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Aplicação da Teoria de Custo de Transação: O caso da Yser Green Energy SA

Transaction Cost Theory Application: The case of Yser Green Energy SA

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Dissertation presented to the University of Aveiro to fulfil the requirements to obtain the degree of Master of Economics, conducted under the scientific guidance of Dr.. Marta Ferreira Dias, Professor Auxiliar and Dr. Leonel Nunes, Professor Auxiliar Convidado of the Department of Economics, Management, Industrial Engineering and Tourism of the University. from Aveiro.

Aos meus pais e irmão.

“Nunca parto inteiramente
Vivo de duas vontades:
Uma que vai na corrente,
A outra presa à nascente
Fica para ter saudades.”
Manuel Cruz

o júri

presidente

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palavras-chave

Teoria dos Custos de Transação, Coordenação da Cadeia de Valores, Biomassa, Pellets, Agronegócios, Estrutura Organizacional

resumo

Adquirindo os efeitos benéficos ao meio ambiente substituindo combustíveis fósseis por pellets de madeira, este projeto visa, no contexto de um produtor de pellets, analisar os custos de transação de todo o processo de trabalho de todo o processo na empresa para a transformação de biomassa em pellets, desde a matérias-prima até ao seu processamento.
Este estudo analisa a cadeia de valor da empresa, aplicando a Teoria dos Custos de Transação e tentando entender se existe uma aplicação viável e quais os custos de trnsação presentes na empresa.
Os resultados deste estudo vão ao encontro de outros realizados dentro do mesmo tema, apoiando a viabilidade da integração vertical e a sustentabilidade da industria de produção de pellets.

keywords

Transaction Costs Theory, Supply Chain Coordenation, Biomass, Pellet, Agrobusinesss, Organizational structure

abstract

Acknowledge the beneficial effects on the environment by replacing fossil fuels with wood pellets, this study aims, in the context of a pellet producer, to analyse the transaction costs of the entire process of working the entire process for biomass transformation in pellets, from raw materials to processing.

This study analyses the value chain of the company, applying the Transaction Cost Theory and trying to understand if there is a viable application and what are the transaction costs present in the company.

The results of this study agree with others carried out under the same theme, supporting the viability of vertical integration and the sustainability of the pellet production industry.

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List of Acronyms

R&D – Research and Development

TC – Transaction Costs

TCT – Transaction Cost Theory

YGE SA – Yser Green Energy SA

1. Introduction

1.1. General Overview

The current economic model is mostly based on the exploitation of fossil fuels to produce energy. It is also assumed that fossil fuels would become, eventually, indispensable for the development of the world economy. Although this approach has proven to be functional, the extreme exploitation of the fossil fuels has increased the complex relation between economic growth and environmental degradation (Azevedo and Matias 2017*)*. To provide a more sustainable option, biomass arises as a raw material of renewable character that produces energy and may be managed wisely, unlike fossil fuels that are finite.

In order to provide an alternative perspective on the use of biomass and mostly, on the industry of biomass, we use the Transaction Cost Theory in the context of a production facility of biomass pellets; (the Yser Green Energy SA). On this company, raw material is turned into pellets that provide many advantages for the consumer. This was the location of my curricular internship.

In the past decade, some research has been made regarding the industry of bioenergy concerning the optimum choices of organizational structure to minimize all possible transaction costs. Downing et al. (2005), Overend (1993) and Atchison and Hettenhaus (2003) explore the choice of business structure regarding agricultural cooperatives or fuel industry. However, at the top of our knowledge there are no research on the application the Transaction Cost Theory to a specific industry considering the firm maturity stage considered in this dissertation.

1.2. Research Questions and Objectives

The purpose of this dissertation is, using the TCT, understand the form of internal organizational of an already-in-operation pellets producer company. The specific questions are related with the reasons for the chosen form of internal organization, the related efficiency and its performance. Our approach follows Altman et al (2007) on the methodology for the case study.

The specific research questions, using the TCT are the following:

1) What are the possible sources and origins of Transaction Costs and its correspondent tangible forms?
2) Which Transaction Costs are presented in YGE and which implication they have in their production?
3) How does the relation between producer and processor of biomass provides stability for the firm?

The objective is to firstly to identify types of transaction costs that can be found on YGE SA. The case of YGE SA present transaction costs in the context of a function company also considering the already structure of business practiced in YGE SA. A review of the relationship of YGE SA and the local producers of biomass is also explored. This is an interesting point to evaluate due to its overall importance as the producers assure the raw material that maintains the plant functioning.

1.3. Methodology

As mention previously, the methodological approach used in here, is a case study. Yin (1994) explains that case studies can be used in the context of organizational processes, organizational change, international relations between others.

In this case, a case study is used because it provides a guideline for the theory that we intend on applying and it achieves concrete results that we, as well intend to achieve.

We will present specific cases of transaction costs and its implications in the supply chain of YGE SA, by presenting the supply chain and further expositions via table.

The data used for this study was collected through multiple sources. In this case, data collection covers all available case-related information, including project documents, project meeting reports and those collected at various operational levels: interviews with workers in all departments and project staff; observation of the project site, observation of the production plant and overall function of the company as usual company procedures, field notes and altogether logic construct.

1.4. Yser Green Energy SA

Yser Green Energy SA, usually called YGE SA was stablished in 2011 and is a company dedicated to the conceptualizing, research and development of product and process technology, for torrified biomass production. YGE SA aims to strengthen its pioneering position in the development of biomass torrefation process, positioning itself in the international market as a supplier of integrated solutions for torrefaction and biomass pellets production, directed to companies in the energy generation and industrial sector. Attentive to market needs, it works to the growing satisfaction of its customers, seeking to develop innovative products of high-quality standards. Its strategy is accomplished every day, through the development of the biomass processing unit which operates under efficiency, economical and sustainable standards.

YGE SA localization is in Oliveira de Azeméis, integrated in the Business Reception Area of Ul – Loureiro. It has 13 workers in total. 10 factory workers, who work in shifts and are responsible for the operation of the production line, accompanied by a chemical engineer who functions as production manager; a chemical engineer who does quality control of the product and an administrative who deals with all bureaucracies and accounting. The overall view of the company can be seen in Figure 1.

Figure 1. YGE SA

YGE SA core business is the production of pellets. Initially, the production plant had a capacity of 5,718t /year (722kg/ h), however with investment and the adjustment of the production line, YGE SA can now produce 1.2t/ h, which reflects on an 8,336 t/year. In Figure 2. Bellow, its can be seen the production plant of YGE SA.

Figure 2. YGE SA Production plant

However, YGE SA also provides services to other pellet production facilities such as samples of varieties of pellets, analyses of carbon, hydrogen and nitrogen, analysis of microporous materials for gas sorption, thermogravimetric analysis (TGA) and ash temperature points. The laboratory can be seen in Figure 3. Bellow, where the analysis are conducted.

Figure 3. YGE SA Laboratory

YGE SA aims to maximize sustainable value creation, striving for excellence both at the business model level and at the level of products and services they develop, in permanent harmony with nature. YGE SA has based its strategy of value creation through the provision of biofuel products and technological solutions for producing torrefied biomass.

1.5. Dissertation structure

In the first chapter, an introduction is provided as a general overview of this dissertation, as well as the research questions and objectives are stablished. The Methodological approach of this dissertation is explored and a presentation of Yser Green Energy SA, hereafter YGE SA, a local producer of biomass pellets is presented.

In the second chapter, a theoretical background is provided regarding the Transaction Cost Theory, - where it is analysed the definition of TCT, the attributes that characterize the transaction costs and lastly, how TCT and organizational structures are related and why this relation so relevant. On this chapter we have also a more precise review of the integration of TCT in biomass supply chains and the biopower industry.

In the fourth chapter, we have a description of biomass use and characteristics as a raw material and biomass pellets as biomass pellets arise as a solution to replace the common fossil fuels.

Further there is discussion of results, conclusions and further suggested research.

2. Transaction Cost Theory

2.1. Transaction Cost Theory Framework

The Nature of Firms, by Coase in 1937 introduced a new concept that broke the limits of neoclassical economic theory and created a new concept of firm. The main idea was that, to truly understand what a company does and how it performs, we must firstly understand why companies exists and therefore, which factors determine the internal organization of economic activity and how companies relate to each other.

Coase (1937) also establish how the price mechanism applied within a firm. It states that price mechanism does not work for a self-sufficient business[1].

For Coase's (1937) a firm is a nexus of contracts. The firm exists as the mechanism that propels greater economic efficiency by reducing the costs of organizing and coordinating productive resources. These costs were later labeled as "transaction costs" and are the basis of the theory of transaction costs. This transaction costs would also include the costs of predicting prices, the costs of negotiation, the costs of predicting and specifying the details of a transaction in a long-term contract, as well as, the costs that arise from the physical act of the transaction and the costs of legally enforcing a broken contract.

