SPAIN				
2010	6,682,000	2,672,804	0,7	1,870,962
2011	7,820,000	3,128,024	0,7	2,189,616
ITALY				
2010	3,060,400	4,526,331.6	0.938	4,245,699
2011	3,133,700	4,634,742.3	0,999	4,630,107
GREECE				
2010	1,700,000	2,514,300	0,81	2,036,583
2011	1,793,500	2,652,586	0,83	2,201,646

Considering market trends, ALGATECII market analysis was carried out in the three target markets: Italy, Spain and Greece with an overview on the Northern Africa regions, identifying the most important problem the olive oil mills are facing with and in particular: 1) the enormous amount of drinkable water that is consumed in olive oil production process; 2) the mixing of washing water instead of its recycling; 3) the serious shortage of water the olive oil producing Mediterranean countries are facing with.

The olive and oil industry was analyzed paying attention to the olive washing process and its environmental health issues, focusing on washing water ponds, odour, bugs, human health and environmental risks. Due to the problems related to the whole wastewater treatment, a focus on the water market issue was done. An overview of the European legislation is included, focusing in particular on the Water Framework Directive 2000/60/EC, the Groundwater Directive 2006/118/EC, the Nitrate Directive 91/676/EEC, the Urban Wastewater Treatment Directive 91/271/EEC.

In order to better understand the needs of the market, its size and problems companies faced with ALGATECII consortium did a survey among Italian, Spanish and Greek SME's. The questionnaire has been used by the consortium to find potential clients interested in ALGATEC II system.

All data were collected predominately form the International Olive Council website which is the most reliable source of information, also other data was collected from the official publications from independent researchers as well as official European Union publications. For each country competitors and potential customers were studied.

To introduce ALGATECII system on the market, a Business plan was developed fixing ALGATECII business goals and marketing strategies, defining medium and long term objectives to be achieved two years after the project completion on the basis of a clear identification of the resources available within the consortium. The Business Plan provides a quantitative assessment of pricing, namely cost advantages to the consortium SME members, with a view to extend the technology and related services to the neighboring regions. The Business Plan identifies: the operational costs, type of personnel needed to carry out such operations, models of agreement with third parties, management of intellectual property and rules for licensing. ALGATECII commercialization strategy has been included in the Business Plan, considering costs, benefit and potential sales partners.

It was demonstrated that ALGATEC II has three product/streams services: 1) Olive mill cooperatives; 2) Large individual olive mills; 3) Joint partnership between small olive mills.

ALGATEC II is quite a unique system available on the market with such techniques to for treating specifically washing water, even though this accounts for the 90% of the water consumed during the olive oil production. However, the competition exists between innovative solutions and common OMWW disposal and the inherent positive and negative effects of these differing formulas on the environment.

ALGATEC II has three main distinctive features:

- Customization
- Appeal
- Assistance

Furthermore the use of such a system will assure: 1) greater financial results thanks to less water demand; 2) increasing reporting legislation; 3) high pressure from local community; 4) positive environmental impacts.

ALGATEC II competitive advantages can be summarized as follow:

- Affordability: The saving on the water costs
- High quality: The high quality of the potable water obtained from the system
- Speed: Customers start reusing the water within two days of the start of the recycling
- Support of the team: An onsite team will training customers and provide with a local support

