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Industrial symbiosis

in Älmhult

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SUMMARY

This report is based on a field study project that has been performed in Älmhult's municipality with the aim of mapping the industrial symbiosis in the region. The focus in this paper has been to identify existing synergies as well as investigate possible ones that might develop in the future. A big part has also been to investigate why these connections exist and what conditions favors cooperation between companies. Älmhult is a small community located in the south part of Småland with 16 000 inhabitants. Early in the project three key actors were identified; E.ON, IKEA Industry and Stena Aluminium, so a lot of effort was initially made to get in contact with them. The group spent one day in Älmhult to get a wider understanding about the companies and through interviews a lot of information was collected. Complementary phone interviews were held with the people who couldn't meet up during the visit and when more questions appeared later on while writing this report.

The results from this project show that most of the existing symbioses revolve around E.ON which gives them an important role in Älmhult. E.ON is an energy company that cooperate with both IKEA Industry and Stena Aluminium by taking care of their waste heat, and they are continuously looking for new opportunities. It's interesting to study these two waste heat synergies that have a lot in common but still operate in different ways. For example, E.ON is in charge of the boilers and the maintenance in their synergy with IKEA, even though the facilities belong to IKEA. When it comes to Stena Aluminium, E.ON buys the waste heat but isn't involved in the technical or operating process. The synergy with Stena Aluminium has led to problems resulting in Stena Aluminium sometimes not being able to deliver waste heat at all. How this efficiency might increase if E.ON was to take care of the maintenance and operation as well has been analyzed and discussed in this report. This conclusion is based on the fact that energy is E.ON's core business and therefore it would be easier for them to handle technical complications, compared to Stena's employees who lack this expertise. Providing the views of Stena that may justify existing dynamic will portray a more balanced, and more fair, message.

Another interesting aspect that is discussed is how important proximity is for making synergies possible. Many articles mention the benefits of proximity, but this study shows some examples where the companies are far away from each other, and in one case they're not even in the same country. A short analysis has been made on this matter and the conclusion is that if the value of the synergy is high enough, it might be beneficial despite long distances.

The municipality don't have the resources to focus on industrial symbiosis related questions, but an interest in the subject has been identified. They have created platforms in Älmhult where different companies can meet, breakfast meetings are one of these platforms. On these meetings, different topics are discussed every time and 50-60 companies participate in average. In the future it would be interesting to discuss possibilities for industrial symbiosis and how it can be used to strengthen Älmhult as a business region.

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1. INTRODUCTION

PROJECT BACKGROUND

This field study project is a part of the Industrial Symbiosis course, which was given at Linköping University during the autumn of 2017. The project corresponds to 2 ECTS, which requires a total of around 200 self-studying hours per group of four members. In this project, each group was given a municipality in which the examiner knew there was potential for industrial symbiosis. The aim of this project was to identify and study these symbiotic relations, and to apply the theoretical knowledge given through lectures and literature studies. This was done by collecting relevant information, contacting actors in the region and analyzing the information to gain a greater understanding in what makes Industrial Symbiosis work in a certain region.

DEFINITION OF INDUSTRIAL SYMBIOSIS

There are various definitions of Industrial symbiosis (IS) used throughout the academic and industrial world. The definition used in this report is the one from Lombardi and Laybourn (2012), stating that "IS engages diverse organizations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs and value-added destinations for non-product outputs, as well as improved business and technical processes." Since this definition not only focuses on material exchanges and flows but also includes the business perspective and information flows it was considered more applicable to this project than other definitions and therefore chosen.

ÄLMHULT

Älmhult is a municipality located in the southern part of Småland, in the Kronoberg Region and right on the border to Skåne, which is shown in figure 1. The municipality has about 16 000 inhabitants of which about 10 000 live in the city centre. In addition to this about 4 500 people commute daily to Älmhult, which shows it's a city with unique opportunities for businesses. (Älmhults kommun, 2017a) The municipality is also home to no less than 1700 companies (Weibull, 2016).

Historically, Älmhult was a place where farming and forestry were important. Later on in the 18th century, the region also turned out to be a good place for ironworks because of the easy access of ore from the bottom of the lakes. These ironworks later disappeared due to much easier ore access from the mountains further up north, and the successful factories had to change their aim. Wood-, glass- and iron refinement factories evolved from the previous ironworks and when the railroad was built, the central part of Älmhult became an important place for companies to expand even more. (Älmhults kommun, 2017b)

Since 1970, there are no longer any glassworks in the area, and most companies today are found within the metal and manufacturing industry (Älmhults kommun, 2017b). IKEA is described by Weibull

(2016) as the flagship of the region and they are also the biggest employer in the region with its 15 affiliated companies.



Figure 1 - An overview of the region. Älmhult Municipality is marked in red.

