MULTITRACES

Co-funded by the Erasmus+ Programme of the European Union

COLLECTION OF STUDY CASES MADE BY INTERNATIONAL STUDENTS FOR RURAL BUSINESS IN GREECE

Systemic Project for the Alfa Wood Group in Kato Nevrokopi, Greece

by the MULTITRACES Program

MULTITRACES

Co-funded by the Erasmus+ Programme of the European Union

TITLE OF THE PROJECTS

THE USE OF RECYCLED MATERIALS IN THE PRODUCTION OF HIGH-QUALITY PELLETS
COFFEE GROUNDS AS AN ALTERNATIVE INPUT RESOURCE FOR MAKING PELLETS, ALFA WOOD FACILITY KATO NEVROKOPI CASE STUDY.

THE BYPRODUCTS OF ASH IN THE PRODUCTION OF BIOMASS ENERGY AND ITS POSSIBILITIES FOR A NEW CIRCULAR ECONOMY SYSTEM.

Andrea Rordríguez

Email: *andreaaars18@gmail.com*

Comîrlă Rareș-Ionuț

Email: *youremailhere@gmail.com*

Jesús David Ortiz

Email: *j2.idesigner@gmail.com*

Nicolás Mondelli

Email: *nicolasmfavaloro@gmail.com*

Silvia Moreno

Email: *youremailhere@gmail.com*

Trăistaru Ștefan-Iulian

Email: *traistarustefan10@gmail.com*

MENTORS:

INTERNATIONAL HELLENIC UNIVERSITY:
Vassiliki KAZANA, Dimitris RAPTIS

ALFA WOOD group S.A.

Dimitris Lazos

Presentation of the company

ALFA WOOD group S.A.

The Alfa Wood Group is a family-run business and it is one of the largest Wood Processing Industries in Greece and one of the most significant in the Balkans. Their vision is to create an environment that increases communication and strengthens bonds between people by uniting them. Acting with its principles, values and social sensitivity, Alfa Wood maintains its commercial presence consistent with corporate social responsibility and sustainable development ideas. With its state-of-the-art equipment, industrial facilities and respective certificates, Alfa Wood carries out modern production methods and practices that comply with national and international environmental standards. As a Group, Alfa Wood if comprise of actors and companies, it has develop for over 40 years in the market through the the evolution of their first plant all they way to the buying of the biggest names in the wood processing market in greece, such as it was the Shelman Group that Panagiotis Iliadis had founded in 1962. Alfa Wood was founded by two Larissaians, Antonis Adamopoulos and Christos Agorastos which with significant investments and successive acquisitions made it a strong player in the market and the wood industry. They slowly grew their business in larissa by adding new products to their production line and expanding their facilities and buying new territory, the even started production activity in Varna, Bulgaria on the year 2000, all in accordance for a better positioning in the market. This only drew more interest and ambition to the company as for in 2004 they proceeded with the buyout of the PINDOS SA fibreboard production company in Grevena which they later expanded into new production lines under the ALFA WOOD PINDOS S.A.

The company later took upon the challenge of buying out the biggest name in the market, The Shelman Group. In 2009 the company was able to acquire the majority of the shares of the group due to it struggling with the financial crisis at the moment, therefore joining the new ALFA WOOD SHELMAN S.A. to the group and positioning them as the largest Wood Processing Industries in Greece. This lasted for about 5 years, in which the company did their best to hold the sinking ship that was shelman group at the moment. In 2014 Shelman went into bankruptcy but still left the Alfa Wood Group as the Leading company in the market. Along the same time period the Group decided to take a more circular economy approach following the future guidelines for companies around the world for a more sustainable future. They decided to enter into the energy and fire business by introducing the production of Wood pellets and briquettes to their production line. In 2011 they launched their new facility of wood pellets in the vicinity of Kato Nevrokopi, a small town to the north-eastern side of the country in the prefecture Drama, part of the Eastern Macedonian Thrace region of Greece. This was later upon reinforcing with the introduction of the briquette production line in 2017 and the installation of the Biomass power plant of 1MWH of production capacity.

Figure 1. Alfa Wood Nevrokopi S.A.

The object of this study emphasis in the Alfa Wood Nevrokopi S.A. which through the years has develop into a growing business for the group and has shown to be a big player in the market as well as a pioneer in the Circular Economy ambit. The company spread over an area of 228,000m2 of which 15,300m2 are factory premises. The Nevrokopi unit is active in the production of bio-fuels and green energy. The products manufactured at this factory are:

- Wood Pelletts
- Wood briquettes
- Wood garden chips
- 1MWH power output using biomass

For the production of the Pellet and Briquettes they have designed a fully automated process in which the raw material is introduced in the first stage and follows the preparation of it in order to start the production. Since both products follow the same initial stages of production they share part of the initial process of Debarking, chipping sieving and drying, it is later on that the line divides into the final stages of pelltizing and briquetting and with it their own packaging lines. the facility produces 6 different lines of pellets and 1 of briquettes. this products follow te same prodcutino line they are montirored in the control panel of the facility in which they can change the ratios of their raw material in order to obtain an specific type pellet. from there the company is able to not only check and control each aspect of the process but also conduct the various test to the product in order to guarantee the quality of the product.

The company prides itself in their high quality products that they guarantee through a certificate they obtain by following different property specification along some ISO standard rules. First of all the company is up to date with their main Iso-standards and conduct their daily check-ups but on top of that they posses the EN pellet certification that ensures that the

product in question possess great property specifications along the lines of their calorific value, ash production, size, durability, components emitted and moisture. This not only garantess the user a good product but also a safe use since not all machines that can receive pellets as fuel are capable to receive any kind of pellet, the less ash content the pellet has the better it is for the machinery, and since they are selled for mainly heating purpose they normally end up in house boilers. For this reason the company has experimented with different types of wood in order to obtain a consistent high quality prdcut, which they have found out to be 100% coniferus woods that they buy by the round Wood log and shipped, via a third company, to the facility from around an area of 600km2.

Regarding their circular economy practice they part take in the production of energy through the use of biomass. Eventhough pellet and briquettes can be used for energy production the company uses biomass mainly from the wood waste sector in order to produce its energy. The 1 MW of electricity is generated using Rankine organic cycle (ORC) technology and equipment from the world-renowned Italian company Turboden, which is a leading force in the design, generation and maintenance of ORC cogeneration systems. this close system enables them to produce electricity which by greek regulations can not be used by their facility, instead is then sold to the grid, they then take what they need for their energy supply from the same grid, which still is about twice what they currently produce.

Figure 2. Alfa Wood Nevrokopi's Turboden ORC cogeneration systems

1. THE USE OF RECYCLED MATERIALS IN THE PRODUCTION OF HIGH-QUALITY PELLETS

Mentors:

International Hellenic University:

Vassiliki KAZANA

Dimitris RAPTIS

ALFA WOOD group S.A.

Dimitris Lazos

Students:

Andrea Rordríguez

andreaaars18@gmail.com

Comîrlă Rareș-Ionuț

youremailhere@gmail.com

Jesús David Ortiz

j2.idesigner@gmail.com

Nicolás Mondelli

nicolasmfavaloro@gmail.com

Silvia Moreno

youremailhere@gmail.com

Trăistaru Ștefan-Iulian

traistarustefan10@gmail.com

Content of the project

Executive summary 10
1. Summary of the Project 12
1.1 Introduction to the Problematic 12
1.2 State of the art 13
1.2.1 Historical framework of the context 13
1.2.2 Existing solutions 15
1.3 Description of the chosen solution 20
1.4 Marketing plan 21
1.4.1 Strategic management planning and marketing 21
1.4.2 Analyzing the marketing environment 21
1.4.3 Setting marketing objectives 25
1.4.4 Developing marketing strategies 26
1.4.5 Implementing and controlling the marketing plan 28
1.5 References 30
2. Calculation and design of the Recycled Wood Supply System 32
2.1 Input data of the project 32
2.1.1 Properties of the pellets and their production 32
2.1.2 Properties of the Recycled Materials 34
2.2 Calculation and design of the Final solution 35
2.2.1 Recycled Wood Waste Greece 35
2.2.2 Introduction to the system 37
2.2.3 Overview of the final System 39
2.5 References 42
3. Investment cost and profitability analysis 43
3.1 Cost of the proposed solution 43
3.2 Benefit of the proposed solution 43
3.3 Cash flows 44
3.4 Conclusions 44
3.5 References 45

Executive summary

Quick overview

The following paper pertain to the culmination of the Multitraces European program for the International Hellenic University. The program promotes the collaboration of multidisciplinary students from 4 different countries, universities, and career paths, all with the purpose of developing projects with local companies from a circular economy and systemic approach. The presented case for this paper relates to the Alfa Wood Group Company one of the biggest wood treatments in Greece, in a specific one of the companies belonging to the group, Alfa Wood Nevrokopi. The company located in the prefecture of Drama, in the vicinities of the town of Kato Nevrokopi works on the production of wood pellets and briquettes. They gladly collaborated with this program to provide their knowledge and assistance for the development of 4 different projects. The developed project portrayed in this paper relates to "THE USE OF RECYCLED MATERIALS IN THE PRODUCTION OF HIGH-QUALITY PELLETS". The study proposed a variety of state-of-the-art solutions surrounding this topic and chose and developed the most suitable one related to the territory and company, in this case, high-grade recycled wood from category A wood waste, which yields the optimal properties for the production of A1 En plus certificate for high-quality and it is a prospective growing source of raw material at a low cost which reduces wastes in the general economy and recycles into energy and heat.

Systemic Analysis

The Territory of Kato Nevrokopi inside the prefecture of drama represents at first glance an advantageous location strategy for the amount of forest that covers the terrain. The high amount of supply that these forests could produce could represent an ongoing low transportation cost for the company. The issue at hand is the forest management inside the region and the country which has inhibited the company from even getting resources from this territory. for that reason, and the current global market for raw round wood the supply for reproduction has lowered in quantities and risen in costs. this opens the field for new source possibilities, all inside the range of properties that relate to the En plus certifications since the company values its high-quality products. As well as this notion of quality comes the fact that alfa wood deals with wood, therefore even if other sources for pellets may arise the goals encompasses those made from woody biomass.

Systemic Project

The project for "THE USE OF RECYCLED MATERIALS IN THE PRODUCTION OF HIGH-QUALITY PELLETS" develops a new company systemic strategy. the purpose of the systemic view looks to improved not only the system that is a company as Alfa Wood but also the one to which it is or will be interconnected with. The project proposes the use of high-grade recycled Category A Wood waste that can be located from their current 600km region of material collection. The Project proposes a collaboration with YPEN and companies like the Siakandaris group the company could get a constant source material of around 66.000 tons

of recycled wood, approximating a 50% intake of the recycled wood waste stipulations for the year 2020. This will be treated beforehand therefore not to be expected investment from part of the company other than the 500-ton storage silo that will automatically feed the process. After that, a new product will come out of it, promoted as high-quality pellets made from recycled wood, to which they can test the market. for later be sold to their current market at a better price, helping in terms of the transitions to more renewable sources in the region. Also, it impacts the ecological aspect of the industry by guiding production into more sustainable types of source materials.

Methodology & Implementation

For the development of this project and papers the systemic design methodology was proposed. This implies the elaboration of 5 stages which are part of a holistic diagnosis of the company and the territory, identification of challenges, identification of opportunities, the development of the system, and the analysis of the outcomes. For the program in question, due to the duration stipulated for it, the methodology was adjusted. The program also proposed the elaboration of 4 different papers, made from projects given by the company, through the formation of groups according to the number of students, this case 8 students, 2 for each paper/project. For the adaptation and the proper development of a systemic project the next approach was taken, in order to obtain a complex multidisciplinary result we decided on working together on each of the 3 papers, this excluded the national team that developed the fourth project which was stipulated from the beginning as a side project. this meant the proper implementation of the different disciplines for each of the papers. This way a Gantt chart was produced for the general production of the 3 papers. This divided the work into different phases. The methodology was adapted due to the previous information at hand which included the holistic diagnosis and the challenges and opportunities that were already given by the company. Our phases were the following: Project Conception and Initiation & Planning, Research Phase, Conceptualization & Analysis, Work Assessment & Design Phase, Project Elaboration Experimentation, and Project Deliverables. Each of these was divided by week and culminated in the delivery of the papers and the presentation on the 28 of July 2022.

Financial Highlights

- Benefits that the company may obtain with a certain quantity of sold pellets made from recycled materials.
- the company sells 15 kg for 6 euros, so 1 kg is 2,5 euros. Due to this, if the company sells 5.500.000 kg per month, it would obtain 13.750.000 euros in total.
- From this quantity, the real benefit is 13.741.183 euros, taking into account that the company does an investment of 7.000 euros and fixed expenditures of 8.817 euros for production

- The net cost-benefit is 112,15 euros per month and the net present value is 68.705.915 euros.

1. Summary of the Project

1.1 Introduction to the Problematic

The resources for the production of pellets have been a challenge since they rose to interest in the market in early 2000 as the European Union and other currents marked renewable energy goals for the future. Pellets were seen as a carbon neutral solution, and therefore their production was driven forward. As the Clear Cut article "Wood Pellet Production, the Destruction of Forests, and the Case for Environmental Justice" [1] this is not the real scenario, pellets for energy and heat, mainly wood pellets, can only be considered Carbon neutral, Sustainable, and renewable, if it is produced from wood waste or biomass. 20 years later the market has demanded a large supply which is being responded to by many companies via the production of pellets from timber wood, meaning some of these companies take part in deforestation to meet the demands.

Through the years the production of pellets became standardized and many countries started to impose some restrictions on the quality. The quality of pellets is directly related to their physical, chemical, and mechanical properties. It affects the emissions resulting from their combustion and also their use in stoves and boilers. Certain European countries have developed standards specifying control parameters and guidelines with a view to guaranteeing the effective and environmentally-friendly combustion of pellets.[2] the most common certification out there is the EN plus certificate which stands in order to ensure transparency for the consumer, guarantee fair trading and globally drive up the pellet quality. Even though pellets have been around since the oil crisis of the 1970s, pellets didn't become popular until the 2000s and it is in 2011 that the creation of a European standard for wood pellets took place (EN 14961-2), followed by a few years later by the international standard (ISO 17225-2).[3]

these standards were also set because of the machinery need to use these products. wood pellets are mainly used in stoves and boilers, even though there are industrial applications, the market needs to account for the lowest common denominator, in this case, house appliances, because of their intake requirements. many boilers and stoves can accept any kind of pellets, the problem starts with the recurrent use of low-quality pellets that can damage the equipment thanks to the high ash buildup.

Alfa Wood is well known for its high-quality pellets, something they achieve due to their automated system and choice of raw material. through years of study and research, they have found that coniferous raw wood is the best choice for their pellets as they demonstrate the highest calorific value and low ash percentage in their pelletize form. With a production capacity of over 60.000 tons per year, Alfa Wood buys around 120.000 tons of coniferous Roundwood to supply their process. Due to the recent covid-19 pandemic and the start of the war in Ukraine the market for timber has changed lowering the global supply and production,

in terms of inflating the prices. This has lowered the production of the company to around 45.000 tons per year and its currently looking for new solutions in its material supply by introducing the possible use of recycled wood materials that can produce the same quality the company is so well known for and keep with the market demand.

In this study, we try to find which materials can be possible candidates to substitute for the current supply or add on to it without messing with the high-quality standard the company is known for. through third-party studies we will compare the production of pellets from different sources, woody, and mixed biomass, to see which one fits the EN qualifications. These studies will take into account the region of drama and how beneficial can these solutions be to the company and the region. the circular economy perspective of the final outcome will be evaluated and put into a possible marketing plan for the company's consideration.

1.2 State of the art

1.2.1 Historical framework of the context

Since the first action plans were established for the change to renewable energy sources the demand for pellets globally has risen, and with it the awareness of the supply source and what to do with it. it is not a secret that in order to produce a renewable energy source, the source has to be truly renewable. since the calorific value in woody pellets, and their low ash content is so good, the market has been pushed to that sector, yet there are other markets that have dived into other types of pellets, coming from different source materials.

This star with a process of experimentation in which the production is analyzed first if the final product can be improved without dealing with changes in the supply. the factor taken into account first was the drying of the raw material before pelletizing [4]. The study presented the issue in quality surrounding the drying techniques in which the convection dryers are referred to since they are the most common ones. the particular case that affected quality is the moisture of the end product. which through the proper drying technique the moister can be lower as well as Low emissions of volatile hydrocarbons. this in terms of not only adjusting better to the end user heating system but as well as for the environment.

The production process has been optimized and improved through the years thanks to the advancement of technologies, and automatization like the one seen in ALFA WOOD, and with it the machinery that is capable to produce these pellets, mainly making a more efficient production but not necessarily a more efficient pellet. The key to this issue surrounds the raw material source which is where many studies come into play.

The market started analyzing different sources through the combustion models to obtain various types of pellets. with the standardization of pellets in 2011 [3], many companies looked at different types of wood to provide a good combustion model that could follow the certification requirements, yet the field was opened to new sources as new combustion models from agricultural waste were evaluated. This introduced the term Mixed Biomass Pellets (MBP) which refers to those produced from other forms of biomass than wood. they are called

mixed due to the various agricultural and forestry wastes mixed into the batch.[6]. This presented a drawback in sulfur and chlorine emission as well as the corrosion of the heating equipment, yet new standards were set for the MBP for commercialization, "NF Biocombustibles Solides" set up two new certifications, "Agro+" and "Agro".

As new parameters were set more experiments took place for the evaluation of new sources, this time expanding on what can be woody biomass, herbaceous Biomass, and fruit biomass. Each field was expanded through the wastes of the different sectors, agriculture, construction, and forestry. The results were compared to the certification model and yet the best results come from the construction department in which pine sawdust played the biggest role [7] something ALFA WOOD discovered on their own in their test, which is the high-quality that can be obtained through pine (coniferous) source materials.

Due to this other studies were developed in hong kong. these more focused on the are that churn out as successful in the previous studies and dealt mainly with construction wastes, formwork, furniture plywood, bamboo, pallets, and even mixed. [8] Obtaining good results in calorific and ash values, yet not compared to international standards. The results were promising and opened the discussion to pallet pellets, which were still highly debated in 2018 [13]. the question comes from the unreliability and inconsistency pallets can have as a wood source and their possible contaminants.

