

Alvesta Case Study

Report

Industrial Symbiosis
(TKMJ38)

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Abstract

This document describes the findings of an industrial symbiosis field study project in the area of Alvesta, a small town in Småland, Sweden. Main goal of the project was to apply theoretical knowledge acquired during a course at Linköpings University by mapping and analyzing any existing symbiotic linkages and their future potentials in Alvesta region giving answer to the following two questions:

- What are the existing and possible future symbiotic networks in the area?
- How did the symbiotic networks come about and what were the driving forces behind these?

Central to carrying out the project was a field visit and personal as well as telephone interviews with actors that the authors identified as potential contributors to a symbiotic network.

Main findings of the field study are the symbiotic network around a biogas plant founded by local farmers (Alvesta Biogas AB) as well as the linkages around the area's sawmills. It was found that especially details about the history and emerge of the biogas plant can be seen as special. Four factors about the plant are forming a crucial combination of assets and support without which the plant might not have succeeded in such an unusual way:

- Being owned by farmers which both are suppliers and customers to the plant, securing both a certain amount of supply and purchase at the same time.
- The plant's business relations with a large group like E.ON.
- An extraordinary role of NORDEA who granted both loan and negotiation knowledge about price determination and contract design.
- As well as the plant's internal driving forces in form of highly motivated people.

Future potentials around the biogas plant are linked to opportunities in increasing their sales. Production currently runs at 30% only and input supply seems easily procurable in larger amounts as well.

The network around the sawmills involves mainly the relation between the local electricity and district heating provider Alvesta Energi AB and the Vida sawmills. For years Vida has provided wood fuel to Alvesta Energi who operates its plant solely on renewable fuel inputs. Worth mentioning are their informal relations when it comes down to everyday practicalities. For a complete network image see the section 3.2.2.

It was also found that the platforms and activities carried out by the municipality of Alvesta show potential in supporting new business relations and mutual exchanges. So far, however, neither municipality nor actors within the described networks are aware of the concept of industrial symbiosis. It would therefore be interesting to find out more about if such an awareness would be able to further foster industrial symbiosis in the area. Future

investigations are also likely to show more symbiotic linkages around Alvesta which could not be covered within the scope of this project.

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Both this project and the course of Industrial Symbiosis have been very absorbing and inspiring. Particularly the application of theoretical knowledge in a real world case has strongly contributed to deepening our knowledge on industrial symbiosis.

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References

1 Introduction

In this sections projects is introduced. The background about the project and the region is described as well as the main objectives and limitations.

1.1 Project Background

This report is the result of a field project performed in the Industrial Symbiosis course during the autumn semester of 2017 at Linköping University. The estimated time of work of each member of the team is about 50 hours which results in a total of 200 hours worked. Main goal of the project is to apply all the theoretical knowledge acquired about industrial symbiosis in to the Alvesta region. This includes collecting information about an existing symbiotic network in the area of Alvesta, analyzing it with help of course literature and communicating it through this report. It has been detected that in the Alvesta region there are already existing symbiotic relations and also potential relations between companies and local actors.

1.2 What is industrial symbiosis

The authors of the report depart from an understanding that Industrial Symbiosis should be seen as a process, rather than a static state. It is the part of industrial ecology that engages diverse organizations in a network to foster eco-innovation and long-term cultural change. This includes producing and sharing knowledge through the network, mutually profitable transactions of by-products and utility synergies, value-added for non-product outputs and improved business and technical processes. This definition mainly follows the lines of the definition of Lombardi and Laybourn (2012), but also Boons (2016).

1.3 Alvesta description and history

Alvesta is a small town in Småland and the capital of Alvesta municipality (Nationalencyklopedin, 2017). Alvesta municipality is the third biggest municipality in the Kronoberg County. The town of Alvesta has about 9,000 inhabitants, about 20,000 inhabitants in the municipality, and is home for roughly 2,800 companies and organizations (Nationalencyklopedin, 2017; Alvesta municipality, 2017a). Today Alvesta has an industry area in the southwest with about 15 companies and there are also plans for building a new industry area, Orrakullen, in the sector (Wigren, 2013).

In 1865 Alvesta was connected to the Södrastambanan, a railway track going from northern to southern Sweden, and along with the railway Alvesta started its development towards an industrial town and an industrial center in Kronoberg county between 1860-1920. The major part of the industries during that time was forestry, slaughterhouses and foundries.

Today Alvesta still has many of those industries. Wood and workshop companies dominate the industrial landscape, which benefits from the fact that forests account for 70 % of the land around Alvesta (Nationalencyklopedin, 2017). Alvesta has two large sawmill companies in close proximity, Vida and ATA Timber. There are agricultural businesses in the area with

plenty of farms and some of these work together to provide for and operate a biogas plant just outside of town.

1.4 Objectives with the project/goals with the project

The main purpose of this study is to investigate the identified and mapped symbiotic relations between industries, companies and local actors in the Alvesta region. This implies knowing the type of relations, how these relations came about, advantages and disadvantages identified and the challenges during the development process. The industries in focus during this report were the sawmills, the biogas plant and the energy company in the region. They were focused on because it was showed during the initial search of information that they took part in what could be symbiotic relationships.

The conditions in the region will also be analyzed to find out if they are favorable for the symbiotic relations.

To be able to fulfill the purpose of this report the questions below have been formulated:

- What are the existing and possible future symbiotic networks in the area?
- How did the symbiotic networks come about and what were the driving forces behind this?

