Introduction of a New Product into an Existing Network

- A case study of recycled PUR at Stena Metall

MASTER THESIS

Peter Danielsson

Margareta Noyan

Department of Industrial Marketing

Master of Supply Chain Management

CHALMERS University of Technology

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Foreword

This master thesis is the final part of examination for Mechanical Engineering and Industrial Engineering and Management educations at Chalmers University of Technology. The master thesis is to investigate in possible future applications for recycled polyurethane at Stena Technoworld, part of Stena Metall.

We would like to thank our supervisor at the company, Mårten Frostne, Managing Director Sweden, Stena Technoworld for the possibility to write this master thesis at Stena Technoworld, and for the guidance throughout the process. We would like to thank our supervisor Kajsa Hulthén, associate professor and Igor Insanic, postgraduate at the Division of Industrial Marketing at Chalmers University of Technology for their dedication and guidance that many times kept us on the right track during the writing of this master thesis. We would also like to thank our friend Arta Sylejmani for her help during the initial stages of this master thesis.

Finally, we would like to thank everyone at the companies that we contacted during this time and that willingly answered our many questions about their respective industries. Especially, we would like to thank the individuals at Chalmers University of Technology and Stena Metall for sharing their information, knowledge and experience.

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Peter Danielsson Margareta Noyan

Abstract

This master thesis is an investigation of possible future applications for a recycled product at Stena Technoworld. The recycled product is a plastic material, polyurethane (PUR), a component Stena Technoworld in Halmstad receives when recycling cooling appliances. Stena Technoworld extracts around 2500 ton recycled PUR annually in its plant in Halmstad that also contains around 0,2 % freon as well as traces of other plastics and metals. The recycled PUR is therefore classified as a hazardous waste and has previously been disposed to landfill, and is currently being utilized by a sister company, Stena Recycling.

The purpose of this thesis is to investigate how value could be created for Stena out of recycled PUR. Further, the purpose of this thesis is to investigate the possibilities and the complications of introducing the recycled PUR into an already established business environment. The main theoretical framework utilized for this master thesis is the Industrial Network Approach, including the Activity-Resource-Actor model as well as Value Creation theories.

The master thesis led to the identification of nine possible applications within three areas: Absorbent, Combustion fuel and Material Recycling. The three applications within the absorbent area are oil spill removal, filters in gully holes and contaminated water cleaner. For the combustion fuel the three applications are fuel for preheating trash, fuel for the cement industry and fuel for the chalk industry. Finally, the three applications for material recycling are cooling appliances, ground insulation and filler material.

The recommendations for Stena Technoworld are to focus on three of these applications, with different combinations of them regarding the time perspective. The recommendation is to immediately commence with selling recycled PUR as briquettes to the chalk industry, while developing the network structure for launching absorbent products based on recycled PUR. In parallel to this, the recommendation is to initiate a material recycling project with interested actors, in order to keep the long term perspective of possible applications for recycled PUR.

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1. Introduction

This master thesis is an investigation in the possible applications for a recycled product at Stena Technoworld in Halmstad. The recycled product has only been utilized internally within the company, and there is an interest in finding new possibilities for the product externally. The interest in recycled products has increased during the last years, and it is considered as a benefit for companies to be able to include the environmental aspect in their businesses. Therefore, a recycled product can be benefited by its criteria's. This chapter will provide a background of the topic chosen, as well as a purpose and an outline for the rest of the thesis.

1.1 Background

Stena Technoworld, a subsidiary of Stena Metall, is one of the main actors in the European recycling industry. Stena Technoworld operates four sites that handle Waste Electrical and Electronic Equipment (WEEE) recycling activities in Sweden. Among the recycling activities currently performed, cooling appliance recycling done in Halmstad is one of the largest at Stena Technoworld. Furthermore, Stena Technoworld performs recycling activities in Germany and Italy where the rest of recycling demand of cooling appliances is handled. (Stena Metall 2011)

The plant in Halmstad receives cooling appliances mainly from Sweden but also from Norway and other Scandinavian countries. These are disassembled into their main components and are properly disposed of or recycled depending on the component. Upon 1995, new cooling appliances contained freon since it was utilized as a blowing agent to create the insulating plastic foam manufactured from polyurethane (PUR). In 1995, freon got classified as a hazardous product and therefore became forbidden to utilize in manufacturing processes. Still, a substantial part of the cooling appliances scraped today are manufactured before 1995 and needs to follow the restrictions for recycling hazardous products e.g. freon, which needs to be insulated in the recycling process. This requires several processing activities in Halmstad to be able to extract the freon from the recycled PUR, (see chapter 4.3.1 for a thoroughly explanation). Even though the processes have been developed and improved through time, the recycled PUR at Stena still contains traces of freon as well as other substances. The PUR in the recycling process has to be grained into a fine powder in order to extract the freon. This in combination with the general properties of polyurethane plastics restricts the possibility of utilizing the recycled PUR in new products and the recycled PUR has therefore been disposed of. It is only recent years that the recycled PUR has been shipped to Stena Recycling where it after some processing is sent to combustion.

Earlier, in 1994, Stena Technoworld, back then Stena Freon Recycling, raised the question if value could be created out of the recycled PUR obtained from the cooling appliances. Stena therefore took an initiative to launch a business case with the purpose of manufacturing and selling products containing recycled PUR. The selected product category, due to PURs properties of high absorptive capacity, was to utilize it as an industrial absorber. Due to certain circumstances the launch was not successful and the project was terminated in 1998 (see more detailed description in 5.1.4).

The developed processes when recycling the cooling appliances has lead to a more refined product with substantially lower amounts of freon that could open up the possibility to utilize recycled PUR when producing new products and thereby provide Stena with a greater opportunity of increasing profits from recycled PUR. Also, Stena Technoworld has gone from identifying themselves as a strictly process oriented company, to a producing company, that produces and sell of products as a potential future development. The increasing importance of the environmental aspect as well as the developed processes when recycling has lead Stena to initiate a project to overview new as well as old applications that could make recycled PUR to something more than a waste product. The development of recycled PUR at Stena has been from considering it as a negative fraction, that Stena Technoworld used had to pay gate fees in order to landfill, into a product that they sell to Stena Recycling where they go break-even, and finally into the next level of material recycling with potential profits. This is in line with the current situation regarding recycled products where the focus is on finding new applications for these, preferable in new products, and by that reducing the environmental footprint of the companies.

The environmental aspect of products and services has become increasingly important for stakeholders, and therefore also for the producing companies. The stakeholders are putting pressure on the different industry companies to regard the environmental aspects. By addressing the environmental aspect of the product or service a company can gain competitive advantage and potentially increase profitability. (Johansson och Winroth 2010)

These benefits are especially feasible in the recycling industry, where the products by definition are recycled and therefore from the start have a competitive advantage when selling and marketing the products. The challenge is to find the right way to introduce the waste product, and also to find a feasible area where the waste product can be utilized. To gain competitive advantage companies must develop skills in manufacturing, selling and delivering products that possess environmental quality and are put on the market for the right price. (Johansson och Winroth 2010)

A company that does not understand its surrounding environment risks to be struck by costly delays or even complete failures. This is true even if the products are considered to be a technological breakthrough or on the market superior products. Frequently, there is a crack between large firms and their market and therefore they forget several important aspects in their customers' activity structures. Often, change activities are necessary transcending from an existing product to new ones (Brandes et al, 1982).

1.2 Purpose

The purpose of this thesis it to investigate how value could be created out of recycled PUR for Stena. Further, the purpose of this thesis is to investigate the possibilities and the complications of introducing the recycled PUR into an already established business environment.

1.3 Outline

The master thesis will give a theoretical as well as empirical description of the problem structure and will finalize in analysis, discussion and recommendations based on the descriptions.

Chapter 1, **Introduction**, is to give the reader an understanding of the problem and the background, both in general and from Stena's point of view. The chapter will also provide the purpose of the master thesis.

Chapter 2, **Problem analysis**, is based on the purpose and will give the reader an understanding of the problems to be analyzed in this master thesis. The chapter will also provide a theoretical framework that together with research questions will be the base for the following chapters of the master thesis.

Chapter 3, **Method**, is to give the reader an understanding of the methods utilized in this master thesis in order to collect the information necessary for the project.

Chapter 4, **Empirical background**, will provide the reader with an understanding of the processes and the companies within Stena Metall.

Chapter 5, **Three cases based on the identified applications**, provide the reader with the empirical information received through interviews and is based on the identified applications.

Chapter 6, **Analysis**, will focus on the different application areas discovered in the empirical findings, and analyze them through the problem analysis and theoretical framework developed in chapter 2.

Chapter 7, **Discussion**, will further discuss the analysis and will provide with the base for the following chapters.

Chapter 8, **Conclusions**, will provide the final conclusions regarding the problems stated in the problem analysis.

Chapter 9, **Recommendations**, will provide Stena with recommendations in regard of application areas for recycled PUR.

2. Problem Analysis

The following chapter discusses the problems related to the purpose and identifies factors that affect the introduction of a product into an already established business environment. These identified factors become the base for the structure of the problem analysis. Furthermore, this chapter provides a theoretical framework that becomes the base for the analysis and for the discussion of these factors further on in this thesis.

2.1 Problem Introduction

As stated in the purpose, the goal with this thesis is to investigate how value could be created out of the fraction of recycled PUR at Stena. In order to do this, the possible applications for recycled PUR have to be identified to create a picture of which industries that could be out of interest. This is done by analyzing information gathered regarding its properties, characteristics and specifications. Within these industries it therefore becomes important to investigate what is valuable to Stenas potential customers, and see what value the recycled PUR could create for them in their business environment. The attempt of bringing a new product to an existing market requires having the recycled PUR as a resource in the center of attention. Therefore, the currently utilized products that the recycled PUR can possibly replace must be analyzed not only for their utilization, but also in their surrounding environment. Figure 2.1 shows a schematic view of an industrial network, with suppliers, the potential customer and its customers. Every company is unique in terms of its resource base which in most cases has been built up over many years (Gadde et al, 2008). Hence, the potential customer will rarely change its supplier structure if it does not see the benefits greater than the sacrifices. It therefore becomes evidently important to identify what these potential customers perceive as important benefits and which sacrifices these companies would have to do, if replacing one or several of their products with Stena's recycled PUR.

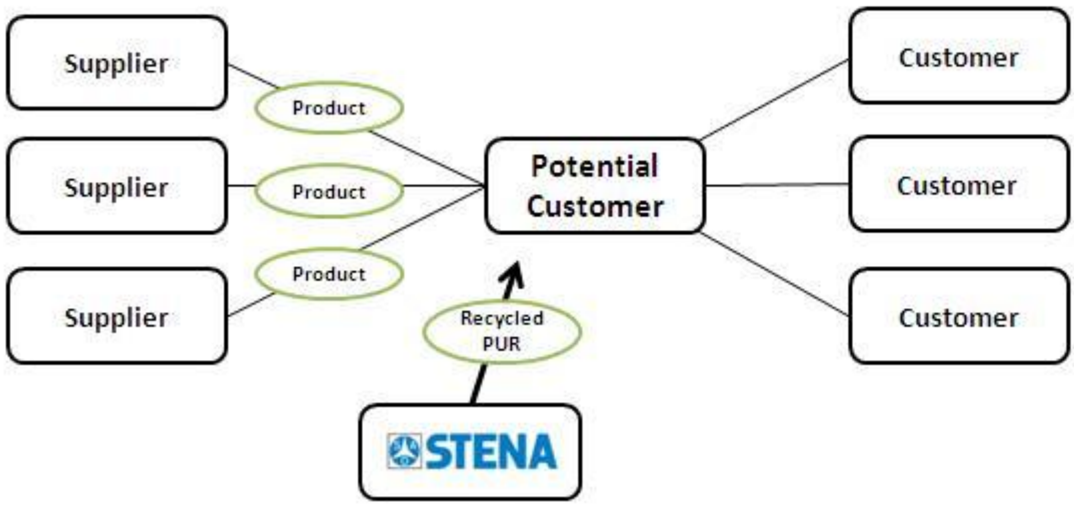


Figure 2.1: Schematic view of the industrial network from Stena's Perspective

This leads to a number of general questions that when answered will provide a picture of the current situation as well as an overview of the industries where the recycled PUR could be applied:

> Q1 - In which applications is virgin PUR currently utilized?
>
> Q2 - What is recycled PUR at Stena, and which processes does it involve?
>
> Q3 - In which applications and industries could the recycled PUR be an alternative product?

The problem analysis is further divided into two sections; *Resources in a network perspective* and *Value Creation*. Each of them starts with a theoretical framework within the subject followed by an analysis of the problem from Stena's perspective as well as the customer's perspective. The first section analyzes the problems related to resources in industrial networks. The second section assesses value creation, both from Stena's as well as from the potential customers' perspective including how the value of a resource changes in different contexts. Finally each section ends by stating a number of summarizing questions.

2.2 Resources in a Network Perspective

All companies are involved in some sort of business network, commonly exchanging resources in structures affecting both the currently present companies as well as possible new entrants. In order for Stena to understand how the market would react when a new product i.e. recycled PUR enter an existing market, it is essential to understand how the established companies and how their resources in the network are related and arranged. In this way it will be possible for Stena to see what efforts it would take bringing the recycled PUR into an existing market and to become a part of the network. This chapter therefore starts with a theoretical framework for analyzing industrial networks followed by a assessment regarding the networks where Stena are, or might be, involved.

2.2.1 The Industrial Network Approach

When considering the business landscape the traditional view has been to see it as an environment where companies has to compete against each other to survive and where each company is an closed unity with only necessary interaction with other companies. (Håkansson, et al. 2009) offer a new framework that views the business landscape as an environment where the companies are interdependent and where the important aspect is the different ways of involvement between the companies even though they are rivals. (Håkansson, et al. 2009) differ between business in theory and in practice, where in theory businesses are seen as independent companies that is only affected by competition, but in practice it is about coping with different situations while interacting with other companies. Figure 2.2 summarizes the Activity – Resource- Actor (ARA) model as well as briefly defines actors, activities and resources, described below.

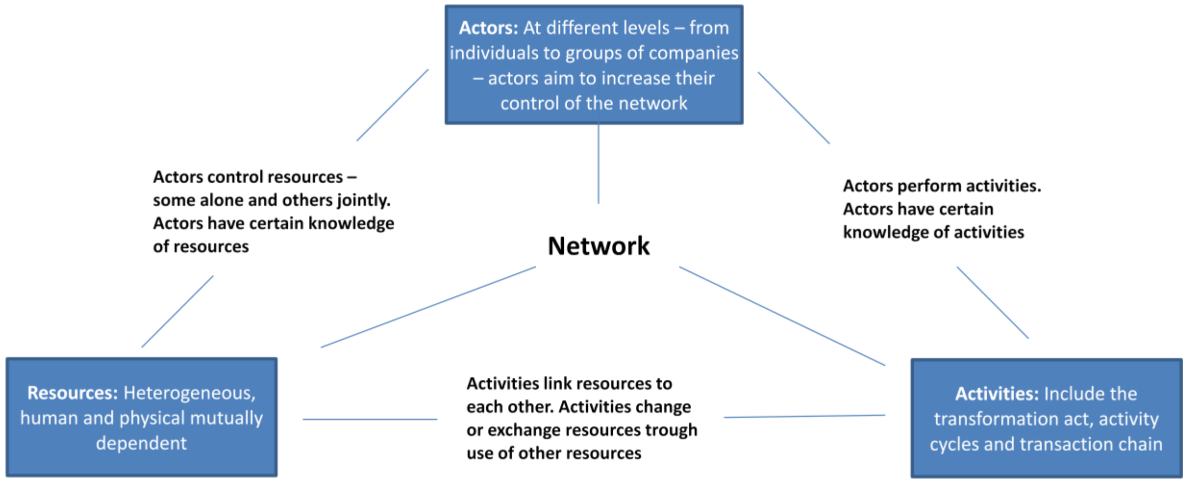


Figure 2.2: The Activity-Resource-Actor model

Business interaction between companies affects the resources and the people that are involved in it and the activities they perform. This is the base for the ARA model that is the refined view of business interaction. The ARA model is a conceptual framework that describes the outcome of an interaction process in three layers between the companies; the actor bonds, the resource ties and the activity links. (Håkansson, et al. 2009)

The ARA model is based on the knowledge of different interaction processes between companies, both long term processes such as production and transportation, as well as short term processes, where interactions within these processes involve more costs than benefits for one or more of the actors. (Håkansson, et al. 2009) observed a reality that is more complex than the classical view of market exchange where the exchange itself does not necessary involves the actors and where the products, services or money is fixed entities with no need for intervention of the actors. Instead of the simple exchange process, a transformation process also occurs that the actors have no control of. This transformation process interferes with the interpretation of the exchange with the different actors, and cannot be explained through the classic market exchange theories. (Håkansson, et al. 2009) indicate the need of understanding which resources that are involved as well as understanding the activities between the actors. Each actor has some initial control of the activities and resources, but in the interaction with other companies, this control is diminished in favor of interaction with other resources and activities. The companies in turn is also affected by other actors in the network, not included in the specific transaction but still affecting the whole network and one or more of the actors in focus.

In the ARA model, the three layers are connected to each other and is the base for the wider network. If one of them is developed or changed, it can open up for new possibilities and changes in the two others, or in the connections between them. (Håkansson, et al. 2009) emphasizes that the changes in actors, resources and activities not only affects them in the certain context they are viewed, but also the different interplays beyond the specific situation. It is therefore of importance to understand the three layers and the connection between them in order to understand business interaction. The section begins with the actor layer, followed by the resource layer and finalize with the activity layer.

Q4 - What actors, activities and resources build up the network structure related to each identified application?

Q5 - Which actors, and which actor bonds, will be affected by the introduction of recycled PUR into the existing network? (Dependencies)

2.2.2 Actor Layer

The actor layer is a reflection of the bonds between the different actors involved in the business interaction. These actors consist of different companies that have bonds between them due to the interaction between the companies. The bonds between companies are in fact bonds between the individuals in the companies, and it is these bonds, and the strength of these, that influence the activities and the resources used in a certain transaction. The actor bonds are important in the development of new transactions between companies as well as in identifying possible solutions in current transactions.

It is the actors that can tie together the resources and activities and therefore execute the actual interaction processes. Therefore, actors have some different aspects to consider in comparison to resources and activities. Most importantly, actors are not insulated features; they are actors only in relation to other actors, which mean that they are thus situated in a web of other actors by definition (Håkansson, et al. 2009).

Actors and their perceptions, behaviors and results

In order to be able to analyze interacting actors, (Håkansson, et al. 2009) provides a model of action consisting of three parts: perceptions, behavior and results. Perception is used as the starting point for analyzing, because it is the starting point for the actor when it form its opinions and act accordingly (Håkansson, et al. 2009).

There are two aspects of perception, one where the focus is on the actual firm and one where the focus is on the firm's connections to other actors in the network. In the first, the actor is influenced by its normative perceptions of how this firm should look like, and in the second aspect the picture is less complete due to the complexity of the different firms involved. The actors picture of these two aspects is based on past experiences, with strive of having as homogeneity worlds as possible. Holmen and Pedersen (2003) describe this as the firm's network horizon, which is the part of the network that the firm is aware of and therefore can take into account. They differ between network context and network horizons, where in network context the focus is on the firm's perspective and where the network horizon further describes the extended view of the entire network for the firm.

Behaviors of the actors are not necessarily triggered by clear intent or purpose and they are often complex and multidimensional. Behavior is connected to perceptions, but more loosely than earlier assumed. Results are a natural end of interaction as interaction is a problem-solving process. The outcomes of interaction are tightly connected to time and space, where any result is always connected to a certain problem at a certain point of time. (Håkansson, et al. 2009)

When analyzing actors interacting, it is important to understand the connections between perceptions, behavior and results. In the perspective of the one firm, these are connected in order, from perception through behavior to results. But as the firm is connected to other firms this order does not apply anymore. By being aware of this, the role of actors can more easily be understood. (Håkansson, et al. 2009)

2.2.3 Resource Layer

The resource layer consists of the resources that the actors have available, divided into tangible resources, e.g. physical items such as plant or equipment, and intangible resources e.g. knowledge or information. The resource layer is the adaption of resources and how well they are tied together. These resource ties arise as the actors mutually adapt their resources over time (Håkansson, et al. 2009).

In the ARA model, the single resource is tied together with other resources in the complex structure that form the business network. The resource structure is therefore not only the different resources, but also the resource ties between them. This means that the resource is not only available in one context, but instead can be utilized in many different ways and aspects which open up for different opportunities but also for different problems. (Håkansson, et al. 2009) suggests the 4R model (Jahre, et al. 2006) as a less complex way of investigating and analyzing the different resources available in the business network (see Figure 2.3 below). The 4R model consists of four groups of resources; products, facilities, business units and business relationships. Products are mostly tangible resources that can be moved and facilities are more permanent tangible resources that cannot be moved that easily. Business units consists of the knowledge and experiences of individuals and groups, while business relationships is the most complex category because it involves both tangible and intangible resources and is the basis for the decisions made within a company (Håkansson, et al. 2009).

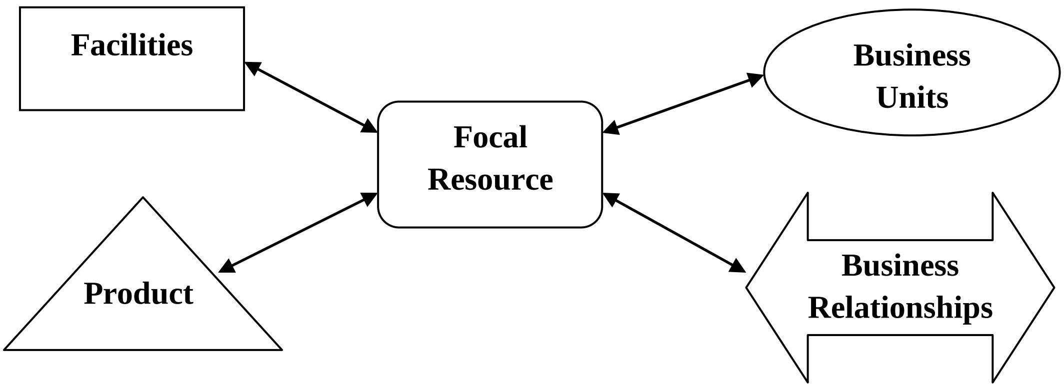


Figure 2.3: A focal resource and its interfaces with other resources (based on (Jahre, et al. 2006)

The four categories can be regarded as a stepwise increase in the interaction between the parties, ranging from products to business relationships. For products, the interaction can be both on arm's length as well as with more extensive interaction. In the latter case, the features of the products, such as adaptations, are outcomes of the interaction between the actors. When regarding interaction in facilities, the attention is on the integrated processes and facilities between the actors. Interaction in business units focus on the skills and capabilities of the individuals and groups, and therefore provide knowledge about the different actors operations and how they can work together. Finally, interaction in business relationships mainly affects the relationships with regard of time. It also affects and is affected by other relationships, which is identified as networking. (Jahre, et al. 2006)

By using the 4R model when considering the resource ties in a business network, the usefulness of a resource can be investigated in relation to the other resource ties in the network (Håkansson, et al. 2009). When using the 4R model, the first step is to map the focal resource, e.g. a product resource, against other product resources and then to follow with the three other types of resources. This ensures that all types of resources are incorporated when mapping those (Jahre, et al. 2006).

> Q6 - How would introducing recycled PUR affect the current resource structure?
>
> Q7 - How are these resources distributed among the actors and how are they inter-related?

2.2.4 Activity Layer

The activity layer is the links between the actors that connects them together. The links can be activities such as production, logistics, administration, deliveries and information handling that is more or less integrated with each other. The activity links are strongly affecting the relationship between actors, and have substantially economic effects for the actors (Håkansson, et al. 2009).

The activities in business interaction processes are all related to each other, and these relations occur no matter what the intentions of the actors are. They will affect the different actors in the network, and therefore will need coordination in order for the actors to fully utilize their potential. The activities can also be occurring in one point in time, or reoccurring over a period of time, with specific effects on the entire network. (Håkansson, et al. 2009)

> Q8 - How would introducing recycled PUR affect the current activity structure?

Similarities and Complementarities in activities

An important aspect for companies is to find synergies between activities. Companies therefore commonly strive for utilization of existing resources when launching new products in order to decrease cost and increase revenues. This aspects is mentioned in an activity based model that states that activities e.g. research, development, transportation, marketing etc. can be either similar or complementary (Richardsson 1972).

Two activities are stated to be similar when they require the same resources e.g. when production of two different products can be produced with the same production equipment or when the marketing activities for two separate products is done by the same marketing personal. Hence, a company can take advantage of finding similar activities that could be performed. A company therefore commonly increases its product assortment with a new product that can take advantage of existing resources e.g. manufacturing equipment, marketing resources as well as sales personal.

Complementary activities are those who are different parts of the same production process and are thus sequential interdependent and thereby have to be undertaken in a certain order. Figure 2.4 illustrates a simple manufacturing process of a fictive product where the product is cut, welded and finally painted.

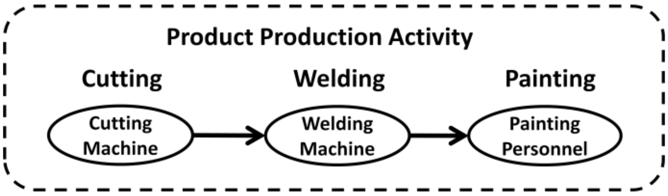


Figure 2.4: Complementary activities in a simple manufacturing process

The welding of the product is in this case an activity and the welding machine a focal resource. If another product activity could be performed by utilizing any of the existing resources, these two activities are similar. Activities that would be performed before, in between or after the separate processing activities can be considered as complementary.

Q9 - Could recycled PUR gain value from established activity structures?

2.2.5 Defining the Problems for Stena

The Stena sphere, and in our case the Stena Metall group consists of several companies with several individual actors that form a complex network structure (see chapter 4.2 for an organization chart). Because of the large expansion within Stena Technoworld during previous years, the network structure has become increasingly complex.

In addition to this, the knowledge within the Stena Metall group about the external companies and the industries they act in is not comprehensive. The recycled PUR might find value in contexts where Stena currently possess limited knowledge and consist of actors outside Stena's current business network. These networks require further analysis. At the same time bonds between individuals within Stena and industries where the recycled PUR could be applicable might exist. These interpersonal relationships could evidently be valuable for Stena and it is therefore important to create an overview of these. Important for Stena is also to identify which actors, within the industrial networks where recycled PUR can be applied, could become key resources. Especially important is to understand how the potential customers can find similarities and complementarities between a recycled PUR product and their existing resources. There might be possibilities for recycled PUR to take advantage of the potential customers existing resource structure consisting of business relationships, business units, facilities and other products.

This is therefore one of the main issues when discussing the introduction of recycled PUR into the already established business environments and the base for some of the questions within this area.

> Q10 - How can the recycled PUR be developed and gain from utilizing existing resources and actors in the business network?

2.3 Value Creation

As stated earlier, the goal with this thesis is to investigate how value could be created out of the fraction of recycled PUR at Stena. Still, no value will be created for Stena if the potential customer does not see the increased value that the recycled PUR could generate. Hence it is crucial for Stena to make sure that the benefits are greater than the sacrifices for the customer when it changes to a recycled PUR product. This chapter therefore focuses on customer value and what factors that could affect the potential customers' decision processes. Still, value creation for Stena is the goal and this chapter therefore also briefly assesses what benefits Stena could receive and what sacrifices Stena would have to do.

2.3.1 Factors Affecting Perceived Customer Value

The perception created by intangible dimensions at the customer side can be stated to be out of particular importance. Researchers stress that these intangible dimensions also have substantial impacts on the sustainability of the added value provided by resources e.g. products or services (De Chernatony, Harris and Dall'Olmo Riley 1998). Several definitions exist that intend to cover all the dimensions of value. Zeithaml (1988) defines value as: *"... the customer's overall assessment of the utility of a product based on perceptions of what is received and what is given"* while Monroe (1990) states that value is "*Buyers perceptions of value represent a tradeoff between the quality of benefits they perceive in the product relative to the sacrifice they perceive by paying the price".* These definitions further stress that, in order to see the value a resource creates at the customer side, a wider perception based view of resources is necessary.

(Håkansson, et al. 2009) proposed that the value a customer receives from one resource depends on the other resources with which it is combined and/or connected to. In a dynamic world, business relationships are particularly important. Business relationships are created over time as the result of interaction with other resources and provide the change processes in resource constellations with direction because they are very influential during the interaction processes (Jahre, et al. 2006). Supplier and customer relationships have become an increasingly important category of resources (Gadde and Håkansson 2008). The value of a relationship to a supplier depends on the how well it fits into the activities and operations of the buying firm and how other suppliers or customers' relationships are affected. Changing supplier may therefore not only imply increasing benefits received in form of a lower price, increased quality, etc., but often also include a sacrifice of previous benefits and creation of tensions. These expressions, sacrifices and benefits, are commonly utilized when defining customer or resource value (Monroe 1990). Although several definitions of customer and resource value exist, defining value is difficult due to its subjective nature, the differences between customers in different situations and between tangible and intangible resources (De Chernatony, Harris and Dall'Olmo Riley 1998).

(Håkansson, et al. 2009) provide a wider perspective when assessing resource value, where all surrounding resources and their ties in between are taken into consideration. Due to this, the complexity and the size of the resource structure affect the difficulty of analyzing what benefits a company gets and what sacrifices that are made when selecting a specific resource.