Others took a different approach by dealing with lignocellulosic wastes such as soybean culture, sugarcane bagasse, and eucalyptus wood for pellets production focusing on the generation of heat energy, and classifying them according to the commercialization standards. [11]. Some even looked deeper into the MBP due to the environmental advantages of dealing with these wastes, such as Portugal which proposed these pellets from their agricultural and forestry waste to reduce the possibility of wildfires. [15]

With the evolution of the technology, new methods were discovered for the change in properties of the raw materials in order to obtain higher quality pellets from sources that were discarded previously. Torrefaction is a "Mild form of pyrolysis at temperatures typically between 200 and 320 °C. Torrefaction changes biomass properties to provide a better fuel quality for combustion and gasification applications" [18] which meant that previously used herbaceous wastes that were not up to standard could enter the production again via this new step in the production line and get closer to high-quality standards.

The innovation has not stopped on the herbaceous, fruity biomass, and some companies have made progress on pellets from coconut shell wastes, which can even be considered inside some standard certifications. [9]

Nowadays the discussion still compasses the woody biomass pellets, but from different angles, in which the waste sare being more and more considered. some studies anylize the Greenhouse Gases Balances between producing wood waste pellets and using virgin wood from the forests. while the virgin material gives you higher quality certifications the wood waste impact at the end of the process is significantly lower than the virgin material. [12] with this, the evaluation of some common contaminants in this wood waste has been analyzed and while not all parameters follow the high-quality certification requirements the results are still promising, some of them following ENplus A1, A2, and B qualifications.[17]

1.2.2 Existing solutions

Regarding existing solutions, many have done a variety of experiments in order to search for the best possible source material, and or to change to a more sustainable one. This in terms is related to the environment in which the experiments are done and the context of the region, trying to exploit certain flaws of waste sth territory in question might have.

When looking for different sources of biomass for pellets extensive research was done on different groups of biomass which yield results that were later compared to the current standard pellet certifications.

Biomass Groups		Wastes	Nomenclature
Woody Biomass	forest wastes	pyrenean oak	*PO*
		pyrenean sylvestris	*PS*
	wastes from wood industry	granulometric separation powder from cork industries	*CP*
		pine sawdust	*SW*
	woody agricultural wastes	vine shoots	*VS*
		olive branches	*OB*
Herbaceous Biomass	herbaceous agricultural wastes	barley straw	*BS*
		wheat straw	*WS*
Fruit biomass	agro-industrial wastes	olive pomace	*OP*
		grape pomace	*GP*

Table 1. Analyzed Pellets, *A Review of Pellets from Different Sources.*[7]

Property	*PO*						*PS*						*CP*					
	A1	A2	B	I1	I2	I3	A1	A2	B	I1	I2	I3	A1	A2	B	I1	I2	I3
M	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
BD	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
DU	¡?	¡?	¡?	¡?	¡?	¡?	¡?	¡?	√	¡?	√	√	¡?	¡?	√	¡?	¡?	√
N	x	x	x	x	x	x	x	√	√	x	x	√	x	√	√	x	x	√
S	x	x	x	x	x	x	√	√	√	√	√	√	√	√	√	√	√	√
Ash	x	x	x	x	x	√	x	x	x	x	x	√	x	x	x	x	x	x
LHV	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

√, OK; x, not OK; ¡?, not OK by less than 5%.

Table 2. Comparison with EN ISO 17225-2 standard (part 1).[7]

Property	*SW*						*VS*						*OB*					
	A1	A2	B	I1	I2	I3	A1	A2	B	I1	I2	I3	A1	A2	B	I1	I2	I3
M	√	√	√	√	√	√	x	x	x	x	x	x	√	√	√	√	√	√
BD	√	√	√	√	√	√	√	√	√	√	√	√	¡?	¡?	¡?	¡?	¡?	¡?
DU	√	√	√	√	√	√	√	√	√	√	√	√	¡?	¡?	¡?	¡?	¡?	¡?
N	x	√	√	x	x	√	x	x	√	x	x	√	x	√	√	x	x	√
S	√	√	√	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√
Ash	x	√	√	√	√	√	x	x	x	x	x	x	x	x	x	x	x	x
LHV	√	√	√	√	√	√	x	x	x	x	x	x	¡?	¡?	¡?	¡?	¡?	¡?

√, OK; x, not OK; ¡?, not OK by less than 5%.

Table 3. Comparison with EN ISO 17225-2 standard (part 2).[7]

Property	BS	WS	OP		GP	
			A	B	A	B
M	√	√	√	√	√	√
BD	√	√	√	√	√	√
DU	¡?	¡?	x	¡?	x	x
N	x	x	x	√	x	¡?
S	√	√	√	√	√	√
Ash	x	x	√	√	x	√
LHV	NR	NR	√	√	√	√

NR, not required; √, OK; x, not OK; ¡?, not OK by less than 5%.

Table 4. Comparison with EN ISO 17225-6 standard. [7]

As can be seen by the previous 4 tables the study "A Review of Pellets from Different Sources" draws a good chart into which type of source materials can be used to obtain high-quality pellets. As no surprise the pine sawdust yielded the best result as to which o these could be commercialized as high-quality pellet, taking into account these are wastes from the wood industry and not virgin pine extracted for this purpose, therefore a sort of recycled waste.

In Hong Kong they took even further the acknowledgment of the wood wastes, they dived into the construction sector to look for possible source materials.

Parameters	Unit	Sample					
		Coal	Furniture plywood	Formwork	Bamboo	Wooden Pallet	Mixed
Energy Value	MJ/kg	21.76	24.98	21.13	18.79	18.95	19.87
Moisture content	%	13.34	8.07	10.78	9.62	10.20	8.86
Cd	mg/kg	0.009	0.014	<0.005	0.007	<0.005	0.006
Cr		0.318	0.896	0.375	0.261	0.112	0.348
Cu		0.309	0.709	0.624	0.342	0.464	0.411
Fe		3.511	415.150	16.114	3.107	2.075	15.737
Pb		3.692	1.252	0.129	0.025	0.067	0.199
Zn		0.890	3.539	1.389	0.965	0.890	1.193
N	%	0.72[a]	1.90	0.10	0.10	0.20	0.80
C		73.32[a]	29.10	44.60	42.90	46.40	45.40
H		4.56[a]	4.00	6.20	6.00	6.50	6.10
O		20.12[a]	29.30	46.80	47.30	46.50	45.80
S		0.11[a]	0.00	0.00	0.00	0.00	0.00
Ash		1.17[a]	35.80	2.30	3.70	0.40	1.90

Table 5. Physical and chemical compositions of the wood wastes samples. [8]

Parameters	Wood pellet[a]	Wood pellet[b]	Austria[c]	Sweden[c]	Germany[c]	Italy[c]	UK[c]	PFI (USA)[d]
Moisture content (%)	5.10	7.70	≤12	≤10–≤12	≤12	≤10–≤15	≤10	<8
Bulk density (kg/m³)	624	591		≥500–≥600		≥550–≥720	≥500	
Ash content (%)	1.20	0.51	≤0.50	≤0.7–≤1.5	≤1.5	≤0.7–≤1.5	≤1–6	≤1
Calorific value (kJ/kg)	17.10	19–20.3	≥18	≥16.9	17.5–19.5	≥16.2–≥16.9	≥15.12–≥16.9	18.61
C (%)	50	50.30						
N (%)	0.10	0.22	≤0.30		<0.30	≤0.30		
H (%)	6.20	5.70						
S (%)	<0.01		≤0.04	≤0.08	<0.08	≤0.05		
Cl (ppm)			<200	≤300	<300	≤300	≤800	<300
As (mg/kg)					<0.80			
Cd (mg/kg)		0.14			<0.50			
Cr (mg/kg)		0.6			<8			
Cu (mg/kg)		1.10			<5			
Hg (mg/kg)					<0.05			
Pb (mg/kg)		0.43			<10			
Zn (mg/kg)		13.20			<100			
K (mg/kg)		493						

Table 6. Characteristics and standards for wood pellets. [8]

In this case, the study compares the pellets between each other and coal. the furniture plywood had great calorific values but really high values regarding all the other properties that one should be looking for in high-quality pellets. Instead, the Pallet and mixed pellets turn out promising numbers as they can be even considered for certifications of A1 and B by the EN plus handbook guidelines. Opening the door to future considerations.

Other studies research pellets made through different Lignocellulosic Biomasses and go a step further into combining them with some woody biomasses to produce MBP. The proposed materials came from Soybean wastes, sugarcane bagasse, Commercial Wood pellets, and eucalyptus sawdust. the combinations performed were between the soybean wastes eucalyptus sawdust and sugarcane bagasse.

Material	Mwb (%)	Mdb (%)	HHV (MJ/Kg)	LHV (MJ/Kg)	LiHV (MJ/Kg)
Sw	10.00 ± 0.26f	10.58 ± 0.28f	16.70 ± 0.13b	15.35 ± 0.13b	13.53 ± 0.12b
Sb	9.00 ± 0.40e	9.89 ± 0.51e	15.06 ± 0.36a	13.71 ± 0.36a	12.18 ± 0.33a
Es	10.0 ± 0.20f	11.02 ± 0.44f	20.10 ± 0.14f	18.75 ± 0.14f	16.54 ± 0.13f
100Sw	8.28 ± 0.42d	9.03 ± 0.50d	16.70 ± 0.13b	15.46 ± 0.13b	13.97 ± 0.09c
100Sb	5.27 ± 0.14a	5.57 ± 0.16a	17.40 ± 0.08c	16.03 ± 0.08c	15.05 ± 0.09e
Cwp	7.60 ± 0.01c	8.23 ± 0.01c	19.37 ± 0.08e	17.96 ± 0.08e	16.40 ± 0.07f
50Es/50Sw	6.43 ± 0.11b	6.87 ± 0.12b	17.92 ± 0.09d	16.56 ± 0.09d	15.34 ± 0.09e
20Es/80Sw	8.77 ± 0.13e	9.61 ± 0.15e	18.19 ± 0.06d	16.83 ± 0.06d	15.13 ± 0.05e
50Sb/50Sw	6.09 ± 0.15b	6.48 ± 0.17b	17.25 ± 0.12c	15.90 ± 0.12c	14.78 ± 0.11d
20Sb/80Sw	6.42 ± 0.10b	6.86 ± 0.11b	17.45 ± 0.20c	16.09 ± 0.20c	14.90 ± 0.19d
CVe (%)	2.94	3.54	0.93	1.01	1.00

Sw soybean wastes, *Sb* sugarcane bagasse, *Cwp* commercial wood pellets, *Es* eucalyptus sawdust, *Mwb* moisture wet basis, *Mdb* moisture dry basis, *HHV* higher heating value, *LHV* lower heating value, *LiHV* liquid heating value, *CVe* experimental coefficient of variation

The letters (a–e) in the same column represent statistical comparisons using Scott-Knott test (5% of significance), while different letters indicate significant differences between the values

Table 7. Average values of moisture (wet and dry basis), and higher, lower and liquid heating values of biomasses and pellets. [11]

Material	VM (%)	Ashes (%)	FC (%)	VM/FC
Sw	62.47 ± 0.71a	26.72 ± 0.74f	10.81 ± 0.03a	5.8
Sb	68.39 ± 0.49b	21.06 ± 0.35e	10.56 ± 0.14a	6.5
Es	84.45 ± 0.16g	0.65 ± 0.26a	14.90 ± 0.11c	5.7
100Sw	62.47 ± 0.71a	26.72 ± 0.74f	10.81 ± 0.03a	5.8
100Sb	80.56 ± 1.98e	5.58 ± 0.44b	13.87 ± 1.77b	5.8
Cwp	82.32 ± 0.38f	1.45 ± 0.18a	16.23 ± 0.20c	5.1
50Es/50Sw	71.13 ± 0.26d	14.03 ± 1.40c	14.84 ± 1.15c	4.8
20Es/80Sw	69.53 ± 0.59c	16.67 ± 0.84d	13.80 ± 0.61b	5.0
50Sb/50Sw	69.47 ± 0.60c	15.02 ± 0.71c	15.48 ± 0.26c	4.5
20Sb/80Sw	67.24 ± 1.49b	19.79 ± 1.15e	12.97 ± 0.51b	5.2
CVe (%)	1.27	5.23	5.39	–

Sw soybean wastes, *Sb* sugarcane bagasse, *Es* eucalyptus sawdust, *Cwp* commercial wood pellets, *VM* volatile materials, *FC* fixed carbon, *CVe* experimental coefficient of variation

The letters (a–e) in the same column represent statistical comparisons using Scott-Knott test (5% of significance), while different letters indicate significant differences between the values

Table 8. Proximate analysis of the biomasses and pellets.[11]

The properties of the final pellets varied a lot between the mixes and the initial source material as well as it didn't yield high-quality pellets. the best results on the table presented were from the commercial pellet and the eucalyptus sawdust, which still isn't better than pine sawdust, the upside is the high growth pace of the Eucalyptus compared to the pine, which still is considered a fast-growing tree, the problem relies on what the territory can provide for the company that is making the pellets.

Some companies have decided to go on the route of more sustainable sources yet lesser quality, by going into coconut shell wastes.

Item Heat	Value (Kcal)	Moisture (%)	Ash (%)	Length (mm)	Diameter(mm)
Coconut Shell	3885	10	5	150-250	/
Coconut Shell Pellets	4200-4600	8	1.5	10-40	8-10

Table 9. Comparison of coconut shell and coconut shell pellet.[9]

The result is good quality pellets that can be exploited in the region where this source is more proficient might be the cases of Indonesia, Philippines, Brazil, Sri Lanka and India. this work perfectly for industrial small and medium boilers, and house stoves.

Experiments are still being done with agricultural waste since it is a huge source of untapped potential as an energy source, agricultural pellets are on the market but in order to replace wood pellets they need to achieve the same calorific value and low ash %percentage residue.

Ref.	Biomass material	Operating parameters				Characteristics of produced pellets								
		P (MPa)	T (°C)	M (%)	d_p (mm)	D_p (mm)	L_p (mm)	ρ_{bulk} (kg/m³)	ρ_{pellet} (kg/m³)	M_p (%)	Ash (%)	HHV (MJ/kg)	Du (%)	Strength
[40]	Olive leaves (OL)	Pelletizer Kahl 14–175	>60	9.0	< 2.50	6	12.3	< 600	< 1000	–	–	19.64	88.6	13.3*
	Olive prunings (OP)		>60	9.0	2.50–4.00	6	24.0	>600	>1000	–	–	–	–	21.0–24.86*
	Olive wood (OW)		40–60	9.0	4.00–5.00	6	28.7	>600	>1000	–	–	17.53	91.7	21.0–24.86*
[49]	mixing moso bamboo with rice straw at ratio	Laboratory pellet mill (L-175),												
	(5:0)		–	16.0	< 2.00	6	13.8	540	1250	–	2.0	18.25	94.1	–
	(4:1)		–	15.8	< 2.00	6	13.5	560	990	–	4.0	18.10	95.3	–
	(3:2)		–	15.7	< 2.00	6	13.6	570	1000	–	6.0	17.5	97.5	–
	(2:3)		–	15.6	< 2.00	6	13.8	600	1040	–	10.0	16.20	99.0	–
	(1:4)		–	15.8	< 2.00	6	13.4	620	1050	–	13.0	16.00	98.7	–
	(0:5)		–	15.9	< 2.00	6	13.2	635	1350	–	16.0	15.40	–	–
[6,43]	Chinese fir-SS (CFSP)	>55.0	>70	10.0–15.0	< 0.45	7	–	–	1110	–	–	–	–	5.0***
	Camphor-SS (CSP)	>55.0	>70	10.0–15.0	< 0.45	7	–	–	1105	–	–	–	–	4.7***
	Rice straw-SS (RSSP)	>55.0	>70	10.0–15.0	< 0.45	7	–	–	1180	–	–	–	–	5.3***
[67]	Softwood Douglas fir	126.0	>200	10.0	0.35–0.45	6	21.0	–	111	–	–	–	–	6.0*
[1]	vigorous sugar maple	49–81.5	75–125	8.1–17.2	0.25–1.00	6	–	–	1026	2.1–11.9	–	–	–	4.03**
	Non-vigorous sugar maple	49–81.5	75–125	8.1–17.2	0.25–1.00	6	–	–	1038	2.1–11.9	–	–	–	46.6**
[106]	Mixed garden waste	Flat pelletizer	80–90	5.0–35.0	6.25–25.4	12–15	31.1–45.1	–	409–1482	–	–	–	64.6–98.3	3.9–55.1*
[102]	Treated wheat straw (TVm4D)	–	95	–	1.00–1.6	6	–	–	969–1036	–	–	–	–	0.4–0.7***
[107]	Corn cob	Flat pelletizer	85	15.0–20.0	3.15	6	–	560–690	–	10.5–12.0	–	–	70.0–95.0	–
[108]	Corn stover with starch flour	Flat pelletizer	50–65	15.0–19.0	2.00–8.00	6	–	548–720	–	11.0–16.0	–	–	88.0–98.8	–
	Corn cob with starch flour	Flat pelletizer	50–65	15.0–19.0	2.00–8.00	6	–	510–644	–	8.0–15.0	–	–	77.9–99.2	–
[109]	Canola meal	Bench-scale extruder	–	–	0.35	6	–	936	–	–	6.5	–	>99.0	6.4*
	Torrefied canola meal	Bench-scale extruder	–	–	0.33	6	–	747	–	–	7.8	23.30	>99.0	3.8*
[79]	microalgae	79.7–111.6	50–100	10.2		6	–	–	1192–1229	–	2.5	27.80	82.0–96.5	–
	Sawdust	79.7–111.6	50–100	9.9	0.58	6	–	–	817–1038	–	0.1	19.42	29.0–85.8	–
	25% sawdust + 75 microalgae	79.7–111.6	50–100	–		6	–	–	1155–1207	–	1.7	25.32	72.4–97.7	–

Notes: d_p the particle size of raw biomass material, D_p the pellet diameter * kgf, ** N/mm, *** MPa.

Table 10. Summary of pellets characteristics at various operating conditions for different biomass materials.[13]

The huge variety of pellets tested in these papers gives us a new spectrum of materials yet they also ruled out a lot of others. The study can be expanded into better experimentations on those who show the most promise which is the Bamboo and the microalgae.