1.5 Limitations

Major limitations of this study are the large amount of companies and the lack of response from some of them which has led to a focus on relationships with the biogas plant, the sawmills and the electricity and district heating provider in the Alvesta area. It was found that contact persons at the companies involved often had no access to quantitative information on their symbiotic relationships which limits the report greatly in this aspect. It was easier to find information about the qualitative nature of the relationships which is why this report focuses more on these. Qualitative aspects include for example how the actors see their collaboration with each other from a personal perspective, assessing who is important for the network and for making it happen and why the different actors chose to work with each other from a practical point of view (e.g. transports, formalities). If a significant relationship has been detected outside these first networks, it has been taken into account during the analysis.

Another limitation experienced during the project is the language barrier. The project group consisted of two native Swedish speakers and two with other native languages. Information found on internet was only accessible in Swedish which made it hard for the whole group to search for information. The interviewees also preferred to take the interviews in Swedish which meant that only two persons could conduct the interviews and understand would was being said.

2 Methodology

The project started with the members of the team researching about Alvesta region which was mostly done using the internet. This included collecting information from the municipality, industries and companies in the area. Most information was received from the webpages of the actors in the area and from local press.

Once the authors had gathered enough information about the municipality and its industries, interviews were conducted with people who were seen relevant to contribute to the project's aims. As previously mentioned, the choice of interviewees relates to course knowledge about potential actors in a symbiotic network on the one hand and by analyzing who such potential actors could be in Alvesta. Concretely, process industries in general, companies known for large amounts of waste flows like sawmills, sewage treatment plants as well as scavengers of these industries like district heating companies and biogas plants were identified as promising sources of information.

The main communication medium with the contacts in Alvesta was by email. To the extent possible, telephone contact was made with relevant parts to try to get more information. Interviews were conducted with local authorities, the district heating provider, one biogas plant and one sawmill, namely Alvesta municipality, Alvesta Energi AB, Alvesta Biogas AB and Vida Vislanda AB.

The purpose of the interviews was to clarify the network, collect more information about the actors, the historical development of the network (how it began and how it is working now), about the opinion of different actors, how the symbiosis affected them etc. Interviews were conducted primarily in person, most of them were done during a field visit to the area (three cases). For interviews that could not be made during the visit, meetings were held by telephone (one case).

Analysis of collected field data was done using course material and scientific literature provided during the course. This report is the result of this analysis and presents the found synergistic relationships. Conclusions regarding the situation today and the future were drawn from the analysis and represent one part of this document.

In addition, a short story has been written in order to summarize the findings of this study in popular writing.

3 Results

In this section the results of the field project are presented.

3.1 Alvesta - Background and spirit

During an interview with Ola Agermark, responsible for industry and commerce (näringslivsansvarig) at Alvesta municipality, he mentioned that the spirit in Alvesta is not so far from the spirit in Gnosjö (Agermark, 2017). "Gnosjöandan" as a concept is used in areas where there is a "do it yourself"-spirit with a lot of informal networks between companies, using what is in close proximity instead of looking far away for help (Gnosjö, 2014).

Agermark mentioned that the spirit in Alvesta, and especially Vislanda, is and always has been friendly minded towards collaborations. According to him this shared view of the companies includes everything from helping with knowledge whenever it is needed to helping with resources that another company needs. This Alvesta spirit, where companies are not afraid of using each other's help, is a stable stepping stone towards further industrial symbiosis collaborations in the area (Agermark, 2017).

Alvesta municipality bought land for a new industrial area called Orrakullen not far from the town of Alvesta. The plan is to increase the amount of companies and thus jobs to the area by offering potential firms an attractive place to settle. Among others this might be achieved by co-locating industries that are in need of heating/cooling (e.g. logistics and warehouses) with the already existing sawmills which could provide this heat. However, the municipality is not explicitly planning the area with industrial symbiosis on mind (Agermark, 2017). Currently Orrakullen is in the detail planning phase (Alvesta municipality, 2017b).

3.2 Introduction to the existing or projected network

Most important networks identified are the symbiosis around Alvesta Biogas and the symbiosis around Vida sawmills with Alvesta Energi. In section 3.2.1 the main actors are described and smaller actors are described within the synergies.

3.2.1 The main actors involved:

- Alvesta Biogas AB: The Alvesta biogas plant was founded by twelve farmers in the area. The plant produces biogas, from manure and offal from farmers, for an equivalent amount estimated to 6,000 m³ per day (Granefelt, 2017). Currently the plant is running at 30% of its capacity (Granefelt, 2017). The waste product in the biogas plant becomes fertilizer that goes back to the farms' own fields (Lantbrukarnas Riksförbund, 2015).
- Vida AB (Vida, 2017): Is Sweden's largest privately owned sawmill company. Production is primarily focused on structural timber for a large assortment of different markets. Operations also include the manufacturing of package material, pellets and biofuel trading.

