Chapitre 6

Bio-resource production on the basis of Industrial Ecology in four European harbours, harbour cities and their region

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Biographies

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Leo Baas has a Master of Science in Sociology of Industry and Business Management with a specialisation in Environmental Sciences. He defended a Ph.D. in Social Sciences on the subject of the dynamics of the introduction and dissemination of the new concepts of Cleaner Production and Industrial Ecology in industrial practice. He has performed research on cleaner production since 1988 and on industrial ecology at Erasmus University Rotterdam since 1994 and at Linköping University since 2009.

He has been a member of the daily board of the European Roundtable on Cleaner Production in the period 1994 – 2003 and is a lifetime member of the International Association of Cleaner Technology. He is an advisor of the UNEP/UNIDO National Resource Efficient and Cleaner Production Centres Programme since 1994, and has performed regional sustainable development assessments in México, Mid-America, South-Africa and Zimbabwe.

He is a member of the editorial boards of Elsevier's Journal of Cleaner Production (Impact factor 3,884) and the International Journal on Performability Engineering in India.

Murat Mirata, *born in 1972, holds a MSc degree in environmental engineering and MSc and PhD degrees in Environmental Management and Policy. For close to 20 years Murat has worked with the implementation of preventative strategies and resource productivity measures at the industrial and regional levels.*

Since 2000 he has coordinated and supported various applied industrial symbiosis projects in six countries. Currently Murat is an assistant professor in Linköping University and is an active member of the coordination teams in two projects working with the development of industrial symbiosis networks in port-city areas. Alongside, Murat conducts research on the role of industrial symbiosis for the development of bio-based economies and coordinates a master's level course on industrial symbiosis. He lives together with his family in southern Sweden.

Abstract

This chapter reflects the design and starting performance of the *Symbiotic bio-Energy Port Integration with Cities by 2020* project (EPIC 2020). The EPIC 2020 project is coordinated by the city of Malmö and is performed in four harbour cities: Malmö in Sweden, Mantova in Italy, Navipe-Akarport in Greece, and Wismar (including Rostock) in Germany. A number of expert organisations and energy companies also take part in the project.

The overall objectives of EPIC 2020 are to build operational and strategic capacity and know-how to promote efficient use of available bioenergy resources, efficient conversion technologies and interactions between different biomass supply chains. EPIC 2020 targets the untapped bioenergy resource potential of ports and port regions and the challenge of generating urban economic growth based on bioenergy resources. The project applies the industrial symbiosis approach to achieve its overall objectives.

Ports provide crossing points between transport modes of goods and resources, with connections to hinterland and on-site industrial activities and a nearby urban setting. This means that ports, despite their limited areal footprint, have access to significant quantities of bio wastes, surrounding bioenergy resources, biomass from crossing supply chains and energy from intensive activities. The aim is to create platforms for the transformation of port areas to efficient and carbon-neutral urban-integrated energy systems, where residual bio and energy resources and linear biomass supply chains are utilized as local and network resources.

The EPIC 2020 project is halfway the 3-year performance framework. Reflection to primary results is provided.

Introduction

This chapter reflects the design and starting performance of the *Symbiotic bio-Energy Port Integration with Cities by 2020* project (EPIC 2020). The EPIC 2020 project is coordinated by the city of Malmö (Sweden) and is performed in four harbour cities/regions: Malmö in Sweden, Mantova in Italy, Navipe-Akarport in Greece, and Wismar (including Rostock) in Germany (see Figure 1). A number of expert organisations and energy companies also take part in the project.

Figure 1: **Overview of participating harbours in the EPIC 2020 project**

The overall objectives of EPIC 2020 are to build operational and strategic capacity and know-how to promote efficient use of available bioenergy resources, efficient conversion technologies and interactions between different biomass supply chains. EPIC 2020 targets the untapped bioenergy resource potential of ports and port regions and the challenge of generating urban economic growth based on bioenergy resources. EPIC 2020 applies the industrial symbiosis approach to achieve its overall objectives.

The industrial symbiosis concept implies that a number of activities interact in order to gain from each other's flows of energy and materials, such as biomasses, bioenergy and residual energy resources. Although the term is "industrial symbiosis", the concept also includes the interaction between cities, industrial sites, agricultural and forestry operations.

