Symbiotic bio-Energy Port Integration with Cities by 2020

# D4.1 An action plan for the sites (Astakos port)

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**Table of content**

# 1. Introduction

The report focuses the Astakos port region and is targeting the direct bioenergy symbiosis approach.

The direct bioenergy symbiosis approach consists in the establishment of efficient local supply chains of locally generated bioenergy resources (such as e.g. excess biogas or waste biomass) among existing industries within a geographic area. In other words, the "direct" development of industrial symbiosis is focusing on existing opportunities and existing businesses, i.e. one's locally generated excess bioenergy or biowaste is considered the other's resource. In order to stimulate development, it is important to focus on the establishment of low cost, high benefit utility sharing projects and ''simple'' exchanges with economic value added. The boundaries for direct bioenergy symbiosis are limited to the port site and the surrounding areas (municipality).

According to Annex I of the EPIC2020 project, a major activity for project partner AKARPORT is to stimulate the development of such type of symbiosis at the port site of Astakos through a series of actions. The achievements of AKARPORT towards this goal are presented in the present report, which constitutes Deliverable D4.1 "An action plan for the sites" of the EPIC2020 project. The report consists of the following sections:

- An overview of the study regarding the biomass potential in the Astakos port area, undertaken by AKARPORT's subcontractor Clean Energy in the framework of WP3 activities
- A presentation of the "incubator for local bioenergy symbiosis", which consists of a series of innovation workshops targeted for identified actors from the site network created in WP2. The structure of the incubator, list of members and meetings are described.
- A description of the main specific plans for bioenergy exchanges identified through the incubator actions, including their main economic, technical and business aspects, along with a SWOT analysis for each initiative.
- A final section on future steps to be pursued beyond the duration of the EPIC2020 project.

# 2. Assessment of biomass potential in the Astakos port area

As a first step for the establishment of bioenergy symbiosis collaborations in the area of the Astakos port, it was considered necessary to have an estimation of the biomass potential / availability in the wider port area. This assessment was performed in the framework of a study by Clean Energy Ltd, which was subcontractor to AKARPORT S.A. for the EPIC2020 project.

The study investigated different biomass resources that can be used mostly either directly as fuels (solid biofuels) or as substrates for biogas production. The area in focus was the NUTS3 administrative division of Etoloakarnania, one of the three regional units of the Region of Western Greece (NUTS 2 administrative unit). Etoloakarnania (population: 210,802, surface area: 5,447 $km^2$) is the area where the Astakos port site is located and to which its activities are mostly linked. The major cities are Agrinio (largest city and economic centre) and Mesologgi (historic capital). The reason for focusing on the wider Etoloakarnania area instead of the smaller area around the Astakos port is that the latter has very small population (11,737 inhabitants in the municipality of Astakos) and consequently, reduced potential to mobilize biomass resources.

A short summary of the key findings of the study per resource type is presented below.

**Wood biomass from forest and agriculture**

The region was found to have very small amounts of forest wood production used for domestic heating purposes (about 6,200 $m^3$). There is a small potential of forest residues that can be considered (~ 2,200 t), but it is unlikely that it will be the focus of bioenergy development, since this resource has not been exploited in Greece even in areas with higher potential.

It has been estimated that there is a potential of about 38,000 dry tons of prunings from tree plantations, the majority of it coming from olive trees. The potential is significant; however there are significant difficulties in mobilizing this type of resource: lack of specialized mechanized equipment, requires active farmer involvement and coordination between many different primary biomass producers. The quality of the woody biomass from prunings is also lower than those of wood pellets used in domestic heating applications. The possibility of exploitation was discussed during the incubator workshops but it did not attract interest from the participating stakeholders.

**Agricultural residues**

About 22,000 dry tons of agricultural residues are estimated to be available in Etoloakarnania, mostly residues from maize (7,500 ha) and cotton (1,850 ha). Again, these resources are hard to mobilize without considerable involvement of the farmers. Additionally, for the specific resources available in the region, the high moisture content during collection makes their management and utilization more problematic compared to “drier” agricultural residues, such as straw. Moreover, these types of biomass are unsuitable for domestic heating applications and cannot therefore be considered as an option for the developing heating market in Greece.

**Wastes from the livestock sector (manure and other by-products)**

The livestock sector is a major economic activity in Etoloakarnania. However, for purposes of mobilization of manure and other by-products the main issue is that most of animals are raised in open-herds, within practically minimal potential to collect and use manure. The most promising sub-sector is that of pig farming, which features 24 modern, organized units. Combined, the manure from these farms could produce 2,481,494 $Nm^3$ of biogas, corresponding to an installed capacity of 612

kWe. Slaughterhouses and aquaculture units are also present in the area; however the residues they produce on their own could hardly justify “stand-alone” biogas units.

**Residues from agro-industrial activities**

Etoloakarnania hosts some agro-industrial units that produce biomass resources that are of interest for further exploitation. The main advantage of agro-industrial residues is that they are a resource produced in a specific location, so there is no issue of organizing dedicated harvesting activities for their collection.

Probably the most important agro-industrial resource is the area is olive kernel, a by-product of olive olive production. Olive oil is produced in more than 70 mills scattered around the area, however the processing of the solid olive mill waste takes place in a centralized secondary olive oil production plant near the city of Mesologgi. After processing, it is estimated that around 3,200 t of olive kernel are available for the market, mostly used in domestic heating or small-scale industrial heating applications. However, an additional quantity of 2,400 tons per year could be provided on the market if olive kernel self-consumption for drying was minimized by the utilization of alternative heat sources. Rice husk is also produced by a rice processing company, but is utilized for self consumption. An additional resource that can be considered as a substrate for biogas production is cheese whey; around 20,000 tons are produced annual, about half of the amount coming from a single company (Delfi S.A.). Due to its acidity, the co-digestion with manure is suggested.

**Municipal solid waste**

Municipal solid waste (MSW) is probably the single most significant resource in the area, constituting a total of around 140,000 t. The organic fraction of this resource constitutes around 47% of the produced quantity.

Currently, most of the MSW produced in Etoloakarnania is going to landfills. However, Greek legislation foresees the implementation of source separation and the treatment of different MSW fractions in order to minimize the waste going to landfill. Within this framework, the utilization of the organic fraction of MSW for biogas production is a very attractive option for the area of Etoloakarnania. In theory, if all the organic content of the MSW was led to an anaerobic digestor, it could lead to the production of 6.9 million $Nm^3$ of biogas per year.