Other studies are performed with the wastes of different regions, pine is almost always in the mix and stats at the best properties yet other contenders enter the ring. In the case of this study other feedstocks are tested and out of it the Scotch broom yields good qualities for a b certification.

Sample	Volatile Matter	Fixed Carbon[1]	Ash	Cellulose	Hemicellulose	Lignin
Pine	85.7	13.9	0.4	50.1	13.5	25.6
Rock rose	82.8	13.2	4.0	33.5	21.9	16.4
Scotch broom	83.3	15.4	1.4	33.9	21.0	11.7
Vine sprout	74.0	23.3	2.7	35.6	26.5	14.3
Triticale	79.6	15.0	5.3	23.2	23.3	3.9
Cynara stalk	74.7	17.2	8.1	43.5	22.2	9.1
Jerusalem artichoke stalk	75.5	17.1	7.4	26.3	12.8	7.4

(1) Determined by difference. Fixed carbon – Dry matter – (Volatile matter + ashes) RSD of volatile matter; ash; and fibre composition determinations – 2.9%; 4.8% and 3.1%, respectively.

Table 11. Proximal and fiber content (wt.% dry matter basis - dmb) of the feedstocks used for pellet making.[18]

As for recycled materials go the community is adamant about their use since they balance better GHG emissions yet there is still discussion about whether to use them or not since they can be unreliable and contaminated. Some studies show that this is not the general case, since you can control and verify the origin and journey of the recycled wood and even some tests try the pellet production out of some wood wastes with possible contaminants such as glues.

Characteristic	Class	Measured value	Reference values of EN ISO 17225-2: 2014		
			A1	A2	B
Moisture content (M)	M10	10% $_{\text{as received}}$	M10 ≤ 10		
Diameter (D)	D06	6.0 mm	D06.6 ± 1 D08.8 ± 1		
Length (L)		13.5 mm	3.15 < L ≤ 40		
Bulk density (BD)	BD650	650 kg m^{-3} $_{\text{as received}}$	BD600 ≥ 600		
Durability (DU)	DU95.0	95.8%	DU97.5 ≥ 97.5	DU97.5 ≥ 97.5	DU96.5 ≥ 96.5
Ash (A)	A0.5	0.4% $_{\text{dry}}$	A0.7 ≤ 0.7	A1.2 ≤ 1.2	A2.0 ≤ 2.0
Net calorific value (pci$_M$)	–	16.5 MJ kg^{-1}	Q 16.5 ≥ 16.5		
Ash melting behaviour	SST	1200 °C	Indicate temperature		
	DT	1380 °C			
	HT	1460 °C			
	FT	1470 °C			

SST shrinkage starting temperature, *DT* deformation temperature, *HT* hemisphere temperature, *FT* flow temperature

Table 12. Physico-mechanical characteristics of pellets produced from planing waste from Norway spruce boards.[17]

Table 12 proposes that many wood treatment industries can produce waste that can later qualify as good, high-quality source material for certified wood pellets.

The state of the art is a current process of discovery in which the world part takes in a huge experiment in order to innovate and improve our current way of living. Pellets can be a Renewable source of energy yet quality has to be accounted for. This ongoing pursuit for the best source material is still very much an issue, in which recycled woods are still the best candidates. This can be qualified around the construction and treatment of wastes, as long as they can be clasified before hand.

1.3 Description of the chosen solution

For the proposed project of "THE USE OF RECYCLED MATERIALS IN THE PRODUCTION OF HIGH-QUALITY PELLETS" the background analysis delta with many source materials instead of only recycled wood. The reason is that currently, the company in Nevrokopi is not being able to obtain the raw material from the territory even though Drama's territory is about 55% forests and the total woody volume of the 173303 ha of the Drama forest land is estimated to 16,061,470m3. This seemed a ridiculous statement at the moment yet the policies behind the agricultural and forestry department inhibit the exploitation of these resources, and the forest cooperatives in charge of the management of this forest do not allow access to even the wood waste.

The feedstock was thought for a second due to the high agricultural produce in the region, but being a wood treatment company the area was outside the economical and business cluster in which they deal, therefore the final solution came with the Recycled woods.

Recycled Woods are a general term that can be properly attributed to what the final solution proposes. the fact is that even though many studies beware the use of this due to the inconsistency in contaminants and the previous treatment that has to be done for pelletizing, we analyze that if their area of recollection is 600 km range the company could properly buy recycled pretreated wood. the question was if it could turn into high-quality pellets, and as some of the studies proposes the use of pallets that are a trackable waste can make even A1 pellets. The concerns still surround the real final quality of industrial production of this kind of pellets, normally pallets are done with low-quality woods therefore at the most the certification you can get from them are a B in the ENplus, yet the other studies propose the possible outcome as a higher quality product.

This can all be achieved with the help of companies like Siakandaris Group, a local waste management company that treats recycled wood, and even though state and regional waste management plans to obtain a greater supply. all of this in combination with the mixing of some pure pine sawdust and or some shreds of pine and the final result can be a High-quality pellet at a lower cost.

1.4 Marketing plan

1.4.1 Strategic management planning and marketing

The aim of this section is to create a marketing plan which is an organized and structured document that defines the business objectives to be achieved in a given period. The object of this document is to detail the strategies and actions to be undertaken in order to achieve the final project (create pellets with the mix of wood and recycled materials) within the planned time frame.

1.4.2 Analyzing the marketing environment

Macroenvironment

In this section, we would focus on the macroenvironment, which consists of large societal drivers of change that are not directly related to the activity of the Alpha wood company but have the potential to affect it.

Once we studied the company and the environment in which is involved, the most significant factors are:

Firstly, **political** factors such as the amount of pollution that the company can emite legally, in order to comply with the limits established by the government to all the companies in the country to collaborate with corporate social responsibility.

Secondly, the **economical** factors related to the budget of the company and its expenses to produce pellets and briquettes with the certificates ENPlus A1 and ENPlus A2 according to the high-quality European standard ENplus.

The third factor is the **social** environment of the company. Alfawood is a family-run business and its values are shaped by their faith in humanity and the world. Its most important values are dynamism, loyalty, sense of responsibility and reliance.

The fourth factor is **technology**. This factor is related to the machines and automated processes that the company has in order to produce pellets and briquettes and bag them into packages.

The fifth factor is the **environment**, related to the purpose of a circular economy with the aim of reducing pollution using biomass and recycled wood and materials.

Finally, the last factor is the **legal** one, which includes regulations and rules from Greece and the European Union in order to create an organized environment between companies in which everyone should participate following the rules to achieve its goals legally.

Internal Analysis

In this Internal Analysis we refer to the controllable elements inside an organization that influence how well the organization operates. Taking into account Internal strengths and

weaknesses may lie in different types of assets that are tangible and intangible. The classification made for Alpha Wood is:

- **Geographical location:** The company is located in Greece, a city in the northwest of Greece. We can say that the location of the company is good because on the one hand, its main purchasing point is Bulgaria and on the other hand the most common sales destinations of the company are Greece, Albania and Italy. Furthermore, the group develops an extensive network of warehouses and distributors of pellets and briquettes so that the consumer has a close access to the point of sale.
  In short, the geographical location gives the company a great advantage as it is relatively close to Bulgaria and the countries to which it exports.

- **Human resources:** Alfa wood employs over 40 local employees and many more in the supply chain. It is the definition of "GREEN GROWTH", even though it operates in a remote area. This company brings career opportunities to people with values, morals and ambitions. It is a strength of the company due to the fact that they invest in people who are passionate about work and motivated to achieve the company's goals.
- **Technological resources:** ALFA WOOD GROUP A.E.V.E. is dedicated to the wood sector. The evolution of the group reveals inner and natural energy that constantly sets new goals and carries them out. Today we can say that it is a leading company in the industrial processing of wood, which contributes to the development of the national economy. In order to obtain pellets of high quality which require high demand in the field of technology, technology must be combined with economy and ecology.
- **Physical facilities:** The facilities in the industrial area of Larissa cover 50.000 m2 with the factory comprising 29.000m2. The premises in Grevena are located on a privately owned plot of 107.000m2, with the buildings occupying 27.200m2. The facilities at Nevrokopi are spread over an area of 228,000m2 of which 15,300m2 are factory premises. The Nevrokopi unit is active in the production of bio-fuels and green energy.
- **Relationships with suppliers:** This is the systematic approach to assessing the suppliers that provide goods, materials and services to the company by determining each supplier's contribution to the success and developing strategies to improve their performance. Currently, the company is not in a very comfortable situation, since due to covid 19 on the one hand, and on the other hand, the war that is being fought between Ukraine and Russia complicates the relationship with suppliers, which translates into a shortage of raw materials for manufacturing.
- **Corporate reputation:** In terms of the image projected by the company and its perception towards its stakeholders, we can say that they could improve it by investing in this project framed within the circular economy, as at the same time as they increase their profits, they could generate a greener and more sustainable image. Alfa wood is distinguished for its entrepreneurial spirit, the ability to adapt and adhere to the requirements of its partners.

- **Ownership of strong brands in the marketplace**: "The company was founded in 1981 and has been following a continuous upturn, making it the largest Wood Processing Industry in Greece and one of the most significant in the Balkans. Together, they have successfully established the ALFA WOOD group in the Greek and international markets".
- **Financial stability:** It is a condition in which the financial system is capable of withstanding economic and financial shocks and smoothly performs its intermediation role.

- **Available production capacity:** The factory has a high production capacity since it can reach 60,000 tonnes of pellets per year, unfortunately due to the shortage of raw material the company is currently (July 2022) producing only 45,000 tonnes, which means that they are producing at 75% of their production capacity.
- **Ownership of strong brands in the marketplace:** The company has to work on its competitive advantages in order to define the company as a coherent company to ensure that consumers identify it and trust it.

SWOT:

Once the previous study has been carried out, where the objective was to analyze the company internally and externally (both the environment and the sector), we can carry out the diagnosis, in which the strengths and weaknesses as well as the opportunities and threats of Alfa Wood are summarized in a table. In order to have a snapshot of the business project to ensure the success of the project.

	EXTERNAL	INTERNAL
POSITIVE	OPPORTUNITY	STRENGTH
	- Internal market maturity level - Consumer preferences - New products emergence	- Geographical location - Technological level - Brand/company image
NEGATIVE	THREAT	WEAKNESS

	- Technical barriers (certificates or approvals) - Existence of emerging markets - Transport system	- Available production capacity - Commercial network/external contacts - Financial resources

Marketing information system (MIS)

- **Internal reporting system:** Alfa wood group employs 350 people and has a network with 10 distributors in Greece and 39 points of sale through local partners in other countries. The company exports about 40% of its annual production in 39 countries, some of them are: Albania, Algeria, Bulgaria, Croatia, Cyprus, England, Egypt, Italy, Kosovo, Morocco, Vietnam, Turkey, etc. Alfa wood produces on average 60,000 tons of pellets and 7.000 tons of briquettes per year with a quantity of power output of 2 mw. In addition, the company proudly states that through the green energy it produces by re-using about 75.000 tons of biomass every year provides electricity to 6.000 homes on an annual basis, while saving approximately 200.000 tons of carbon dioxide (CO_2) every year.
- **Marketing intelligence system:** Firstly state that, one of the most important aspects that can cause a huge impact on the company is the ability to stay ahead of the market

  having a comprehensive understanding of its competitor, the industry or the changing consumer landscape, among others. We can prove that Alfa Wood is trying their best to be at the forefront of the sector, always framed in the values of sustainability and high quality.

  Secondly, nowadays with the new technologies is really easy to find useful data which can help the company, some of this tools are:

  - Chambers of Commerce (http://www.plancameral.org)
  - Jetro (http://www.jetro.go.jp)
  - International chamber network (http://www.worldchambers.com)
  - World trade organization (http://www.wto.org)
  - Ministry of Trade Country Channel (https://comercio.gob.es/es-es/paginas/index.aspx)
  - Commercial Guides Countries Embassies USA (https://www.export.gov/ccg)

- **Marketing research system:** It is the systematic collection, organization, analysis and interpretation of the primary or the secondary data to find out the solutions to the

marketing problems. This allows you to state a specific problem as your current business goal and investigate all the details necessary for developing its solution. If you are thinking of developing a new product, you should conduct marketing research. Then, based on your findings, you'll manage to create a solution. For instance, the case of introducing recycled materials for pellet production. Before developing this new product, it is important to do research and study its benefits and drawbacks in order to prove if it is feasible or not and create solutions to problems.

- **Marketing models:** These models are highly important because they attempt to show us what the outcome should look like if we change the variables of the company. In other words, marketing models can give the company the answer to different hypotheses to know certainly what will happen.

  In this project, a lot of questions and hypotheses can be made. For example, one question related to the number of materials could be: how much quantity of recycled materials should be added to the pellets in order to obtain a higher profit? or how much the properties of the final product will change if we add a higher or lower percentage of that recycled material?

  As we can see, the marketing model as well as the rest of the sections that make up the marketing plan are key in order to succeed in our project.

1.4.3 Setting marketing objectives

Once the Alpha Wood company has a thorough understanding of the marketing environment, we have to proceed with developing the marketing objectives. In a few words, the marketing objectives state what the marketing function must accomplish in order to succeed in the recycled materials project.

These objectives can be quantitative or qualitative. In order to succeed they have to be specific, measurable, attainable, relevant and time-based.

Regarding this project on the use of recycled materials for the production of pellets, we can say that the aim of this project is to make a profit by recycling waste from different materials with the objective of using them for the production of pellets combined with the biomass to obtain the certifications that the company manufactures but using the circular economy to try to pollute less. How can we achieve it?

- By investigating which recycled materials can be used to produce pellets and studying its properties.
- Studying if those materials are able to comply with the company's A1 and A2 certifications
- Choosing which material is the most feasible both when it comes to obtaining it and when it comes to transforming it into pellets.
- Proceeding to its manufacture and subsequent sale.

1.4.4 Developing marketing strategies

There are some marketing strategies that the company can develop in order to achieve the best possible results from its new products. Developing marketing strategies means deciding which markets to target and how to develop the marketing mix to reach that market.

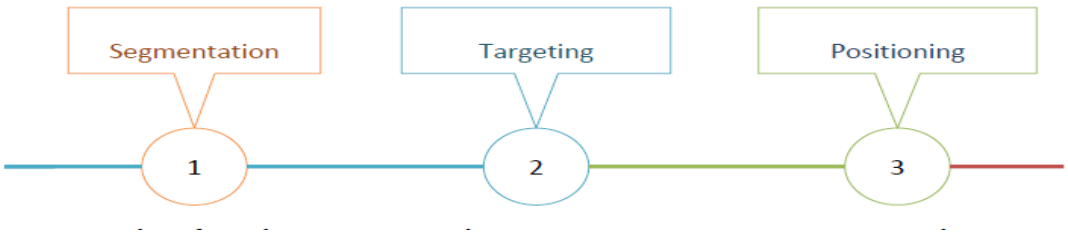
Companies consider different levels of market segmentation according to their own resources and objectives:

- Mass marketing.
- Market segments.
- Market niche.
- One-to-one marketing.

In this case, Alfa wood focuses on market segments, where there are homogenous groups of consumers sharing one or more similar characteristics that cause them to have relatively similar product needs and buying characteristics. For instance, the pellets and briquettes that the company sells, many people have the need to buy them for the winter season in order to get heat in their houses. That people represents an homogenous group sharing the wish to have pellets to get their houses warm.

Market segmentation has many benefits such as:

- Highlights existing business opportunities (markets with unattended needs) and allows the company to respond quickly to even slight changes in what target customers want. For example, if a determined group of customers want a specific pellet certificate, the company would produce more of that certificate in order to satisfy that group's needs.
- Helps to set priorities (given limited resources). If the company had some supply problems and had limited resources, it would have to establish priorities such as choosing which certificate to produce taking into account its resources and the needs to produce a determinate quantity with a determinate quality, and also the benefits it would obtain from that production.
- Facilitates competitors analysis (focusing on the immediate ones, deciding about the kind of competitive advantage to seek). This way, Alfa wood could make advantage of every opportunity to grow externally and be better than other companies in many aspects.



The criteria for developing marketing strategies are:

1. Geographic: nations, states, regions, cities or neighborhoods.
2. Socioeconomic demographic: age, sex, family life-cycle, income, occupation, education level or social class.
3. Psychographic: psychological and personality traits, lifestyles or values.
4. Behavioral: benefit sought, usage rate, user status and occasion (time of the day/week/month/year).

When evaluating different market segments (TARGETING), the company must take into consideration the segment's overall attractiveness and its own resources and goals. Then, the company needs to decide how many segments it can serve best. They have three different targeting strategies:

- Undifferentiated
- Concentrate
- Differentiated

In the case of Alfa wood, the targeting strategy would be differentiated because the company attempts to serve all customer groups with the products they might need. The company designs and produces a different commercial offering for each segment. For example, it produces different types of pellets depending if it is for industrial use or for domestic use.

In orden to segment the market, it is also important to determine:

1. **Product**: It has to create different packaging/models for the different existing segments.
2. **Price**: Obviously depending on the quality of the ash content and the kilogram per package will affect the final product.
3. **Distribution**: Different distribution channels for different segments. Although the company subcontracts the distribution to another company, it has to take into account the cost and time involved in sending the packages depending on the sector to which they are sent.
4. **Communication**: Different communication strategies for different segments.