Social emotional and functional value in customer selection processes

In a key multi-disciplinary study including psychological, economical and marketing aspects performed by Sheth, Newman and Gross in 1991, a comprehensive attempt was conducted to identify and categorize the key dimensions affecting the perceived resource value. Sheth et al (1991) stated five dimension categories; functional, social, emotional, epistemic and conditional value that affect the decision made by consumers and are consistent with renowned researchers within psychology e.g. Maslow, Katona and Hanna. Among these five categories *functional, social* and *emotional values* are in general the three values that scholars tend to agree exist (Callarisa Fiol et al, 2009).

Functional value is often seen as the main value affecting the selection process in traditional economic utility theory. Functional value is the value a customer obtains from product properties e.g. quality, service quality, and price (Sweeny et al, 1999). The valuation of functional value can further be described as an economic and rational analysis comparing the provided benefits from acquiring a product or service with the sacrifices that have to be made to attain it. Benefits and sacrifices in this context can be both monetary e.g. price, as well as non monetary (Callarisa Fiol et al, 2009). The social values can both be seen in the aspect of social values of the company, as well as the social values of the individuals within the company. The social values exist due to the fact that companies essentially are organizations of people which transfer these values into the company (Callarisa Fiol et al, 2009).

Emotional value derives from the perceived values from the feelings and emotions that the product or service generates in the buyer (Callarisa Fiol et al, 2009). This category involves emotions and feelings created by the product or the utilization of the product e.g. joy, fear, anger or feelings of pleasantness, relaxation, calmness etc. For example, the consumer selection process might be affected by feelings of comfort associated with previous experiences of a certain product. At the same time, the emotional value is also affected by interpersonal relationships e.g. friendship or personal recognition between employee and customer, and personalized treatment, which can be out of great importance in an industrial perspective (Callarisa Fiol et al, 2009).

2.3.2 Economical Value for the Customer

Creating customer value is regarded as a prerequisite for long term company success (Porter, 1985). In traditional marketing literature, value is commonly referred to in monetary terms as when Porter (1985, p. 3) defines value as "*What buyers are willing to pay*". What the customer actually pay for a product or service is commonly substantially more than the initial price paid. The total value of a product or service therefore depends on its utilization from the day it is procured until it is dispatched or terminated. Hence, the economic customer value provided by a product or service can be evaluated by looking at the products or services life-cycle benefits, gains, and life cycle sacrifices, costs.

When comparing an already existing product or service in an economic perspective with a new competing product or service providing equal or close to equal amount of financial gain, the new alternative can be evaluated by its economic costs provided to the customer over the total life-cycle (Best 2009).Except for the initial price paid the life cycle based cost model also includes acquisition cost, usage costs, maintenance costs, disposal costs etc. By lowering these sources of costs for a customer, their benefits and value can be created (Best 2009). This life cycle cost model can therefore be utilized comparing the costs of a given alternative product or service in comparison to an already utilized or competing one. The following costs are included in the life cycle cost model:

- Price paid
- Discounts / Rebates
- Delivery
- Installation costs
- Shipping Material costs
- Inventory (Holding costs)
- Financing Costs (Loan interest)
- Owning Costs (Insurance)
- Usage Costs (cost of use)
- Maintenance Costs
- Replacement Costs
- Disposal Costs
- Resale Value (Negative number)

The economic value is delivered when a net economic *gain* is achieved during the product's life-cycle (Best 2009). Hence, in order to provide with economic value for the customer, at least one of these costs has to be lower for the alternative product or service than the originally utilized one. Even though a product or service offers an excellent customer solution, the price can be to high relative to the benefits provided (Best 2009).For example, the purchase process of a product is both time and resource consuming and could be streamlined in order to lower order entry, logistic and inventory procedure cost. Case studies have revealed that the cost of the purchasing processes can be as large as 50 percent of the total life-cycle cost of a product or service (Best 2009).

2.3.3 Defining the Problems for Stena

The recycled PUR at Stena is today considered as waste, and therefore does not provide Stena Metall with any value. The two companies within Stena Metall that is affected by the recycled

PUR is Stena Technoworld that produce the recycled PUR when recycling cooling appliances and Stena Recycling that currently handles and utilize all the recycled PUR. The recycled PUR has been a cost for Stena Technoworld in the past, and has now a higher value as it can be utilized by Stena Recycling instead. Never the less, the intension of Stena Metall is to identify possible applications where the total value of the recycled PUR can be increased. In order to be able to increase the value of the recycled PUR, it is important to consider not only the economic value, but also the functional, social and emotional values and the benefits and sacrifices connected to them.

Q11 - What functional value does recycled PUR provide Stena today?

Q12 - What functional and monetary value could recycled PUR provide Stena with if utilized in other applications?

2.3.4 Defining the Problems for Stena's Customers

The change in value will also affect the potential customers for the identified applications for recycled PUR. There will be effects on not only the functional value, but also on the social and emotional value when considering introducing the recycled PUR. The possibility for the customers to replace their current products with the recycled PUR will mean that they will use a less expensive product that will affect the functional and economical value. But it will also affect the other functional values such as the quality of the products which need to be considered. The emotional and social values will probably be affected by the environmental aspect of using a recycled product, and also be affected by the deepened relationships between the companies and Stena. The customers will also have benefits and sacrifices connected to the recycled PUR if replacing their existing resource in their network. These sacrifices and benefits can be in the form of the replacement of other resources, the adjustments for the recycled PUR into the processes at the companies and also the gain and loss of interpersonal relationships. In order for the implementation to be successful, these benefits and sacrifices need to be identified and actions to turn sacrifices into benefits need to be established. Finally, it is important to consider the costs for the customer in not only purchasing the recycled PUR, but also the handling costs, storage costs and transportation costs, among others, that will affect the economic value for the customer.

Q13 - What could be the perceived benefits and sacrifices for a customer utilizing recycled PUR instead of their existing products in different applications?

Q14 - What are the customers perceived value regarding the possibility of introducing the recycled PUR into their processes?

Q15 - Which costs are lower or higher than the original costs and how are they affecting the economic value for the customer?

3. Method

This chapter provides the methods utilized in this master thesis. The master thesis is a case study, with both qualitative and quanätitative research. The chapter starts with explaining the case study approach followed by how the information collection was performed and finally the research process.

3.1 Case Study Approach

The chosen method for the research is a case study approach. The selected research approach will provide a deeper understanding of the chosen topic. Case studies in business research are widely adopted in use of real-life cases (Eriksson och Kovalainen 2010). Case study methods popularity is based on the ability to grasp and present cases that would have been too complex to present otherwise (Eriksson och Kovalainen 2010). The case study is based on both qualitative research such as interviews as well as quantitative research. In this master thesis an investigation in the potential future applications for recycled polyurethane was conducted, and thereby provided with a deeper understanding of the introduction of a new product into an already established network. A case study will provide a better understanding of the dynamic and complex business network environment and by using a set of specific cases, a focus will be set on solving the issues related to that specific cases. The case study will additionally answer how and why questions which are suitable when the exploratory research is conducted (Yin 2003). Furthermore, it allows for researching the contemporary actions and how the chosen market has changed over time (Yin 2003).

3.1.1 Quality Criteria

The quality criteria were regarded throughout the research process in order for the findings to prove relevancy for the purpose of the study and in order to prove that all actions were properly reviewed to secure the reliability and validity of the research. They are divided into construct validity, internal validity, external validity and reliability.

To secure the construct validity of the research process must according to (Yin 2003) cover two steps; select the changes to be explored and secondly illustrate how the selected measures reflected the selected changes. The construct validity is secured by using correct data collection methods. Therefore it is significant to use multiple sources to be able to establish a chain of evidence. The internal validity criterion is to test the ability to conclude causal effects of different factors. It tests the ability to claim causal effects of the factors researched and will be a criterion to take into account. The external validity makes use of the questions if the study's findings can be applicable in other markets or for other products, or perhaps the same product but in different regions or countries. Here the focus is on if it can generalize the findings based on analytical generalization as the case study research relies on. Last but not least the reliability of the research conducted has to be confirmed. This criterion is tested by assuming that the result will be the same if another researcher would conduct the same research. Reliability is important to ensure that no bias is involved and to prove that it is of great importance to keep documents of all steps during the process. In short one must document all the steps as if someone ought to be doing the same procedure all over again. (Yin 2003)

3.2 Information Collection

The information was collected through literature review and interviews. The main focus was on the qualitative data, since the main data was collected from qualitative interviews, and this information was the base for the master thesis.

3.2.1 Literature Review

The literature review was mainly based on literature from public sources, with additional information from Stena's internal documentation. The literature review was divided into two parts, one academic literature review and one general literature review.

The academic literature review became the foundation for the problem analysis and the theoretical framework presented in this master thesis and was mainly based on publications from different article databases of Chalmers University of Technology, as well as on previous course literature during the course at the Supply Chain Program at Chalmers University of Technology. The focus on the search has been regarding industrial marketing, environmental science, customer value and logistics.

The general literature review has mainly been focused on the internal documentation from Stena, with independent research as well as documents provided by the interviewed individuals. The general literature review has also consisted of research of articles and information through the internet, where the companies in focus for the different applications has been investigated around.

3.2.2 Interviews

One important part of the primary data is interviews with all involved parties that in one way or another are involved in the product or the market itself. The interviews are therefore some of the most important sources of information (Yin 2003). To cover the internal insights, interviews was conducted within Stena Metall. Hence, there were also external interviews conducted with all parties that are involved in the topic now or that might be involved in the future. The interviews do not follow a strict order. In addition, the interviews are formed in a way so that the conversations are covering the main topics the researchers would like to discuss (Yin 2003). The number of interviews performed throughout the project was due to time limits carefully selected not to compromise the time scope. During the interviews, open ended question was asked which invited the respondents to be involved in the discussion and inform, rather than just answering questions (Yin, 2003).

The qualitative interviews were foremost conducted face to face but did also take the form of mail and telephone interviews. The questions that was asked and discussed during the interviews was be based on the research questions. The questions were sent to the respondents in advance so that they got the opportunity to prepare for answering the questions.

Furthermore, observations where PUR production and processing activities were conducted contributed to deeper knowledge of the recycling activities. These observations were done in a non-participant way. (Eriksson och Kovalainen 2010)

During this master thesis, 33 interviews were conducted with representatives from Stena Technoworld, Stena recycling as well as others, summarized in Table 3.1.

Table 3.1 Interviews conducted in this master thesis.

Stena Technoworld	
Bauer, David	**H&S Manager**
Frostne, Mårten	**Managing Director Sweden**
Karlsson, Leif	**Plant Manager Halmstad**
Olofsson, Stefan	**Halmstad**
Ringdahl, Erik	**Business Development**
Sjölin, Sverker	**Development Manager**
Sobon, Andrzej	**Plant Manager Cools**
Stena Recycling	
Andersson, Jan-Erik	**Product Manager**
Axelson, Oskar	**Cools**
Kolseth, Snorre	**Development Manager Cools**
Petersson, Claus	**Quality Manager**
Söderberg, Hans	**Sales**
Wernäng, Glenn,	**Plant Manager**
Others	
Andersson, Bernt	**RDE (former employee at Electrolux)**
Bergström, Göran	**Bayer**
Boldizar, Antal	**Polymeric Materials and Composites, Chalmers University of Technology**
Claussen, Kim	**Bayer**
Cohen, Ilan	**Electrolux**
Ekberg, Christian	**Stena Professur, Chalmers University of Technology**
Foreman, Mark	**Chemistry, Chalmers University of Technology**
Forsgren, Christer	**R&D Director**
Gyllenhammar, Marianne	**Combustion, Stena Metall**
Helin, Anders	**RDE (former employee at Electrolux)**
Holmberg, Krister	**Professor Surface Chemistry, Chalmers University of Technology**
Jansson, Anders	**Cementa, HC Miljö**
Juvel, Daniel	**SMA Minerals**
Karlsson, Kurt	**Safesorb Managing Director**
Karlsson, Stellan	**Nordkalk**
Kirkhoff, Jan	**Ikaros**
Retegan, Teodora	**Chalmers Industry Technology**
Roxendahl, Stellan	**BASF (Elastogran)**
Stenvall, Erik	**PhD Chalmers University of Technology**
Wiegandt, Linus,	**Buyer PEAB**

3.3 Research Process

The research process was based on the interviews described above, and contains several steps that gave us the direction of the master thesis during the project. The empirical data, the analysis and the recommendations are the result of the research process. The research process started with the initial interviews, followed by a screening of all possible application for recycled PUR that we came across. This was complemented by additional interviews and research and finally led to the recommendations for possible applications for recycled PUR. The research process can be seen in Figure 3.1 below.

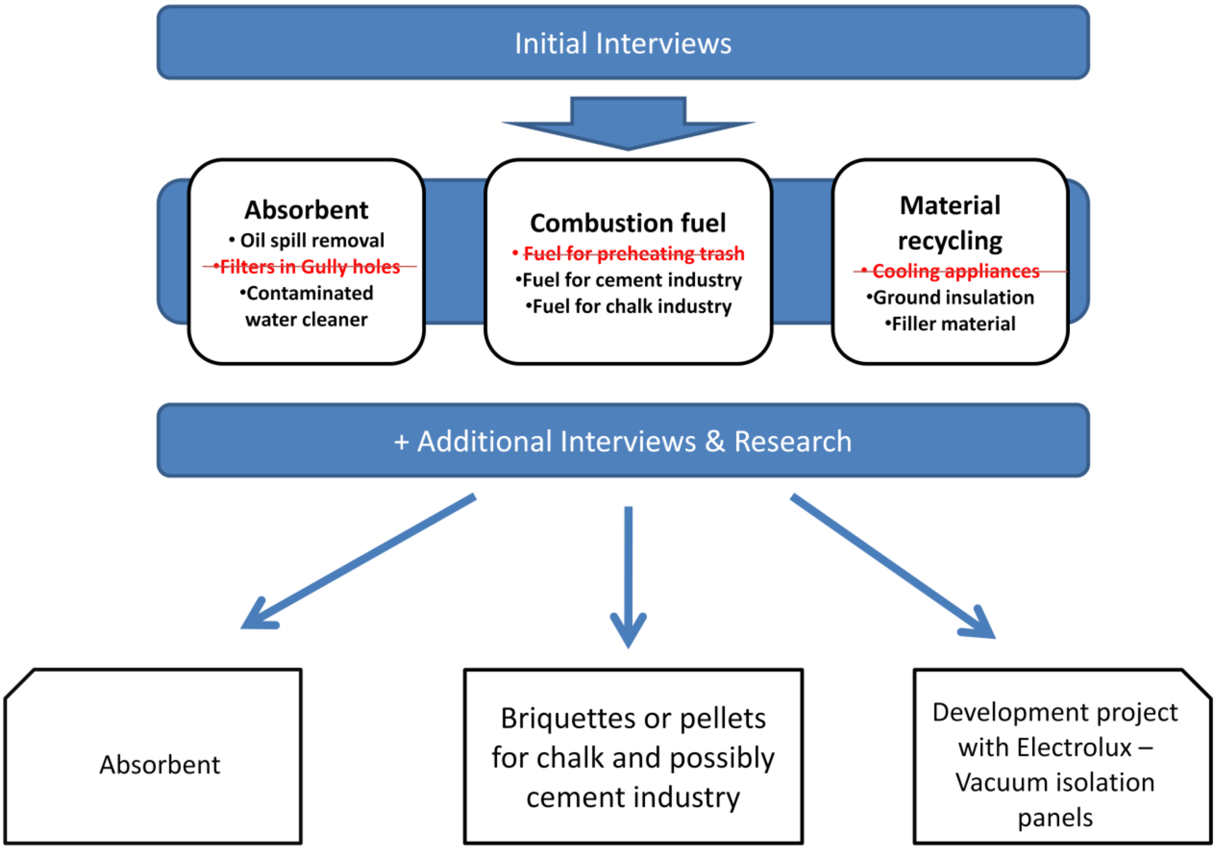


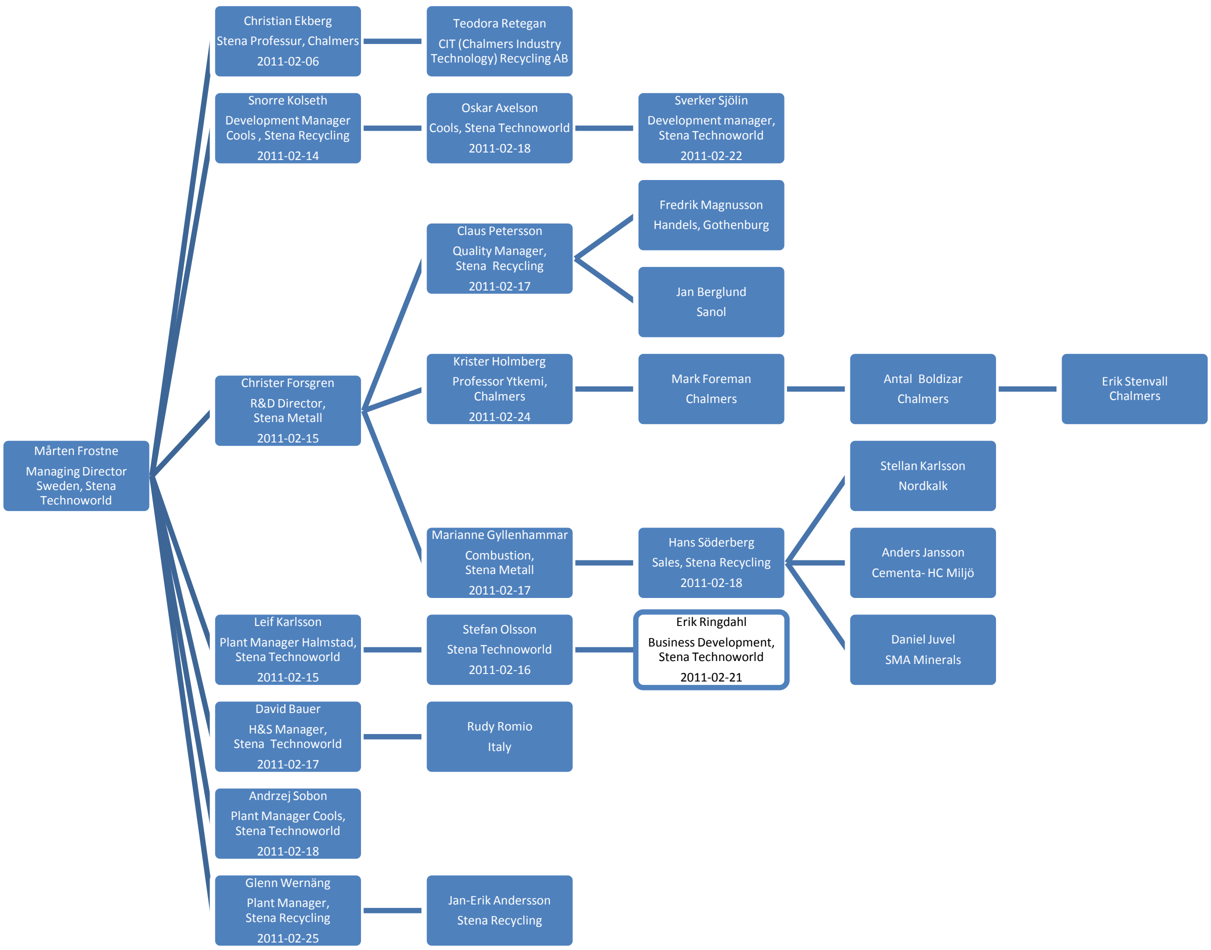
Figure 3.1: The research process for the master thesis

3.3.1 Initial Interviews

In order to get an initial picture of the information available about PUR the initial focus was on the internal information available at Stena. A list of persons to interview was therefore created with the help of our supervisor at Stena Technoworld, Mårten Frostne. This list contained people at Stena that Mårten Frostne thought would have relevant information about PUR as well as about the industry in general. To the list of persons at Stena we also added people at Chalmers that could have relevant information about the topic.

The interviews were conducted during a two week period in Gothenburg, Halmstad and by phone. The interviewee received a document with questions several days in advance in order to be able to prepare for the interviews (see appendix A). The interviews were recorded and later on fully transcribed. During the interviews information about which additional people to contact was received, and they were added to the list of interviewees. See Figure 3.2 for the list of people we interviewed as well as who gave us the contact information to them.

After the initial set of interviews, a structure of the possible applications areas for recycled PUR was created based on the information collected. These areas were the base for the following investigations. There were three areas, with three subgroups in each, totaling in nine possible applications for recycled PUR as can be seen in Figure 3.1 above.



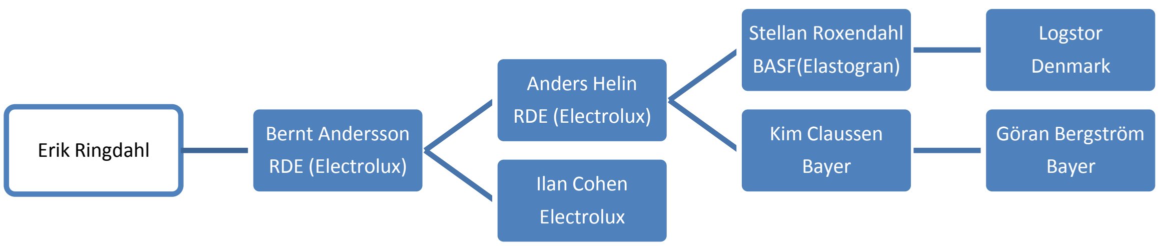


Figure 3.2: Interview chart

3.3.2 Additional Interviews and Research

In order to get a full picture of the situation today for the different application, the interviews were complemented with additional research regarding the market potential, with focus on actors in the market and their market share, investments costs, estimated market prices and estimated selling price for Stena (see Appendix G). The information collected lead to an evaluation of the feasibility of each application which lead to the decision to reduce the number of applications from nine potential to three possible, in discussion with Mårten Frostne at Stena Technoworld.

The last phase was to investigate further within the three possible applications in order to build an as comprehensive picture as possible. This included further interviews with already interviewed and additional persons within the industries of these three applications, as well as additional information about the markets that the three possible applications would act within. This was the base for the analysis and recommendations for Stena Technoworld regarding the possible outcome for recycled PUR. The additional interviewees can also be seen in Figure 3.2 above.

4. Empirical Background

This chapter will provide the empirical findings that are the base for the understanding of the three cases presented in the next chapter. The chapter starts with an introduction of the market for plastics and PUR in Europe and continues with information about the company Stena, PUR at Stena and finally the process of extracting PUR at Stena's site in Halmstad.

4.1 The Market for Plastics and Polyurethane in Europe

Plastics can be seen as one of the most crucial material resources in the society today and has experienced an increasing demand (Plastics Europe 2010). In 2009, the world consumed over 230 million ton of plastics, out of which Europe consumed 45 million ton and Sweden 800 000 ton (0,35%) of the total world consumption. Although the total demand for plastics in the world increases rapidly, the trend in Europe and Sweden over the period 2007 to 2009 has decreased (PEMRG, 2010). At the same time, less of the plastics go to landfill each year and the amount recycled increases. In 2009, Europe handled 24,3 million ton of plastic waste which was a decrease of 2,3 % from 2008. Out of the total amount of plastics handled, 54 % or 13.1 million ton was recovered (5, 5 million ton, where material recycling and 7,6 or 31,5% by energy recovery) and the remaining 46 % was sent to disposal. Energy recovery quantity increased with 2,2 % mainly because of stronger usage of post consumer plastic waste as alternative fuel in special power plants and cement kilns (Plastics Europe 2010).

Polyurethane belongs to the family of thermo set plastics and can therefore not be recovered by melting it down for creation of new products (Stenvall 2011). Polyurethanes are commonly utilized in production of flexible foams as well as other products. Virgin polyurethane is produced by the simultaneous reactions of polyol and water with an isocyanate, in the presence of various additives (Plastics Europe 2010). PUR stood for roughly 3 million ton or 7 % of the total weight of plastics consumed in Europe 2009 (Plastics Europe 2010). As with all plastics, PUR can be utilized for many applications by several industries (showed in Figure 4.1) depending on processing methods. Common areas of usage are car seats, cushions and mattresses due to its good insulation properties and its relative low cost (Plastics Europe 2010). PUR has seen a slight decrease in demand from 2007 until 2009 (illustrated in Figure 4.2) yet it had a much smaller decrease than for the plastics market in general (PEMRG, 2010).

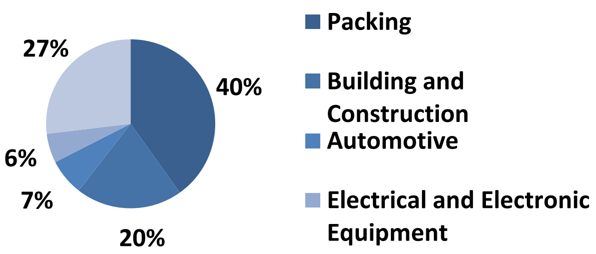


Figure 4.1: Europe Polyurethane Demand by Segments 2009

Source: (Plastics Europe 2010)

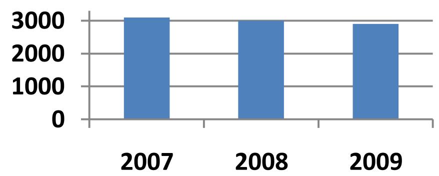


Figure 4.2: Europe Polyurethane Demand for Polyurethane 2007-2009

Source: (Plastics Europe 2010)

4.2 About the Company Stena

Stena is a family owned company with around 19 000 employees, a turnover of 47 billion and a revenue of 1, 7 billion SEK in 2009. Stena consist of three fully owned parent companies; Stena AB (publ) that handles shipping, ferry lines, offshore, property and finance business areas, Stena Sessan AB with business activities mainly in shipping and equity and property management, and the Stena Metall Group that is a leading innovative recycling company (Stena 2010).

For this master thesis, the focus is on the Stena Metal Group that consists of six subsidiaries; Stena Recycling, Stena Technoworld, Stena Stål (Eng: Steel), Stena Oil, Stena Metal International and Stena Metal Inc (see Figure 4.3 below). The two companies of interest within the Stena Metal Group are Stena Technoworld, which is the company initiating this project, and Stena Recycling which is involved in the development of recycled PUR.

Stena Technoworld is the leading recycler of electronics products in Europe where they collect, process and recycles used electronics from households, businesses and manufacturers in Europe. Stena Recycling handles waste from throughout society and transforms it into value for its customers. They handle ferrous and non-ferrous metals, plastics, paper, hazardous waste and other waste. (Stena Metall 2011)

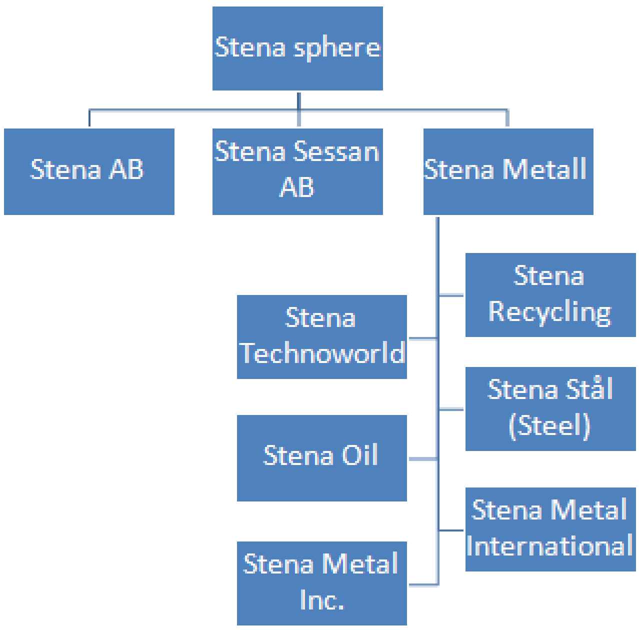


Figure 4.3: The organization chart for the Stena sphere

4.3 Recycled PUR at Stena

Stena Technoworld has been recycling cooling appliances at their site in Halmstad since 1995. During the process of recycling cooling appliances, fractions of different sorts of plastics and metals are dissembled, where PUR is one of them. At the plant in Halmstad, 450 000 cooling appliances are handled each year. From each one of them, around 5,5 kg

PUR can be extracted which leads to the Halmstad plant obtain around 2500 ton of recycled PUR annually. For a long period of time, this amount of recycled PUR was seen as waste and was land filled, until Stena Recycling found a usage for it in their Hot Mix facility, where it absorbs oil and then is used as fuel, and their contaminated water pit facility, where it is used for absorbing oil from contaminated water.

The recycled PUR does not only consist of PUR. As mentioned earlier, recycled PUR also consists of certain levels of freon (consisting of Chlorine and Fluor) and Pentane that is not removed throughout the process. There are also traces of other substances that can be identified in the recycled PUR, such as coal, hydrogen, sulfur and nitrogen (See Appendix H). It is these substances that make recycled PUR differ from virgin PUR and be classified as waste.

At Stena, the goal is to develop the recycling in accordance with a waste- hierarchy, where the best approach is to prevent waste from being produced, and the least desirable approach is landfill. Between these there is energy recycling, material recycling, re-usage and minimization of waste, see Figure 4.4 below. This is the reason that Stena Metall initiated a project earlier, Purol, and one of the reasons for Stena Technoworld to initiate an investigation around recycled PUR today. The goal for such a project is to move the waste up in the waste-hierarchy and at the same time increase the revenues for Stena.