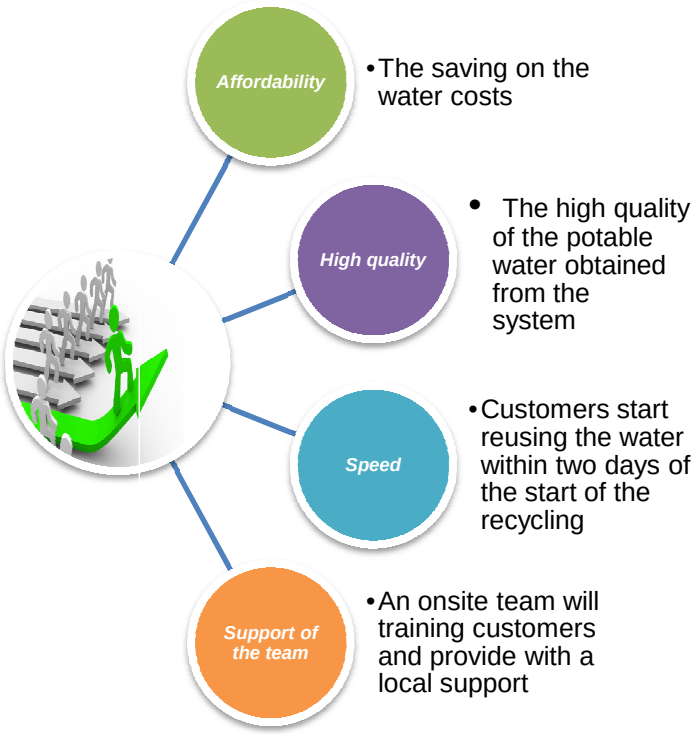

***Fig 11**. ALGATEC II competitive advantages*

All these elements represent ALGATEC II plus compared with similar systems available on the market. Due to the high selling price, two sales strategies were identified:

1. One time purchase
2. Subscription fee

***Fig 12**. ALGATEC II sales strategies*

It was estimated that the use of ALGATEC II technology, assuming that a medium mill will process 5.000 tons of olive per campaign, consuming a volume of 500 m^3 of drinkable water in the olives washing process, producing 1.089.324,62 liters of olive oil in a campaign lasting 100 days per year is able to obtain savings in the volume of water used for washing olives up to a 90%, according to the project trial plant results. Furthermore the use of ALGATEC II system the mill will save is equal to € 2.202,48 per year.

In addition to the three DEMO work packages, two more were foreseen devoted to management activities and exploitation and dissemination activities. Both had run during the whole project duration and their main objectives are listed below:

WP1: Project Management. Leaded by the project coordinator BIOAZUL, it was designed to secure an efficient running of the project, the management activities have been divided into two tasks:

- Task 6.1: General financial and administrative coordination, leaded by BIOAZUL, whose main tasks foreseen were:
  - To report and liaise with REA being the communication point between the project and REA.
  - To prepare the Consortium Agreement, signed by all partners and submit it to REA.
  - To prepare the Grant Agreement, collect all Forms A from project partners and submit it to the Commission for final signing.
  - To organise and/or support with the organisation of the project meeting and prepare project meetings.
  - To receive the payments and distribute the EC contribution among project partners.
  - To prepare project amendments to the Grant Agreement.
  - To submit all deliverables of the period to the EC.
  - To arrange the preparation of the two Periodic Reports, the progress reports and final report with project partners contributions.
  - To compile all the financial statements from the partners for the EC.
  - To develop the Quality assurance and its updates
  - To follow up the implementation of the Project Management Board's decisions.
  - To ensure the smooth running of the project activities in accordance to the Annex I.
- Task 6.2: IPR, exploitation and dissemination management leaded by BIOT. The main tasks carried out have been:
  - Revision of relevant IPR issues affecting the project results to preserve the interest of the SME partners.
  - Reviewing all publication and dissemination material related to the project in order to avoid conflicts with regards to IPR.
  - Compilation of information about the final interest of the SMEs partners in the project results and its exploitation.
  - Developing of the Plan for using and disseminating the foreground with the collaboration of all partners.
  - Checking the progress of the IPR issues, in close cooperation with the project coordinator.

WP5: Dissemination and exploitation of the project results. Leaded by BIOAZUL, it was designed to disseminate the project results for its later commercialization and exploitation. The work was divided into four tasks and main outcomes have been:

- 5.1 Creation of the project website leaded by BIOAZUL.
  - Website launched in April 2013, www.algatec2.eu , in English, Italian and Spanish, and updated during the whole project life Revision of relevant IPR issues affecting the project results to preserve the interest of the SME partners.
- 5.2 Training and dissemination activities leaded by ENCO.
  - Creation of a project logo.
  - Training of the SMEs participant on the ALGATECII system
  - ALGATECII manual composed by one section on the PBR and another on the membrane module available in English, Italian and Spanish.

- Creation of the ALGATECII database, including almost 350 entries from which the expert group was appointed.
- Meeting with expert group.
- Three ALGATECII workshops targeted to relevant stakeholders, two in Spain and one in Italy
- Demonstration days for potential clients.

