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School of Business and Management

Master's Programme in Supply Management (MSM)

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**SOURCING STRATEGIES IN WASTE & RESIDUE BIOFUEL
FEEDSTOCK SOURCING**

Master's Thesis

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ABSTRACT

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The purpose of this thesis is to understand how a biofuel producer sources waste and residue feedstocks in a highly competitive and dynamic feedstock market. This study aims to define the most important factors affecting the sourcing strategy and the way sourcing is carried out by a biofuel producer. In addition, the importance as well as the impact of sustainability in feedstock sourcing is examined. The study is conducted as a qualitative single case study and the empirical data was collected through interviewing representatives from the case company. The results of this study show that even though the sourcing strategy is really case specific, relationship management and buyer proactivity is a critical part in feedstock sourcing. Furthermore, sustainability is a defining factor in feedstock sourcing and certain standards must be met to even make the sourcing itself possible. Greatest external factor affecting the sourcing were found out to be the legislation and policies regarding biofuels as well as the nature of the feedstock market. The policies and legislation were seen to define the demand for the feedstock. As wastes and residues are by-products, the level of supply is viewed as stagnant and not impacted greatly by the demand which results in a rather unique sourcing scenario regarded as demand driven.

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Tämän Pro Gradu –tutkielman tarkoituksena on oppia ymmärtämään, kuinka biopolttoaineiden tuottaja hankkii jäte ja tähde syöttöaineita erittäin kilpailullisilla ja dynaamisilla raaka-ainemarkkinoilla. Tämän tutkimuksen tarkoituksena on määritellä tärkeimmät tekijät, jotka vaikuttavat biopolttoaineita tuottavan yrityksen hankintastrategiaan ja tapaan toteuttaa hankintaa. Lisäksi tutkimuksessa tutkitaan vastuullisuuden merkitystä ja vaikutusta raaka-aineiden hankinnassa. Tämä tutkimus toteutettiin kvalitatiivisena tapahtumatutkimuksena ja empiirinen data hankittiin haastattelemalla kohdeyrityksen edustajia. Tämän tutkimuksen tulokset osoittavat, että vaikka hankintastrategia on todella tapauskohtainen, suhteiden hallinta ja ostajan aktiivisuus ovat kriittinen osa raaka-aineiden hankintaa. Lisäksi vastuullisuus on ratkaiseva tekijä raaka-aineiden hankinnassa ja tiettyjä vaatimuksia on noudatettava, jotta hankintaa on ylipäättään mahdollista toteuttaa. Suurimpina hankintaan vaikuttavina ulkoisina tekijöinä havaittiin biopolttoaineita koskeva lainsäädäntö ja politiikka sekä raaka-ainemarkkinoiden luonne. Poliitikan ja lainsäädännön nähtiin määrittelevän raaka-aineiden kysynnän tason. Jätteet ja tähteet ovat sivutuotteita, josta johtuen raaka-ainemarkkinoiden tarjonnan taso on suhteellisen vakio eikä esimerkiksi muutokset niiden kysynnässä vaikuta tuotantoon merkittävästi. Tästä on seurannut melko ainutlaatuinen hankintamarkkina, jota pidetään kysynnän ohjaamana.

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"Success is a journey, not a destination. The doing is often more important than the outcome." Arthur Ashe

In Helsinki, April 5th 2020

Arttu Pesonen

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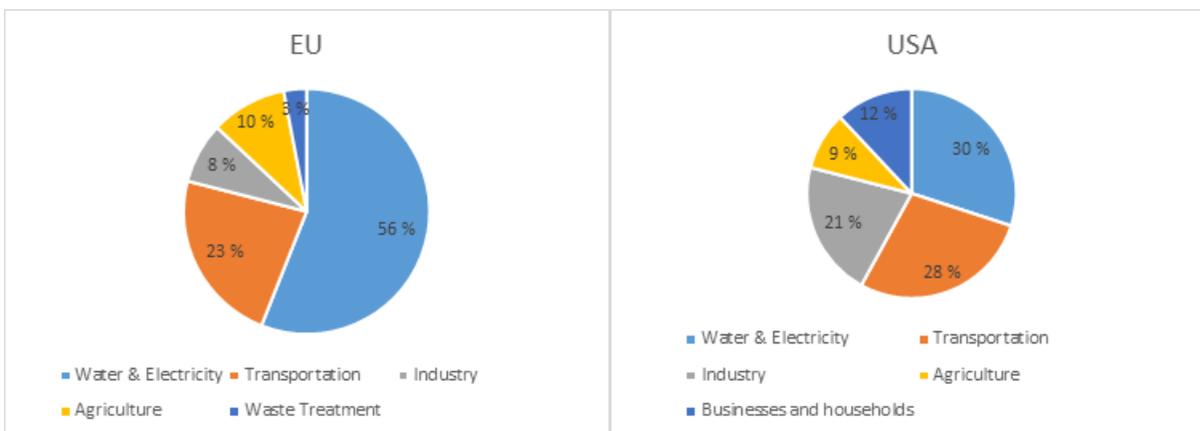
1. INTRODUCTION

The purpose of this master's thesis is to gain insight on the ways a biofuel producer opts to source its feedstock in the dynamic waste and residue feedstock markets for the production on a global scale and present the factors that have a great influence in the chosen strategy. The introduction chapter presents the ultimate goals of this study. A brief opening on the background of this research is followed up by stating the objectives and limitations of this research and the research problems themselves. The theoretical framework is presented after this and the key definitions of the study are also stated. Final part of the introduction presents the structure of this thesis.

1.1 Background of the research

Climate change and greenhouse gas emissions are truly a global concern. Countries around the world have started to act in order to prevent the progression of climate change and to significantly reduce the amount of greenhouse gas emissions emitted to the atmosphere. Substantial amounts of all greenhouse gas emissions are caused by the combustion of fuels in energy production and transport. For example, in 2015 the amount of greenhouse gas emissions caused by transportation accounted for 23% of all emissions in Europe and 28% in the United States of America (see figure 1). (EPA 2017; Eurostat 2017) Other major sources of greenhouse gas emissions are industrial production, agriculture, and waste treatment.

Figure 1. *Greenhouse gas emissions sector by sector in the EU and US in 2015 (EPA 2017a; Eurostat 2017)*



Over the course of the last two decades, countries across the world have pursued different alternatives in order to reduce their need for fossil fuels. Consequently, environmentally friendly produced renewable energy and biofuels have become relevant alternatives and are increasingly replacing fossil fuels and reducing dependency on them. (An, Wilhelm and Searcy 2011)

Biofuels are an effective way to reduce greenhouse gas emissions, both in energy production and in transport. The use of biofuels is promoted through various methods, for example in the EU through directives and in the US through a national program. The biofuel obligations for transport unequivocally oblige fuel producers to mix fossil fuels with a certain proportion of biofuels. The interest in biofuels naturally rises through their promoted use, which leads to a more competitive market from the feedstock point of view. Increased competition in the feedstock market forces producers to adjust their ways of sourcing biofuel raw material accordingly.

With the support of governments globally the biofuel sector is expected to grow dramatically during the upcoming decade. The implemented regulations and obligations

to fulfill mandates in European markets especially together with the support of governments in emerging markets of Asia and Latin America is expected to accelerate the growth. This creates a highly competitive market for the feedstocks and decreases availability of raw materials such as used cooking oil and animal fat. Due to the competitive setting of the feedstock market, the producers are forced to find ways to ensure the availability of the feedstocks and the access to those in the longer term. (Business Wire 2017)

The topic of sourcing strategies is not new itself but by going specifically into the sector of biofuels and the biofuel feedstock sourcing, a more intriguing topic can be formed. The aim is to determine the characteristics of sourcing strategies for biofuel feedstocks globally and present the general factors that influence the decision on the chosen strategy that is used. The supply chain in the biofuel industry is perhaps not the most transparent due to the nature of the market itself. Thus, a general overview of the biofuel industry and the drivers of it will be presented to lay the foundation for the rest of the theoretical parts of this study as well as the empirical part.

1.2 Research objectives, questions & limitations

This research focuses on the global sourcing strategies used for waste and residue feedstock sourcing by a biofuel producer. More specifically, the aim is to first understand how a sourcing strategy is chosen in an excess demand supply market and what are the key factors influencing sourcing decisions, and does geographical area of the market as well as the sourced feedstock affect the strategy used to source the feedstock in question. One key driver in the biofuel sector is sustainability and thus the role of sustainability in sourcing of biofuel feedstocks will be evaluated and discussed. The ultimate goal of this thesis is to determine which are the most common and viable sourcing strategies in feedstock sourcing and are they applicable regardless of sourced feedstock and geographical location, or are they context-sensitive.

Based on the goals of this study, the primary research question of this thesis is as follows:

MRQ1 “How does a biofuel producer source biofuel feedstocks globally in a highly competitive dynamic market with excess demand?”

Additional aims of this research are used to form a set of sub-research questions with the purpose of supporting the main research question of this study. The sub-research questions of this study are as follows:

SRQ1 “What kind of factors need to be taken into account when sourcing in excess demand markets?”

SRQ2 “How to ensure the sustainability of biofuel feedstock sources?”

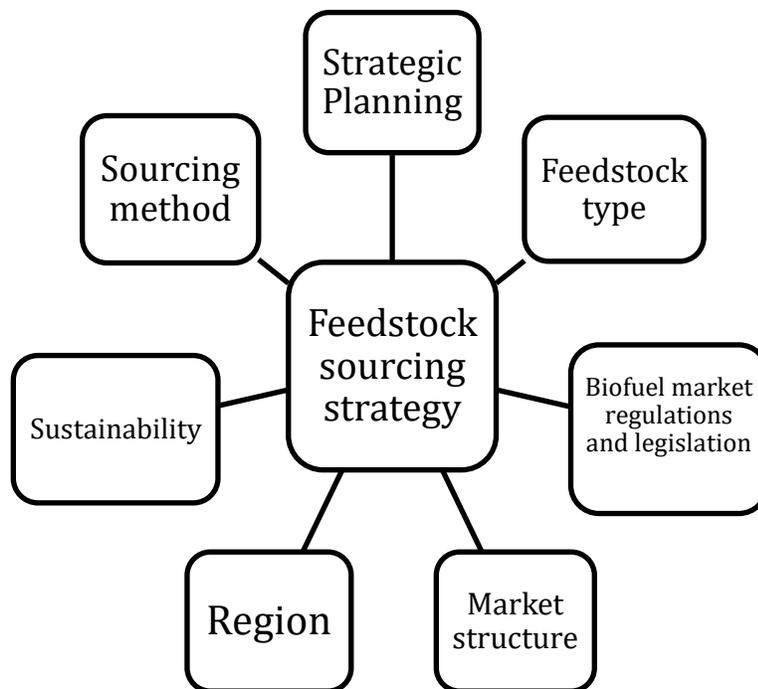
A clear limitation of this research is that the focus is on one sole company and two feedstock types of waste & residue category. This means that clear limitations are conveyed to this study by the method through which the study is conducted. The goal of a case study is to create an in-depth comprehension of a sophisticated issue or object, by not only verifying the findings of previously conducted research, but also extending the understanding with the help of newly gathered information. This is made possible by meticulously analyzing the circumstantial evidence of factors and their relationships. Due to the limited source of detailed information and insight, the ability to generalize the results is critically impaired. (Soy 1997) Typical for a qualitative research method is that instead of a logical concept, reference is made to practices which clear definition is challenging. The key difference to quantitative research is that it does not aim to present

the obtained research material in numerical form. (Koskinen, Alasuutari & Peltonen 2005, 30)

1.3 Conceptual framework

The conceptual framework of the study illustrates the factors that play a part in the sourcing strategy for biofuel feedstocks. Sourcing strategy takes into account internal as well as external factors and with the combination of gathered information, a sourcing strategy and implementation of it can be carried out accordingly. Conceptual framework below illustrates the key theoretical components as well as other findings of the study (Figure 2).

Figure 2. *Conceptual framework*



1.4 Definitions

In order to assist the reader of this study to comprehend the main concepts and thus the general purpose of this study, a list of definitions is provided that will assist the reader to get a grasp of the topic. These definitions will be covered in a far more specific manner in the next chapters of this study.

Global sourcing

Global sourcing refers to sourcing raw materials irrespective of national boundaries. In this study global sourcing refers to a producer's efforts to source sufficient amounts of feedstock for its current production levels while seeking alternative options to increase the amount of feedstock supply in the future.