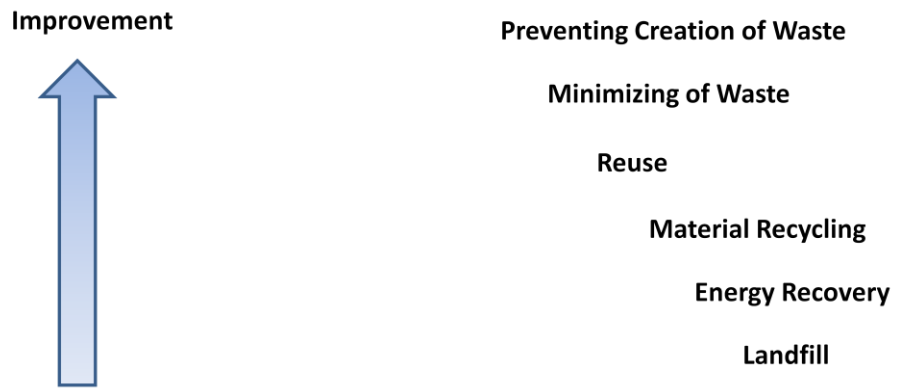


Figure 4.4: The waste-hierarchy at Stena

4.3.1 The PUR Process in Halmstad

The process of extracting PUR from the cooling appliances at the plant in Halmstad is visualized in the Figure 4.5 below. It consists of nine steps, from the intake of the cooling appliances to the production of PUR briquettes.

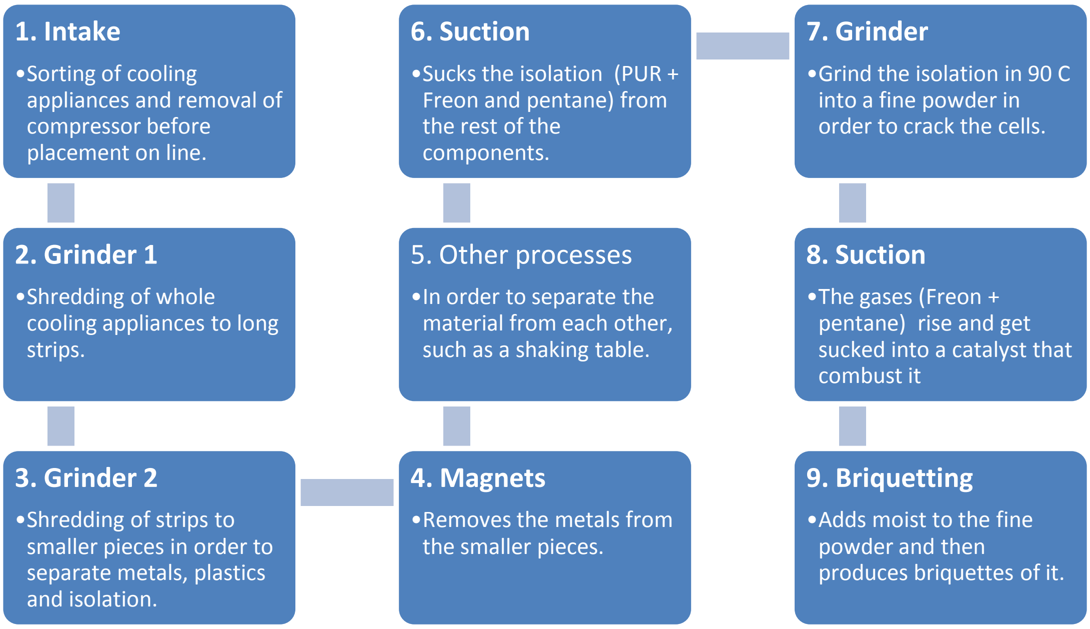


Figure 4.5: The process of extracting PUR from the cooling appliances at the plant in Halmstad

In the **first step**, the intake, the cooling appliances arrive to the plant. Here they are sorted, and a visual control is done in order to detect any cooling appliances that will not fit in the process. Some cooling appliances for instance contain large metal pieces that would get stuck in or damage the grinders. In this stage the cooling boxes that are larger than the refrigerators, are separated and put into another process at the plant. The cooling appliances, mostly refrigerators, are then put onto a line that will lead it to the first grinder. During the initial time on the line, employees will remove the compressor from the cooling appliance.

The cooling appliance then continues to **the second step**, the *first grinder*. Here the whole appliance goes through the grinder, cutting it into long stripes. The stripes are then in **the third step** sent to the second grinder, which is a new investment since September 2010. This grinds the stripes into smaller pieces and also makes the metal, plastics and insulation separate from each other. These small pieces are then going on a line under a large magnet, **the fourth step**, where most of the metal is separated from the rest. There can be some problems with small, light aluminum pieces, but this step will sort out the most of the metal.

The **fifth step** consists of several different processes, but as some of these do not affect the processing of PUR there is no need to go into detail in this step. The important aspect is that the different materials are separated from each other as much as possible, which make it possible for the insulation to be suctioned in **the sixth step**. Because the insulation still contains gas (freon or pentane), it is light and therefore can be sucked up through the suction. In **the seventh step**, the process is to separate the gas from the PUR in order to handle the gas, especially freon, in an environmental friendly way. Therefore the insulation goes through a third grinder that grinds the insulation so that the cells in it crack, and the gas can come out of the PUR. While it is grinding, the temperature rises because of the friction. This makes the gases rise, and in **the eighth step** they get sucked up into a catalyst and into a combustor where they are properly destroyed. The powder that comes out consists of only PUR, with only small levels of freon and pentane. **The final step** is to add some moist to the powder in order to be able to produce briquettes of it. The briquettes are more compact than the powder, and therefore take a smaller volume in the trucks when transporting it out of the plant in Halmstad. (L. Karlsson 2011) (Olofsson 2011)

5 Three Cases Based on the Identified Applications

During the interviews at Stena, nine different applications where identified which have been divided into three cases based on their nature of utilization. These are; an Absorbent Case, a Combustion Fuel Case and a Material Recycling Case. Within the Absorbent Case the applications are; Oil Spill remover on Land, Gully Hole Filterer and Contaminated Water Cleaner. These three application areas belong to the same market for oil- and chemical absorption which will thus further on be referred to as the absorbent market. In the Combustion fuel Case the applications are; preheating of trash, fuel for cement industry and fuel for chalk industry. Finally, for the Material Recycling Case, the applications are; cooling appliances, ground or sound insulation and filler material.

5.1 The Industrial Absorbent Case

This chapter starts with explaining the three applications where the interviewed individuals at Stena suggested that recycled PUR could be utilized, all related to PURs high absorptive capacity. An attempt of creating a product from the recycled PUR has been done before in the Purol project. Hence, this project will also be comprehensively explained. The chapter continues further with describing the current market for absorbents by outlining its actors, its products and how these are processed.

5.1.1 Oil Spill Remover on Land

The most frequently mentioned possible application for recycled PUR is to utilize it when oil has been spilled in industrial environments e.g. the shop floor in a factory. This is also something that Stena Technoworld currently does in their facility in Halmstad when oil spill occurs. When a spill of oil occurs, some of the recycled PUR is strewed on the oil, where the recycled PUR absorbs the oil which thereby easily can be shoveled into a bag or a container (Figure 5.1). The recycled PUR is by Claus Pettersson et al stated to be an outstanding absorber, foremost for oil and solvents (Petersson 2011). The drawback with Stenas recycled PUR in comparison to other absorbing materials is stated to be the properties it obtains due to that it is grained into a very fine powder. The powder easily spreads into the air, contaminating the surrounding area where it is utilized which can cause respiratory irritation or become a fire risk. The fraction of residuals and other substances in the recycled PUR may also cause problems to sensitive manufacturing processes and could cause allergies if not handled cautiously (Petersson 2011).

Figure 5.1: Illustration of granular absorbent usage
Source: (PK-Produkter AB 2011)

5.1.2 Filtering in Gully Holes

According to Claus Petersson (Petersson 2011), another possible application would be to utilize the recycled PUR as the absorbing material in gully hole- filters, filtering oil and other chemicals from water coming from yards. An investigating study regarding PUR's absorption properties were conducted at Chalmers by Miljötekniska laboratoriet in August 2007. This investigation aimed to see if the recycled PUR could be utilized in filter cassettes, filtering oil or other contaminating substances out of water. The result was that the recycled PUR absorbed between 15 to 30 %, which was not considered as effective enough (Knutsson 2007). There were no further investigations in the possibility to change the surface structure of PUR in order to enhance the ability to absorb oil in water, but this is something that the persons interviewed at Stena think is a future possibility (Kolseth, Recycled PUR 2011). According to Christer Forsgren (Forsgren 2011), there could be possibilities to enhance the surface qualities of PUR and by that improve its absorption properties by spraying some sort of oil onto it at the production site in Halmstad. This would make it easier for oil in water to be absorbed by the PUR because it already has oil on its surface and thereby obtains improved absorptive properties. At the same time, (Forsgren 2011)points out the problem with finding such a substance that will stick to every PUR particle and then remain on the surface no matter the time aspect. The risk of this substance going into each particle and then stop enhancing the surface and by that the absorption qualities of PUR is a factor to consider. Krister Holmberg, professor in surface chemistry at Chalmers University of Technology, also sees the potential in spraying a substance onto each PUR particle (Holmberg 2011). He describes it as that the two components that make PUR, isocyanat and polyol, are hydrophobic and hydrophilic respectively. The hydrophilic part is not compatible with oil, so the larger part of polyol, the harder it is to stick oil to it, especially in water. So the component that would be sprayed onto the powder of recycled PUR should be in order to make it more hydrophobic. One suggestion from (Holmberg 2011) is to use a latex suspension in order to get the desired qualities of each PUR particle and in the same time use a product with low cost. If such a process were to be incorporated in Stena's plant in Halmstad, there would be a need for investments in machines of some type in order to be able to spray the substance onto the PUR. The possibility to incorporate this into the existing production process in Halmstad is possible according to (Olofsson 2011), responsible for production at Stena in Halmstad, but need further investigations.

Currently, the application to utilize the recycled PUR as the absorbing substance in a gully hole filters is difficult due to problems described. Still, Stena have collaborations with companies with extensive knowledge how this problem could be solved and thereby give Stena yet another possibility of increasing the value of the recycled PUR. For instance, the gully hole filter application might be possible to perform if Stena utilize external knowledge regarding surface treatments.

5.1.3 Contaminated Water Cleaner

The third mentioned absorbent application for recycled PUR is the possibility to absorb oil that has contaminated water. Instead of using the recycled PUR in filter cassettes, this would be that recycled PUR either could be sprayed on the water as it is or be held within stockings and then placed into the water for absorption of the oil, again taking advantage of the property of PUR that it does not absorb water (Figure 5.2). A company in Stavanger tried the idea of spraying Stena's recycled PUR onto the water in order to absorb the oil, where the idea was to sell it as an anti oil catastrophe product (Kolseth, Recycled PUR 2011). According to Kolseth the company did not manage to sell the product, leaving them with large amounts of unutilized recycled PUR. The company has since then been terminated, making additional information difficult to obtain. It is also recalled that they had problems with understanding what happened to the PUR when it entered the water, the possible hazardous effects of PUR in contact with water as well as problems with fire in the material. The methods for increasing the absorption ability explained in section 5.1.2 would work just as well for this application.

Figure 5.2: An example of how contaminated water can be cleaned with an absorbent, here in form of a worm for maritime usage.

5.1.4 The Purol Project

Stena Freon Recycling in 1994 raised the question if value could be created by the fraction of recycled PUR, coming from recycled cooling appliances. Back then, the recycled PUR was a negative fraction for Stena Freon Recycling, creating land fill costs. Therefore, Stena Freon Recycling launched a business case with the purpose of investigating the possibilities that the recycled PUR instead could generate value by being the raw material for new products. The selected product category was to utilize it, due to PUR's high absorptive capacity, as an industrial absorber. This chapter is based on information gathered from the remaining work papers together with extensive interviews conducted with key persons at Stena Metall. The original documentation and information regarding the Purol project is not available anymore due to the time passed as well as lack of office space. Neither Jan Berglund, the representative from Sanol within this project or Fredrik Magnusson, one of the the main responsible for the project from Stenas side could be reached in our investigation of the Purol project.

After two years of collaboration between Stena Freon Recycling and Sanol AB, an already established oil recovery company, Stena Freon Recycling decided to go forward with Sanol AB as cofounder of the upcoming project. Sanol was stated to be "*a leading established company in the Nordic market for absorbers, having already well developed absorption systems*". Sanol stated that there was a great possibility for this product named Purol, to gain a substantial part of the Scandinavian market for oil recovery both on land and for maritime usage, foremost for industrial purposes. According to estimations done by Sanol, the production was supposed to be able start in early spring 1995, but in reality the prototype was not completed until early 1997.

A further investigation of the Swedish market lead to that the main competing products was identified within the field of absorption. One of the strongest competitors within this area was stated to be Absol, a product consisting of grained minerals currently manufactured by Yxhult AB, which had the most of the market selling, roughly 5000 m^3 annually. The second largest competitor was stated to be Zugol, a product manufactured from pinewood bark by Zugol AB, a popular product for outdoor utilization, selling about 1000 m^3 annually. Except for these two main competitors around 30 other different kinds of absorbers were identified but were considered to have the drawback of having a too high sales price, among them a number of other PUR based products. They were therefore considered not to be able to compete on the large volume market.

The framework of the project was a joint venture, Purol AB, shared 50/50 between Stena AB and Sanol AB. Within Stena AB the idea was that Stena Freon Recycling was going to account for 25 % and 25 % should be accounted for by another part within Stena AB. The timeframe of the project was set to two years and the cofounders agreed upon a project plan where capital first of all should come from the owners of the joint venture but secondarily also external investors could be considered. From Stenas side, the one of the key persons in the project was Fredrik Magnusson, a student from Gothenburg University; School of Business, Economics and Law, who earlier performed an investigating thesis in the subject and after that was hired to further develop the products technical specifications as well as to market them. The products had some technical weaknesses and therefore needed to be further developed and improved. One example was that the surface layers of the products needed to be tougher.

On the Swedish market, five major customer categories were identified;

- Manufacturing industries working with cutting fluids
- Automotive workshops, car dumps and gas stations
- Haulage companies, contractors and companies utilizing forest machines
- Ships and plants for oil filtration
- All other industries were oil leaks can occur

Three different lines of Purol products was created; *loose granulates, pillow and Stockings* with the idea of utilizing some of Sanols and Stenas already existing production facilities.

- **Loose granulate absorber:** A powder with the grain size of 4 mm which is to be spread over the contaminated area and then brushed or scraped off the surface. Manufactured in connection to Stena's plant for recycling of cooling appliances in Halmstad.
- **Pillow shaped absorber:** A pillow utilized when the oil spill occurs in a controlled way, for example when draining oil from a gearbox or an engine in a car. To be manufactured in various lengths in Sanol ABs facility in Vellinge.
- **Sock shaped absorber:** A special kind of worm like absorbers to be manufactured in Sanol ABs facility in Vellinge.

These products were going to be part of a system with an environmentally friendly retaking system for the utilized absorbers. For these product categories respectively, the sales forecast can be seen in table 5.1 below.

Table 5.1: Estimations of sales conducted by Sanol AB in cooperation with Stena AB.

Product	Volume pcs	Price [SEK]	Income [SEK]	m^3
Granulate (small sack)	10 000	1 / liter	500 000	500
Granulate (large sack)	500	0,5 / liter	250 000	500
Pillow	125 000	20	2 500 000	850
Sock	50 000	15		500
Σ			**4 000 000 SEK**	**2350 m^3**

The product development did not reach expected results and even if earlier identified product flaws e.g. the weak surface layer had been diminished, that was stated to have brought problems with decreased penetration properties. Regarding the Loose granulate absorber product, it was stated that it had problems with its fugacity properties.

Except for the problems out of technical nature that showed over the project, marketing and sales issues had emerged over time. Claus Petersson (Petersson 2011) states that Fredrik Magnusson encountered severe troubles, partly due to that launching a usable product was not seen as Stenas core competence and partly due to that the already established competitors had valuable information about the customers within the absorbent market. The competitors knew exactly when the customers were going to be low in stock and were therefore always one step ahead of Purol AB.

After more than one year of work and very little progress with Purol, Stena AB the 11 of March 1998, together with Sanol AB, took the decision to terminate the project.

5.1.5 The Products and Their Production Processes

A large variety of products for oils- and chemical absorbing products are available in the market. The products are produced out of different raw materials, refined to several shapes and qualities in order to cover the diverse demands from the customer side. The raw materials the producers utilize for absorbent production varies between natural stone based materials, wood based products and synthetic polyurethane or plastic based products. According to a market overview further presented in Appendix B, the most frequently used raw materials are Moler stone, Polyurethane / other plastics, Sand & Chalk mixtures, Pinewood bark and Vermiculite. Out of these five raw materials can either be utilized in granular form or be the base for production a diverse range of products (See Figure 5.3) in order to cover the varying demand from the users of absorbents. The granules can be poured into socks or rugs to be utilized when the oil spill occurs in a predefined manner e.g. absorbing fluids from cutting processes or draining oil from a gearbox or an engine. *Granules, Worms for usage on land*

and absorption of oil on land, *Stockings for maritime usage* and *Rugs* are still considered to stand for the largest share of the industrial absorbent products sold and consumed.

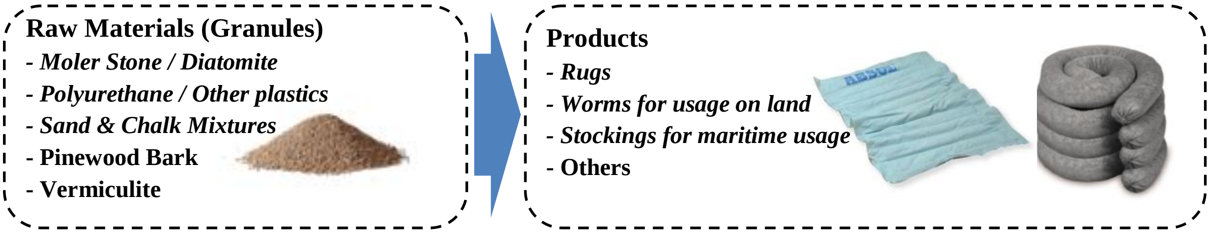


Figure 5.3: Range of products based on five different raw materials

5.1.6 Absorbent Product Performance and Price

As stated by the customers regarding demands, the product performance for an absorbent is required to be “good enough”. If Stena desires to convince the potential customers that a recycled PUR absorbent could remove the oil spill in an acceptable way, this can be done by benchmarking the recycled PURs absorption performance against other utilized absorbent materials. In this benchmark price also becomes a factor since these two factors combined can give Stena insight in recycled PURs relative efficiency. Benchmarking the absorbents with these two factors also gives Stena valuable information that could be utilized when positioning the product in the market. Figure 5.3 summarizes the information compiled regarding material performance in terms of absorption capacity and price, for the five most commonly utilized materials when producing absorbents. Hence, this becomes a rational analysis comparing the tangible benefits (absorbed oil per liter absorbent) from acquiring a product with the sacrifices that have to be made (SEK paid per liter) to attain it. Due to lack of product information, vermiculite could not be included in this benchmark.

In Figure 5.4, the products in the upper left corner can out of the criteria price and absorption capacity be seen as the “best buy” for the customers as they have the lowest price (SEK / Liter) and high absorptive capacity (liter oil / liter absorbent). At the same time other demands regarding purity, usability and service are evidently important (section 5.1.7) which depends on where and how the products are supposed to be utilized (Kirkhoff 2011).

Table 5.2 Four kinds of absorbents based on four different raw materials

	Absol		Zugol	ÖKO-Pur			Absodan		
Name	**Röd**	**Blå**	**Miljöskyddsmedel**	**Pulver**	**Fingran.**	**Grovgran.**	**Superplus**	**Plus**	**Universal**
Material	**Sand & Chalk**		**Pinewood bark**	**Recycled Polyurethane**			**Heat Treated Moler Stone**		

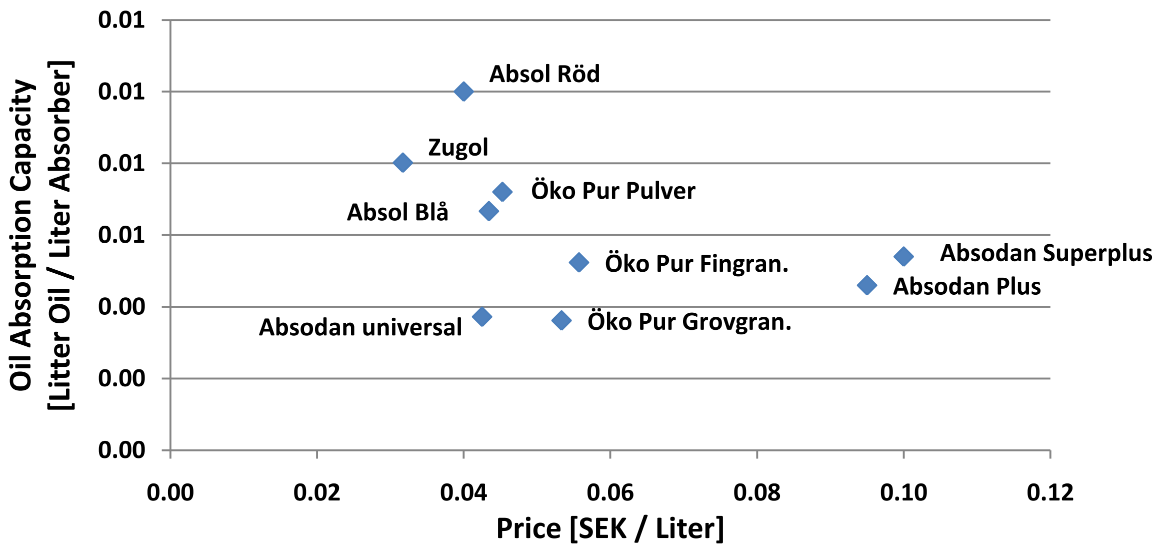


Figure 5.4 Liter absorption capacity per liter absorbent from the producer's using one of the five most frequently used absorbent materials

Sources: See appendix C

The products with the lowest price and the highest absorption capacity per liter are Zugol, Absol Blå & Röd and ÖKO-Pur Pulver. However Absol is staded to be relatively heavy which customers commonly do not take into consideration (Kirkhoff 2011). The Figure illustrate that recycled PUR, in these graphs represented by ÖKO-Pur, can be a well performing alternative to the other absorbent. They place themselves somewhere in the middle, both in terms of price and absorption capacity.

Figure 5.5 shows what the customer pays per liter absorbent for different sorts of absorbents. The figure indicates that when refining the products, increasing the products usability, the price increases.

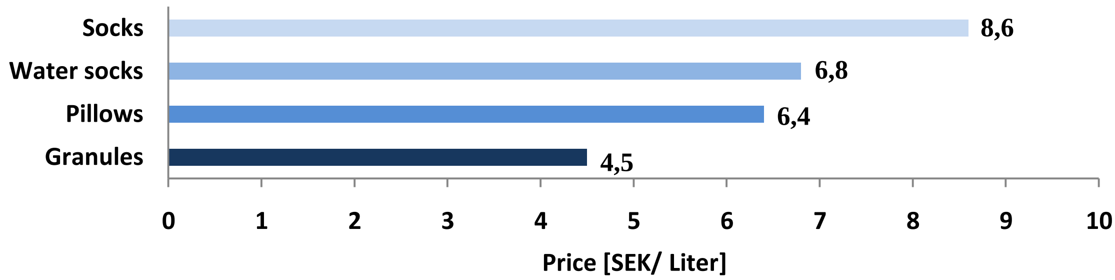


Figure 5.5: The different products that could be manufactured from the recycled PUR and the competitors price in SEK / Liter (Appendix B)

This implies that product refining could be an important factor to incorporate when designing a product strategy. Hence, an actor in the market that are in possess of the resources required for product refining could be out of essence.

5.1.7 The Current Market for Absorbents

To simplify the identification and the understanding of the actors on the absorbent market, the companies are divided into four categories related to their function in the absorbent supply chain; Producers of absorbents, Intermediaries - distributing and/or reselling absorbents, End users and Recycling companies who recycle the absorbents after utilization. Figure 5.7 provides with an overview of the physical flow of the absorbent products from an external perspective and the identified actors in the supply chain.

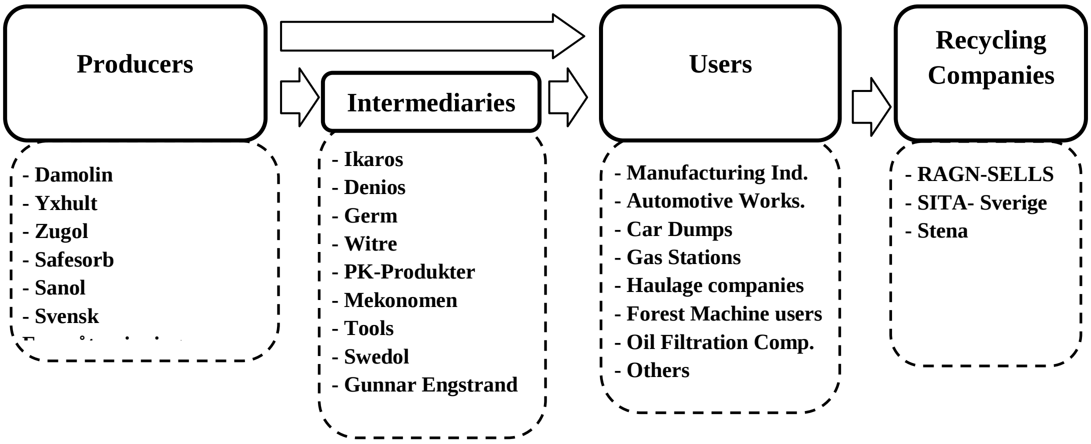


Figure 5.6: A schematic view of the physical flow of absorbents as well as examples of companies in each actor category.

Except for the producers of the absorbents mentioned in the interviews with Stena; Absol, Zugol and Vermiculite, three other major producers of absorbents exist. These are Svensk Freonåtervinning AB, Damolin A/S and Safesorb AB (Appendix C). Svensk Freonåtervinning produces and distributes three different qualities of granules. Their processing plant for recycled polyurethane is located in Lövsta outside Eskilstuna and the processed material is sold by the brand ÖKO-Pur. The recycled polyurethane is primarily taken from their recycling of cooling appliances but also from recycled pipe insulation and insulation material from houses (Svensk Freonåtervinning Web site 2008). Svensk Freonåtervinning to a large extent sells their products directly to the end users of absorbents. The owners of Svensk Freonåtervinning AB are Oeko-service Luxembourg SA (Svensk Freonåtervinning: Allabolag.se 2011), a relatively large company located in Luxemburg, specialized in material recycling, material recovery and processing of waste (EUROPAGES SA 2011). Another large producer of absorbents is Damolin A/S, located in Denmark producing a wide range of Diatomite- and stone based products as well as plastic based absorbents (DAMOLIN A/S 2011). Damolin's main brands within absorption are Absodan and Sorbix, which are distributed to large intermediaries e.g. *Germ AB* and *PK-Produkter AB*. By refining the raw material Diatomite, Absodan reach a relatively high absorption capacity. *Safesorb AB is a* relatively small producer of absorbers, located in Halmstad. The size of the actors in the supply chain differs extensively. While the producers in terms of turnover and workforce in general are relatively small (Appendix E), both the intermediaries and the recycling companies are relatively large with higher annual turnover and number of employees than the producers. The profit margin of the companies with the main activity of dealing with absorbents, Zugol AB and Safesorb AB, have over the time 2007 to 2009 been positive with an average of 8,8% for Zugol AB and 20,3% for Safesorb AB (Appendix E).

The intermediaries dealing with absorbents

All of the producers of absorbents don't utilize direct sales, but commonly utilize the relatively large existing network of intermediaries in form of resellers of industrial material and equipment. One of Sweden's largest providing companies of spare parts for cars, car accessories and car repairs; Mekonomen AB is also a large intermediary for absorbents. Mekonomen AB in 2010 had 230 stores and also agreements with more than 1 300 workshops to provide or utilize their assortment. The absorbers are according to Bengt Ericson at Mekonomen AB, both utilized internally by the workshops to remove spill of oil and chemicals as well as provided as a product to their customers. Out of the companies that does not have physical stores; Ikaros is the largest actor in terms of turnover and state that they have roughly half of the Swedish market for absorbents (Kirkhoff 2011). Ikaros also state that the market knowledge and awareness among the intermediary companies in the absorbent market varies substantially.

The list of resellers connected to a small producer of absorbers, *Safesorb AB*, shows that an extensive part of the distribution of absorbents is done by smaller local resellers. Out of Safesorb ABs 58 resellers, 24 are single stores and 30 are stores owned by Swedol (K. Karlsson 2011). All the identified intermediaries identified (listed in Figure 5.7) do not only provide absorbents or products related to absorbents, but also with a greater assortment of other industrial goods.