KEY OBJECTIVES AND LIMITATIONS

The key objectives of this field project was to identify the symbiotic relationships between companies in the municipality. Focus has been put on mapping these connections, as well as on understanding how they developed and what makes them work and possibly evolve today. Trying to understand the different actors' perspectives regarding both business and environmental incentives has also been a very important part in this project.

The time frame of this project has been the biggest limitation. This has probably affected the quality of the studies and this report. It also resulted in the need for the group to limit the project early on. Three big companies very identified as the key actors so focus was put on these. Further investigation was made to find additional manufacturing companies that could be a part of these synergies. The reason for focus on manufacturing companies was that they have the potential to have big flows of both energy and material waste. All the manufacturing companies were not investigated because lack of obvious existing synergies. The extend of the project limited the possibility to research deeper these further.

The fact that some companies were contacted early on in this project and some were identified and contacted later on has also created some problems. During interviews new interesting companies emerged but due to lack of time they were not investigated further. Trying to get in touch with the right person has sometimes also been extremely time consuming, especially due to the fact that most of the companies are a part of a bigger company.

2. METHODOLOGY

To gain knowledge about the region, the main focus in the beginning of the project was to gather information about Älmhult. This was made mainly through literature studies and the internet, but also by talking to Pierre Ståhl, who works with a similar symbiosis project for Energikontor Sydost. He was able to provide information about what companies that could be of interest in this project and those companies could later on be researched even more. When looking into different companies, number of employees, revenue and especially manufacturing companies were considered since the group realized all companies in the municipality couldn't be contacted due to the extent of this project.

Information about synergies may exist online, but information about how they evolve rarely do and therefore the group decided to contact the companies directly early on. A total of 31 persons were contacted in order to find the right people with knowledge about the synergies. When this initial research was completed, a number of relevant contacts had been identified and phone interviews were held and a field trip to Älmhult was scheduled for September 21st.

In Älmhult the group got to meet with 5 different actors and 6 persons somehow involved with synergies. Additionally, 9 phone interviews have been held in order to get enough facts for this report to collect and analyze information about the current synergies and also considering possible future synergies. Focus in this report has however been put on investigating how the current synergies developed in order to understand what factors are important when it comes to creating good relationships and exchanges between companies. The system has also been analyzed to create an even greater understanding in why the synergies is or is not perceived as successful by the actors involved.

The project resulted in this scientific report and also a shorter summary in popular writing to be used on an online portal that supports future research in Industrial Symbiosis. A presentation of the results for the rest of the class is also to be held.

3. RESULTS

The results have been divided up categories in order for the reader to easier understand the different synergies that has been mapped in this project. Existing synergies are the most relevant ones found through research and through interviews with actors directly. Possible synergies include companies found in the area in which the group saw potential in eventual synergies, while future synergies include collaborations that actors have mentioned and that is being investigated. This chapter also includes information about the different platforms and third parties that have been identified as important actors interested in symbiotic relations in this area in different ways.

To create a clear picture of the synergies we start by introducing a schematic image of the relevant flows identified in the system. The figure is displayed below with different colors depending on the flow.

KEY ACTORS

IKEA Industry is one of many IKEA affiliates in Älmhult. Previously IKEA Industry was called Swedwood but it changed its name in 2013. The company manufactures kitchen cabinet doors in the Älmhult factory and it is located in an industry cluster south of the Älmhult city centre. (Göth, 2012)

Another key actor placed in the same industry cluster is E.ON with it's heat plant Elmeverket that has provided Älmhult municipality with district heating since it opened in 2010. E.ON was the heat distributor before Elmeverket was initiated as well, and the previous boilers using different kinds of fuel (bio oil, gas and biomass) are being used when the demand is high. Elmeverket is a bio-based heating plant that uses residue that they buy from saw mills in the region (Nystedt, 2010). The district heating demand in Älmhult is 100 GWh of which Elmeverket stands for 70 % (Albertsson, 2017).

Stena Aluminium is on the contrary not placed in the same industry cluster, but in the centre of the city right by the railway station. Stena Aluminium is a producer of recycled aluminium which they produce in Älmhult by buying aluminum scraps from Stena Recycling. The recycled aluminium is later sold to foundries outside the region and the maximum volume that can be produced annually in Älmhult is 90 000 tonnes. (Stena Aluminium, 2017)

Stena Aluminium is a part of the Stena Metall group. The melting process uses LPG as the only energy input, and the process generates a lot of heat that can be recovered which will be described later in this report. (Stena Aluminium, 2016)