- 5.3 Development of material for project dissemination leaded by ENCO.
  - Project flyer and project poster in English, Italian and Spanish.
  - ALGATECII CD-rom compiling all relevant information generated in the project.
  - Project promotional video in English and Spanish.
- 5.4 Further dissemination activities leaded by ENCO.
  - Project activites and outcomes widely disseminated in media, websites, electronic newspapers, regional TV programmes, etc.
  - Euronews video available in 13 languages.
  - Project presented in relevant events.

1.4 Potential impact

In recent years a growing concern has been expressed throughout the EU regarding water scarcity and droughts, especially in Southern Europe where this scarcity already leads to severe conflicts between different water users having direct impact on citizens and economic sectors which use and depend on water, like agriculture. It was estimated that by 2007, at least 11 % of Europe's population and 17 % of its territory had been affected by water scarcity, putting the cost of droughts in Europe over the past thirty years at EUR 100 billion.

Unfortunately, due to climate change and subsequent environmental problems, this trend is expected to continue. Spain, Italy and Greece, main olive oil producers, are specially affected by water scarcity and droughts, so water-saving technologies will strongly contribute to mitigate the economic and environmental consequences of climate change in rural areas.

The EU is actively developing legislation which affects among others the olive oil sector, to control water sources and water management and which encourage the wastewater reuse strategies. For instance, the **Urban Wastewater Treatment Directive** (91/271EEC) states in its Article 12 that "*wastewater shall be reused whenever appropriate*" under the requirement of "minimising the adverse effect on the environment" in the light of the objective of first article of the same directive which is clearly defined as the protection of the environment from the adverse effects of wastewater discharges. Likewise, the **Water Framework Directive (WFD)** (Directive 2000/60) includes the reuse water between the measures that can be included in the program of measures to be applied in each river basin to meet the objectives set out in Article 4 of the Directive. In this sense, the WFD refers under Annex VI to "emission controls" and under Annex VI to "*efficiency and reuse measures, inter alia, promotion of water efficient technologies in industry and water saving techniques for irrigation*". Nitrogen and phosphorus concentrations are being specially watched in wastewater from agriculture because of their influence on the oxygen balance of water, as they are the main cause of eutrophication.

WW is a highly pollutant residue due to its polyphenols content (which inhibits bacterial degradation and are also citotoxic) and oil content (which forms a film on water surface, hindering oxygen dissolution and thus preventing aquatic life). Therefore, the use for irrigation is limited or even forbidden, as its involves damages in the groundwater and soil biodiversity.

As previously mentioned in this report, main expected technical result of the ALGATECII project was to develop an eco-innovative affordable system for reducing the consumption of drinkable water in the olives washing process by 90 %, which produces drinkable water quality that could be re-use in the production process for olives washing.

The ALGATEC system implementation would therefore, decrease the ecological footprint of the olive mills activity by increasing the water efficiency, allowing the reduction on the consumption of fresh water (reusing the treated WW), and diminishing the volume of their highly polluted effluents.

Substantial benefits to the environment are foreseen with the implementation of the ALGATEC II solution, such as:

(1) The reduction on water, soil and groundwater contamination;

(2) Reduction of the carbon footprint of producing companies; less waste generated and positive impact on climate change due to the capture of CO2 of the atmosphere by the microorganism growing in the PBR for the proper function of this technology; As committed in the Kyoto-Protocol it should be part of all national and regional economic strategies to reduce the CO2 emissions to lower the greenhouse effect. ALGATEC II enables a safe and high efficient WW treatment with a system that captures CO2 from the atmosphere and can be a part of a local concept to fulfil global objectives.

(3) Reduction of water consumption of producing companies and thus stress relief of this resource;

(4) Generation of better water quality for reuse purposes, therefore an undisputable advantage for the population's life quality;

(5) An innovate treating water option instead of the use of evaporating ponds which raises complaints due to the unpleasant odours and the presence of stagnant water that increases insect populations, accidental leakage of WW to soil and pond overflow.