Overall, the most promising biomass resources for a symbiosis approach based on biomass appear to be the organic fraction of MSW, the agro-industrial residues and the waste from the larger animal farms. All these residues are produced in specific points; the current legal framework requires some specific treatment steps and it is far easier to monitor the adherence to these requirements. For agricultural residues, the legal push is not so strict and open-field burning or soil incorporation are still acceptable disposal methods. Additionally, the organization of supply chains with a significant size would require the cooperation of a far larger number of stakeholders than in other cases; as a result, the organizational issues would be far greater.

# 3. Incubator for local bioenergy symbiosis

A major aim for WP4 is the formation of an "incubator for local bioenergy symbiosis", which was to be formed from network members identified in WP2. The activities of AKARPORT related to the formation of the incubator are as follows: 1) Creating the incubator from the network, i.e. invitations, screening of potential members, communication; 2) Arrange and hold a number of innovation workshops; 3) Create and disseminate the action plan forward to create business agreements.

Based on the interactions between regional stakeholders and potential incubator members and feedback collected from WP2 activities, the following structure outline was decided by AKARPORT for the incubator:

- The incubator should have, at least in this stage, an informal status, e.g. no charter, binding or non-binding documents for participation, etc. It was considered that any administrative burden would be a hindrance to participation in the incubator in the initial phase.

- The incubator workshops would be organized as parallel activities to the networking activities of WP2. This would allow easy integration of potential new members, as well as minimize project related costs.

- Bilateral communications, including skype and telephone calls, would be an important aspect of communication between AKARPORT and incubator members.

- Technical concepts for the bioenergy symbiosis approach would be formulated out of the results of Clean Energy's study and verified / elaborated with incubator members. Incubator members were free to raise any additional issues, such as new idea or preliminary concepts for a project that could be the basis of further symbiotic relationships.

- AKARPORT would organize the meetings of the incubator network members (physical or otherwise), set dates, send invitations, summarize the main findings, etc.

Even during the initial phases of WP2 (D2.1, Site-specific network plans), a list of interesting stakeholders with interest in participation in the incubator network was presented. Additional members were identified during subsequent events, while some candidates did not participate in the end, due to several external reasons. The following table summarizes the main stakeholders that have been initially identified, as well as later additions. The table records the main reason for considering a stakeholder for the incubator, a qualitative assessment of their level of interest in its activities as well as other comments of relevance.

Table 1: Summary of major incubator members in the Astakos area

| Incubator member | Reason for inclusion | Comments |
|---|---|---|
| AKARPORT | EPIC2020 partner. Operator of port site and industrial area of Astakos port | AKARPORT acted as the initiator and coordinator of the incubator network. |
| Agrino | Biggest rice producer in Greece. Utilizes the rice husk residue for heat production. Has plans to develop a CHP boiler to replace the current heat production. | The CHP plant would be located in the site of its production facility. The company has not expressed an interest to relocate to the Astakos harbour area. |
| Amalthia | Production and export of olives. Produces olive kernels as residues, which can be used as fuel source. | Amalthia was initially reconsidering relocating to the port site; currently, the management does not appear to take steps towards this direction. |
| NIREUS | One of the leading aquaculture companies in Greece. Produces small amounts of biogenic wastes; interest in alternative sources of heat. | Nireas is already present in the port site with a production unit. |
| Delfi | Operates a cheese production unit. Currently pays external company to collect its cheese whey residue, which is used for biogas production. Is interested in developing a biogas unit locally. | Delfi is considered as a key actor for one of the two major bioenergy conversion plans identified for the area. |
| Municipality of Agrinio | Largest municipality in the Etoloakarnania area. Responsible for their waste management plan, which affects the waste management plan for the whole region. | The Municipality of Agrinio is considered as a key actor for one of the two major bioenergy conversion plans identified for the area. |
| Municipality of Mesologgi | Historic capital of Etoloakarnania, major city and waste producer. | The city of Mesologgi has a port, interest to consider synergies between AKARPORT and the port authorities. |
| Pig farms | Livestock is a major economic activity in Etoloakarnania. Pig farms are the most modern of the animal farms and produce pig slurry, which can be considered as substrate for biogas production. | Participating through the Association of pig farmers. Large number of units, difficult to organize. |
| Olix Oil | Edible olive oil production and treatment of olive oil by-products | Olix Oil has expressed interest to relocate to the port site. |

| Incubator member | Reason for inclusion | Comments |
|---|---|---|
| Slaughterhouses Agrinio / Ayfantis | Produces slaughterhouse residues, some of which can be treated via anaerobic digestion | Quantity of residues not significant to start a new unit on their own but can provide material for further treatment. |
| Independent consultant | Expert knowledge of the area and contacts with primary sector | Not considering as key actor for implementation of new projects but could facilitate contacts between companies |

As can be seen from the table above, the incubator consisted of several different companies, mostly focusing on the agro-food sector. The participation and cooperation of public authorities was ensured through the Municipality of Agrinio, the major city in the area.

The stakeholders active in the incubator were of equal importance for the formulation of bioenergy symbiosis approach. Roughly, the stakeholders can be divided into **three main groups**:

- **The bioenergy symbiosis "champions"**; these are the Municipality of Agrinio (from the public sector) and Delfi S.A. (from the private sector). Both have very real problems to solve, e.g. the handling of the municipal solid waste and the disposal of the cheese whey residues respectively. In both cases, the final disposal of the waste represents a cost either for the citizens of the municipality or the company operation. The major distinction between those actors and other stakeholders is that both produce on their own significant quantities of residues/wastes; on the other hand this means that the costs of disposal are significant, both relatively and in absolute amounts, on the other hand it means that they can start considering alternative means for their utilization on their own.

- **The bioenergy symbiosis "adherents"**; these are companies that have an interest in the concept (as can be verified by their participation in the incubator workshops), can participate in a symbiosis exchange but for various reasons cannot be a "champion". The most common cause for this is that they produce wastes, which can be a cost, but their quantity is not significant to start considering on their own alternatives for utilization. The slaughterhouses and NIREUS are typical examples of this group. Other actors, such as the pig farmers, employ some disposal methods which generate no added value but which incur little additional costs. Another case of adherents is companies that could benefit from one of the final bioenergy carriers produced from a bioenergy unit; in most cases, this means that the "adherent" would be interested in utilizing the heat produced from a biomass/biogas CHP plant. There are some limitations in this approach, e.g. either the CHP unit would have to be built close to the adherent or the adherent would have to relocate near the CHP unit. The adherents in the case of Astakos are interesting in supporting an emerging initiative if an opportunity presents itself, but in most cases have not expressed an interest to start one on their own.