Biofuel

Biofuel is a type of fuel that has been produced from a renewable feedstock. Their primary purpose is to serve as an alternative for fossil fuels in order to reduce the greenhouse gas emissions that are emitted to the atmosphere as a consequence of using fuels. In this study biofuels refer to renewable fuels that have been produced from waste & residue -category feedstocks "Used Cooking Oil" (UCO) and "Animal Fat" (AF)

Biofuel feedstock

Feedstock that is used as the starting component in the production of a biofuel. Biofuel feedstocks cover materials that are classified as waste & residues or vegetable oils

Sustainability

Sustainability as a concept can be understood as a practice which emphasizes the ability to preserve the ability of future generations meeting their needs without compromising

the ability to meet the needs of today (WCED 1987). According to Triple Bottom Line (Elkington, 1997), sustainability is a concurrent balancing of economic, environmental, and social goals at microeconomic level. From a business point of view Hassini et al. (2012) regard sustainability as the firm's ability to operate with a longer term goal of sustaining the economic, environmental, and societal prosperity.

Excess demand market

A market type in which the market demand for a commodity is greater than its market supply, resulting in an increase of the commodity price.

1.5 Thesis structure

The second chapter of this study begins with presenting the general outlook of the biofuel industry today and where it is currently headed, especially from the feedstock point of view. A general overview of the industry provides a relevant basis for the following parts concerning global sourcing and the strategies used in the biofuel sector. Chapters 2 & 3 of this study present the current theoretical findings while the focus of chapters 4, 5, and 6 is the empirical aspect of this study. The purpose of theoretical parts of this study is to provide a comprehensive framework for the study which will then be analyzed based on the written academic literature available. The theoretical part is followed up by the empirical part of the study which begins by defining the methodology. Choices from the methodological standpoint are also rationalized during this chapter. Fifth chapter presents the results gathered from the qualitative interviews conducted with the interviewees. These acquired results are then analyzed and discussed. Finally, the last chapter of this study presents the answers to the main research question as well as the answers to the sub-research questions. The study concludes with recommendations for further research directions.

2. BIOFUEL INDUSTRY AND THE FEEDSTOCK MARKET

Biofuels are not exactly a new innovation. In fact, biofuels have been available for consumption even before cars were available for the public. One reason why biofuels have not been utilized in the past that much is explained by the relatively cheap prices of fossil fuels, such as gasoline or regular diesel. As a result of many things, such as climate change and the instability of oil prices, the need to find proper substitutes for the fossil options has emerged. This is where biofuels step into the picture.

The reason why biofuels are needed and the reasons behind their growth can be explained through many ways but generally there are four key factors that answer the question:

1. Preserving our planet: Battle against the climate change
2. Increased energy consumption globally
3. Secure the energy supply
4. Utilization of the scarce resources

The battle against climate change causes nations to seek alternative, low-carbon sources of energy and fuel. Traffic represents one of the largest sources of greenhouse gas emissions, or carbon emissions. Replacing or even substituting a portion of fossil fuels used in road transportation with renewable alternatives such as biofuels is an efficient way to reduce these emissions. Fuel production from renewable materials is important because it will lower emissions (Wicki 2017). One could argue here that the solution would be to switch to electric vehicles. While electric vehicles are a good alternative in theory,

they tend to be very expensive and currently the infrastructure for vehicle charging is not globally reliable. Thus, biofuels present themselves as a viable alternative for fossil fuels.

In 2050 the population of the world is estimated to be between 8 and 10.5 billion people. (UN Population Division 2011). Adding the astonishing economic growth in emerging areas to the equation results in a hefty increase of energy consumption. By all means biofuels alone cannot account for the growing demand of energy, but the world must start to exploit natural resources in a better manner and thus increase the usage of renewable energy sources like biofuels.

Table 1. *The world population growth between years 2010 and 2050. (United Nations Medium Projection 2011)*

Region	Population size (millions) 2010	Population size (millions) 2050	Absolute change 2010–2050 (millions)	Ratio 2050/2010	Assumed total fertility 2045–50
Europe	738	719	-19	0,97	1,91
Northern America	344	447	103	1,30	2,07
Asia	4 164	5 142	978	1,23	1,88
Latin America	590	731	161	1,27	1,79
Oceania	36	55	19	1,53	2,21
North Africa	209	332	113	1,54	2,03
Sub-Saharan Africa	856	1 960	1 101	2,29	3
World	6 896	9 306	2 419	1,35	2,17

Securing the supply for the increased demand will become more and more challenging as the distribution of resources is very much scattered around the planet. Biofuels can positively affect the security issue as biomass, i. e. feedstocks, is globally accessible in a

much more balanced way. If we take a look at the world's crude oil sources and compare them to used cooking oil or animal fat, it is no surprise that the latter two resources could be collected from all around the planet but crude oil resources are not located in all parts of the globe. With biofuels the world can essentially decrease the dependence on fossil energy resources and fulfil the newly created demand of energy.

Circular economy and sustainability have become very important and trendy topics during the past decade. Companies have realized that they must adopt sustainable efforts to their strategies as consumers are more attracted to buy and associate themselves with businesses that operate in a sustainable manner (Verschoor 2014). For instance, using waste and residue based raw materials as a biofuel feedstock is a textbook example of operating in the ways of a circular economy. Not only by making the most out of waste materials and converting them into biofuels is both sustainable and circular, it is also a way to reduce the emissions that would otherwise be emitted to our atmosphere through refining fossil resources. Circular economy is critical for our survival in the future and it starts with using the natural resources to the greatest degree. (laquaniello et. al. 2018)

2.1 Development of the biofuel market

The growth of the biofuel industry has been massive. A vast amount of governments all over the world, namely from OECD countries, have pushed for the market introduction of biomass for energy purposes during the past decades. The push for creating new markets has resulted in the implementation of new policies that aim to promote the use of biofuels. These policies have impacted the global markets and their developments significantly. The amount of sourced bioenergy has constantly been increasing and instead of sourcing it locally, it is being sourced globally via producers as well as traders. Already from the early 2000's till 2009, the growth in production volumes globally is very dramatic, as written in an article by Lamers et al. (2011). For instance, the biodiesel production

volume in Europe has increased twelve-fold when comparing the production volumes between years 2000 and 2009.

Moreover, in 2013 the biodiesel production volumes according to the OECD-FAO (2013) in the largest producer regions were as follows: Europe 11,276 million litres (39,6%), The US 6057,5 million litres (21,2%) and major Latin American producers Brazil and Argentina accounted for slightly over 5 million litres combined. Rapid growth of biofuels began midway through the first decade of this century as the charts and data above present in the case of biodiesel. (Takeuchi, Shiroyama, Saito, Matsuura 2018)

The next two sub-chapters of chapter 2.1 will cover reasons for why the biofuels industry has grown tremendously in the two largest producer regions and will continue to do so going forward. The impact of legislation will be presented first which is then followed up by sustainability and its influence to the constantly developing market. The reason for describing these items is to illustrate what has caused the feedstock market to be in its current state and thus how a buyer is generally assumed to operate in a market where demand exceeds supply.

2.1.1 Biofuel legislation in EU and the US

Legislation implemented by governments and regional unions like the EU have impacted the development of the biofuels market substantially. The goal of these national programs and international directives is to increase the usage of renewable energy sources, such as biofuels, and thus steer countries away from fossil energy sources. For instance, transport is one of the most crucial sectors in the European energy strategy because transport accounts for up to a third of the EU's total energy consumption and a quarter of its greenhouse gas emissions (Linares & Pérez-Arriaga 2013). This sub-chapter will present the legislative developments in Europe as well as the United States of America.

The EU

The widespread use of biofuels in the EU has been accomplished by the union provided reference framework as well as the incentives implemented by the member states. Incentives used to promote biofuels amongst the member nations are nation aided tax exemptions, fossil and biofuel blending obligations, and import barriers. The motivation for different support methods varies from one member nation to another: For others the main incentive is behind agricultural trade, while others see biofuels simply as an efficient approach to reduce GHG emissions. (Khanna et al. 2010)

During the last 30 years three different policies are seen as the key factors behind the development of the biofuels: Common Agricultural Policy (CAP) that was implemented in 1992, biofuel directives that were implemented in 2003, and lastly the climate and energy agreement implemented in 2008. The CAP reform kick-started the development of biofuel production and enhanced the future growth of the market. CAP provided the opportunity for farmers to grow inedible crops on a “remote/set-aside land”. Simultaneously some member nations of the EU introduced, on their own initiative, tax incentives for biofuels and thus promoted biofuels use as a blend with fossil fuels. (Khanna et al. 2010)

In 2003 the fuel policy took an ambitious leap forward through the implementation of directives for biofuel usage (2003/30/EY) and energy taxation (2003/96/EY). The Biofuels Directive set targets for the blending ratio of biofuels until 2010, although it did not obligate the member nations to meet the targets with the possibility of facing potential fines if they failed to do so. The energy taxation directive made it possible for the member nations to grant tax exemptions and tax deductions. Due to the nature of these two directives there was considerable fragmentation in the development of biofuels across the EU as the directives gave member nations a lot of leverage and leeway when it came to implementing these political instruments by country. (Khanna et al. 2010)

The third and extremely significant leap was taken in 2008 with the climate and energy agreement. New directives were published together with the new agreement were the updated directive for renewable energy (2009/28/EY) as well as the fuel quality directive (FQD) (2009/30/EY). The renewable energy directive (RED) covers all renewable energy rather than just biofuels for transportation. The purpose of RED is to act as a precept for the member nations of the EU in the process of formulating their own national fuel policies. The fuel quality directive sets restrictions for the quality of gasoline and diesel. The goal of FQD is to reduce adverse effects on the environment and health. (Khanna et al. 2010)

The US

The growth of the biofuel industry in the US has rapidly grown during the past decades and it has encountered various changes during this time period. The biofuel policies have been developed on not only national level but also on state level. The best examples of proactive states on this matter are California and Oregon which have taken concrete steps towards promoting the biofuels as a source of energy in the transportation sector. In the US the focus of the research has been on so called second generation biofuels. Second generation biofuels refer to biofuels that have been produced from specific feedstocks, such as animal fat or used cooking oil, under the waste and residue biomass category. The energy policy act of 2005 was a crucial step towards the development of renewable energy in the US. This particular multimillion national energy plan concerns energy efficiency and environmental protection, modernization of energy infrastructure and enhancing the energy source options of both fossil and renewable based. (Gupta & Demirbas 2010)

In 2005 under the energy act, the renewable fuel standard (RFS) was created. RFS complemented the already valid Clear Air Act (CAA). The RFS contains several obligations out of which one very significant was that the annual usage of biofuels must reach 1 million gallons by 2012. The RFS is maintained and executed by the

Environmental Protection Agency (EPA) and the ministries of agriculture and energy. (EPA 2017b) In 2007 President Bush published a determined program for reducing the consumption of fossil fuels and increasing the consumption of biofuels. The so-called “20-in-10” program aimed to reduce the consumption of fossil fuels by 20% in the following 10 years, meaning by 2017. This goal was being pursued by energy efficiency as well as increased use of biofuels. (Gupta & Demirbas 2010)

The Energy Independence and Security Act was also implemented in 2007 which set targets of likes that had never been set before; the bill calls for annual use of biofuels to reach 36 billion gallons by 2022, of which 21 billion gallons must be second-generation biofuels. Also, for the very first time the legislation in the US mentions the Low Carbon Fuel Standard (LCFS) which calls, inter alia, for a 20% reduction in the carbon intensity of renewable fuel over its lifecycle. (Gupta & Demirbas 2010)

Implementation of policies and directives in the biggest biofuels end-markets have made the industry itself a very attractive one. It is seen as relatively lucrative due to the fact that governments have artificially supported the growth of the market with said tax exemptions for instance. Growing production volumes means that the competition for the feedstocks is increasing. The overview of the feedstock stock market and its characteristics will be presented in sub-chapter 2.2.

2.1.2 The impact of sustainability

The connection between renewable markets and sustainability is heavily evident. Markets are very keen to pursue possibilities that enable them to be a part of a sustainable economic ecosystem. Issues for maintaining the sustainability perspective tend to surface due to the pressure of economic development for a market, especially from a producer standpoint. (Borawski et al. 2019) According to Geissdoerfer et al. (2018) and Rashid et

al. (2013) the introduction of sustainable innovations are dependent on incentives as well as revenue mechanisms to enable the utilization of sustainable solutions.

Unlike during the past decades, companies do not necessarily have a choice when it comes to adopting sustainability to their operations and measuring the degree to which it is considered and carried out. Internal as well as external stakeholder pressure demands companies to evaluate the environmental and social aspects and what they mean to the way the company operators, albeit economical aspects cannot be forgotten. (Carter, Liaine Easton 2011) The renewables industries are very competitive in today's business world and even Flint and Golicic (2009) argue that especially the supply chains must be sustainable in such markets.