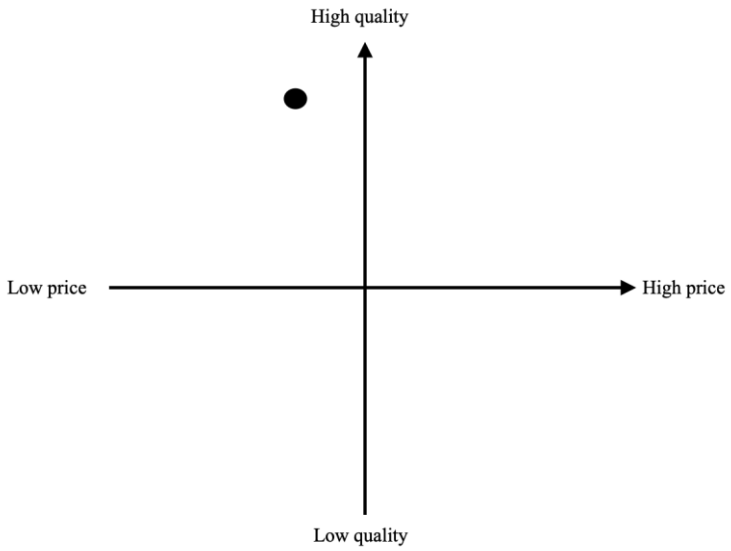
Another way of developing marketing strategies is by positioning the products in the market. The positioning consists of arranging for a market offering to occupy a clear, distinctive and desirable place relative to competing products in the minds of target consumers. It is what the company does to the mind of customers, so companies position the product or the brand in the customers' minds. The result of this strategy is the creation of a customer-based value proposition, the reason why the target customers should purchase the product.

The positioning process is the following:

1) IDENTIFY product attributes and their importance for customers.

2) EVALUATE the positioning and images of competing products.
3) ESTABLISH the desired positioning.
4) COMMUNICATE the positioning

In this case, the positioning of Alfa wood with the use of recycled materials to produce pellets would be high quality and asequible price. As we can see in the following graphic, the black point is the products made from the recycled materials, with high quality and medium-low price.



1.4.5 Implementing and controlling the marketing plan

Implementation means putting plans into action.

There are several ways to organize the marketing function:

- Functionally (separates marketing into distinct components –sales, advertising...-).
- Geographically.
- By product (brand, product line...).

Controlling means measuring actual performance, comparing it to planned performance, and making necessary changes in plans and implementation.

This process requires that marketing managers obtain feedback on whether activities are being performed well and in a timely manner.

1.5 References

1. Wisner Alexandra, Musil Robert, Tiwari Shom, Sung Sarah, & McAuliff William. (2019). Clear Cut: Wood Pellet Production, the Destruction of Forests, and the Case for Environmental Justice. Rachel Carson Council.
2. García-Maraver, A., Popov, V., & Zamorano, M. (2011). A review of European standards for pellet quality. Renewable Energy, 36(12), 3537–3540. https://doi.org/10.1016/j.renene.2011.05.013
3. ENplus - History. (2022). Enplus-Pellets.eu. https://www.enplus-pellets.eu/en-in/about-us-en-in/history-of-enplus.html
4. Ståhl, M., Granström, K., Berghel, J., & Renström, R. (2004). Industrial processes for biomass drying and their effects on the quality properties of wood pellets. *Biomass and Bioenergy*, *27*(6), 621–628. https://doi.org/10.1016/j.biombioe.2003.08.019
5. Karkania, V., Fanara, E., & Zabaniotou, A. (2012). Review of sustainable biomass pellets production – A study for agricultural residues pellets' market in Greece. *Renewable and Sustainable Energy Reviews*, *16*(3), 1426–1436. https://doi.org/10.1016/j.rser.2011.11.028
6. Nunes, L. J. R., Matias, J. C. O., & Catalão, J. P. S. (2014). Mixed biomass pellets for thermal energy production: A review of combustion models. *Applied Energy*, *127*, 135–140. https://doi.org/10.1016/j.apenergy.2014.04.042
7. Miranda, Teresa & Montero, Irene & Sepúlveda Justo, Francisco & Arranz, J. & Rojas, Carmen & Nogales, Sergio. (2015). A Review of Pellets from Different Sources. Materials. 8. 1413. 10.3390/ma8041413.
8. Hossain, Md. U., Leu, S.-Y., & Poon, C. S. (2016). Sustainability analysis of pelletized bio-fuel derived from recycled wood product wastes in Hong Kong. *Journal of Cleaner Production*, *113*, 400–410. https://doi.org/10.1016/j.jclepro.2015.11.069
9. Coconut Shell Biomass Pellet Production Line. (2016). Wood Pellet Machine Supplier. https://wood-pellet-line.com/coconut-shell-biomass-pellet-production-line/
10. Ray, A., Li, C., Thompson, V., Daubaras, D., Nagle, N., & Hartley, D. (2017). *Biomass Blending and Densification: Impacts on Feedstock Supply and Biochemical Conversion Performance*. https://inldigitallibrary.inl.gov/sites/sti/sti/Sort_8651.pdf
11. Scatolino, M. V., Neto, L. F. C., Protásio, T. de P., Carneiro, A. de C. O., Andrade, C. R., Guimarães Júnior, J. B., & Mendes, L. M. (2017). Options for Generation of Sustainable Energy: Production of Pellets Based on Combinations Between Lignocellulosic Biomasses. Waste and Biomass Valorization, 9(3), 479–489. https://doi.org/10.1007/s12649-017-0010-2
12. Whittaker, C. (2018). Production of Wood Pellets from Waste Wood. *Greenhouse Gases Balances of Bioenergy Systems*, 181–191. https://doi.org/10.1016/b978-0-08-101036-5.00012-4

13. Pellets from Pallets | Biomassmagazine.com. (2018). Biomassmagazine.com. Mostafa, M. E., Hu, S., Wang, Y., Su, S., Hu, X., Elsayed, S. A., & Xiang, J. (2019). The significance of pelletization operating conditions: An analysis of physical and mechanical characteristics as well as energy consumption of biomass pellets. *Renewable and Sustainable Energy Reviews*, *105*, 332–348. https://doi.org/10.1016/j.rser.2019.01.053

14. Sirous, R., da Silva, F. J. N., da Cruz Tarelho, L. A., & Martins, N. A. D. (2020). Mixed biomass pelleting potential for Portugal, step forward to circular use of biomass residues. *Energy Reports*, *6*, 940–945. https://doi.org/10.1016/j.egyr.2020.01.002

15. A, J. J., S, L. B., & B, M. I. (2020). THE POTENTIAL OF WOOD AND AGRICULTURAL WASTE FOR PELLET FUEL DEVELOPMENT IN NIGERIA-A TECHNICAL REVIEW. *International Journal of Engineering Applied Sciences and Technology*, *4*(11), 598–607. http://www.ijeast.com

16. Cesprini, E., Greco, R., Causin, V., Urso, T., Cavalli, R., & Zanetti, M. (2021). Quality assessment of pellets and briquettes made from glued wood waste. *European Journal of Wood and Wood Products*. https://doi.org/10.1007/s00107-021-01695-1

17. San Miguel, G., Sánchez, F., Pérez, A., & Velasco, L. (2022). One-step torrefaction and densification of woody and herbaceous biomass feedstocks. *Renewable Energy*, *195*, 825–840. https://doi.org/10.1016/j.renene.2022.06.085

2. Calculation and design of the Recycled Wood Supply System

2.1 Input data of the project

2.1.1 Properties of the pellets and their production

To better understand how recycled material can play a role in a pellet company as alfa Wood we need to dive deeper into what pellets are, how they are made and what are the characteristics of this high-quality pellets the company and the market are so adamant of.

Pellet is a form of biofuel with a wide range of applications, consisting of agglomerates or biomass compacts, and is actually a type of natural biofuel in woody form, also known as a wood pellet. Pellet is a standardized cylindrical biofuel 40 mm long and 6 mm in diameter with quality specifications. for the preparation of which no chemical additives or other substances are used, thus making it a completely environmentally friendly product.[12]

As seen in the previous chapter pellets change their properties due to the source material they are made of. The objective of this Solid Biofuel is to replace non-renewable energy sources such as coal and oil, it is commonly compared to coal due to the nature of the usage of this product, which is via burning. Pellets can be used to produce heat and energy depending on the machine it is placed on, for domestic use, it is mostly used for heating. The reason why pellets have become a great source of energy compared to the raw biomass with which they are produced is that through the pelletizing process the properties improved to a longer burn and less residue produced.

Alfa wood is a wood treatment company, therefore they exclusively deal with wood pellets, to which they acquire round pine wood products for the elaboration of pellets and briquettes.

The common process for the pelletizing method comes in 9 stages which are:

Raw material Preparation: The company acquires their biomass of choice and stores it to later be introduced into the process, this time is also taken advantage for reducing the moisture content of the material. Alfa wood proclaims that for every 2 tons of raw material 1 ton of pellets come out of it, due to the later process of water loss and debarking.

Size reduction: for pellets, the size shouldn't be bigger than a diameter of 5mm. This first stage of reducing the raw material comes with debarking since the company buys the raw round pine wood. The final product is around 40 mm after this stage.

This stage is accompanied by the **sieving** process, in which any contaminants are removed. This is normally done by a de-stoner or magnetic separator. In the case of Alfa Wood, since their raw material is virgin the most contaminants they have is the bark which is extracted with the chipping process.

After that, the material is collected in 2 different industrial 500 tons silos, and 1 for sawdust. There the proportions can be controlled and sent to the pelletizing process according to the recipe of the day.

After the materials are selected they pass through a second grinding process to arrive at the 5 mm size needed for pelletizing and are later sent through a rotary drum dryer to reduce the moisture content to 8-12%.

Then comes the process of pelletizing where the material is pressed through a die and with heat and pressure the pellet is formed. Due to the natural components of wood, the particles remain together thanks to the lignin produced by the wood under pressure. The machine used to pelletize the raw materials into wood pellets is called a pellet mill. A Ring die pellet mill is the one used in Alfa wood and has a capacity of over 1ton per hour.

later comes the cooling stage to allow the pellet to settle and maintain its form and after that comes the final checkup and packaging. Alfa Wood conducts a daily test on their pellets to ensure the final product not only works but is up to the standard they are guaranteeing. They do this daily for the En plus certification on their products since the Deutsches Pelletinstitut comes around once a year to collect the daily test results and conduct their own testing in order for them to maintain their product certificates.

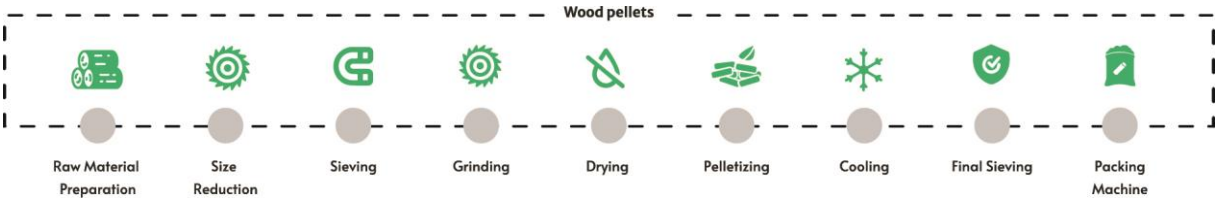


Figure 5. Pellet Production.

This system, therefore, ensures that the pellets produced in the factory have some specific properties. Since their 6 varieties of products are under the A1 A2 and B certificates we can ensure that their properties are as followed in the table .

Property	Unit	ENplus A1	ENplus A2	ENplus B	Testing standard [11]
Diameter	mm	6 ± 1 or 8 ± 1			ISO 17829
Length	mm	3,15 < L ≤ 40 [4]			ISO 17829
Moisture	w-% [2]	≤ 10			ISO 18134
Ash	w-% [3]	≤ 0,7	≤ 1,2	≤ 2,0	ISO 18122
Mechanical Durability	w-% [2]	≥ 98,0 [5]	≥ 97,5 [5]		ISO 17831-1
Fines (< 3,15 mm)	w-% [2]	≤ 1,0 [6] (≤ 0,5 [7])			ISO 18846
Temperature of pellets	°C	≤ 40 [8]			
Net Calorific Value	kWh/kg [2]	≥ 4,6 [9]			ISO 18125
Bulk Density	kg/m³ [2]	600 ≤ BD ≤ 750			ISO 17828
Additives	w-% [2]	≤ 2 [10]			-
Nitrogen	w-% [3]	≤ 0,3	≤ 0,5	≤ 1,0	ISO 16948
Sulfur	w-% [3]	≤ 0,04	≤ 0,05		ISO 16994
Chlorine	w-% [3]	≤ 0,02		≤0,03	ISO 16994
Ash Deformation Temperature [1]	°C	≥ 1200	≥ 1100		CEN/TC 15370-1
Arsenic	mg/kg [3]	≤1			ISO 16968
Cadmium	mg/kg [3]	≤ 0,5			ISO 16968
Chromium	mg/kg [3]	≤10			ISO 16968
Copper	mg/kg [3]	≤10			ISO 16968
Lead	mg/kg [3]	≤10			ISO 16968
Mercury	mg/kg [3]	≤ 0,1			ISO 16968
Nickel	mg/kg [3]	≤10			ISO 16968
Zinc	mg/kg [3]	≤100			ISO 16968

[1] ash is produced at 815 °C
[2] as received
[3] dry basis
[4] a maximum of 1% of the pellets may be longer than 40mm, no pellets longer than 45mm are allowed.
[5] at the loading point of the transport unit (truck, vessel) at the production site
[6] at factory gate or when loading truck for deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)
[7] at factory gate, when filling pellet bags or sealed *Big Bags*.
[8] at the last loading point for truck deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)

Table 13. Threshold values of the most important pellet parameters.[11]

The properties of the final pellet are highly regarded by the company and for a pellet, out of recycled materials some parameters are to be in question. Since the nature of the source material is from the same origin as the current raw material some properties are of no concern when producing wood pellets. The main ones to take into consideration are the moisture content, the ash percentage, the calorific value (which are not set in the certificate but should lower the company's current standards), and of course the contaminants which can be represented in the elements found in the end product.

2.1.2 Properties of the Recycled Materials

As previously touched on in the state-of-the-art section recycled material was thought for the possible use in the production of high-quality pellets. This is due to the test made from different entities and the properties that were affected by it. Something important to denote is that not all recycled materials are able to produce the same quality pellet, in order to achieve it a specific source should be acquired. For this measure, the wood wastes have different categorizations which will later be expanded on for the implementation of the system.

Parameters	unit	Pallet	En Plus
Energy Value	Mj/kg	18.95	-
Moisture Content	%	10.20	0.2% over the limit
Cd	mg/kg	<0.005	A1
Cr		0.112	A1
Cu		0.464	A1
Fe		2.075	-
Pb		0.067	A1
Zn		0.890	A1
N	%	0.20	A1
C		46.40	
H		6.50	-
O		46.50	-
S		0.00	A1
Ash		0.40	A1

Table 14. Pallet pellet properties with Enplus grading in comparison.

The properties at hand from table 5 were taken and compared with the EN plus properties in order to analyze if it can be a proper source for high-quality pellets, this can be evident in table 13.

The pallets used in these studies were for shipping and packaging goods, they normally have a 12-year life cycle before being thrown away either for landfills or recycling. The pellet produced was of the same diameter the En plus certificate accepts (6-10mm diameter) and the

final product proposes a calorific value of 18 MJ/kg which corresponds to 5 KWh/kg which is the average value of the Alfa Wood Pellets.

The table 14 also proposed high-quality pellets out of wood treatment shavings and were compared to the En plus properties. In the end, the Recycle wood proposes an excellent raw material for the pellets yet a proper treatment should be done first and that is where the recollection comes into play.

2.2 Calculation and design of the Final solution

2.2.1 Recycled Wood Waste Greece

For the next part we evaluate the quantities that can be obtained in order to even consider the possibility of the recycled wood waste as a viable source for production at the capacity of a big wood company such as ALfa Wood.

For a yearly production of around 60.000 tons of pellets, a company like alfa wood purchases around 120.000 tons of round pine wood due to the ratio of lost during the production is around 2:1. Therefore we need to calculate via third-party research if the quantities are available.

Another thing to look around for is the quality of the recycled material. Wood waste is not simply clean pieces of untreated pine offcuts. A system of classification is required to differentiate between different grades of wood waste material. In Europe, there is a classification system that relates to the type of wood product from which the waste originated and what (if any) treatment had been applied to the original wood product. This approach results in a three-tiered A-B-C (or variations thereof) categorization of wood waste (Warnken, 2001): A) Wood waste is derived from untreated solid wood materials. B) Wood waste is derived from engineered panel products such as particleboard, medium density fibreboard, and plywood. C) Wood waste is derived from preservative-treated timber products. [3]

Some studies propose different calculations for the amount of wood waste available in greece. The waste wood quantities in Greece available for thermal recycling are estimated at 1,070,000 m3 /yr (640,000tn/yr), corresponding to 288,000 toe [1] as proposed by a 2004 study. This in terms allows us to stipulate that if the classification were to be equally divided we can be talking of around 213.000 to 426.000tn/yr of possible source material.

Of course, the division of these quantities is not accurate and is not recent enough to produce a viable system yet there are set institutions that are in charge of recollecting and managing this waste. The Ministry of Environment and Energy (YPEN) is responsible for the

development and implementation of environmental and waste management policies at the national level. This means they are responsible for the classification of these wastes. they have put up some policies and calculations according to recent years and have also calculated some projected numbers.

The current number stipulates some low quantities of wood-related wastes for the recycling sector as of 2017, as can be seen in the table 15. In the same report, they also project a new number for the year 2020 in which they speak of the wood wastes and their possible recycling quantities, seen in table 16.

Materials	Material recycling* (tonnes)	Other forms of recycling (tonnes)	Total recycling (tonnes)	Energy recovery (tonnes)	Total recovery (tonnes)
Glass	34,531	0	34,531	0	34,531
Plastic	81,701	0	81,701	12,600	94,301
Paper/ Cardboard	551,132	0	551,132	8,400	559,532
Metal	64,628	0	64,628	0	64,628
Wood	3,200	7,600	10,800	2,200	13,000
Organics	224,603	0	224,603	36,000	260,603
Total	**950,824**	**7,600**	**967,395**	**59,200**	**1,026,595**

*Including composting

Table 15. Total Quantities of Greece's waste (per specific stream) recycling and recovery for 2017 (YPEN, 2019).[4]

		2020 TARGETS BASED ON NWMP				
		RECOVERY THROUGH SEPARATE COLLECTION		RECOVERY THROUGH MBT FACILITIES		DISPOSAL
MATERIAL	TOTAL PRODUCTION (tn/yr)	SORTING AT SOURCE RATE (%)	COLLECTED QUANTITIES THROUGH SEPARATE COLLECTION (tn/yr)	MBT INPUT (tn/yr)	RECOVERY (tn/yr)	LANDFILLING (tn/yr)
Bio-waste	2,560,500	40%	1,024,200	1,536,300	1,024,200	512,100
Paper	1,283,200	65%	% 1,664,325	896,175	256,050	640,125
Plastic	803,400					
Metal	225,400					
Glass	248,500					
Wood	265,800	50%	132,900	132,900	79,740	53,160
Rest Recoverable	93,200	70%	65,240	27,960	4,660	23,300
Others*	300,000	0%	-	300,000	-	300,000
Total	**5,780,000**	**50%**	**2,886,665**	**Bio-waste**	**Bio-waste**	**Bio-waste**

*Informal sector – waste pickers/scavengers

Table 16. 2020 Targets based on National Waste Management Plan (NWMP, 2015).[4]

The amounts projected stipulate 265.800 tons of wood waste of which 50% are to be processed for recycling. it would be incorrect of us to assume that the full amount of the

recovered material was to be used for the input of the Alfa Wood Company yet it introduces the possibility of a sustainable source material that could feed the whole production process. At the most, it proposes a reduction in other non-sustainable and expensive materials. For comparison a ton of high-grade recycled wood can go for about 20 euros in 2022 (taken from the lets recycle price page) [13] to the 80 euros a ton of round pine wood costs.