Williamson (1981), describes efficiency as the basis of the transaction costs theory. It explains that, when understanding efficiency limits within a company, there are only two possible options – or the company produces the component itself or purchases the missing component from an outsider source.

Regarding the definition of TCT, for Richman and Macher (2006), Transaction Cost Theory describes firms in organizational terms rather than in neoclassical terms. It recognizes that for a scenario of positive transaction costs, trade or transaction, agreements must be "governed". The contingencies of a transaction must be organized and some governance models will be more adequate than others. For Williamson (1981, p. 552), "A transaction occurs when a good or a service is transferred across a separable technological interface. One stage of activity terminates and other begins. With a well-working interface, as with a well-working machine, these transactions occur smoothly."

Hobbs (1996) describes transaction costs as the costs of performing any exchange or transaction, whether being in a separable interface or between companies in a market. Transaction

[1] Is a self-sufficient business if able to provide for itself and doesn't need outsourcing in order to function.

Costs usually arise wherever an enterprise is, within a vertically integrated enterprise in a market or in a command economy[2].

In the table below (Table 1), there are presented some examples of transaction costs that Hobbs and Young (2000) explains that may arise before (ex-ante), during or after (ex-post) the transaction itself occur.

[2] Command economy refers to a system in where the government controls all angles of the nation's economy, such as businesses and housing.

Table 1. Types and Sources of Transaction Costs – Hobbs and Young (2000).

Sources and Origins of Transaction Costs and Their Tangible Forms		
Cost Type	**Cost Source**	**Tangible forms of Transaction Costs**
Ex-ant costs – Costs than arise before the transaction		
Search Cost	Lack of knowledge about opportunities; product research, prices, markets, demand, supply…	- Promotion costs, advertising, - Travel costs - Personal time cost
Screening Cost	Uncertainty about the reliability of potential suppliers / customers; Uncertainty about the actual quality of goods / services	- Consultancy costs or service fees; - Costs of Credit Rating Checks
During Transactions		
Negotiation Cost	Objectives and conflicting interests between parties involved; Uncertainty of willingness and willingness of other party to trade; Uncertainty of rights and duties in the contract;	- Licensing fees; - Insurance
Ex-post Costs – Costs that arise after the transaction is complete.		
Transfer Costs	legal, extra-legal or physical constraints to the movement / transfer of goods / services	- Handling / storage costs;
Monitoring Costs	Uncertainty about possible variations in the quality of goods / services; Uncertainty about performing "tasks" under quality assurance	- Audit fees; - Product Inspection Costs (Quality Assurance) - Investments in quality measurement methods
Renegotiation Costs	Updating contracting, Set up of new terms	- Legal fees

Williamson (1981) also defined the critical dimensions that would describe a transaction. Those critical dimension are uncertainty, the frequency with which transactions occur and the degree to which specific investments in durable transactions, are required to achieve the lowest possible cost. TCT is also based on two behavioural assumptions concerning the parts involved in the transaction itself: the actors have limited rationality and they may have opportunistic behaviours.

Richman and Macher (2006), defines uncertainty as the unpredictable changes that may occur surrounding a trade. It may also refer to unpredictable changes in the business environment. Uncertainty concerns with the risks of maladaptation.

Arrow (1974), as well as Koopman (1957), developed economic models explaining how uncertainty is incorporated into the decision-making process of economic agents and stressing the importance of information on drafting contracts.

Frequency, as the word indicates, refers to the number of times a transaction occurs and the fundament of its nature. The more often a transaction occurs, more dependent are both parts of the transaction itself.

The specific investments in durable transactions, are usually called specific assets and are mentioned and characterized by Williamson (1981) as the most important and more neglected dimensional factor that describes a transaction. Specificity of assets may be divided in three most relevant types: local, physical and human assets specificity. Local specificity should be studied before the implementation of the firm. It may rely on prior decisions aimed at minimizing storage and transportation costs.

When a determinant component of a producing process is required, physical asset specificity arise. It’s a very important factor to be considered in decision.

Human asset specificity defined by Pohlmann et al (2004) as the learning by doing process where the employer acquires specific abilities for the tasks required. In other terms, human assets may be defined by the degree that they are specific to the firm and, if possible, the ease with which productivity can be measured.

Pohlmann et al (2004) also explain that dedicated asset specificity arises when a supplier makes an investment that, except for the prospect of selling a significant amount of product to a particular customer, would not be made. For example, an investment from an auto parts supplier to serve a particular mechanic or car shop.

Da Silva and Brito (2013) mention Williamson (1991), about the possibility of more of asset specificity species to appear: brand specificity referring to the capital, neither physical nor human, that materializes in a firm's brand, being particularly relevant in the franchise world; and temporal specificity, in which the value of a transaction, depends mostly, on the period of time in which it is processed, being especially relevant in cases of perishable products.

Limited rationality is recognizing all possible transactions that can be organized efficiency through contracts.

Richman and Macher (2006), also mention Williamson (1991) when explaining opportunistic behaviour and how to safeguard both parties from it. They rely on select institutional arrangements in order to minimize the expected total costs of the transactions involved.

At a corporation level, Gulati and Singh (1998), state that trust plays an important role in creating alliances. It is suggested that firms with repeated ties, are more likely to form strategic alliances than to organize as joint ventures or minority equity unlike first time firms.

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2.2. Transaction Cost Theory and Forms of Organizational structures

This section aims to fully understand why transaction cost theory and organizational structures are so importantly correlated. TCT aligns individual transaction (who will differ in attributes, and in it differentiate asset specificity) in order to minimize costs and achieve a viable form of governance.

Masten (2000), describes organizations and institutions as, from the point of view of transaction costs, the means by which the parties try to regulate behaviour. The overall purpose being, to adopt arrangements of internal organization that promote efficient adaptation while economizing costs of achieving deals and solve legal disputes.

The figure below (Figure 4.), portrays some different factors that may be in play, when achieving a governance/organizational structure that would be better and costs saving:

Governance Scheme

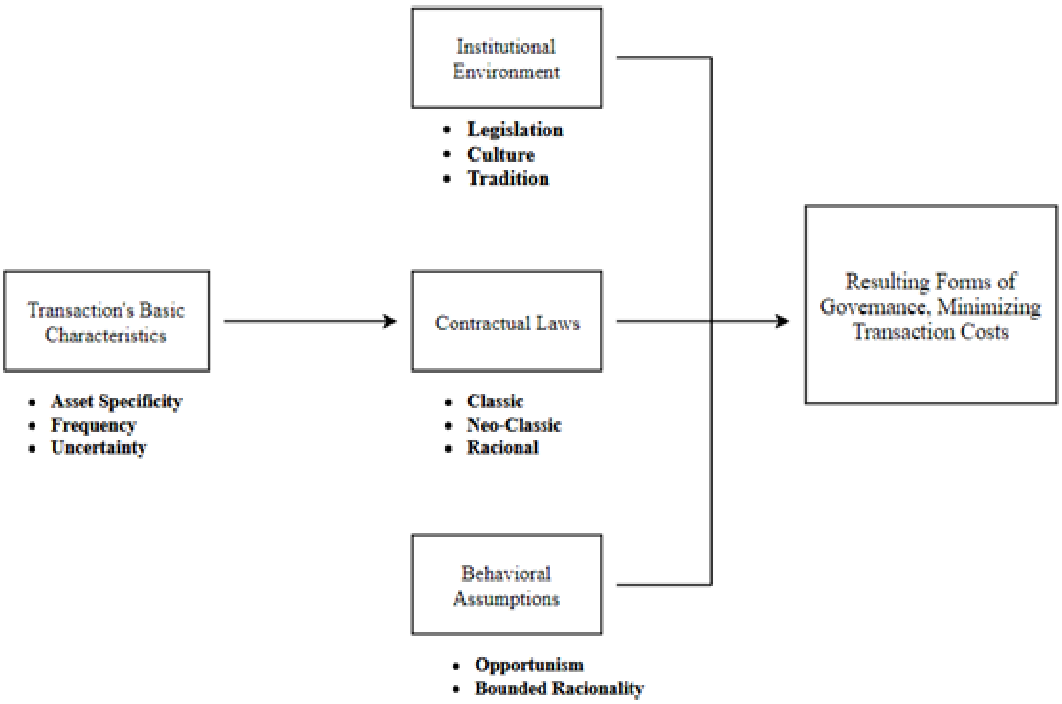

Figure 4. Governance Scheme - Zylbersztajn (1995)

Fundamentally, there are three governance structures labelled as cost saving. It can be via-market; via- hybrid forms and via hierarchical or vertical integration. The choice of how to choose the structure is based on the analyses of the attributes of the transaction mentioned above (uncertainty, frequency and asset specificity).

In order to make decisions, a pivotal problem arises in economic organization: the choice between markets and governance structures for the firm's decisions. Williamson (2008), states that the specificity of assets may be in first consideration. If the firm's assets are not specific, a market is preferable and provides more advantages and less costs in production. If the firm's assets are specific with tendency to increase specificity, the benefits of using a market decrease as the transaction costs rise.