- Alvesta Energi (Alvesta energi, 2017): Sells and distributes energy, heating and electricity, primarily to the towns of Alvesta and Moheda. Alvesta Energi produces their own heat by burning biofuels and have done so since the start in 1998 (Hed, 2017). To be able to meet the higher demand they also have an oil pan which is rarely used though (Hed, 2017). They produce heat in Alvesta, Vislanda and Moheda and generated 105.3 GWh of heat in 2016 (Alvesta Energi, 2016). The distribution of electricity is managed by the wholly owned subsidiary Alvesta Elnät AB. Alvesta Energi also offers broadband services.
- ATA Group (ATA, 2017): Is one of Sweden's largest privately owned sawmill and pulp production groups. Besides the sawmills, the group are also working with pulp factories. The by-products (bark, sawdust, shavings) from the production at the sawmills is used as fuel for their own solid fuel plants and are also sold as fuel for companies that need heating.
- E.ON Sweden AB (E.ON, 2017): Is part of the international group E.ON SE based in Essen, North Rhine-Westphalia, Germany. The group operates one of the largest utilities owned by investors in the world. E.ON Sweden AB produces and supplies energy to the Nordic market in the form of electricity, gas, heat, cooling and waste management, as well as energy-related services.

3.2.2 Network structure

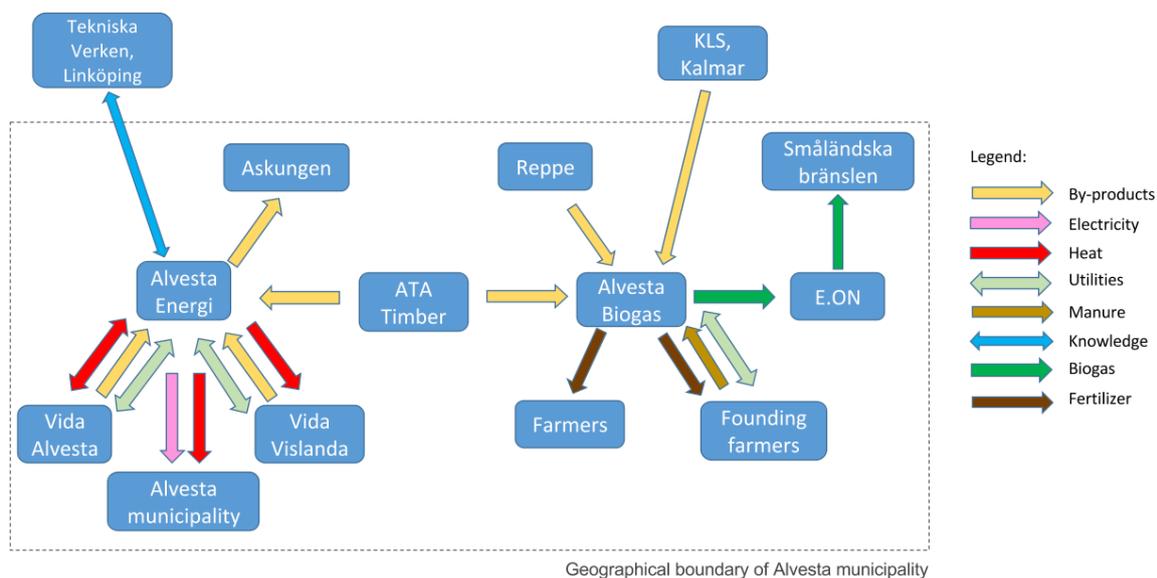


Figure 1 shows the mapped linkages in the area.

3.3 Synergies

In this section the symbiotic network linkages seen in Figure 1 are described.

3.3.1 Alvesta Biogas - E.ON - Småländska bränsle: exchange of biogas

Småländska bränslen is an automobile company that offers both electric and biogas vehicles. They also own fueling stations around the Alvesta area for biogas cars (Elbilarna, 2017).

Process outputs are 6,000 m³ of upgraded biogas per day which is bought by E.ON and Småländska bränsle. E.ON serves as an intermediary between Alvesta Biogas and Småländska bränsle. For example the local transportation company in Växjö uses this biogas in circa 40 of their busses bought through E.ON. According to Joakim Granefelt, one of the twelve founding farmers, this has worked out very well and Växjö is content with both the performance and reach of their bio fuelled busses (Granefelt, 2017).

3.3.2 Alvesta Biogas - 12 founder farmers: exchange of manure, fertilizer, utility

As Alvesta Biogas AB has been founded by local farmers it is natural that the manure for their process comes from the farms of the twelve founders.

Along with biogas, Alvesta Biogas AB produces upgraded, odour free biofertilizers which are delivered to the twelve founding farmers as well as to other farmers in the area. The biofertilizers which are taken back to the farmers are directly transported to newly built wells at the fields and not to the wells at the barns as it used to be. One advantage of this is that the farmers don't need to transport it out to the fields themselves. The number of transports have thus not increased in total (Granefelt, 2017). The amount of manure that is supplied by the farmers is taken back to the farms in form of biofertilizer. About 80,000 tonnes of manure are transported from the farmers yearly (Linköpings Universitet, 2017).

3.3.3 Alvesta Biogas - KLS: exchange of slaughterhouse waste

KLS is a slaughterhouse that processes only Swedish meat. Operations include pig, beef and lamb. KLS sells everything from cuts to finished products (KLS, 2017). The twelve founder farmers of the biogas plant, for example, send their animals to KLS for slaughtering (Granefelt, 2017).

As mentioned above, manure is used in the biogas production. Manure, however, is not enough for sustainable production (Granefelt, 2017). They needed more inputs. The proportions of inputs are 40% manure and 60% for all other inputs which has proven to be the optimum ratio of inputs for the process. Therefore, Alvesta Biogas AB buys slaughterhouse waste from KLS in Kalmar which is delivered to the biogas plant on a daily basis. (Granefelt, 2017).