The producers have commonly have agreements with the recycling companies in order to provide more than just a product to the users. So have the intermediaries, who play an evidently important role taking the absorbents to the market by utilizing in depth market information gathered from various business interactions. The industrial Intermediaries that provide absorbents also provide a large assortment of products where absorbents only correspond to a small share. Hence, a customer procuring absorbents often procure additional industrial products. The intermediaries are also in some cases large consumers of absorbents, as with Mekonomen mentioned earlier. The recycling companies are in some cases also large customer by also being extensive users of absorbents. Ikaros states that RAGN-SELLS except for being their preferred recycler are one of their largest customers for absorbents, purchasing large amounts of Vermiculite products (Kirkhoff 2011).

The primary demand from the customers is evidently to get rid of their spilled oil or chemicals. This has to be performed according to Swedish laws and regulations regarding hazardous waste (Örtling 2009). Hence, one of the options available for the producers or the intermediary providers of absorbents is to extend the service to also include handling and recycling of the utilized absorbents. Out of the absorbent suppliers, three out of seven investigated absorbent producers and four out of nine intermediaries currently perform this through collaborations with recycling companies e.g. SITA Sverige AB or RAGN-SELLS (Appendix D). Ikaros states that they offer all their customers a recycling system for hazardous waste (Efstratiadis 2009). PK-Produkter and Mekonomen have similar agreements with SITA Sverige AB. In this way, the intermediaries are interconnected with the recycling companies, illustrated by Figure 5.8. The physical flows of products from the intermediaries to are illustrated with arrows.

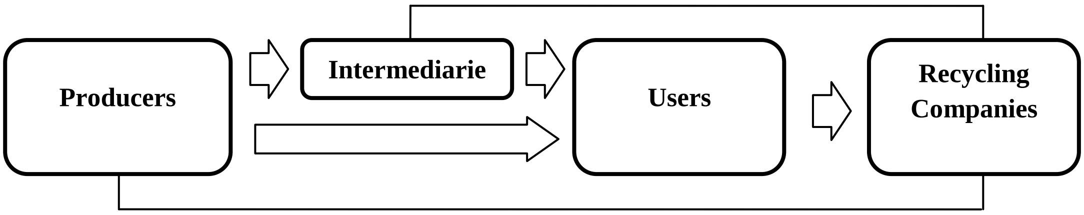


Figure 5.7: A schematic view of the flow of absorbents including connections between the intermediaries and the recycling companies.

Although all intermediaries utilize different channel structures, online stores are commonly utilized as sales channels either for providing product information or as a direct sales channel. Swedol states that roughly 80% of their total sales are done in their 34 physical stores (Swedol AB Web site 2010). Although Witre does not have any physical stores, they provide their customers with a pickup service in Mölndal, Gothenburg, in connection to their warehouse. In terms of physical stores, Mekonomen AB is the by far largest actor and is with high probability also one of the larger in house users of absorbents. Gunnar Engstrand AB, a reseller of absorbents situated in Stockholm, is though the only company out of the intermediaries that has a turnover exclusively related to absorbents.

The end users of absorbents and their demands

The demands from the users of absorbers are diverse, from simple oil absorption on the shop floor to absorbing of oil absorption in water or in industries with tough purity demands, e.g. the pharmaceutical industry. The main users are stated to be the middle to large size industrial companies (K. Karlsson 2011). In 1994, five different user categories were identified; Manufacturing companies working with cutting fluids, automotive workshops, Haulage companies, ships and plants for oil filtration and others. Out of these five categories, the manufacturing companies were stated to have the toughest demands regarding usability and purity (Petersson 2011). This customer category therefore represents the demand from the customers in this section.

Except for the criteria of usability and purity, the demand from the customer is represented with which degree of service that is demanded from the absorbent supplier. In general, the demands from where the products are utilized are fairly simple.

The Volvo Group, the world's second largest truck manufacturing company, states two main demands regarding absorbents; usability and purity. The usability is the most important of the absorbent properties for the users in the factories e.g. maintenance staff, cleaning companies and industrial engineers on the shop floor. Göran Erlenbrandt, Environmental Engineer at Volvo Group, states that the absorbent should be good enough job by removing the spilled oil.

In the case of external cleaning companies, these set the demands while the None Automotive Purchasing business unit (NAP) at Volvo are responsible for the procurement process. Volvo Trucks at the same time set demands regarding purity. Jan Gustafsson, Manufacturing Environmental Manager at Volvo Group, states that the absorbent is not allowed to contain any of the materials or substances that are listed on Volvos Black List. Jan Gustafsson also states that products containing materials and substances on Volvos Gray List should also be avoided as much as possible.

The demands from PEAB, a relatively large construction company, are roughly the same as for Volvo Group. The absorbents should do the job and be simple to utilize to a low cost (Linus Wiegandt, 2011). Linus Wiegandt also mentions that the cleaning activities often are performed by external companies e.g. Lambertsson AB. Even though PEAB are able to set some of the demands regarding the absorbents, the procurement and selection process of absorbents is outsourced to Lambertsson.

The recycling companies

The absorbents are after utilization sent to a recycling company where it is handled as hazardous waste. There are several companies that provide this service in the Swedish market, but only two in that have been identified as collaborators with the identified producers and intermediaries in the absorbent industry and are therefore further described in this chapter.

As illustrated in Figure 5.6, there are two major companies recycling utilized absorbents; SITA Sverige Ab and RAGN-SELLS AB. SITA Sverige recycles everything from plain paper to hazardous waste for over 30 000 customers from a wide range of areas e.g. construction, manufacturing and real estate companies as well as from public sector institutions and shopping malls (RAGN-SELLS AB 2010). Except for the service of recycling the waste, SITA provide their customers with a wide range of services related to recycling and environmental control e.g. waste consulting services, leasing of waste containers and control services regarding waste regulations. This is something that SITA calls Miljöcirkeln®, in which they supply with sorting and recycling experts to their customers.

RAGN-SELLS, as in the case of SITA Sverige; collects, process and recycle waste. The customer base of RAGN-SELLS is similar to SITA’s, consisting of companies, organizations private customers. According to their website, the focus is to utilize their competence and their experience to solve the problems of their customers. For hazardous waste, RAGN-SELLS are able to provide their customers with a recycling system containing five services; analyzing the current waste situation, creating necessary declarations, providing with necessary stickers in order to mark the waste, pick up of the waste and providence of waste statistics as well as result evaluation (RAGN-SELLS AB 2010). All services are according to RAGN-SELLS performed according to regulations and laws. Customer information is accessible through a customer portal.

5.2 The Combustion Fuel Case

Regarding combustion fuel, there were three application areas that were identified during the interviews; fuel for preheating trash, fuel for chalk industry and fuel for cement industry.

5.2.1 Fuel for Preheating Trash

The industry for combustion of trash in Sweden currently consists of 31 waste disposal plants that handle waste from households, industries and others in Sweden (Avfall Sverige 2011). These plants use the waste as the fuel and turn this into electricity, heat and cool (Avfall Sverige 2011). Still, there can sometimes be a need for an additional source of fuel instead of just the waste. It is in this context the possible application for PUR as a fuel for preheating trash has emerged.

The waste disposal plants currently change a gate fee for waste and are thereby used of getting paid for the waste they receive. This waste is used as fuel and they therefore do not need to look for other sources of fuel. However, during an interview with Christer Forsgren another aspect emerged. During the winter there can be ice and water in the waste which will affect the combustion properties. As this occurs, there is a need to utilize an additional burner that will preheat the trash. Currently, the plants commonly utilize the relatively expensive diesel fuel to perform this activity. According to Christer Forsgren, there could therefore be a possibility to instead utilize recycled PUR, due to recycled PURs relatively high energy value. (Forsgren 2011)

According to Christer Forsgren (Forsgren 2011), there are drawbacks to consider using recycled PUR as fuel for preheating trash at the waste disposal plants. Firstly, it is important to consider the fluoride levels as well as the chlorine levels resulting from the freon in the recycled PUR. This is confirmed by Stefan Olofsson (Olofsson 2011), who claims that it can be difficult to sell the recycled PUR as a fuel to waste disposal plants without first reducing or completely removing the chlorine in the recycled PUR. Secondly, using PUR instead of diesel would require an investment in an additional furnace, as the currently used furnaces cannot handle the PUR powder. This could be done by either adjusting an existing furnace, or acquiring an additional one which would require new space that is not accounted for today

To summarize, the collective opinion at Stena is that this application is not feasible since it will be difficult to sell the recycled PUR as a fuel instead of paying the gate fee to the waste disposal plants in order for them to handle it as hazardous goods (Söderberg 2011). Also, because of the energy requirements of the waste disposal plants, this application does not provide Stena with the possibility to sell the recycled PUR continuously over the year.

The information for fuel for preheating trash was difficult to collect. This is mainly due to that industry does not have any information available of purchased fuel simply due to that the main fuel has a gate fee instead of a price.

5.2.2 Fuel for the Chalk Industry

During the interviews at Stena, the possibility of selling the recycled PUR as a fuel for the Chalk industry was one of the applications identified. There are five actors within the chalk industry in Sweden: Nordkalk, SMA Minerals, Oyma, Imerys Mineral and Movab (Svenska Kalkföreningen 2011). Of these actors, Nordkalk is especially interesting because Stena Metall already has an established relationship with them where Stena Metall provide Nordkalk in Köping with recycled thermoplastics from Halmstad. This current flow of recycled thermoplastics is functioning well and the collaboration has created relationships between the companies. Nordkalk currently utilize pellets consisting of wood and paper from a company in Holland. Nordkalk utilize roughly 13 000 ton pellets annually. Hence, their demand gives the possibility to sell the large amounts of the recycled PUR Stena Technoworld produce to one single customer. If pelletized, the recycled PUR can be combined with plastics from recycled electronics in Halmstad, offering Nordkalk 7500 ton each year. There might also be a possibility to combine it with 4000 ton recycled cable plastics from Halmstad, in order to come up to larger volumes. The reason for combining PUR with plastics into pellets is not only to gain larger volumes of the fuel, but also in order to increase the energy per density of the pellets. PUR in itself has a too low energy value in relation to its density, and the fuel is thereby not effective enough in itself. Combining the recycled PUR with other plastics will increase the energy level in relation to the density, even though this is something that requires to be tested and verified.. Nordkalk currently procure their pellets to a cost of 1200 SEK per ton. If Stena were to sell the pellets for half the price, 600 SEK, and then consider the logistics that today is 300 SEK per ton, we have a probable result of 300 SEK/ton. In order to be proactive there is also a possibility to include recycled biomass from Stena's own facilities into these pellets as biomass is consistently preferred over fossil fuel due to taxes and other incentives opposed by the government. (Söderberg 2011)

This alternative would require an investment at Stena Technoworld in Halmstad in the form of a pelletizing machine, producing pellets out of the different components. Except for the pelletizing function, the machine would also be required to have the ability to crush the pieces of plastics. On the other hand, this alternative does not require any investments from Nordkalk since their current processes are adjusted to pellets. (Söderberg 2011)

According to Hans Söderberg there have been discussions with Nordkalk about providing them with pellets from recycled PUR. Stena has even offered to help during the transition to using Stena's pellets in regard of extra personnel at their site. The interest from Nordkalk has been low due to that the pellets from Holland meet their requirements and functions without any problem. Hence, Nordkalk therefore have little incentives to change. Hans Söderberg therefore thinks that the best way to approach this is to produce a pellet consisting of the components discussed before and to present Nordkalk with an actual product. (Söderberg 2011)

One aspect to consider according to Stefan Olofsson (Olofsson 2011) is the level of chlorine. If it was to be reduced to close to zero, it would open up the possibility to sell recycled PUR as a fraction for combustion instead of as a hazardous product. As mentioned earlier, this should be considered in relation to that the freon, which consists of chlorine, is forbidden since 1995. Therefore the number of cooling appliances with freon is declining, and by that the levels of chlorine in the recycled PUR.

The situation at Nordkalk became the starting point, leading the investigation further in establishing the actors in the market and other potential customers aside of Nordkalk. All the actors in Sweden are members of Svenska Kalkföreningen (The Swedish Chalk Association), but only two of them are combusting chalk in chalk furnaces. These two companies are Nordkalk and SMA Minerals which therefore became the focus of the investigation (Juvel 2011). SMA Minerals has two chalk furnaces in Sweden, one in Rättvik and the other in Sandarna where they utilize fuels e.g. blast furnace gas, oil, coal and other alternative fuels. The amount of coal utilized by SMA Minerals is between 20 000-25 000 tons annually, which could possibly be replaced by the pellets. Daniel Juvel also expressed an interest in utilizing the recycled PUR as a powder that they could utilize directly in the furnace, but that they do not have the possibility to handle and storage it. A prerequisite for that solution would therefore be that the transportation would be just in time, so that the PUR powder could go right into their process. Daniel Juvel (Juvel 2011) expressed that this would be a more thinkable solution for them, but that they are also principally interested in the pellets solution.

During the course of this master thesis, a collaboration between Nordkalk and Stena Technoworld was initiated. Stena has sent a small amount of PUR briquettes directly to Nordkalk, which they have crushed to powder by using screws and then inflated into the furnace. Hans Söderberg at Stena Recycling describes this solution as very fortunate as it was not guaranteed to being a possible solution. Stena is still considering the pelletizing solution, mostly because that would guarantee a certain quality to Nordkalk, regarding size and energy levels, but as the solution of providing Nordkalk with the briquettes does not need any investments, this solution will be tested first. (Söderberg 2011)

According to Stellan Karlsson at Nordkalk, the tests of receiving the PUR briquettes have not met their expectations. Nordkalk does not have a crusher, but grinding screws, and are therefore dependent on that the briquettes not being so hard that they will not be crushed into powder. Unfortunately, this has been the case during these test trials. At the same time, the shipments do not only consist of recycled PUR but of other materials as well, which cannot be handled by the processes at Nordkalk. It therefore causes a stop in the intake for the furnace and make the handling of the recycled PUR difficult. A solution for this is according to Stellan Karlsson an investment at Nordkalk in a crusher that can handle the received PUR and therefore secure that the processes will not be affected, an investment he estimates to around 0,5 million SEK with installation and start-up costs included. With such a solution, Nordkalk would be able to handle a large amount of PUR that is available from Stena. With an annual usage of 40 000 ton coals, where up to 20 % is allowed to be replaced by recycled fuel, Stellan Karlsson estimates that Nordkalk can handle between 500 and 1000 ton PUR from

Stena each year. As mentioned earlier, a solution where Stena sends powder directly to Nordkalk is not of interest because of the handling difficulties. Even if this solution has been started, Stellan Karlsson expresses that Nordkalk, in the long run, still is more interested in the pelletizing solution because of the easier handling, more even energy level and easier replacement for coal, of course with regard of the cost structure. (S. Karlsson 2011)

5.2.3 Fuel for the Cement Industry

PUR has a high level of energy and would therefore be suitable for the production processes that require high levels of energy. The PUR powder can be used as an additive in order to increase the energy levels of the fossil fuel used today in the main combustors. According to Christer Forsgren (Forsgren 2011), Cementa do not appreciate PUR as it is as a powder because of the handling problems. Instead they would like to receive PUR when it has been used at least once, maybe as an absorbent, in order to simplify the handling processes. Also it can then have the characteristics as burnt coal which is what the cement industry is using today in their furnaces. In that case, PUR can be sold as a fuel instead of disposed of as hazardous material.

The cement industry in Sweden has only one actor, Cementa, whom are a part of Heidelberg Cement Group. Cementa have three facilities in Sweden; Slite, Skövde and Degerhamnand produces roughly 2,9 million ton of cement annually. The production processes are considered as energy intensive, with 35- 40 % of the productions total emissions of carbon dioxide coming from the fuel used in production. The major share of this fuel is fossil, (69%) and Cementa therefore aspire to increase the amounts of biomass as well as hazardous waste fuel in order to fulfill their environmental goals. Also, as production of cement requires high furnace temperatures, it is possible for them to utilize hazardous waste as combustion fuels without hazardous emissions. (Cementa 2011)

As Cementa is the only actor in the cement industry in Sweden, the focus on our investigation has been if they would be interested in a solution with the pellets mentioned for the chalk industry as they currently utilize plastic pellets from Germany and Holland. Anders Jansson (Jansson 2011) at Heidelberg Cement Miljö is very familiar with the question regarding future applications for recycled PUR. He was the initiator of the current solution where the recycled PUR is sent from Stena Technoworld to Stena Recycling, as Heidelberg Cement Miljö and Reci used to be sister companies. According to the chemical specification received from Anders Jansson, the pellets have a calorific value, which is the energy value, of between 19 – 21 MJ, which should be put in context with recycled PUR that has a calorific value of around 24 MJ. According to Anders Jansson, Cementa can handle recycled PUR as a hot mix today, but do not wish to utilize it as a powder due to the complications then arising in their processes. Cementa can also handle the recycled PUR as pellets, if the specification is met and in relation to price and logistic solution. One problem regarding this solution is that Cementa today do not pay anything to handle material like this. Instead they have a gateway fee of around 200 – 1500 SEK for each ton they receive. Cementa has stated that another problem related to the recycled PUR is the low amounts that can be delivered to them, according to Marianne Gyllenhammar (Gyllenhammar 2011).

For the cement industry the market potential was calculated as consisting of 2% of Cementa's alternative fuel. The investments costs would be none for Stena if PUR could be used as a powder at Cementa, or the cost of a pelletizing machine if it were to be pelletized. The fuel that would be replaced and that PUR would challenge the coal, with an estimated market price of roughly 800 SEK/ton. The estimated market price for PUR pellets would then be 400 SEK/ton, half the price of coal.

5.3 The Material Recycling Case

For material recycling, three application areas were identified; reuse in new cooling appliances, ground insulation and filler material.

5.3.1 Reuse in New Cooling Appliances

One of the applications that came up under the interviews at Stena was to utilize the recycled PUR as a replacing material when manufacturing new cooling appliances. This application could have the advantage of not only being a way of reducing production and material cost for the manufacturers but to be an opportunity for the cooling appliance actors to reach their internal environmental goals by reducing their environmental footprint. (Frostne 2011)

Larger companies commonly have stated goals regarding their environmental performance. So does Electrolux, a major manufacturer of home appliances originating from Sweden. According to the company website, one of their goals regarding sustainability is among others to: *Reduce resource consumption, waste and pollution in our operations* (Electrolux 2011).

The technical news paper Ny Teknik describes that Electrolux performed a study regarding this application in 2003 (Köhler 2003). The article explains that two attempts of material recycling of plastics in the cooling appliances has been conducted; usage of recycled thermoplastics for manufacturing new cooling appliance cabinets and usage of recycled insulation foam, recycled PUR, into the new insulation of the cooling appliances. Neither of these attempts was according to the article successful, but the reasons for the failures are not fully explained in the article. It would therefore be out of great interest to gain further knowledge about these tests and see if the increased purity of the PUR today relative to 2003 could give new opportunities for success.

5.3.2 Recycled PUR in Ground Insulation and as Filler Material

Due to the properties that newly manufactured PUR possess as an insulation material, the idea that the recycled PUR could be utilized in other applications where these properties are desirable came up. Stefan Olsson states that everything from ground insulation of houses to insulation utilized inside walls have been discussed in the past. In these applications, the recycled PUR would foremost be utilized as a filler material to reduce cost and to decrease the environmental footprint done by production of new material. Around 10 000 villas or smaller houses are built annually (Statistiska Central Byrån 2011). If the recycled PUR could replace 5 % of the existing PUR the ground insulation for these houses could provide a market of over 900 tons of recycled PUR (Appendix G).

There are several actors in the market of insulation panels in Europe. According to an investigation made by the Swedish construction company Skanska in 2010, there are six main actors for producing insulation panels of PUR; EcoTherm, Bauder, Celotex Limited, SPU Systems Oy, Spurab and Polyterm. These companies focus on panels for insulation of walls, floor and roofs of houses (PDF Skanska, 2010). There are also several actors on the Swedish market for insulation panels that are specific for insulation of cooling appliances such as; Nova Panelsystem AB, KI Panel (Huuree), Panelbyggen Väst AB, Kyl AB Frigoväst and 3S AB among others. These companies often market their PUR as CFC-free.

5.3.3 Development Within Material Recycling

Stena is not stated to have any natural partner to cooperate with within this area but two different models are mentioned by Mårten Frostne at Stena Technoworld (Frostne 2011). The first is to simply find an actor within this field and convince them to purchase the recycle PUR as it is today for them to dispose and develop. The second idea would be to find a collaborating partner within this field and manufacture and design a product within this field together. It is according to Mårten Frostne desirable to maximize the value created from PUR and therefore worthwhile considering alternative value increasing processes for the recycled PUR for achieving this purpose.

In order to further develop the possibilities within material recycling, a deeper investigation was committed with focus on finding an application that was possible to invest in a long term. As mentioned earlier, the strongest lead within this field was Electrolux and their research around PUR in material recycling, which became the starting point for the investigation.

During the interview with Erik Ringdahl (Ringdahl 2011) at Stena Metall, the contact details to a person with knowledge about this field were mediated. The person, Bernt Andersson, had formerly worked at Electrolux and is now a consultant at a company called RDE. During the interview with Bernt Andersson (B. Andersson 201) several aspects came up. He confirmed that the solution of using the recycled PUR powder back in the insulation of new cooling appliances is not feasible because the mechanical properties of the insulation will become too poor. This is confirmed by Anders Helin (Helin 2011), also a former employee at Electrolux, that worked within the company for more than 30 years and who has been involved in developing the insulation in cooling appliances at Electrolux. He emphasizes that the floating properties of PUR is important when producing the insulation in the cooling appliances, and that when adding recycled PUR to the process it affects the properties of the insulation in a negative manner. He also mentioned that there have been investigations in backing the process of recycled PUR, trying to get the original components and by that be able to produce PUR again, but that these processes took so much energy that there was no incentives to carry on that path.

Bernt Andersson also recommended contacting Ilan Cohen, Director at Electrolux that is well familiar with PUR, in order to investigate the stand point of Electrolux today within this matter. Ilan Cohen (Cohen 2011) also confirmed that the possibility of using recycled PUR within the insulation in cooling appliances is something that has been investigated and not something Electrolux thinks is a future possibility for recycled PUR. But, Ilan Cohen had another aspect of the usage of recycled PUR that is vacuum insulation panels that can be used in cooling appliances or any other products in use of insulation panels. The recycled PUR can then be packed within aluminum and then undergo a chemical process in order to produce these panels. He recalled that Bayer had done investigations in this several years ago, but that the purity and the structure of PUR were too poor at that time. This can be a field of research initiated by Stena, and Ilan Cohen expressed that he would be very interested in participating in such an investigation.

When contacting the main suppliers of PUR, consisting of Bayer, BASF and The Dow Chemical Company, the same picture emerged of the possibilities of using PUR within material recycling. Göran Bergström (Bergström 2011) at Bayer Material Science recalled a project performed in Germany focusing on chemical recycling of PUR called "Schwarze pumpe" that identified the problems with this process and the large consumption of energy. Also he acknowledged the importance of keeping the floating properties when producing insulation panels of PUR, affecting the insulation qualities which he identifies as the most important aspect when considering this. He also mentioned that the high pressure machines used today when producing these insulation panels would not be able to handle PUR as a powder, and that this would be a troublesome aspect when looking into this further.

At Elastogran Nordic AB, a part of BASF Polyurethanes Sweden AB, Stellan Roxendahl (Roxendahl 2011) recommendation is to use the recycled PUR as fuel, because it is the best way of using the product according to them. Stellan Roxendahl recalls of a company in Denmark that is using chemical recycling today. The company is called Logstor and manufactures pipe systems that are insulated with virgin PUR. When the pipes are utilized, they are recycled through the chemical process. Glycol is added to the pipes and then is processed through a heating process that separates it into their main components. This is an energy demanding process, and he imagined that there would not be an interest in doing the same process with our recycled PUR if the environmental aspects of the transportation were to surpass the benefits of chemical recycling. When contacting the company in Denmark, they expressed that they only do the process for their own products and that they are not interested in buying in PUR from other companies or form collaboration with another company today.

The information collected from the different actors related to material recycling of recycled PUR was put together in a table in order to get an overview (see Table 5.3).

Table 5.3: Information collected from the different actors related to material recycling of recycled PUR

	Chemical recycling	Cooling appliances
Bernt Andersson **RDE, formerly Electrolux**	No information regarding chemical recycling	Gives a lower insulation quality, weakens the properties of insulation
Anders Helin **RDE, formerly Electrolux**	Too much energy is required, not worth it	The floating properties are important which the powder affects
Ilan Cohen **Director at Electrolux**	Thinks that this is a “lost case”	Is interested in developing vacuum insulation panels of recycled PUR
Göran Bergström **Bayer Material Science**	Not recommending this	Properties of insulation most important, which means good floating properties
Stellan Roxendahl **BASF/Elastogran**	Logstor in Denmark does it, but it requires large amounts of PUR and that the logistics is not to complex	No further input regarding this, they recommend combustion.
Logstor, Denmark	They do it with their own product, have no thoughts about doing it large scale.	No information regarding cooling appliances.

6. Analysis

This chapter provides an analysis which is based on the empirical findings viewed through the problem analysis and the theoretical framework earlier identified as the Industrial Network Approach. It starts with the analysis of the current situation at Stena, and develops further into the three application areas; absorbent, combustion fuel and material recycling.

6.1 Analysis of the Current Situation at Stena

The network structure of the current situation at Stena Metall can be seen in Figure 6.1 below. It is the base for understanding the developments and progress of the different application areas identified and is therefore of importance to understand. As can been seen in the figure, Stena Technoworld has an activity where they recycle the cooling appliances, and receive the resource recycled PUR. There are two activities at Stena Recycling; absorbent in Hot Mix and Contaminated water pit. Finally the figure also visualizes the need for a possible application probably involving another actor. Since an earlier attempt of selling recycled PUR as an absorbent already has been performed in the Purol project in 1994, this project will also be analyzed further in this chapter.

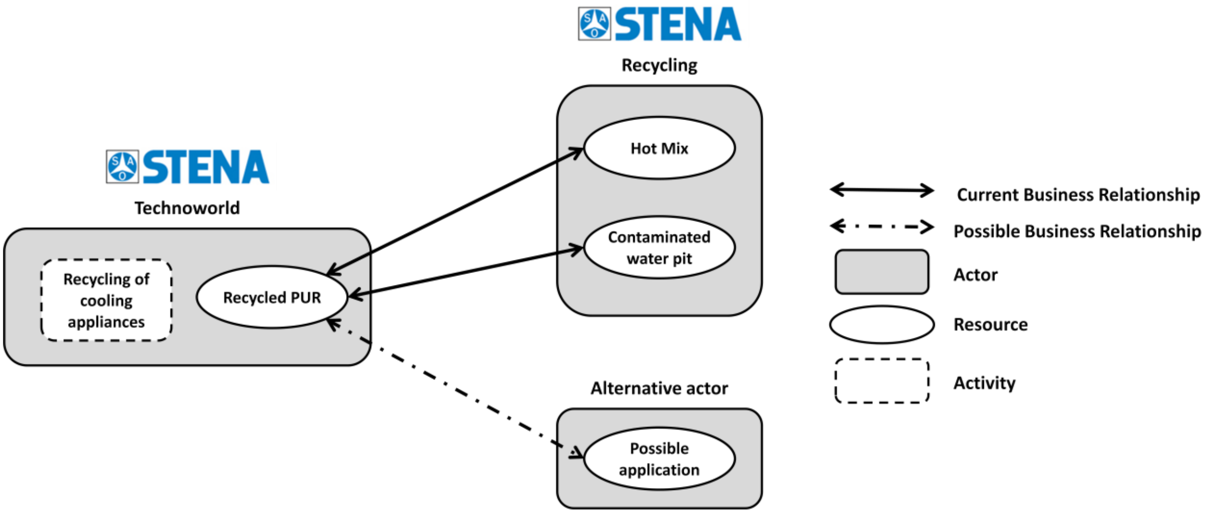


Figure 6.1: A network perspective of the current situation at Stena

A Network Perspective of the current situation at Stena

There are several actors involved in the process of recycling PUR, both within the Stena sphere as well as externally, which has been evident during the construction of the cases presented in chapter 5. For most of these actors, the recycled PUR is not their main concern and therefore only one resource of many they consider in their day to day operations. This is the reason for the behaviors and results of these individual actors, because they prioritize between these different resources. Internally at Stena, there are several individuals with extended knowledge about the different resources that Stena handle, among them recycled PUR. Many of these individual actors also have knowledge about the recycled PUR and how it affects the other resources. These individuals have well developed perceptions of the network context, that is how the recycled PUR is affecting Stena, but not as developed perception of the network horizon, how the recycled PUR is affecting other companies outside of Stena. As has been noticed during this master thesis, it is not the quality of the information these individuals carry that is the issue, but instead the possibilities for them to communicate their knowledge to other actors and know which actors that are the right for each identified problem. As it is today, there is little information available within the Stena sphere about which individual actor that has what knowledge, which leads to a time consuming approach for finding the right information from the right individual. There are several individual actors at Stena that have developed bonds with individual actors at other companies. These bonds are the foundation for acquiring knowledge externally and by that getting to know the different industries better. There is also a problem with communication within the Stena sphere, as different individuals can have bonds with other individuals at the external companies, without the individuals at Stena being aware of it. It also leads to a time consuming approach, and possibly to a situation where there are mixed signals from Stena out to the external actors. But it is important to remember that there should be possibilities for internal and external individuals to form bonds with each other, as this would deepen the relationship between the companies as well as extend the network further.