Coase (1937), explained that organizational costs and losses by error will increase with the special conditions of a transaction. The internal organization costs will tend to be higher if the transactions are differential, either for its location or characteristics of its activities. In that sense, the costs or monitoring and managing employers will increase if the manager is not well adapted to the production process or if it is totally excluded from the local. The transaction will be more complex, when it's harder to describe and expose each responsibility and obligation of each party. It will also increase the costs of internal organization as it can aggravate uncertainty. This requires a closer look by the administration, so it is a progress and adapt process to possible circumstances changes.

Last but not least, Williamson (1985) recognizes as the main contribution of TCT, the relation of the limitations and costs associated with organizational alternatives, to the attributes of transactions in a discriminatory manner, which is to say, in a way that allows perspectives and hypothesis to be formulated and tested about the organizational form.

3. Agribusiness and Transaction Cost Theory

3.1. Supply Chain Coordination and Transaction Costs

This chapter consists on the literature review of the studies about the coordination between supply chains and the intent of minimizing transaction costs, which has aroused the interest of many scholars. The following part, interests in exploring the biomass supply chain and its relationship with the Transaction Costs Theory literature and how its development and approach can help make further long term (right) decisions. Many authors studied agro-industries that will help stablish some relations between the specific industry of biopower through biomass.

Generally, a supply chain is characterized by the shared links and process existent between a supplier and consumer. As Katz et al. (2003) explain, these links can vary from activities like the acquisition of raw material, to the delivery of the product to the end client. It starts when the raw materials enter the producing process of the organization, via supply chain system and proceed to become a finished product that will be supplied to clients through distribution. Several firms may be linked together in order to produce one single product, each adding value to one another and to the product as it moves through the supply chain. The shared set of value creating activities can go from product design, information procurement, production, processing, marketing and logistic services.

As described in the previously chapter, three of the most common forms of business organization are via-market; via- hybrid forms and via hierarchical or vertical integration. However, in the biopower industry that uses biomass as a raw material and as demonstrated by Altman and Johnson (2008), there are three main forms of business most commonly found:

- Vertical integration or internal supply: These involve the biomass producer integrating into the bioenergy production chain and in rarer cases, the energy producers are reversely integrated into biomass production.

- Outsourcing: System involving independent energy producers who buy biomass as fuel for their energy generation needs/independent biomass producers. This category includes both the use of spot markets, formal contracts and informal contracts.

- Internal and external procurement/sourcing combination: This option involves the company that purchases from both internal and external sources.

Richman and Macher (2006) explored other studies that have applied the TCT at its central problem. They mention Allen and Lueck (1992a, 1992b), that studied the use of simple short-term contracts in agribusinesses. Allen and Lueck (1992a, 1992b) reflect on the simplicity of said contracts, giving it comparative advantage of enforcing contracts through the market. The use of simple and informal contracting is supported by the good characters of agricultural economy such as its good reputation information, the relatively low transaction costs, the immobility of farmers and the desire of maintaining good long-term relationships.

In its assessment Overend (1993), considers spot markets and short-term contracts more efficient and concludes that spot markets should be developed in areas where independent biomass producers sell their products to other independent biomass processors. It provides characteristics of the bioenergy industry but does not fully suggest a highly vertical system. It states that the industry should rely more on contracts, markets or spot markets for fuel purchases, at least. It argues that industries should have short term purchases or use the spot market for fuel purchases due to the instability of fuel prices.

Klass (1998) leans over industrial organization, while reporting strategies regarding storage and shipping that were contrary to industry developers. It recommends horizontal and vertical integration and clarifies that not only should there be a unified ownership along the supply chain of biomass production and bioenergy processing, but also producers of biomass should be more integrated in the process of bioenergy. It also points out that these industries could be way more developed if organizational problems could be avoided.

Masten (2001) studied agricultural transactions as well, presenting a wide range of governance structures mentioning the temporal specificity that may arise from agricultural perishable products and the specificity of the nature of investments required. The author also describes the several links in vertical integration supply chains, where he includes research and development, production of raw materials, various stages of intermediate processing or assembly, packing, transport, storage, marketing and distribution.

Altman et al (2007), mention another study by Atchison and Hettenhaus (2003) where it is discussed a one-pass harvesting system where biomass residues are collected with grain harvesting. The processing plants for this biomass, should be located near waterways to use maritime transport.

Downing et al., (2005) also recommends vertical integration and uses agricultural cooperatives as an example of research, financing and exchange mechanism. Specifically, cooperatives of biomass producers and organization of biomass exchanges. It measures the performance of agricultural performances through an exam of structure, strategies, business methods and response in business environments. The study also suggests that there is potential for these operations with the increase in biomass feedstocks for bioenergy, especially in rural development.

Altman and Johnson (2008) studied the bioenergy industry in the U.S.A and characterizes it by being highly vertically integrated. Three-quarters of the firms also rely on vertical integration to purchase fuel instead of trying to predict of spot markets prices. Altman and Johnson (2008) have also claimed that future biomass-based industries may be heavily vertically integrated, due to the disruption of the organizational forms that require fuel. These authors leave a warning note on using different methods of outsourcing, as short and long term contracting. Joint ownership and strategic alliances are also considered mechanisms for acquiring biomass from external organizations. In this same study Altman and Johnson (2008) found that about 75% of the biopower industry (used in their sample) in the U.S.A is vertically integrated, either between biomass production or biopower production stages. Bioenergy companies that would base themselves after biopower plants have also the possibility of being highly vertically integrated.

Altman et al (2007), regarding the cellulosic ethanol industry, have found that processors are exploring hybrid forms of organizations for the future, with the use of custom contracts for harvesters and delivery and formal contracts with biomass producers. Short term and long-term contracts are also alternatives to spot markets and vertical integration.

3.2. Inspired by Transaction Costs

The most fundamental paper for our research is a great example on the alliance of TCT and biomass supply chains. Altman et al (2007), aim to understand the most appropriate organizational choice for future and emerging cellulosic ethanol industries and their stable development. This research explores an emergent new industry through the lens of transaction cost theory.

The article shares the Case of Iogen Corporation, a Canadian biotech company, that has internal research units to produce cellulose-based ethanol from corn husks and straw. Iogen uses an enzymatic hydrolysis process that produces sugar from the cellulose and hemicellulose that the biomass portions provide. Later, the sugar is fermented to produce ethanol.

In this specific case, this paper discusses the location of the first cellulose-to-ethanol plant of Iogen and provides this analysis through TCT. The main concern is providing the raw material to fully explore the capacity of the new plant, based on an efficient supply chain.

First, the case study explores the preferable sites of location of the plant, having in consideration the three main production farmers already linked to the firm, which are either in Canada and Idaho with the intention of building a processing facility at one location, depending on government-level financial incentives.

Iogen uses standard production contracts with individual farmers. they provide an option of 5 to 6 years of purchace and when Iogen decides to invest, the other contracts with other farmers, will eventually expire.

Next, the point of view of farmers is explored and explained that the price of the raw material is usually either a fixed price or variable, if tied to the price of fuel or crude oils.

In Iogen case, there is a “extra” step to the supply chain; the farmers produce the raw material however the harvesting and delivery of the raw material are contracted separately. This requires having two different set of contracts and relationships for farmers and for harvest and delivery. Another option provided by the authors is to have the harvest made by the producers but delivery separate. However, this will create considerable costs, due to the area of land required and the bulkiness, collection, storage, and long-haul transport of the feedstock. The company that provide harvest and delivery will have the need to invest in specific assets as the location of the hay or straw producing are not traditional or typical. Therefore, the harvester and deliver will invest in high specificity assets and will require long term contracts.

The authors recognize the asset specificity in Iogen Corporation leads to its choice to pursue long term contracting. When dealing with delicate products and modified enzymes, the feedstock is required to have a certain quality. Adapting the enzymatic process to different kinds of feedstock of biomass would highly increase costs on reformulating the enzymatic process. So, Iogen would benefit from long-term contracts even to minimize the higher administrative costs. Nonetheless, a viable alternative pointed by the authors may be using the use of low-cost spot markets for its flexibility.

The low asset specificity of the farmers moves them towards the flexible and low-cost spot markets while TCT suggest that long term contracting should be developed between Iogen and custom harvesters. The authors suggest that presented these factors, the development of a spot market for straw, where custom harvesters buy the straws on the field and sell them on long term contracts to Iogen. It is also stated that the continuous development of technology can alter asset specificity and therefore it may change internal organizational structure.

Lastly, Altman et al (2007), justifies Iogen choice of long-term contracts with both farmers producers and harvesters, since harvesters will have to invest on asset specificity and will most likely also prefer long term contracting. It is important to remember that biomass-based producers may prefer spot markets and the supply chain may evolve to a spot market for field-based straw farmers and long term contracting between harvesters and the firm.