Ports are logistic nodes with high importance in the management and coordination of resource flows to and from on-site, hinterland, and overseas industrial activities as well as nearby urban settings (Cerceau *et al*., 2014). Consequently, despite their limited land footprint, ports have access to bio wastes, surrounding bioenergy resources, biomass from crossing supply chains and energy from intensive activities. This makes port areas fertile contexts for exploiting industrial symbiosis solutions and for testing more sustainable industrial and urban development by improving port–city relationships and systematically exploiting synergies among diverse port–related and urban activities. EPIC 2020 is built on this premise.

It is possible for the targeted ports, cities and industries to participate in EPIC 2020 irrespective of their present status on bioenergy issues. They will have the opportunity to explore the challenges regarding urban economic and sustainable growth of port areas associated with the potential of locally supplied bioenergy resources and with available and possible conversion technologies. The aim is to create platforms for the transformation of port areas to efficient and carbon-neutral urban-integrated energy systems, where residual bio-material and energy resources and biomass supply chains are utilized as local and network resources.

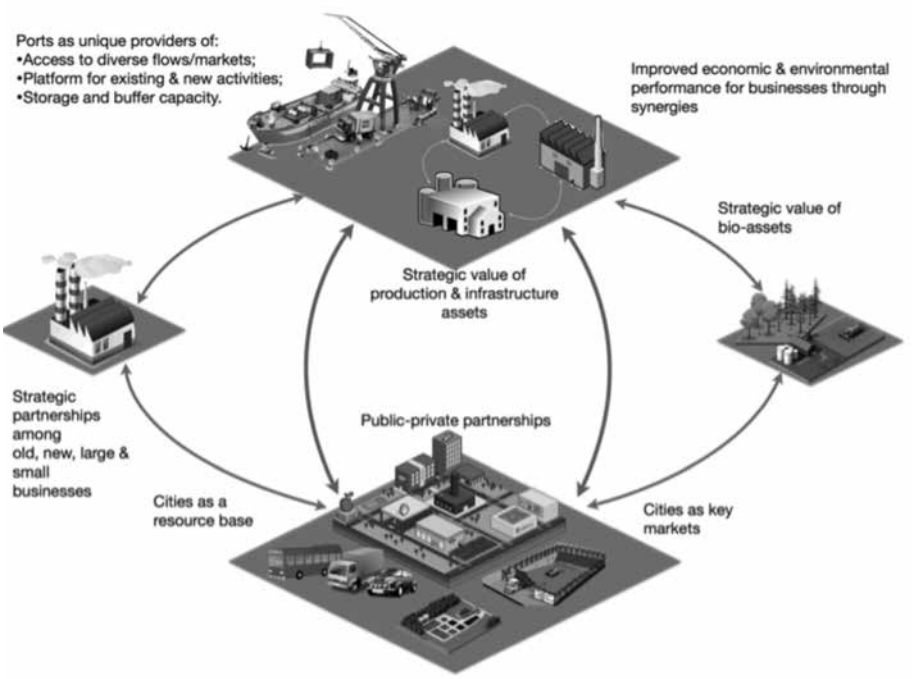
Theory and Methodology

EPIC 2020 is based on constructive learning theories (Piaget, 1978, Bodner, 1986) and collaboration theory (Wood & Gray, 1991). Piaget's theory of cognitive development proposes that humans cannot be «given» information which they immediately understand and use. Instead, humans must «construct» their own knowledge. They build their knowledge through experience. This theory on constructive learning is applied in regional networks.

Within the project, direct communication among the partners is established and relies on a variety of different communication tools. Monthly teleconference meetings scheduled by the meeting leader as well as bilateral communication via Skype and E-mail support the vital communication efforts of all partners.

In the earlier stages of the project, a risk assessment for the project was conducted during a meeting in Athens with participation of all partners. After the workshop, a risk management and contingency plan was developed under the leadership of Malmö. The plan involved a number of relevant events and newsletters. The development of an EPIC 2020 concept and vision was also initiated in this meeting and was finalized under the leadership of Linköping University soon after. Main principles of this vision are depicted in Figure 2.