The ALGATECII project directly addresses some of the objectives pointed out in the thematic priorities of the 7th EC Environment Action Programme as:

1. to protect, conserve and enhance the Union's **natural capital**: *The Union has made commitments to halt biodiversity loss and achieve good status for Europe's waters and marine environment. Moreover, it has put in place the means to achieve this, with legally-binding commitments including the Water Framework Directive,…*
2. to turn the Union into a **resource-efficient**, green, and competitive low-carbon **economy:** *There is a special focus on turning waste into a resource, with more prevention, re-use and recycling, and phasing out wasteful and damaging practices like landfilling. Water stress is increasingly affecting more parts of Europe – not least because of climate change – and the need for further action towards more efficient use of water is highlighted.*

Due to the likely toughening of environmental legislation in the near future, many of the currently operating wastewater treatment systems will no longer be acceptable, and will have to significantly increase their efficiency. Upcoming changes are lain down in the Directive 2000/60/EC (Water Framework Directive) and other regulations for especially sensitive areas and areas of abstraction of drinking water (as described in Drinking Water Directive 98/83/EC). In addition to chemical or organic pollutants, the presence of microbial pathogens is strictly controlled when it comes to bathing or drinking water (76/160/EEC, 91/692/EEC, 98/83/EC).

With regards to soil protection, the EC adopted a Soil Thematic Strategy (COM(2006)231) and a proposal for a Soil Framework Directive (COM(2006)232) in 2006 with the main objective of protection European soils.

The problem of meeting existing and forecasted more stringent new regulations affects especially small communities and industries in rural areas and without access to centralised wastewater treatment plants.

Therefore, solutions as the proposed ALGATECII system are in line with the current need of increasing the sustainability of European agricultural sectors, especially with regards to a very valuable and scarce resource "WATER" in the main producing countries. ALGATECII development significantly contributes to solve the above mentioned problems by offering a highly efficient, low maintenance system for the treatment of WW, allowing its reuse in the process, applicable in olive oil producing areas all over Europe.

The environmental benefits associated to the decrease of the ecological footprint, were expected to have also economical advantages for the olive mills, mainly SMEs, reducing the costs associated to the fresh water consumption, and the management costs linked to the wastewater generated.

The 5 SME partners will benefit from their participation in the project and will have considerable advantages compared to the other companies of the sectors. Their participation will increase SMEs competitiveness, for the producing, the market expert and for the technology provider SMEs. The specific benefits for the individual companies are:

- The three SME providers of technology BIOAZUL, BIOT and ISITEC will gain a leading position in the market as the developers of this innovatove solution ALGATEC II, increasing the product portfolio for a market that is especially important in Andalusia and other countries leaders in olive oil production, and opening new market opportunities and gaining sales in a market that is demanding new solutions under the current legislative framework. BIOT has the exclusivity rights as inocula being the provider of it for each ALGATECII system sold as well as the PBR, BIOAZUL the membrane module, while ISITEC of the control panel.
- DESAM as the end user has benefited of the knowledge gained during the project development and of those related to have the pilot plant installed at their facilities: economic

saves, reduction the carbon footprint, lower water consumption and the prestige of having an innovative cleaning technology.

- ENCO: as a Market Analyser SME in the field wastewater treatment has benefited of the experience gained in the olive oil marlet and is expected to be used by ENCO as a high-added value, and projected in all future projects and activities. Other benefits are related to the partnership building, which means that for every new partner or stakeholder there is a new business opportunity to be taken advantage of, both at EU level and internationally. Overall, it is expected that ENCO increases its competitiveness in mid/long-term.

Due to olive oil well-known health benefits, the production of olive oil is continuously growing and therefore the amount of WW needed to be treated. In the context of this international growing market, the further development proposed of the ALGATEC II system leads to an innovative and truly economic solution for olive oil mills to treat and reuse WW in olive oil production. Besides being economically efficient, due to the relative low investment and maintenance costs, the system will contribute to avoid negative environmental impacts of using the WW for olive irrigation avoiding ground water pollution and soil damage.

There is a huge opportunity in this market because there is a new growing need that has currently no/inefficient solutions. Olive oil producers are increasingly taking their water management seriously due to financial, reputational and legislative pressures as previously mentioned.

The participants of this project estimate that there is a market potential of more than 12,000 olive mills in the EU27 which urgently demand a new eco-friendly, low-cost WW treatment technology. Including the demand for low-cost and easy to maintain solutions in the developing countries (such as the new emerging producing countries Turkey, Tunisia and Syria) the numbers will increase significantly.