A proper way to obtain high-grade recycled wood in Greece is via third parties which already work in the sector as is the case of the Siakandaris Group.

2.2.2 Introduction to the system

For the proposal of the system we evaluate the current production process of the Alfa Wood Company to see at which stage the material has to be properly inserted and also where can they collect the proposed source material.

The company explained to us the fact that currently, they look for material inside a 600-500 km region since out of this range the relationship between transportation costs and the cost of the materials is not viable for earnings. This draws a map, figure 6, that expands into Bulgaria, north Macedonian and Greece. Meaning the final input of the source material can be higher than that stipulated in the previous chapter. Companies like the Siakandaris Group [2] which are pre-established recycling companies in the region and have operations around the country can guarantee a high-grade pretreated recycled wood chip. Their promise relies on the following: "*The final fine product is now ready to be used as a raw material in the wood industry, for the production of paper or even for the production of alternative fuels."* The transportation can be achieved by a fleet inside the tertiary company with whom they manage their current transportation inside this region.

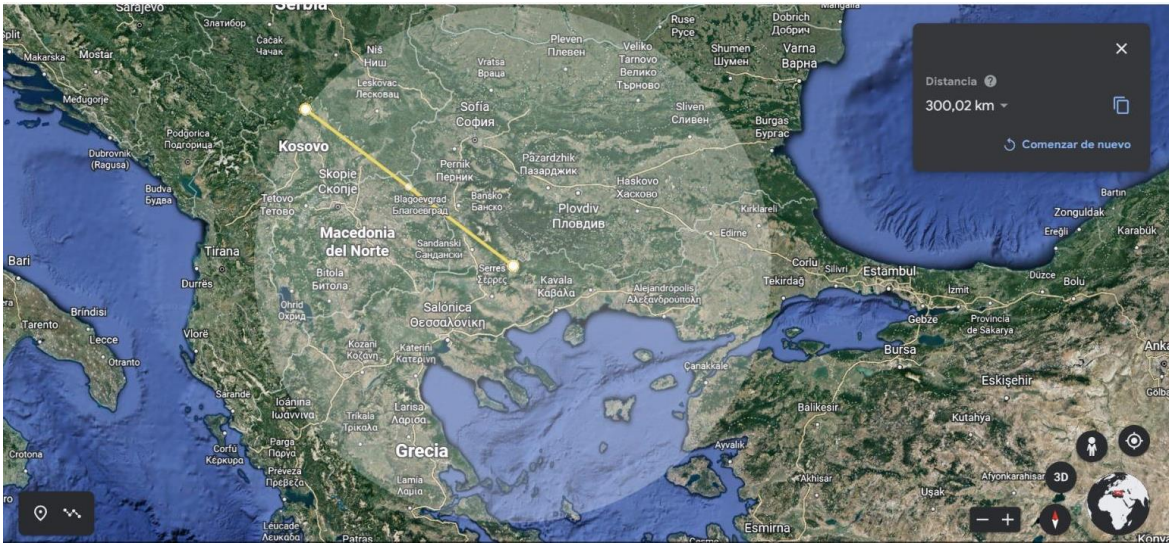


Figure 6. The 600km region from the Alfa Wood Nevrokopi site.

For the introduction to the system, we are assuming the proposed material arrives pretreated to the plant, as companies like the Siakandaris Group [2] promise the following pretreatment

"*The treatment of the wood easte is initially hand-based in order possible impurities to be removed from the main material stream. Then, through a special shredder the clean wood input stream is crushed. During the extraction process of the shredded material from the shredder, the wood stream passes through a magnet. The magnet's purpose is to isolate and collect any remaining small metal piece (nails, screws, hoops, etc.).*"

With this promise, the first 3 stages of the production are already guaranteed by the provider figure 7.

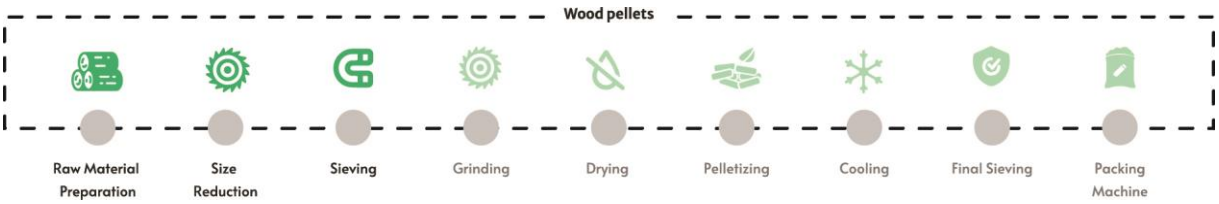


Figure 7. Processes that intervene in the pellet production inside Alfa Wood Nevrokopi

Due to the other qualities and products Alfa Wood already produces we do not suggest they throw in this material as a complete substitute but start as a new product line and give it a trial for year-round certification quality consistency. for this procedure to be done they would have to handle their storage carefully and not mix the recycled source with the round pine wood. the possibility being explored could be a new 500-ton silo figure 7 that can automatically feed the process with the new source material and enter the main production line when the moment comes to produce, as AlfaWood changes recipes and packaging from intervals of time to produce their 6 different graded pellets.

Figure 8. Current 500-ton silos of the Alfa Wood Nevrokopi Company

2.2.3 Overview of the final System

For the final overview of the system, we evaluate the whole multitraces program as a systemic project. As it can be appreciated in the figure 9 the strategy 2 tackles the insertion of the new recycled material source material solution to the current alfa Wood Company system, as it can be compared with the first map in figure 3.

The Project proposes a collaboration with YPEN and companies like the Siakandaris group the company could get a constant source material of around 66.000 tons of recycled wood, approximating a 50% intake of the recycled wood waste stipulations for the year 2020 [4]. This will be treated beforehand therefore not to be expected investment from part of the company other than the 500-ton storage silo that will automatically feed the process. After that, a new product will come out of it, promoted as high-quality pellets made from recycled wood, to which they can test the market.

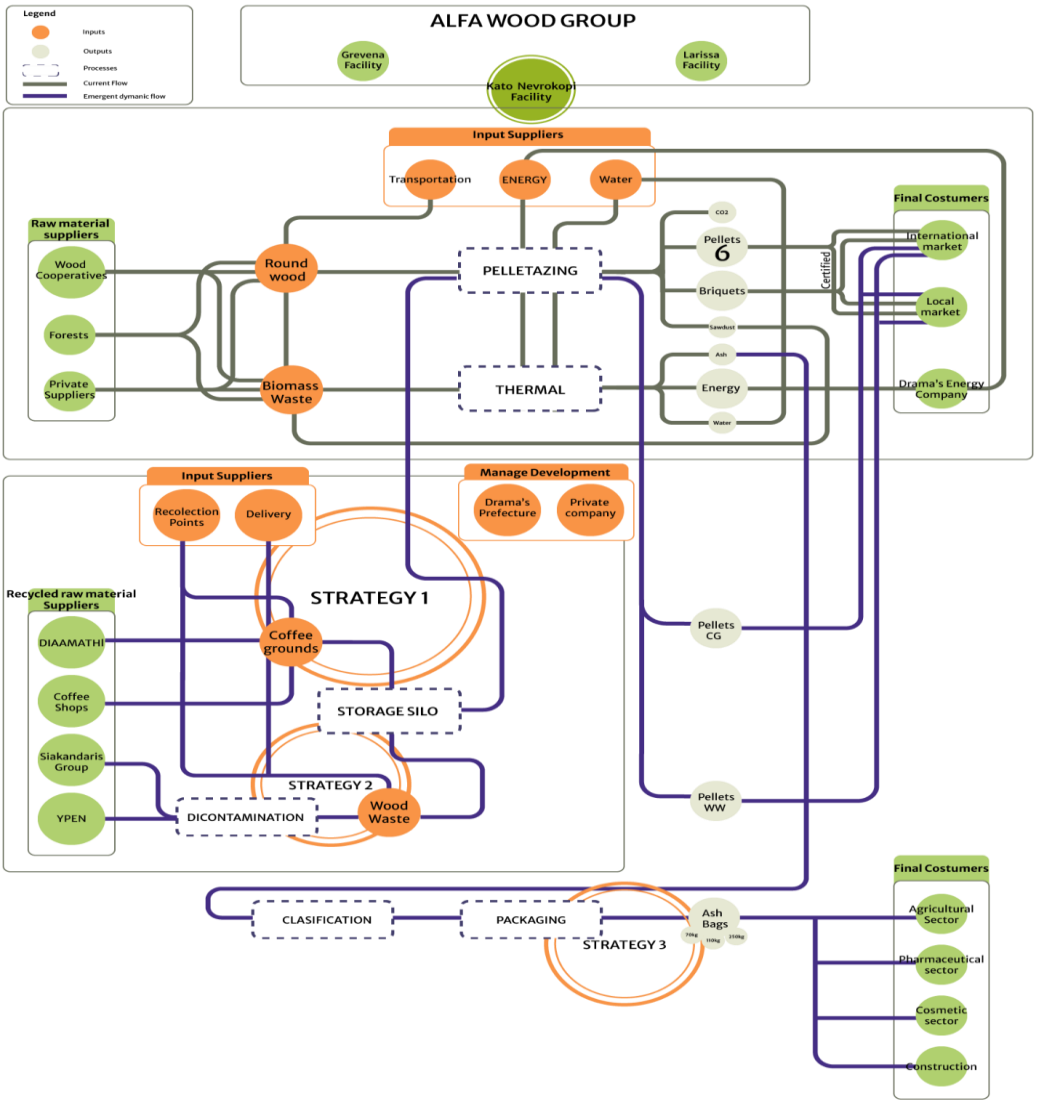


Figure 9. Multitraces Program 2022 Systemic Project on the Alfa Wood Nevrokopi Company

2.4 Conclusion

For the calculation of the final design for the project "The Use Of Recycled Materials In The Production Of High-Quality Pellets" we first talked about the properties of high-quality pellets as the main parting point for the future pellets since it is the companies standards. here we made evident the elements it contains but more precisely the properties which are more accounted for when making En plus pellets, these are special qualifications for wood pellets, and the main difference between wood sources are the calorific value, ash percentage, and moisture content.

The recycled wood pellet showed to be a suitable material for high-quality pellets as the ash percentage and the other elements entered inside the en plus A1 requirements, yet the moisture content was above the range for only 0,2% something that could be lower inside the drying and keep it inside the requirements.

The viability of the project is confirmed till that point, is in the calculation related to the amounts available that the feasibility of the production that can the numbers do not give a clear picture. as Greece proves to improve their waste recollection still the amounts and effort are not properly up to date to guarantee a final amount, even less how many of it can be acquired from a single company. This study invites the future indagation on the current numbers of wood wastes and what amount can be retrieved for the pellet production.

As for the system's final introduction, with a low investment from part of the company, the new source material can be acquired in a pretreated way, in which the company wouldn’t have to invest more into the decontamination of the wood, and simply go by as usual.

The study also suggests the acquisition of pretreated material from the Siakandaris Group in order to perform some preliminary tests of pelletizing the material to corroborate the hypothesis planted by this study and the test done by the state of art presented in chapter 1.3

2.5 References

1. Kakaras, Emmanuel & Evangelos, Karlopoulos & Pavloudakis, Francis. (2002). The Use of Waste Wood for Energy Production: Technical Aspects and Management Issues. 10.1007/978-1-4615-0296-8_49.
2. WOOD RECYCLING | Siakandaris Group. (2017, April 6). Siakandaris Group | Ανακύκλωση - Διαχείριση Αποβλήτων. https://www.siakandaris.gr/en/recycle/wood-waste-recycling/
3. Karlopoulos, E., Grammelis, P., Christidou, M., Chovan, T., Varbanov, P., & Klemeš, J. (2013). Estimation of the Potential for Low Cost Solid Fuels of Selected Areas in Hungary and Greece. 35. https://www.aidic.it/cet/13/35/103.pdf
4. I. FRANTZIS & ASSOCIATES LTD AND BLACKFOREST SOLUTIONS GMBH. (2020, April). GUIDE ON SEPARATE COLLECTION OF MUNICIPAL WASTE IN GREECE. https://ypen.gov.gr/wp-content/uploads/2021/09/Final-Report_A1.1_Separate_Collection_20200624_final.pdf
5. Hossain, Md. U., Leu, S.-Y., & Poon, C. S. (2016). Sustainability analysis of pelletized bio-fuel derived from recycled wood product wastes in Hong Kong. Journal of Cleaner Production, 113, 400–410. https://doi.org/10.1016/j.jclepro.2015.11.069
6. Cesprini, E., Greco, R., Causin, V., Urso, T., Cavalli, R., & Zanetti, M. (2021). Quality assessment of pellets and briquettes made from glued wood waste. European Journal of Wood and Wood Products. https://doi.org/10.1007/s00107-021-01695-1
7. Make Fuel Pellets from Pallet Factory Residue. (2018, November 16). Biopellet Machine & Wood Pellet Plants Manufactures-One-Stop Service. https://www.biopelletmachine.com/biopellet-making-guidance/make-pallet-factory-residue-into-pellets.html
8. Aruna, P., Laarman, A., Hil, P., Raman, A., Dward, E., Oulter, C., Rederick, F., Ubbage, C., & Bstract, A. (n.d.). S OLID W OOD P RODUCTS U SED PALLETS AS A SOURCE OF PELLET FUEL: CURRENT INDUSTRY STATUS. Retrieved July 23, 2022, from https://www.srs.fs.usda.gov/pubs/ja/ja_aruna003.pdf
9. Whittaker, C. (2018). Production of Wood Pellets from Waste Wood. *Greenhouse Gases Balances of Bioenergy Systems*, 181–191. https://doi.org/10.1016/b978-0-08-101036-5.00012-4
10. About Energy Pellets of America | Wood Pellets | Bedding Pellets. (2018, June 29). Energy Pellets of America; Energy Pellets Of America. https://www.energypelletsamerica.com/about/
11. ENplus Handbook, Part 3 -Pellet Quality Requirements ENplus Quality Certification Scheme Part 3: Pellet Quality Requirements. (n.d.). https://enplus-pellets.eu/en-in/component/attachments/?task=download&id=103
12. Pellet - ALFA WOOD GROUP - PELLET & BRIQUETTE INDUSTRY. (2018). Alfapellet.gr. https://www.alfapellet.gr/en/pellet-mpriketa/pellets.html
13. Wood prices 2022 - letsrecycle.com. (2022, July 5). Letsrecycle.com. https://www.letsrecycle.com/prices/wood/wood-prices-2022/

3. Investment cost and profitability analysis

3.1 Cost of the proposed solution

CATEGORY	COST	VALUE	
	Shipping, transport and logistics	40€	/ton
	Packaging	24€	/ ton
	Commodities	20€	/ton
	Employee salaries	44000	monthly
	Taxes and deductions	24	%
Direct costs	TOTAL	44.084€	
	Bank interests	3%	
	Depreciation of machinery	10%	
	Indirect material for production	85€	
	Energy bills	20€	/ton
Indirect costs	TOTAL	119€	
Intangible costs	Productivity losses	10%	
Benefits		12708,3	
Total costs		44.084	
Total costs 20%		8.817	
Net cost-benefit		112,15	
Net present value		68.705.915	

3.2 Benefit of the proposed solution

Benefits	
Kg	**Euros**
1	2,5
15	6

5.500.000	13750000,00

3.3 Cash flows

CASH FLOWS				
Years	Investment	Income monthly	Expenditure	FCA
0	7.000	0	0	0
1	0	13750000,00	8.817	13.741.183
2	0	13750000,00	8.817	13.741.183
3	0	13750000,00	8.817	13.741.183
4	0	13750000,00	8.817	13.741.183
5	0	13750000,00	8.817	13.741.183

Sum of income	68750000	
Sum of expenditure	44.085	
Cost Investment	51.085	
C/B	1345,80	annually
	112,15	monthly

3.4 Conclusions

In this part of cost and profitability analysis we have studied all the costs of the proposed solutions to the company. We have also made hypotheses about the possible benefits that the company may obtain with a certain quantity of sold pellets made by recycled materials.

In the first table we have divided the direct, indirects and intangible costs with its components and we have calculated the total costs as well as the total costs with just the 20% of the company involucrated in the project.

Then, talking about the benefits of the proposed solution, we have discovered that the company sells 15 kg for 6 euros, so 1 kg is 2,5 euros. Due to this, if the company sells 5.500.000 kg per month, it would obtain 13.750.000 euros in total.

From this quantity, the real benefit is 13.741.183 euros, taking into account that the company does an investment of 7.000 euros, for a space to store all the recycled materials, and has an expenditure (direct, indirect, intangible costs from the 20% of the company) of 8.817 euros each month.

These operations have led us to conclude that the net cost-benefit is of 112,15 euros per month and the net present value is 68.705.915 euros.

3.5 References

Home. (s/f). AlfaWood. https://en.alfawood.gr//

2. COFFEE GROUNDS AS AN ALTERNATIVE INPUT RESOURCE FOR MAKING PELLETS, ALFA WOOD FACILITY KATO NEVROKOPI CASE STUDY.

Mentors:

International Hellenic University:

Vassiliki KAZANA,
Dimitris RAPTIS

ALFA WOOD group S.A.