Figure 2 : EPIC 2020 concept and vision



The efforts to set up specific port site collaboration networks resulted in realization that a deeper understanding of the actors in the area, as well as of the existing networks and interests is essential for finding right methods for engaging relevant stakeholders (conform with Cerceau *et al.*, 2014). Consequently, a two-day Industrial Symbiosis development workshop was organized by Linköping University in Linköping, Sweden. All regions participated in the meeting and got familiar with the development of stakeholder processes relevant for a regional industrial symbiosis project. As part of this event, project partners also had the opportunity to familiarize themselves with a highly relevant operational industrial symbiosis network in the East Götland region of Sweden and interact with representatives of this network. During this workshop, each port site has developed a draft of network development plan, which was presented and discussed and all regions got relevant feedback from the team of Linköping University. The work on network development plans continued after the meeting.

Adopted project methodology includes stages of data collection and analyses, identification and examination of synergistic development possibilities, and the formulation of public and private action plans to support the realization of identified potentials. In order to capture the interplay between the project activities and outcomes and relevant technical, organizational, and institutional factors prevailing in different contexts identification of the initial conditions in each port site and regular monitoring and evaluation steps are also included in the project.

Research field

Malmö is the biggest city of the panel on the basis of the number of inhabitants. The region Askatos is somewhat bigger than Malmö, however, the population is half the number of the Malmö region. Wismar/Rostock has the smallest region and is the smallest municipality. Both Mantova and Wismar/Rostock are small municipalities (less than 50000 inhabitants). Navipe-Askatos and Malmö are medium-sized municipalities. Table 1 provides the number of inhabitants and geography in details:

Table 1: Size issues of the four regions in terms of inhabitants and km²

City	Regional inhabitants and km²		Municipal inhabitants and km²		Port in km²
Askatos	680190	11318	209500	5498	2
Malmö	1271281	11027	307800	158.4	2.3*
Mantova Valdaro	411636	2339	47223	64	1.35
Wismar	150000	2117	45000	41.4	0.6

**Northern Harbour*

All harbours (as only the Northern Harbour is included for Malmö) are categorized as small harbours. Malmö has an urban environment including many industries and its hinterland is dominated by agriculture. The other harbour cities have a rural/forestry hinterland. On that basis, Wismar has a wood industry.

All ports are seaports, except Mantova that has an inland port. Two of the larger ports of the sample have ownership structures involving both public and private parties. The Copenhagen Malmö Port (CMP) is a Swedish-registered limited liability company and is a Danish-Swedish joint venture. The company is port- and terminal operator in Copenhagen (Denmark) and Malmö (Sweden). Its shareholders represent public and private interests. The company is owned by City & Port Development I/S (50 %), City of Malmö (27 %) and various private owners with 23 % of the shares in total.

The port of Wismar is the other port owned jointly by public and private sectors and primarily hosts activities dealing with the raw round wood as well as the already processed lumber. The raw materials and products of the international timber industry and the local timber cluster can be integrated efficiently into an environmentally and economical sensible circulation in this way.

Askatos has a privately owned harbour and Mantova has a publicly owned harbour. Details about ownership and type of harbours and their annual turnover are provided in Table 2:

Table 2: Characteristics of the four harbours

City	Nature ownership port authority	Annual turnover of goods in tonnes/year	Type of harbour
Askatos	Private	230000	Sea port
Malmö	Public/Private	8038000*	Sea port
Mantova Valdaro	Public	350000	Inland port
Wismar	Public/Private	7000000	Seaport

**Northern Harbour*

The annual turnover of goods is transported as summarised in Table 3:

Table 3: Characteristics of annual mode of traffic in the four harbours

City	Annual Ship traffic	Annual Truck traffic	Annual Rail traffic
Askatos	70 ships, 15000 tonnes	6000 trucks, 80000 tonnes	-
Malmö*	1 340 ships	238 000 trucks	28 250 truck trips
Mantova Valdaro	350 ships, 350000 tonnes	16000 trucks, 315000 tonnes	35 trains, 35000 t.
Wismar	1500 ships		

**Northern Harbour*

Reference states in port sites

Technical, informational, economic, political and organizational conditions prevailing in a context have a key influence on the generation and utilization of bio-energy resources and on the pace and direction of industrial symbiosis developments (Mirata, 2004; Jacobssen & Anderberg, 2004). Consequently, necessary tools and routines were developed and adopted in order to capture the characteristics of these conditions at each project site at different stages of project's execution. The situation at the beginning of the project was referred to as the "reference state" and carries particular importance both for understanding the potential variations in progress in different sites and for monitoring the impact of project activities in different sites. In the following, prevailing characteristics of the reference state in different sites are clarified.