As the market exist the arguments for an improved competitiveness of SME proposers can be summarised as follows:

- the innovative and competitive ALGATEC II system allows the participating SMEs to enter the fast growing market for washing water treatment and reuse, ·
- the ALGATEC II system demonstrates a clear step beyond the state-of-the-art with the advantage of a self-regulated, low-cost modular system that enables efficient and environmentally friendly treatment of WW,
- during the pilot plant tests the SMEs gain practical experiences and knowledge about the performance of the system under real conditions.

In addition, the end-users which are mainly SMEs, will benefit from an increased efficiency in drinkable water consumption as well as in wastewater treatment and reuse, reducing production costs and therefore increasing their competitiveness, mainly due to the reduction of 90% of drinkable water used to wash the olives will be recycled.

ALGATEC II has a European approach with the participation of three EU countries (Italy, Germany and Spain). The main problem addressed by the project (the purification of WW from oil mills) has a European dimension taking into account that the main producing countries are located in Europe (Spain, Italy and Greece) and cannot be tackled separately by each involved country or specific sector, or by each individual participant. The results will be showed from a global perspective to an international market.

The European market is the first target market with more than **8,000** olive mills only in Spain, Italy and Greece which in 2010/2011 produced more than 2 million of olive oil (IOC, 2013). With a predictions of increased production of olive oil globally, consequently higher level of WW especially in water scarce countries, it is very important to undertake any measures for the optimisation of the recycling of olive mills washing water. In 2010/11 the world production of olive oil was approximately 3.08 million metric tons, Mediterranean countries accounted for almost 97.4% of this production.

The ALGATECII system main target customers are the medium sized mill cooperatives and large olive mills due to the huge amount of washing water processed. The objective is therefore to increase the ALGATECII's market presence in the Spanish, Italian and Greek (or Mediterranean market) olive oil mill industry as a pioneer in olive washing water treatment.

The competitive edges of the developed system are based on its affordability, high quality of the treated water, speed allowing start reusing the water within two days of the start of the recycling, and the post sale technical support.

The most promising sales strategy is the direct sale of the system, which will include basic assistance.

The estimations of sales for the next two years are of 9 units of medium capacity (500m3). With these sales, the break-even point (revenue = costs) would be reached in the first year.

During the project, it has been demonstrated that ALGATECII system has been efficient in removing the pollution load of olive mill washing water and producing water of drinking quality, that could be re-used within an olive mill. Therefore, the technical objectives have been achieved as foreseen.

On the other hand, with regards to the affordability of the system, it could be concluded that, based on costs analyses performed, the ALGATECII system treatment costs range between 10.40 €/m^3 for the complete system, including the membrane module, to 2.40 €/m^3 of the most basic configuration which only includes the PBR system (recommended for locations with milder weather during the campaign, that needs discharge water quality outlet but not drinking water quality outlet). This cost is competitive with around 16 €/m^3 which is the cost of the traditional system.

The cost of treatment affects the price of the product (liter of olive oil) in amounts well below the euro cents. Specifically from 0.0048 to 0.0012 euros per liter of oil on the market depending on the system configuration chosen. (Costs referred to the Spanish market price).

Another important aspect to take into consideration when evaluating the impact of the ALGATECII results are the problems associated to the most common method used by the olive mills for treating their WW: the evaporation ponds. It use has raised several complaints by inhabitants due to the unpleasant odours and the presence of stagnant water that increases insect populations, especially in tourist areas, which represent a significant part of the olive growing zone in the Mediterranean. Therefore, local governmental authorities are looking for alternative methods for reducing these problems.

Moreover, the EU Directives, such as the IPPC, are more and more strict on the allowed management routes of such wastes, and the no implementation of them will be followed by quite high fines.

Last but not least, the price of potable water is expected to be higher in the future, especially in the most important producing countries such as Spain, Italy and Greece where: a) actual prices are relatively low compared to other EU countries, and b) better management of water should be implemented due to the more common problems with water shortage and droughts.

As a consequence of all mentioned arguments, the consortium believes that the competitive results obtained during the ALGATECII project have an opportunity in this attractive market and in very short term the ALGATECII technology will be considered as a alternative solution for the reuse of WW in the food industry.