4. Raw Material and Final Product

4.1. Biomass in Europe and Portugal

The increasing demand of biomass worldwide as brought up some concerns about the availability of this raw material and how it may be managed in a sustainable way. The European Union is one of the largest consumers of biomass, consuming more than 1 billion tonnes of dry matter biomass per year. 60% of this biomass is used in the food and feed industries, 19.1%for bioenergy and 18.8% for biomaterials (Camia A. et al, 2018).

The largest sector for both domestic supply and trade is the agriculture sector with 65.5%, along forestry (34.2%) and other marine-based sectors (0.4%). In agricultural production, the residues correspond to about 46% of the harvested product.

In the European Union only, close to 800 Mt in dry matter biomass is harvested and used, every year. From this biomass, 578 Mt are from agriculture, 227Mt from forestry, 1.5Mt from fishery biomass and 0.03Mt from algae.

The land-based biomass, agricultural and forestry sectors, represent about 1500 Mt of biomass produced in the European Union; 1000 Mt for agricultural biomass and 500 Mt for forest biomass. Forest biomass, however, may not all be harvested as a third of the remaining wood produced in a year continues in the forests to maintain certain ecosystems and the carbon sink (Camia A. et al, 2018).

Forest biomass is at greater focus since it is the source of raw material of YGE, SA. The sustainable management of forest resources and forest waste is a central problem in the discussion of sustainable development and the biomass industry (Borges et al, 2007). The management of forests contributes for economic and social development. It reduces the risk of forests fires and the development of rural areas providing new job creation. External factors may also affect the exploitation of forests, direct or indirectly, such as technological advances, consumer preferences or trends, natural disasters or political considerations (Päivinen et al, 2010).

Since the 2000's, the total stock of forest biomass in the European Union has been increasing. From the 160 million hectares of forest available, about 134.4 million hectares are available for wood supply, as observed in the Figure 5. below.

Total Forest area in 2013 in EU-28

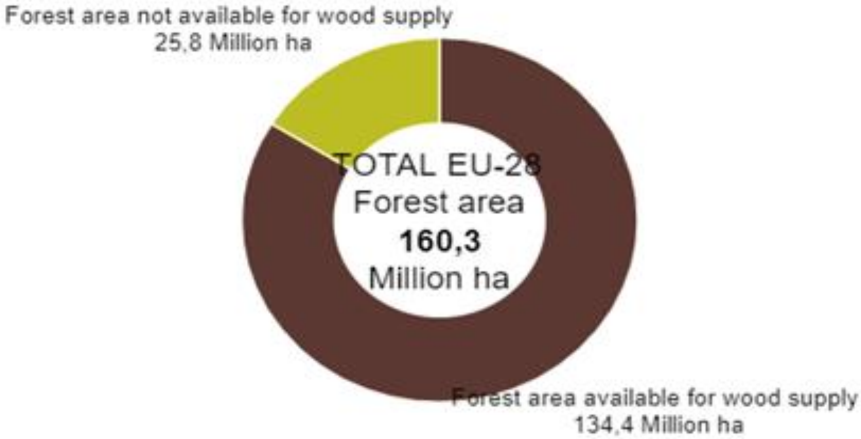

Figure 5. Total Forest area in 2013 in EU-28
Source: European Commission[3]

In this regard, Portugal has a total forest area of 3.2 million hectares, of which 2.11 million hectares are available for wood supply, and about 1.09 million hectares not available. For this study is important to mention the Above-Ground Biomass, since it is the primary source of raw material for YGE, SA. Above-Ground Biomass includes only growing stock, with a minimum 15cm height and a minimum of 9cm top diameter (Camia A. et al, 2018). In Portugal, this source of biomass represents about 106 096 thousand tonnes of dry matter, while other wood components and forest residues represent about 62 392 thousand tonnes of dry matter, which reflects the low availability of this resource and reinsures the sustainable development of the forestry sector in Portugal. Monteiro et al (2012), stablish that the greatest potential for pellet production in Portugal would be agricultural residues as the production of corn. However, the difficulty in harvesting and the uncertainty in quantification of this kind of residue, mitigates the interest of the pellet sector.

Nearly half of the use of forest biomass in Europe represents energy production (48%), with the consumption and use of wood pellets increasing. The remaining 52% of woody biomass is for material uses (Camia A. et al, 2018).

In Portugal, the electric energy production from biomass has been increasingly over the years. As the graphic below shows, since 2010 there has been a steady growth in the production of electric energy from biomass. This can be observed in Figure 6.

[3] **https://ec.europa.eu/knowledge4policy/visualisation/forest-area-2013-eu-28-availability-wood-supply_en**

Electric Energy Production from Biomass in Portugal (Gigawatt-Hour)

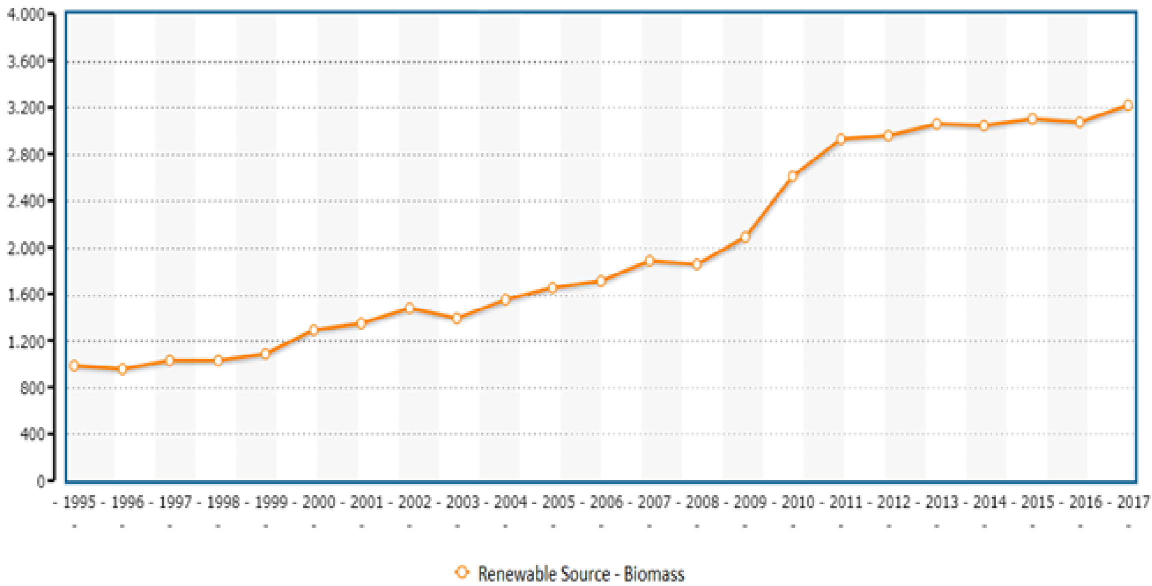

Figure 6. Electric Energy Production from Biomass in Portugal (Gigawatt-Hour)

Source: PORDATA[4]

The main objective of Portuguese energy policy is to minimize energy dependency and reduce greenhouse gas emissions and there is a growing use of renewable energy resources. Thus, forest biomass is increasingly becoming a viable alternative for energy use in Portugal, where part of forest biomass is already used for energy use in industries such as pulp production, particle board production and biomass production. densified for energy purposes (briquettes and pellets) (Nunes et al, 2016). However, it should be noted that the mobilization of new processing technologies is a key factor for the widespread use of biomass as an alternative to fossil fuels, where it is necessary to assess the economic viability of supply chains and supply thereof.

There are numerous advantages in Portugal for the use of biomass as an energy source, including a reduction in external dependence on the importation of fossil energy products to replace the use of renewable and endogenous resources and the development of the Portuguese economy, creation of new jobs and the reduction of CO_2 emissions and other pollutants.

Jäger-Waldau et al (2004) characterizes biomass as non-fossilized and biodegradable organic material originating from plants, animals and microorganisms. Includes products, by-products and wastes from agriculture, forestry and related industries, with non-fossilized and biodegradable organic wastes from municipal and industrial waste. Biological waste includes "biodegradable garden and park waste, household food and kitchen waste, restaurants waste and retail stores, and comparable food processing plant waste.

[4]**https://www.pordata.pt/Portugal/Produ%c3%a7%c3%a3o+de+energia+el%c3%a9ctrica+total+e+a+partir+de+fontes+renov%c3%a1veis-1127-9118**

Dias (2002) refers to biomass itself as a fuel who has many relevant properties such as ease of drought, high calorific value, low ignition temperature, high volatile content, high combustion rate and low activation energy. These properties can be influenced not only by the type of fuel, but also by the properties of the furnace.

