EPIC

Symbiotic bio-Energy Port Integration with Cities by 2020

Contract no. : IEE/12/807/SI2.645929

# Deliverable D3.2: "*Digital maps to illustrate and visualize links, published on the project web page*"

**Due date:** M16

**Actual submission date: September 24th, 2015**

**Project start date:** April1st, 2013 **Duration:** 36 months

**Work package concerned:** 3

**Concerned work package leader:** Prof. Antonis Kokossis

**Dissemination level:** Public

**Names and affiliations of the authors:**
A. Kokosis, S. Bikos, G. Lignos (NTUA)

# Table of Contents



## A. Executive Summary

The purpose of this Deliverable is to visualise information from previously carried out bioenergy potential assessments (e.g. Deliverable 3.1), in order to stimulate and promote the efficient use of available bio-resources (see Technical Annex 1 of the Project Description). The objective is to integrate bioenergy and biomass flows exchanges, existing and proposed, into one geographic representation, preserving and expanding the bioenergy networks presented in D3.1. Deliverable 3.2 is a computer-based *Platform* comprising two different tools: the GIS Tool and the Mindmaps Tool. The platform serves as a dissemination set of tools for stakeholders, by allowing them to calculate the bio-energy potential of an area on a map and to provide a knowledge map connecting several bio-energy technologies with the available biomass types for each port. Both address bioenergy networks in the same four ports: Astakos (GR), Malmö (SE), Mantova (IT) and Wismar (DE).

The Geographic Information System (GIS) Tool utilises data from a variety of sources, organised in several layers. Information has been mustered from earlier projects related to local bioenergy potential; databases on existing enterprises, land uses and related information held by Municipalities; the European / International project "CORINE Land Cover[1]" on pictorial representation of land uses; inter-industrial connections coming from D3.1; post-D3.1 data contributed by the port-partners. Data have been brought to a uniform appearance and way of handling. The Platform has been designed to host content, which can only be altered by the Platform administrator, thus it is not characterised as "dynamic" and "real time", but rather "static" . Users can collect actual data from the Platform to help them decide on new investment in their geographical area of interest. A transportation costs application is also included, but it is not integrated with the map. Users can change the parameters: means of transportation, distance, tonnage of goods and type of container. The application then returns results such as: transportation cost, transportation time and GHG output.

The Mindmaps Tool depicts the possible connections between functional units (biomass producers, bioenergy consumers, biomass-to-bioenergy transformation processes) and flows of material and energy. The underpinning information comes from port-specific ontologies, in which functional units and flows have been organised in classes and are connected through

[1] http://www.eea.europa.eu/publications/COR0-landcover

object properties which were named “has_input” and “has_output”. Representation of parts of so classified information gives rise to distinct facets of each port’s Mindmap. The same information coupled with quantitative data, is envisaged to be used at a later stage to optimise a port’s symbiotic network according to pre-determined criteria (e.g. maximal bioenergy potential, maximal monetary value of network products, etc.). Industries of each port area think of their data on industrial flows quantity as sensitive, and it was agreed to have them protected somehow.

The Platform has been submitted to the project partners for feedback with the help of structured questionnaires in GoogleForms. Said feedback has been adopted in the Platform, to the extent practicable. We recognise that more can be done in the same direction, given more resources. Working on the Platform has triggered improvements in the enabling IT toolkit and the underlying ontologies, in anticipation of more dynamic use of the Platform later in the project.

This Deliverable has been structured in the form of a Main Part, of which this is the Executive Summary; Appendix A, which is a User’s Manual to the Platform; and Appendix B, which contains the questionnaires used for partner feedback and their responses. The Main Part elaborates on key findings and lessons learnt from development and within-project use of the Platform. Next is given a discussion on each port, to reveal the usefulness of the Platform in improving understanding of features pertaining to the port’s symbiotic network. The Main Part wraps up with a few points on how this Deliverable forms a basis for future work of other Work Packages.

## B. Key Findings – lessons learned

### GIS

For the purposes of D3.1, a decision was taken to research for industrial activity within and around each port and further include agricultural and livestock activities of the greater Region of each port. In this way, sufficient geographical proximity was ensured among actors on each port site. However, several connections could not take place where the distance was higher than a critical maximum: as in District Heating Networks and Steam Networks. The significance of smaller distances is crucial when it comes to transportation costs. Thus GIS is the only way to ensure that the given quantity of a given type of biomass, is in a reasonably distant region. The user can activate the layers of interest, creating unique scenarios, by using the “rectangular” icon. This enables the selection of several areas, companies, biomass producers etc. at a time. The user can then generate statistical analysis results: (max, min, average and total) of the selected points and areas in energy or power units (kWh, kW).

While still in “beta” testing mode, the GIS platform usage gave quite interesting information about the ports in question.

D3.2 proved that integration of earlier projects can lead to a detailed GIS analysis, such as in the case of Malmö and Mantua. Where possible, having homogenously structured data, helps identify the total bioenergy potential. Anaerobic Digestion (AD), as a way to produce NG compatible biogas seems to be the easiest conversion process to implement in most places. Given that Malmö's first and most important goal is produce biogas, and that the AD compatible feedstock is not enough, gasification is promoted as an alternative. A bioethanol biorefinery in Mantua is highly probable as an investment, since a more valuable product needs to be produced if manure is used for biogas production in such high quantities. Finally, an incineration plant within Astakos is highly recommended, coupled with a pellets factory, making the drying step of the pellets cheaper and the whole investment more profitable.