Informational conditions - knowledge level about industrial symbiosis

The reference states evaluation survey showed the following level of knowledge about industrial symbiosis at the government, industry, knowledge institutes and small businesses in the four cities (See Table 4):

Table 4: Level of knowledge about industrial symbiosis

City	Government	Industry	Knowledge institutes	Small businesses
Navipe-Askatos	Generally very limited across the board			
Malmö	Some	No	Fair	Not known
Mantova Valdaro	Some	No	Some	No
Wismar	Some	Fair	Fair	No

Policies

Policy landscape applicable to different port sites were characterised as following:

- In Navipe-Askatos, there were no specific regional policies and targets for biomass conversion at the start of the EPIC 2020 project. The continuation of the National Strategic Reference Framework (NSRF) for the period 2014-2020 provided an opportunity for funding and promoting biomass conversion projects on a regional level. The Joint European Support for Sustainable Investment in City Areas (JESSICA) Programme also presented funding opportunities for bioenergy projects developed in the framework of urban infrastructure works. There was also support through subsidies; the level depending on the type of investment.
- In the City of Malmö, there was an “Environmental Programme” for 2009-2020 which includes long-term targets for the city’s energy use. The City of Malmö’s own organisation shall be climate neutral by 2020, and by year 2030 the entire city shall be a 100 % supplied by renewable energy. These targets are very ambitious and also central in all projects performed within the city. There are several different networks active in the region that supports companies with developing their businesses in environmental and energy issues, both from a technological and a market perspective. Two examples of such networks are; “Sustainable Business Hub” and “Energikontoret Skåne” (Office of Energy in Scania, the region of Malmö in Sweden).

– In Mantova, there are no provincial policies on biomass conversion and clean technologies.

– In Wismar, Climate funding guidelines (Climate Protection Action Plan) of the state Mecklenburg-Western Pomerania have been identified. The support is through subsidy.

Fundings and financial risk assessment

An overview about the main investments, the finance availability and financial risk assessment in the region is presented in Table 5:

Table 5: The main investments, the finance availability and financial risk assessment in the region

City	Main investments	Finance availability	Financial risk assessment
Askatos	Mixture of funding initiatives	Bad	Mediocre
Malmö*	Mainly private, but also public, and a mixture of them both	Good	Appropriate
Mantova Valdaro	70% National infrastructural funding 20% European funding (half for promotion and dissemination and half on the infrastructures) 10% Province of Mantova/ Port Authority by own funds	Good	Appropriate
Wismar	Not appropriate	Bad	Mediocre

**Northern Harbour*

Organisational factors - level of trust and history of cooperation

Concerning the level of trust, initial situation in different port sites had the following characteristics:

– In Askatos, the level of trust between government, industry and port authority was poor. There were no network activities between these organizations in the past.

– In Malmö, the level of awareness regarding “technical and business benefits offered by symbiotic relations” is low. The level of trust between government, industry and port authority is generally good in Sweden, and these parties have cooperation experiences.

– In Mantova, the level of trust between government, industry and port authority is good as representatives of all are involved in a local Propeller Club. There were network activities between these organizations in the past. In 2011, there was a national call with incentives for the creation of local thematic districts for energy: the Lombardy Region stimulates the Province of Mantova to create an Energy Industrial district in Mantova. More than one third of the entire Lombardy region's energy consumption took place in Mantova. The enterprises signed an agreement coordinated by the Province over that theme. There are no strategies for capturing "market opportunities for bio-energy or clean-tech technologies".
– In Wismar, the level of awareness of the main actors regarding market opportunities for bio-energy or clean-tech technologies and technical and, especially in the industry sector, business benefits offered by symbiotic relations is high.

In all harbour cities, the main actors understand "market opportunities for bio-energy or clean-tech technologies" very well. The level of trust between government, industry and port authority is mediocre on the regional level and high on the local level. There were no network activities between these organizations in the past. There are no strategies for capturing "market opportunities for bio-energy or clean-tech technologies".

Technical aspects of resource flows and characteristics of the industrial system

In Navipe-Astakos, biomass conversion activities and the amount of biomass that is available for bio-energy production are difficult to detect. Navipe-Astakos provides agricultural data as background information. There is one biogas plant operating in the Preveza area (Greece). 20% of the overall bio-resource flows are within the region, and the remainder is outside.