3.3.4 Alvesta Biogas - Lantmännen Reppe AB: exchange of glycol waste

Lantmännen Reppe AB is a manufacturer of glucose syrup. They process wheat that is the raw material for five main products: glucose syrup, vitale wheat gluten, ethanol for human consumption, dried and modified starch and feed raw materials (Reppe, 2017).

As another input to the biogas process, Alvesta Biogas buys glycol waste (syrup, fats) from Reppe in Lidköping and Växjö. Glucose production creates waste that often needs to be washed from the facilities. Instead of just washing this away, Alvesta biogas collects it and uses it as feed stock in the biogas production (Granefelt, 2017).

3.3.5 Alvesta Biogas - ATA Timber: exchange of wood waste (fuel)

Process heat needed at the biogas plant is added by burning wood fibres, a waste product delivered by ATA Timber (Granefelt, 2017).

3.3.6 Alvesta Energi - Vida Vislanda: exchange of heat, utility and wood waste

Alvesta Energi buys fuel, for example wood, bark, etc., from Vida Vislanda to fuel their district heating processes as well as electricity production. Last year around 100 GWh of fuel was bought by Alvesta Energi from Vida Vislanda (Hed, 2017). In turn, Vida Vislanda buys approximately 8,500 MWh of energy in the form of heat from Alvesta Energi every year.

Vida Vislanda even shares utility with Alvesta Energi by letting them buy a piece of land from Vida to have their boiler on. The contract between Vida and Alvesta Energi is renewed on a yearly basis.

3.3.7 Alvesta Energi - Vida Alvesta: exchange of heat, utilities and wood waste

As mentioned above Alvesta Energi is in a symbiotic network with Vida in Vislanda, and they are also in a symbiotic network with another sawmill belonging to Vida in Alvesta. The contracts between both actors are renewed each year. Alvesta Energi's boiler was allowed to be built on Vida Alvesta's property. Being in need for heat for the wood drying process, the sawmills received this heat from Alvesta Energi at first. But when the sawmill expanded they were in need of more heat, more than Alvesta Energi could provide and they built their own boiler, which means that Vida Alvesta no longer buys heat from Alvesta Energi on a regular basis (Hed, 2017).

Alvesta Energi's boiler is still today located on Vida's property and the two boilers are interconnected to be able to transfer excess heat if needed and if possible. Last year 3-4 GWh excess heat were delivered to Vida Alvesta from Alvesta Energi. In their boiler Alvesta Energi uses the by-products from Vida's sawmills as fuel (bark and wood-chips), the same as Vida uses in their boiler for process heating. Since the boilers are only located about 5 meters from each other Alvesta Energi and Vida participate in utility sharing as well. The same truck is used for transporting the fuels to the boilers, and it is Vida who transports the fuel to both: When they transport fuel to their own storage they also drop off at Alvesta Energi's storage. The closeness of both storages also makes it possible that one actor can use the fuel in the other party's storage if required (Tholin, 2017).

3.3.8 Alvesta Energi - Askungen: exchange of incineration ashes

Askungen is a company dedicated to recycle ashes of wood burned as biofuel. They ensure the safe return of ash to the forest, where the nutrients in the ash promote the development and vitality of the forests (Askungen, 2017).

Alvesta Energi buys the services of Askungen and they collect the ashes produced by the incineration of Alvesta Energi's boiler and returns it to the forest (Hed, 2017).

3.3.9 Alvesta Energi - ATA Timber: exchange of by-products

As mentioned above Alvesta Energi uses by-products from sawmills as fuel in the boiler for district heating. The by-products they buy from Vida in Alvesta is not enough so they also buy by-products (bark and wood chips) from another sawmill in the area, ATA Timber (Hed, 2017).

3.3.10 Alvesta Energi - Tekniska Verken: knowledge sharing

Tekniska verken is an energy and resource company based in Östergötland. They offer solutions in many fields, for example electrical grids, district heating and broadband. (Tekniska Verken, 2017)

Alvesta Energi is a part-owner in Bixia, a electricity company. Another part-owner in Bixia is Tekniska Verken. The two share information with each other about meter readings and the usage of tools to measure and supervise the district heating net and electricity grids (Hed, 2017).

3.3.11 Alvesta Energi - Alvesta municipality: exchange of heat, electricity

The heat and electricity that Alvesta Energi produces are transported to the municipality of Alvesta (including Moheda).

3.4 Key symbiotic networks - their past and future potentials

In this section the history and future potentials about the symbiotic networks are described.

3.4.1 The story behind Alvesta Biogas

The start point of the symbiotic network existing around the biogas plant were twelve farmers in the area which decided that, together, they would like to investigate into how to use all the energy that was possible to harvest around their farms (Granefelt, 2017). The initial thought was that they would be working with their forest on their lands and use bark and woodchips to produce electricity for their own usage at their farms. In that process they also recognized a common problem for all farms, the farms had a lot more manure than they could use, so they decided to go with this idea instead. With the manure they realized that they could start producing biogas. The initial thought was the same as with the bark and woodchips, the biogas would be used by themselves at the farms. But they decided to sell the biogas as fuel for vehicles instead. Apart from the business opportunity behind this decision, they also wanted

to create a greater impact of their actions on societal level such as environmental and health benefits (Granefelt, 2017).