Looking at the benefits of using biomass, we may consider its renewable energy character. Prando et al (2016) also consider that sustainable development of biomass production and exploitation, may contribute to a better forest management and therefore, reduce the risk of forest fires, as well as, the creation of new green spaces and creation of new jobs. Using biomass as an energy source can help develop the economy of many countries by reducing external dependence on other fossil energy products, reducing their imports and developing sustainable resources. The environmental advantages are great because the use of biomass as a solid fuel for combustion will help to not increase CO2 emissions to the atmosphere compared to the use of fossil fuels.

For Nunes et al (2015), the disadvantages include the release of environmentally harmful gases that may be present in biomass and the high costs of biomass production, collection, transport and treatment, as well as the maintenance of regional biomass availability and the problem of compensation of the resources involved.

The use of biomass for calorific value is the oldest and most common use for biomass. Energy recovery from these materials can be accomplished in several ways such as direct burning without any processing of the raw material, through chip burning systems in which the raw material is pre-ground in the raw material and by the manufacture and Burning wood pellets. Biomass, however, can be converted in three different ways, which can later supply fuels to the energy industries, generate electricity, etc. Biomass can be converted to physical form (physico-chemical conversion) Physical-Chemical conversion and biological conversion. In physical form we can find splinters, densification and pelletization that are considered solid biofuels. Within the Physical-Chemical conversion, there is pressing, extraction and chemical treatment - this will be liquid biofuel. Torrified Biomass can then have several uses in different industries, as observed in Figure 7.

Biomass Supply Chain and its Applications

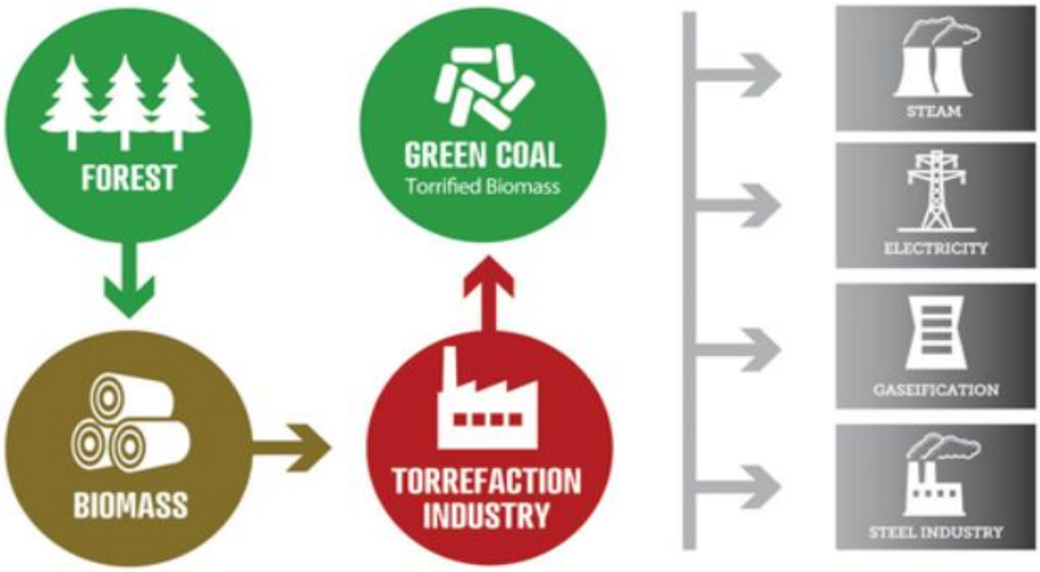

Figure 7. Biomass Supply Chain and its Applications
Source: YGE, SA Website

Nunes et al (2015), also explore the opportunities and advantages of using biomass in the textile industry and mention economic advantages applicable to many other industries where conversion technology is possible. Replacing one fuel with another involves technological aspects, whether properties of the fuels themselves, especially their physical state, their calorific value, the characteristics of their combustion, the supply logistics and how they are stored. These aspects decisively influence the viability of replacing fuel, traditionally used in industry by biomass. Increased demand for biomass may develop the need for a larger forest area thus promoting the use and exploitation of abandoned land, more efficient forest management for energy purposes and preventing forest fires. Forest sector development involves job creation, promotion and stimulation of the local economy and contributes significantly to the promotion of an endogenous renewable natural resource, creating conditions for the settlement of populations in rural areas and combating rural land abandonment.

Regarding social responsibility, the adoption of environmentally friendly policies is practiced by many biomass firms raising awareness towards the community where its insert and transmitting an image of responsibility and social concern reinforcing bounds and relations with communities.

Even though the technology for the use of biomass as a raw material is at long existing in Portugal, due to the economic international crisis is very difficult for companies to achieve credit or sources of financing which limits many possible entrepreneurs into investing or pursuing this industry. All the technology necessary to burn biomass is Portuguese being importation would not be required reducing logistic costs.

4.2. Wood Pellets

Pellets are biofuels that can be produced from agroforestry residues such as sugarcane bagasse, sawdust and wood shavings. They are compact biofuels that have low humidity, allowing high combustion efficiency, standing out for being a natural product with easy handling and high energy density (Garcia et al, 2016).

Wood pellets, considered to be a more accessible transport for renewable energy, associated with very low greenhouse gas emissions, are made of densified wood waste. Due to their high energy density, which is 4 to 10 times higher than wood waste, wood pellets form an efficient form of biomass to store and transport.

Wood pellets have the advantage of ensuring low emission of volatile compounds while having efficient combustion. In addition, ease of transport between producers and consumers (Berghel et al, 2014).

The process of pellet production, regardless of its high initial cost, can be very profitable and it has relatively low-cost raw material. When in proper operation, the regular wood pellet process involves several stages such as drying, hammer milling, pellet pressing, fine screening and storage.

Nunes and Azevedo (2018), demonstrated that with the use of a Lean model in the biomass sector, more specifically in biomass pellets, companies gain competitive advantages derived from the reduction of production times and costs. The Lean model consists in eliminating or adapting unnecessary activities that are not working in the best way. This model cuts across production times and costs in order to increase quality and response to customer needs. It presents pellets as a viable alternative to sustainable energy; it creates jobs and local wealth.

The model of producing pellets has been built to be functional, small scale and to provide the desired finished product.

Another process under study and testing is the introduction of a torrefaction phase. Torrefaction is a heat pre-treatment process that consists of upgrading the raw biomass to a denser energy fuel. The purpose of roasting is to destroy / corrupt the fibrous structure and persistence of biomass; It converts biomass feedstock that is uneven into a consistent homogeneous bioenergetic material. This step increases the potential of wood pellets, facilitating storage and transport, and improves the durability and strength of pellets, making them less likely to disintegrate, giving them hydrophobic characteristics. The benefit compared to wood pellets include higher percentages of co-combustion, reduced handling and transportation costs, lower sensitivity to degradation and better grinding properties (Adams et al, 2015).

To increase pellet use and competitiveness as a sustainable fuel, pellet quality and durability are extremely important. Product handling and delivery are as important to the production process as any other step. The quality of pellets may also be affected by the quality of the raw material.

Because wood pellets are easily breakable and their process creates dust that is combustible and explosive, they are suitable for small stoves in power plants as well as for domestic use as they do not need proper distribution networks.

Regarding the domestic pellet market in Portugal, Nunes et al (2016) states two major difficulties to surpass. First, the limitation of biomass resources (and production of biomass) to the production of pellets. Second, convinving samll scale clients that pellets are a viable alternative to other fuels.

5. Discussion of Results

5.1. Transaction Costs and its sources at YGE SA

This part aims to answer the first question proposed in this study and one of the main issues in the methodology case. - Which are the sources of transaction costs and how to avoid them (at a long term)? -.

Firstly, it is important to explore the location of YGE SA. Even though the decision was made before the installation of the facilities, it is interesting to explore why YGE SA choose Loureiro, Oliveira de Azeméis as its location. In the district of Aveiro alone, there are two logging cooperatives that could supply YGE SA, both located at 30km from YGE SA. Since producers of raw material collect from diverse forests where they grow Pinus, the shortest this distance the better. Also, the easiness of access to highways both for Portugal distribution and selling and international markets was a main factor on location decision. The location was also selected due to the possibilities of the expansion of the facilities due being part in a recent Business reception area. This business centre is also the best location for new (industrial) clients.

Oliveira de Azeméis, is a very industrial zone. Human labour was not a difficult resource to achieve as the employers usually have already experience in heavy machinery, driving forklifts as well as, in a general production environment. Some tasks include cleaning equipment and ensuring stable operation of the production line.

Yser Green Energy SA location, Loureiro, Oliveira de Azeméis facilitates the supply of raw material, land rotes for distribution and maritime transportation, as stated by Atchison and Hettenhaus (2003) which are very relevant to a successful plant location. Since YGE SA produces 5.718t/year, it requires a supply of 11.436t/year of raw material hence long-term contracts will be preferred as long-term beneficial relation is mutual.

On the other hand, hiring specific knowledge may be a challenge. Those may be more interested in working in big urban centres.