The increased awareness of sustainability and its importance to our world and legislative incentives create an attractive market for companies to step in. These factors play a significant role in the growth of the biofuels market. Wheeler and Elkington (2001) claim that by adopting sustainability to the way a company operates, a real value can be created for its stakeholders. From the biofuels market point of view, sustainability is answering to the demand and needs of the customers as they are choosing to buy a product that is created to be a more environmentally friendly alternative to its fossil counterparts. Consuming renewable energy sources is desirable for the environment because it decreases the consumption of fossil fuels and the emission of greenhouse gases from their combustion and thus reduces the pollution from the transport industry for example. Moreover, it fills the increasing gap of demand and supply in fuels in the world. (Borawski et al. 2019)

2.2 Feedstock market characteristics and influence to supply strategy

The feedstock market is becoming more and more competitive. Increased use of used cooking oil animal fat as a feedstock in not only biofuels but other industries is affecting the availability amongst other market related things. The following two sub-chapters will focus on used cooking oil and animal fat with the purpose of describing the characteristics of these two feedstock markets and how they can potentially affect the sourcing strategy. Also, the general pathways of both UCO and AF from source to biofuel are presented in these sub-chapters.

2.2.1 Used Cooking Oil

Ever since the support programs for biofuels, a rising concern has been the trade-offs with food prices and land use change when it came to the production of conventional biofuels that originate from food and crop based feedstock (Searchinger et al. 2008, Britz and Hertel 2011, Laborde and Valin 2012). The production of advanced (renewable/second generation) biofuels from waste and residue feedstocks account for a major portion of the biodiesel production. The largest feedstock volume-wise under waste and residue category is used cooking oil (USDA 2017a). For instance, UCO is the largest biofuel feedstock in China, Korea, and Japan while in Europe UCO accounted for 20% of all feedstock used in biofuel production. (USDA 2017a, USDA 2017b, USDA 2017c)

Used Cooking Oil (UCO) refers to oils and fats that have been used in the food processing industry, fast foods, restaurants and even households for cooking and frying food (Tsoutsos and Stavroula 2013). Generally speaking UCO is either fully of vegetable origin or of mixed origin meaning the original source is animal fats and oils and the type of produced UCO is strongly linked to the local consumption habits. According to Peters et

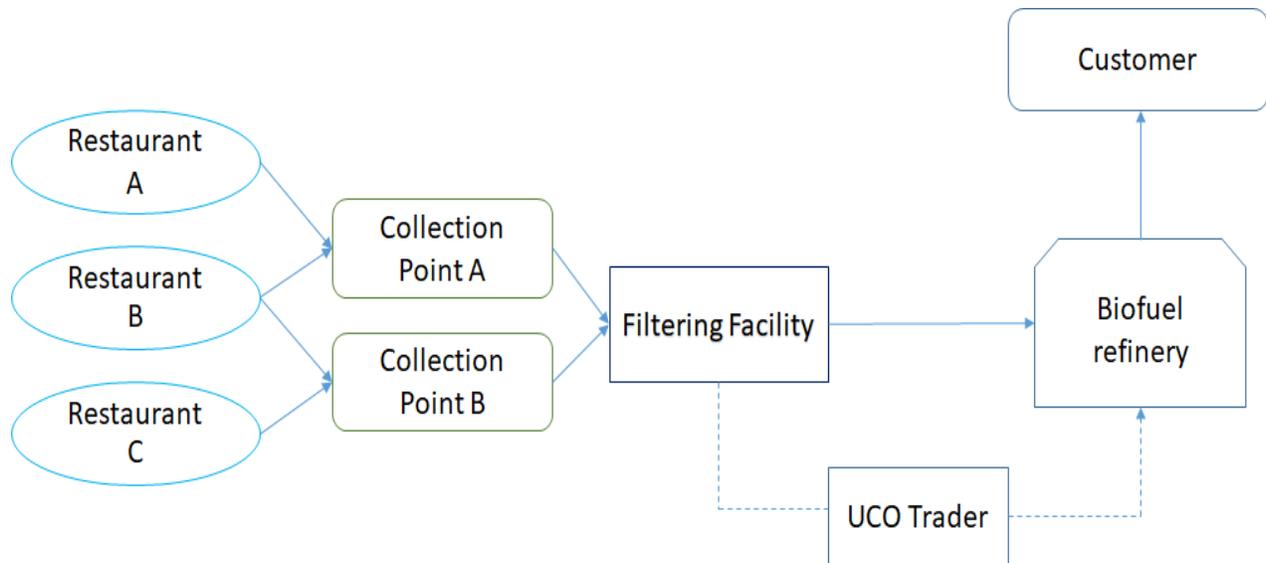
al. (2013) the origin of produced fats and oils for 90% in Europe is vegetable oils. Due to the nature of used cooking oil and the way it is being collected globally, it is not necessarily a homogenous good meaning that not only the quality of UCO is not very reliable but also its availability is somewhat seasonal (Toop et al. 2014). Characteristic for UCO collection is that there are a lot of producers who are very small and the collection is primarily done in a very local manner (Toop et al. 2014).

Different certification schemes also play a part in the UCO market. For instance, a supplier might be certified by the ISCC which means that they're capable of supplying ISCC certified UCO which is more valuable as non-certified UCO is not eligible to all markets whereas ISCC certified UCO fulfills the rigorous criteria that is being held in most of the European markets.

Characteristics for an UCO supply chain is that they tend to present themselves as relatively complex with multiple intermediaries participating in the aggregation of volumes. In a normal scenario the supply chain from point of origin to biodiesel for UCO is as follows:

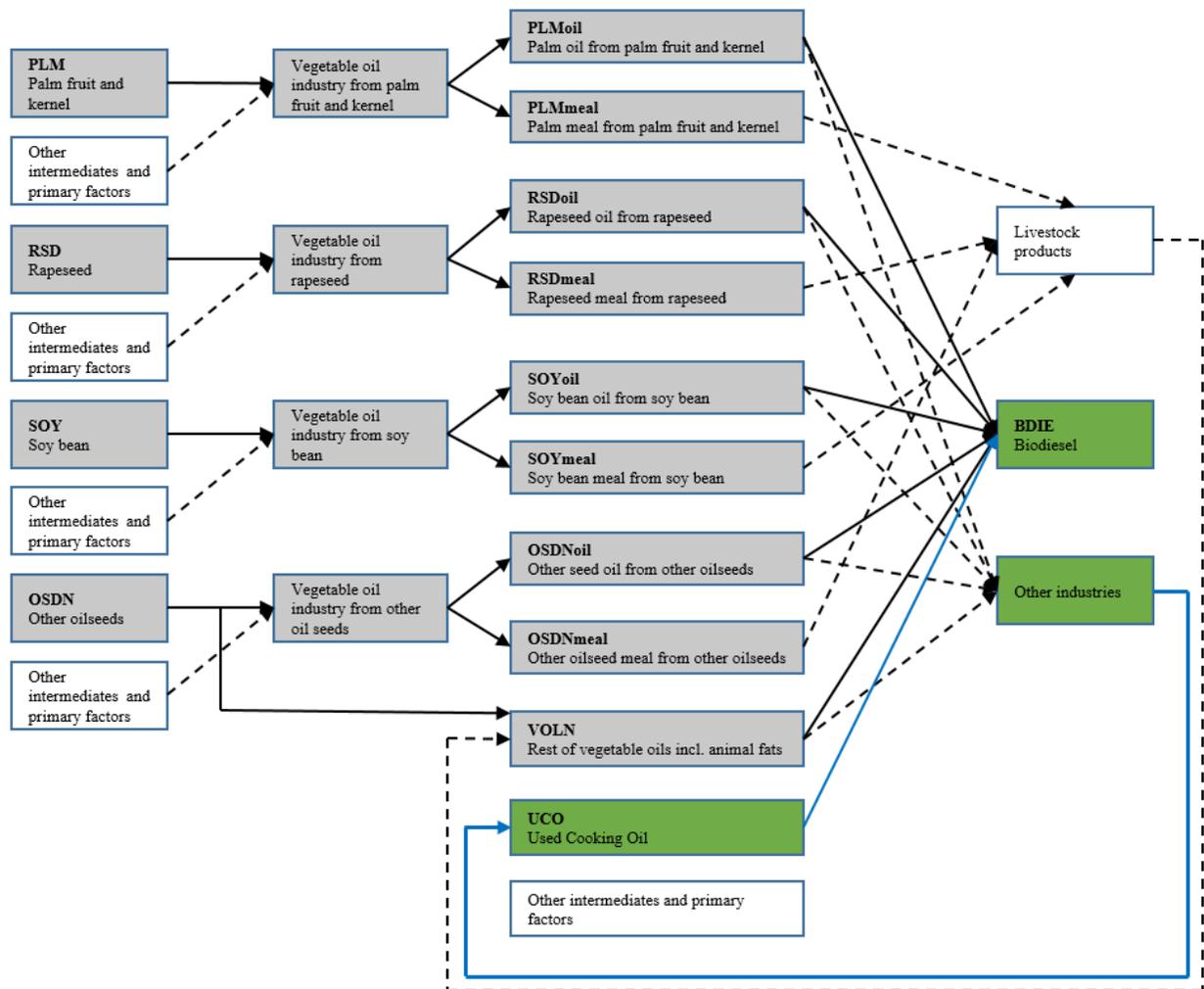
1. UCO produced as waste & residue in restaurants for instance (point of origin),
2. UCO collected to a first collection point
3. UCO transported to a filtering facility (supplier)
4. Trader between the supplier and the producer (in some cases)
5. UCO transported to a biofuel refinery for production (producer)
6. Renewable biodiesel produced and ready to be distributed to the biodiesel market.

Figure 3. *An example of UCO supply chain from point of origin to biofuel customer based on available public literature (synthesis).*



The Figure 4 below illustrates the biofuel pathway from feedstock to biodiesel. The UCO pathway is highlighted in green with blue lines.

Figure 4. Biodiesel production pathways according to Delzeit, Heimann, Schuenemann, Soeder (2019).



The future outlook of the UCO market seems promising. Constantly increasing utilization rate of UCO as a biofuel feedstock ramps up the market growth of UCO. In addition to biofuels, UCO is used in the production for other smaller segments such as animal feed and oleo chemicals and bio lubricants. Increased use in the biofuels sector along with

other smaller sectors increase the demand of UCO and thus develop the market to grow bigger. Moreover, the initiatives taken by individual governments as well as regional policies are expected to fuel the growth of the UCO market even stronger which is why the market is assumed to prosper during the upcoming decade. (Allied Market Research, 2020)

On the contrary though, hindering factors for the growth of the UCO market are the increased amount of thefts, lack of general awareness, and the frauds related to UCO. According to Sapp (2019), over 20 people were charged with the theft of UCO along with other federal crimes. Also in 2019 Dutch officials investigated a biofuel producer for committing an UCO fraud meaning that they falsely claimed and reported the feedstock used in production as sustainable used cooking oil even though that was not the truth (Dutch News 2019). These types of events and crimes are expected to have a negative impact on the growth of the market and hinder the availability of the feedstock.

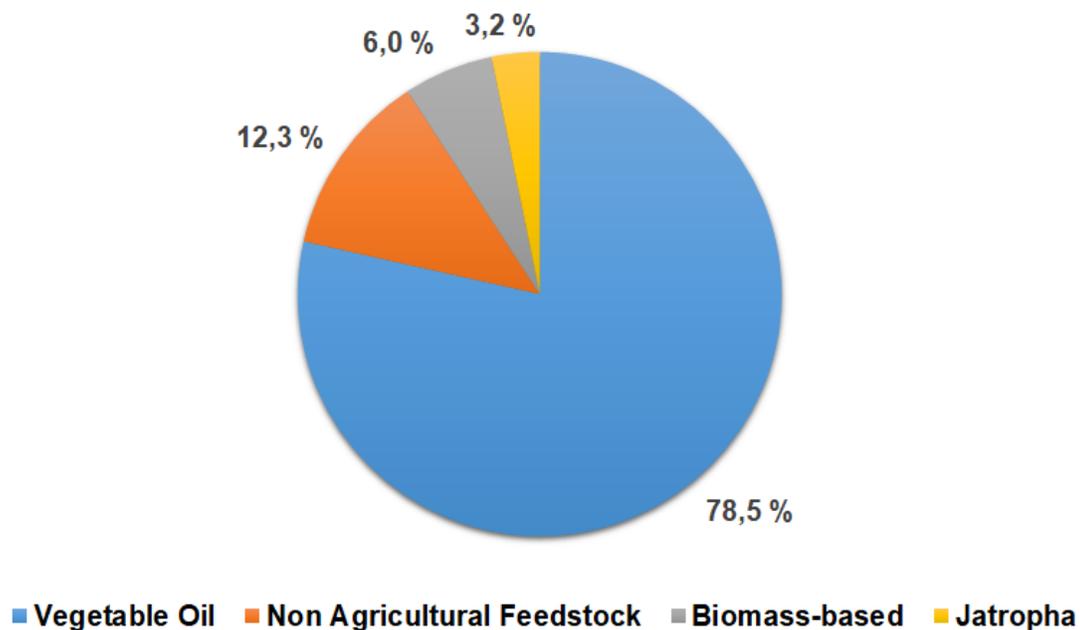
2.2.2 Animal Fat

To this day the focus of most research towards biofuel feedstock has been towards vegetable oils and its excess products such as used cooking oil (Balat 2011). Another feedstock classified as waste & residue is animal fat (AF) which has overtime been recognized as a very viable alternative to vegetable oils as a biofuel feedstock. In brief, animal fat originates from meat processing waste that is further processed into meat bone meal and rendered to animal fat waste at rendering plants. Rendering refers to the heating process of the raw material which is carried out to eliminate threats for human and animal health.