Two of the farmers, Joakim Granefelt and Jan Svensson, were the visionaries in the project. During the process, and still today, they have act as the intermediaries and middlemen in the creation of the biogas plant. In the beginning they gathered everyone and their ideas, they were the driving force in the process and the two also organized every meeting with all other actors that were needed. As well they made sure that all these twelve farmers remained in good faith about the biogas plant. Still today, these two are the ones who are running the productions and taking care of everything that needs to be done (Granefelt, 2017).

The first problem they encountered was that no one had any knowledge about biogas production. They received money to go on field trips to different biogas plants in Sweden. When they felt they had sufficient knowledge they applied for the environmental permits they needed and got funding for 60 % from Länsstyrelsen for the costs of getting the permit. The building arrangement for the plant was procured 2013 from, Swedish Biogas International (SBI). SBI helped with a lot of knowledge and also they set up a plan and guaranteed how much the plant was capable of producing. Besides from building the plant SBI has been an important actor in creating the industrial symbiosis network by, as mentioned, providing knowledge which helped the farmers to receive the loan from the bank (Granefelt, 2017).

Where the project met its biggest difficulties was with the financing of the plant. Granefelt and Svensson met with several banks, who didn't want to grant them a loan. Granefelt and Svensson have always been very clear with that the farmers are not going to risk their farms as safety going into this project. Eventually they met with Nordea, which were positively minded towards the idea. Here SBI and E.ON played an important role in getting the loan granted. SBI attended the meeting and guaranteed the production of the biogas plant. The guarantee and that SBI is a well known actor worked as safety for the bank. As mentioned before, another important actor was E.ON. Alvesta Biogas had already agreed with Småländska Bränslen (SB) about buying their biogas. SB is a small company and the bank was unsure what would happen if they went bankrupt. Therefore, the bank wanted a bigger safety. Joakim then contacted E.ON and got them to work as a safety for the bank. E.ONs part in the network is sort of a middleman, the initial contract was that E.ON only had to buy the amount of biogas that SB wanted to buy. E.ON bought the amount that SB wanted and SB then bought it from E.ON. As it developed E.ON today buys more biogas and uses it in their own biogas net. One really important part of Alvesta Biogas contract with Nordea was that Nordea convinced E.ON to insert a minimal price level that Alvesta Biogas would get paid for the biogas. The price of biogas is typically unstable and fluctuates a lot which guaranteed an income for Alvesta Biogas (Granefelt, 2017).

When the economy was in place the building of the plant started and 2014 was a hectic year. The plant was built and in the year's' end the first biogas was produced. Since the first biogas always is of lower quality the first shipment was sent in february 2015. Today the plant has one full time and seven part time employees besides from the 12 farmers. The future plan consists of trying to increase the production. The main goal is to use the food waste from the municipality. Alvesta municipality is going to introduce "gröna påsen" to collect food waste at it is the biogas plant's goal to procure the buying of food waste (Agermark, 2017). Gröna påsen

is an initiative in Linköping where food waste are being collected in green bags to be able to separate it from regular waste. It can then be thrown in the regular refuse chute (Tekniska Verken, 2016)

3.4.2 The story behind the Alvesta Energi / Vida network

Alvesta Energi has originally been founded because of the close proximity to the sawmills which would serve as continuous suppliers of wood fuel (Hed, 2017). The relationship between Alvesta Energi and Vida has therefore been ongoing since the foundation of Alvesta Energi in 1998. Vida's geographical proximity in both Alvesta and Vislanda was more beneficial and therefore a big incentive for cooperation (Hed, 2017). Discussions about collaboration in both Alvesta and Vislanda intensified with Alvesta Energi's need for increased district heating capacity and electricity production on the one hand, as well as Vida Vislanda's need for process heat on the other hand. The original plan in Vislanda was that the companies were going to buy surplus heat from each other, but today Vida Vislanda needs to buy energy every month to keep their business going. Vida has a 8 MW boiler today but they push it to 9-9.5 MW. The company would need a 12 MW boiler to manage their need of heat by themselves without buying from Alvesta Energi (Lagerbielke, 2017).

In Alvesta the original plan was that Alvesta Energi was in charge of the boiler on Vida's premises and would sell process heat to Vida in Alvesta. Then Vida needed more process heat than Alvesta Energi could provide and therefore they decided to build a new boiler. Alvesta Energi helped with the knowledge and the building of the boiler. When Vida's boiler was done Alvesta Energi stopped selling process heat to them (Lagerbielke, 2017).

There are no future plans on Vida Vislanda's side in intensifying the relationship with Alvesta Energi, which is a comparably small customer to Vida in terms of selling fuel wood. Most of the fuel from the sawmill is sold to Växjö. Instead, Vida wants to focus more on improvements on efficiency measures in their own boiler in order to reduce dependence from the bought heat from Alvesta Energi (Lagerbielke, 2017).

3.5 Platforms

In the Alvesta municipality there are many platforms where companies can meet each other. Some of them are branch oriented and at some platforms all types of companies are welcome.

3.5.1 Meeting places

Once every month the municipality of Alvesta organizes an event they call "Näringslivsfrukost" which is a breakfast meeting for companies in the area. The meeting platform were developed as platform for companies to meet each other and increase the knowledge about companies in the area (Agermark, 2017). The meetings were developed since there was a need for this kind of communicative platform and the aim is to increase the collaboration between companies. During these breakfasts the companies get to introduce themselves and what is going on with them right now and sometimes the breakfast has a theme which is to be

discussed during the meeting. According to Ola Agermark, enterprise manager at Alvesta municipality, industrial symbiosis as a concept has not been discussed as a theme yet even though there are plenty of symbiotic networks in the area (Agermark, 2017).