Dimitris Lazos

Students:

Andrea Rordríguez
andreaaars18@gmail.com

Comîrlă Rareș-Ionuț
youremailhere@gmail.com

Jesús David Ortiz
j2.idesigner@gmail.com

Nicolás Mondelli
nicolasmfavaloro@gmail.com

Silvia Moreno
youremailhere@gmail.com

Trăistaru Ștefan-Iulian
traistarustefan10@gmail.com

Content of the project

1. Project overview 49
1.1 Executive summary 49
1.2 Introduction to the Problematic 51
1.3 Short review of Coffee consumption and waste in Greece 52
1.4 State of art 53
1.4.1 Historical framework of the context 53
1.4.2 Existing solutions 56
1.5 Description of the final solution 61
1.6 Marketing Plan 61
1.6.1 Strategic management planning and marketing 61
1.6.2 Analyzing the marketing environment 62
1.6.3 Setting marketing objectives 66
1.6.4 Developing marketing strategies 66
1.6.5 Implementing and controlling the marketing plan 69
1.7 References 69
2. Calculation and design of the system/ installation/equipment 72
2.1 Input data of the project 72
2.1.1 Properties of the pellets and its production 72
2.1.2 Properties of the Coffee Pellets 76
2.2 Calculation and design of the Final solution 77
2.2.1 Coffee Shops-Waste in Drama 77
2.2.2 Introductión to the system 79
2.2.3 Overview of the final System 80
2.4 Conclusion 81
2.5 Reference 82
3. Investment cost and profitability analysis 83

1. Project overview

1.1 Executive summary

Quick overview

The following paper represents the culmination of the Multitraces European program for the International Hellenic University. The program has the role to facilitate collaboration of multidisciplinary students from 4 different countries, universities, and career paths, all with the purpose of developing projects with local companies from a circular economy and systemic approach. The presented case for this paper relates to the Alfa Wood Group Company, one of the biggest wood treatments in Greece, in a specific one of the companies belonging to the group, Alfa Wood Nevrokopi. The company located in the prefecture of Drama, in the vicinity of the town of Kato Nevrokopi works on the production of wood pellets and briquettes. They gladly collaborated with this program to provide their knowledge and assistance for the development of 4 different projects. The developed project portrayed in this paper relates to " COFFEE GROUNDS AS AN ALTERNATIVE INPUT RESOURCE FOR MAKING PELLETS, ALFA WOOD FACILITY KATO NEVROKOPI CASE STUDY. ". The study proposed a variety of state-of-the-art solutions surrounding this topic and chose and developed the most suitable one related to the territory and company, in this case, high-grade wood coffee pellets made from spent coffee grade waste, which yields the optimal properties for the production of A2 and B1 En plus certificate for high-quality and it is a growing source of raw material that is a waste in the general economy and can be recycled into energy and heat.

Systemic Analysis

The Territory of Kato Nevrokopi inside the prefecture of drama represents an advantageous location strategy for the high number of businesses that produce coffee waste. The city of drama with a high number of coffeeshops în close proximity represents an easy way of collecting the spent coffee grounds for the company. Alfa wood deals with wood aș their main source for production , therefore even if spent coffee grounds may not be a good addition to the pellets it can be used as biomass for burning.

Systemic Project

The project for "COFFEE GROUNDS AS AN ALTERNATIVE INPUT RESOURCE FOR MAKING PELLETS, ALFA WOOD FACILITY KATO NEVROKOPI CASE STUDY."

develops a new company systemic strategy. The purpose of the systemic view looks to improve not only the system that is a company as Alfa Wood but also the one to which it is or will be interconnected with. The project proposes the use of spent coffee grounds waste that can be located în the city of Drama and the region of Kato Nevrokopi from their current 600km region of material collection. The Project proposes a collaboration with DIAAMATHI

and companies that produce and collect coffee waste. After that, a new product will come out, promoted as high-quality pellets made from spent coffee waste, to which they can test the market. for later be sold to their current market at a better price, helping in terms of reduction and adding value to the spent coffee waste in the region. Also, it impacts the ecological aspect by reducing waste that is bad for the landfill.

Methodology & Implementation

For the development of this project and papers the systemic design methodology was proposed. This implies the elaboration of 5 stages which are part of a holistic diagnosis of the company and the territory, identification of challenges, identification of opportunities, the development of the system, and the analysis of the outcomes. For the program in question, due to the duration stipulated for it, the methodology was adjusted. The program also proposed the elaboration of 4 different papers, made from projects given by the company, through the formation of groups according to the number of students, this case 8 students, 2 for each paper/project. For the adaptation and the proper development of a systemic project the next approach was taken, in order to obtain a complex multidisciplinary result we decided on working together on each of the 3 papers, this excluded the national team that developed the fourth project which was stipulated from the beginning as a side project. this meant the proper implementation of the different disciplines for each of the papers. This way a Gantt chart was produced for the general production of the 3 papers. This divided the work into different phases. The methodology was adapted due to the previous information at hand which included the holistic diagnosis and the challenges and opportunities that were already given by the company. Our phases were the following: Project Conception and Initiation & Planning, Research Phase, Conceptualization & Analysis, Work Assessment & Design Phase, Project Elaboration Experimentation, and Project Deliverables. Each of these was divided by week and culminated in the delivery of the papers and the presentation on the 28 of July 2022.

Financial Highlights

- Benefits that the company may obtain with a certain quantity of sold pellets made from spent coffee grounds.
- A low cost for implementation determined by the close proximity to the coffee shops for collecting the waste and no additional machinery needed în the process of production.

1.2 Introduction to the Problematic

In recent decades, and due to the global interest in combating climate change and greenhouse gasses in particular, renewable energy has become one of the main reference points for this purpose. Biomass is the fourth most widely used energy resource in the world and is widely available at reasonable prices. Unlike other feedstocks for biofuels, biomass residues or wastes do not compete with food supply and are widely available at reasonable prices *[1]*. Subsequently, the use of alternative biomass wastes such as food processing wastes has been found to be particularly beneficial in reducing greenhouse gasses. Generally, this alternative biomass is not used and usually ends up as accumulated waste combined with poor disposal.The process of waste-to-energy conversion into a valuable product is an effective way to solve the problem of waste management, which, although common in all countries of the world, is caused by exponential factors such as population growth, industrial growth and consumerism, furthermore its use could also helps to control or mitigate environmental degradation. Direct combustion is a thermochemical technique for converting biomass into heat and work *[10,11]*. Compacted solids known as fuel pellets (FPs) are sustainable and high quality biomass-based materials that are granular and have the shape of spheres or cylinders with a size of a few centimeters *[12]*. FPs are consumed for electricity and power generation, as well as for residential heating and district heating *[13]*.

In 2018, 52% of FP consumption was in the residential sector and 48% of FP consumption was in the industrial sector *[4,5]*. There are different types of FPS produced from different resources. The best known type, on which most certifications are based, is wood pellets. Burning wood pellets does not affect the overall balance of CO2 in the atmosphere because they are derived from renewable resources.

In 2018, the largest FP consumer was the EU 28 with 26.05 million tonnes (50%), followed by China with 17.6 million tonnes (33%) *[4,5]*. The growth of the global pellet market is steadily increasing due to the increased demand as a substitute for coal, as well as the current crisis in the Russian-Ukrainian conflict. This growth has allowed the energy industry to look at waste from agriculture, forests, or a combination of both to a possible response to the shortage.

The European Union is in line with the United Nations Sustainable Development Goals (SDGs), which set 17 targets to transform our world into a more sustainable one. Recycling waste into biofuels and value-added products is among these goals to help transform our world into a greener one with affordable and clean energy, sustainable cities and communities, responsible production and consumption of resources, and combating climate change *[14]*.

Such a goal can only be achieved through the circular economy, which not only uses solid waste, but also creates a network with the various stakeholders involved, both private and public, to develop conversion of such waste into valuable products and clean energy sources. Spent coffee grounds (SCG) are the main by-product of coffee production that are currently treated as worthless waste and their recycling has not yet been explored *[9]*.

In addition, the energy industry has become interested in using these coffee wastes as an alternative to improve pellet quality, as they have been shown to have good heating capacity and lower ash production as long as they are mixed with high quality biomass, an important amount of research has been done on this topic.

Due to the increase and shortage of raw material prices in the post-Kovid period, Alfawood will not reach its annual production target of about 60,000 tonnes of pellets by 2022. Therefore, it is important to look for alternatives that do not reduce but improve the quality of its certified products, which are known for their excellent quality, thus creating economic benefits for the company. The main objective of the project is to demonstrate quantitative and qualitative technical data that prove the potential of SCG as a viable innovative alternative to the pellet production in Alfa Wood.

1.3 Short review of Coffee consumption and waste in Greece

Coffee is the most consumed beverage in the Western world after water. Consumption in the domestic market is increasing year after year, not only in terms of quantity consumed, but especially in terms of quality *[16,17]*. Greece may not be the first place that comes to mind when talking about coffee, but Greeks have deep roots with coffee culture, it is an integral part of their culture and they love their way of preparing coffee so much that they take it seriously as a daily ritual (day and night) that cannot be missing in their routine. The coffee industry in Greece is huge, according to the World Coffee Organization, Greece ranks 17th among the countries with the highest coffee consumption in the world, with a per capita consumption of 5.4 kg per year. In 2018, Greeks consumed 40,000 tonnes of coffee, equivalent to 5 billion cups of coffee/510 pairs per person. Greeks enjoy 40% of coffee in a coffee shop (consumption value 3 billion) and 60% at home (consumption value 400 million)*[2,3,16,17]*.

According to EUROSTAT reports *[6,7]*, Greece produces 524 kg of solid waste per person per year, of which 407 kg (78%) ends up in landfills, more than 40% of which is organic waste. Greece has one of the highest landfill rates in the EU and is far from EU targets. The Greek state does not have a strong public policy to support effective separation, collection and reuse of organic waste, even though the European Union requires all its member countries to achieve relatively high recycling rates. At the same time, Greece performs poorly in eco-innovation and recycling of municipal waste, which are prerequisites for achieving a circular economy. In particular, Greece is the fourth worst country in terms of recycling in all of Europe.

Consequently, Greek urban centers have a problem not only in terms of environmental degradation, but also in terms of environmental, social and financial unsustainability.

1.4 State of art

1.4.1 Historical framework of the context

Nowadays, there are a large number of documented studies on various ways and means of treatment, disposal, reuse and recycling of SCG in different categories and scientific disciplines. This is due to the technological progress made in this context in areas such as agriculture for use in biofuels, pharmaceutical and industrial chemical industries, composting, papermaking and many others due to their chemical properties that favor these types of processes.

In this context, there has been increased interest in the use of SCG for bioenergy production because in many ways it is an ideal waste stream for energy production, as it is a "clean" compound that requires no or minimal separation of environmentally harmful components and is therefore relatively easy to use and suitable for waste-to-energy systems. However, since we are in a sector where product certifications, in this case of pellets and briquettes, are very important in terms of compliance with production, chemical and environmental standards, there are several studies that indicate that SCGs need to be blended with organic components, preferably wood *[15, figures1,2,3,4,5]* in order to achieve the standardization, showing that SCG can even improve the calorific value and reduce the amount of ash, in contrast to the results when pellets are made by only SCGs components.

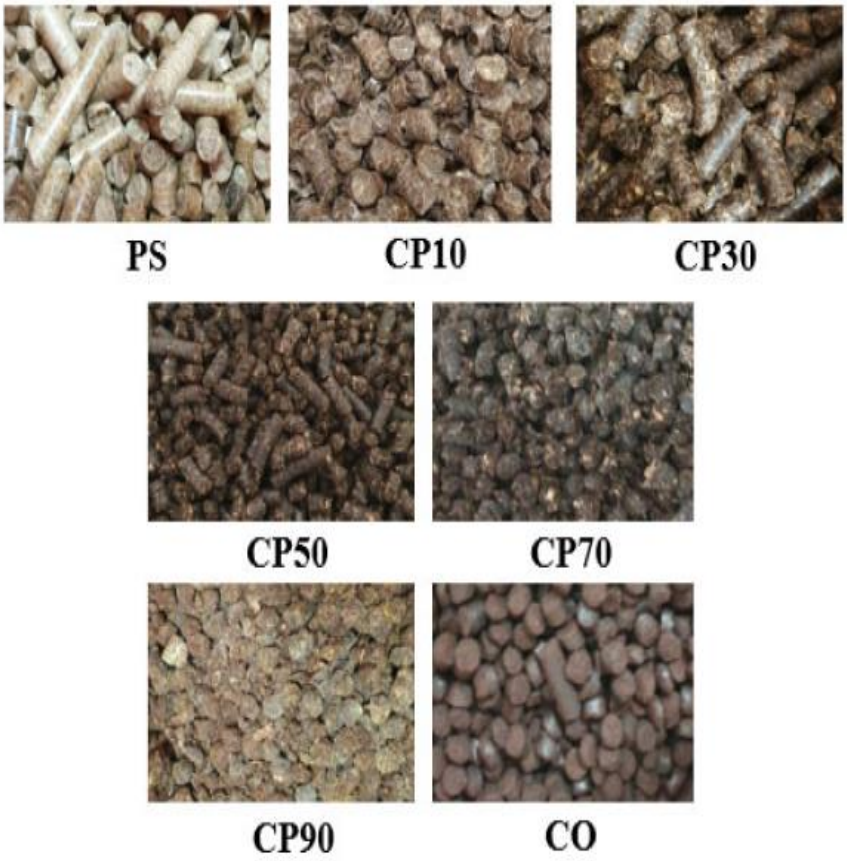


Figure.1 Pellets produces using various blending ratios of SCG and Pine sawdust CPn, n=% of SCG used

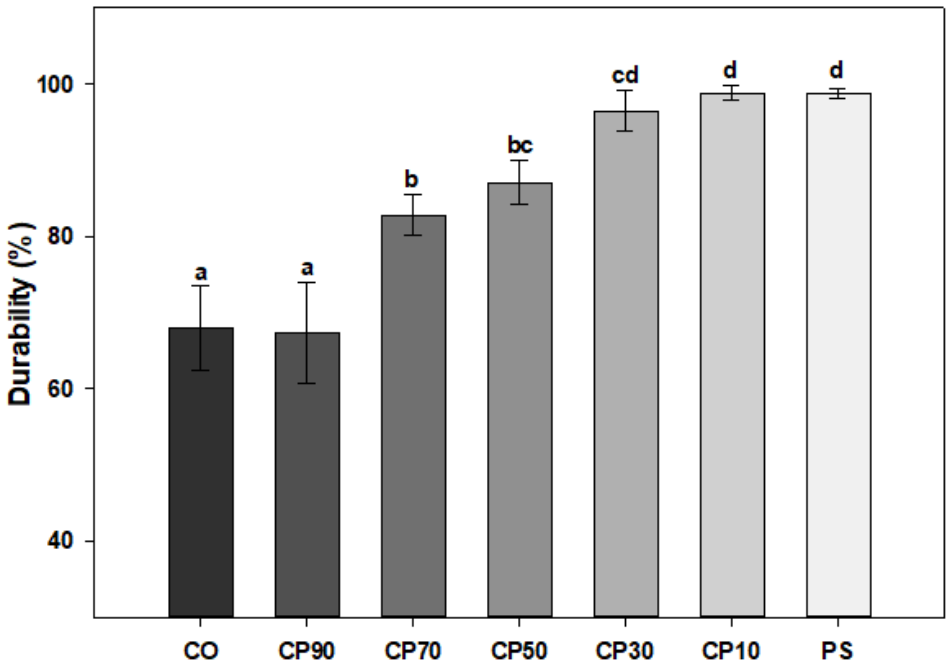


Figure 2. Durability percentage of each type of pellets revelated.

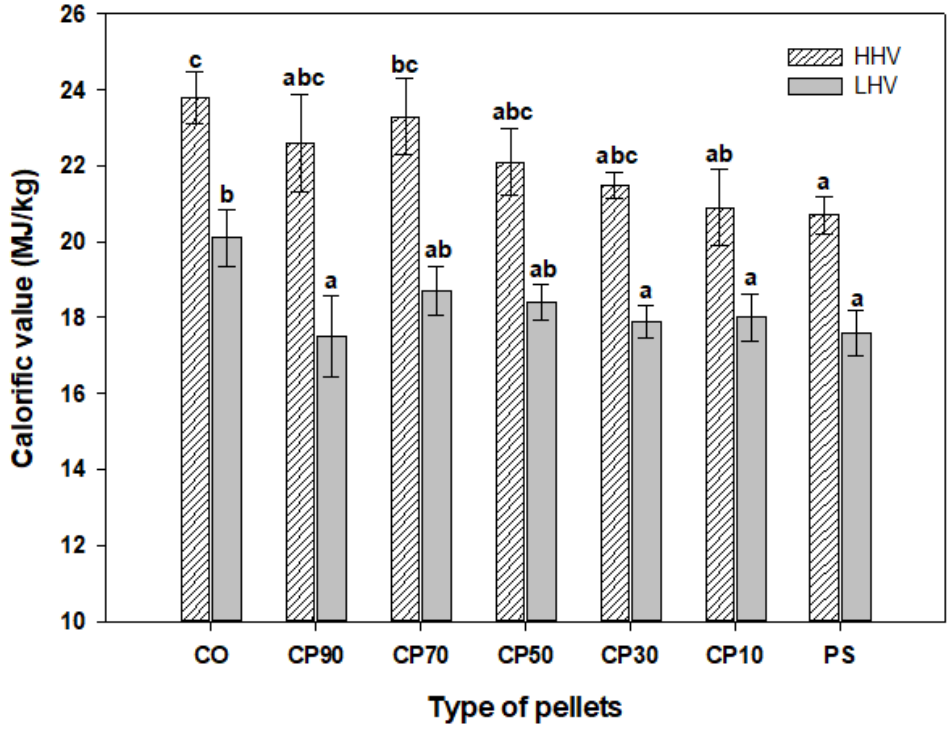


Figure 3. Calorific Value percentage of each type of pellets revelated.