Malmö has several plants with electricity, district heating and bio-fuel production on the basis of industrial symbiosis, mainly as material flows between the port and the city. A new biogas plant is in the planning stage. There are symbiotic exchanges between the utility companies, industries, and the city.

Mantova lacks renewable energy production.10% of material flows are confined to the port area; 20 % within the boundaries of the Port & Municipality; 50 % within the wider region.

Wismar has 43% renewable energy production and significant amounts of residual woody biomass are used for energy production.

The existing business support system(s) and bio-resource companies for the four cities are described in the following way. The Patras Science Park S.A.,

located 70 kilometres from the Askatos port area (http://www.psp.org.gr), is one of the six Science and Technology Parks (STPs) established in Greece back in the early 1990s under the auspices of the General Secretariat for Research and Technology (GSRT). An initiative of the Foundation for Research and Technology and the Institute of Chemical Engineering Sciences (FORTH/ICE-HT) became an independent Public Limited Company (Sociètè Anonyme) owned by the Greek Ministry of Finance in 2001. For over 15 years, PSP supports the growth of innovative, technology based companies across several sectors such as ICT, biotechnology, clean energy and other industrial technologies, contributing to the City Region's knowledge economy. Patras Science Park hosts several engineering companies, including HELBIO (http://www.helbio.com/), which develops and markets hydrogen fuel processors for energy applications and hydrogen production systems from bio-fuels.There has not been industrial symbiosis and biomass conversion activities in the past that does not exist today anymore.

In Malmö is an overview made by consultancy firm WSP of the in and out flows of some of the companies. Existing bio-resource companies are:

- VA-syd is collecting household waste since 2012, the target is the 40 % food waste is utilised.
- SYSAV is planning to build a biogas plant during 2014 in the Northern harbour area (Biogas syd).

There is a waste heat exchange ongoing in the area.
The only support system existing in Mantova is delivered by the Chamber of Commerce of Mantova by a call giving some financial incentives to the enterprise utilizing, transiting theport infrastructures in the Port. The support depends as well as on the tonnes of goods, the distance of origins and the kind of means used. There are no existing bio-resource companies. There has not been industrial symbiosis and biomass conversion activities in the past that does not exist today anymore.

There is no existing business support system in Wismar. The greatest amount of material, exchanged between the port and the industry is based on raw-wood products (spruce and pine). A turnover of 1,400,000 tonnes of raw wood from Seaside is managed within the harbour and also a main part of the wood products are exported via ships. With respect to energy exchanges is noticed that the harbour exchanges energy only indirect as a handler of raw material and products.

A business support system does not exist. The bio-resource companies are:

- Illim Nordic Timber GmbH & Co KG. sawmill with a raw-wood consumption of 2.200.000 m^3/year
- Egger Holzstoffwerke Wismar GmbH & Co Kg.: fiberboard factory

– Hüttemann GmbH: glulam factory

– German Pellets GmbH: wood based pellet production

– Paletten Service Wismar GmbH: pallet factory

There has not been industrial symbiosis and biomass conversion activities in the past that does not exist today anymore.

Involvement of stakeholders

The involvement of knowledge institutes for the EPIC2020 project is provided in the following overview:

- In Askatos, the University of Patras is involved.
- The consultancy firm WSP is involved in the harbour development of Malmö since 2011. Linköping University was involved in network activities in Malmö from 2014.
- The University of Mantova is involved with a degree prize for a thesis on the EPIC 2020 project aims.
- In Wismar, the "Hochschule Wismar", a university of applied science technology, business and design, is involved.

An indication of key organisation(s) and actor(s) for the EPIC 2020 project are reflected upon by the following overview. Because the EPIC 2020 project started from scratch in Askatos, the key organisation(s)/ actor(s) for the EPIC 2020 project were identified only in late 2014. The mayor of Askatos and several companies are the main stakeholders in the project group. In Malmö the stakeholders for the EPIC 2020 project were identified while the analysis was ongoing. The list of stakeholders is mentioned in the overview below.