- **The bioenergy symbiosis "observers"**; these are stakeholders that have an interest in the concept (as is verified by their participation in the incubator) but it was not possible to identify a bioenergy symbiosis concept in which they could participate at this point or the pooling of resources with other stakeholders would not make sense. A company belonging in this group is Agrino. Agrino it is interested in developing a small scale CHP biomass boiler using its own residues (rice husk). However it was found that the scaling up of the CHP boiler

using additional residues from third sources as input would not have an economic advantage for the company.

It is also worth mentioning two cases that have been identified in early stages of the project but did not express an interest to participate in the incubator network:

- Knauf, a company operating a drywall (gypsum board) production unit to the north of Astakos port as well as a gypsum mine. It was considered as a potential heat end-user for the drying of its products. The company was approached but did not join the incubator; a possible reason is the expected relocation of its production site to another area of Greece (Volos).

- The local olive kernel mill, operated by ELSAP S.A. The company handles the residues from local olive mills and produces olive kernel, which is already used as local fuel for heating. The company has a large self-consumption of olive kernel for the drying of its product and could be interested in alternatives fuel sources. However, an initial assessment of the cost of the drying alternatives suggested that any alternative heat source would have to be very cheaply priced. There are limited options to ensure this and for this reason, the company so little added value in joining the incubator. A discussion on this issue is presented later in the report.

In the Annex to this report, detailed information on the dates, participation and discussion topics / major conclusions for each incubator workshop are presented.

# 4. General framework for bioenergy symbiosis in the Astakos port area

Based on the results of the biomass potential study, the expert knowledge of AKARPORT on local conditions and in-depth discussions with the members of the incubator network, a SWOT table regarding the direct bioenergy symbiosis concept in the Astakos port area was drafted.

Table 2: SWOT analysis of direct bioenergy symbiosis in Etoloakarnania

| **Strengths** | **Weaknesses** |
|---|---|
| • Significant amounts of local biomass resources<br>• Only industrial area in Greece located near a port<br>• Strong livestock and food production sector | • Fragmentation of agricultural holdings makes it difficult to mobilize effectively agricultural biomass<br>• Open herds make difficult the collection of manure from animal husbandry<br>• Small-size of enterprises producing biomass resources<br>• Road infrastructure currently inadequate<br>• Geographical distribution of waste producing residue companies |
| **Opportunities** | **Threats** |
| • Increased energy costs and taxation of fossil fuels increase interest in lower cost alternatives, such as bioenergy<br>• Financial support mechanism for electricity production from biomass / waste<br>• New legal framework for MSW handling provides opportunities for promoting utilization of biogenic content<br>• New Western Greece highway under construction with direct connection to the port of Astakos<br>• New municipality development plan promotes the establishment of an entrepreneurial park close to the port area | • Financial crisis and political instability affect investments<br>• Financial support mechanism for bioenergy subject to changes by the government<br>• Negative public perception against thermal processes due to perceived environmental danger from emissions |

Most of the weaknesses and strengths identified are common for all areas of Greece and have affected the development of bioenergy investments in other locations. Other than those though, the Astakos port area has few significantly specific weaknesses; the main one, regarding road connection to the nearby cities will be soon upgraded with the construction of a new highway. The development of bioenergy symbiosis concepts should therefore take advantage of the opportunities, the most important being the financial support mechanism for bioenergy production and the new framework

for MSW treatment, as well as take advantage of a major local strength, e.g. the presence of an industrial area within the port area.

A major item for discussion for the incubator was the decision on the potential bioenergy commodities to produce, the location of production units and, finally, the most suitable technology option. The following points summarize the main conclusions of the discussions.

- The most mature end-product for such projects should be **electricity**. The main reason is that the produced electricity can be sold to the grid for a very attractive feed-in tariff, at least given the current legal framework. Alternative or complementary end-products are discussed below:

    - **Heat**: combined heat and power production (CHP) is highly desirable, since it increases the profitability of an investment and – to a certain extend – mitigates the dependency on feed-in tariffs. Heat-only production in medium/large scale units can be economically profitable (indeed, it is already applied by some companies, e.g. Agrino) but the development of new applications would be limited by the short heating period in Greece or the lack of large-industrial heat consumers.

    - **Solid biofuels**: the market in Greece has taken off in the recent years. Demand is met mostly by three types of fuels: firewood, wood pellets and olive stones. Local production is bounded and is already utilized to a certain extend. The use of other biomass sources would result in lower quality fuels, not suitable for the domestic heating market and would require significant effort in mobilization, without being sure that they could compete with the low-cost olive stones that are already available in the area.

    - **Bio-methane**: the natural gas grid has not yet reached the area, so the upgrading of any biogas produced to bio-methane is not considered as a suitable option.

    - **Liquid biofuels**: might be an option for farmers to grow crops suitable for biodiesel production. Not discussed in depth, since it was not of much interest to companies participating in the incubator.

- Based on the above, **the optimal location for a combined CHP plant would be the industrial area of the Astakos port.** The reasons are the following:

    - The construction of such units in the industrial area would simplify the licensing procedure, which can take up a lot of time.

    - The heat production of a CHP unit could be supplied to a micro-heating grid in the industrial area. The port heating consumption itself is fairly small, so a large amount of excess heat would be available to companies that would consider relocating within the industrial area. This heat would be competitively priced (e.g. at half the price of heating oil on an energy basis), so this would be an incentive for more companies to relocate.

    - The relocation of companies in the Astakos port area can trigger in the future further bioenergy (or other) exchanges between the companies.

- **Anaerobic digestion** seems to be the most suitable technology option for the conversion of the available bio-resources to electricity (and heat). The main reasons are the following:

- Anaerobic digestion is a state-of-the-art technology for the treatment of the high-moisture, biodegradable fractions such as those available in the area.

- Although the main design of an anaerobic digestion unit would be based on a certain amount of important waste streams, companies that produce smaller amounts of biodegradable wastes could benefit from the presence of an anaerobic digester.