Besides the "Näringslivsfrukost" it is also organized platforms based on the branch of the companies. Twice every year the municipality hosts a meeting for all service and tourism with the same goal as the "Näringslivsfrukost". Alvesta teknikföretag also organize meetings where 15 industry companies meet each other regularly (Agermark, 2017).

In relation to these platforms study visits are also performed yearly at different companies and industries in the area and people from the municipality visit 15-20 companies every year with the goal to grow an understanding and create all kinds of relationships in the area. The goal with this study visits are to raise awareness of what is going on in the area, not to just create industrial symbiosis network. Even though it is not a goal to create symbiotic networks these study visits provide an important opportunity for companies to realise how they can work with each other (Agermark, 2017).

3.5.2 Social platforms

The municipality of Alvesta works extensively with trying to grow the relationships between companies but also just raising the awareness of what is going on in the area. By raising awareness of what companies are in the area, as well as what projects are going on right now at different companies and at regional level they hope to increase the collaboration in the commerce (Agermark, 2017). As mentioned above different platforms are organized where companies can meet each other and in addition to that a monthly newsletter is sent out to all the big companies and industries in the area (Agermark, 2017). The goal with this newsletter is to raise awareness among the companies. By raising awareness this newsletter enables companies to see what is going on in the area and what companies there are, which in the future hopefully can lead to them using the connections that are already in proximity, now that they have the knowledge (Agermark, 2017).

4 Analysis

In this section the existing network is analyzed by discussing key enhancers and key barriers.

4.1 Key enhancers

The present network in Alvesta came up spontaneously without any help from outside and by the economic interest of the companies involved. It is thus a self-organized network and not a planned one (Mirata, 2017). According to Agermark (2017) the ties between the collaborating companies are often informal with no solid framework of what is being shared in the network. Material, energy and human resources are split between companies and being driven by the general spirit in Alvesta and the friendliness in the network. These informal networks are considered a necessity for symbiotic exchanges and also provide a foundation for future development in industrial symbiosis (Walls & Paquin, 2015).

Industrial symbiosis is hard to create by itself and it is reliant on the self-interest of the actors that take part in the network (Chertow, 2000). There is a need for certain actors for industrial symbiosis to take place, Chertow describes the need for actors with the anchor-tenant relationship or anchor and scavengers as Walls & Paquin describe it (Chertow, 2000; Walls & Paquin, 2015). Anchors provide the stable flow that creates by-products and scavengers are actors whose core business relies on other actors' by-products (Walls & Paquin, 2015).

In Alvesta the twelve farmers have created a rather unique organisation where they are only dependent on themselves in delivering agricultural products to the biogas plant to keep it running. They are not in need to buy anything from other farmers because they only use slaughter waste from their own cattle, use manure only from their own farms and so on. They merely depend on others when getting none farming products and this is why this organisational structure can be assumed to be unique in its way. The set up also creates a unique way of resource dependency where they are only depending on themselves for the flow of manure (Granefelt, 2017). The biogas plant would today be able to run on only the manure from the farmers but to receive better quality of the biogas other inputs are needed as well (Granefelt, 2017).

As well as the biogas plant, the sawmills have played an important role in creating the industrial symbiosis network that exists today. Alvesta Energi was created with the sawmills in the region as an origin and the initial thought have always been to use the material provided in close proximity. The company has always been reliant on the by-products from the sawmills (Hed, 2017). Therefore, the sawmills can be seen as the anchors in their network and without them there might not have been one. An industrial symbiosis network would still maybe have developed where they bought the biofuels from somewhere else but the symbiotic network between actors in Alvesta region would not have taken place.

Both Alvesta Energi and the biogas plant can be seen as the scavengers in the Alvesta network (Granefelt, 2017). Just as Alvesta Energi relies on the by-products of the sawmills and Alvesta Biogas relies on numerous by-products, from all the actors named in the results chapter in order to produce their biogas.

Another important role in making the network transparent and provide security is the one of brokers and intermediaries (Chertow, 2000). Brokerage can be described as the dynamic where a third-party organization steps in to help the symbiosis emerge (Chertow, 2000). Intermediaries are a key lubricant for the network and a key function of them are to raise awareness of the industrial symbiosis network and work as knowledge banks (Walls & Paquin, 2015). The symbiotic network that exists today around the biogas plant would not have happened if it weren't for the actions of Nordea and E.ON (Granefelt, 2017). Nordea's knowledge and involvement was crucial in terms of setting biogas prices and contracts which lead to an atypical way of making business for a biogas plant. E.ON can be seen as the most important customer as they guaranteed to buy biogas from the plant and at the same time act as a service broker towards Småländska bränslen. Both companies can therefore be seen as intermediaries and E.ON can also be seen as a service broker, without whose contribution and support, the biogas plant would not exist as it does today. In the same network SBI also played the role as an important intermediary and coordinator, to provide the knowledge needed for the symbiosis to emerge. According to Granefelt (2017), the market for biogas plants in Sweden is a difficult one, and therefore biogas plants can be seen as high risk projects which have a hard time becoming profitable. Alvesta Biogas, however, has been profitable from year one which could be due to their unusual approach to deal with the market and setting prices - a result of their set of supporters.