Figure 5 illustrates the estimated distribution of primary feedstock groups used in the production of biodiesel by 2020. As one can see, vegetable oils are calculated to account

for 78,5% of all used feedstock which does not leave room for consideration about the largest source of raw material used in the production. Due to the relatively expensive cost and at times unreliable availability of the vegetable oils, the absolute price tag of biodiesel is generally higher than that of regular fossil fuel, thus affecting the availability. (Balat 2011, Sanli et al. 2014, Roschat et al. 2017)

Figure 5. *Distribution of the feedstock usage in biodiesel production globally (Vivekanandhan et al. 2013).*



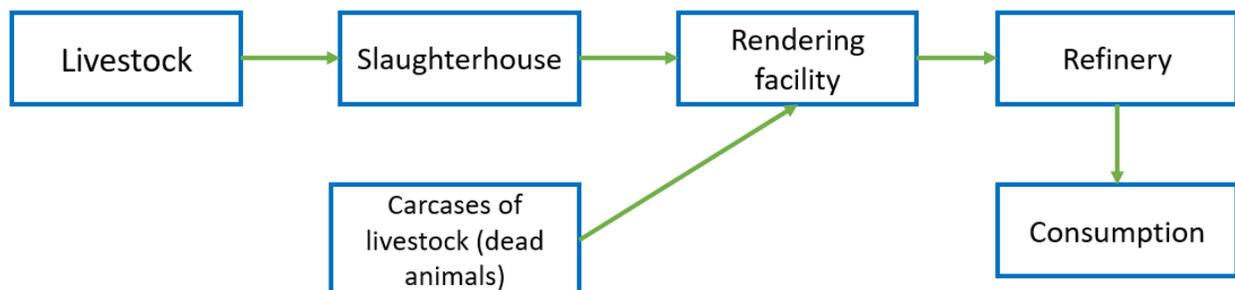
Longer term production of biofuels cannot be maintained sustainably by merely relying on vegetable oils regardless of the growth of biofuels due to the high cost of vegetable oils. Moreover, relying on vegetable oils as the primary feedstock can result in food scarcity as the vegetable oils originate from edible oils very much and these edible oils are meant for human consumption rather than biofuel production. (Alajmi et al. 2017) This has sparked several researchers to investigate alternative sources for the production and as a result animal fat was recognized as a cheap source of biofuel feedstock. Selvakumar and Alexis (2016) researched the production of biodiesel by using a type of animal fat as

the feedstock. According to them animal fat based biofuel appears to be a suitable substitute for fuel used in turbine engines. Use of animal fat also enhances the eco-friendly atmosphere as it contributes to the reduction to greenhouse gas emissions, improves the availability of fuel and thus helps in the battle of future fuel scarcity.

Waste animal fat originates from factories or slaughter houses used in the meat production industry. More specifically, the rendering process of animal fat, processing of dead animals as well as the enormous food processing presents a very attractive platform for low cost biofuel feedstock. (Bankovic- Ilic et al. 2014, Dias et al. 2012, Canakci 2007) Main categories of animal fat are tallow, pork lard, poultry fat, and fish fat (Bankovic- Ilic et al. 2014, Balat 2011). Animal fat waste is seen to provide numerous benefits for biofuel production. For instance, the properties of animal fat waste are clean and renewable and it is of relatively low water content. Both of these factors indicate that the quality of animal fat based biofuel is decent. (Balat, Balat 2010, Ghaderi et al. 2012)

Figure 6 below according to Baladincz and Hancsók (2015) illustrates a summarized pathway for animal fat to biofuel, meaning from point of origin to consumption.

Figure 6. *Streamlined pathway for animal fat to biofuel in consumption (Baladincz, Hancsók 2015)*



The use of waste animal fat as a biofuel feedstock is expected to grow also along with the growth of the biofuels industry as animal fat is gaining a stronger position as one of the more desirable feedstock used in the production. As a biofuel feedstock animal fat is globally more acceptable than crop-based biofuels (vegetable oils derived from palm fruits) for instance. Biofuels based on crop-based feedstocks have over time drawn more and more negative media attention and its use as a biofuel feedstock has been limited with the latest policy updates.

Characteristic for the AF market is that a biofuel producer is more likely to source the feedstock through intermediaries rather than directly from its point of origin. The market is made up of globally large players who control large volumes which can cause problems in ensuring the availability in the longer term.

2.3 Excess demand market

The waste & residue feedstock market and the nature of it is rather unique. Traditionally sourcing of a good can be done through orchestrating a competitive bidding scenario for potential suppliers which leads into supplier selection and thus procurement of a good from a specific supplier, or multiple if necessary. In the feedstock market this is not the case as demand for the feedstocks exceeds their current supply. That being said, the reasons for this high demand are presented next.

Perhaps surprisingly to some, commercially produced UCO has already been collected for over three decades as UCO primarily supplied the market of animal feed. Things took a turn in 2002 when an EU-wide ban towards UCO use as animal feed was implemented through the update in “Animal By-Products Regulations” (EU 2009). This caused a need for the collectors of UCO to find a new end-market for the collected waste material in order to keep their businesses running. Around 2002 the biofuels industry started to grow properly which led to increased demand for feedstock in the biofuels industry and now

the collectors of UCO had found a new customer segment for their material. In 2009 the demand of UCO really started to increase in the biofuels industry through the implementation of RED and FQD which were applied to further accelerate the growth of biofuels. The targets of these directives together with restrictions on cultivated feedstocks enhanced the position of UCO as feedstock in the industry which basically meant increase in the demand. In 2010 the rapid growth caused UCO producers to be in possession of relatively valuable material instead of just paying external parties to collect the waste UCO from them. This meant that now instead of producers paying for the collectors, the collectors had to pay for the producers in order to acquire the UCO volumes. Fast-forward to the present day, the demand of UCO amongst European producers is so huge that local UCO supply is not sufficient and thus it has to be sourced from third countries (CBI 2015). (Loizides et al. 2019)

The statistical data provided by the European Biodiesel Board (2019) supports the statement of demand exceeding supply. Currently the European biodiesel industry produces roughly 11.5 million tons of biodiesel annually and the UCO based biodiesel is included in that total production quantity. However, the capacity of the UCO refining sector is over 21 million tons. To further support this statement, regarding UCOME (biodiesel produced from UCO) the difference between supply and demand was calculated to be around 30% which lead to Europe importing a volume of 500,000 tons of UCO from third countries to at least shrink the gap a little (Greenea 2018).

One solution to closing the gap between supply and demand is to utilize domestic UCO in a better manner. Domestic production of UCO is calculated to account for slightly over 850,000 tons, of which only 48 000 tons are collected (Greenea 2016). Approximately 800,000 tons end up in the environment as waste causing damage to nature for instance (Hanisah, Kumar, Tajul 2013). With domestic UCO supply being more or less untapped, the competition for commercial UCO today is stronger than ever before as still today, due to the presented factors, the demand exceeds the supply.

Waste animal fats have become a more relevant feedstock during the last decade. For instance, in the US a total volume of 986 million pounds of animal fat was used in biodiesel production (Brorsen 2015). According to ERS (2015) the trend of average consumption of meat per individual is bearish also which supports the statistics of animal fat rendering and its negative growth in table 2. This means that the only option for biofuel producers is to simply pay a premium on the animal fats in order to secure the feedstock supply there instead of other industries where animal fats are used (Brorsen 2015).

Table 2. *Animal fats production, consumption and exports in the US 2009-2014*
(Brorsen 2015)

Category	2009	2010	2011	2012	2013	2014
Production						
Inedible tallow	3,375	3,332	3,278	3,204	3,179	2,991
Edible tallow	1,837	1,825	1,955	1,790	1,776	1,627
Yellow grease	1,924	1,915	1,998	1,950	1,986	2,054
White grease	1,293	1,263	1,280	1,310	1,302	1,282
Poultry fat	1,010	1,039	1,048	1,047	1,062	1,076
Total Production	9,440	9,373	9,559	9,300	9,306	9,030
Methyl Esther						
White grease	334	333	533	408	468	427
Tallow	531	170	431	385	452	355
Poultry fat	135	100	240	176	160	174
Other animal fat	69	42	85	48	-	30
Yellow grease	156	246	471	670	977	1,074
Other recycled oil	14	40	195	289	304	186
Total Methyl Esther	1,239	931	1,955	1,976	2,361	2,246
Total Use	6,623	5,432	5,102	5,362	5,350	5,198
Exports	2,817	3,192	2,672	2,294	1,898	1,802

While the statistics above represent the case of US origin animal fats, an assumption can be made that the consumption of meat is not increasing globally which means that the potential pool of animal fats is not expected to grow significantly, a decrease in the pool of available animal fat feedstock is more probable. Based on this assumption the competition for available animal fat on the feedstock market is only going to increase as production volumes are growing and producers are thus willing to pay more for the feedstock. In short this supports the statement of demand exceeding supply, in the case of animal fat also that is.

3. SOURCING STRATEGY

Sourcing strategy as a term is rather multidimensional. The aspects of sourcing strategy do not limit merely on deciding the general nature of sourcing, i.e. local sourcing vs global sourcing. For instance, an important decision regarding a sourcing strategy concerns a structural decision on defining the amount of suppliers that would be used to purchase goods of identical or similar nature. Another key essence of a sourcing strategy is the need of formulating the most optimal approach towards the type of item that is being purchased. To further clarify, this decision is made based on the category of the purchase and the situation surrounding the market of the purchase target. The goal here is to find the best ways of responding to different situations that represent fundamentally distinctive challenges.

Sourcing strategies are hardly generalizable due to the fact that the strategy is tailored to meet the requirements of a specific targeted product which is decided to be sourced. Factors such as product type, nature of the product market, power balance between the buyer and the suppliers and the resources of a buyer are few examples that greatly affect the framework of a sourcing strategy. (Corey 1978)

On a very general level the elements of a sourcing strategy can be analyzed through theoretical models like resource-based view (RBV) or transaction cost economics (TCE). This thesis will not focus on describing these theories on any deeper level but one takeaway from these theories is presented. While these theories emphasize different factors, both of them help the buyer to make decisions on the key elements of the strategy. These key elements are make-or-buy decision, collaboration, individual vs consortium sourcing, and centralization vs. decentralization. Make-or-buy decision is a rather self-explanatory element which refers to the decision of producing the item in question in-house, or opting to acquire it from the external parties of the market. Collaboration here refers to the decision of whether the supplier is worth investing

additional resources for expanding the relationship for future considerations or not. Individual versus consortium sourcing is the decision of either focusing the sourcing resources on maximizing the individual purchasing position or opting to utilize a network of buyers to collaborate and exploit the power of collaboration in buying. Finally, centralization versus decentralization refers to the decision of either having a centralized common function responsible for all purchasing, or alternatively having decentralized purchasing functions that are responsible only for their own function specific purchases. Both options carry their own benefits and the decision here should always be carefully considered based on the product or products that are being sourced. (Ahtonen & Virolainen 2009)

Having recognized the key elements of the strategy, the big decision of the type of sourcing strategy can be made. Through a rough separation, there are two types of sourcing strategies: single sourcing strategy or multiple sourcing strategy. (Johnsen, Miemczyk, Howard 2014).

Multiple sourcing is best explained as the use of several suppliers for supplying the buyer with same or similar items or services. As a practical example, a company can choose to source specific types of biofuel feedstocks from 10 or 15 suppliers. Suppliers under this specific scope are to an extent offering comparable raw materials and even if the buyer is buying one type of feedstock from one supplier and another type of feedstock from another supplier, the buyer can still switch suppliers if deemed necessary. With multiple sourcing -approach a company can decentralize the risks and thus avoid critical dependency on a certain supplier. Through multiple sourcing a company can create healthy competition between its suppliers especially if these suppliers are aware of each other's existence. Multiple sourcing is commonly perceived as a decent option as it makes it possible for the buyer to maintain alternative supply options and it is a good way to minimize risks towards potential disturbances on the supply flow. (Johnsen, Miemczyk, Howard 2014)

Multiple sourcing has received its fair share of critique as supplier relationships are viewed to be a collaborative relationship that can create value for both parties rather than just a tool to conduct simple transactions between a buyer and its supplier. Womack et al. (1990) and Nishiguchi (1994) highlighted in their studies that the Japanese automotive industry leaned towards single-sourcing and creating extensive relationships with suppliers rather than opting to go with the multiple-sourcing -approach. In the case of Japanese automotive industry the single-sourcing -approach appeared to produce significant benefits. However, that does not necessarily mean that single-sourcing is the better option out of these two as the type of sourcing strategy is decided case by case.