- **Thermal processes** (e.g. combustion) is investigated as an option for some bioenergy concepts, but it was found that the symbiosis potential is not great (see below), at least for the time being.

# 5. Specific plans for bioenergy exchanges

A major achievement of the incubator of the Astakos port was the formulation of concepts for two major bioenergy conversion units: a “public” symbiosis hub, based on the organic fraction of the MSW and a “private” hub, based on the utilization of cheese whey and pig slurry. A case of a company that could benefit from the heat production of these two units has also been identified within the port area. Although of a much smaller scale than the other concepts, AKARPORT itself realized the cost savings that could be achieved by switching from its current heating oil boiler to biomass. Finally, the case of a CHP unit of Agrino was discussed and analyzed, although it was not possible to identify any symbiosis opportunity for this project at the current stage.

The following sections present the main technical and economic features of each identified case, the environmental benefits as well as the main barriers to implementation that have been identified by the consortium.

## 5.1 The MSW treatment plant

As discussed, an initial assessment of the biomass potential in the Etoloakarnania area, suggested that municipal solid waste (MSW) where the most important local resource in terms of quantity. About 47% of this resource is biogenic.

During initial discussions with the incubator members, particularly with the Municipality of Agrinio, the major city in the area and major producer of MSW, the incineration option was discussed as a possibility for energetic utilization. In this scenario, the MSW are are source separated in blue bins (for recyclable materials) and green bins (rest) which are handled by MRF (Material Recycling Facilities) and MBT (Mechanical-Biological Treatment) facilities respectively. After recovery of useful recyclable materials, the remaining quantity of around 20% of the initial total MSW streams can be used as RDF (refuse-derived-fuel) for production of electricity. The results of an initial assessment by Clean Energy syggested that it was possible to be an RDF incineration plant with 3.5 MWe installed capacity burning 27,945 t of fuel per year.

This plan had some significant drawbacks; first it considered that all the quantity of the MSW would be handled by the source separation system, which is hard to do immediately. This would affect the dimensioning of such a unit and would result in higher specific investment costs. Secondly, the combustion of RDF (or MSW in general) is not a process that is well liked by the general public in Greece; it was expected that the implementation of such a solution would raise strong opposition from the public and NGOs and would be more difficult to be accepted by the municipal council. Finally, and most importantly, the legislation affecting MSW in Greece changed during the course of EPIC2020 and separate source separation of organic materials became mandatory.

Instead of being a hindrance, this was considered as an opportunity to further collaborate with the Agrinio municipality and assist in the development of a new concept, respecting the new requirements for the legislation. The main feedstock considered for this type of conversion would be the organic fraction of the MSW.

The current planning of the Municipality of Agrinio foresees that, in order to reach the National target for the separate collection of organic MSW, around 36,000 t/y would have to be collected from new, brown bins and from waste collected in green bins and treated in a MBT facility. The majority of this amount (20,000 t/y) would come from the city of Agrinio and other municipalities in the 2$^{nd}$ administrative division for waste management of Etoloakarnakia. The remaining quantities would come from municipalities in the 1$^{st}$, 3$^{rd}$ and 4$^{th}$ administrative divisions for waste management of Etoloakarnania.

For the treatment of this organic fraction with high solid contents, dry anaerobic digestion would be the optimal technology option for conversion of this resource to bioenergy. There are good examples of its application in other locations in Europe and there is limited need for additional water input.

The following table summarizes the main features of this technology option based on a technical and economic analysis performed by Clean Energy.

**Table 3: Overview of organic fraction of MSW biogas CHP plant**

| | | |
|---|---|---|
| **Feedstock streams** | 36,000 t/y of organic faction of MSW | 20,0000 t/y from Agrinio and nearby municipalities 16,000 from other municipalities in the Etoloakarnania area |
| **Biogas production** | 3,765,420 $Nm^3/y$ | 65% methane content |
| **Efficiency** | 33% (electrical)<br>50% (thermal) | |
| **Operating hours** | 7,000 | |
| **Unit capacity** | 1.2 MWe<br>1.7 MWth | |
| **Investment cost** | ~ 12 m€ | According to the ”Implemetation guide for source separation schemes and handling systems for biowastes”[1] |
| **Electricity production** | 8,053 MWh | Feed-in tariff of 114 €/MWh |
| **Heat production** | 12,201 MWh | Considered to be sold for 50 €/MWh |
| **Stabilized compost production** | 11,664 t/y | High quality compost produced after screening of resource; estimated to be sold for around 10 €/t |
| **Rejects for disposal** | 7,776 t/y | Going to landfill; cost of disposal from 35 €/t (2016) rising to 60 €/t (2021) |
| **Payback time** | 21.1 years | Assuming electricity & compost sales and rejects for disposal costs (at 60 €/t) |
| **$CO_2$ savings** | 9,252 t from electricity production<br>3,258 t from heat utilization | Calculated using typical emission factors for alternatives in Greece: 1.149 $tCO_2/MWh$ for electricity and 0.267 |

[1] Available here: http://www.ypeka.gr/LinkClick.aspx?fileticket=s4cpXe0WeIc%3D&tabid=367&language=el-GR

| | | |
|---|---|---|
| | | $tCO_2$/MWh for diesel |

A main feature of the investigated concept is that the end result does not incur any additional costs to the citizens of the municipality; disposal costs for the rejects are more than covered by the electricity sales. Some additional revenue can be generated by the production of high quality compost, which is integrated in the dry digestion plant. The payback time can be further decreased if heat sales are considered; it drops to 17.4 years if 20% of the heat is sold and to 10.2 years if 100% of the produced heat is utilized.

Although the proposed concept can be profitable and result in the reduction of the waste handling costs, there are some barriers to its implementation. First, the investment cost is quite high (higher than other alternatives which do not consider energetic utilization of waste); therefore, the investment might have to be realized as a public-private partnership and not as a public partnership as was the municipality's intention. Secondly, the feed-in tariff regime is subject to changes in Greece which might affect the overall profitability of the investment. Thirdly, the payback time is quite long. Finally, some NGOs push for the composting of waste without energetic utilization.