In addition, so called champions can have a very significant and important part in symbiotic networks. They are often individuals with a special driving force and willingness to spread information about industrial symbiosis and to get more companies involved (Walls & Paquin, 2015). In Alvesta especially the two initiators of the biogas plant, Joakim Granefelt and Jan Svensson, can be assigned the roles of champions. They were the driving forces behind investigating the possibility of how to set up a biogas plant and convinced the other farmers as well as many other important actors which should become crucial for their project. This supports what Hewes and Lyons (2008) imply in their study with the importance of a champion to develop social relationships to build up trust among the stakeholders. It is also these two men that have been searching for knowledge and then spreading it to the other farmers and around the area. The champions have a critical key part when a new company is going to learn about industrial symbiosis (Walls & Paquin, 2015).

Granefelt and Svensson have participated in all necessary meetings. They were also the ones who contacted all required companies to get the network around the biogas plant initiated and intact. The process went relatively fast which supports the view of Walls and Paquin (2015), who mention the importance of having a rapid process time to get other actors in the community to interact in exchanges.

Geographical proximity can be important for an industrial symbiosis to emerge and to grow. Walls and Paquin (2015) believe that a close geographical proximity between companies can give advantages to an industrial symbiosis network compared to networks with longer distances, such as lower transportation costs, knowledge sharing and utility sharing. Even though much of the symbiotic network around Alvesta is not within an industrial park, geographical proximity between the actors was discovered to be important in several places. For example the farmers that own the biogas plant are placed in a maximum radius of ten

kilometres from each other and the plant which facilitates the transports - especially as they only use one lorry to carry out all transports. They also have other non-owner farmers in close proximity who they sell their upgraded fertilizer to. They do however need to travel to Kalmar to pick up the slaughterhouse waste. This is why they preferably look for new customer farms that lie on the way to Kalmar to make transports more efficient. Alvesta Biogas buys wood chips from ATA Timber which lies nearby the plant. Summing up, except the slaughterhouse in Kalmar, all stakeholders in the symbiosis network around the biogas plant are placed close to each other and as Walls and Paquin (2015) predicted this turned out to be of advantage to the network.

Another example in which geographical proximity was decisive to start collaboration is the case of Vida and Alvesta Energi. In Alvesta the energy company have their boiler on Vida's territory and it is only 5 meters away from Vida's own boiler. Thus the proximity leads to transportation sharing when the companies are able to use the same tractor to fuel the boilers, which can be assumed to reduce personnel costs, emissions, etc., and eliminate the cost of purchasing additional vehicles as well as no extra storage space is needed. Without proximity a collaboration with the storage would not have been beneficial to them and thus might have never come up.

For the success of industrial symbiosis one can not only recognize the network perspective of how the networks look and work (Walls & Paquin, 2015). The key to become successful and endure competition on a global scale is depending on the willingness of the companies to take part in these networks, and the willingness is highly reliant on the individuals in each company and therefore the individual perspective is of interest (Walls & Paquin, 2015; Porter, 1998). Building social capital within the network via social ties and repeated interactions works as a lubricant toward the development of industrial symbiosis and has also been identified as an important part in Kalundborgs' succes (Walls & Paquin, 2015). The social glue that binds networks together are important to be able to administer competitive assets and it requires personal relationship which also creates a common interest in the network (Porter, 1998). The breakfast meetings organized by Alvesta's municipality could be seen as such a platform that supports communication (Agermark, 2017). During the meeting the companies get face-to-face contacts with each other which the social capital is built upon. The geographical proximity also creates opportunities for repeated interactions between the employees of the companies, as indicated by (Hed, 2017), which helps create and build the social capital which could be beneficial for future collaboration between the companies.

As mentioned before the present network in Alvesta and the region is a result of self-organizing with a lot of informal collaborations and networks between companies. However, existing plans of the municipality about a new industrial area (Orrakullen) has potential from an industrial symbiosis perspective as it co-locates industries together with the already present sawmills. This might facilitate future symbiotic linkages. However, Orrakullen is not being planned with the concept of industrial symbiosis actively being on mind, but rather because certain needs of the new industries have been identified and the area happens to be able to provide these needs by using by-products and shared utilities (Agermark, 2017).

4.2 Key barriers

Diversity is an important mechanism to create stability and resilience within a resource-dependent system (Lombardi et al, 2012), as a diverse system is more likely to have other actor to fill gaps created when an actor leaves the system (Korhonen, 2005a).

In this respect, the sawmills play a key role in the situation in Alvesta region. There is currently a certain risk because of the dependence on these anchors. Would the network survive if one of the sawmills dropped out? This risk can be rated as acceptable, though, because there are at least two large sawmill companies - Vida and ATA. So if one of them dropped out of the network leaving the other actors without the necessary by-product streams, the other company might be able to make up for the shortage. This situation can produce each good and bad situations. The "security" given by the support of two large companies can give a false sensation of comfort and that can lead to a lack of attention to that part of the network. By having two large companies it is hard to believe that the resource flow from either of them will stop and therefore the network might not be prepared for it. On the other hand, the large companies can exert pressure on the network and prevent the increase of diversity by having power over the network. None of these attitudes is advisable for a good industrial symbiosis network development, but both can be a barrier (Paquin et al, 2014).

Also the lack of companies diversity in the area is believed to be a barrier that don't allow the network to grow. Following Walls and Raymond paper, that could ensure more exchange opportunities by having a great amount of materials, technologies, and processes farther to various values, perspectives, trends and priorities, and a potential wisdom base to drive innovation and business formation (Chertow, 2000).