THE SYMBIOTIC NETWORK

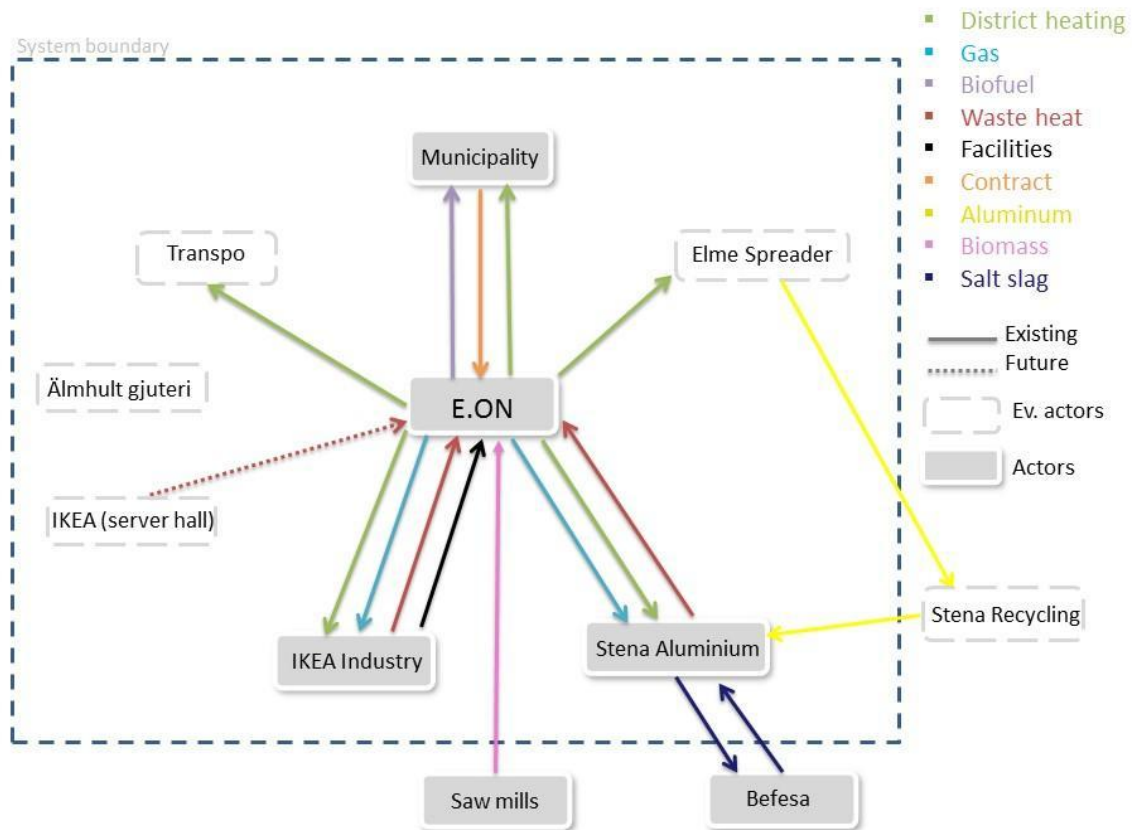


Figure 2. Schematic picture of the identified symbiotic relations and also possible ones in Älmhult – did you miss to include a connection to gjueteri?

EXISTING SYNERGIES

E.ON - STENA ALUMINIUM

The start of the project

In 2011, Stena Aluminium signed a 15-year contract with E.ON regarding collecting the waste heat from their production and distributing it to the district heating system. At the same time they decided to replace their heating system in the facilities from gas to E.ON's district heating. The contract meant that Stena Aluminium would provide up to 25 GWh to the grid every year, which corresponds to the all year heat demand for around 1200 houses. (My news desk, 2011) However, today the delivery from Stena to E.ON is approximately 10 GWh which is about 10 % of the total demand. (Albertsson, 2017)

Staffan Persson, the CEO of Stena Aluminium at the time, explained the company's situation when the cooperation begun. There had been long debates with the community about the location of Stenas factory in Älmhult and both of the parties agreed that it wasn't ideal, but the costs of moving the

factory was too high for any of the parties to handle. Since the company decided to almost double their production in Älmhult they met even more resistance from one person of the community. The production increase was due to a market drop in aluminium the year 2008 which led to the merging of two factories. According to Persson there was a good dialogue between the municipality, the governor of Kronobergs County and Stena Aluminium on how to integrate the company with the town in a better way. To meet the demands from the community, Stena Aluminium needed to build a higher chimney in which they invested in gas purification system. It was then they also saw the potential in selling their waste heat to the energy company in the region, E.ON. The equipment was to be paid for by, operated and maintained by Stena Aluminium itself and not by E.ON. There was never any discussion regarding letting E.ON run the maintenance instead. Persson (2017) also states that the reason for the investment was the company's ongoing interests in circular economy and environmental effects, but they also saw an opportunity to get a return on the investment and making amends with the community.