The final barrier mentioned was further investigated within the incubator. According to an study by an external contractor of the Municipality of Agrinio, a centralized composting plant could be constructed for the treatment of the organic fraction of MSW. The plant would result in the production of 8,300 t/y of high quality compost (from brown bins), 10,700 t/y of lower quality compost (from material separated from green bins) and 2,500 t/y of rejects for landfilling. Assuming that the high quality and low quality compost can be sold for 10 and 5 €/t respectively and that the rejects to landfilling cost 60 €/t, then the operation of the composting unit generates a loss of 13,500 € per year. The construction and operating costs for the centralized composting plant have not been considered. It is clear that this option is not actually cost neutral to the citizens of the municipality.

## 5.2 The cheese whey / pig slurry anaerobic digestion unit

The second major conversion option identified for the Astakos port area is an anaerobic digestion unit for the co-treatment of cheese whey and pig slurry. The main instigator of this unit is the company Delfi S.A., an important local cheese producer.

Cheese whey is a by-product of the cheese production process with a high organic load; because of this, it cannot be disposed of directly in the environment. Delfi is currently paying to dispose its cheese whey production; the material ends up in a biogas plant in another area of Greece, where it is used as feedstock. The economic benefit of the energetic utilization of cheese whey is therefore quite evident for Delfi; it is the transformation of the residue from a cost to a potential revenue source (through the generation of electricity). Delfi estimates that it can mobilize around 30,000 t per year of cheese whey, both from its own production as well as from smaller cheese units present in the area.

Technical sources suggest that, due to its acidity, cheese whey is best digested along with manure. The best source of manure in the area of Astakos is the local pig farms, which are fairly large, organized units. At least three such farms (around 1,600 sows in total) located near the port of Astakos (location: Rigani Ksiromerou) were identified by the Assosiation of Pig Farmers during discussions at the incubator.

Due to the high moisture content of the feedstocks employed, the wet anaerobic digestion was considered as the optimal technology option for the material. It is a different technology from the dry anaerobic digestion considered for the organic fraction of MSW, which explains why the two systems cannot be merged in a common initiative.

The proposed biogas unit could also receive minor feedstock quantities from other sources; for example, the Aifantis slaughterhouses located in Agrinio could supply around 370 t/y of residues (mostly blood and fat); their contribution to the biogas production would be minimal but the main advantage is the treatment they would receive before disposal. Some of these materials might require pasteurization before they enter the digester through.

If additional make-up water is required for the operation of this unit, then this can be supplied by the current aerobic treatment unit of the port of Astakos; this unit is already processing waste water from the nearby city.

An additional reason for disentangling the two proposed biogas systems is the difference in their procedures for implementation; the "public" unit would have to go through a longer period of consultation with local stakeholders, has a much higher investment cost and requires the implementation of the source separation during waste collection. Therefore, the time frame for the realization of this investment is longer. On the other hand, the unit proposed by Delfi can be realized fairly quickly, once the proper licences are issued.

The following table summarizes the main technical and economic features of the proposed investment, based on an analysis by Clean Energy (AKARPORT's subcontractor). The case here assumes that the feedstock material would be supplied for free by the producers.

**Table 4: Overview of cheese whey / pig slurry biogas CHP plant**

| | | |
|---|---|---|
| **Feedstock streams** | 30,000 t/y cheese whey<br>52,800 m3/y (pig slurry)<br>Others (e.g. slaughterhouse residues ) in smaller amounts | |
| **Biogas production** | ~ 1,040,000 $Nm^3$/y | 540,000 $Nm^3$ from cheese whey, rest from pig slurry, methane content ~ 60% |
| **Efficiency** | 33% (electrical)<br>50% (thermal) | |
| **Operating hours** | 7,000 | |
| **Unit capacity** | 293 kWe<br>444 kWth | |
| **Investment cost** | ~ 1 – 1.3 m€ | Around 3,700 – 4,500 €/kWe |
| **Electricity production** | 2,053 MWh | Feed-in tariff of 230 €/MWh (if no public subsidy for investment) or 209 €/MWh (if public subsidies are used) |
| **Heat production** | 3,111 | Considered to be sold for 50 €/MWh |
| **Payback time** | 2.8 years | Assuming the highest feed-in tariff and only electricity sales |
| **$CO_2$ savings** | 2,359 t from electricity production<br>831 t from heat utilization | Calculated using typical emission factors for alternatives in Greece: 1.149 $tCO_2$/MWh for electricity and 0.267 $tCO_2$/MWh for diesel |

Based on the analysis above it is clear that the unit can be profitable in a fairly short time (about 3 years) considering only the electricity sales. This can be reduced even further if heat sales are considered (2.1 years for the sale of all the heat).

As discussed, the investment can be realized fairly quickly once the licensing phase is finished. The main barriers to implementation are the financing, which can be an issue, as well as changes in the feed-in tariff scheme by the government. The latter is a major risk if they take place before the unit signs a supply contractor with the grid operator and may affect the profitability of the investment.

## 5.3 The case of heat utilization from biogas CHP plants

The identification of potential end-users for the heat produced by any biogas CHP plant is a very interesting issue.

An option that was discussed within the incubator was the construction of a new district heating system and its connection to the biogas CHP unit(s). Some significant issues have been identified with this approach:

- Greece in general has a shorter heating period and lower heat demands compared to Northern European countries. The heat produced for the CHP system would only be used for a short period of time (estimated to be between 1,500 – 2,000 hours) for the case of Etoloakarnania.

- The closest municipality to the port, the city of Astakos is located at a distance of about 10 km, which is not inhibitory for the construction of a DH system; however, an investment of 400 – 1,000 €/m (4 – 10 m€) is required for the heat distribution network alone.

- For a city with the number of inhabitants of Astakos, it is estimated that a unit in size of 6 -7 MWth would be required to cover the heat demand during the operating season of the DH system; this exceeds the thermal capacity of the units calculated previously.

Industrial end-users present more advantages in the case of heat utilization, since the demand can be spread throughout the year. Additionally, in the case they are concentrated in a small geographical area, as can be the industrial area of the Astakos port, the cost for the construction of a small-scale heat distribution system is greatly reduced.

One such potential heat user identified within EPIC2020 is the company NIREUS, which is one of the most important aquaculture companies in Greece and has a production site within the Astakos port. The company consumes about 500 tons of diesel per year for the heating of fish tanks used for breeding. The current cost for this fuel is 0.8 €/t and it has a typical density of 0.84 kg/l. The current fuel costs are estimated to be in the range of 475,800 €/y.