Treleven and Schweikhart (1998) defined single-sourcing as follows: “Fulfilment of all corporate requirements for a particular product by one selected supplier”. Characteristic for single-sourcing is that the buyer resorts to supplier development and other similar practices in order to commit to the relationships between the company and the supplier. Single-sourcing strategy enables the buyer to benefit from economies of scale and generally lower the entire costs of the supply chain, at least in the case of Japanese automotive industry (Treleven and Schweikhart 1998).

The significance of sustainability as a part of sourcing strategy has risen during the past decade. Sustainability is in the core of the biofuels industry which is why the next sub-chapter will be focusing on the influence sustainability has towards the way a biofuel producer sources the feedstock for biofuel production. The following sub-chapters after 3.1 will present the basic concept of global sourcing, a sub-type of multiple-sourcing (3.2) which followed up with the a few viable procurement methods used to execute the strategy in the case of a large multinational biofuel producer company (3.2.1 & 3.2.2).

3.1 The influence of sustainability

One could say that by ignoring the importance of sustainability a company will not have a long term future. Sustainability is a key factor playing a part in the sourcing strategy of a company due to the fact that companies are constantly evaluated and technically obliged by its stakeholders to address sustainability related matters such as environmental, social, and ethical matters regarding the company's operations. (Carter & Easton 2011) Stakeholders do not always differentiate the company in question and its suppliers which is why focal companies of large supply chains, such as biofuel producers for example, are often held accountable for the sustainable behavior of their suppliers also. That being said, a company is more or less obliged to the sustainability of the supply chain to much larger extent than what the economic reasons would justify. (Rao & Holt 2005; Seuring & Müller 2008) According to Carter and Easton (2011) the supply chain managers of a company can positively or negatively influence sustainability related topics like social and environmental performance via supplier selection and supplier development for example.

Sustainability in supply chains is studied quite thoroughly, which made it possible for Seuring and Müller (2008) to analyze 191 papers covering the issue in question. Their analysis summarized the key reasons why sustainability is a hot topic and must be included as a part of the strategy:

1. Legislation and regulations
2. Customer demands
3. Stakeholder pressure
4. Competitive edge
5. Activist groups, such as environmental and social
6. Loss of reputation

Sustainability in the biofuel industry is enforced through regulations, directives, and national policies. In addition to the renewable energy consumption targets set in the renewable energy directive (RED) by the EU, the directive also contains a specific sustainability criteria for all biofuels produced or consumed in the EU area. This is mainly done to ensure that the production of biofuels can be proved to be sustainable and environmentally friendly. (European Commission 2017c) Companies can show evidence of being compliant towards the sustainability criteria through nation specific systems which are also recognized as voluntary schemes by the European Commission. All of these voluntary schemes are in-line with the sustainability criteria set for biofuels by the EU. By being compliant with the voluntary schemes, evidence can be shown that the biofuel production does not exploit land with high biodiversity, land with high carbon stock was not converted for biofuel production purposes, and finally that the production of these biofuels result in sufficient amounts of GHG (greenhouse gas) savings. Some of these voluntary schemes might go much further than the EU's sustainability criteria and therefore can assess environmental protection and social criteria in a very demanding level also. (European Commission 2017d)

For instance, in case of a Finnish global biofuel producer Neste, the sustainability of used biofuel feedstock is guaranteed with a meticulous supplier approval process. After having passed the approval process, a supplier must provide documents which are used to prove the sustainability of the feedstock. These documents contain all the relevant information needed for ensuring that the feedstock is sustainable and compliant with the market regulations. All of the renewable feedstock used by Neste are traced back to where they are collected or cultivated. Neste requires all the renewable feedstock to be produced in accordance with responsible and sustainable practices. (Neste 2018) Over time the sustainability feedstock sourced from suppliers can also be ensured by conducting audits independently or with third parties and potential improvements can be implemented through supplier development activities.

3.2 Global sourcing

The most accurate way to summarize purchasing of goods globally according to available literature is to call it global sourcing. According to Christopher et al. (2011) global sourcing has been an attractive approach amongst companies seeking competitive advantage as the world is more connected than ever before and the significance of national borders have decreased. In literature global sourcing is also referred to as “global procurement” or “international purchasing” which is why for clarifying purposes this thesis will use the definition of global sourcing according to the manner Trent and Monczka (2003) defined it as: “Global sourcing is proactive integration and coordination of common items and materials, processes, designs, technologies and suppliers across worldwide purchasing, engineering, and operating locations”. Finally, Arnold (1989) views global sourcing as a way to exploit the ability of purchasing on a global scale.

The concept of global sourcing strategy is generally perceived to refer to the management of logistics determining which production units will serve specific end-markets and how raw materials will be supplied for production. The ultimate objective of a global sourcing strategy is to take advantage of its own competitive advantages as well as those of the suppliers and the provisional location specific advantages of different countries in global competition. (Kotabe and Murray 2004) In this paper global sourcing strategy refers to the way a biofuel producer ensures the access and availability to biofuel feedstocks so that it can produce biofuels at the highest capacity possible and thus be able to supply the demand of the biofuel market to the best of its ability.

The following chapters will present three general ways of multiple-sourcing raw materials in a global scale with the purpose of securing current availability to the raw-materials, ensuring that production is not threatened by regional disruptions in raw material production, and finally the long-term access to raw materials to secure and even strengthen its position as a company in the market.

3.2.1 Direct procurement and procurement through an intermediate

Direct procurement as a term is rather self-explanatory. It refers to the act of purchasing raw materials, such as biofuel feedstock, for production of end-products like biofuels. Direct procurement is most often utilized when a company seeks to purchase a large quantity of raw material from a pool of suppliers. Supplier is generally selected based on the cost, reliability and quality. Direct procurement is a good method when the target of procurement is frequently purchased and is crucial for business purposes, such as biofuel feedstock for biofuel production. In this thesis direct procurement refers to a scenario where a producer buys the biofuel feedstock directly from the supplier rather than through a broker or other intermediate.

Figure 7. *Direct procurement of biofuel feedstock*



It can be assumed that buying directly from the supplier of the feedstock is cheaper than compared to the same event, but through a broker. The more intermediates there are in a supply chain, the more expensive will the purchased feedstock become naturally. Establishing a relationship with the actual supplier of the feedstock itself is also a method of securing a stable source of supply as the relationship between a supplier and the buyer can yield mutual benefits for both parties and strengthen the position of both players in their respective markets. In this type of scenario it is also easier for a biofuel producer to monitor the sustainability of its supplier as the supply chain is not as complex as it is when there are additional parties involved.

As for procurement through an intermediate, the driving reasons are more or less the same as through buying directly for the original supplier of raw material. The key difference here is that the intermediate is an additional party between the buyer and the supplier. These intermediates, also referred to as traders or brokers, purchase volumes of raw materials from the raw material producers and trade them to the highest bidders. Generally a buyer has to resort to purchasing through an intermediate in a situation where they control significant volumes of specific feedstock or if the buyer cannot easily get access to the supplier who has produced the raw material in the first place. Figure 8 below illustrates the scenario of buying through a broker, and figure 9 illustrates the scenario of buying through a trader.

Figure 8. *Procurement of feedstock through a broker*

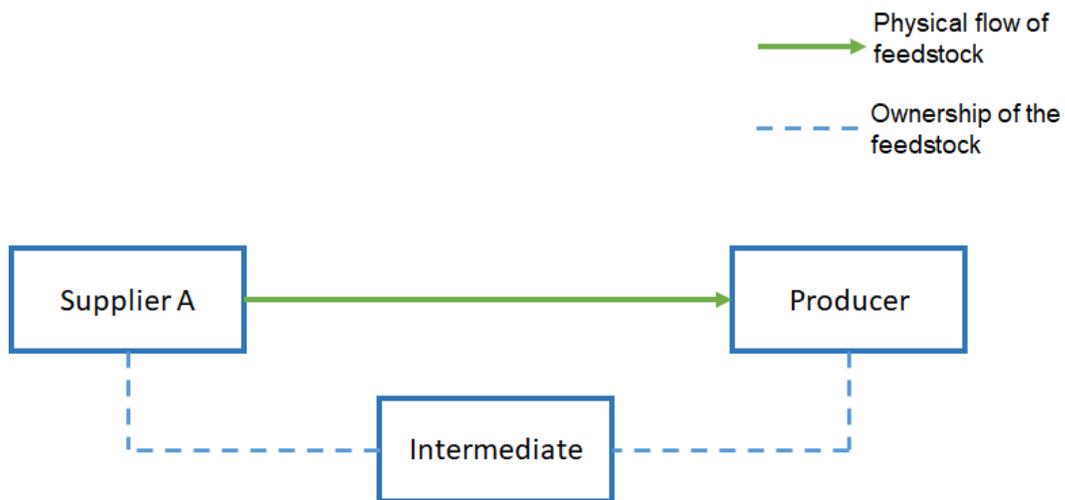
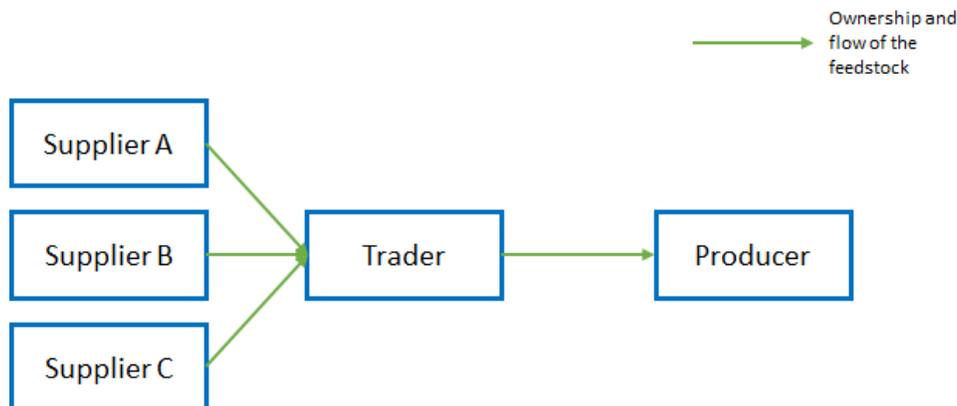


Figure 9. *Procurement of feedstock through a trader*



3.2.2 Supplier acquisition

Perhaps the rarest method in feedstock sourcing is the acquisition of a supplier. In practice this means that the biofuel producer acquires the majority share of controlling assets and therefore is able to secure the availability of feedstock in the longer term. One reason for acquiring a supplier could be the risk of a competitor doing so which would result in the loss of those volumes purchased from the supplier. Supplier acquisition does not necessarily mean that the buyer will make dramatic changes to the daily operational activities, but aims to develop and improve the performance of the acquired supplier more efficiently.

While there are no clear indications according to academic literature, supplier acquisition can be argued to happen after a lengthy relationship between the supplier and buyer. By acquiring a supplier, the buyer can secure future volumes for itself and at the same time limit the availability for the competitors which creates competitive advantage for the buyer.

4. EMPIRICAL STUDY

The purpose of previous chapters was to formulate a theoretical frame for this study. The theoretical part is followed up now with the empirical part of this study. The research questions of this study as well as the nature of the study subject are comprehensively evaluated in designing the empirical part of this study. As Hirsjärvi et al. (2007) say, the methods used in answering the research questions of the study is based on the primary aim of the study. The following empirical part was carried out by interviewing people relevant to the subject of this study from the case company. Some secondary data provided by the case company was also utilized in the empirical analysis in addition to the data acquired from the interviews. The purpose of this chapter is to describe the research method, how the data was collected and analyzed and finally argue the reliability and the validity of this study.