In this case it is possible to try and observe possible ex-post costs that may be present. In the Table 2. below may be found an overall look of ex post costs present in YGE SA.

Table 2. Types of Ex-Post Transaction Costs Present at YGE SA.

Note: own elaboration, based on knowledge acquired by the experience on the internship.

Costs	**Source of costs in YGE SA**
Negotiation costs (common during transactions)	- Insurance costs for employees; - Product licensing fees. - Costs that can arise from the uncertainty of commercialization – both when YGE reaches spot markets (and may not be sure of the quality of the services or goods) and from clients that may bargain for the lowest price.
Transfer Costs	- Costs of storing product or reusable materials such as big bags and pallets. - Transport costs.
Monitoring Costs	- Costs of controlling product quality, noise level and overall safety measures for employers' wealth. - Audit costs as well.
Renegotiation Costs	- May occur when contracts are expiring (both within suppliers or costumers and employers of YGE as well), and/or as a loss of opportunity cost by lower past decision making.

Some of the ex post costs mentioned above may translate into some concrete situations. First, the trading costs that may arise from using spot markets. At the fuel level, for example, YGE SA had initially chosen a local supplier, which owned a gas station, with the intention of extending this relationship. However, despite the accessibility, local proximity and availability of delivery, the prices charged did not support the low delivery costs. Therefore, YGE SA preferred to purchase fuel from spot markets by selecting and researching potential suppliers with whom it would later contact.

YGE SA has a small capacity building and lacks a large warehouse in its proximity that could provide storage for bigbags or pallets. In some rare occasions YGE SA had to rely on the outsource of an external warehouse with the intention of storing materials that were not in use but can be damage by climacteric conditions.

Monitoring costs are also very relevant for YGE SA. Monitoring helps create a safe environment for workers. Since, the workers are for longer periods of time, under the noise of machinery that ensures the production process, tests must be done annually to verify that the level of noise does not affect workers in the long run. Workers, in turn, are equipped with all necessary safety materials such as gloves, earplugs, protective boots, helmets and clothing that is appropriate to the heat of the production line as well as the cold that may occur. All these purchases were insured by the department of hygiene and safety at work.

When approximating the end period of a mutual benefit contract both parts tend to want to extend the relations. In some few moments, when reaching the end of contract YGE SA must evaluate the benefits inherent to the contract and if they are viable or not. If not, it should and try to renegotiate the terms having in consideration that if it’s a benefice relation, it has no interest in losing the other part.

5.2. Relationship Producer/Processor and YGE SA Supply Chain

In order to fully understand the core of the relationship between producer and processors of biomass (in the case specific of YGE SA), it's important to explore YGE SA supply chain. YGE SA does not include in its co-vertical integration of pellet production, the production and harvest of raw material.

YGE SA receives raw material in the form of logs, without leaves, burnt wood or other forest residues (these would affect the colour and quality of the pellet) and, as a long term investment decision YGE SA acquired a machine that will shred the biomass into chipped biomass – ready for the process of biomass into pellets.

YGE SA purchases each tonne of Pinus logs at a 34€/t to 36€/t, but if purchase already shattered each tonne of shatter biomass would come up at a 50€/t, being this very reasonable difference in the cost of raw material enough to reach vertical integration.

The supply chain of YGE SA includes processing of raw material, intermediate assembly or maintenance, packing, transport, storage, marketing and distribution, as well as Research and Development. These are also on accordance with the links described by Masten (2001) in vertically integrated supply chain in agrobusiness. The primary activities of YGE SA may be observed in the Figure 8, as well as the pelletization process in accordance with YGE SA production, in Figure 9. YGE SA is actively integrated and adopted the distribution in small pre-packaged stock - 15kg bags and big bags.

YGE SA Primary Activity: Reception of Raw material

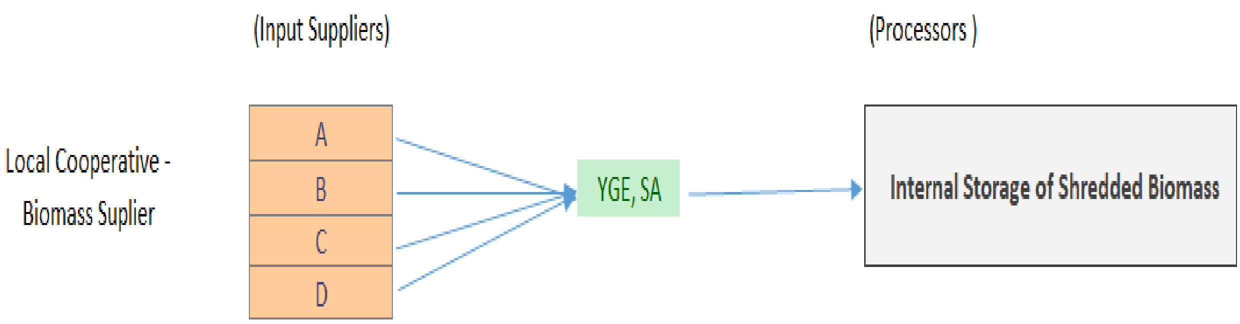

Figure 8. YGE SA Primary Activity
Note: own elaboration, based on knowledge by the experience on the internship.

YGE SA – Line of Processed Biomass

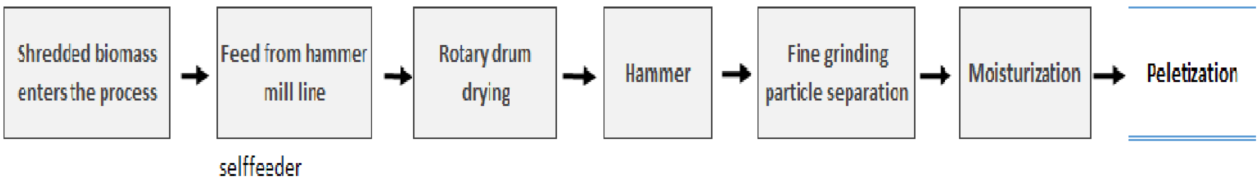

Figure 9. YGE SA Pelletization Process
Note: own elaboration, based on knowledge by the experience on the internship.

To assure the well-functioning of the pellet production line, a firm relation must be well stablished with the suppliers of raw material.

In the Table 3. below, an overview of this relationship can be observed:

Table 3. Relationship structure between YGE SA and Biomass-based Cooperative.
Note: own elaboration, based on knowledge by the experience on the internship.

<table>
<tr><th colspan="3">Relationship between producers and processors of raw materials</th></tr>
<tr><td colspan="2">Producers</td><td>Processors</td></tr>
<tr><td colspan="3">1) Contractual Perspective</td></tr>
<tr><td colspan="3"><u>Objective of the transaction</u>: To assure the quality of the raw material from the moment of harvest until respective transportation to YGE SA installations</td></tr>
<tr><td colspan="3">2) Transaction Attributes</td></tr>
<tr><td>Asset specificity</td><td>Relative to high</td><td>- Abundance of raw material
- Specificity of only Pinus or acacia slows supply
- YGE SA invested in a chipper which facilitates producers process and enlarges the range of suppliers available</td></tr>
<tr><td>Frequency</td><td>High</td><td>- Transactions occur on a weekly basis, in order to produce YGE SA must receive raw material at a constant paste.</td></tr>
<tr><td>Uncertainty</td><td>Relative</td><td>- Main supplier is a biomass based cooperative – there is supply of raw material, but it varies depending on the price YGE SA is willing to pay.</td></tr>
<tr><td colspan="3">3) Governance</td></tr>
<tr><td>Implicit contracting process</td><td colspan="2">It manifests by the will of continuing mutual benefit contracts.</td></tr>
<tr><td>Governance expected structure</td><td colspan="2">Integration Co-Vertical by YGE SA – Producers supply raw material in bulk (logs) – first process phase by YGE SA (chipper)</td></tr>
<tr><td>Governance expected structure</td><td colspan="2">Bilateral dependency – few biomass-based cooperatives/ local producers – price may be slightly inflated</td></tr>
<tr><td>Implication</td><td colspan="2">There is an overall need and desire to assure stable relations with biomass-based cooperatives to ensure the supply of quality raw material.</td></tr>
</table>

The overall relationship between YGE SA and the biomass based cooperative works well. YGE SA sets the maximum price to the biomass cooperative, that then informs producers of the prices being practiced at each company. Depending on the price, producers choose to deliver raw material or not. YGE SA uses this as a strategy to control the supply of raw material, by increasing the price when in need of supply and lower the price when it has enough stock to process for a few weeks.

YGE SA choose to work with this cooperative for its trustworthy reputation and for being a mark in forest-based industries in Portugal.

YGE SA business structure/governance can be described as vertical integration and hierarchical since that the process of treatment of the raw material is at YGE SA, with the outsourcing of raw material (through an agricultural cooperative) and the occasional use of market spots, integrated with short-term contracts. The supply chain relies only on the supply of biomass, in this specific case Pinus logs, being the following process of the treatment of the raw material, all in the installations of the YGE SA, as well as the arrangement of transport and logistics companies that assured the transport of the product to clients.