Assuming that the company switches to heat supplied by a local DH network connected to one or two of the aforementioned biogas heating plants and that the heat is priced at 50 €/MWh, then calculations indicate that the heating cost would drop to 167,200 EUR/y, or a saving 64.9%. Additionally, the fuel switch would result in $CO_2$ savings of 1,577 tons per year. The heat consumption of the NIREUS facility would be in the range of 48% of the total heat production of the MSW anaerobic digestion unit.

There are no significant internal barriers for the realization of this option; the main point is that its implementation is connected to the construction of one or both of the biogas CHP plants mentioned above.

An additional case was considered regarding the potential benefits of relocating the olive kernel mill within the Astakos port site. The olive kernel mill produces about 5,600 tons of olive kernel per year; however, 43% of this amount is used for self-consumption (drying of incoming material and steam production for extraction of kernel oil). Assuming that the fuel is combusted with an efficiency of 80% and that it can reach a market price of 100 €/t, the "cost" of the thermal energy used internally is around 36 €/MWh. This is lower than the target price of 50 €/MWh for the heat supplied by the local heat distribution system. Therefore, it is was clear to the incubator that this option was not viable, at least with the current prices of the olive kernels.

## 5.4 The AKARPORT heating boiler

An example of a simple bioenergy symbiosis approach is the case of the heating boiler at the AKARPORT facilities. It is a simple, commercial system currently combusting about 14,000 litters of heating oil per heating season. The costs for the company are in the range of 11,200 € per year with the current heating oil prices (0.8 €/l).

Biomass heating in Greece used to be a niche market until 2011 – 2012; until that time, there was a ban on the use of biomass in large urban centres, while the heating oil price was mostly quite low and unburdened by taxes. The situation changed when both those two framework conditions changed at about the same time; the lifting of the ban on biomass heating and the increase of taxation for heating oil. Several domestic, as well as industrial consumers changed their heating fuel to biomass since that time.

For AKARPORT, the ban on biomass use was not in effect; however at the time when the boiler was installed, the Greek biomass market was quite undeveloped. Additionally, the use of heating oil was the main practice for heating and comes with low requirements for maintenance and cleaning of the boiler.

Within the EPIC2020 and during the investigation of AKARPORT's own consumption and needs, it was found that it could be possible to change the heating system for the use of biomass. The investment cost for the purchase and installation of a biomass heating boiler is quite low (estimated in the range of 10,000 € for the case of AKARPORT). Regarding fuel, the use of olive kernels (stones) is suggested. They are a well known fuel to Greek manufacturers of biomass boilers and have a very competitive price (~ 80 €/t). It is estimated that AKARPORT would require about 30 tons of this fuel per heating season of this fuel, with a cost of about 2,400 €. The cost savings realized by the fuel switch are significant and would result in a payback time of less than two years. Additionally, the fuel switch would result in the savings of about 37 tons of $CO_2$ per year.

The ideal source of olive stones would be Olix Oil, an olive processing company that intends to relocate in the port area in the future. This would also minimize any delivery costs. Alternatively, there are other potential suppliers in the area, such as the company Amalthea or the local olive kernel mill.

There are no major barriers to the implementation of this option and AKARPORT intends to perform a boiler switch before the next heating season.

## 5.5 The Agrino CHP boiler

Agrino is a company located in the city of Agrinio; it is one of the most important rice producers in Greece. The company is producing rice husk as a by-product (around 2,400 t/y according to their own calculations) and is already utilizing it on-site for the cooking of rice, e.g. for heat production.

In the incubator workshops, the company expressed its interest to construct a CHP unit firing rice husk; the heat would still be used for the cooking of rice, while the electricity production would be sold to the grid for a feed-in tariff.

An assessment of the options for the CHP construction was performed by Clean Energy (AKARPORT's subcontractor) along with the feedback from Agrino. Based on the typical fuel properties of rice husk and keeping the thermal production constant, the capacity of the CHP unit was found to be around 220 kWe; due to the very small size, the Organic Rankike Cycle (ORC) technology was proposed[2]. The option of increasing the capacity of the unit by combusting additional solid biofuels found in the local area was explored; the goal to decrease the specific investment costs and ideally decrease the pay-back time. Olive stones were considered as the most suitable option given their low prices and the presence of potential suppliers (Amalthea, Olix Oil) within the incubator. A comparison between the two options is presented in the Table below.

**Table 5: Comparison of sizing option for the Agrinio CHP boiler**

| | **Only rice husk** | **Rice husk + Olive kernel** |
|---|---|---|
| **Capacity (kWe)** | 223 | 536 |
| **Specific investment (€/kWe)** | 10,200 | 7,900 |
| **Efficiency, electrical** | 18% | |
| **Efficiency, thermal** | 70% | |
| **Operating hours** | 7,000 | |
| **Fuel input (t)** | Rice husk: 2,400<br>Olive kernel: - | Rice husk: 2,400<br>Olive kernel: 3,000 (100 €/t) |
| **Feed-in tariff (€/MWh)** | 198 | |
| **Investment costs (€)** | 2,273,143 | 4,232,143 |
| **Fuel costs (€)** | - | 300,000 |
| **Electricity sales (€)** | 308,880 | 742,500 |
| **Payback time (years)** | 7.4 | 10 |

Essentially, the use of an additional fuel, beyond what the company already has available for "free", results in a larger increase in the fuel costs compared with the cost savings achieved by increasing the capacity of the unit. The situation is the same even if the unit size increased to 1.8 MWe and the investment cost dropped to 4,500 EUR/kWe.

The low electrical efficiency of the ORC technology is a major reason why this was observed; however, there are practically no other viable technology options at this unit capacity.

[2] Technical information about the ORC technology was found in the following link from a major manufacturer: http://www.turboden.eu/en/public/downloads/09A06400_paper_orc_turboden_clotilde.pdf

The analysis above illustrates the fact that Agrino does not appear to be currently an important hub for further development of symbiosis approaches. The CHP boiler it is pursuing is economically viable; however, the payback time of 7.4 years might be considered a bit risky given the current economic climate in Greece.

# 6. Future steps and actions beyond EPIC2020

The identification of two major potential bioenergy symbiosis projects in the AKARPORT site has been a major outcome of the EPIC2020 project. Although the AKARPORT itself is not a major contributor to the biomass input for these projects or a significant consumer or bio-electricity or bio-heat, the further development of these projects and their location to the industrial area of the port provides significant advantages for AKARPORT and a good incentive for industrial companies to relocate within the port area. For these reasons, AKARPORT intends to further pursue the development of these concepts, even beyond the project duration.