The proceeding of the project

Since E.ON and Stena Aluminium already had a good relationship due to previous businesses in which E.ON sells gas to Stena, there was no complication with this new agreement (Pettersson, 2017). This was something that E.ON also agreed on during their interview (Stål, 2017). Both the current and the former CEO states that they have a good dialogue and a relationship built on trust with E.ON. However, as previously mentioned, Stena hasn't been able to deliver the planned capacity yet due to technical problems.(Pettersson, 2017)

These technical problems that sometimes occur isn't always prioritised according to the CEO, Fredrik Pettersson of the company. He claimed that the profit from the waste heat is so marginal that he sees it more as a good-will act, and an act to enhance the company's eco friendly status, rather than a economical beneficial investment. Because of this, Stena Aluminium doesn't put a lot of resources to this area when there are problems. This means that the delivery of heat sometimes stands still and doesn't deliver any heat to E.ON. When the deliveries from Stena have problems, E.ON has to increase their usage of virgin biomass in order to reach the district heating demand. Pettersson states that since the process is such an extreme small part of their operation it does not get the attention it might deserve or it should get to be an optimal process. (Pettersson, 2017)

The companies meet once every quarter to discuss the proceeding of the cooperation. The meetings participants are the site managers and not the CEOs. E.ON has offered to help Stena Aluminium with their technical issues which includes sending someone from E.ON to help out at the site since the company has a lot more experience and expertise in the area of energy management. This however was not something that played out. The interviewees from E.ON believe that the reason is that they were missing incentive, but they also had the belief that there are quite good money to be made for Stena Aluminium if they would be better at keeping the process going. They are also under the impression that the company is a bit short on staff and that all the more technical information doesn't always reach the top, to the CEO. (Albertsson and Stål, 2017). What Stena thinks about this is however unknown.

There are not any big personal connections between the workers at E.ON and Stena Aluminium although it's a small town. It may be because of the fact that many employees commute into the city from bigger cities. (Albertsson, Stål, 2017)

STENA ALUMINIUM - OTHER COMPANIES

Befesa

Stena Aluminium recently started a cooperation with the German company Befesa. They wash the salt slag that Stena gets as a by product when melting the aluminium and clean salt sends back to Stena Aluminium. They need the salt in the melting process and by getting back their own recycled salt they can reduce the amount they send to landfill. (Ulaosson, 2017)

Elme spreader

One of all the companies that was contacted is Elme Spreader, which is one of Älmhults biggest employer (Erlingsson, 2017). They are producing solutions for container handling, like truck spreader, crane spreader and spreaders for straddle carriers for the handling of containers, trailers and swop bodies (Elme Spreader, 2017). This kind of manufacturing requires a lot of energy and material, and it causes waste material. Stena Recycling buys all the waste before selling the resources on an open market, where one of the interested purchasers are Stena Aluminium (Erlingsson, 2017).

E.ON – IKEA INDUSTRY

The start of the project

E.ON and IKEA Industry made an agreement in 2008 to use the waste heat from IKEA's production. The cooperation started because IKEA Industry had a big growth in production, and they felt the need of an investment in two new boilers to correspond to the expansion. They consulted with E.ON about the boilers and got referred to a man at another company. He recommended them to invest in two bigger boilers, but that resulted in a problem. After the installation of the new boilers the production rate decreased a bit and therefore the boilers were not profitable any more. So if they would have burn all their own wooden waste products they would get a very high temperature inside their buildings and if they didn't use the waste, it was put on landfills. Once again, IKEA contacted the man who recommended the boilers, who now worked at E.ON and therefore saw the opportunity to connect IKEA industry with the heating system. That gave IKEA the opportunity to get rid of the waste heat and at the same time make money out of it. Together they created an investigation group with a handful people from the both companies to come up with a concept. (Albertsson and Stål, 2017)

The beginning of the cooperation was a bit slow, E.ON's site manager Albertsson (2017) mentions. There were two big companies that formed a big agreement and that leads to a lot of administration, which takes time. For E.ON, where energy is the core production, the cooperation was obvious. IKEA, on the other hand, are producing kitchen cabinet doors, and therefore it might be a lack of both knowledge and interest in this kind of questions (Albertsson, 2017). The technical manager at IKEA Industry, says that it was an obvious decision to send the waste heat to E.ON (Viberg, 2017). Viberg (2017) further states that for IKEA, sustainability and the environment are two main questions in the whole company. Because of that reason the cooperation is made by two parties that both see the

profit from this. IKEA Industry gets economical benefits of the collaboration, and E.ON can buy waste heat for a lower price than what it had cost to buy fuel and burn it by themselves (Albertsson and Stål, 2017). Today IKEA deliver 20 GWh waste heat to E.ON, which is 20 % of the total heat demand (Albertsson 2017).