In our context, PUR is the focal resource that the application investigations were based on and it can therefore be assumed that the recycled PUR is also the focal resource for Stena. The recycled PUR at Stena has become something that could be called an unwanted resource. It is a byproduct that Stena receives when they are disposing of the freon content in the cooling appliances, and therefore they cannot change the structure of the recycled PUR as a powder.

There are several activities involved in the network around recycled PUR. First of all, there are the activities that occur within Stena Metall. As of today, only Stena Technoworld and Stena Recycling are affected by the handling of recycled PUR. The activities around recycled PUR within these two companies are explained earlier in chapter 4, and in addition to these are the logistical activities in order for the recycled PUR to be transported to Stena Recycling's site. There are also other activities involved, e.g. the collection of the cooling appliances and the transportation of these to Stena Technoworld's site in Halmstad. The activity links visualized in the picture are possible to break, with some of them being easier than others. The other activity links between Stena Technoworld and Stena Recycling are easier and possible desirable to break, especially in order to make room for another possible application for recycled PUR. As mentioned earlier in chapter 4, the activity link to Hotmix should be more prevailed than to the contaminated water pit, as Stena Recycling are developing an alternative solution for this one today.

Value Creation for the current situation at Stena

Today, the perceived monetary value of the recycled PUR within Stena is low. The reason for this is that it has gone from being a cost to now barely break even within the organization, as Stena Technoworld is selling it to Stena Recycling. As described earlier, the recycled PUR is today utilized in two processes at Stena Recycling. It is in this sense that the recycled PUR already provides a value for Stena in form of internal economical value, as Stena do not need to purchase any other products for these two processes. If there are applications found for recycled PUR where the shipments to Stena Recycling would need to cease, this would affect the internal value. This would implicate that the economic value that can be gained from an application would need to be higher than the internal economic value, as well as the alternative cost for Stena Recycling to replace the recycled PUR. There is also a value in being able to provide with a product that is recycled and by that affecting the social value. Both for the company, as they can gain marketing and good will benefits by providing a recycled product, but also for the individuals at the company who can identify themselves with an environmental friendly approach which can bring them a sense of pride to work at Stena, something that will also affect the emotional value of the individuals at Stena.

6.2.1 The Purol Project

The cooperation between Stena and Sanol ended without success and with little value added for any of the companies involved (Arbetspappret, 1998). Due to the limited amount of data regarding this cooperation that is still available today, the reasons for the outcome is difficult to analyze. Two of the persons that could have contributed with additional and important information regarding this cooperation, Fredrik Magnusson and Jan Berglund, have left their respective company and could not be reached.

Even though information that could have brought light upon the reasons for the outcome of the project is not available, some statements can be done. In the papers covering the basic outline of this cooperation, Sanol is stated to be a leading actor in the absorbent market, having an already well developed absorption system. The empirical data gathered from various sources states that if this was the case in 1994, the situation has evidently changed since then. Current information reveal that Sanol currently is a relatively small local actor with limited amount of resources and a simple activity structure. The relative size of Sanol, with few or no employees and a turnover of less than 0.5 MSEK limits the company's possibilities of creating valuable business units and relationships.

Statements made by Claes Pettersson, Quality Manager at Stena Recycling, regarding that the competing companies had extensive information about the customers' consumption and demand for absorbents further points out the importance of business relationships. The competing companies knew quite accurately the stock level for absorbents of the utilizing company, contacted them in the right time and sold an extensive amount of absorbents covering utilization for a long period of time. Hence, the continuing interaction between the actors, the customers and their existing suppliers of absorbers might have given their existing suppliers a competitive advantage. The knowledge about the customers and the market seem to have been an important resource in order to compete in the absorbent market.

The resource ties may also have created troubles for Stena and Sanol to enter the market, if the competitors in addition to offering the absorbents at the same time offered recycling of the absorbents. This is something that currently is performed by the actors on the absorbent market, both from the producer and the intermediary actors. Figure 6.2 shows the actor bonds that exist between some of the absorbents supplier, both producers of absorbents and intermediaries, and recycling companies. Hence, changing existing supplier of absorbents may change, impair or terminate the business relationship with the recycling company affecting other activities.

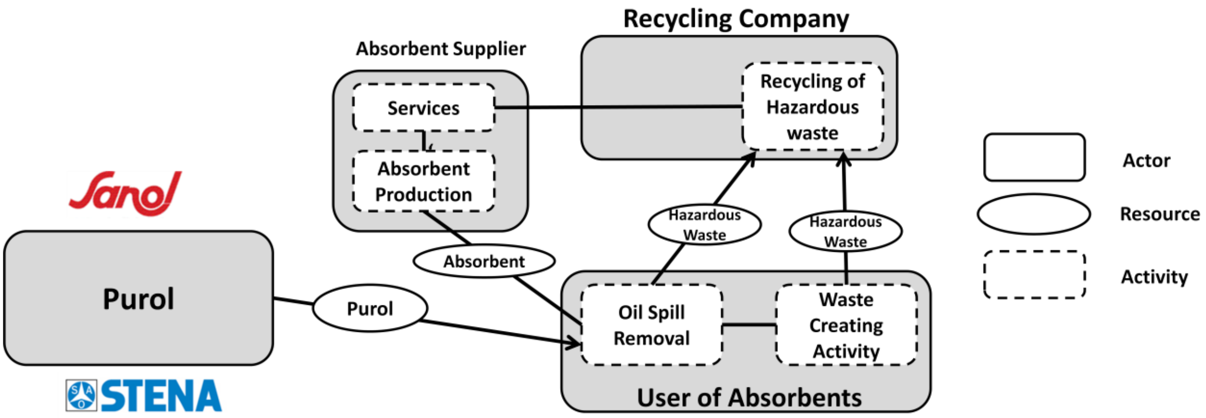


Figure 6.2: Actor and activity overview showing the flow of the absorbents and the links between actors

The documentation available clearly states that the responsible individuals at Stena expected quick wins at a limited risk associated with the project (Arbetspappret, 1998). Hence, when results did not come as soon as expected, the support from the managers responsible of the project decreased. In the meeting during when the termination of the project is documented, it is mentioned that problems existed on a product level. These product technical flaws that the recycled PUR might possess could therefore also have been a factor causing the termination of the project. Even though the problems might have been possible to solve, problems may cause uncertainty and distrust. If the managers are not willing to solve these problems, it can be difficult to built this trust again once it has been damaged.

6.2 Analysis of the industrial absorbent case

This chapter provides a general analysis of the absorbent market, the companies it consists of and their products, utilizing the theoretical framework. If Stena decides to take a new product to the absorbent market, Stena need to decide upon the degree of product refining, target customers and a strategy how this should be performed. Section 6.2 therefore ends with stating the strategic options available for Stena, identified from the general analysis. These become the foundation of the conclusions drawn in chapter 8.

6.2.1 General Analysis of the Absorbent Supply Chain in a Network and Value Perspective

As stated in section 5.1.4, there are four main actor roles in the supply chain for absorbents; producer, intermediary, user and recycler that recycle the utilized absorbents. Figure 6.3, showing the supply chain of absorbents, implies that the physical flow of absorbers have fairly few steps. Still, actors interact in what (Håkansson, et al. 2009) refer to as the business environment with links between activities, ties between resources and bonds between actors.

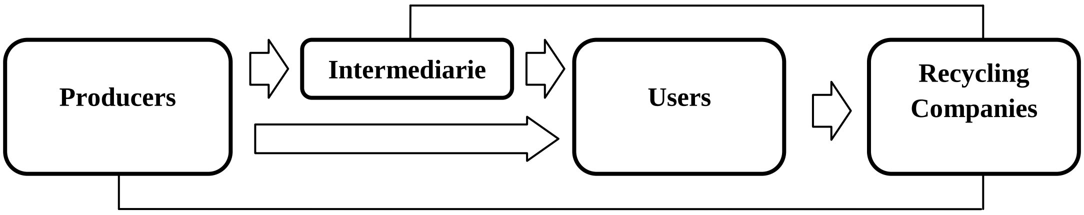


Figure 6.3: A schematic view of the actor roles in the absorbent supply chain and the physical flow of absorbent between these.

The absorbent supply chain consists of several unfamiliar actors for Stena. Still, due to the Stena Groups relative size and diversity in activities, several bonds may exist to companies in this supply chain, coming from other business transactions. Actor bonds are important in development of new transactions between companies as well as in identifying possible solutions in current transactions (Håkansson, et al. 2009). Hence, if new business transactions are to be created e.g. with new potential customers or for processing the recycled PUR, there would be an opportunity to utilize all the interpersonal and business relationships that Stena currently possess. The interviews revealed that Stena's resources in form of business relationships outside the company were evidently great. Stena therefore currently cooperates or have interpersonal connections with several companies that could be important for creating collaborative activities combining necessary resources.

The demand for removal of the oil spill exists inside Volvos and PEABs factories and construction sites. However, these companies are not the actual users of the absorbent since the cleaning service in some of these is outsourced to an outside actor (Figure 6.4). At PEAB, the decisions regarding these kinds of issues are often incorporated into other products or services that are outsourced to companies e.g. Lambertsson Sverige AB (Linus Wiegandt, 2011). These actor are then the actual users with the absorbent demand and are therefore responsible for the selection and procurement processes related to these products. In the case of PEAB, the procurement and selection activities are performed by Lambertsson.

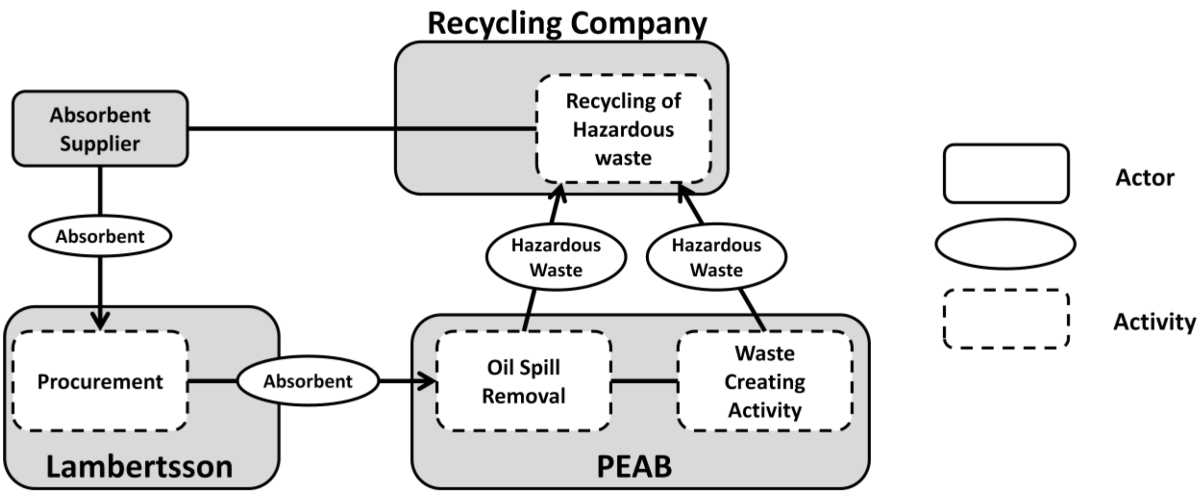


Figure 6.4: The PEAB example

Stenas decision of choosing actor role in the supply chain could be based on information regarding where the highest relative profitability exist. Measuring the relative performance of the different actor roles in the absorbent supply chain is though difficult due to the fact that few of the identified companies deal exclusively with absorbents. One way of assessing this problem could therefore be to perform a qualitative analysis of an actor that has had relatively high profit margin the past years. One actor in the absorbent supply chain that over time has outmatched its competitors is the producer / importer Safesorb, who had a profit margin of 17 and 24 % between 2007 and 2009. These relatively high profit margins of Safesorb AB may be due to several reasons. First of all Safesorb provide a relatively large assortment of products out of different qualities and with a wide range of degree of refining (Safesorb AB 2011). Safesorb though states that their granules is the most of their business and that the refined products, e.g. pillows and worms, stand for a relatively small share of their total sales (Safesorb AB, 2011). Another explanation could be that Safesorbs' products are provided by Swedol AB, which except for their sales to businesses online or by contract also have 34 physicals stores, spread all over Sweden (Figure 6.4). These stores hence provide Safesorb with a large network of customers and could imply the relative importance of utilization of intermediaries in possess of physical stores.

Product performance and refining

Refining the product by improving the surface quality has by experts in the field of surface chemistry been stated to be possible, all though the processes may be complex and costly to implement (Holmberg 2011). Stena may not have the resources needed for such process, neither competence nor equipment, and would either have to procure equipment and develop competence on their own or outsource the task to an actor in possession of these resources. On the other hand, the absorbent supplier Safesorb states the refined products to correspond to a relatively small part of the total consumption.

The perceived value of recycled PUR depends on how it is combined with other resources. The total perceived value of the recycled PUR by the customer is affected by its functional, emotional and social values. The functional value of the recycled PUR is related to the absorption and removal of the spilled oil at a lower price. According to the empirical data presented, the functional value of the absorbents for the customers is mainly affected by the price of the absorbent, its absorption performance as well as its purity. The social and emotional factors are other factors that influence how the value of the resource is perceived. In case of absorbents, important emotional values could be related to reliability and trust in the recycled product while the social are related to the interpersonal relationships existing between buyer and supplier. The recycled PUR can be perceived having a higher value when being compared with other products in regard of its properties of being recycled and environmentally friendly.

The customers' perceptions of what benefits that actually are received and which sacrifices that are made by changing to the new recycled PUR based product are also out of essence. The customers' demands differ depending on their perspective and who in their activity chain that sets the demands. If the cleaning service is outsourced (as in the case of PEAB) the supplier of the cleaning service may also be responsible for the procurement of the absorbents. In that case, the actual procurer of the absorbent may not be affected by costs appearing later on in the product life cycle e.g. disposal of the utilized products. Hence, if Stena would consider designing a package solution including both the absorbent and the recycling of it after it has been utilized, the origin of the targeted customers' demands requires to be addressed in order to create benefits and minimize sacrifices for all the involved actors. Controlling the customers' sacrifices could therefore beneficial in the absorbent market. This structure would lower the total life cycle cost caused by the absorbent.

A fundamental investment analysis reveals that in order to create a Stena granular absorbent product, an initial investment of around 1,3 million SEK would be required in order to attain the resources needed e.g. packing equipment (Appendix F). Hence, there might be other options for Stena to consider if the initial investments and the risk are to be kept low. From this analysis three major options can be derived for Stena, ordered by the size of the initial investment required, which will be discussed in the following chapters:

1. Providing the recycled PUR as a raw material to an existing producer or intermediary dealing with absorbents without collaboration or further interaction (section 6.2.2)
2. Create a collaboration with a producer or intermediary in the absorbent market with extended business interaction (section 6.2.3)
3. Create a Stena product and make all the required manufacturing and processing activities in house (section 6.2.4)

6.2.2 Sell as a Raw Material to an Existing Producer or Industrial Intermediary

The analysis presented in 6.2.1 implies that relatively extensive investments in terms of financials would be required , e.g. packing equipment, in order to acquire the resources needed to create an in house absorbent product from the recycled PUR. An alternative could therefore be to sell the recycled PUR to an already existing producer or an intermediary for them to dispose, refine and sell. This would avoid taking a large financial and operational risk investing in equipment, staff hours and competence needed for entering the market. This option would also keep the tied up capital low for Stena while the costs recycled PUR currently creates for Stena could be lowered and the sales might generate an income. The resources that currently exist within Stena would in this model be left out and unutilized.

The Network Perspective of the recycled PUR as a raw material

The potential customer in form of a producer or an intermediary could take advantage of their already established resource structure in form of facilities e.g. warehouses' and packing equipment or interpersonal relationships e.g. customer or supplier relationships (Figure 6.5). The recycled PUR would also be able to attain synergies within logistics and other activities. The producer or intermediary could synchronize the shipments of the recycled PUR products with their already established flows of goods to their customers and thereby lower the marginal cost.

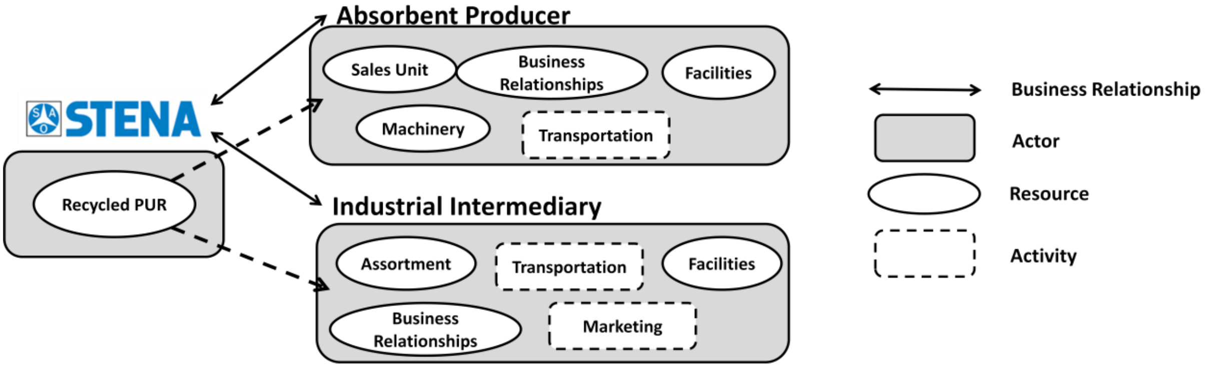


Figure 6.5: A schematic view of the alternative of selling the recycled PUR as a raw material to a producer and/or an intermediary as well as examples of resources that could increase the value of the recycled PUR.

The relationship between Stena and the producer would in this case be an arm's length relationship with limited interaction. Hence, this option might not give Stena increased market knowledge and experience which could be out of relative importance. As a raw material supplier Stena would also have limited abilities of utilizing internal resources in form of organizational and interpersonal relationships. At the same time the idea of selling recycled PUR as a raw material would be relatively simple for a competing recycler e.g. Svensk Freonåtervinning to replicate. If Stena could convince a producer or an intermediary that their material could be an alternative to their already existing product portfolio, this would be a feasible option.

Value Creation through a raw material approach

The cost for currently sending recycled PUR the 421 km from Halmstad to Köping is stated to be around 300 SEK / ton. If an absorbent supplier (intermediary or producer) willing to procure the recycled PUR as a raw material could be found and reached, this would imply a relatively low marginal transportation cost per liter absorbent. An opportunity would therefore exist for Stena to compete with existing raw materials in terms of price, while the absorbent supplier could deliver the product to a relatively low price to the end customer. Hence, the relatively low price for the recycled PUR as a raw material would give the intermediary or producer an opportunity to lower the total life cycle cost due to the higher margins created.

On the other hand, Stena would not have any control over the absorbent users' other costs and would therefore not be able to increase the value to the end customer. The structure of the activities will be decided by the procurer of the recycled PUR, hence leaving them with the control over the absorbent users' life cycle costs.

6.2.3 Collaboration with a Producer or an Intermediary

In 1998 the joint venture created between Stena and Sanol failed to deliver expected results. Still, the option to create a joint venture or some other sort of collaboration together with an existing producer or intermediary dealing with absorbents remains. By combining the resources needed for packing and production together with other valuable resources e.g.

business relationships and contacts possessed by both the companies, the risk can be reduced for Stena at the same time increasing the created value of the recycled PUR.

The Network Perspective of collaborations

There are two different options for Stena regarding collaboration; develop a collaboration with a producer or with an intermediary. A schematic example of how collaborating with a producer could be performed is provided by Figure 6.6. The figure shows examples of resources that could be shared, e.g. machineries and business relationships, and thereby would be able to create similarities in future activities. If Stena would recycle the hazardous waste from the absorbent user, this could become a complementary activity and provide further value to the customer. Still this would require that the absorbent producer currently does not have this kind of agreement with a recycling company or is willing to change to Stena. By selecting this option the relatively large investment in a packing machine might, in the case of collaborating with a producer, be possible to avoid. At the same time the new developed products processing, production activities have similarities with the producers' existing activities.

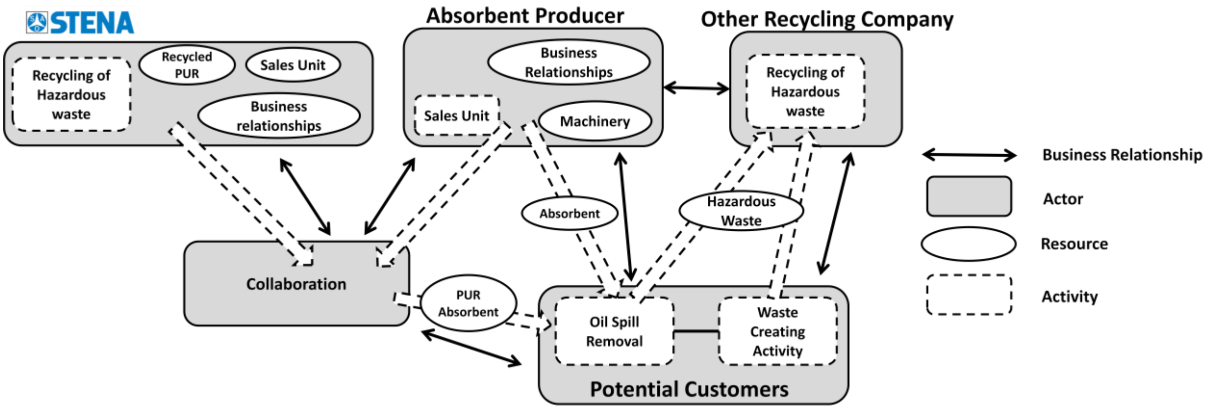


Figure 6.6: Example of the ARA structure in case of creating a joint venture or a collaboration with an existing producer of absorbents

The second option mentioned, to collaborate with an existing intermediary in the market, could imply other similarities and complementarities in activities. An intermediary might not have the machineries required for product processing, but might possess several other valuable resources. The products could be distributed through the intermediaries' distribution network, gaining value by utilizing that the intermediaries already developed resource structure of customers and physical stores. Swedols physical stores sell 80% of the total amount of products sold by Swedol (Swedol AB 2011). Hence, even though no sales data specifically for the absorbents is available for Swedol, this could point at the relative importance of business interaction with companies having a network of physical stores. The focal resource, in this case the absorbents, creates ties to Swedols resources e.g. their network of physical stores which increase its value. Thereby the absorbents at the same time gains further value trough creation of resource ties to Swedols business relationships, business units and additional products provided, as can be seen in Figure 6.7.

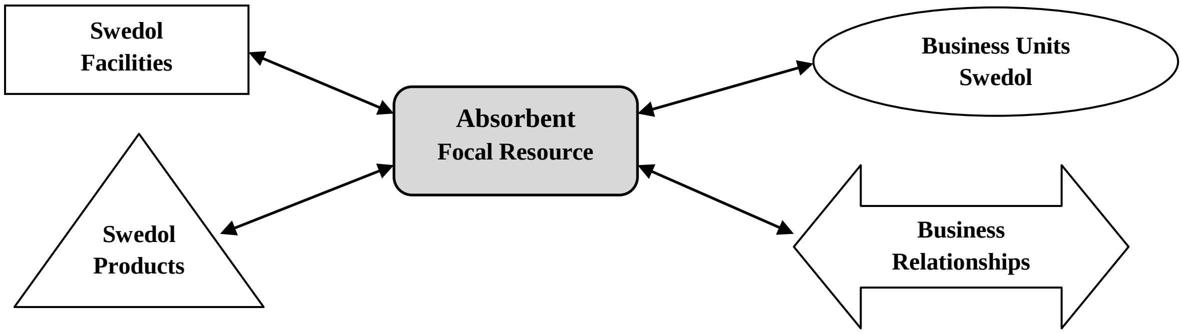


Figure 6.7: The 4R model for the focal resource absorbent

The intermediaries possess important intangible resources e.g. customer consumption data for absorbents as well as interpersonal relationships to these companies. Stena could provide these companies with a component in possess of favorable absorbent qualities that they could incorporate in their end products for their customers. This option would also give Stena increased market knowledge in the absorbent market at the same time utilizing the business relationships that Stena currently possess. Stena would also be able to provide complementary activities e.g. recycling of the hazardous utilized absorbents. Still, some of the producers then would have to sacrifice their existing collaborations with other recycling companies.

This option would still leave the possibility for Svensk Freonåtervinning to replicate this model by engaging in a further collaboration with a recycling company e.g. SITA Sverige or RAGN-SELLS. That would leave the possibility for Svensk Freonåtervinning to compete on the same market as Stena Metall, and to be able to provide the same solution as Stena Metall could provide.

Value Creation through collaborations

The benefits and the sacrifices, the gains and losses, would in the case of a collaboration be shared with another actor decreasing the financial risk of the project. Still, the risk has to be put into comparison what the actors actually could gain from the project. First of all an actor would be required to be found that actually would see the benefits from this kind of collaboration. The producers could perceive the benefits and the gains as not great enough since the products would interfere with there already existing ones, cannibalizing on their already existing product line. There could be a risk that for instance the producer’s sales unit favor internally produced products.

The intermediaries commonly have several brands of absorbents in their assortments (Appendix B). Even though this could give several possibilities to find similarities between product activities, the new recycled PUR product would therefore also be exposed to competition from already existing products. The relationships between the intermediaries and their suppliers have been developed over a long period of time and might therefore be relatively strong. At the same time several of the intermediaries of absorbents already have collaborations with recycling companies, extending the service by care of the absorbent users waste. This would give an opportunity for the collaboration to lower the total life cycle cost of the absorbents.

Hence, either strong benefits have to be created in order to convince an intermediary to change the recycling system provider, or an intermediary without this kind of collaboration have to be found. At the same time, very few of the intermediaries evidently have all the resources needed.

The Purol project was a joint venture between Stena and Sanol, and ended with little value added. In order to develop a new joint venture or collaboration with an existing actor in the absorbent market, new support is required from the managerial staff at Stena. The failure in the past might hinder the new project to gain the support necessary for a new startup. Hence, in order to convince the managerial staff, this project probably has to be presented and performed in a new way where the mistakes from the Purol project are addressed and actions taken to avoid them.

Intermediaries e.g. Mekonomen are interested in becoming increasingly environmentally friendly in their day to day operations . Hence, the will of this may increase the perceived value of the recycled PUR and be an incentive for replacing old suppliers and instead collaborating with Stena. Still, the functional value has to be good enough to meet Mekonomen’s functional requirements.

6.2.4 In House Production of an Absorbent Product

The option involving the largest initial financial investment for Stena is to create a Stena product and perform all the required manufacturing and processing activities in house. The basic idea would be to utilize components in Stenas existing resource structure at the same time procuring other required resources from external actors, as shown in Figure 6.8. Still, this option does not rule out business interaction with intermediaries. These could become important customers in this option, where the recycled PUR is processed and packed in house.

The Network Perspective of an in house produced product

According to calculations done, this option would require roughly 1,3 million SEK in initial investments in order to attain the most important resources (Appendix F). Still, the uncertainty of this sum is relatively high since the lack of space in the recycling facility in Halmstad might make other large investments necessary.

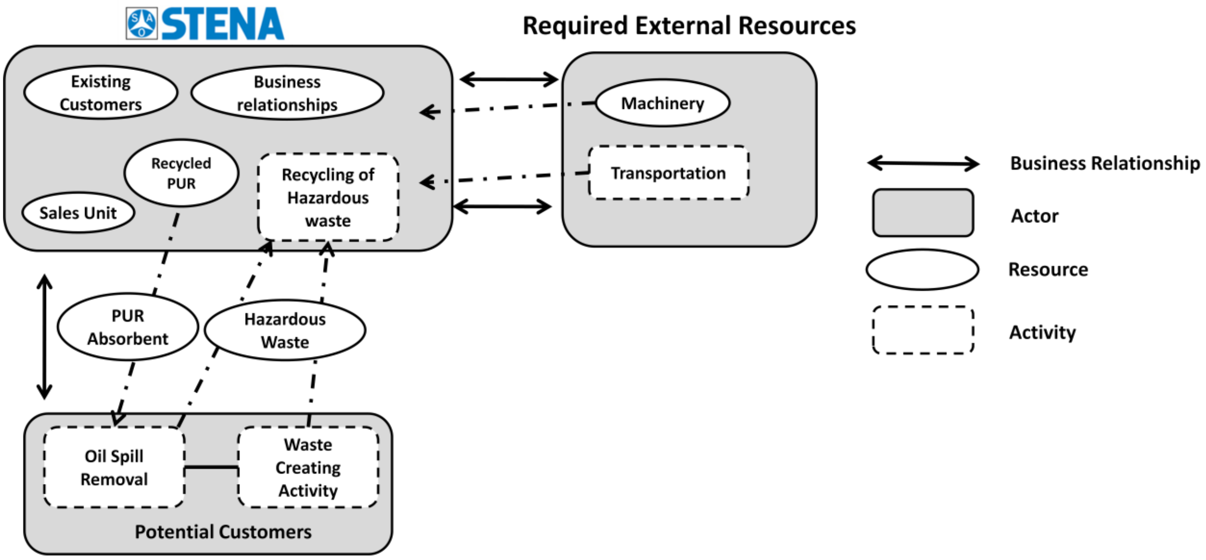


Figure 6.8: A network perspective of the in house option

The transportation costs are according to these calculations critical for the financial success of the recycled PUR absorbent. It would therefore be desirable to find similarities with other activities in order to reduce the costs. Opportunities for utilizing existing transportation flows to the potential customers could therefore become an important success factor.