Regarding the "public" bioenergy symbiosis hub (the unit for the anaerobic digestion of the organic fraction of MSW) AKARPORT is planning follow-up meetings with local and regional authorities. The purpose is to include the anaerobic digestion CHP plant in the final, regional planning for the treatment of the MSW, by highlighting its economic advantages over the composting alternative. The importance of the sitting of the unit within the industrial area of the AKARPORT will also be highlighted to the regional authorities, due to its potential for contribution to regional development and the attraction of investors. Additionally, AKARPORT will utilize contacts developed within the WP2 activities to identify sources of funding for the project and potential technology suppliers.

An additional point that is of interest for the public authorities is the participation in the Covenant of Mayors initiative (http://www.covenantofmayors.eu). Signatory cities pledge action to support implementation of the EU 40% greenhouse gas-reduction target by 2030 and the adoption of a joint approach to tackling mitigation and adaptation to climate change. Participation in the Covenant is a good way for a municipality to realize its bioenergy potential and to implement concrete actions for their mobilization. During the EPIC2020 duration, no municipality in Etoloakarnania joined the Covenant; however, the Municipality of Agrinio joined the Covenant on the 7$^{th}$ of March, 2016. The formulation and submission of an action plan is the next step to be taken in this process. AKARPORT intends to support the municipality in the drafting of this plan, using the valuable local experience gained within the EPIC2020 project.

Regarding the "private" bioenergy symbiosis hub (the unit for the anaerobic digestion of the cheese by-products and pig farm residues), AKARPORT is also planning meetings with the major company initiating this concept. Support for the selection of a technology provider through the contacts developed within the EPIC2020 project, as well as possibilities for funding will be jointly pursued.

Finally, AKARPORT intends to pursue options for keeping the incubator active and expanding its membership. Some of the activities, such as the skype meetings, can be realized with practical zero additional cost for the members, other than the time expenditure. The technical support of an experienced contractor was found to be critical for the development of new concepts and procedures; for this reason, further collaboration opportunities within the framework of European or National research and collaboration projects will be pursued.

The involvement of actors from the primary sector, mostly farmers, is a major target to be pursued in the future, since – other than the MSW – these are the most significant producers of biomass in the area. Connections through collaboration with farmers associations and cooperatives should be further pursued within the project. An example that has been raised by the Astakos network member, CERTH (Centre for Research and Technology Hellas) is the participation in the demonstration actions of the new, Horizon2020 funded project, uP_running. The aim of this project is the mobilization of prunings and uprooting wood biomass from permanent tree crops. The area of Etoloakarnania was found to have significant amounts of this residues (38,000 dry tons from prunings), which can be utilized in local applications. The connection of primary sector producers

(mobilized through uP_running) and final end-users such as municipalities (motivated to turn to biomass heating through the Covenant of Mayors) can be an interesting goal for the area as a whole. A new pellet production plant using these residues could be built on the industrial area of the port and – ideally – use heat for drying from an anaerobic digestion CHP unit. This would further increase the level of integration between the companies and promote further bioenergy exchanges.

# Annex: Incubator workshops

1st Incubator Workshop (kick-off)

The kick-off meeting for the Incubator was held on 22/12/2014, at the Agrinio city (the biggest city in the Etoloakarnania area), with 20 participants (4 from the public sector and 16 from the private). It also served as the kick-off meeting for the local network for the Astakos port (WP2).

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| Western Greece Regional Authority | Consultant | Regional Authority |
| Pig farming and piggeries Association | President | Agricultural Association |
| LEGHORN HELLAS | President | Poultry farm |
| Messologgi Municipality | Vice Mayor | Municipal authority |
| Independent consultant (agronomist) | Self | Technical advisor to agricultural cooperatives / Tomato producer |
| FLAKAS S.A. | Managing Director | Slaughterhouse/Pig farming unit |
| AGRINO S.A. | Quality control Director | Rice producer company |
| NIREUS S.A. | Technical Director | Aquaculture company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| Independent consultant (mechanical engineer) | Self | Energy consultant |
| Xiromero Municipality | Mayor | Municipal authority (closest city to Astakos port) |
| MELIADIS S.A. | Owner | Olive and oil processing company |
| IRIDA S.A. | Quality control engineer | Fish and animal feed company |
| DELFI S.A. | Operations Manager | Dairy milk products producer company |
| Independent consultant (Environmental Engineer) | Self | Consultancy services (environment) |

| | | |
|---|---|---|
| Agrinio Municipality | General Secretary | Municipal authority |
| OLIXOIL | Managing Director | Olive and oil processing company |
| Agrinio Recycling Association | President | Recycling Association Agrinio |
| KARVELAS S.A. | Owner | Cereals and animal feed company |

Topics discussed:

- Presentation of the subject industrial symbiosis as a starting point for biomass /bioenergy potential bioresources exchanges
- The identification and selection of the most appropriate set of actors to work with
- Building trust issues
- Ways to map actors based on their
  - ✓ Activities
  - ✓ Knowledge
  - ✓ Values
  - ✓ Motives
  - ✓ Experiences over time
  - ✓ Networks

Major conclusions:

- Willingness to participate in the incubator was expressed by several participants, both from the public and private sector (from 10 entities).
- Industrial Symbiosis is an entirely new concept in Greece and almost all participants had little to no knowledge of it.
- The willing members promised to provide data for their own operations e.g. waste/residues production and energy needs.
- Some cost data may be helpful in order to support potential bio-waste exchanges.
- Need to build trust among potential incubator members was identified as a key issue.
- The presence of public servants was considered as an accelerator factor of confidence building.
- It was decided all subsequent physical meetings of the incubator would be held in Agrinio, which is a central meeting place in all Etoloakarnania area.