Apart from the waste heat from IKEA's boiler, E.ON also helps to cool the compressors in the factory. E.ON got involved by an initiative from IKEA, after the waste heat was connected to the district heating. They had bought new compressors and wanted a smart solution when it comes to how to take care of the extra heat that is generated. Instead of fanning away the heat, E.ON solved the problem by cooling the compressors against the district heating system. This resulted in a heat flow of 1200 MWh every year, which corresponds to 1,2 % of the municipality's annual demand. (Albertsson and Stål, 2017)

The proceeding of the cooperation

In the 10-years agreement they signed, it was decided that IKEA Industry who had bought the boilers wouldn't pay for anything more. E.ON would instead pay for and be in charge of the daily operations and make sure the plant was running smoothly. E.ON took the biggest investment cost and paid for the expansion of the pipelines connecting IKEA Industry to the district heating grid. IKEA Industry signed up to pay for the electric energy for the boilers.

Today they have regular meetings to discuss the operation of the system. The meetings are held once a quarter in which IKEA's technical manager, EHS manager and some operation staff are represented, and the participants from E.ON are also around four people, including site manager Albertsson. The discussions include checking off what has happened, what happens now and plans for the future. Both parties think that the current system and solution works good and do not want it to end (Albertsson, Stål and Viberg, 2017). The 10-years agreement is about to run out, and this autumn a new negotiation will be held. IKEA doesn't see any reason to change the agreement from the current one. There might be a discussion about expanding the cooperation, which can be found under "*Future synergies - E.ON and IKEA Industry*", but it's not highly prioritized by IKEA according to Viberg (2017).

E.ON – ÄLMHULT MUNICIPALITY

The municipality has not played any role in the synergies regarding spare heat (Axelsson, 2017). A synergy that they do have is regarding biogas. In the year 2010 a cooperation between E.ON and the municipality began when E.ON was to build a biofuel station in Älmhult (Älmhult kommun, 2010). The biogas itself is not produced in Älmhult but in one of E.ON's seven plants in Sweden (E.ON, 2017). The motivation for building this station was that the municipality would invest in having a large amount of their vehicles driven by biogas. The station was built the next year and the cooperation is still working as agreed. (Axelsson, 2017).

POSSIBLE SYNERGIES

During the research in finding relevant companies to contact and when asking the key companies about other, to us unknown, synergies some interesting possibilities emerged.

ÄLMHULT GJUTERI

The foundry in Älmhult is a modern foundry that manufactures cast iron. The company has a long production history and a capacity of 7.500 tonnes a year (Holsbyverken, 2017). They use induction ovens for production, which produce excess heat. At the moment they use accumulation tanks to collect this heat. The environmental manager at Älmhult gjuteri says that they have a large demand of heat in their facilities because of the large ventilation. She recalls some cooperation with E.ON a while back, but has no further knowledge about it. The company has investigated to sell their sand from the production but hasn't found any possible buyers. (Strähle, 2017)

TRANSPO KONSTRUKTION AB

Transpo is a 60 years old construction company that delivers advanced components in steel and metal. They are a subcontractor with a complete manufacturing process with a revenue of 60 M SEK. (Transpo, 2017)

When contacting the CEO he stated that they don't have any cooperation with the companies in Älmhult, except buying heat from E.ON. They are not selling any of their production waste, but it's taken care of by another, to us unknown, company. (Claeson, 2017) He didn't have time to discuss this question with us further.

ÄLMHULT KOMMUN

The municipality does not have an important role in the synergies between companies in the area. Neither the collaboration between E.ON and IKEA Industry, nor the one between E.ON och Stena Aluminium has been arranged by the municipality in any way. Both of these started and proceeded on their own, without any involvement from the municipality. The environmental director, Cecilia Axelsson, mentioned that they don't have the resources to investigate flows that possibly can connect companies with each other. The support from the municipality is mostly about economical and business related questions. There is no demands in terms of environmental or energy efficiency from the municipality, but that's a responsibility of Länsstyrelsen. In the municipality's strategic development plan they describe how they want to expand the industry cluster in the south and want to concentrate the industries to one area (Älmhult, 2017). This is primarily to keep industries away from the city center, but facilitating for synergies between the companies is seen as an interesting idea (Axelsson, 2017). The environmental director of the municipality also works as an energy advisor for private persons and companies, and helps them to become more energy efficient. It doesn't involve any inter-organisational collaboration between companies, it's just internal efficiency. These topics are something that could be discussed on the breakfast meetings, if there was an interest of questions of this kind. (Axelsson, 2017)

FUTURE SYNERGIES

E.ON AND IKEA'S COMPUTER BUILDING

In the same industry cluster as Elmeverket and IKEA Industry, another IKEA affiliate has a building that holds computer servers for IKEA's cash register systems throughout the world. This server hall generates heat that could be recovered, and studies revolving this are being carried out by E.ON in other parts of Sweden (Löwenham 2017). Considering the fact that the building is located just across the street from Elmeverket makes it interesting when it comes to connecting this building to the district heating system, since residual heat is cheaper for them than buying biomass (Albertsson and Stål, 2017). The IKEA affiliate involved in this has not been contacted due to the extent of this project, therefore their incentives are unknown.