The benefits for Stena stated in the section regarding the option of collaborating with a producer or intermediary still remains. Still, this option gives Stena more control over the project while one drawback with this option is that the important absorbent market knowledge remains as a resource that Stena does not possess.

The recycled PUR could in this way both be incorporated in existing customers recycling systems as well as becomes a complementary activity and a competitive advantage when attracting new customers. Svensk Freonåtervinning who also sells their recycled PUR as an absorbent product does not recycle hazardous waste. Hence, if they would like to perform this option, they would have to collaborate with another recycling firm.

Value Creation through in house production of absorbents

Even though the functional value after testing the recycled PUR further would meet the customers' demands, the social and emotional values involved in the customers' selection process remains. The interpersonal relationships in the market could become hinders when attracting new customers. It is therefore important to make sure that the recycled PUR is tested thoroughly so that Stena could utilize that information in their sales activities.

Due to strong interpersonal relationships between the actors in the absorbent industry it becomes important for Stena to utilize their existing customers as an important base of sales. Stena currently provide their customer with several services around the actual recycling of hazardous waste. It is here where the recycled PUR could become a competitive advantage if incorporated into Stena's existing package solution for hazardous waste (Stena Metall 2011). Stena would thereby take care of the whole life cycle as well as the life cycle costs for customers' utilization of absorbents. This gives an opportunity for creating deals that both could lower the total cost for the customer at the same time increasing the value created by recycled PUR for Stena.

The empirical findings point at the importance of utilizing intermediaries as a sales channel. Since the product then is going to compete with the intermediaries existing product assortment of absorbents, it is evidently important that the recycled PUR product is trusted and supported.

6.3 Combustion Fuel

For the area of combustion fuel, the following chapters focus on the chalk and the cement markets. The chapter starts with a general analysis of the both markets with the use of the frameworks presented in chapter 2 and follows with an analysis of the different options that are available for Stena if pursuing this application.

6.3.1 General Analysis of the Chalk and Cement industries

The chalk and the cement industries have many similarities, which can be viewed in chapter 4 where the respective industries are described. They are both industries with a high demand for combustion fuel as input to their furnaces. They can both handle various types of fuels, both in regard of material as well as fuel structure. Also, both the industries have few actors in the Swedish market, the chalk industry having two and the cement industry only having one actor. Finally, they both currently have collaborations with Stena and therefore have a logistical and administrative structure in place which is positive when regarding further collaborations.

The Network Perspective of the chalk and cement industries

In the beginning, the analysis of the market of combustion fuel is that of the combinations of both the chalk and cement market. The starting point is the ARA model, with division of actor bonds, resource ties and activity links. The ARA model for the combination of the two industries can be seen in Figure 6.9 below. Here the current business relationships between Stena Technoworld and Nordkalk and Cementa are visualized, as there is currently some transportation of plastics. Also, the possible business relationships between Stena Technoworld and Nordkalk, Cementa and SMA Minerals are visualized, with the possibility of transporting recycled PUR to these companies.

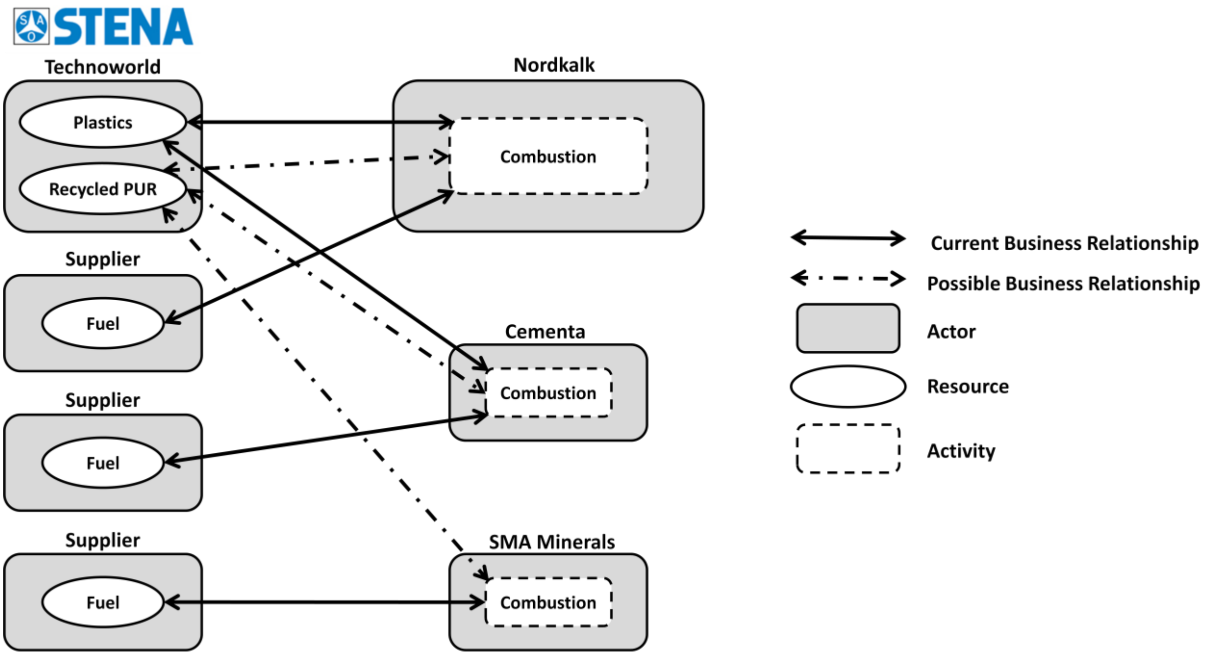


Figure 6.9: The ARA model for the market of the combustion fuel for the chalk and cement industries

In order to build a comprehensive picture of the current situation, the ARA model for the two industries is based on one focal actor, Nordkalk. The reason for this is that the developments made within this area are mainly based on the collaborations and communication between Stena and Nordkalk. Therefore the initial solutions for applications for recycled PUR will be focused on Nordkalk as the actor. Focusing on Nordkalk instead of Stena as the focal actor provides with a model that actually is based on the focal resource, in this case the recycled PUR, and the actors and activities in connection to it. The focal actor can be switched to any of the three possible actors available, but the focal resource will always be the recycled PUR no matter the context.

An important factor to consider is the knowledge of the actors. As we will see, the knowledge of the actors in the different companies is of great importance for the future possibilities to collaborate. Also, the knowledge is an important aspect that needs to be considered when evaluating the possibilities for recycled PUR. Stena has a large advantage in the form of actors within the organization with valuable knowledge. By collecting that knowledge regarding recycled PUR in combination with the knowledge about the chalk and cement industries, the base for a greater understanding of the entire network can be gained and be put into the right context, a development that has been started by this investigation around recycled PUR.

As mentioned, the different actors at Stena have certain perceptions that are the base for their behavior and the results. If viewed in insulation, the different situations can be explained by these factors, and the reason for the behavior of certain actors can be explained. But when considering the entire network horizon that Stena is a part of, it becomes evident that the individual actors at Stena do not have the whole picture of the situation and therefore do not behave in accordance to what is best for the entire network. This is understandable considering the individual actors that work with the day-to-day processes, but becomes a sort of sub-optimization when the individual actors that has a higher position within the company do not have the information available to see outside the network context. This is affecting the possibilities for Stena do develop and take advantage of their different resources. Even though this has been seen in the context of recycled PUR, this is viable for the entire network within Stena. The reason for this could be the large expansion of the different companies within the Stena sphere, with little time to adjust or establish the many ways of communication. Examples of this can be viewed in the following chapters when describing possible solutions for the recycled PUR.

As mentioned, the focal resource is the recycled PUR that is provided by Stena. Depending on which structure of actors and activities the recycled PUR will be put in, the resource can have different characteristics and therefore be viewed as different resources in the different contexts. It is important to consider that even though recycled PUR is the focal resource, there are also other resources present in the situation for these industries. Important to consider is the resources that are to be replaced by the recycled PUR and that have activities and actors connected to them that will affect the entire network and the possibility of replacing them with the recycled PUR. This shows that the decision of replacing the current fuel with recycled PUR is not only affected by the focal company and Stena, but also by the other actors on the market.

As mentioned, resources can be analyzed with the 4R model containing products, facilities, business units and business relationships (see figure 6.10). It can be used as a checklist in order to see that all the aspects of resources have been considered when analyzing. Regarding products, these have been discussed in the form of both the recycled PUR as well as the fuels that the recycled PUR is to replace. Facilities in this context are the sites where production processes takes place, which is the site in Halmstad for Stena, the site in Köping for Nordkalk, the sites in Slite, Skövde and Degerhamn for Cementa and the sites in Rättvik and Sandarna for SMA Mineral. The importance of stating these is that the activities that are needed in order to execute certain solutions, recycled PUR must be possible to handle for the processes at the production facilities. These are the resources that are expensive to change and where every change would imply that an investment needs to be considered. The business units is the three actors, companies, that are reflected upon in this context, Stena Technoworld, Nordkalk and Cementa, as well as the suppliers for fuel that are involved in the extended network. Finally, the business relationships are the already established relationships between individuals at Stena and Nordkalk and Cementa respectively.

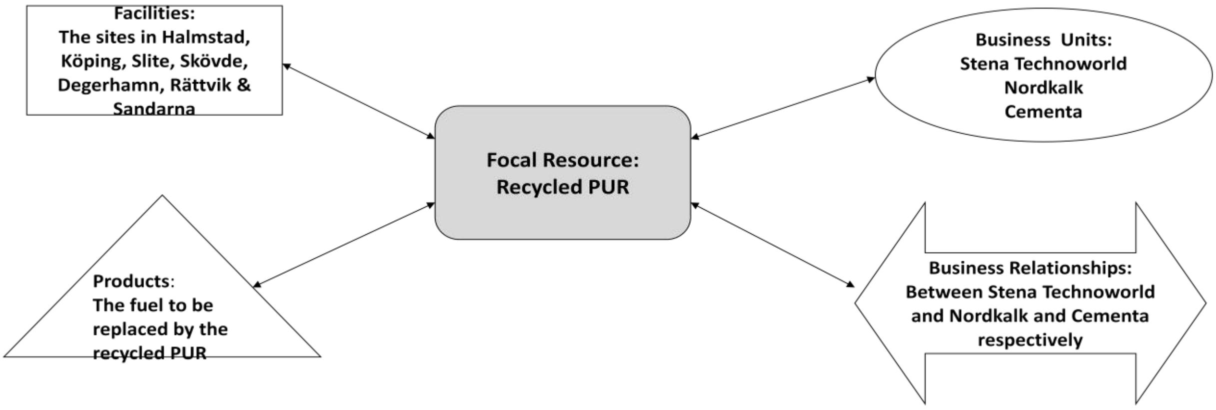


Figure 6.10: The 4R model for introducing the recycled PUR into the chalk and cement industries

As discussed in chapter 5, the resource recycled PUR can be utilized in its current state as briquettes, where the additional activities will be less comprehensive than if it were to be altered by certain activities into pellets. Also, it is important to understand the different activities that are involved in order to be able to handle fluctuations in them that alter the entire situation. Such activities can be value-adding activities e.g. special adjustments of the recycled PUR to the companies' processes and adjusted logistical solutions. Examples of these will be discussed further below.

Value Creation in the chalk and cement industries

It is also important to consider the perceived resource values and which sacrifices and benefits that are related to the recycled PUR. Focal for these industries is to understand what benefits and sacrifices that the actors relate to the introduction of recycled PUR in order to be able to address them. The benefits are among other the possibility for a deeper relationship with Stena, the possibility to exchange some of their fuel to a less expensive alternative, to be able to use a recycled product as fuel and by that gain social good will. The largest sacrifice that the actors perceive is the time and effort needed to adjust into utilizing recycled PUR instead of the currently utilized fuel. This can be explained by the social and emotional factors that influence how the value of the resource is perceived. In this context it is therefore important for Stena to convince the other actors of the benefits of using a recycled product from an environmental aspect as well as marketing perspective. This would require a level of trust between the individual actors at the companies, where the trust should be built by the individuals at Stena. This will be discussed in detail below, but if this perceived sacrifice for the individual actors can be addressed, Stena will have a better chance for this application area. Also, the functional value is important when regarding recycled PUR for combustion fuel, as the quality of the recycled PUR need to fulfill the companies' requirements, to a price that will make them replace their current fuel with recycled PUR.

With the background of the general analysis of the combustion fuel area, there are two possibilities for Stena to consider when evaluating possible applications for recycled PUR, which is to provide the industries with unrefined powder or to provide them with refined pellets. These are described in the following two sections:

1. Provide the industries with unrefined powder (section 6.3.2)
2. Provide the industries with refined pellets (section 6.3.3)

6.3.2 Provide the Industries with Unrefined Powder

The first alternative is to handle the recycled PUR in its current form and provide the companies with the briquettes directly from Halmstad. This will be analyzed from the perspective of Nordkalk which is a company in the chalk industry, because these collaborations have already been established. Further, the analysis will focus on SMA Minerals and in the chalk industry, as they have expressed the possibility of receiving unrefined powder and finally Cementa in the cement industry that is not as interested in this solution.

The Network Perspective of providing the industries with an unrefined powder

The network structure for providing the industries with unrefined powder with the actors, resources and activities can be viewed in Figure 6.11 below.

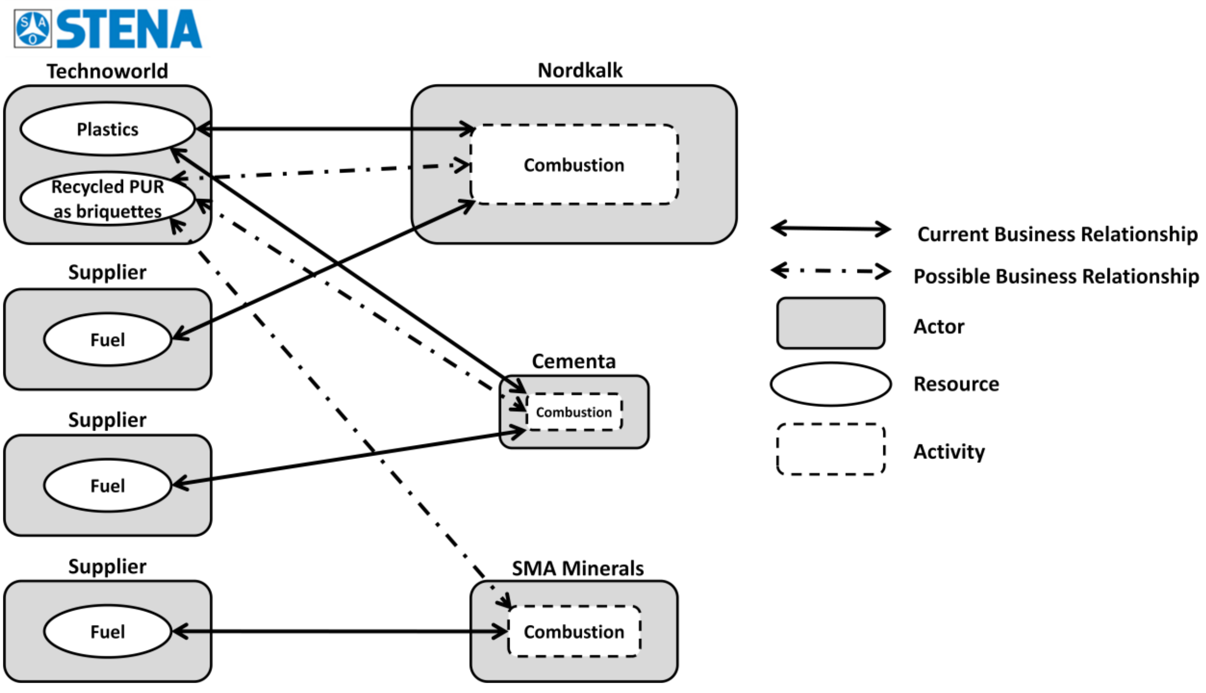


Figure 6.11: The ARA model for providing the industries with unrefined powder

As for the general picture, the focus is on Nordkalk as an actor and the recycled PUR as the resource. In this picture, Nordkalk and SMS Minerals are the ones that are open to the solution of receiving PUR as briquettes or a powder and therefore are relevant in this context. There are also actors involved that currently are supplying the companies with fuel. As mentioned in chapter 5, these suppliers can be one of many possible and the information about which supplier Stena would replace is therefore not transparent. If Stena would pursue this option and continue with supplying Nordkalk with recycled PUR, and also possibly supply SMA Minerals with recycled PUR, it is important that they ask the question of who they are replacing so that they can be proactive and prepare themselves for any action the replaced actor can undertake. As the amounts of recycled PUR provided by Stena is not able to fill the whole capacity at Nordkalk and SMA Minerals, and only a small part of the capacity at Cementa, there is a large possibility that the other actors will not see Stena as a big threat they need to take action against. But as mentioned before, it is still important that Stena understand who these actors are.

Another aspect regarding actors is the individuals at the companies, and how their perceptions and behaviors can affect the outcome of the possibility to sell the recycled PUR directly to them. This will be more evident in the next chapter regarding pellets, but is also important in this context. As we saw in chapter 5, the individuals at Nordkalk feel that there are difficulties regarding introducing the briquettes into their processes and therefore do not feel that it is worthwhile because the solution and the fuel they currently utilize are well adapted to heir processes. Due to that Stena has come this far and have introduced the recycled PUR to Nordkalk, it is important that they maintain the trust and the interest of the individuals at Nordkalk and respond quickly to their feedback in order to maintain this option for the recycled PUR. It will be easier to adapt the processes and activities for this solution if they keep the individuals involved positive to the change and make them understand the benefits of using recycled material. This of course means that the top management of the companies also needs to be positive to this, but it is equally important that the individuals that work day-to-day with these processes also get involved and become positive to the change.

Another aspect is the individual actors at the companies, and their relation to one another. As mentioned, Hans Söderberg at Stena Recycling is in contact with several individuals at Nordkalk, e.g. Stellan Karlsson, and is therefore their connection to Stena. Still, since Stena currently provides Nordkalk with other plastics, there are several other individuals at the companies that also have contact with each other. The problem is that there is no one who has the overall picture of which individuals at Stena that has contact with individuals at Nordkalk. This can of course be of less importance if the communication about the recycled PUR is homogeny from Stena’s direction, but can cause problems if Stena sends mixed signals to Nordkalk, as well as to SMA Minerals and Cementa. The actor layer and the relationships between the individual actors can been seen in Figure 6.12 below, where the arrows between the actors show that there are interactions between several individuals at the companies, and the arrows between the individual actors indicate the important identified relationships.

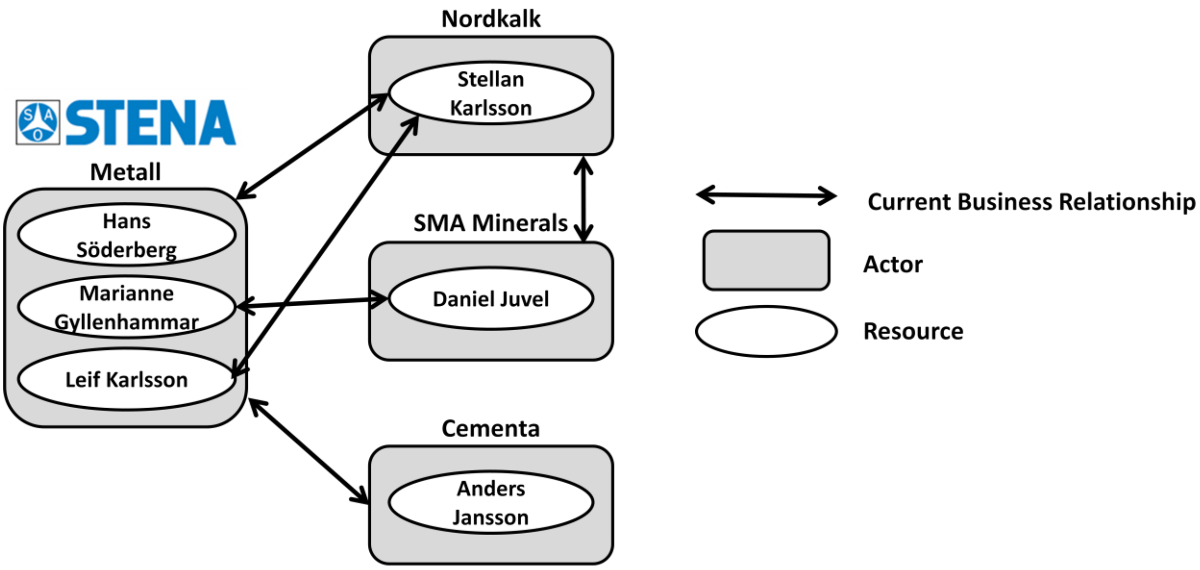


Figure 6.12: The actors and the relationships between them

As with the situation of understanding which actors that is to be replaced by Stena if they provide these companies with recycled PUR, it is also important to understand which resources that are replaced. As the current amount sent to Nordkalk as a test is low, it is not evident which resource that will be replaced if the amount recycled PUR would grow, but the most possible scenario is that a certain amount of the pellets that Nordkalk currently utilize as fuel is the resource that will be replaced. It is also important for Stena to collect the information they have available about the specification of their PUR in order to secure that there will not be any long-term consequences for the receiving companies to use a product that have traces of fluor or chlorine.

There are quite a few activities to consider when providing the companies with PUR briquettes. First of all, there is the activity of logistics, of actually getting the resource to the companies' sites. In the case of Nordkalk, there is already an established logistical solution that can be utilized and that is currently utilized for transporting other plastics. For SMS Minerals, the important aspect is that they do not have the possibility to store the recycled PUR and would therefore like a solution where smaller quantities are delivered to them more frequently. This will of course affect the cost structure of this solution and make it less interesting for Stena to pursue if the solution with Nordkalk is viable.

Another aspect of the activities for this solution is the handling of the briquettes at Stena's site in Halmstad as well as the quality of the briquettes. As mentioned, the briquettes have various qualities according to Nordkalk, with some of them being very loose and therefore hard to handle, and some of them being very hard and therefore difficult to crush. Therefore, there is a need for Stena to look over the processes at the site in Halmstad and secure a certain quality of the briquettes. Also, the briquettes currently are stored on the outside side next to other products. This makes it difficult for Stena to secure that no other products are delivered with the PUR briquettes, a problem Nordkalk mentioned that they have discovered and that will also affect the possibility to sell it to SMS Minerals.

Finally, an activity that Stena need to consider is the handling, or actually the crushing of the briquettes into powder. As mentioned earlier, this requires a certain quality of the briquettes where they should not be too hard to crush, but it also needs an activity where the actual crushing is performed. Due to the handling problems, this should be done at the receiving company's site, but it is nevertheless an important factor to consider because it will affect the willingness for the receiving company to accept the briquettes. It will also affect the cost structure if the receiving company needs to make further investments in equipment at their site.

Value Creation through providing the industries with unrefined powder

When considering the perceived value aspects for providing the industries with an unrefined powder, the most important value to consider is the functional value. That is the base for the emotional and social values that will make it possible for Stena to sell the recycled PUR to these industries. As mentioned, in order to understand the actors, it is important to understand that the functional value in this context is the quality of the briquettes, as discussed earlier, and the price of the recycled PUR. If the quality issues identified are not handled quickly by Stena, which will affect the perceived functional value negatively and make it difficult to take advantage of the close collaboration between the companies already established. The price is a key component in making the receiving companies, perceive the benefits of switching to recycled PUR larger than the sacrifices. The social values in this context is the environmental aspect of switching to a recycled fuel that will benefit the receiving companies image as well as the individuals sense of pride of working at such a company. Finally, the emotional value is the willingness of the individuals at the companies to adapt the processes to this new type of fuel, as well as wanting to find solutions in cooperation with Stena. This can be seen in the case of Nordkalk, where the first idea was to introduce pellets, but where a faster solution was decided mutually where the briquettes were being tried in their processes.

6.3.3 Provide the Industries with a Refined Product

The second alternative is to refine the recycled PUR into pellets that will be produced at the Stena plant in Halmstad and thereafter transported to the companies in focus. Here the analysis will also start with the focus of Nordkalk, with further analysis focusing on Cementa and SMA Minerals.

The Network Perspective for providing the industries with a refined product

The network structure for providing the industries with an unrefined powder with the actors, resources and activities can be viewed in Figure 6.13 below.

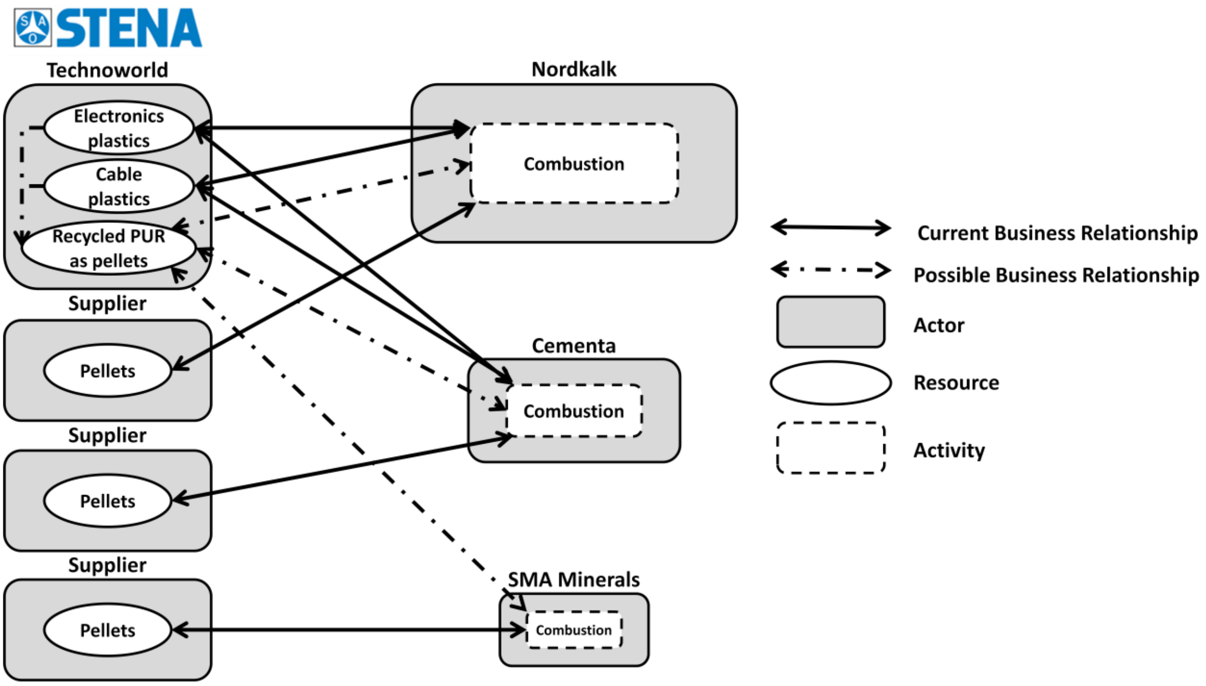


Figure 6.13: The ARA model for the refined pellets

As in the previous pictures, this picture also focuses on Nordkalk as the focal actor because the solution of providing pellets has been developed for Nordkalk. Here Cementa a larger actor than SMA Minerals because they are also a possible actor that Stena can provide these pellets to and have expressed an interest in such a solution. SMA Minerals expressed that they are principally interested in pellets, but as the reason for Stena to consider different actors is to differentiate the risks, SMA Minerals is the last actor of these three actors they would approach for this solution. The main reason for Stena to differentiate the risks is because of the needed investment of a pelletizing machine in order to be able to pelletize the recycled PUR. This means that if Nordkalk terminate the collaboration before the return of investment for the machine is finalized, Stena will not profit from the investment. This can be handled by long term contracts between Stena and Nordkalk, but also by communicating with Cementa and securing that the pellets produced also can be put into the processes.

The resource structure in this context is similar to the one described for unrefined recycled PUR regarding the replacement of other resources currently provided to the actors by their suppliers. But there is a few more aspects to consider regarding the resources for the refined pelletized recycled PUR. One of them is that the resource recycled PUR can be combined with one or two other resources available within Stena. This provides Stena with several possibilities to adapt the criteria of the pellets so that they can be adjusted to what Nordkalk in this case needs. It also gives Stena the possibility to adapt the contents of the pellets in the future and therefore be able to follow any change in demand that their customers could have. One example of this is the possibility mentioned to incorporate some biomass into the pellets in order to be able to classify it as renewable energy, something that would probably benefit Stena in the future. Another aspect to consider is the possibility to replace not only a small part of the resource currently utilized by Nordkalk, but more than half of it. This would make Stena an important competitor for the company in Holland that currently provides the pellets to Nordkalk. This would mean that the importance of Stena to understand the competing actor and the network it works within in order to be able to handle that they become a large actor on the market.