4.1 Research method

The research methods used in academic research are commonly separated into two different groups: Quantitative methods, or qualitative methods. Highly characteristic for quantitative study is to rely on collect numerical data and create statistical analysis based on the gathered numerical in order to constitute concrete examples of statistical relationships amongst the data. (Alasuutari 2011) The purpose of a quantitative research method is to inspect causal connection, generalization, and the predictability (Hirsjärvi & Hurme 2008). The goal of a qualitative research method is to formulate a thorough comprehension of an actual phenomenon or event and the various aspects concerning it. Characteristic for a qualitative study is that the sample of examined data is relatively small but on the contrast the sample of data in question is covered very literally (Eskola & Suoranta 1998) General examples of research methods utilized in qualitative research according to Metsämuuronen (2005) are interviews, observation, and text analysis. Qualitative data can be acquired through verbal or visual ways (Uusitalo 1991). Several researchers have argued that rather than considering quantitative and qualitative

methods as competing research methods, they should be regarded as complementary methods that can yield benefits for both options mutually (Hirsjärvi et al. 2007).

A wide spectrum of research data collection methods are available to carry out qualitative studies. One rather prevalent method in the collection of data is the case study method. Case as a concept is relatively broad, but commonly it refers to a specific company, or a department of a company for example. There is no certain limit to how many different cases can be included within a case study, but generally case studies deal with one or few cases at best. (Koskinen et al. 2005) Table 3 below presents definitions of a case study according to Yin (1984, 23) and Schramm (1971):

Table 3. *Definitions of case study. Yin (1984, 23) and Schramm (1971)*

Author	Definition	Year	Published in
Yin	"An empirical inquiry that investigates a contemporary phenomenon within its real-life context"	1984	Case Study Research: Design and Methods
Schramm	"The essence of a case study -- Is that it tries to illuminate a decision or a set of decisions: why they were taken, how they were implemented, and with what result"	1971	Notes on case studies for instructional media project

The goal of this qualitative case study is to better understand how a biofuel producer operates in an excess demand feedstock market and shed light on the viable sourcing strategies and determine the key factors steering the choice of sourcing method towards one or several different options. As a result of the chosen research topic and the essence of it, a case study is a very obvious choice for the research method used in this study. One favoring factor behind choosing case study as a research method is that case studies tend to produce very practical findings due to the fact case studies are conducted in a close relation to practice rather than theory. Natural for a case study is that it originates from a functional starting point and the acquired results are introduced into practice (Metsämuuronen 2005).

4.2 Data collection and analysis

The primary data in this case study is acquired through semi-structured theme interviews. The structure of the empirical part is constructed through the themes of the interviews. The flexibility of semi-structured theme interviews together with the nature of the subject in question naturally led to this data collection method. Characteristic for theme interviews are that themes and questions in those are planned on a general level prior to conducting the interviews, but are open to change to some degree during the interviews (Hirsjärvi et al. 2008). Semi-structured theme interviews are relatively casual for the interviewees and the researcher can participate in the discussion without entirely taking the control of it (Koskinen et al. 2005). This empirical study is based on the interviews of three representatives from the case company. All interviewees are professionals from the case company's supply chain function and were willing to take part in this study. The interviewees of this study as well as the case company are anonymous to provide for the most open possible discussion during the interviews.

The interviews took place in March 2020 and the average duration of these interviews was an hour. The case company representatives were contacted via email and the interviews were conducted face-to-face or through an online meeting call. The interviews were recorded with the permission of the interviewees and transcribed afterwards to decrease the possibility of misinterpretations of the answers. The roles of the interviewees are presented in the table 4 below.

Table 4. *Interviewees*

Interviewee A	Head of Supply
Interviewee B	Feedstock lead
Interviewee C	Supply Manager

4.3 Reliability and validity of the study

The level of a research study and how it is perceived amongst the readers is inevitably based on its reliability and validity. Reliability, in research context, refers to the repeatability of the research measures. Simply put, this refers to the ability to produce comparable results by using the same method towards the same topic of study. Validity, on the other hand, refers to the capability of the research to evaluate the most desired factors in question. The reliability and validity of a qualitative study should be evaluated regardless of the fact that these approaches are deemed more appropriate for a quantitative study. (Hirsjärvi et al. 2007)

As stated, characteristic for qualitative studies are the narrow sample pools of data which are argued to produce profoundly subjective findings that cannot be generalized compared to those results produced by exploiting a quantitative study method. However, one should comprehend the purpose of a qualitative study and internalize the fact that

the purpose diverges from quantitative studies. Even though the sample group utilized in qualitative study may be relatively tiny, the results of the study can very well be used to reinforce the theory and what has already been found through previously conducted studies. (Soy 1997)

Various factors can have an impact on the reliability of a qualitative study but arguably the research process is perhaps one of the more important factors. One way to strengthen the reliability of a study is to carefully define and disclose the entirety of the research process including all its particles. In practice this means that the researcher depicts the circumstances under which interviews were conducted, how long were these interviews, potential diversions, and to what extent might the researcher have drawn wrong judgements. (Hirsjärvi et al. 2007) Additionally, the researcher is not the only person with a great influence on the reliability of the study. Due to the nature of qualitative research method, it is significantly impacted by the subjective opinions of an individual at a certain time which should not be overlooked when evaluating and analyzing the results of the study (Hirsjärvi & Hurme 2008). For instance, an interviewee might provide dishonest and inaccurate false responses in order for them to be socially more acceptable. There is also always the possibility of misunderstanding the question which can result in unreliable empirical data. Eskola & Suoranta (1998) mention that interviewees are not solely responsible for errors and misunderstandings in qualitative research data but one should not forget that the researcher is heavily reliant on the interviewees and thus subject to their individual opinions and therefore exposed to drawing false interpretations more easily. However, there are no certain ways to ensure that the research does not tamper the acquired answers and ignore specific details that would affect the results of the study unfavorably (Tuomi & Sarajärvi 2009).

The purpose of this research is to formulate a comprehensive understanding of a certain setting rather than creating a generic overview of the chosen topic. That being said, recognizing factors of the interviewees are excluded from this research with the aim of improving the reliability of the study.

5. EMPIRICAL RESULTS AND FINDINGS

This chapter will present the results and findings of the empirical study which are based on the three theme interviews conducted within the case company. The results are presented according to the three main themes of the interview body. The themes and their respective interview questions are presented in Appendix 1. Presentation of the results begins with the analysis of the waste & residue feedstock market and how the interviewees perceive the market to be and behave, and also how the characteristics of the market influence the way a buyer operates within the market. Secondly, the role of sustainability in the case company is described and how it affects the sourcing of raw materials as well as how sustainability is ensured and monitored by the case company in raw material sourcing. Thirdly, the sourcing strategies in biofuel feedstock sourcing are described and the primary influences to the strategy and implementation are presented. The case company of this empirical study is a relatively large biofuel producer which sources waste and residue raw materials to produce biofuels like biodiesel for instance.

5.1 Waste & Residue feedstock market

5.1.1 Market characteristics and the impact of legislation

The perception of waste & residue feedstock market amongst the interviewees was very similar, to little surprise. The characteristics of the market were described in very similar ways and the general consensus was that the market is rather unique and heavily differs from a traditional commodities market. The key reason here is that the suppliers who produce these wastes & residues do not produce them as a primary product in their businesses. Restaurants and food manufacturing facilities are focusing on producing food and meals for the customers and the used cooking oil is a by-product that is dealt with on the site and sold in the market. The availability of animal fat is most definitely based on the meat consumption of humans so the meat itself is the primary product and the leftover

waste animal fat is sold in the market. The opinion of interviewees was that companies do not go into the business of producing UCO or AF as their primary product.

“The biggest difference with the waste & residue raw material market versus traditional commodities is that they’re by-products. They are not typically the primary source of revenue or profit from the sites that they’re produced at. That creates an interesting picture for the supply because suppliers are not usually in a position where they will increase production for specific waste and residue. The increase or decrease in production for a specific waste and residue is usually due to the main primary product.”

- Interviewee C

“The main features of the waste & residue raw material market are that typically the waste and residue streams are side-streams. The production of these do not vary on the demand, but rather on the production of the main products or the collection. Typically the demand has not been driving the increase of the available raw material so this isn’t like a traditional market where increase in demand will increase the production.” - Interviewee A

The theoretical part presented how implementation of legislative matters like regulations and directives have fueled the growth of the biofuel industry. The legislation extends all the way to the raw materials from which the biofuels are produced so the interviewees gave their opinions on how the legislation impacts the waste and residue market. All of the interviewees said that the biofuel regulations have essentially created the demand for raw materials in the biofuel industry. The legislation has given incentive for the producers of waste and residue feedstocks to improve the collection of these side-streams. This has increased the availability of the raw materials in the market and the implementation of legislation is seen as a key factor here.

“They always have a very strong impact and they essentially dictate the demand we see for these feedstocks” - Interviewee C

“Since the proper starting point of the biofuels industry is somewhere around 2000, when the first sort of biofuel regulations were put in place – since that, it has created new demand for some of these waste and residue feedstocks.” - Interviewee B

The interviewees brought up the fact that while legislation has been the driving factor behind the increased demand for the raw materials, a change in the legislation might make some feedstock more attractive than the other. As of late, the waste and residue feedstocks have been more favorable compared to other feedstock categories. For instance, the demand for a specific feedstock might hinder or completely demolish with the implementation of new regulations or updates to them. The key takeaway here is that while legislation is the driving force behind the industry, it may also cause temporary disruptions and challenges to the companies operating in the industry.

*“The demand has been growing as the regulations have developed towards favoring more waste feedstocks rather than the vegetable oil feedstocks for instance.”
- Interviewee A*

“The legislation selects which feedstocks are in favor or out of favor with the end-markets - - one year a certain feedstock can be more in favor than the next year. As policy changes, it is important to be adaptive and able to use a wide variety of waste and residues. So these changes can be anticipated and adjusted, so you can adjust when the change happens. The impact is huge and some feedstock there may be a very mature supply chain where you are sourcing for an extended period of time and then a piece of legislation may completely invalidate it from an economic standpoint

which makes the market no sense to operate in. That is the real power of the legislation in these markets.” - Interviewee C

5.1.2 Supply versus demand

In the theoretical part, chapter 2.3, the market of waste and residues was described as an “excess demand market” meaning that the demand outweighs the supply to a certain degree. An observation from the interviews was that perhaps describing the market decisively as an excess demand market is rather exaggerated as the interviewees regarded the waste and residue feedstock market more as a dynamic market, although a demand driven one. As mentioned in the previous sub-chapter where the market characteristics were described, the level of supply is much more stable and demand tends to vary more due to legislative changes for instance. The main thing here according to the responses is that supply and demand are more disconnected in these markets and have a harder time responding quickly than other traditional markets because of the legislation and also the fact that the supply inputs are by-products.

“The supply side goes back to the description of unique aspects of waste and residues so they’re typically by-products, meaning that the supply side can often be very hard to impact if demand is exceptionally high that may not be enough to stimulate more production of by-product. Given that’s the case and the demand side is usually a function of mandates from legislation, it is very easy for those two sides to be out of sync with each other. If a policy is too aggressive with certain feedstocks, it could be quite easy for a time to come when that supply does not actually exist or it is insufficient to meet the demand that has been mandated.” Interviewee C

Although the interviewees see the supply side being a fairly stagnant one, changes in the supply do happen at times due to many external factors like run-rates of certain

agricultural facilities or the consumption habits of humans for example. On a general level the interviewees did not see demand have a significant impact on the supply but one interviewee mentioned that the demand can have minor positive impacts on the supply side as a whole:

“Typically the supply is not impacted by the demand, but there is sort of a gradual potential for increase. Like in the case of UCO, where the demand has led into collection improvement of UCO” Interviewee B

When it came to estimating the supply and demand of wastes and residues in future, interviewees expected that the demand is expected to grow going forward but also new segments of wastes and residues to arise as the circular economy approach is gaining more popularity.

“I think in general there is general continuing increased focus on circular economy and re-utilizing waste feedstocks and preferring to use these types of waste and residue raw materials not only in biofuels but other industries as well. I do think that there will be regulation to support the demand growth also going forward. New elements of demand will emerge but also there will be more and more focus on other segments so we will see new segments of waste and residue become the primary focus of growth.”

Interviewee A

5.1.3 As a buyer in the waste & residue market

The nature of the waste & residue market forces a buyer of the raw materials to focus on different factors in order to gain access and ensure the availability of the raw materials so that the planned production volumes can be reached. Most emphasis by the interviewees was put on relationships and the way relationships are managed by the buyer. As presented above, the market appears to be very demand driven which puts the pressure on the buyer rather than the supplier. With mutually beneficial key relationships both parties can strengthen the position of each other and develop as companies.