E.ON AND IKEA INDUSTRY

IKEA Industry are using a solvent in the lacquer for the kitchen cabinet doors. Currently IKEA burn the solvent with gas from E.ON. The gas is added to make the combustion continuing and keep the temperature constant (Viberg, 2017). The solvent has a high energy value and E.ON is interested in taking care of the heat that is generated here. E.ON have already prepared to make it possible to cool it against the district heating (Albertsson and Stål, 2017). The reason why the heat extraction hasn't started is because IKEA Industry are investigating if they can change the lacquer used today to another lacquer that's more environmentally friendly and without solvent (Viberg, 2017).

PLATFORMS

BREAKFAST MEETINGS

The municipality organizes breakfast meetings and CEO meetings for companies, in order to discuss business. Approximately 50-60 companies participates, sometimes up to a 100, depending on what's on the agenda. The organizer of the meetings, the enterprising director at Älmhult kommun, tries to have different topics to discuss on each appointment and arranges them spread out at the companies. His idea is to reach all the companies and respond to their interests and needs, but also to create new valuable discussions between them. (Hansson, 2017)

The only existing collaborations the enterprising director knows about is E.ON-Stena and E.ON- IKEA Industry and a discussion about industrial symbiosis hasn't been on the agenda so far (Hansson, 2017). The environmental director, however, thinks it would be an interesting thing for the future if there is enough time to do so (Axelsson, 2017).

TRIS – PROJECT

TRIS stands for Transition Regions towards Industrial Symbiosis and is an international project funded by the European Union. Five regions are involved in this five year program that works towards raising awareness about the subject, to standardize IS practices and to display its environmental and economic benefits. The only Swedish region involved in this is Kronoberg which not only includes Älmhult, but also Alvesta and Växjö. Mapping of the symbiotic collaborations in Alvesta has been done

earlier this year which resulted in a “Symbiosis good practice” report. A similar mapping and report will be produced for Älmhult municipality later on. (TRIS, 2017)

Energikontor Sydost is the Swedish organization responsible for this project through project manager Pierre Ståhl (Energikontor Sydost, 2017). He is interested in the same symbiotic relations and will develop the results from this report further when he does a mapping of the region (Ståhl, 2017).

4. ANALYSIS AND DISCUSSION

THE DIFFERENCE BETWEEN THE IDENTIFIED SYNERGIES

All of the existing synergies, except the one between the municipality and E.ON, are some sort of self-organizational synergies between industrial actors (Boons F., Chertow M., Park J., Spekkink W. & Shi H, 2016). The E.ON - Stena Aluminium synergy did not occur only because of the economical benefits. Stena seems to be more interested in the environmental impact of the synergy, but also in using its effect to enhance their eco-friendly image. Although the CEO at the time the synergy started, states that there was an economical driving force behind the cooperation as well, the current CEO's statements implies otherwise. It is unclear if the economical aspect has had any impact for Stena Aluminium, or if there was another underlying aspect. It is however clear that E.ON is the actor who gain the biggest economical benefit from the synergy. An interesting question is why this synergy isn't as successful as the E.ON- IKEA synergy. The drivers seems to be similar according to the interviewees from the companies. They all state that it is the environmental factor that created value in the symbiosis, but if one looks at the facts presented about the startup of the symbiosis they differ. The reason IKEA initiated the synergy with E.ON was to find an economic beneficial way to deal with the excess heat from their oversized boilers. To make it more affordable to run the big boilers, IKEA needed to make a profit in selling waste heat. Since they're still using the oversized boilers IKEA still has strong economic motivation to maintain the synergy. The difference in the E.ON - Stena Aluminium synergy is that the later doesn't have the same economic incentive but is more driven by keeping up the environmental friendly status of the company. One big difference might just be that IKEA has bigger economic motives to maintain the synergy than Stena Aluminium. How big these economic benefits are and how they vary between the companies hasn't been investigated further.

One big difference between the two synergies that is discussed above, is also the maintenance of the technical process. It is clear that if E.ON is the one to operate and pay for the operational costs of the plant, the heat flow would be more constant since their main focus is to produce heat. This might be a reason why the collaboration between IKEA and E.ON is working more optimal since they have formed this exact agreement. As mentioned in the results, this type of agreement was never on the table when Stena Aluminium and E.ON discussed their contract.