The activities in providing the pellets to the receiving companies of course involve the process at Stena in the actual production of the pellets. Because this would be a new process that would need to be incorporated within their current activity structure, this is a source of potentially fluctuating quality and amount of pellets produced. There is also the aspect of the activity at the receiving company, where the pellets need to be able to fit into their processes as easily as the currently utilized pellets. Another aspect of the activity structure is that Stena can utilize the similarities in the activities of Nordkalk in the cement industry, and Cementa in the cement industry when deciding of the properties of the pellets. By also considering the complementarities in the processes, Stena can be proactive and take these aspects within consideration before adjusting their processes, e.g. production and development, to produce the pellets from the recycled PUR. The activities related to the pelletizing of recycled PUR can be seen in Figure 6.14 below. The similarities in the activity structure is visualized, with the focus on the transportation, the handling and the storage.

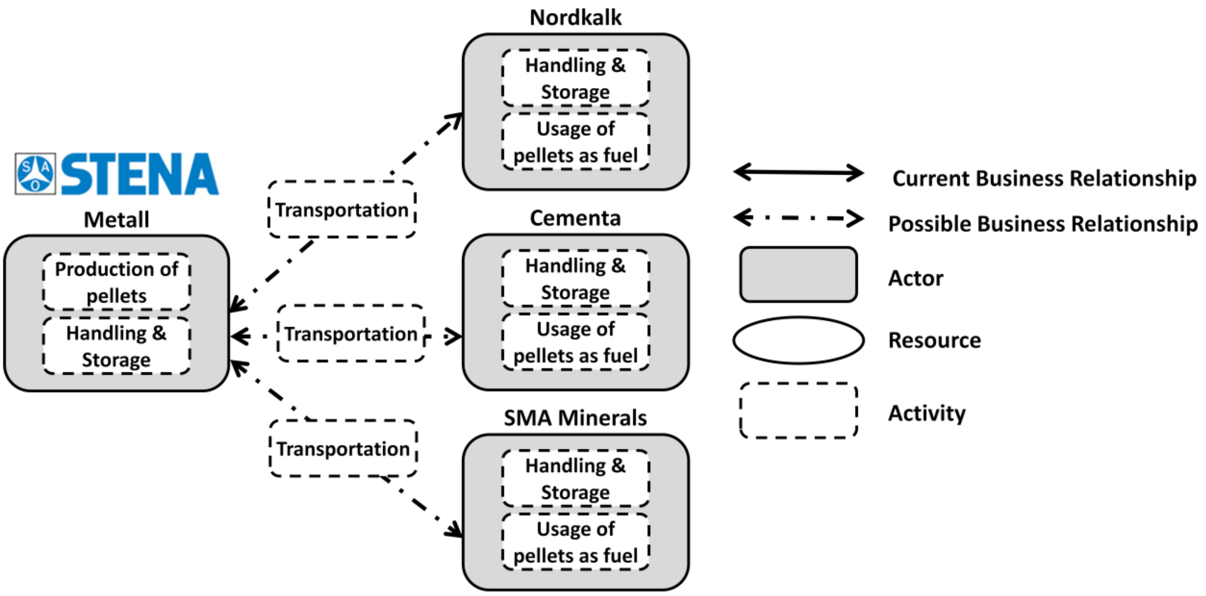


Figure 6.14: The activity structure for recycled PUR as pellets

Value Creation through providing the industries with a refined product

The perceived value is as for the earlier case the monetary and quality aspects for the customers that can provide them with a new product to replace the fuel they currently utilize to a lower price and with an environmental aspect connected to the pellets. The perceived value for the production of pellets is also focused on Stena's point of view. The functional value for Stena is mainly the monetary value in being able to produce pellets that will result in revenues even though a large investment is needed. In combination with this, the quality of the pellets in regard of how well the investment is fulfilling it, is also a perceived value Stena will be regarding. If Stena can successfully in also incorporate biomass within the pellets, this will be the base for social value for the company as well as for the individuals that will connect this to strong emotional value.

6.4 Material Recycling

The area of material recycling is the application area that was investigated with a long term perspective, with the focus on finding possible areas for further investigation that could provide value in the future. It is therefore different from the other two areas of absorbents and combustion fuel and do not provide us with any possible applications for Stena to start with immediately. Instead, this area should be considered as a base for thinking outside the box and rethinking the possibilities for recycled PUR. This analysis focuses on the possibility of introducing a development project with Electrolux in order to develop vacuum insulation panels from recycled PUR.

In general, the area of material recycling has been investigated before and there has been no success in developing viable solutions for incorporating recycled PUR within new material. As mentioned before, there have been investigations around the possibility of chemical recycling and the usage of recycled PUR in the insulation in new cooling appliances, none with success. During the investigations around the possibility of material recycling, the development project was the strongest application area with a future potential, and is therefore the base of the analysis. For the material recycling application area there is hence only one application we investigated:

> Development project with Electrolux regarding vacuum insulation panels (section 6.4.1)

6.4.1 Development Project with Electrolux

The development project with Electrolux is initiated by Ilan Cohen at Electrolux, where the focus on the development would be to develop vacuum insulation panels with an incorporation of recycled PUR.

The Network Perspective of a development project

The network structure for this possibility can be seen in Figure 6.15 below.

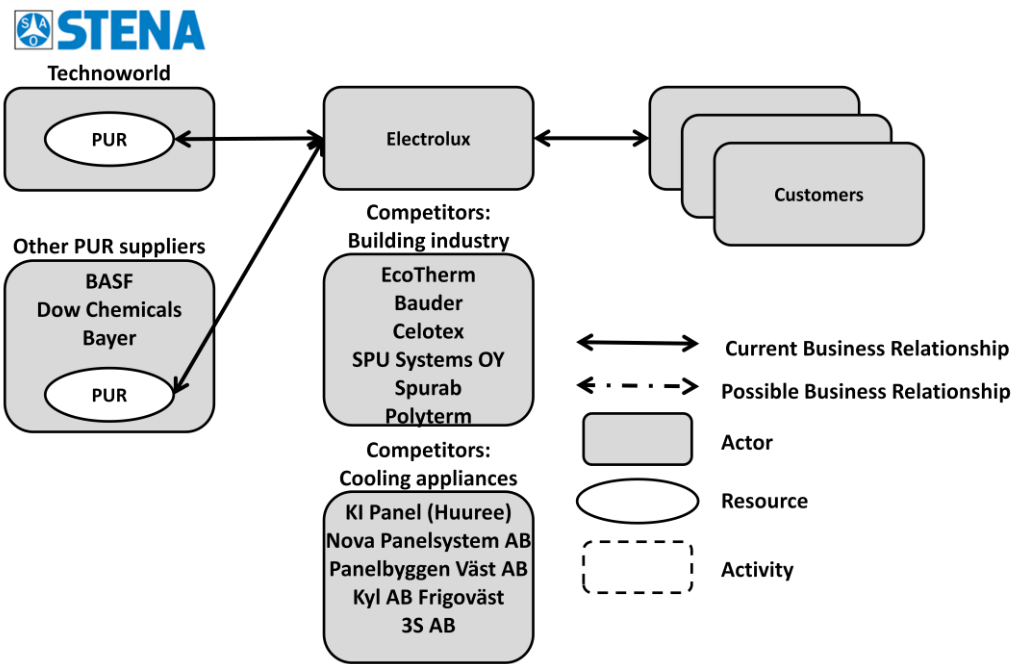


Figure 6.15: The network structure for the development project

The picture is based on Electrolux being the focal actor because that they were the initiators for such collaboration, but also because they would be the company utilizing the panels and by that compete with the already established actors from which they currently purchase the panels. As can be seen in the figure, the main current suppliers of virgin PUR today are BASF, Dow Chemicals and Bayer. Also, the competitors for such a project are categorized under the building industry and the cooling appliances. The reason for stating these actors as competitors instead of potential companies to collaborate with is because of the nature of this collaboration.

The purpose of Electrolux would be to develop panels that they can use themselves, and therefore eliminate the current dependency of the established actors within the industry. That would mean that the intention is to not involve the suppliers in the early stages of the project. On the other hand there a need for finding an actor that would be able to develop the processes with Electrolux and Stena and by that produce such a panel. It is therefore important for Stena to understand the actors involved as well as their intentions for the involvement and by that to understand the reasons for their actions in such a development project. When regarding the resources in this context it is important to analyze the dimensions of two components; the resource of recycled PUR and the resource of the actors' knowledge. In the beginning of the project, the main part would consist of the actors' knowledge, and the small part of the recycled PUR. But as the project develops, this correlation would switch, so that the main resource instead is the recycled PUR, and the smaller part now being the actors' knowledge. This would be a factor to consider for Stena, were they to initiate such a project with Electrolux, because it can give an estimation of the costs involved in such a project.

The activities for executing such a project would naturally consist of the actors' possibility to meet and discuss the project. Stena, being the recycler of Electrolux cooling appliances, already have established routes of communication with Electrolux which is an asset for such collaboration. The actors are very important in such a collaboration, because their perceptions and behavior are the factors affecting the result. It is therefore important for Stena to keep other possibilities open while investigating this line as a possible application for recycled PUR.

Value Creation through a development project

When considering the value creation for this project, there are certain aspects that are important to focus on. First of all, the strongest incentive for the different actors involved in such a project is the economical value. This is deciding the purpose of the project, and can be stronger than the other aspects of value e.g. functional, emotional or social values. This is important for Stena to be aware of, so that they do not mistake the others actors' social or emotional values being the reason for the project. These values can instead be the driving force for continuing the project during periods when difficulties occur. Secondly, it is important for Stena to capture the value created in form of the knowledge of the different individual actors, as this is the most important resource that can be gained from such a project.

7. Discussion

This chapter provides a discussion of the analysis of the possible applications of recycled PUR. It starts with pros and cons around different applications. Further, it continues with discussing the findings presented in the analysis. The chapter ends with a general analysis of how Stena can combine the three application areas. This becomes the foundation of the conclusions provided in chapter 8 and the recommendations to Stena presented in chapter 9.

Stena as most companies, find themselves in an ever changing business environment with constant change occurring in their current activity, resource and actor structures. This means that Stena constantly need to reconsider their current structures in order to find new alternatives to their current business model. The problem with the recycled PUR has existed over a long period of time with several individual actors involved; several of these with the goal to solve this problem once and for all. It has been evidently difficult for these actors to find a solution to the problem. Hence, changing environment infer that a solution that did not find progress in the past due to certain prerequisites, might be a value adding and successful solution in the future. It is therefore important to state that applications that are discarded today should be kept in mind since they might become important value adding resources in the future. This might give new possibilities to transform the recycled PUR into products that can be marketed and sold out of new premises.

The different application areas identified, as well as the benefits and sacrifices connected to these, implies different possibilities for Stena to consider when deciding upon which of these applications to proceed with. As Stena wants to go from landfill, to energy recycling and move further towards material recycling according to their internal waste hierarchy pyramid, the application area they should focus on would be the absorbent industry. The waste – hierarchy pyramid suggests that the optimal solution would be if utilization of PUR in cooling appliances could be prevented. This is though something that is out of Stenas control and implies that Stena are bound to the lower part of the pyramid. When moving towards the top of the waste pyramid, it is also important in an environmental perspective to determine which level in the hierarchy that gives the least total environmental footprint. This is due to that even though alternatives of how to refine the recycled PUR might exist, these might for instance consume large amount of energy in the refining process. These alternatives could therefore, even though positioned in a higher level in the waste pyramid, be worse for the environment than for instance to utilize the recycled PUR as combustion fuel.

The absorbent application is promising, with possibilities of creating large financial gain for Stena. The potential income for a granular absorbent by far out beat the other the other possible applications (Figure 7.1). Still, this idea has been tried before, both by Stena and by other actors, commonly with a failure as result. This application requires different sorts and amount of resources as well as different types of business interaction depending which of the stated options that Stena selects. Also the activity structures will differ in these different options even though the same activities will be performed.

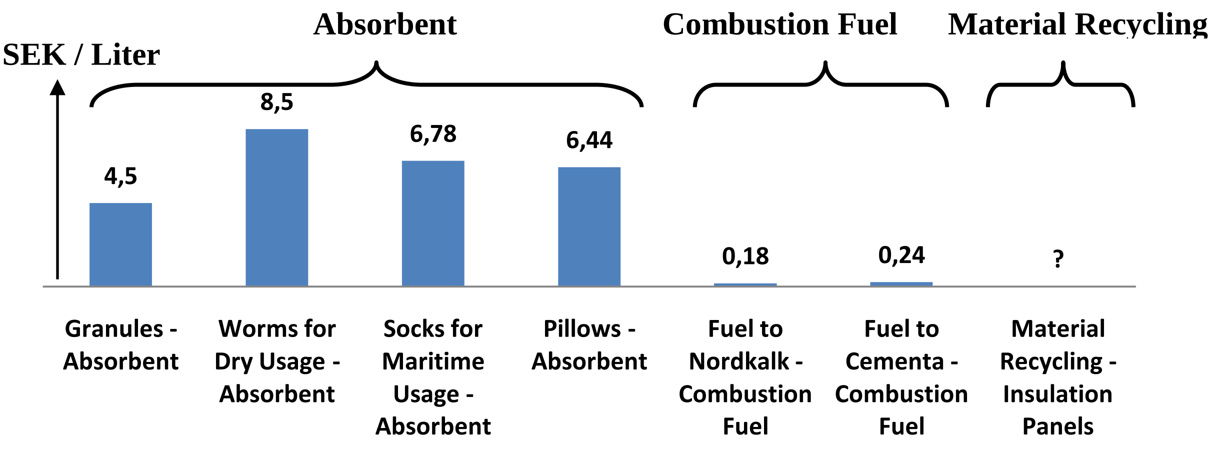


Figure 7.1: Average price per Liter of material for the different applications.

The first option, to sell the recycled PUR as raw material (section 6.2.2), is the least risky of the three. Still, the feasibility of this application is affected by the willingness of the producers to actually procure this material. In order to pursue this option it therefore has to be investigated from Stena's side, if it is possible to find an actor in the market willing to do this. The network horizon commonly makes it difficult for an outside actor to see what benefits that a producer might have from procuring the recycled PUR. This solution has also been stated in the analysis to lack possibilities to provide the customer with substantial additional value.

The second option, a collaboration with a producer or an intermediary (section 6.2.3), gives Stena the possibility to keep the financial and operational risk low at the same time gaining value by combining the actors' resources. Still, as with the first option, the critical issue is to find an actor that actually would gain from this kind of collaboration. The gain from Stena's side is evident, where the collaboration can reduce the costs caused by the recycled PUR. The gain for the collaborating actor might be less prominent. The recycled PUR products might cannibalize on the producers existing products and therefore be superseded by the producer. Hence, one of the main issues with this option would be to create a constellation for the collaborating that makes both parties see the benefits to be larger than the sacrifices.

The analysis shows the relative importance to utilize existing network structures as a resource. Tangible resources e.g. physical stores as well as intangible resources e.g. business and interpersonal relationships have among others been recognized as important factors to consider for an absorbent provider. So has the intangible information e.g. the understanding of where the actual demand for absorbents exists. These are resources that are commonly possessed by the intermediaries, which also could be possible collaboration partners to Stena. Still these intermediaries seem to lack other crucial resources e.g. a packing machine. An intermediary might at the same time possess valuable knowledge in how a recycled PUR product could be launched in order to most likely reach a successful outcome. Still, as with the producer, the recycled PUR product might cannibalize on the existing product assortment and therefore provide the intermediary with little value added. The actual constellation of this kind of collaboration is therefore important to assess in order to make sure that both parties are given expected benefits from the project.

The third option proposed, in house production of an absorbent product, let Stena have the full control of the absorbent supply chain. The largest uncertainties in this option are the actual performance e.g. absorptive capacity as well as the issues with the actual handling and packing of the product. Even though the performance should be similar to the products provided by Svensk Freonåtervinning, this has to be tested further. The example discussed in the analysis includes an investment of a relatively expensive packing machine as well as possibly investing in product facilities. Even though this should be feasible to perform, this also has to be further assessed. These two uncertainties indicate that if the packing could be avoided by for e.g. finding a large user of industrial absorbents e.g. Volvo or Mekonomen willing to test this product, these problems could be reduced. Stena currently receives relatively large amounts of absorbents in the form of hazardous waste from their recycling customers. These customers could as stated by the analysis, be an extensively valuable resource as well as a door opener for Stena to become a player in the absorbent market. Without any help from an intermediary, it might take time and effort for Stena to obtain the knowledge required to successfully put a recycled PUR absorbent on the market. Even though this thesis provides Stena with an overview of the absorbent market, this industry consists of a huge number of actors which all would take too much time and effort to cover. It is also evidently difficult to foresee how large benefits the absorbent options would realize which could imply that another alternative also have to be considered.

The combustion fuel area with recycled PUR sold as fuel to the chalk and cement industries is also an interesting area for Stena as it is possible to start with this application immediately. As it is possible to commence with this application immediately, there is no needed investment or logistical planning to be made and therefore this application can generate revenues immediately. The aspect to consider here is that there has already been a test project initiated where briquettes of recycled PUR is delivered to Nordkalk that uses them in their furnaces. This test project indicates that the major threat to the continuity of the project is the communication between Stena Technoworld and Nordkalk regarding the quality aspects. Another interesting solution is when the recycled PUR in combination with other plastics can be sold as pellets. This application needs an investment in a pelletizing machine, so if the recycled PUR can be sold to Nordkalk as briquettes there is no need for Stena to develop the pellets for now. Still, as the needs of the different actors as well as the changing business environment in the combustion fuel industries constantly are changing, it is important for Stena to investigate further into the possibilities around the production of pellets so that this application can be utilized if the need for it arises in the future.

The material recycling area is more interesting because it opens up the possibility for Stena to find an application that is adding more value to both Stena as well as the customer. Unfortunately, there is no application available within material recycling for recycled PUR. But as the project with Electrolux would be initiated, there is a possibility for one or several future applications within material recycling. There is a certain degree of uncertainty regarding this area, as the outcome of the project cannot be guaranteed. This uncertainty, on the other hand, also implies the possibility for outcomes that was not expected within the project. Also, the development of this project will secure that Stena continue to investigate and develop new application areas for recycled PUR.

Therefore, a possible combination solution for Stena is to start with selling the recycled PUR as combustion fuel to the chalk and possibly cements industries while developing the absorbent solution. As the absorbent solution would require low amounts of the recycled PUR in the early stages, the combustion fuel area would not be affected. But as the absorbent application would continue to grow, larger amounts of the recycled PUR would be needed, which would affect the combustion fuel area. Therefore, the need to secure certain levels for the combustion fuel is important, as the absorbent application will never be utilizing the whole amount of recycled PUR available. The amounts of recycled PUR needed for the two areas could be adjusted as the areas develop and be optimized for the different applications. One solution could be to have an agreement with Nordkalk where the amounts of recycled PUR not utilized by the other applications (such as Hotmix and Absorbent) would be transported to Nordkalk. This would implicate that Stena then would have to adjust other criteria such as price, if the levels of recycled PUR transported to Nordkalk cannot be guaranteed.

8. Conclusions

PUR is currently used in cooling appliances as insulation, but is also used as flexible foams in several other products. Stena Technoworld obtains recycled PUR from the insulation in the cooling appliances at the plant in Halmstad, and receives a product that contains not only PUR but also traces of other substances, most importantly freon. This thesis has identified nine different applications in industries e.g. the absorbent industry, the chalk industry, the cement industry as well as the manufacturing of cooling appliances industry.

According to this thesis, the recycled PUR currently provide value for Stena Recycling when utilized in two of Stena Recyclings current activities; absorbing oil and solvents in the contaminated water pit as well as binding the crude oil in the hot mix to simplify transportation. The responsible at Stena Recycling has though concluded that the cleaning of the contaminated water in this pit can be done without the recycled PUR in the future and can hence be utilized for other value adding activities.

For each identified application, there is the possibility to identify the different actors, resources and activities involved and to identify how the actor bonds, the resource ties as well as the activity links would be affected. For the combustion fuel area, the main conclusion is that the activity links are important in order to successfully introduce recycled PUR into the already established networks within the chalk and cement industries. In material recycling, the actor bonds are very important as they are the ones responsible for the continuity of the project. There is also a need for the network structure to change and adapt to the new resource, as the already established actor, resources and activities need to be complemented with new ones when introducing the recycled PUR.

Out of the identified possible applications for recycled PUR, three application categories have been concluded to be able to provide added value for Stena, which is illustrated in Figure 7.1. Out of the identified applications, the absorbents would currently be able to provide the highest financial value for Stena.

In the different applications, there are several values that will affect the potential customers' selection process. Quality, usability and price are the most important benefits in terms of functional values for absorbent users while price, quality and the difficultness in handling the recycled PUR affects the selection of a combustion fuel. For the absorbents the most important emotional values perceived environmental friendliness of the products as well as reliability, while the reliability in the product as well as in the provider dominates in importance for the identified combustion fuel customers. The customers sacrifice the reliability their existing resource structure provides, at the same time sacrificing business relationships and social values e.g. interpersonal relationships.

The potential customers of a recycled PUR absorbent state that they will perceive it to have a higher value than its competing products if it can be stated to be environmentally friendly at the same time removing the oil in a accepted matter to an acceptable price. Some of the identified potential customers also put demands regarding purity since some substances would affect their existing processing activities. The perceived value from the potential combustion fuel customers is relatively low due to the uncertainty that a change in fuel would imply regarding quality and possible amount to supply. For the combustion fuel, there might therefore be possibilities to increase the perceived benefits by combining the recycled PUR with additional resources or providing with complementary activities e.g. just in time deliveries.

The different options give different possibilities for Stena to control the actual cost of the customer. The raw material option would limit the possibility for Stena of controlling the absorbents total life cycle costs while the in house produced absorbent would give Stena a possibility of including the absorbent into their existing package solution for hazardous waste, illustrated in Figure 8.2.

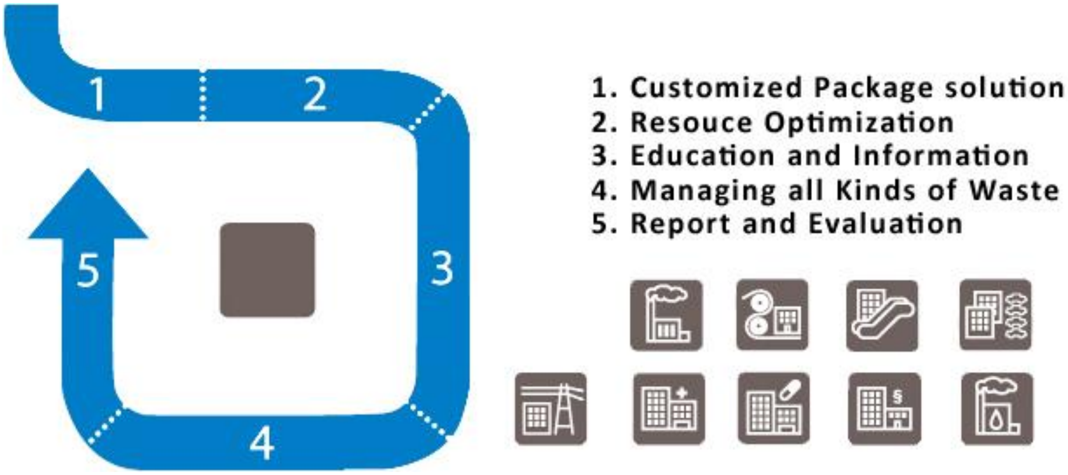


Figure 8.2: Stena's package solution for hazardous waste

The intention of this master thesis has been to provide Stena Technoworld with a comprehensive picture of the knowledge about recycled PUR within the company today, an investigation in the external information available for certain application areas and finally with an analysis and conclusion about which applications that are feasible for Stena today and in the future.

This master thesis should been seen as a starting point for Stena regarding the possibilities around recycled PUR and should be followed up by additional information, testing and investigation in the applications that Stena choose to follow up for recycled PUR.

9. Recommendations to Stena Metall

This chapter provides the Stena Metall group, especially Stena Technoworld, with recommendations based on the discussions and conclusions above. We will start with recommendations regarding which possible applications for recycled PUR to follow with and how to prioritize between them. Further, we will provide Stena Metall with additional recommendations that can be of assistance when introducing the recycled PUR into the already established markets.

Recommendations regarding the possible the applications

As analyzed and discussed above, there are three possible applications for the recycled PUR produced by Stena Technoworld. These are: the possibility of selling the recycled PUR as absorbent, to use the recycled PUR as fuel in the chalk and cement industries and finally the development project regarding vacuum insulation panels in collaboration with Electrolux. These applications can be prioritized in regard of short-term and long-term perspective, which is visualized in Figure 9.1 below.

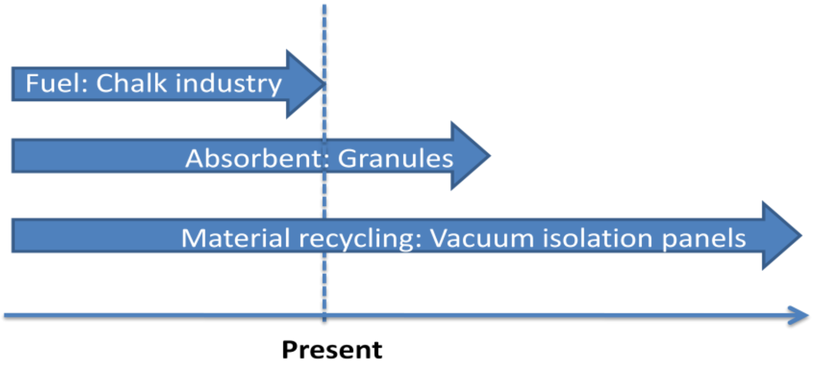


Figure 9.1: The potential applications in time perspective

For the short-term perspective, we recommend that Stena Technoworld commence in selling the recycled PUR as briquettes to Nordkalk in the chalk industry. As discussed above, the communication as well as the logistics is already in place for this alternative, and the processes at Nordkalk are already being adjusted to handling the PUR briquettes during the test period that have been started. At the same time, should start an investigation of properties of the recycled PUR further to assess absorption capacity as well as health aspects of the product.

For the mid-term perspective we recommend that Stena Technoworld develop the recycled PUR into products that can compete with the other products in the absorbent industry. Which out of the options explained in chapter 6 to pursue is up to Stena Technoworld to decide. One option in the mid-term perspective would be to utilize one of Stenas existing customers as a test customer in order to obtain feedback and to remove product uncertainties. As figure 9.2 illustrate, our recommendations are to let the share of recycled PUR utilized for absorbents and material recycling products grow by cannibalizing on the share of recycled PUR utilized as combustion fuel.

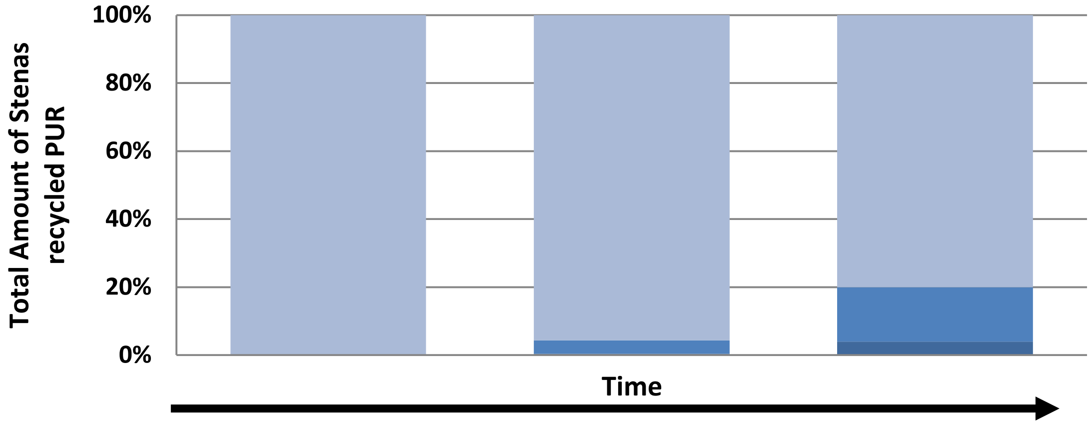


Figure 9.2: Amounts out of the total recycled PUR utilized for the different applications over time.

For the long-term perspective we recommend Stena Technoworld to collaborate with Electrolux and possible some PUR producers in developing vacuum insulation panels. This is not as secure in monetary value perspective as the two other options, but it requires less effort and no investments, and can possible provide with future possibilities for recycled PUR.

Additional recommendations

In order for Stena to more effectively take advantage of the knowledge of the employees within the company, we recommend them to work in cross-functional groups in development projects e.g. identifying and implementing possible applications for recycled PUR and by that ensure that a plan of action can be secured. There are good examples of collaborations between the individuals at the specific companies such as Stena Technoworld, so the recommendation is that the structure of these collaborations is also used between the different companies within the Stena Metall Group.

Prospect of future research

Several aspects have been comprehensively covered in this thesis. At the same time there are some areas or aspects that could be prospects for future research. First of all, no technical research has been conducted in this thesis. Hence, technical investigation regarding issues e.g. processing methods of PUR could provide further information to recyclers of cooling appliances in the future.

Secondly, the production of pellets for the chalk and cement industries need further investigations. The processes at Stena Technoworld’s plant in Halmstad need to be adjusted to producing pellets, and a certain quality level needs to be established. Also, there are further research needed in the possible combination of recycled PUR and the cable- and electronics plastics.

Finally, the energy market is a market undergoing constant change implying what is currently considered as waste might become a cash cow in the future. It would therefore be out of value to investigate what the energy market will look like in the future.

10. References

Written Sources

Best, Roger J. Market-Based Management - Strategies for Growing Customer Value and Profitability. New Jersey: Pearson Education, inc., 2009.