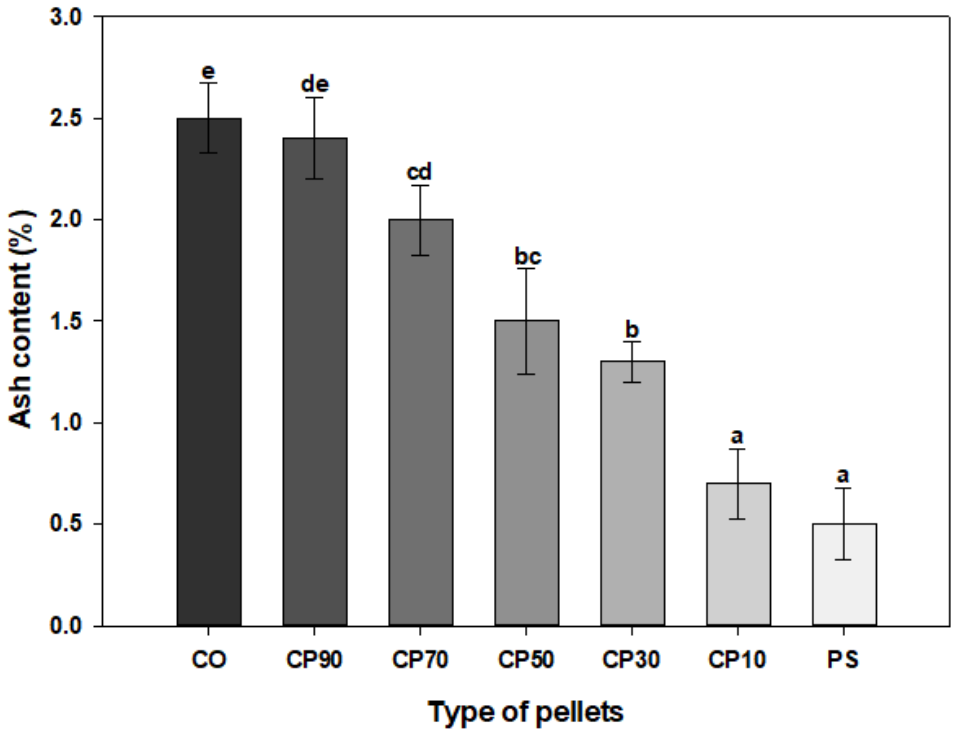


Figure 4. Ash percentage of each typeof pellets revelated.

Specifications	CO	CP90	CP70	CP50	CP30	CP10	PS
Diameter × Length (mm)	5 × 7	5 × 9	6 × 11	9 × 18	8 × 21	8 × 14	8 × 15
Bulk density (kg/m³)	710	680	500	510	580	710	760
Moisture (wt.% wb)	8.7	15.5	12.1	9.6	9.5	7.0	7.8
Ash (wt.%)	2.5	2.4	2.0	1.5	1.5	0.8	0.5
Durability (%)	67.9	67.3	82.8	87.1	96.4	98.8	98.7
HHV (MJ/kg)	23.1	22.6	23.2	22.1	21.5	20.9	20.7
LHV (MJ/kg)	20.1	17.5	18.7	18.4	17.9	18.0	17.6
Biomass content (wt.%)	98	97	98	98	99	99	99
S (%)	0.12	0.11	0.11	0.08	0.04	0.02	0.01
Cl (%)	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01
As (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cd (mg/kg)	<0.10	<0.10	0.11	0.19	0.35	0.79	0.73
Cr (mg/kg)	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0
Cu (mg/kg)	14.6	14.6	12.2	9.5	5.6	3.9	1.7
Pb (mg/kg)	<1.5	<1.5	1.8	4.3	5.4	6.2	8.1
Ni (mg/kg)	<1.2	<1.2	<1.2	1.2	<1.2	<1.2	<1.2

Table 1. Fuel properties of various pellets

A study conducted by CERTH in collaboration with the University of Wroclaw in 2017 showed that SCGs work best as an additive for the production of high-quality pellets. Studies

have also been conducted to economically analyse the potential of using SCGs in processes such as pyrolysis in Central Greece, as well as environmental studies. These studies examine the advantages and disadvantages of the various end products, but do not focus on methods to implement a full value chain for used coffee grounds.

1.4.2 Existing solutions

bio-bean elements

Description

The UK consumes 98 million cups of coffee every day, creating hundreds of thousands of tonnes of spent coffee grounds every year. Much of this discarded resource ends up in landfill emitting harmful greenhouse gasses, including methane.

Bio-bean work with the biggest companies in the UK to transform these spent coffee grounds into value at an industrial scale, giving new life to a material previously considered waste, and contributing to a circular economy.

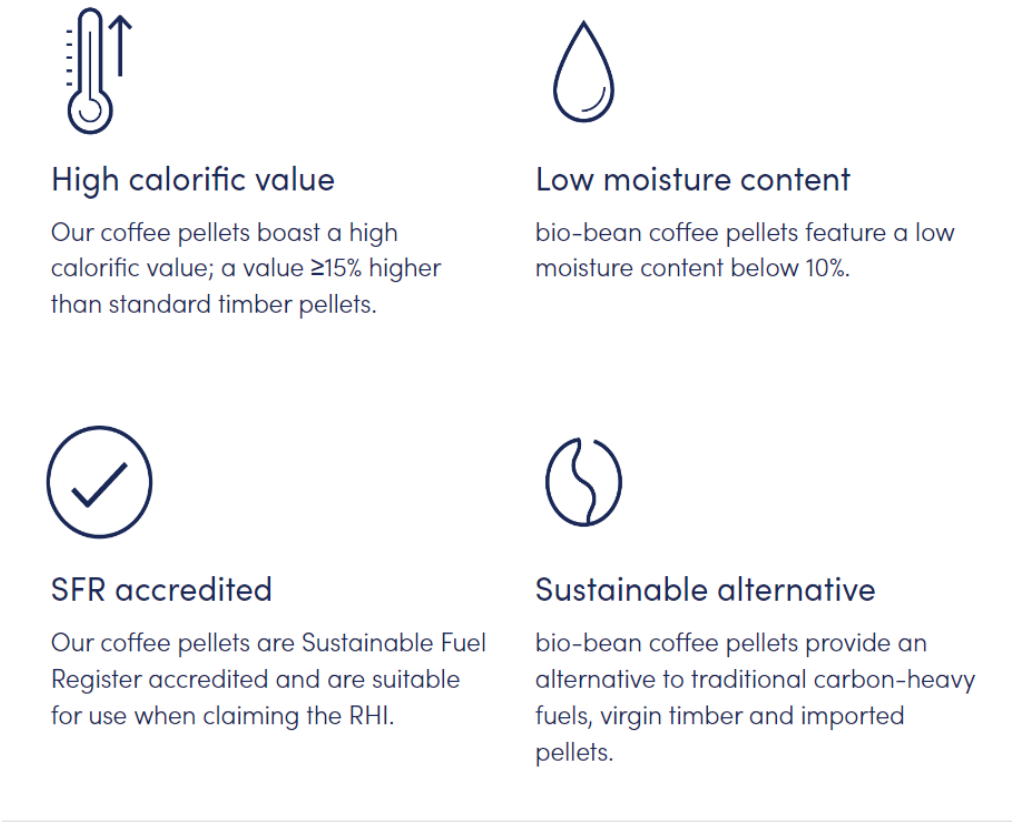


Figure 5 Advantages Bio-bean coffee pellets [18]

Main Results

- Bio-bean biomass pellets made from recycled coffee are a heat-efficient choice for businesses looking to reap the benefits of sustainable energy generation.
- Ideal for use in large commercial and industrial biomass boilers, their coffee pellets displace the need to use virgin timber and reduce reliance on imported pellets.
- With an ever-increasing call for sustainable alternatives to carbon-heavy fuels and the need to reduce reliance on virgin timber or imported pellets, their biomass pellets made from recycled waste coffee grounds offer the perfect solution.
- their coffee pellets exploit the high calorific value of coffee, boasting a net calorific value ≥15% higher than standard timber pellets. They feature consistently low moisture content, high bulk density, a high ash melting point and good durability making them a high-performing alternative. Their efficient burn profile saves businesses money, requiring reduced volume and therefore fewer deliveries to achieve the same energy output as wood pellets. They are Sustainable Fuel Register (SFR) accredited, and therefore meet the criteria for RHI approval.

Information taken from institutional website [18]

Figure 6 Product eference Ecobean pellets [19]

Description:

Over 500 million cups of coffee are drunk in Poland every year and there has been an 80% increase in coffee consumption. What should be done with all those waste coffee grounds that would otherwise end up in landfill?

Polish enterprise EcoBean, together with Warsaw University of Technology, has developed a new method for the production of coffee logs from leftover coffee grounds.

Coffee logs are a carbon-neutral biofuel which can be used for open fires, BBQs, stoves and fireplaces. They burn for longer, produce more energy than wood, are made in a cost-effective way and provide a sustainable alternative that burns longer and produces more energy than wood.

Ecobean is already working on additional applications for spent coffee ground, such as a biodegradable biopolymer that might be used to produce disposable cups or straws.

Main results:

- EcoBean will start collecting waste coffee grounds from 100 suppliers in 2020 first quarter

- In its first year, it plans to receive 240 tonnes of waste coffee grounds
- With this leftover, coffee production capacity reaches almost 1 million coffee logs annually
- Each coffee log is made from the grounds of 25 cups of coffee
- Coffee logs are a clean energy significantly lowering CO2 emissions, compared to landfill disposal
- After proof of concept, EcoBean plans to scale up business in EU.

Information taken from institutional website [19]

Figure 7 Product eference Kafsimo project [20]

Description

'Kafsimo' is a groundbreaking community-based project which collects used coffee grounds from cafes in Northern Greece and converts them into clean biofuel.

Its immediate aim is to reduce the amount of organic waste sent to landfill by collecting used coffee grounds and transforming this economic 'output' (coffee waste) into a green economic 'input', a biofuel. At the same time, the project addresses social issues, such as inclusivity, employment and consumption habits, thus contributing to social, economic and environmental sustainability.

The long-term aim of the project is to create a prototype model of collection and recycling of coffee waste; a model that can be replicated in other regions and easily adapted to other organic waste streams, so that more and more waste can be diverted from the landfill and used as an economic 'input' and more and more people can benefit from the resulting output – the biofuel.

With the slogan 'Close the Circle', the team of Kafsimo along with its network of partner-cafes in two cities of Northern Greece encourages citizens to change their coffee-drinking

habits to reduce the amount of coffee that ends up in the landfill. Operating in a socially inclusive manner and in line with the principles of a fair and equitable economy, Kafsimo simultaneously addresses environmental, social and economic issues.

Main Results:

Environmental

- 100,000,000 kg of coffee waste ends up in the landfills of Greece every year, polluting the atmosphere, the land and the aquifers. This project collects the coffee grounds via a low emissions vehicle, therefore reducing the use of fossil fuels related to transport and the number of sanitation vehicles needed to transport waste to landfill. Currently approximately 400 kg of coffee is collected daily from 70 cafes.
- The 'Kafsimo' products (briquettes and pellets) is excellent solid biofuel which provides heat, without the reliance on fossil fuels and with a smaller atmospheric output. The fuel's origin, collection process and use all contribute to a reduced environmental footprint.
- Through the participating cafes, the public becomes acquainted not only with the project itself, but also with environmentally friendly ways to consume coffee and other drinks, such as through Staramaki and reusable coffee cups.

Social

- It creates jobs for vulnerable social groups and provides training in the wider green-economy. Through this approach and the subsequent economic independence, vulnerable groups of the community are empowered and social integration is supported. The Kafsimo team also engages in widespread public education on the reuse and repurposing of organic waste, as well as in more specialised training workshops with university students.
- This public engagement encourages active citizenship in general and emphasises the potential of each individual to contribute to environmental and social transformation through local actions and small changes in their habits.

Economic

- In Greece, environmental activity and green entrepreneurship is developing as a new, emerging sector of the economy. This project -which is run as a social enterprise- showcases how waste management and the circular economy can be self-sustaining business rather than a charity. The proper management of food waste not only saves resources but also avoids the costs associated with collection, transportation and disposal and provides cheaper fuel. In addition, over time, the economic benefits of reduced municipal costs wasted on landfill fines will be transferred to citizens in the form of lower municipal taxes.

Information taken from institutional website [20]

1.5 Description of the final solution

The purpose of this project is based on the main problem that Alfa Wood is currently facing, which is the increase in raw material and energy prices due to recent events at the European level, as well as the fact that Greek public policies regarding the regulation and control of forest areas and the already organized cooperatives, do not even allow the company to use the waste that is generated in the forest areas around the factory, most of which is lost. For these reasons, it will be difficult for the company to meet its annual production target by 2022, resulting in significant economic losses.

We now know that the company must be open to the possibility of diversifying its inputs to mitigate and prevent future resource shortages. Therefore, due to the high agricultural production in the rural areas of Drama, Feedstock was originally an idea, but since Alpha Wood is a company that specializes in the production of wood, it is outside the economic and management framework in which it is embedded. For this reason, one of the solutions found is the inclusion of SCG as an additional component for the production of pellets that comply with the above parameters.

In general, SCG is a biomass waste that has recently gained importance in the bioenergy sector due to its chemical properties, which give it a higher calorific value and lower ash content than conventional pellets and briquettes made of wood. In addition, many studies confirm that it is a resource that does not require extra treatment to decontaminate it and that it can be immediately integrated into the production chain, since it does not require crushing processes, being a particulate material that can be pressed.

In the light of this scenario, the objective of this case study project is not only to offer an alternative and viable solution to the Alfawood company, but also to provide an opportunity to broaden its systemic panorama and establish relationships with other actors that will also expand its vision of the circular economy and help in the transition from a linear waste management system to a circular system that will also enable community participation and strengthen its cultural attachment to coffee and renewable energy. While it is known that there is extensive research on how SCG can be converted into bioenergy, this document includes specific laboratory tests conducted by Alfawood in its production environment to determine how and in what quantities it would be useful to achieve the goal of accreditation, which is a very important part of its viability, but it also focuses on a much broader consideration of the "whole" situation that would arise around this new material as an emerging property of a new system, from the moment it is disposed of as waste to the moment it adds that value in its processing and conversion into bioenergy, being a very general analysis of the dynamics within the system. Logistics, including separation, collection, transport and storage.

1.6 Marketing Plan

1.6.1 Strategic management planning and marketing

The aim of this section is to create the marketing plan, which is an organized and structured document that defines the business objectives to be achieved in a given period. The object of

this document is to detail the strategies and actions to be undertaken in order to achieve the final project (create pellets with the mix of wood and coffee proving that the coffee has the required properties) within the planned time frame.

1.6.2 Analyzing the marketing environment

Macroenvironment

In this section, we would focus on the macroenvironment, which consists of large societal drivers of change that are not directly related to the activity of the Alpha wood company but have the potential to affect it.

Once we studied the company and the environment in which is involved, the most significant factors are:

Firstly, **political** factors such as the amount of pollution that the company can emite legally, in order to comply with the limits established by the government to all the companies in the country to collaborate with corporate social responsibility.

Secondly, the **economical** factors related to the budget of the company and its expenses to produce pellets and briquettes with the certificates ENPlus A1 and ENPlus A2 according to the high-quality European standard ENplus.

The third factor is the **social** environment of the company. Alfawood is a family-run business and its values are shaped by their faith in humanity and the world. Its most important values are dynamism, loyalty, sense of responsibility and reliance.

The fourth factor is **technology**. This factor is related to the machines and automated processes that the company has in order to produce pellets and briquettes and bag them into packages.

The fifth factor is the **environment**, related to the purpose of a circular economy with the aim of reducing pollution using biomass and recycled wood and materials.

Finally, the last factor is the **legal** one, which includes regulations and rules from Greece and the European Union in order to create an organized environment between companies in which everyone should participate following the rules to achieve its goals legally.

Internal Analysis

In this Internal Analysis we refer to the controllable elements inside an organization that influence how well the organization operates. Taking into account Internal strengths and weaknesses may lie in different types of assets that are tangible and intangible. The classification made for Alpha Wood is:

- **Geographical location:** The company is located in Greece, a city in the northwest of Greece. We can say that the location of the company is good because on the one hand, its main purchasing point is Bulgaria and on the other hand the most common sales destinations of the company are Greece, Albania and Italy. Furthermore, the group

develops an extensive network of warehouses and distributors of pellets and briquettes so that the consumer has a close access to the point of sale.

In short, the geographical location gives the company a great advantage as it is relatively close to Bulgaria and the countries to which it exports.

- **Human resources:** Alfa wood employs over 40 local employees and many more in the supply chain. It is the definition of "GREEN GROWTH", even though it operates in a remote area. This company brings career opportunities to people with values, morals and ambitions. It is a strength of the company due to the fact that they invest in people who are passionate about work and motivated to achieve the company's goals.
- **Technological resources:** ALFA WOOD GROUP A.E.V.E. is dedicated to the wood sector. The evolution of the group reveals inner and natural energy that constantly sets new goals and carries them out. Today we can say that it is a leading company in the industrial processing of wood, which contributes to the development of the national economy. In order to obtain pellets of high quality which require high demand in the field of technology, technology must be combined with economy and ecology.
- **Physical facilities:** The facilities in the industrial area of Larissa cover 50.000 m2 with the factory comprising 29.000m2. The premises in Grevena are located on a privately owned plot of 107.000m2, with the buildings occupying 27.200m2. The facilities at Nevrokopi are spread over an area of 228,000m2 of which 15,300m2 are factory premises. The Nevrokopi unit is active in the production of bio-fuels and green energy.
- **Relationships with suppliers:** This is the systematic approach to assessing the suppliers that provide goods, materials and services to the company by determining each supplier's contribution to the success and developing strategies to improve their performance. Currently, the company is not in a very comfortable situation, since due to covid 19 on the one hand, and on the other hand, the war that is being fought between Ukraine and Russia complicates the relationship with suppliers, which translates into a shortage of raw materials for manufacturing.
- **Corporate reputation:** In terms of the image projected by the company and its perception towards its stakeholders, we can say that they could improve it by investing in this project framed within the circular economy, as at the same time as they increase their profits, they could generate a greener and more sustainable image. Alfa wood is distinguished for its entrepreneurial spirit, the ability to adapt and adhere to the requirements of its partners.
- **Ownership of strong brands in the marketplace**: "The company was founded in 1981 and has been following a continuous upturn, making it the largest Wood Processing Industry in Greece and one of the most significant in the Balkans. Together, they have successfully established the ALFA WOOD group in the Greek and international markets".