It is also interesting to discuss the lack of and/or influence of key persons in the different symbioses. The former CEO of Stena Aluminium is perceived as a person with a big interest in environmental sustainability. During the interview, the former CEO gave the impression that the synergy was of great

value. But in the current situation Stena doesn't seem to prioritize this collaboration that high. The change of interests from key persons in a company can play a big role in the synergy's survival and future as discussed by Walls & Paquin (2015). During the interviews it didn't emerge any obvious champions in the other synergies. This may have been because of a lack of such persons or because the people that got interviewed didn't have enough knowledge.

The biofuel synergy between the municipality and E.ON is not by definition of the self-organized type since it doesn't involve two industrial actors, as defined by Boons, Chertow, Park, Spekkink and Shi (2016). It is however behaving like one, with the same outcome and motivation behind the cooperation (Boons F., Chertow M., Park J., Spekkink W. & Shi H, 2016). The driver behind this synergy is not very different from the others, the municipality wants the environmental benefits and E.ON sees the economical value. The thing that differ this symbiosis from the others is that this synergy is pretty much self-sufficient. It takes little costs and effort to keep it going since it is built on a simple contract. The municipality only needs to drive a specific amount of vehicles on biogas and E.ON simply needs to make sure there is biogas at the tank station. In this type of self-sufficient relation there might not be a need of any higher trust or a bigger economical value.

E.ON'S ROLE

One could argue on whether E.ON acts as an scavenger or an anchor In Älmhult. They are a central actor in the symbios who supply the other actors with resources, but they also depend on other actors' waste in the symbiosis (Walls & Paquin, 2015). It is however clear that without E.ON the current synergies would not exist.

THE IMPORTANCE OF PROXIMITY

Walls and Paquin (2015) states that research in the field of IS historically has focused on areas in which the industries are placed in a cluster and/or has geographic proximity. They further state that it's an important component in the arising of the IS and also in the further development, both to support social linkages that can facilitate material exchanges, knowledge, trust, utility-sharing and reducing of transports. As Älmhult's environmental director mentioned about the strategic development plan of the municipality, it wasn't taken into consideration how to locate companies in the same area to facilitate for the companies to collaborate with each other. The reason was rather to keep the industries away from the city center. Even though it wasn't the municipality's intention to create possibilities for exchanges between the future upcoming companies, they might be able to support and influence this later on.

The importance of proximity is under debate however, because of today's global society according to Lombardi and Laybourn (2012). The IS in Älmhult is very interesting to consider in this matter, since two of the identified synergistic relations occur between one company within the system boundary and one outside of it. This goes against what many authors talks about, one example is Chertow and Ehrenfeld (2012) who states that proximity is important for IS to emergence and for it's development.

Stena Aluminium's waste product salt slag that is sent to Germany and afterwards sent back to the factory is, according to us, an evident symbiotic relation. This because using the by products that used to be put on landfill creates a valuable resource for Befesa, as well as a new resource from Stena, while both lowering costs and creating environmental benefits. These kind of collaborations is after all what industrial symbiosis is all about as discussed by Lombardi and Laybourn (2012).

The other boundary crossing synergy identified in this project revolves around Elme Spreader's waste products, of which we have not been able to collect much information regarding neither quantity or type. The fact that their waste is being taken care of by Stena Recycling and sold on an open market to Stena Aluminium has potential when it comes to developing a collaboration. The exchanges are already happening in a self-organized way although they are not verified by a written agreement. That means there are possibilities to do so since it may be both economically beneficial as well as a possibility for environmental marketing for all of the companies. On the other hand there can be administrative hinders that complicates such agreements. This needs to be looked into more, but we have not been able to do that.

POSSIBLE AND FUTURE SYNERGIES

If Älmhult Gjuteri can come up with a better way of using less heat and still manage to have good ventilation, they might be able to connect the factory to the district heating system and start delivering their waste heat. Their focus during the last years has been to make their own company more energy efficient and therefore don't have any synergistic relations. This is interesting to discuss in order to know how energy efficiency counteract the purpose of IS. When companies makes internal improvements that leads to less waste, heat or energy use, it might not be interesting to start a collaboration with another company that find value in this waste products. This might be the situation for Älmhult Gjuteri, but lack of information regarding their production makes it hard to say what could be done. However, we don't mean that internal improvement is something that shouldn't be done, it just doesn't work that well with IS in all cases.

It is interesting why such a big company as Transpo has no connection to other companies, except buying heat from E.ON. When we were talking on the phone with their CEO he didn't express much interest in this matter. Therefore it might be a topic which isn't highly prioritized in their company and that could be one reason why no synergies exists. The company doesn't have that many employees and therefore doesn't have any person that works with these kind of questions (Claesson, 2012). It is however hard to speculate with this limited information but it would be interesting to look more into this case in the future.