The case of YGE SA is in line with previous studies on agribusiness organizational structures. Overend (1993) suggests a not fully integrated vertical system where the industry relies more in contracts or markets for fuel purchases. YGE SA integrates almost every phase of its process except the production of raw material with the occasional use of spot markets and short-term contracts, not only for fuel, but other maintenance services which require human specific knowledge.

YGE SA choice of business structure also goes in line with Downing et al., (2005) suggestions as its recommended a vertical integration with the use of agricultural cooperatives as examples of research, cooperation, financing and exchange mechanism, with special regard to an example of a case like YGE SA and cooperatives that provide biomass and the organization of this exchanges.

5.3. Impact of TC on performance

Finally, the final purpose is to identify the transaction costs that may rise from problems or inefficiencies that many times YGE SA may not control. Some of these situations may be managed previously in order to avoid further implications. The cases mentioned below are identified as a result of the experience in the internship.

The solution for these problems namely technical aspects, process line temperatures and malfunctions and so on, are a constant study of trial and error in order to progress in the right direction. Others are harder to predict but easier to solve. Table 4. describes transactions costs and its implications in production.

Table 4. Transaction Costs and Implication on the process line.
Note: own elaboration, based on knowledge by the experience on the internship.

Transaction Costs and implications on the pellet production value chain, YGE SA

Problem / Inefficiency	Transaction Costs Source	Implication
Over production	Asymmetric information	- Excess stock; - Lack of local storage
Climatic Conditions	Limited Rationality	- Affects raw material collection, delivery and quality; - Affects raw material (higher weight, higher production costs / + burner energy) - Yield is affected - Impaired pellet quality when in contact with water - possibility of defective product due to weather conditions
Packing material / parts or processors	Asset specificity (physical asset specificity)	- High costs / high maintenance costs
Process malfunctions / Temperature variations	Asymmetric information	- Quality / Durability Variations - Forced stops - Low productivity due to slowing the process to cool
Technical Specifications / Machinery & Tooling	Asset specificity (physical asset specificity)	- Difficulty finding domestic suppliers with prices matching European suppliers - Difficulty finding blacksmiths (specific knowledge)
Low control in the process of delivery of raw material	Opportunism and asymmetric information	- Quality may be compromised
Few biomass processors for pellet production rationality limited	Limited Rationality	- Quality variations within the national suppliers

Overproduction it is not an event that occurs often. The final market for YGE SA, allows for the product to constantly being sold and replace with new. However, there are some predictions on sales that later may not be fulfil.

The lack of a nearby space where YGE SA can storage its product, as already mentioned, also adds to the previous issue and creates a problem with increasing transaction costs. Not only YGE SA cannot over produce its capacity as it may be very difficult supply to multiple clients at the same time.

Some weather conditions need also to be assured concerning the output of YGE SA. Wood pellets are durable and resistance, but they request to be stored in a low humidity place. Water directly affects the quality of pellets, as they disintegrate when in contact with too much humidity or water.

Regarding the raw material, we also have some weather restrictions, because wet wood is heavier and may increase production costs due to the rising on the drying time in the burner.

The high specificity of the machinery and the high costs of maintenance are also factors to be consider in firm decisions. Structure like the matrix, bearings and covers must be replaced after 400 hours of use, which requires continued investments in upgrading the production line and researching how to increase the durability of these components. In the last year, YGE SA has been trying to find new solutions regarding the maintenance of the technical components however it has found a few setbacks that have forced stops and gone back to previous suppliers.

Even though all suppliers may be found in Portugal, YGE SA has reach in a few occasions to international suppliers, whose prices (both the products and delivery prices) are more competitive.

Regarding asset specificity, YGE SA choose to invest in the primary phase of processing the biomass, making a viable long term investment that decreases not only the costs of raw material due to its "raw state", but increasing the range of suppliers available in the preferable location for the plant. Unlike Iogen Corporation who has made the choice to have to separate contracts with producers and collectors of raw material (which in that case proved to be more viable), YGE, SA has only a contractual relation to manage, investing only and maintain and build a prosper relation with the cooperative.

In the process line, YGE SA doesn't have the same problem regarding human knowledge as Iogen; which is a highly technological process, while YGE SA is a more mechanical process in which the workers have also acquired knowledge.

The R&D department adds another dimension to YGE SA as the quality control management is assured. The investment was made in specific knowledge and laboratories facilities who provide outsourcing of laboratory services such as overall quality analyses, ash density, calorific value, testing of new pellet qualities for other industry companies or the like. The torrefaction process already was explored in the company, as it is a pillar of R&D.

As any other company YGE SA suffers at time of some limitations. The constant need of verification and maintenance of processing machinery and other mechanical components which have a period of utilization, increases costs and can reflect in forced stops, in the production quality and quantity which may cause stock break.

6. Conclusion

Overall, YGE SA structure matches the research presented in this study. By integrating Transaction costs through vertical integration YGE SA, reaches reduction of external dependency and environmental uncertainty, easier information gathering, easier supervision and improvements on authority and process levels.

Within the biomass industry and relevant assets, YGE SA covers storage, transport and processing of biomass facilities. This creates openness to build a strong relation with biomass producers which is perpetuated by the willingness of maintaining beneficial relations.

The biomass sector is affected by economic variables that change according to current circumstances like fuel price, agronomical and technological factors, which YGE SA achieved to minimize including Research and Development in its supply chain, another valuable decision regarding minimizing Innovation expenses at a long-term.

One suggestion for the improvement of YGE SA organization, would be to invest in more marketing and distribution to physical stores, solutions that would increase the awareness and consequent name and reputation of the company – it could overall, raise awareness of the pellet market to the common consumer exposing the long-term economic viability.

Internationalization could also be a more explored solution (since it already exports to Spain), as the Portuguese market its still maturing and growing awareness to pellets uses. Exploring the possibilities of YGE SA internationalization through the lens of Transaction Costs Theory would also be a good subject case for future studies.

This study was partially limited by the lack of other articles and studies that draw a clearer perspective on a more direct approach to the application of this theory. The methodological base article, although appropriate to the theme, focuses on a different time scenario than the one addressed in this case.

The study is also limited to the daily context of the company during my internship and the results obtained are based in part on my observation and interpretation of the company's workings.

Agricultural economists should work closely with agribusiness leaders to overcome the supply chain and other economic and organizational barriers faced by the biomass production and processing sectors.

Scholars should interpret the remaining gaps in these sectors as an opportunity to participate in the evolution of the agricultural sector within developed economies.

References

Adams, P.W.R., Shirley J.E.J. & Mcmanus M.C.. (2015): "Comparative Cradle-to-gate Life Cycle Assessment of Wood Pellet Production with Torrefaction." Applied Energy 138 367-80. doi: 10.1016/j.apenergy.2014.11.002.

Altman, I. & Boessen, C. & Sanders, D. (2007). Applying Transaction Cost Economics: A Note on Biomass Supply Chains. Journal of Agribusiness. Vol.25. Page 1-8. doi:10.22004/ag.econ.62290

Altman, I. & Boessen, C. & Sanders, D. (2007). Contracting for Biomass: Supply Chain Strategies for Renewable Energy. Southern Agricultural Economics Association, 2007 Annual Meeting. Page 1-18. Doi: 10.22004/ag.econ.34907

Altman, I., & Johnson, T. (2008). "The choice of organizational form as a non-technical barrier to agro-bioenergy industry development." Biomass and Bioenergy, 32(1), 28–34. doi: 10.1016/j.biombioe.2007.06.004.

Altman, I., & Johnson, T. (2009). "Organization of the current U.S. biopower industry: A template for future bioenergy industries." Biomass and Bioenergy, 33(5), 779–784. doi: 10.1016/j.biombioe.2008.12.002.

Arnulf J. & Bertoldi P. (2004) "Status Report 2004: Energy End-use Efficiency and Electricity from Biomass, Wind and Photovoltaics in the European Union". Luxembourg: EUR-OP. Page 1-110. Isbn: 92-894-8193-5

Arrow, K. J. (1976). "Les limites de l'organisation." Vendôme: Presses Universitaires de France. page: 1-96. Doi: ark:/13960/t4xh51m57

Brouthers, K. D. (2002). Institutional, Cultural and Transaction Cost Influences on Entry Mode Choice and Performance. Journal of International Business Studies, 33(2), 203–221. doi: 10.1057/palgrave.jibs.8491013.

Cardenas, L. & Lopes, F. D. (2017). "The formation of strategic alliances: a theoretical analysis from the theory of resource dependence and the theory of transaction costs." Page: 1-8. http://dx.doi.org/10.1590/S1679-39512006000200005.