“It puts a high importance on relationships and dealing with suppliers in an effective way. Being a counterparty that suppliers want to work with, because the supplies can be relatively inelastic. The important thing is having key relationships with suppliers that can be counted on reliably delivering.” Interviewee C

“The buyers have to be active themselves due to competition. As a buyer we have to reach out to the supplier and be willing to build the relationships between us and suppliers. We don’t expect the sellers to be very active and we don’t expect them to make sales trips to meet us and build relationships so we have to be active as a buyer and meet the suppliers, build technical solutions and in that sense it’s much more activity on buyers side in these types of markets.” Interviewee A

5.2 Sustainability

5.2.1 Influence of sustainability in sourcing

Sustainability is a topic that has become very trendy especially during the last decade. Increased awareness of sustainability related topics has transferred to the ways of

working in companies. Especially in the biofuels industry, the influence of sustainability is very strong and the credibility of the entire industry is based on sustainability. End-customers of biofuels want to know that the biofuel they've purchased is refined from sustainably produced raw materials and have confidence in the integrity of the supply chain from point of origin to the end-customer. The legislation also puts a great emphasis on sustainability as different directives and national programs have targets for greenhouse gas emission reductions for instance. When it came to the importance of sustainability in waste & residue sourcing, the interviewees' opinions very once again very much aligned and the general opinion was that it is most definitely a very important matter and plays a big part in the way things are done today.

“Legislation on renewable fuels and renewable energy is one major reason why sustainability is getting more attention and it is becoming a key characteristic that buyers of end-fuel products want in their supply chain as a baseline criteria for the end-market buyers.” Interviewee C

“Certainly when it's regulated demand like in biofuels, there's a kind of “license to operate” requirement for sustainability. If the biofuels business is not sustainable, then the whole point is going away so in that sense companies who are sourcing waste and residues specifically for biofuels, need to focus very much on sustainability of the sourcing and the sustainability of the production of the feedstock.” Interviewee A

The interviewees brought up the fact that while sustainability is a very crucial matter in sourcing of raw materials and it essentially formulates the framework for the entire process, it is a very potential area of improvement for the supplier. By helping the supplier to improve their sustainability practices, a foundation for key relationships can be formed. As previously brought up in the answers by the interviewees, key relationships are very much desired in waste and residue feedstock sourcing so through close collaboration on sustainability, a key relationship can be created for years to come. Improving

sustainability practices in the supplier is seen as a way to have a positive impact on the industry when it comes to sustainability and how it is practiced amongst the producers of wastes and residues.

“One important thing is that some suppliers that may not be the most sustainable or have the best situation at the moment, it is also important to try to have positive influence on the industry and move it in the right direction. -- say that some suppliers may not have the best sustainability track record. This does not mean that they should not be worked with. That can be viewed as an opportunity to bring the industry forward and improve standards in many different areas.” Interviewee C

“If a supplier is not quite meeting our standards, we can help them to improve on safety, or be it human rights, or different requirements we have in place to make sure that the supplier and their operations are sustainable. It’s not about not working with suppliers that are not sustainable but about supporting them to meet our requirements and through that really drive impact.” Interviewee B

5.2.2 Monitoring and ensuring sustainability

Given that sustainability is deemed to be very important, the buyer must continuously evaluate the suppliers and ensure that the internal requirements as well as the market compliance requirements towards sustainability are met. While there is no one correct way to monitor and ensure the sustainability of a supplier and purchased supplies, the interviewees explained that various sources of information are used. The means include different internal stakeholders involved in the sourcing and potentially external parties like certification bodies. Examples of ways to ensure sustainability are at least site visits, independently conducted audits, 3rd party audits, and information available from the market. Having traceability for all the supplies was also mentioned in the interviews. This

means that the supplies can be traced to their point of origin and there are no disconnects in the upstream of the supply chain all the way to the buyer.

“We can request information from the suppliers, we can validate it by visiting the suppliers, we can audit the suppliers, and we can also require them to have certification in place which means 3rd party audits have taken place by external certification bodies.

We can also use the information from the market so there’s different information providers who do constant checks both in terms of countries, regions and their respective sustainability issues which are relevant for different regions so we can focus on those.” Interviewee A

“We tend to view the supply chain evaluation as a team effort. -- In the end it’s about the connection between us and the suppliers so the commercial team knows about our requirements when they are talking with our suppliers and following up, when our sustainability experts are visiting or auditing and we also follow up on the 3rd party certification results.” Interviewee B

5.3 Sourcing strategy

In the process of defining a sourcing strategy for wastes and residues the interviewees brought up various factors. On a general level the interviewees brought up the same factors, although depending on their own role when it came to creating and carrying out the sourcing strategy, different factors were emphasized. For instance, Interviewee C believed that the most important factors in the sourcing strategy are supplier relationships and logistics. Interviewee B believed that if deemed beneficial for the buyer, the logical aim is to go deeper into the upstream and minimize the amount of middle men. Interviewee C on the other hand mentioned that the type of sourcing strategy heavily depends on the specific feedstock which is being sourced and whether it is considered strategically important. What this basically means is that does the supplier prefer focusing

on only few suppliers and building key relationships with those or does the buyer want to purchase from a variety of suppliers and thus enable the efficiency of the suppliers and boost up the competition amongst them.

“I would say the supplier relationships and the logistics capability because you need the relationship to purchase the material from the right people and then you need the logistics expertise to actually get it where it needs to be.” Interviewee C

“If it's a strategic market that we're interested in and if the market is consolidated so there's a lot of volume in the hands of only a few companies, then specifically it makes us want to target some kind of partnership. On the other hand, if it's a very fragmented market, then it's unlikely that we would focus on specific partnerships – we would focus more on having many suppliers and working efficiently within the market. Maybe choose a few of the best ones and try to support them to grow and then to build stronger partnerships later on with them.” Interviewee A

*“If it is only beneficial to us, we want to go deeper into the raw material value chain.”
Interviewee B*

5.3.1 Sustainability in the sourcing strategy

While sourcing strategy is strongly dictated by the economics involved according to the interviewees, sustainability is also taken into account in the process of formulating a sourcing strategy for all biofuel feedstocks. According to the interviewees the sustainability criteria must be met before a single transaction is made between the supplier and the buyer. That being said, sustainability is arguably one of the most important factors in the sourcing strategy if not even the most important.

“It’s not necessarily a sourcing strategy thing but more a sustainability driven sourcing strategy. Generally put, if a supplier does not meet our values or they don’t work in line with our supplier code of conduct, then we can’t work with them. We need to work with companies who are at least dedicated to improve on their sustainability.” Interviewee A

“Sustainability is pretty much the first bar that we will look at for waste and residues”

Interviewee C

“Of course sustainability is taken into account. We have this kind of “sustainability commitment” which means certain factors that our vendors and their raw materials must meet.” Interviewee B

5.3.2 Sourcing methods

All of the interviewees mentioned that the sourcing of wastes and residues can be done through working directly with the supplier, through a trader or a broker of the feedstock, or even through acquiring the supplier. The decision of which method is used depends on the strategic importance and how much you want to actually put effort into the sourcing. Working with traders or brokers is regarded as the most convenient method, but it has a clear negative impact on profitability which means that going through a broker or a trader is not very price-efficient. While all of these methods have their purpose and provide their own value, the strategic importance as well as the type of the market define which method should be opted to go with.

“All of them have a purpose and value, it depends greatly on which market you’re in and how the market operates to decide each of them should be used properly.”

Interviewee C

“You can set up the sourcing in many different ways. It depends also on how much effort you want to put into it. Typically the easiest way is to buy through trader companies who will make it easy for you. So if you want to buy feedstock for your production facility in say France, the easiest way is to of course let some trader who has contacts into the market and conveniently bring it to you while meeting the requirements of different specifications.” Interviewee A

In addition, geographical location and the logistics involved play their part and can potentially exclude some of the methods mentioned above out of the picture. The logistics might require significant investments so a clear strategic motive is most often required for larger investments in securing future feedstock volumes.

“It may also be about logistics: Setting up tanks, transportation capabilities in the country of origin and setting up an entity in the country where suppliers are located. -- nevertheless, I’d say that any of these decisions can be the right one, the strategic motives behind usually determine the choice of method.” Interviewee A

5.3.3 Significance of the sourcing strategy

The significance of the sourcing strategy was also discussed in the interviews and all of the interviewees believed that the sourcing strategy is at very least critical, if not even the most important part of the business for a biofuel producer. Without a sourcing strategy a biofuel producer does not have raw materials to be used in the production meaning that

there is no end-product to be sold to the market. The significance of the sourcing strategy is also widely recognized within the case company and the interviewees believe that it receives a lot of attention and investment of resources.

“It is really heavy and important. Of course, if you think about this company and compare it to the market, I wonder if there are that many companies that are investing so heavily into sourcing raw materials.” Interviewee B

“In general I’d say that feedstocks are critical for any biofuel business.” Interviewee A

“I would say that it is arguably the most important part of the business because without the feedstock there is nothing to produce. Also, given the market dynamics, it is critically important to have a proper sourcing strategy if someone is in the renewables business - out of all variables, it’s arguably the most important thing for this type of business.”

Interviewee C

6. ANALYSIS OF EMPIRICAL RESULTS AND FINDINGS

The focus of this chapter is to analyze the findings gathered from the interviews according to the three themes of the empirical part.

6.1 Describing the waste & residue feedstock market

The empirical data quite clearly suggests that the waste & residue feedstock market is very different from markets in which traditional commodities are traded. This view is supported also by the theoretical evidence provided in the theoretical part of this study. Wastes & residues are by-products which means that they do not receive the greatest degree of attention from the producers. This type of characteristic results in unpredictability and volatility within the market. Compared to other feedstock types like vegetable oils or crop-based oils which are the primary product for their supplier, wastes and residues have a distinctive difference when it comes to the nature of the feedstock market. In the waste & residue feedstock market the demand for these raw materials does not directly affect the supply side which is seen as a rather fixed factor, although the increased demand has most probably improved the collection habits of these raw materials. As we're talking about wastes and residues, the quality of these materials tends to vary quite a lot which brings a variety of other challenges that are not encountered with other feedstock types that are regarded as more standard products.

The impact of legislation to the waste and residue feedstock market has been massive. Not to say that the market did not exist before the legislation because it did, but the demand for the raw materials has drastically increased as a result of these. The regulations in the biofuels industry have made the wastes and residues, like UCO and AF, to be extremely attractive and thus the demand for these have increased very much. Furthermore, the regulations we have today in the biofuels industry are currently favoring

wastes and residues as a biofuel feedstock to other types like vegetable oil feedstocks. While the legislation is seen as the driving force behind the growth and in increase in demand, it may also end up being the demise of the wastes and residues one day. While there's no reason to currently believe that the regulations would force biofuel producers to steer away from wastes and residues, a simple change in the biofuel legislation and the regulations can essentially perish the demand entirely for wastes and residues. Important for a biofuel producer is to be prepared in all cases for potential changes when it comes to regulatory changes and be adaptive at the time when it is required. Having a broad feedstock pool of different types is seen as a good way to prepare for situations like this. The best way to summarize the power of legislation is to perceive it as the most dominant market factor of all.

The theoretical chapter 2.3 described the waste and residue market as a market where demand exceeds supply. The interviewees emphasized the fact that rather than describing the market as an excess demand market, a more accurate way to describe the market is view it as a dynamic, demand driven market where the supply is a stagnant factor while demand is much more volatile. The demand for the feedstocks is a function of mandates from the legislation according to Interviewee C and therefore there it is easy for supply and demand to be disconnected from each other. From a really baseline standpoint is that if we look at AF and UCO for instance, those are highly connected to people's consumption habits like eating at restaurants or people eating more meat. Those trends, whether or not certain populations will go out to eat more at restaurants or eat more meat, those are factors that are highly disconnected from the renewable fuel and renewable energy legislation that we see in many different countries or states. However, the current situation with the market is that the demand is high and has been increasing over time as the legislation favors wastes and residues over a variety of other feedstock types. The legislation for renewable energy and biofuels is getting more aggressive each year which means that the demand is looking to grow as the utilization of renewable energy and biofuels is set to increase the portion of all energy sources used in the future. Moreover, with the circular economy becoming an increasingly popular trend in the

modern world, it is expected that not only current waste and residue feedstock types will continue to grow in terms on demand, but also new ones will emerge and they are expected to go rapidly.

The nature and the characteristics of the market are considered and must be adapted to by the buyer when operating in such a market. The interviewees stressed the importance of relationships and buyer proactivity as well as cross-company collaboration. In a market where there are often more buyers than suppliers, the supplier's obvious choice is to work with those buyers who provide added value to their own operations. Suppliers do not also have to really go out of their own way to find suitable buyers for fruitful collaboration or even partnerships as the market sort of forces the buyer to take the action. While it is important to provide competitive prices as a buyer to the supplier, in addition to price there might be other priorities for the suppliers such as consistency and reliability. Factors such as these provide the basis for key relationships which provide access to the feedstock on a longer term from the buyer's perspective.