Table 6: Key network partners

Key network partners	Position towards EPIC
CMP- the port authority	Information provider
City of Malmö: Environmental Dept. Newly started NH group	Information exchange, important project for Malmö's environmental programme
City of Malmö: Real Estate office	Important that they understand the benefits of IS when appointing land to new business!
City of Malmö: Street office	Find crossing points in logistical issues
City of Malmö: Trade and industry office/ Malmö Clean-tech	Provides conditions for clean-tech companies to establish, knowledge provider
Etableringsgruppen (Real Estate Office Director, Industry Director + CMP)	Important that they understand the benefits of IS, information receivers

Key network partners	Position towards EPIC
E.ON	Partner with large interests in the project, information exchange
Sysav	Promising for a case/ network participant
Norcarb/Carbonics	Promising for a case/ network participant
Lantmännen	Information exchange/ network participant
Länsstyrelsen- Swedish government	Information exchange, knowledge in waste heat for the region
Current business in NH	Information exchange/ network participant
Potential business in NH	Use EPIC to marketing NH
Region Skåne	Information exchange
Other businesses in Malmö and surroundings	Information exchange with chosen functions

Key organizations for the EPIC 2020 project in Mantova are: Province of Mantova, Comune di Mantova, Camera di Commercio di Mantova, Valdaro SPA, Cittadini dei borghi di Formigosa e Castelletto Borgo prospicenti il porto, Tea energia, and IES refinery.

Potential participating companies in Wismar are:

- Illim Nordic Timber GmbH & Co KG: biggest user of biomass in the region
- Egger Holzstoffwerke Wismar GmbH & Co Kg
- LFA Mecklenburg-Vorpommern: state forest service of Mecklenburg-Western Pomerania with close connections to the wood value chain and therefore to the region of Wismar.

Activities performed within the project

Network formation

Site-specific activities within EPIC 2020 have started with the initiation of local networks. For this, relevant local stakeholders were identified and informed about the objectives of the project. Whenever possible, network development efforts built on existing active networks (initiated by other projects such as E-harbours in Malmö) and utilized established interaction and communication routines. A detailed action plan was developed for each site. The plan is attentive to the work to be performed in different sites. The specific conditions for the extent are known. This plan is communicated with leading organizations in each project site to assure its relevance for the project tasks and context-specific conditions in each site. A dedicated workshop was organized in Navipe-Astakos to inform relevant stakeholders about the industrial symbiosis concept and the specifics of the project.

Data collection

After the networks were formed and the representatives of the different organizations were committed to their tasks, the data collection for the objectives of the EPIC 2020 project started. For this purpose, a dedicated data collection template was utilized. Generally, basic information concerning the port was easily collected (such as: total port's area, type of trade in and out, types of ships, connections with other ports, maps etc.) but detailed data concerning material and energy flows of each Functional Unit (FU) were more difficult to collect. An overview of the data collection process at the port sites provides the following information:

- In Malmö, data was enough for the analysis. Processing of data from various reports, from interviews conducted with companies in the area, and survey data on energy use and waste generation,, was performed.
- In Mantova, a list of industries and companies within the Mantova region showed bio-energy potential. Furthermore, potential biomass producers have been identified from the agricultural sector in the region. The data collection focused on acquiring data on biomass residues based on statistics made by farmers associations, environmental and municipal authorities.
- In Wismar, the concentration of wood processing industry created an unique Industrial Symbiosis setting: almost every company has its own separate energy system fuelled by waste wood and producing power, steam and heat.. Good quality data on local resource flows were accessible.
- In Akarport, no data were obtained during the reporting period. However, a sub-contract agreement signed early in January 2014 with Clean Energy started to be the basis for undertaking the data collection on behalf of Akarport. At the end of 2014, the generated EPIC 2020 network, involving among others the mayor of Akarport and representatives of the industry in the region, took this task over.