E.ON seems interested in being able to use waste heat in the district heating system when the price is cheaper than using their own virgin biomass. Therefore, it is not surprising that using the spare heat from the computer server building is interesting for them. Even though this is another IKEA affiliate than IKEA Industry, the fact that E.ON and IKEA Industry already have a strong and trusting

relationship can be a positive influence and might be one reason behind this potential synergy. As previously mentioned, the economic benefits might be bigger for E.ON at the same time as it would be a great way for IKEA that's already a "environmental friendly" company to strengthen their brand (Viberg, 2017). The possibility for E.ON to recover more heat for the district heating system through incinerating the lacquer in IKEA Industry's production is a very interesting cooperation. Especially because of the openness it shows between the companies. We first found out about this possible synergy through people at E.ON, which also shows that they have a good dialogue about the problems that may or may not occur depending on what IKEA decides to do in the future. This is also an example of how "trust supports the creation and deepening of relationship between IS firms, allowing more complex network arrangements to arise" according to Hewes & Lyons (2008).

THE ROLE OF THE MUNICIPALITY

There's a lot of things the municipality could do to help and support the development of industrial symbiosis. An example of a municipality in Sweden with a successful, supportive work is Sotenäs kommun (Carlsson, 2017). Even though there are different circumstances in each place, the acting from the municipality could be expected to be the same. By supporting businesses and industries with education and knowledge about what industrial symbiosis is and what benefits it can bring in terms of economical, environmental, personal relationships etc., the companies can get familiar with the concept and maybe start to consider this in the future. The municipality can help plan how and where the city should grow, be supportive to companies and create valuable meetings between the acting companies in the region. In Älmhult they don't prioritize questions about this.

What also has to be highlighted when talking about the role of the municipality, is how a symbiosis is established and how good the continuing cooperation works. When an industrial symbiosis is planned there could be a lack of trust and interaction, and it doesn't automatically gain acceptance in businesses (Mirata, 2017). On the other hand, a planned IS has a better optimization potential, since the goals and visions of the system in which IS is to take place are built-in and it usually takes less time to develop (Mirata, 2017). What can be expected of Älmhult municipality is not to create and organize an IS, but instead to be a supporting actor for the companies and create possibilities for synergies when planning the future developments in the city. The diversity in Älmhult is very narrow. Most of the companies are working with manufacturing, stocking or with distribution and that may make it harder to build up an industrial symbiosis network. It might a good idea for the municipality in trying to expand the businesses and attract companies within other branches in order to increase the possibility for new synergies. A diversity of actors is necessary to ensure the opportunities for exchanges exist, as it provides a better variety of resources flows (Walls and Paquin 2015, Chertow 2000).

Organized breakfast meetings could be a perfect platform to exchange experience and knowledge for the companies if they are performed in the right way (Mirata 2017). The meetings can help to create more personal relationships and build trust in these, and also identify new partnerships. What could be developed from today's situation is that the environmental director is somehow also involved in

the existing breakfast meetings. She is the one with best knowledge in environmental related questions and showed an interest in participating in these kind of activities. The reason why she isn't involved today is because of lack of time. These breakfast meetings might be even more important based on the fact that so many people commute to, and therefore might lack the natural local connection to Älmhult. If people go to meetings they learn more about the municipality and they might feel a deeper connection. It is also good for both the commuters and for the people living in Älmhult so they can get to know each other and later collaborate when they have built trust in their relationship.

The on-going TRIS-project can result in being a springboard or an inspiration for the municipality to work more with investigating IS. Maybe TRIS can deliver good findings in possible synergies that could help the municipality's further work as well as inspiring them to prioritize this question more. Sometimes a small input could be the only thing that is needed to start thinking in new terms, and Energikontor Sydost could be the coordinator together with the municipality that helps the actors with this. In Sotenäs municipality for example, everything started with a field trip to Kalundborg, and on the way home they had already made the first sketch of the synergies in the municipality (Carlsson 2017).

5. CONCLUSION AND FUTURE WORK

One of the most important conclusions is how different incitements affect the development of a successful IS, which is confirmed in the analysis between E.ON - Stena Aluminium and E.ON - IKEA Industry. These synergies show the impact that trust can have in making the collaboration run smoothly. This can be seen in the collaboration between IKEA Industry and E.ON where IKEA trust E.ON enough to let them maintain the boilers in their facilities. This makes it possible for the people with the highest competence to handle the technical issues.

The content in this report shows that proximity can facilitate industrial symbiosis relations but however this is not compulsory which is shown in the synergy between Stena Aluminium and Befesa.

Älmhult is an interesting city located in a region with possibilities for industrial symbiosis based on the infrastructure. An idea for future research would be to expand the system boundary and/or look into the companies that weren't investigated. It would also be very interesting to do further research into how energy efficiency affects industrial symbiosis and if it's possible to combine these two.

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