6.2 Significance of sustainability

Opinions of the importance of sustainability were very unanimous between the interviewees. UCO and AF industries have not always been regarded as the most sustainable even if they have been more sustainable than most other raw material industries. The importance of sustainability has increased after wastes and residues became a significant feedstock category in the biofuel industry as the regulations have relatively strict standards that must be met in order to claim the feedstock and consequently the produced biofuel as sustainable. Due to the demanding standards of the industry, better transparency is required as the customers and the authorities require evidence of sustainable practices. The supply chain all the way from the point of origin up to the end-customer must fulfill the sustainability criteria set by the authorities. In addition, different parties within the supply chain might even require more than what the authorities

do so all parties involved must be able to provide concrete evidence of complying. All in all, sustainability is very much a top priority in this industry.

Sustainability does have a big impact on sourcing also. As mentioned, the end-customers of the final product want to have confidence in the integrity of the supply chain. According to the interviewees the confidence is provided by the biofuel producer who must carefully operate when it comes to choosing suppliers for instance. The producer cannot source raw materials from suppliers who cannot comply with the sustainability requirements and are not willing to go to the desired degree regarding sustainability practices. However, according to the interviewees the case company does not directly disqualify suppliers who may not be the most sustainable at the given time. Sustainability to them is also about helping the counterparty and working with them if there are matters that require improving when it comes to sustainability. The interviewees state that this is a key way to drive impact on the industry and move it towards the right direction. Obviously the aim is to work with suppliers who meet the standards right from the start and meeting the requirements is an important condition in order to be in business with the case company. The supplier has to be willing to improve and work with the buyer in case improvements are viewed as necessary. As for other factors like price, a direct link does not really exist but a better price offered by a buyer might motivate the supplier to meet the sustainability requirements.

Ensuring and monitoring of the sustainability can be done through various ways according to the interviewees. Information can be requested from the suppliers, the information can be validated by visiting the suppliers, and suppliers can be audited internally or by using third parties. The supplier can also be required to have a valid certification, such as an ISCC certificate, issued by a third party. Information available from the market can also be utilized as the information providers in the market tend to follow region specific sustainability issues amongst the market participants. The key here is to use the right approaches in the right places to ensure compliance towards sustainability related matters. Supply chain evaluation which contains the ensuring and monitoring of

sustainability, is viewed as a team effort according to one of the representatives from the case company. Different stakeholders of the supply chain evaluation are expected to provide relevant information in order to have a reliable understanding of whether the case company is being compliant with their strict supply chain standards. One concrete way to follow the sustainability of the supplier is to validate the traceability information provided by the supplier and follow that the supplies delivered are in line with the set criteria.

All in all, monitoring sustainability is highly related to the connection between the buyer and the supplier as the communication between the buyer and supplier must leave no confusions or misunderstandings when it comes to communicating sustainability requirements and following up on detected issues through site visits for instance. Monitoring and ensuring sustainability is perceived as a constant process and the main goal is to be as aware as possible of all potential issues. Ultimately you cannot know everything as a buyer so focusing the resources and improvements efforts should be aimed towards the issues where most impact can be achieved.

6.3 Formulating a sourcing strategy

The most important factors influencing the type of sourcing strategy for wastes and residues or any other feedstock type for that matter were seen as case specific rather than widely generalizable. The importance of relationships and logistics were mentioned from a more operational perspective. On a more strategic level, the economics and the strategic importance of the feedstock has a great impact on the type of sourcing strategy. The feedstock markets are very dynamic and vary regionally so even for a specific feedstock, the sourcing strategy can vary. The strategic importance of the feedstock will determine whether the buyer will aim for building strong partnerships with a supplier or simply buy from as many suppliers as possible and diversify the supplier portfolio. Moreover, in some cases the buyer might want to go deeper into the upstream and minimize the amount of aggregators to secure availability and access in the longer term.

Given that the feedstock is strategically important for the buyer, in consolidated markets where only few suppliers control a significant portion of all volumes, partnerships are regarded as favorable. However, in fragmented markets it is more likely that the buyer aims to select multiple suppliers and there exploit the efficiency of the market. Through this approach a few top performers can be “selected” to be supported for future growth and then to build strong partnerships with them. The ultimate purpose of sourcing strategy can be summarized to be about building sufficient contingency in a case where one or many suppliers cannot perform to the expectations, how to manage this type of scenario without major disruptions to the operations of the buyer.

The representatives from the case company also stated the sustainability is a key component in any sourcing strategy for a biofuel feedstock. All suppliers must fulfill the sustainability criteria of the case company in order to become a supplier. The case company has a sustainability commitment which means that the suppliers and their feedstock must meet. Sustainability is an area where the buyer can drive a positive impact on the market and work with suppliers that are less sustainable than others while still meeting the minimum criteria that the case company has for all suppliers. This type of approach was described as a sustainability driven sourcing strategy rather than sustainability being one component in the sourcing strategy.

The sourcing method used to carry out the sourcing strategy is influenced by economics and long-term planning. The methods were aligned with the sourcing methods presented in the theoretical part so out of those options, the decision would be chosen based on the geographical location of the feedstock market and the feedstock type itself. After those, economics can be plugged in and the most relevant players of the market can be identified which allows the buyer to evaluate the best possible approach.

All of these methods have their own upsides and downsides. Partnerships consume more resources but in terms of price, they are more efficient. Traders and brokers are

convenient but less price-efficient and not as reliable in longer-term. Traders can provide logistical solutions and ensure the traceability of the upstream which makes it easier for the buyer. Nevertheless, the choice of sourcing method is not viewed as a straightforward matter and it is very difficult to generalize as the amount of variables affecting the choice is very large.

All of the interviewees saw that the sourcing strategies for feedstocks are extremely crucial, perhaps the most important thing for a biofuel producer. Without the feedstock there is essentially no business so the importance of having a proper sourcing strategy cannot be stressed enough. The importance of sourcing to the case company was highlighted by describing through how heavily the case company is focusing on the sourcing and investing in it to not only maintain its current position in the market but also strengthen it going forward.

7. CONCLUSIONS

The final chapter of this study presents the conclusions of the empirical part and provides answers to the research questions based on the findings from theoretical and empirical parts. Finally, the chapter concludes with the limitations of the study and suggestions for future research directions are given.

7.1 Answering the research questions

The research questions of this study were presented in chapter 1.2. The main research question of this study was: *“How does a biofuel producer source biofuel feedstocks globally in a highly competitive dynamic market with excess demand?”* While the theoretical evidence did not have a clear solution to this, the literature suggested that the markets of wastes and residues like AF or UCO are really competitive due to push of legislative incentives and increased importance of sustainability matters. The empirical evidence described the markets of AF and UCO in a very similar manner and also emphasized the importance of sustainability in the sourcing process. However, the empirical evidence brought up the importance of supplier relationship management and the proactivity of a buyer in these relationships. To ensure not only present, but also future volumes, a buyer must invest in the relationships with its suppliers and aim to develop them. The degree to which the relationships are developed and invested in greatly depends on the strategic importance of the feedstock as well as the structure of the market. Generally speaking the trend is that biofuel producers across the world are investing more and more into the relationships. The goal here is that these relationships would be extended into mutually beneficial partnerships that will secure the access to the raw materials in the longer term. The sourcing method used is region and feedstock specific and should be carefully evaluated in each scenario against the current situation from legislative perspective as well. Simply put, the benefits of having aggregators and other types of intermediates make the sourcing process convenient for the buyer but at the same it is not very price-efficient and the relationship is not very extensive. Direct

relationship to the supplier is more resource intensive for the buyer but it still considered more price-efficient and it provides the opportunity for future partnership and potentially even a merger & acquisition. These choices are also considered from the legislative standpoint as changes in legislation can render a certain type of feedstock irrelevant in the future. This means that a specific type of waste and residue feedstock might not be as important in the future as it is today.

Table 5. *Consolidated feedstock market versus Fragmented feedstock market factors*

Topic	Consolidated feedstock market	Fragmented feedstock market
<i>Supplier portfolio</i>	Small	Large
<i>Relationship importance</i>	High	Mediocre - Low
<i>Sourcing method</i>	Case specific	Case specific
<i>Target</i>	Few strategically important relationships	Efficient competition between suppliers
<i>Goal</i>	Long-term partnerships	Ensure continuous supply flow regardless of potential disruptions, potential partnerships in longer term

First sub-question of this study was: “*What kind of factors need to be taken into account when sourcing in excess demand markets?*” Both parts of the study brought up the fact that wastes and residues are by-products which is the biggest factor in these markets. This means that the supply is rather stagnant and does not greatly respond to the demand from the market. The level of supply is in correlation with completely separate external factors like the consumption habits of people which refers to the demand of meat and how much food is produced in restaurants and food manufacturing facilities. Nobody starts a business primarily to produce UCO or AF in order to respond to the demand, these materials are by-products that are produced in the process of producing the main

revenue stream of their producer. The impact of legislation was presented in the theoretical part mainly according to the views of Khanna et al. (2010) and Gupta & Demirbas (2010). These views were supported by the empirical evidence. The key takeaway was to monitor the situation with upcoming legislative changes and understand if the feedstock will be relevant in the future or not. Finally, the importance of relationship management was heavily emphasized which falls into the lap of the buyer as the suppliers do not really need to seek the buyers due to the nature of the raw material market.

The second sub-research question was *“How to ensure the sustainability of biofuel feedstock sources?”* There is no one correct way to ensure the sustainability of the feedstock by the buyer but the empirical evidence suggested different ways to carry this out. A buyer can conduct visits, audits, utilize public information and also work together with the suppliers to improve the sustainability of the sourced feedstock. Key takeaway here is that no supplier will be worked with if they do not meet the minimum sustainability criteria. This can be argued to ensure the sustainability of the feedstock from the very beginning and with previously mentioned approaches the sustainability performance can be monitored and improved going forward. These efforts are viewed as a way to drive a positive impact on the industry as a whole which is also the goal of the case company, according to the representatives. Regardless of everything, there will always remain the possibility for sustainability related violations as you cannot always know everything. The key is to focus on the most important topics which are region as well as feedstock specific. Table 6 below summarizes the ways a buyer can ensure and monitor the sustainability of the feedstock sourced from suppliers.

Table 6. *Ways of ensuring and monitoring sustainability of the feedstock*

Ways to ensure and monitor sustainability
Due diligence vetting
Supplier visit
Supplier audit

3rd party audit
3rd party certification
Traceability documentation
Public information
Supplier development

7.2 Limitations and a suggestion for further research

The qualitative study was argued to contain some limitations when it came to the ability to generalize the findings of the study. This study focused on one specific company and all three interviewees represented the same company. There are multiple producers in the biofuels industry and the ways of operating can greatly vary between the producers. Nevertheless, the goal of this study was necessarily not to produce generalizable results. The goal was to understand the subject of the study at a more deep level and go beneath the surface of the chosen topic.

With that being said, the future suggestions for further research are made. The study focused on only wastes and residues which does not represent the complete pool of all feedstocks used in the biofuel production. Similar type of research towards other feedstock types like cultivated feedstocks would most probably produce different types of results as these feedstocks are not by-products. By studying different feedstock groups, a more comprehensive general overview of the feedstock sourcing could be presented. For instance, crude palm oil has been a relatively hot topic in the mainstream media and researching sustainability issues there could prove to be very beneficial to understand the whole feedstock market of vegetable oils better.

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APPENDICES

Appendix 1.

Semi-structured interview questions

Preliminary questions

- Role/title, professional back-ground & experience
- General overview of work area / work responsibilities

THEME 1 Waste & Residue Market

- In your experience, what are the main features of the waste & residue raw material market?
 - Which issues / factors are particularly emphasized from a sourcing perspective?
- How have regional and international legislation (directives / regulations such as EU RED and EPA RFS2) affected and are currently affecting the w / r Feedstock market?
- How do you see the supply and demand in the w / r Feedstock market?
- How do you expect the supply versus demand balance to evolve in the waste & residue raw material market in the future?
- How does the supply versus demand balance affect your actions as a buyer in the w / r market?
 - If demand exceeds supply, how do you react as a buyer?

THEME 2. Sustainability

- Is Sustainability important in sourcing waste and residue raw materials
 - if yes, why? / if not, why?
- What impact does sustainability have on waste & residue sourcing?

- e.g. impact on supplier selection,
 - e.g. impact on price and willingness to buy
 - other impact(s)?
- How do you ensure that the raw materials you purchase meet the Sustainability criteria?
 - How is sustainability monitored on behalf of the buyer in sourcing raw materials?

THEME 3 Sourcing Strategy

- Which factors are most important in creating a sourcing strategy for waste & residue raw materials?
 - How do the waste & residue market characteristics influence choice of sourcing strategy?
- How is sustainability considered in your sourcing strategy?
- What sourcing methods are available for waste & residue feedstock sourcing?
- What are the key factors influencing the choice of sourcing method?
- How significant is the sourcing strategy of biofuel feedstock for the renewable business / entire business of the case company?