Camia A. & Robert N. & Jonsson R. & Pilli R. & García-Condado S. & López-Lozano R., van der Velde M. & Ronzon T. & Gurría P. & M'Barek R. & Tamosiunas S. & Fiore G. & Araujo R. & Hoepffner N., Marelli L. & Giuntoli J. (2018). "Biomass production, supply, uses and flows in the European Union. First results from an integrated assessment", Publications Office of the European Union, Luxembourg. Page: 9-107. doi:10.2760/539520, JRC109869

Coase, R. H. (1937), "The Nature of the Firm". Economica (new series), Vol. 4, Issue 16, p. 386-405. 8https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

Da Silva, A. & Brito, E. (2013). "Uncertainty, bounded rationality and opportunistic behavior: a study in brazilian industry." RAM. Revista de Administração Mackenzie. 14. 176-201. Doi:10.1590/S1678-69712013000100008.

Dias, J. J. M. (2002). "Utilização Da Biomassa: Avaliação Dos Resíduos E Utilização De Pellets Em Caldeiras Domésticas". Master's thesis, Instituto Superior Técnico De Lisboa. Page: 1-112. At: http://www.enersilva.navegantes.info/areasubir/articulos/Tesis%20Mestrado%20Joao%20Dias.pdf

Downing, M. & Volk, T. & D. Schmidt. (2005). "Development of New Generation Cooperatives in Agriculture for Renewable Energy Research, Development, and Demonstration Projects". Biomass and Bioenergy. 28:425-34. https://doi.org/10.1016/j.biombioe.2004.09.004

European Commission. (2018). "A New Eu Forest Strategy: For Forests and The Forest Sector". Report from The Commission to The European Parliament, The Council, The European Economic and Social Committee and The Committee of The Regions. Brussels. Pages: 1-12. At: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52018DC0811

Faria C. & Nunes L. J. R. & Azevedo S. G., "Portugal as a producer of biomass fuels for power production: An analysis of logistics costs associated to wood pellets exportation," 2016 51st International Universities Power Engineering Conference (UPEC), Coimbra, 2016, pp. 1-5. doi: 10.1109/UPEC.2016.8113991

Gulati, R. & Singh, H. (1998) "The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances." Administrative Science Quarterly, 43, 781-814. http://dx.doi.org/10.2307/2393616.

Halinen, A. & Törnroos, J. (2005). “Using Case Methods in the Study of Contemporary Business Networks.” Journal of Business Research. 58. 1285-1297. 10.1016/j.jbusres.2004.02.001.

Hobbs, J. & Young, L. (2000). “Closer vertical co-ordination in agri-food supply chains: A conceptual framework and some preliminary evidence.” Supply Chain Management: An International Journal. 5. 131-143. doi: 10.1108/13598540010338884.

Hobbs, J. E. (1996). “A transaction cost approach to supply chain management.” Supply Chain Management: An International Journal, 1(2), 15–27. doi: 10.1108/13598549610155260.

Jäger-Waldau, A. & Bertoldi P. (2004) “Energy End-use Efficiency and Electricity from Biomass, Wind and Photovoltaics in the European Union.” Luxembourg: EUR-OP. Pages:1-136. ISBN: 92-894-8193-5

Karlson, S. H. (1998).” Industrial Organization in the European Union: Structure, Strategy, and the Competitive Mechanism”. Journal of Comparative Economics, 26(2), 407–409. doi: 10.1006/jcec.1997.1483.

Katz, J. P. & Bloodgood, J. M., & Pagell, M. D. (2003). Strategies of supply communities. Supply Chain Management: An International Journal, 8(4), 291-302. https://doi.org/10.1108/13598540310490053

Klass, D.L. (1998) “Biomass for Renewable Energy, Fuels, and Chemicals”. Academic Press, San Diego. Pages 1-651. https://doi.org/10.1016/B978-012410950-6/50003-9

MacNealy, M.S. (1997). “Toward better case study research. Professional Communication”, Pages 182-196. IEEE Transactions on. https://cecas.clemson.edu/cedar/wp-content/uploads/2016/07/4-Toward-Better-Case-Study-Research.pdf

Masten, S. E. (2001). “Transaction-cost economics and the organization of agricultural transactions. Advances in Applied Microeconomics.” 9. Pages 173-195. Doi.10.1016/S0278-0984(00)09050-7.

Panoutsou C. (2017). “Modelling and Optimization of Biomass Supply Chains. Top Down and Bottom Up Assessment for Agricultural, Forest and Waste Feedstock”. Page 1-292. doi: 10.1016/c2016-0-03577-5.

Nunes L. & Matias J. & Catalão J. (2015), "Analysis of the use of biomass as an energy alternative for the Portuguese textile dyeing industry", Energy (ELSEVIER), Vol. 84, pp. 503-508, May 2015, http://dx.doi.org/10.1016/j.energy.2015.03.052.

Nunes L. & Matias J. & Catalão J. (2016), "Biomass in the generation of electricity in Portugal: a review", Renewable and Sustainable Energy Reviews (ELSEVIER), Vol. 71, pp. 373-378, May 2017, Retirado de http://dx.doi.org/10.1016/j.rser.2016.12.067.

Nunes, L. & Matias, J. & Catalao, J. (2016). “Wood pellets as a sustainable energy alternative in Portugal”. Renewable Energy, 85, 1011-1016. DOI: 10.1016/j.renene.2015.07.065

Overend R. (1993). “Biomass Power Industry: Assessment of Key Players and Approaches for DOE and Industry Interaction. Golden”. CO: National Renewable Energy Laboratory. Page 1-33. https://inis.iaea.org/collection/NCLCollectionStore/_Public/25/040/25040954.pdf

Päivinen, R., M.& Lindner, K. R. & M. J. L. (2010). "A Concept for Assessing Sustainability Impacts of Forestry-wood Chains." European Journal of Forest Research 131, no. 1: 7-19. doi:10.1007/s10342-010-0446-4.

Pohlmann, C. M. & Braga de Aguiar A. & Bertolucci, A. & Martins, E. (2004) “Impact of asset specificity on transaction costs, capital structure and company value.” Page: 1-17. http://dx.doi.org/10.1590/S1519-70772004000400002.

Prando, D. & Boschiero M. & Campana D. & Gallo R. & Vakalis S. & Baratieri M. & Comiti F. & Mazzetto F. & Zerbe S. (2016). "Assessment of Different Feedstocks in South Tyrol (Northern Italy): Energy Potential and Suitability for Domestic Pellet Boilers." Biomass and Bioenergy 90 (2016): 155-62. doi: 10.1016/j.biombioe.2016.03.039.

Reynolds, K. M &, Twery, M. & Lexer, M. J. & Vacik, H. & Ray, D. & Shao, G., & Borges, J. G. (2008). “Decision Support Systems in Forest Management. Handbook on Decision Support Systems” 2, 499–533. doi: 10.1007/978-3-540-48716-6_24

Richman, B. D. & Macher, J. T. (2006). "Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences." Duke Law School Legal Studies Paper No. 115, pp. 1-63 http://dx.doi.org/10.2139/ssrn.924192.

Robert K. Y. (2014). "Case Study Research Design and Methods (5th ed.)." Thousand Oaks, C. 282 pages. The Canadian Journal of Program Evaluation. Doi: 10.3138/cjpe.30.1.108.

Selkimäki, M. & Prinz R. & Mola-Yudego B., & Röser D. (2010). "Pellet Market, Raw Materials, Handling and Logistics in Northern Periphery." PELLETime. Working Papers of the Finnish Forest Research Institute. 157. 1-55. At: https://www.researchgate.net/publication/235655046_Pellet_market_raw_materials_handling_and_logistics_in_Northern_Periphery_PELLETime

Van Der Stelt, M.J.C. & Gerhauser, H. & Kiel J.H.A. & . Ptasinsk K.J, (2011). "Biomass Upgrading by Torrefaction for the Production of Biofuels: A Review." Biomass and Bioenergy, Pages 3748-3762. doi: 10.1016/j.biombioe.2011.06.023.

Williamson, O. E. (1981). "The Economics of Organization: The Transaction Cost Approach." American Journal of Sociology, 87(3), 548–577. doi: 10.1086/227496

Williamson, O. E. (1985, 1987). "The economic institutions of capitalism." New York: Free Press. Pages 316-318. https://doi.org/10.1016/0167-2681(87)90011-4

Williamson, O. E. (2008). "Outsourcing: Transaction Cost Economics And Supply Chain Management. The Journal of Supply Chain Management", 44(2), 5–16. doi: 10.1111/j.1745-493x.2008.00051. x.

Zylbersztajn, D. (1995). "A estrutura de governança e coordenação do agribusiness: uma aplicação da nova economia das instituições." 238 p. Tese (Livre-Docência) – Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo, São Paulo. At: http://www.erudito.fea.usp.br/PortalFEA/Repositorio/616/Documentos/Tese_Livre_Docencia_DZ.pdf