Callarisa Fiol, Luis J, Miguel A Moliner Tena, and Javier Sa´nchez Garcı´a. "Multidimensional perspective of perceived value in industrial clusters." Journal of Business & Industrial Marketing, 2011: 132–145.

De Chernatony, Leslie, Fiona Harris, and Francesca Dall'Olmo Riley. "Added value: its nature, roles and sustainability." European Journal of Marketing, 1998: 39-56.

Eriksson, P, and A Kovalainen. Qualitative methods in business research. London: Sage, 2010.

Gadde, Lars-Erik, and Håkan Håkansson. Supply Network Strategies. Chichester: John Wiley & Sons Ltd, 2008.

Håkansson, Håkan, David Ford, Lars-Erik Gadde, Ivan Snehota, and Alexandra Waluszewski. Business in networks. Glasgow: Bell and Bain, 2009.

Jahre, Marianne, Lars-Erik Gadde, Håkan Håkansson, Debbie Harrison, and Göran Persson. Resourcing in business logistics. Malmö: Liber AB, 2006.

Johansson, G, and M Winroth. "Introducing environmental concern in manufacturing strategies - Implications for the decision criteria." Management Research Review Vol.33 No.9, 2010.

Knutsson, Jesper. Analysrapport ”Avskiljningseffektivitet av oljespillvatten i PUR-skumfilter”. Göteborg: Miljötekniska laboratoriet BoM, 2007.

Köhler, Niclas. "Industrin Ratar Oren Plast från Skrotade Kylskåp." EU-Direktiv Tvingar fram Återvinning om Två År. -: Ny Teknik, December 10, 2003.

Monroe, Kent. Pricing: Making Profitable Decisions. -: McGraw-Hill, 1990.

Plastics Europe . Plastics – the Facts 2010: An analysis of European plastics production, demand and recovery for 2009. Annual Report, Brussels: Association of Plastics Manufacturers, 2010.

Porter, Michael, 1985, Competitive Advantage, London, Simon Schuster Ltd, 1985

Richardsson, G. B. "The Organization of Industry." The Economic Journal, 1972: 883-896.

Sheth, J.N.B.I., and B.L. Newman B.L Gross. "Why We Buy What We Buy a Theory of Consumer Behavior." Journal of Business Research Vol 22, 1991: 159-170.

Sweeney, J C, G N Soutar, and L W Johnson. "The Role of Perceived Risk in the Quality–Value Relationship: A Study in a Retail Environment." Journal of Retailing, 1999: 77-105.

Yin, R K. Case study research: Design and Methods. New York: Sage, 2003.

Zeithaml, Valarie A. "Consumer Perceptions of Price, Quality, and Value: A Means-End Model and Synthesis of Evidence." Journal of Marketing, 1988: 2-22.

Örtling, Tim. Recudering av Mängden Avfall från Byggproduktionen- En fallstudie av JMs Projekt i Käglinge. Master Thesis, Luleå: Luleå University of Technology, 2009.

Electronic Sources

Allabolag.se. May 5, 2011. www.allabolag.se (accessed May 10, 2011).

Avfall Sverige. Avfall Sverige. May 2011. http://www.avfallsverige.se/.

Cementa. 2011. http://www.heidelbergcement.com/se/sv/cementa/home.htm (accessed April 2011).

DAMOLIN A/S. Company Profile: DAMOLIN A/S. 2011. http://www.damolin.dk/Default.asp?ID=77 (accessed May 5, 2011).

Efstratiadis, Johannes. September 1, 2009. http://www.ikaros.net/getpage.asp?do={65C2846C-3537-4832-AD89-C8C735CBABEA} (accessed March 25, 2011).

Electrolux. Electrolux Environmental Policy. January 1, 2011. http://group.electrolux.com/en/electrolux-environmental-policy-697/ (accessed March 10, 2011).

EUROPAGES SA. May 2011. http://www.europages.co.uk/OEKOSERVICE-LUXEMBURG-SA/bch-EUR-LUX003896-00101-25-xx/company-information.html (accessed May 14, 2011).

PK-Produkter AB. Granulat: PK-Produkter AB. 2011. http://www.pk-produkter.se/granulat_granulat.htm?gclid=CJO7iqir7KgCFUTxzAodkQ58DQ (accessed April 4, 2011).

Plastics Europe. What is plastic: Plastics Europe. 2010. http://www.plasticseurope.org/what-is-plastic/processes.aspx (accessed May 3, 2011).

RAGN-SELLS AB. Systems for Hazardous Waste: RAGN-SELLS AB. 2010. http://www.ragnsells.se/Vara-tjanster/Fardiga-paket/system-for-farligt-avfall/ (accessed May 16, 2011).

Safesorb AB. 2011. http://www.safesorb.se/index.htm (accessed May 13, 2011).

Statistiska Central Byrån. Färdigställda nybyggnader 2010 – definitiva uppgifter. May 6, 2011. http://www.scb.se/Pages/PressRelease____313547.aspx (accessed June 6, 2011).

Svensk Freonåtervinning: Allabolag.se. May 5, 2011. http://www.allabolag.se/5560725946 (accessed May 5, 2011).

Svenska Kalkföreningen. March 2011. http://www.kalkforeningen.se/.

Stena. About. May 2010. http://www.stena.com/sv/Sphere/About+stena+sphere/Om+stena+sfaren.htm.

Stena Metall. Om oss. May 2011. http://www.stenatechnoworld.se/Om-oss/.

Svensk Freonåtervinning 2008. http://www.freonatervinning.se (accessed March 5, 2011).

Swedol 2010. http://www.swedol.se/sv/butiker_s41.html (accessed April 5, 2011).

Swedol AB. Butiker: Swedol AB. 2011. http://www.swedol.se/sv/butiker_s7.html (accessed May 17, 2011).

The Vermiculite Association. 2011. http://www.vermiculite.org/Vermiculite.php (accessed May 12, 2011).

Interviews

Forsgren, Christer, interview by Margareta Noyan Peter Danielsson. R&D Director (02 15, 2011)

Gyllenhammar, Marianne, interview by Margareta Noyan Peter Danielsson. Combustion, Stena Metall (02 17, 2011)

Stena Technoworld

Bauer, David, interview by Margareta Noyan Peter Danielsson. H&S Manager (02 17, 2011)

Frostne, Mårten, interview by Margareta Noyan Peter Danielsson. Managing Director Sweden, (02 16, 2011)

Karlsson, Leif, interview by Margareta Noyan Peter Danielsson. Plant Manager Halmstad, (02 15, 2011)

Olofsson, Stefan, interview by Margareta Noyan Peter Danielsson. (02 16, 2011)

Ringdahl, Erik, interview by Margareta Noyan Peter Danielsson. Business Development,(02 21, 2011)

Sjölin, Sverker, interview by Margareta Noyan Peter Danielsson. Development Manager (02 22, 2011)

Sobon, Andrzej, interview by Margareta Noyan Peter Danielsson. Plant Manager Cools, (02 18, 2011)

Stena Recycling

Andersson, Jan-Erik, interview by Margareta Noyan Peter Danielsson. (05 26, 2011)

Axelson, Oskar, interview by Margareta Noyan Peter Danielsson. Cools, (02 18, 2011)

Kolseth, Snorre, interview by Margareta Noyan Peter Danielsson. Development Manager Cools,(02 14, 2011)

Petersson, Claus, interview by Margareta Noyan Peter Danielsson. Quality Manager, (02 17, 2011)

Söderberg, Hans, interview by Margareta Noyan Peter Danielsson. Sales, (02 18, 2011)

Wernäng, Glenn, interview by Margareta Noyan Peter Danielsson. Plant Manager (02 25, 2011)

Others

Andersson, Bernt, interview by Margareta Noyan Peter Danielsson. RDE (former employee at Electrolux) (2011)

Bergström, Göran, interview by Margareta Noyan Peter Danielsson. Bayer (2011)

Boldizar, Antal, interview by Margareta Noyan Peter Danielsson. Chalmers (2011)

Claussen, Kim, interview by Margareta Noyan Peter Danielsson. Bayer (2011)

Cohen, Ilan, interview by Margareta Noyan Peter Danielsson. Electrolux (2011)

Ekberg, Christian, interview by Margareta Noyan Peter Danielsson. Stena Professur, Chalmers (02 06, 2011)

Foreman, Mark, interview by Margareta Noyan Peter Danielsson. Chalmers

Helin, Anders, interview by Margareta Noyan Peter Danielsson. RDE (former employee at Electrolux) (2011)

Holmberg, Krister, interview by Margareta Noyan Peter Danielsson. Professor Surface Chemistry, Chalmers (02 24, 2011)

Jansson, Anders, interview by Margareta Noyan Peter Danielsson. Cementa, HC Miljö (2011)

Juvel, Daniel, interview by Margareta Noyan Peter Danielsson. SMA Minerals (2011)

Karlsson, Kurt, interview by Peter Danielsson. Safesorb Managing Director (May 10, 2011)

Karlsson, Stellan, interview by Margareta Noyan Peter Danielsson. Nordkalk (2011)

Kirkhoff, Jan, interview by Peter Danielsson. Absorbents (May 17, 2011)

Retegan, Teodora, interview by Margareta Noyan. Chalmers Industry Technology (02 06, 2011)

Roxendahl, Stellan, interview by Margareta Noyan Peter Danielsson. BASF (Elastogran) (2011)

Stenvall, Erik, interview by Peter Danielsson. PhD Chalmers University of Technology (March 4, 2011)

Wiegandt, Linus, interview by Peter Danielsson. Buyer PEAB (March 15, 2011)

Appendix

Appendix A – Interview Questions

Below there are some questions we will use as guidelines during the interviews. You might not be able to answer all of them, but please keep in mind that we do not have much information about recycled PUR so any information is of help to us.

What is your profession?

How long have you been working at the company?

Do you know which components your recycled PUR consists of? Freon, flame retardants?

What do you know about recycled PUR in general?

How are you involved in the process of recycled PUR?

Would you be able to explain the process of recycling PUR?

What applications, according to you, are there for recycled PUR?

How can recycled PUR function as pure Polyurethane?

What implications are there for industries using recycled waste?

What implications are there for industries using recycled PUR?

Do you believe there are any possibilities to compete on the existing market, considering the Freon level?

What competitors are there in the Polyurethane industry?

Appendix B – Absorbent Product Overview

Granules

Actor / Product	Grain size	Volume/pro.[l]	Weight [kg]	SEK	SEK/Kg	SEK / liter
Ikaros						
Vermiculite Fine	2-4 mm	100,0	8,5	239,0	28,1	2,4
Vermiculite Medium	3-6 mm	100,0	8,0	279,0	34,9	2,8
Vermiculite Large	4-8 mm	100,0	7,0	269,0	38,4	2,7
Denios						
Universal finkornigt	0,125-1mm	40,0	22,0	176,0	8,0	4,4
Universal grovkornigt	1-3mm	38,0	20,0	212,0	10,6	5,6
Allvädersoljeabrorbent, kapacitet 24 l/VE	0,125 - 4mm	40,0	20,0	176,0	8,8	4,4
Gran-Sorb universal	0,4 - 3,4mm		13,6	172,0	12,6	
Sanol AB						
SanolStrö	N/A	100,0		139,0		1,4
Optisorb Strö	N/A	20,0		120,0		6,0
Svensk Freonåtervinning						
Öko-PUR Grovgranulat	N/A	36,7	16,0	195,8	12,2	5,3
Öko-PUR Fingranulat	N/A	38,5	16,0	214,5	13,4	5,6
Öko-PUR Pulver	N/A	38,1	8,0	172,5	21,6	4,5
Germ						
Absodan Universal Grovkornig granulat	1-3mm	40,0	20,0	170,0	8,5	4,3
Absodan Plus Finkornig granulat	0,3-1mm	10,0	10,0	95,0	9,5	9,5
Absodan Superplus Finkornig granulat	0,3-0,7mm	20,0	10,0	100,0	10,0	5,0
Witre						
Granulat: Absorbent Pig Dry Universal	N/A		18,1	195,0	10,8	
Granulat: Absorberande granulat Pig Peat	N/A		5,0	369,0	73,8	
Granulat: Absorberande flingor Vattenavv.	N/A		10,4	389,0	37,4	
Granulat: Absorberande flingor Universal	N/A		10,4	155,0	14,9	
PK-Produkter						
ZUGOL Miljöskyddsmedel	N/A	40,0	9,0	*	*	*

Absol	0,5-5mm		**18,0**	*	*	*
Absodan PLUS		**20,0**	**10,0**	*	*	*
Absodan UNIVERSAL		**40,0**	**20,0**	*	*	*
Average		**48,3**	**13,3**	**202,0**	**20,8**	**4,6**

Worms for dry usage

Actor/ Product	D [m]	L [m]	Volym/pro. [dm3]	Total [dm3]	SEK	SEK / liter
Ikaros Cleantech AB						
Universal Orm ø7.6x122 cm, 40st/frp	0,076	1,220	5,534	221,379	984,1	4,4
Universal Orm ø7.6x305cm. 6st/frp	0,076	3,050	13,836	83,017	529,7	6,4
Oil Only Orm ø7,6x122cm. 15st/frp	0,076	1,220	5,534	83,017	802,1	9,7
Oil Only Orm ø7,6x122cm. 40st/frp	0,076	1,220	5,534	221,379	2004,5	9,1
Oil Only Orm ø7.6x305cm. 6st/frp	0,076	3,050	13,836	83,017	797,0	9,6
Denios AB						
Universallänsor, kapacitet upp till 103 l/VE	0,075	1,200	5,301	53,014	779,0	14,7
Universallänsor, kapacitet upp till 103 l/VE	0,075	1,800	7,952	79,522	852,0	10,7
Universallänsor, kapacitet upp till 103 l/VE	0,075	3,000	13,254	132,536	527,0	4,0
Sanol AB						
Sanol Längder	0,075	1,500	6,627	132,536	895,0	6,8
Germ						
Absortionsorm universal, 7,62mm, L=1,22 m	0,076	1,220	5,564	5,564	48,0	8,6
Absortionsorm 7,62 cm, L=1,22 m för petroleumpr.	0,076	1,220	5,564	5,564	43,0	7,7
PK-Produkter						
Oil Only Orm, Vit	0,076	1,220	5,534	166,034		
Oil Only Orm, Vit	0,076	2,440	11,069	66,414		
Universal Orm, Grå	0,075	1,220	5,390	107,796		
Universal Orm, Grå	0,075	2,500	11,045	110,447		
Witre						
Absorbtionsläns Univ. , Ogrinal Pig® Sock Antracit	0,080	1,070	5,378	107,568	755,0	7,0
Average	0,1	1,7	7,5	87,9	557,0	8,5

*Price to customer excl. VAT

Source: www.ikarose-line.nu, www.freonatervinning.se, www.germ.se, www.denios.se, www.sanol.se, www.witre.se, www.pk-produkter.se

Worms for maritime usage

Actor/ product	d [m]	L [m]	Volume [dm3]	Total [dm3]	SEK	SEK/liter
Ikaros Cleantech AB				-		
Oil Only Länsa	0,200	6,100	191,637	383,274	1963,1	5,12
Oil Only Länsa	0,200	3,050	95,819	383,274	1812,5	4,73
Oil Only Länsa	0,200	25,000	785,398	785,398	4048,0	5,15
Oil Only Länsa, Sock-in-Net Boom	0,200	3,050	95,819	383,274	1550	4,04
Oil Only Länsa, Sock-in-Net Boom	0,130	3,050	40,483	161,933	845	5,22
Oil Only Länsa	0,130	3,050	40,483	161,933	1167,3	7,21
Oil Only Länsa	0,130	25,000	331,831	331,831	1986	5,98
Denios AB						
Densorb Oljespärra, kap. up to 276 l/VE	0,130	3,000	39,820	39,820	1410,0	35,41
Oljespärra, kapacitet upp till 276 l/VE	0,200	3,000	94,248	94,248	1920,0	20,37
Oljespärra, kapacitet upp till 276 l/VE	0,200	6,000	188,496	188,496	1920,0	10,19
Sanol AB						
Sanol Länsa med kätting	0,180	10,000	254,469	1526,814	1150,0	0,75
Sanol Länsa med rep	0,180	10,000	254,469	1526,814	1040,0	0,68
Sanol Länsa utan rep	0,180	10,000	254,469	1526,814	990,0	0,65
Germ AB						
Absortionslänsar for petrol.	0,203	6,100	197,429	197,429	1080,0	5,47
Absortionsläns for petrol.	0,127	3,050	38,636	38,636	390,0	10,09
Witre AB						
Absorbtionsläns Eko	0,080	1,220	6,132	73,589	1125,0	0,02
Absorbtionsläns oljor vattenavvisande	0,200	3,000	94,248	376,991	2265,0	6,01
PK-Produkter						
Avspärrningsläns Oil Only Oljeläns	0,130	3,000	39,820	39,820	*	*
Avspärrningsläns Oil Only Oljeläns	0,200	5,000	157,080	157,080	*	*
Brunnsläns Oil Only Oljeläns	0,200	0,450	14,137	14,137	*	*
Average	0,17	5,07		480,07	1320,00	6,03

Source: www.ikarose-line.nu, www.freonatervinning.se, www.germ.se, www.denios.se, www.sanol.se, www.witre.se, www.pk-produkter.se

Pillows

Aktor / products	h [m]	w [m]	l [m]	Volym psc [dm3]	Total [dm3]	SEK*	SEK/l
Ikaros Cleantech AB				-	-		
Universal Kudde, 10 st/frp	0,05	0,43	0,43	9,245	92,45	460,7	5,0
Denios AB							
Universal-kuddar i skålar	0,07	0,25	0,25	4,375	52,50	795,0	
Sanol AB							
Sanol Matta	0,03	0,45	0,75	10,125	121,50	975,0	8,0
Witre AB							
Absorberande kudde, Pig® Pillow	0,05	0,43	0,53	11,395	182,32	1150,0	6,3
PK-Produkter							
Oil Only Kudde, Vit	0,07	0,43	0,48	14,448	231,17		
				9,92	**135,99**	**845,16**	**6,44**

* Price to customer excl. VAT

Source: www.ikarose-line.nu, www.freonatervinning.se, www.germ.se, www.denios.se, www.sanol.se, www.witre.se, www.pk-produkter.se

Appendix C – Comparison of properties between different absorption materials

Table 3

Product	Vermiculite			Absol		Zugol	ÖKO-Pur			Absodan		
Name	Fine	Medium	Large	Röd	Blå	Miljöskyddsmedel	Pulver	Fingran.	Grovgran.	Superplus	Plus	Universal
Material Base	Vermiculite			Sand & Chalk		Pinewood bark	Recycled Polyurethane			Heat Treated Diatomite		
Grain Size [mm]	2-4	3-6	4-8	0,2-1	0,5-5	7,5 % < 0,25 76,2 % 0,25 < 5,0 16,3 % > 5,0	N/A	N/A	N/A	0,3-0,7	0,3-1	1-3
Absorption Capacity [liter oil/ liter]	N/A	N/A	N/A	1	0,7	0,8*	0,7	0,5	0,4	1,1	0,9	0,3
Price to customer [SEK/ Liter]	2,4	2,8	2,7	4	3,8	3,2	4,5	5,6	5,3	10,0	9,5	4,3

***Based on the assumption: crude oil density = 0,87kg/literhttp://www.zugol.se/teknisk-info.html**

All prices are price to customer based

Appendix D – Actors in the absorbent supply chain

Table 4 identified producers of absorbents. The information has been extracted from interviews as well as from the companies' websites.

Absorbent Producers	Production Material	Channel structure	Brand	*Worms*	*Maritime Stockings*	Pillow	Recycling System Provider
Sanol AB	Anealed Biologically Degradable Foam	**B2B, B2C**	Sanol	✓	✓	✓	✗
Svensk Freonåtervinning AB	Recycled Polyurethane	**B2C**	ÖKO-Pur	✗	✗	✗	**SITA Sverige AB, RAGN-SELLS Specialavfall AB**
Damolin A/S	Moler stone*	**B2B**	Absodan, Sorbix	✗	✗	✗	✗
Yxhult AB	Sand and Chalk	**B2B**	Absol	✓	✓	✓	✗
Zugol AB	Pinewood Bark	**B2B**	Zugol	✓	✗	✓	**RAGN-SELLS Specialavfall AB**
Damolin A S / Ikaros*	*Vermiculite Stone*	**B2B, B2C**	**Vermiculite**	✓	✗	✗	**RAGN-SELLS Specialavfall AB**
Safesorb AB	Moler Stone*, Polypropylen	**B2B**	Safesorb	✓	✓	✓	✗

*Ikaros sell Vermiculite under their own brand where the raw material is bought from Damolin A/S

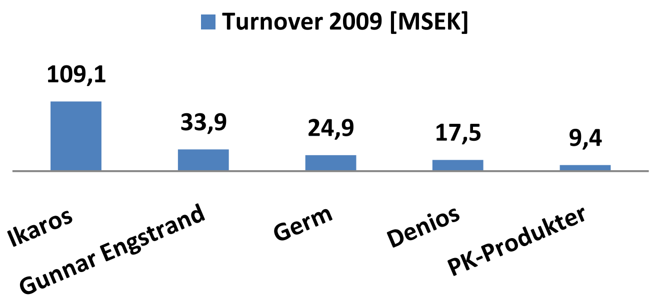
Table 5 Intermediaries in the supply chain of absorbents

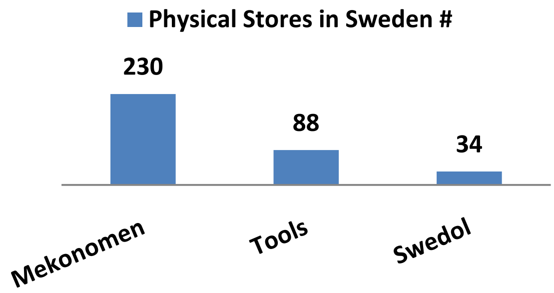
Absorbent Producers	Type of Actor	Brands	*Worms*	*Maritime Stockings*	Pillow	Recycling System Provider
Ikaros	**B2B**	**Reseller of own Brands**	✓	✓	✓	**RAGN-SELLS Specialavfall AB**
Denios	***Product R&D and manufacturing***	**Reseller**	✓	✓	✓	✗
Germ	**Reseller**	-	✓	✓	✗	✗
Witre	**Reseller**	-	✓	✓	✓	✗
PK-Produkter	***Reseller industrial Goods***	**Reseller B2B**	✓	✓	✓	**SITA Sverige AB**
Mekonomen	**User, B2B, B2C**	-	✓	✗	✗	**SITA Sverige AB**
Swedol	***B2B***	**Stores, Internet** **SAFESORB, Absol**	✗	✗	✗	✗
Gunnar Engstrand AB	***B2B***	**EasiTex (own), Absol, Absodan och Zugol.**	✓	✓	✓	✗

Appendix E – Profitability indicators for the absorbent industry

Indicator of the profitability comparison for companies selected due to that they mainly deal with absorbents (Allabolag.se 2011)**.**

	Zugol AB	Safesorb AB	Sanol AB	Gunnar Engstrand AB
2007	9,56 %	16,67 %	- 5,44 %	8,27 %
2008	15,27 %	24,40 %	-23,22 %	9,19 %
2009	1,68 %	19,93 %	3,14 %	4,81 %
Average	**8,84%**	**20,33%**	**-8,51 %**	**7,42%**





Turnover A comparison of the size of some of the actors in the absorbent industry.

Physical stores for some of the intermediaries covered in the thesis. The information is extracted from the companies' websites

Source: Information compiled from (Allabolag.se 2011)

Turnover for some of the absorbent producers

Geographical location of the producers of absorbents (safesorb: Halmstad, Sanol: Partille, Zugol: Falun, Svensk Freonåtervinning: Lövsta Damolin: Denmark)

Source: Information compiled from (Allabolag.se 2011)

Appendix F – Cash flow Analysis for Investment Helautomatisk Säckfyllningsmaskin

Initial costs	2011	2012	2013	2014	2015	2016	2017	2018		Discounted
Equipment Cost	-500 000*	-	-	-	-	-	-	32 500		
Installation Costs	-30 000*									
Education of staff	-1 725*									
Cost for adapting facility in Halmstad	-750 000**									
Sum initial costs	**-1 281 725**	**0**	**0**	**0**	**0**	**0**	**0**	**32 500**		**-1 265 047**
Variable Costs										
Maintenence	-5 000	-5 150	-5 305	-5 464	-5 628	-5 796	-5 970	-6 149		
Operatörskostnad	-54 000	-55 620	-57 289	-59 007	-60 777	-62 601	-64 479	-66 413		
Material Bags	-6 250	-6 438	-6 631	-6 830	-7 034	-7 245	-7 463	-7 687		
Cost of Transportation	-69 007	-69 007	-69 007	-69 007	-69 007	-69 007	-69 007	-69 007		
Other Costs	-5 000	-5 000	-5 000	-5 000	-5 000	-5 000	-5 000	-5 000		
Sum Variable Costs	**-139 257**	**-141 214**	**-143 230**	**-145 307**	**-147 446**	**-149 649**	**-151 919**	**-154 256**	**-1 172 278**	
Discounted Variable Costs	**-139 257**	**-128 376**	**-118 372**	**-109 171**	**-100 708**	**-92 920**	**-85 754**	**-79 158**		**-853 716**
Sales	625 000	643 750	663 063	682 954	703 443	724 546	746 283	768 671	**5 557 710**	
Discounted sales	**625 000**	**585 227**	**547 986**	**513 114**	**480 461**	**449 886**	**421 257**	**394 450**		**4 017 381**
Discounted Cash flows	**-795 981**	**456 851**	**429 613**	**403 942**	**379 753**	**356 966**	**335 503**	**331 970**		**1 898 617**

Assumptions

Market estimations		Sales estimations		Assumptions regarding Transports		Other estimations	
Inflation	3%	Tonnes sold annualy	40	Number of transports per year	24,00	Number of staff to educate	2
Discount rate	10%	Antal säckar [~30 ton]	2500	Cost per ton Halmstad - Köping	300,00	Salvage value (of initial value)	10%
Depriciation years	7	Price Per liter	2,5	Tonkm cost	0,66	Hours of operator work per day	1,00
		Customer price per bag (Excl tax)	100	Distance to Mekonomen central warehouse	521	Tax	35%
				LTL factor	0,50	m2 built	50
						Cost per m2 built	15000

Appendix G – The contents of recycled PUR at Stena, March 2008

Fuel	PUR
Source	Halmstad
Lab	Reci
Time of sample	mars-08
Elementary analysis	
C (% dry fuel)	64,80%
H (% dry fuel)	7,00%
S (% dry fuel)	0,02%
N (% dry fuel)	5,90%
Cl (% dry fuel)	0,29%
F (% dry fuel)	0,004%
O (% dry fuel)	15,99%
Ash (% dry fuel)	6,00%
Total dry fuel	100%
C (% fuel)	58,45%
H (% fuel)	6,31%
S (% fuel)	0,02%
N (% fuel)	5,32%
Cl (% fuel)	0,26%
F (% fuel)	0,003%
O (% fuel)	14,42%
Ash (% fuel)	5,41%
Fukthalt (%)	9,80%
Total fuel	100%
Heating Value	
Effective heating value (MJ/kg dry fuel)	25,07
Calorimetic heating value (MJ/kg dry fuel)	26,70
Effektive heating value (MJ/kg fuel)	22,38
Calorimetic heating value (MJ/kg fuel)	24,08
Ash analysis (mg/kg dry fuel)	
Al (aluminium)	5398
As (arsenic)	1
B (bor)	
Ba (barium)	175
Ca (calcium)	4295
Cd (cadmium)	5
Co (cobolt)	1
Cr (chromium)	19
Cu (copper)	294
Fe (iron)	9792
Hg (mercury)	0
K (potassium)	525
Mg (magnesium)	391

Mn (manganese)	39
Mo (molybdenum)	2
Na (sodium)	469
Ni (nickel)	21
P (phosphorous)	127
Pb (lead)	76
Sb (antimony)	
Se (selen)	
Si (silica)	3716
Sn (tin)	6
Ti (titan)	5401
Tl (tallium)	
V (vanadin)	2
Zn (zinc)	1410

Appendix H – Additional research regarding the market potential

Application	Market Potential [kg]	Investment Cost	% STENAPUR	Est. Market Price [SEK/Kg]	Estimated selling price Stena
Absorbent - Hazardous	2 500 000	0 SEK	100,0%		
Contaminated Water Cleaner		Depending on cooperator	0,0%	800 - 4000 SEK/set of products	Around 1000 SEK/set of products
Filters in Gully Holes	Not possible application	N/A	N/A	N/A	N/A
Oil Spill absorbent	1 400 000	Depending on cooperator	56,0%	22,11 (3,6 / liter)	Further investigation
Alternative Fuel For Preheating Trash	Not possible application	Pulverbrännare (CF)	N/A	N/A	N/A
Cement Industry	117 773 000	0 or 7 500 000	4710,9%	0,8	100 - 200 SEK/ton
Chalk Industry	11 500 000	7 500 000	460,0%	1,2	300 SEK/ton
Cooling Appliances	243 000	Contact Electrolux	9,7%	Further investigation	Further investigation
Ground / Sound Insulation for Buildings Insulation	920 700	Contact Insulationmanufacturer	36,8%	1,5*	
Filler material			0,0%		