2nd Incubator Workshop

It was held on 19/3/2015 via Skype. It is to be noted that the skype meetings were chosen as a mean to cut down project costs and also as the best way (next to physical presence) to bring together private entrepreneurs and public servants. There were 7 participants, 5 from private and 2 from public, the following:

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| AIFANTIS | Veterinarian | Slaughterhouse |
| Independent consultant (agronomist) | Self | Technical advisor to agricultural cooperatives / Tomato producer |
| KARVELAS S.A. | Owner | Cereals and animal feed company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| MELIADIS S.A. | Owner | Olive and oil processing company |
| DELFI S.A. | Operations Manager | Dairy milk products producer company |
| Agrinio Municipality | General Secretary | Agrinio City Municipality |

Topics discussed:

- Better understanding of IS concept
- Capabilities in terms of resources exchanges
- Explore the issue of working together
- Identification of best courses of action for the incubator development
- Degree of involvement of each entity
- Internal and external communication channels

Major conclusions:

- Trust between the private companies and the public entities is crucial for the incubator development
- The presence of public entities was helpful to private companies in strengthening the confidence among the different actors.

- The newly elected first time Left Government is about to change the existing environmental Law, increasing this way the ambiguities as regards the new Waste Management framework to be implemented by the Regional Authorities.

3rd Incubator Workshop

It was held on 23/6/2015 via Skype. There were 6 participants, 4 from private and 2 from public sector, the following:

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| Messologgi Municipality | Vice Mayor | Municipal authority |
| Consultancy services (agronomist) | Self | Technical advisor to agricultural cooperatives-Tomatoes producer |
| KARVELAS S.A. | Owner | Cereals and animal feed company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| DELFI S.A. | Operations Manager | Dairy milk products producer company |
| Agrinio Municipality | General Secretary of Agrinio Municipality | Municipal authority |

Topics discussed:

- Clarification of the new Waste Management legislation regime
- Available technologies for the wastes exploitation
- Possible financing solutions regarding the potential bio-waste exchanges
- Permitting licenses issues

Major conclusions:

- The new Waste Management legislation is likely to delay the public entities initiatives regarding their Waste Management Plans (municipalities) from proceeding into potential PPP (Public Private Partnerships). The reason is that a lot of Law clarifications are needed.
- The logistics cost is crucial in evaluating possible bio-waste exchanges among the incubator members. The reason is that potential members are small family enterprises located far from each other with small waste content

- The concentration of the small enterprises would help IS bio-waste exchanges.
- The industrial area of port of Astakos is the ideal location to accept MSW industrial units.

4th Incubator Workshop

A series of Skype calls were held on 23/6/2015, 3/7/2015 and 29/7/2015. There were 5 private sector participants, and 1 from public, as follows:

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| Consultancy services (agronomist) | Self | Technical advisor to agricultural cooperatives-Tomatoes producer |
| KARVELAS S.A. | Owner | Cereals and animal feed company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| DELFI S.A. | Chemical Engineer-Operations Manager | Dairy milk products producer company |
| Agrinio Municipality | General Secretary | Municipal Authority |
| OLIXOIL | Managing Director | Olive and oil processing company |

Topics discussed:

- Possible ways to incorporate the new legislation framework as regards the management of Urban Waste.
- Natural mapping of the local resource flows (identified in WP3) and business interactions to enable the incubator development.

Major conclusions:

- It was decided to evaluate a potential biogas CHP unit from the digestible organic fraction of MSW waste
- Possible financing scenarios were elaborated

5th Incubator Workshops

A series of Skype calls were held on 6/10/2015 and 3/11/2015 via Skype. There were 6 participants, one public and 5 private companies.

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| Consultancy services (agronomist) | Self | Technical advisor to agricultural cooperatives-Tomatoes producer |
| KARVELAS S.A. | Owner | Cereals and animal feed company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| DELFI S.A. | Operations Manager | Dairy milk products producer company |
| AGRINO S.A. | Quality control Director | Rice producer company |
| MELIADIS S.A. | Owner | Olive and oil processing company |

Topics discussed:

- Appropriate courses of action to be followed for the incubator advancement
- Legislative interventions to be submitted in the Regional Authorities
- Potential bio-waste exchanges evaluation scenarios

Major conclusions:

- Strengthening of confidence among incubator members has produced tangible results in the form of disseminating real internal waste production data, valuable for the evaluation of bio-waste possible exchanges
- Successful collaboration to reach goals agreed by non-profit and profit companies is the natural outcome of the incubator development process
- Competences and training needs were identified

6th Incubator Workshop (final)

The final workshop of the incubator was held as a physical meeting on 21/12/2015 in Agrinio city with 8 participants, 7 private and 1 public, as follows:

| Stakeholder name | Representative | Type of organization |
|---|---|---|
| Consultancy services (agronomist) | Agronomist | Technical advisor to agricultural cooperatives-Tomatoes producer |
| KARVELAS S.A. | Owner | Cereals and animal feed company |
| AMALTHIA S.A. | Vice-President | Olive packaging company |
| DELFI S.A. | Operations Manager | Dairy milk products producer company |
| MELIADIS S.A. | Owner | Olive and oil processing company |
| NIREUS S.A. | Technical Director | Aquaculture |
| Agrinio Municipality | General Secretary | Municipal authority |
| AGRINO S.A. | Chemical Engineer | Rice producer company |

Topics discussed:

- Presentation of a Waste Management Plan elaborated by Clean Energy (subcontractor) for the Aetoloakarnania District
- Presentation of alternative waste management scenarios (by Clean Energy)
- Further actions to be taken for the sustainable development of the Incubator, after the project end.

Final Conclusions:

- The IS fundamentals, its benefits and implications and the underlying success factors were clearly understood and incorporated in the private companies Business Plans but also in the 5 year Strategic Development Plan of the Municipality of Agrinio.
- The biomass / bioenergy evaluation study (conducted by Clean Energy, the Akarport's subcontractor) has shown that there is sufficient biomass potential in the Aetoloakarnania district, mostly from the agricultural and animal husbandry sectors that can be used in an IS Incubator Action Plan.
- The establishment of an MSW treatment unit at the port of Astakos industrial area produces tangible benefits both for the Aetoloakarnania district and for the port in itself.
- The initial observed lack of confidence among the incubator members was diminished in the course of the incubator workshops, mainly due to the participation of public authorities.
- Potential bio-waste / bio-energy exchanges were identified.
- An Action Plan has been elaborated in order to safeguard the incubator development.

- The participation and cooperation in the incubator of both private and public entities was successful and ensured through the Municipality of Agrinio, while the collaboration with the nearby port of Mesologgi, established near the end of the EPIC 2020, will contribute significantly for maintaining a dynamic incubator network after project duration.