Experience has proved it essential to design the structure of data at the beginning of GIS data collection, in order to allow a faster analysis and integration to take place. However, it is unknown if it would be easy for the port authorities to process the GIS data, since this would demand investment in time for training and development. The trade-off would be, and in this case was, the engagement of NTUA to put most of the data in a single format, as all of them were come from diverse sources, with different structure, for different purposes, in different detail and in different languages. They were not produced for the purpose of EPIC, which meant time consuming processing for NTUA. Many numerical data needed to be transformed into integers, and then again into the right measurement units. Additionally, Swedish and German locales needed to be adjusted.

Some difficulties arise when the source of information differs. The colour scheme of different land uses coming from the CORINE Land Cover project has been helpful, although it is often hard to distinguish land uses with similar hues. Most of the primary sector data gathered in D3.1 come from statistical sources, which makes their inclusion in the GIS representation impossible.

## Mindmaps

The second tool of this deliverable is called "Mindmaps". This is designed to inform users of theoretically (thermodynamically) possible connections among flows and functional units within each port area. The depicted flows come from diverse sources: company questionnaires and statistics.
The weight of connection lines is universally fixed, since this way sensitive information (i.e. industrial flows' quantities) is not shared with the public. Connections are grouped in "has_input" and "has_output", in two distinguished colours, red and green correspondingly. FUs are distinguished from the flows as they are represented in small capitals. The colouring of both the flows and the FUs follows similar coding with the one used in D3.1 Industrial Symbiosis Networks.
In this representation, future, expand and current connections are not depicted as in the case of D3.1, as the goal is to offer to the users in a compact way, the compatibility among all flows and FUs. For the users who would like to see the status of each connection and their potential (available only for the primary sector), they can still see the D3.1 diagrams when they click on each port's Mindmap.

Flows and Functional Units are grouped according to an ontological classification, allowing the user to activate the group of interest. Enablers, the fictional units which transform biomass to bioenergy, are also classified into: pre-treatment, main and upgrade. Pre-treatment is the mechanical process which reduces the material size and the moisture content of the flow, or recovers the organic fraction of it. Main is the process which transforms biomass into bioenergy: anaerobic digestion, CHP, fermentation, gasification and pyrolysis. Finally, upgrading technologies are incorporated, to allow bioenergy carriers to meet the specifications of Natural Gas: methanation and biogas upgrade. One more upgrading enabler is used: the Ethylene one, which is only utilised in the case of Mantova's port.
Technically, the Mindmaps tool supports very fast updates, which allowed NTUA to make changes and send them over to the subcontractor: "AvMap", who could upload them in a matter of minutes.

## C. Discussion and conclusions per port

**Malmö** was found to host numerous companies that were not included in the D3.1 report, as they carried out non-industrial activities, or they were not big enough. Malmö has the largest population among the four ports-cities and thus reasonably supports more developed urbanised activity than other ports. Furthermore, a previously completed project by "The County Administrative Board of Skåne" and an organization called "Biogas South"2 has offered information on biogas and gasification of biomass potential per Municipality and per type of biomass, as well as existing biogas plants throughout the whole Scania Region. The latter ones can be used as potential "biomass sinks".
The Malmö Municipality has offered information about all companies present in the area, according to the most updated available data, irrespective of their relevance to EPIC. Too much information might lead to adverse effects – among other things – to the speed of the GIS application. Future projects would need to (a) specify in greater detail the type of data they need up front, (b) cater for the eventuality of having to sift through larger bodies of data for those relevant to them.

**Wismar** was found to have no industrial activity additional to the reported in D3.1, but some biogas plants, which can be used as biomass sinks. This means that the inclusion of industrial companies within EPIC in this port area scores high. On the other hand, it also means that there were no additional areas of high interest within and around Wismar.
Farmland, forests and grassland are distinguished easily, on top of the Corine's coding, this way the user could investigate possible agricultural-based symbioses.

**Mantova's** map includes a number of companies, which show no bioenergy potential. The most interesting feature of this port is the very high number of livestock farms, which are accompanied by manure-based biogas potential. Forests and other areas of interest are easily distinguished. The port is separated in several areas, allowing the user to investigate the best possible area for investment.

[2] http://www.lansstyrelsen.se/skane/SiteCollectionDocuments/Sv/publikationer/2011/Biogaspotential_i_Skane_111114.pdf

**Astakos** was found to host no industrial activity within the narrowly defined port area, although, there is high bioenergy potential in the greater Region, which could fuel bioenergy plants. Olive mills are abundant in the area and could also be included in the symbiotic network, as olive cake could form a great source for bioenergy production. However, for the moment, olive pomace cake is directed to pomace mills to produce pomace oil, thus restricting symbiotic availability of olive cake directly from the olive mills. Apart from forestry and agricultural potential, this area is also abundant in livestock and slaughterhouse activities which could fuel biogas plants.

## D. Connection with other Deliverables and Work Packages

This platform serves as a precursor of the tool currently under development within the WP4, which focuses on real time biomass availability and exchange actions. The great difference between these two platforms is that the present one operates on the basis of Grosso Mondo biomass availability and industrial activity already known since the completion of Deliverable 3.1. The present platform also provides information about the geographical abundancy of each biomass in every port, which can serve as an indication of what to expect in every region.

Appendix

A. User Manual: Web GIS for the EPIC2020 Project
B. GIS and Mindmaps Questionnaires and feedback