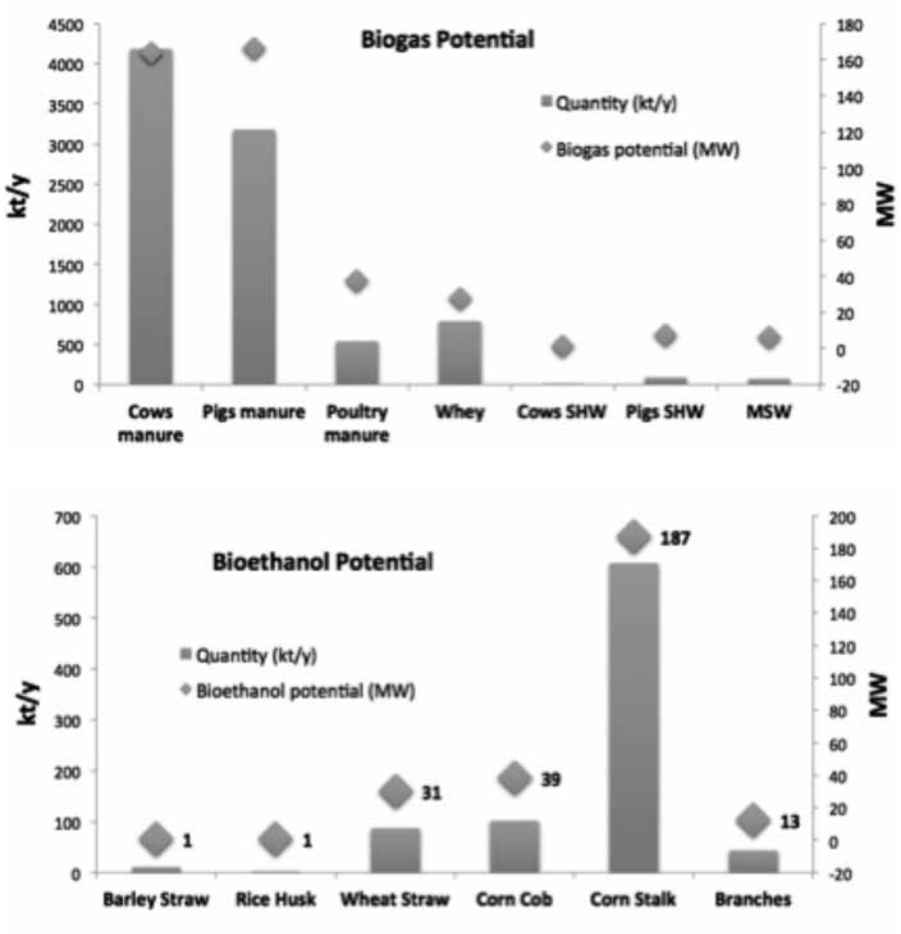
The collected information was used for the identification of internal and external bio-energy resource potential for different port sites – as summarized in Table 7.

Table 7: Bioenergy resource potential identified across project sites.

Port	Malmö	Mantova	Wismar	Astakos
Total Bioenergy Potential(MW)	233	681	175	157
Internal	38,3	0	0	0
External	194	681	175	157

These resources were further categorized according to their source and potential application area – as exemplified in Figure 3.

Figure 3 : Bioenergy resource potential identified for the Mantova site.



For two of the project sites, the collected data was also integrated with a GIS system in order to help identify and assess internal and external bio-resource flows and potentials. Building on the collected data and subsequent analyses, new development opportunities were identified for Malmö and Mantova regions, and assessments for their feasibilities were initiated and are under way by the time of writing. Alongside, preparation of action plans and local policies that can support the realization of identified potentials have been initiated.

Findings halfway the EPIC 2020 project

Echoing the findings of earlier studies (Baas, 2007, Brings Jacobsen, 2009) it was seen that the generation of an Industrial Symbiosis stakeholder network takes time, especially when work has to start from scratch.

Navipe-Astakos

The Navipe-Astakos Harbour is the third biggest harbour of Greece. It has the needed space and infra-structure to manage a big amount of resource flows, including waste materials. When it is connected to the major national roads and other major ports in the region in the near future, the waste materials from the entire Western Greek and Epirus region can be transferred to this port site. Despite the reluctance of organizations for new investments during the economic crisis, the investments in Industrial Ecology and bio-resources are perceived attractive because of profits for all stakeholders. Besides that the need for clean fuel grew in Greece because of economic and environmental reasons. The prospect that the biogas production can be cheaper than imports motivates an investment in this.

A difficulty to propose Industrial Symbiosis projects was the fact that in Greece no data are available about the waste that is generated in the agricultural sector.

A major Greek experience was that the stakeholder meetings were crucial for coping with changing laws and constantly evolving technologies. Despite companies were reluctant at the start among others by the fact that many companies operate not as legally as they should, the representatives in the Stakeholders network worked together better than expected.

As main success factors was seen: the will of relevant organisations to help, the positive view of society and the promised benefits of the EPIC 2020 programme.