Economy is also something that can be a barrier for developing industrial symbiosis. As already mentioned in section 4 finance was a barrier for developing the biogas plant. If Nordea had not provided the loan or introduced the minimum price in the contract the symbiotic network might not have been there today. Economic aspects are often a key-drive for introducing collaboration between companies and if the economical incentives are low the search for collaboration might not even be initiated.

Walls and Paquin discusses resource dependence as a key factor for prolonging industrial symbiosis (Walls & Paquin, 2015). The contract between Vida and Alvesta Energi are only written on one year basis, when the contract time is over Alvesta Energi could choose to buy the rest products elsewhere (Lagerbielke, 2017). In the interview with Jennie Tholin at Vida Energi she also mentions that Vida sells their by-products to whoever pays the most, and Alvesta Energi does not receive any benefits from being from the same area (Tholin, 2017). This could create uncertainty in the network and if Alvesta Energi decides to buy from someone else the symbiotic network in Vislanda disappears and it might show that the network is too reliant on the actors that are there today. The uncertainty that the set up of contracts create also makes any long-term planning between the actors impossible and investments into large IS-projects might then face a high risk of not being introduced. It is believed that a longer contract would mean that the companies are in business with each other for a longer period of time, and during that longer period of time it is a bigger chance that they develop a thriving relationship than there are with a one year contract.

Today Vida Vislanda also are depending on excess heat from Alvesta Energi, as said earlier. The risks of being depending on someone else's by-products, as Vida sees it, is a hinder for the industrial symbiosis (Lagerbielke, 2017). In the future if Vida will upgrade their heating boiler they will aim to build a boiler that is big enough for them to produce all the process heat they need, and therefore not buying excess heat from Alvesta Energi. As of today Vida is satisfied with the heat they receive from Alvesta Energi because it enables their business but in the future as mentioned they are looking for providing their own heat.

During the interview with Roger Tagesson at ATA Timber he brought up that they were too specialized and focused on their main product to be able to focus on industrial symbiosis (Tagesson, 2017). This is also a point raised by Mats Eklund (Eklund, 2017), focusing on just a main product might hinder the development of industrial symbiosis. This is a barrier for developing further collaboration between companies, they are so focused on the end product that they don't realise the potentials with industrial symbiosis. This might also be an explanation why we have not seen further development in the region.

4.3 Future of the network

As mentioned in the previous chapter Alvesta Biogas are hoping to get food waste from Alvesta municipality as input to their process. If this happens the network will expand even further and the biogas production will increase. Småländska bränslen are also planning on building more fueling stations for the biogas, this would require Alvesta biogas to produce even more biogas but it would also increase their revenue.

The relationship between Alvesta Energi and Vida Vislanda as mentioned is unstable and the contract between them only runs yearly. This creates uncertainty in the network and the future is aswell uncertain. Askungen buys the ashes from Alvesta Energi and this could also be done with the ashes from Vida Vislanda. Today the ashes are collected and landfilled, because Vida thinks the services of Askungen are too expensive (Lagerbielke, 2017), but in the future this is an opportunity for the network to expand even more.

The future industry area of Orrakullen also presents a major opportunity for symbiotic exchanges in the Alvesta region to grow. The area will be close to the biogas plant which presents opportunities for growth. While planning the municipality for example has had the sawmills as a background and plan to use them for different solutions such as district heating (Agermark, 2017).

5 Conclusion and future work

Alvesta and region already has an interesting industrial symbiosis network and also shows interesting opportunities for future development of industrial symbiosis. Even though symbiotic linkages in the area exist, there is no awareness of the concept of industrial symbiosis. Neither the interviewed actors within the network nor the municipality were familiar with it.

In the region there are companies, though few, with by-products that are typically useful for exchange. The spirit in the region, the platforms that exist today and future plans make it interesting to study for industrial symbiosis purposes. The history of how the network came about also hints towards dynamics that are interesting for future studies and that could support IS development elsewhere.

Many of the networks existing in Alvesta have developed through informal relationships. These are important for creation of industrial symbiosis and many of them have happened through the close geographical proximity in the region. But if the companies want to increase their network a possible way is to do so through face-to-face contact. The platforms to do this are already in place in the region, with the municipality hosting many meeting opportunities for different companies. Those platforms and activities carried out by the municipality of Alvesta show potential in supporting new business relations and mutual exchanges.

The history about Alvesta Biogas and how its network developed might be of extra interest. The structure of the organization made possible through the involvement of the twelve farmers are unique for the development of such networks and the involvement of Nordea, too, was a crucial part of the evolution.

As mentioned above the geographical proximity and industry colocation has played an important role for the spontaneous networks to develop. This is also something that will most probably continue to play an important role in the future, for example because of the municipality's plans for a new industry area in which proximity will most likely contribute to the success of any upcoming network.

A downside with the current situation in Alvesta is that the low diversity of industries might hinder the further development of industrial symbiosis. The competition between companies and the sole focus on core processes is also something that might hinder industrial symbiosis in the area.

Future Work

The authors believe that there are many collaborations still to be explored. Not all the companies in the area were contacted during the writing of this report, due to the limitations of the projects, and it would be interesting to further investigate what further collaborations there are. Further investigation would also include an opportunity to raise awareness the companies in the area more about the concept of industrial symbiosis.

As mentioned in the report one key enhancer for the development of the network around the biogas plant was the minimal price E.ON would pay for the biogas. It would be interesting to

further investigate how these types of contracts can enhance the stability and creation of industrial symbiosis networks.

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