Malmö

Malmö had already connections with industry on Industrial Symbiosis issues and initiated the EPIC 2020 project. Despite that, the forming of the EPIC 2020 stakeholders network took more time than estimated and halfway through the project many partners do not know properly what the EPIC 2020 entails. That might be caused by the fact that the project management has changed three times. In addition, several actors took some initiatives and important actions were performed before the deadline. However, knowledge about completed actions was inadequately disseminated to a wider group due to insufficient communication channels. In addition, the time to process and make good sense was not enough. Actors tend to mind their own business, and do not know and focus on the activities

and needs of businesses around them. In general, the partners should have a better understanding about what is expected from them. An external actor can provide a breakthrough in this situation, and this role was partially played by the Linköping University.

When the clean-tech study was completed and potentials were identified halfway the EPIC 2020 project, a milestone was reached and dynamics changed drastically. More actors were actively engaged in the process and additional resources were acquired by the region to investigate promising alternatives further. There are no financial and policy related results yet, but cooperation and coordination among industrial partners intensified drastically. The working groups on department and operational management level in the city discuss Industrial Symbiosis options for the port and city development.

The formal project partners, and in particular the utility company E.ON, being very active and progressive in energy related areas is seen as a key success factor in Malmö. Relatedly, the potential value of other core partners with other areas of expertise could bring to the project is acknowledged. Stakeholders working mainly in Malmö region taking the lead in the overall EPIC 2020 are also seen as an important success factor.

On the flip side, some key stakeholders having an inadequate understanding of the goals and targets of the project and of the responsibilities implied for different parties is seen as a main barrier. Furthermore it was very difficult to deliver in time, when input is needed from numerous actors that are not partners in the project.

Mantova

The reference state in Mantova had some supportive elements for the EPIC 2020 project. The well infra-structured inland port has a good proximity to a number of production industries and service providers. The productive industries of the manufacturing cluster are in many cases satellites of multinationals which meant a barrier in bio-tech investments. As the chemical industry sector had no service centre, it was difficult to get representatives of several companies in the stakeholder network. Extensive presence of agricultural and animal breeding activities within the region, parallel projects exploring the potentials of biofuel production in the area, and presence of a district heating network in the city of Mantova were additional strengths.

The planning of the EPIC 2020 project was seen as adequate, although the hypotheses on bio-energy potentials that were put on paper were received as too optimistic. The initial EPIC 2020 communication tool aimed at stakeholders that were new to the project was also seen as too generic. The readers received more the general idea of an environmental project instead of an Industrial Symbiosis project on bio-resources.

A big amount of job hours was spent to the enterprises' involvement in the data collection. The port authority in Mantova acted as a leader, most of the companies were followers. The communication among local stakeholders was less than expected and was linked to the absence of a preliminary practical action plan and its communication with stakeholders. The external communication was not as good as it could be on the basis of a more specific EPIC 2020 brochure.

Halfway the EPIC 2020 project, a number of interesting development opportunities is identified for the area. Despite the economic crisis, relevant stakeholders showed high levels of interest in the identified possibilities and accordingly the project successfully advanced into subsequent phases focusing on detailed feasibility studies. The outcome of these studies is expected to play a pivotal role in the region. At a generic level, the inability of the local stakeholders to collectively formulate a development scenario for Mantova is seen an important barrier.

Wismar

In the case of Wismar, there was already a good technical cooperation between actors.. The EPIC 2020 project however, was found to be too theoretical and beyond the interests of enterprises, consequently lowering industry's interest in the project. As there were already industrial symbiosis processes operational, the industry primarily assumed an observatory role, hindering progress towards bigger EPIC 2020 targets.

Bringing different actors together is considered to be a critical success factor in Wismar. On the other hand, the overall attention given to qualitative aspects by the project was considered as a difficulty, as the industry is more perceptive to quantitative and financial assessments. Moreover, the project's development in this region was adversely affected by the administrative challenges faced.

Conclusion

Overall, the EPIC 2020 project leadership was experienced as adequate. Despite numerous coordination replacements, the Malmö coordination team was very efficient and precise. That meant that the continuity of the EPIC 2020 project and its implementation was ensured.

When there are no (sort of) Industrial Symbiosis networks that already function, it is difficult to motivate and engage representatives from government, industry, and NGOs in a stakeholders' network. That takes more time than outsiders often expect.

The internal and external communication of Industrial Symbiosis stakeholder networks was different per site because of their dependency on the context. The same was found for success factors and barriers.

The potentials for the production and application of bio-resources on an Industrial Symbiosis basis were found everywhere.

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