- **Financial stability:** It is a condition in which the financial system is capable of withstanding economic and financial shocks and smoothly performs its intermediation role.

- **Available production capacity:** The factory has a high production capacity since it can reach 60,000 tonnes of pellets per year, unfortunately due to the shortage of raw material the company is currently (July 2022) producing only 45,000 tonnes, which means that they are producing at 75% of their production capacity.

- **Ownership of strong brands in the marketplace:** The company has to work on its competitive advantages in order to define the company as a coherent company to ensure that consumers identify it and trust it.

SWOT:

Once the previous study has been carried out, where the objective was to analyze the company internally and externally (both the environment and the sector), we can carry out the diagnosis, in which the strengths and weaknesses as well as the opportunities and threats of Alfa Wood are summarized in a table. In order to have a snapshot of the business project to ensure the success of the project.

	EXTERNAL	INTERNAL
POSITIVE	Opportunities	Strenghts
	• Internal market maturity level • Consumer preferences • New products emergence	• Geographical location • Technological level • Brand/company image
NEGATIVE	Threats	Weaknesses
	• Technical barriers (certificates or approvals) • Existence of emerging markets • Transport system	• Available production capacity • Commercial network/external contacts • Financial resources

Table 2 SWOT analysis.

Marketing information system (MIS)

- **Internal reporting system:** Alfa wood group employs 350 people and has a network with 10 distributors in Greece and 39 points of sale through local partners in other countries. The company exports about 40% of its annual production in 39 countries,

some of them are: Albania, Algeria, Bulgaria, Croatia, Cyprus, England, Egypt, Italy, Kosovo, Morocco, Vietnam, Turkey, etc.

Alfa wood produces on average 60,000 tons of pellets and 7.000 tons of briquettes per year with a quantity of power output of 2 mw. In addition, the company proudly states that through the green energy it produces by re-using about 75.000 tons of biomass every year provides electricity to 6.000 homes on an annual basis, while saving approximately 200.000 tons of carbon dioxide (CO_2) every year.

- **Marketing intelligence system:** Firstly state that, one of the most important aspects that can cause a huge impact on the company is the ability to stay ahead of the market having a comprehensive understanding of its competitor, the industry or the changing consumer landscape, among others. We can prove that Alfa Wood is trying their best to be at the forefront of the sector, always framed in the values of sustainability and high quality.

  Secondly, nowadays with the new technologies is really easy to find useful data which can help the company, some of this tools are:

  - Chambers of Commerce (http://www.plancameral.org)
  - Jetro (http://www.jetro.go.jp)
  - International chamber network (http://www.worldchambers.com)
  - World trade organization (http://www.wto.org)
  - Ministry of Trade Country Channel (https://comercio.gob.es/es-es/paginas/index.aspx)
  - Commercial Guides Countries Embassies USA (https://www.export.gov/ccg)

- **Marketing research system:** It is the systematic collection, organization, analysis and interpretation of the primary or the secondary data to find out the solutions to the marketing problems. This allows you to state a specific problem as your current business goal and investigate all the details necessary for developing its solution. If you are thinking of developing a new product, you should conduct marketing research. Then, based on your findings, you'll manage to create a solution.

  For instance, the case of introducing coffee for pellet production. Before developing this new product, it is important to do research and study its benefits and drawbacks in order to prove if it is feasible or not and create solutions to problems.

- **Marketing models:** These models are highly important because they attempt to show us what the outcome should look like if we change the variables of the company. In other words, marketing models can give the company the answer to different hypotheses to know certainly what will happen.

  In this project a lot of questions and hypotheses can be made. For example, one question related to the amount of materials could be: how much coffee should be added to the pellets in order to obtain a higher profit? or how much the properties of the final product will change if we add a higher or lower percentage of coffee?

As we can see, the marketing model as well as the rest of the sections that make up the marketing plan are key in order to succeed in our project.

1.6.3 Setting marketing objectives

Once the Alpha Wood company has a thorough understanding of the marketing environment, we have to proceed on developing the marketing objectives. In a few words, the marketing objectives state what the marketing function must accomplish in order to succes on the coffee project. These objectives can be quantitative or qualitative. In order to succeed they have to be specific, measureable, attainable, relevant and time-based.

The purpose of this project is framed in the circular economy, since the aim is to give a new life to the waste from the production of coffee beans produced in the region of Drama, considered as waste until now, reducing the dependence on the raw material, giving it a diversification of risk, at the same time creating an eco-friendly initiative, generating a greener conscience in the region of Drama and showing the good work of the company Alfa wood.

To achieve the proposed objective, it would also be necessary to:

- See if it could be manufactured in the company.
- Study if it is profitable and cost-efficiently.
- Find out how to pick coffee and how many coffee shops there are and how many kilograms of coffee we are talking about.

1.6.4 Developing marketing strategies

There are some marketing strategies that the company can develop in order to achieve the best possible results from its new products. Developing marketing strategies means deciding which markets to target and how to develop the marketing mix to reach that market.

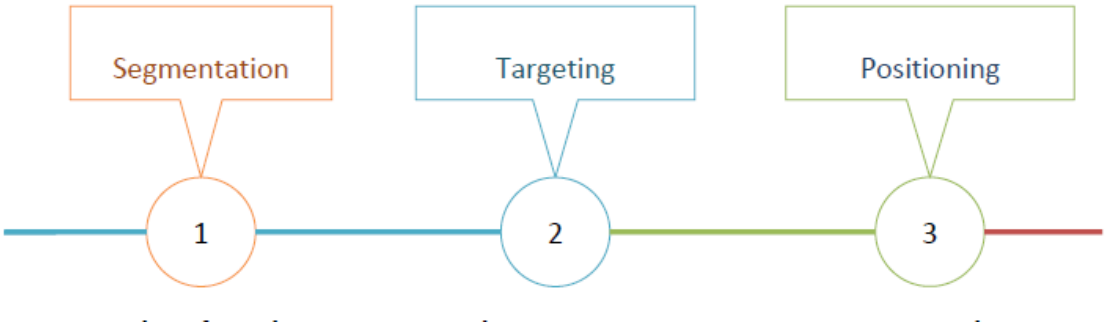
Companies consider different levels of market segmentation according to their own resources and objectives:

- Mass marketing.
- Market segments.
- Market niche.
- One-to-one marketing.

In this case, Alfa wood focuses on market segments, where there are homogenous groups of consumers sharing one or more similar characteristics that cause them to have relatively similar product needs and buying characteristics. For instance, the pellets and briquettes that the company sells, many people have the need to buy them for the winter season in order to get heat in their houses. That people represents an homogenous group sharing the wish to have pellets to get their houses warm.

Market segmentation has many benefits such as:

- Highlights existing business opportunities (markets with unattended needs) and allows the company to respond quickly to even slight changes in what target customers want. For example, if a determined group of customers want a specific pellet certificate, the company would produce more of that certificate in order to satisfy that group's needs.
- Helps to set priorities (given limited resources). If the company had some supply problems and had limited resources, it would have to establish priorities such as choosing which certificate to produce taking into account its resources and the needs to produce a determinate quantity with a determinate quality, and also the benefits it would obtain from that production.
- Facilitates competitors analysis (focusing on the immediate ones, deciding about the kind of competitive advantage to seek). This way, Alfa wood could make advantage of every opportunity to grow externally and be better than other companies in many aspects.



The criteria for developing marketing strategies are:

1. Geographic: nations, states, regions, cities or neighborhoods.
2. Socioeconomic demographic: age, sex, family life-cycle, income, occupation, education level or social class.
3. Psychographic: psychological and personality traits, lifestyles or values.
4. Behavioral: benefit sought, usage rate, user status and occasion (time of the day/week/month/year).

When evaluating different market segments (TARGETING), the company must take into consideration the segment's overall attractiveness and its own resources and goals. Then, the company needs to decide how many segments it can serve best. They have three different targeting strategies:

- Undifferentiated
- Concentrate
- Differentiated

In the case of Alfa wood, the targeting strategy would be differentiated because the company attempts to serve all customer groups with the products they might need. The company

designs and produces a different commercial offering for each segment. For example, it produces different types of pellets depending if it is for industrial use or for domestic use.

In orden to segment the market, it is also important to determine:

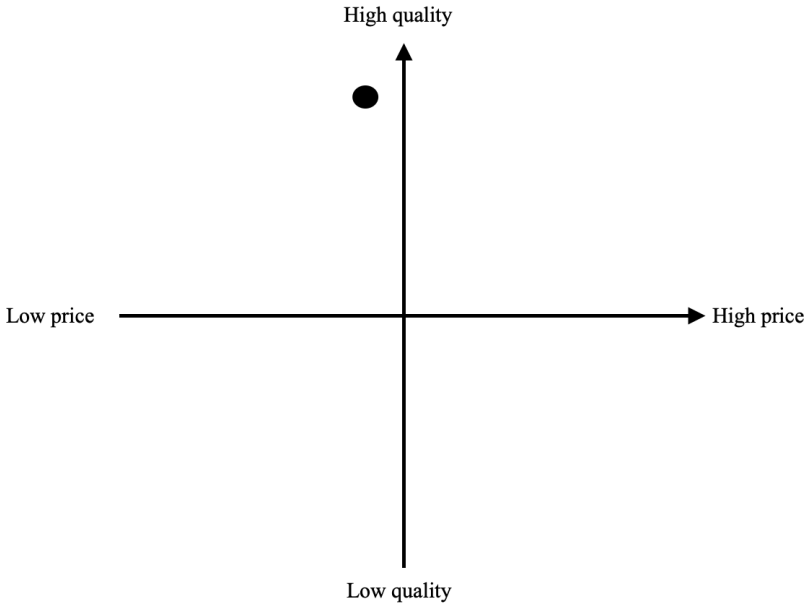
1. **Product**: It has to create different packaging/models for the different existing segments.
2. **Price**: Obviously depending on the quality of the ash content and the kilogram per package will affect the final product.
3. **Distribution**: Different distribution channels for different segments. Although the company subcontracts the distribution to another company, it has to take into account the cost and time involved in sending the packages depending on the sector to which they are sent.
4. **Communication**: Different communication strategies for different segments.

Another way of developing marketing strategies is by positioning the products in the market. The positioning consists of arranging for a market offering to occupy a clear, distinctive and desirable place relative to competing products in the minds of target consumers. It is what the company does to the mind of customers, so companies position the product or the brand in the customers' minds. The result of this strategy is the creation of a customer-based value proposition, the reason why the target customers should purchase the product.

The positioning process is the following:

1) IDENTIFY product attributes and their importance for customers.
2) EVALUATE the positioning and images of competing products.
3) ESTABLISH the desired positioning.
4) COMMUNICATE the positioning

In this case, the positioning of Alfa wood with the use of coffee for the production of pellets would be high quality because it would comply with the certifications A1 and A2 from the company. Regarding the price, it could be cheaper because the purchase of the coffee is cheaper than other materials, so the price would be more asequible and it could be sold to another sector of the population that needs the pellets to be cheaper. We can see it visual in the following graphic:



1.6.5 Implementing and controlling the marketing plan

Implementation means putting plans into action.

There are several ways to organize the marketing function:

- Functionally (separates marketing into distinct components –sales, advertising...-).
- Geographically.
- By product (brand, product line...).

Controlling means measuring actual performance, comparing it to planned performance, and making necessary changes in plans and implementation.

This process requires that marketing managers obtain feedback on whether activities are being performed well and in a timely manner.

1.7 References

1. Abbas, Y., Jamil, F., Rafiq, S., Ghauri, M., Khurram, M. S., Aslam, M., Bokhari, A., Faisal, A., Rashid, U.,Yun, S., & Mubeen, M. (2020). Valorization of solid waste biomass by inoculation for the enhanced yield of biogas. Clean Technologies and Environmental Policy, 22(2), 513–522.
2. Ahmed, A., Abu Bakar, M. S., Hamdani, R., Park, Y.-K., Lam, S. S., Sukri, R. S., Hussain, M., Majeed, K., Phusunti, N., Jamil, F., & Aslam, M. (2020). Valorization of underutilized waste biomass from invasive species to produce biochar for energy and other value-added applications. Environmental Research, 186, 109596.
3. A. E. Atabani1.,Eyas Mahmoud., Muhammed Aslam.,Salman Raza Naqvi.,Dagmar Juchelková.,Shashi Kant Bhatia., Irfan Anjum Badruddin., T. M. Yunus Khan7.,Anh Tuan Hoang.,Petr Palacky. Emerging potential of spent coffee ground valorizationfor

fuel pellet production in a biorefinery. Environment, Development and Sustainability https://doi.org/10.1007/s10668-022-02361-z

4. European Pellet Council (EPC). (2018). World Pellet Map. Retrieved 15th October, 2021, from https:// epc. bioen ergye urope. org/ about- pelle ts/ pelle ts- stati stics/ world- pellet- map/.
5. European Pellet Council (EPC). (2019). Bioenergy Europe Pellet Report 2019. Retrieved 25th November, 2021, from https:// epc. bioen ergye urope. org/ wp- conte nt/ uploa ds/ 2020/ 02/ SR19_ Pellet_ final- web-1. pdf.
6. Eurostat: Municipal waste statistics, https://ec.europa.eu/eurostat/statisticsexplained/index.php/Municipal_waste_statistics 2.
7. Eurostat: Eco-innovation index, https://ec.europa.eu/eurostat/databrowser/view/t2020_rt200/default/table?lang=en 3.
8. Eleni Intzidi., Bas Paris., Valia Zourna., Marina Koumoutsakou., Clio Christopoulou., Maria Angelidou., Ilias Papagiannopoulos. Kafsimo: recycling coffee waste into bioenergy Implementing a circular waste management system: a case study of SCG.
9. Scully, D. S., Jaiswal, A. K., & Abu-Ghannam, N. (2016). An investigation into spent coffee waste as a renewable source of bioactive compounds and industrially important sugars. Bioengineering, 3, 33.
10. Shahbaz, M., Al-Ansari, T., Aslam, M., Khan, Z., Inayat, A., Athar, M., Naqvi, S. R., Ahmed, M. A., & McKay, G. (2020). A state of the art review on biomass processing and conversion technologies to produce hydrogen and its recovery via membrane separation. International Journal of Hydrogen Energy, 45(30), 15166–15195.
11. Sheng, C., & Azevedo, J. L. T. (2005). Estimating the higher heating value of biomass fuels from basic analysis data. Biomass and Bioenergy, 28(5), 499–507.
12. Smaga, M. (2016). Quality parameters of the solid fuel produced from coffee grounds and tea grounds. Acta Innovations, 20, 26–30.
13. Thrän, D., Peetz, D., Schaubach, K. (2017). Global wood pellet industry and trade study 2017. Retrieved 28th November 2021, from https:// www. ieabi oener gy. com/ wp- conte nt/ uploa ds/ 2017/ 11/ Two- pagesumma ry-% E2% 80% 93- Global-Wood- Pellet- Indus try- and- Trade- Study- 2017. pdf.
14. United Nation (UN). (2021). THE 17 GOALS. Retrieved 4th December, 2021, from https:// sdgs. un. org/goals.
15. Woo, D.- G.; Kim, S.H.; Kim, T.H. Solid Fuel Characteristics of Pellets Comprising Spent Coffee Grounds and Wood Powder. Energies 2021, 14, 371. https://doi.org/10.3390/en14020371
16. Athens Coffee Festival. 2022. *COFFEE MARKET IN GREECE - Athens Coffee Festival*. [online] Available at: <https://www.athenscoffeefestival.gr/en/the-festival/coffee-market-in-greece/> [Accessed 27 July 2022].
17. World Coffee Portal. 2022. *Greek coffee in the post-Covid era*. [online] Available at: <https://www.worldcoffeeportal.com/Latest/InsightAnalysis/2022/July/Greek-coffee-in-the-post-Covid-era> [Accessed 27 July 2022].

18. bio-bean. 2022. *bio-bean | We recycle coffee on an industrial scale for a circular economy*. [online] Available at: <https://www.bio-bean.com/> [Accessed 27 July 2022].
19. Circulareconomy.europa.eu. 2022. *EcoBean turns leftover coffee grounds into clean energy products | European Circular Economy Stakeholder Platform*. [online] Available at: <https://circulareconomy.europa.eu/platform/en/good-practices/ecobean-turns-leftover-coffee-grounds-clean-energy-products> [Accessed 27 July 2022].
20. Incommon.gr. 2022. *2. Kafsimo | InCommOn*. [online] Available at: <https://incommon.gr/kafsimo/> [Accessed 27 July 2022].

2. Calculation and design of the system/ installation/equipment

2.1 Input data of the project

2.1.1 Properties of the pellets and its production

To see how the coffee pellet can be of use for Alpha Wood we need to understand what pellets are ,how they are made and what are the characteristics of these high-quality pellets the company and the market needs. The company makes wood pellets that use A1, A2 and industrial standards. `

Pellet fuels (or pellets) are biofuels made from compressed organic matter or biomass and is actually a type of natural biofuel in woody form, also known as wood pellet.Pellets can be made from any one of five general categories of biomass: industrial waste and co-products, food waste, agricultural residues, energy crops, and untreated lumber.[3]

Pellet is a standardized cylindrical biofuel 40 mm long and 6 mm in diameter with quality specifications. for the preparation of which no chemical additives or other substances are used, thus making it a completely environmentally friendly product.[4]

Pellets are made from woody biomass în a process with many steps that take the raw material up to the finished packed pellets. Alpha wood uses a mix of woody biomass mainly pine logs , sawdust as their main source for production of the pellets .

A first step în the production of the pellets is the gathering of the row material , which is made with trucks from the suppliers în area of 600kmp from their facility. The trucks that are coming to the facility are wight checked at the arrival and at the leaving aș way to check and record the quantities of the transport . For many of the types of biomass that are coming a sample is taken for analysis of the quality. After the material has arrived it is stored outside for drying în the sun and to be used when needed.

The main processes în the making of pellets are :

1. Chipping

În this process the wood biomass (pine logs) is moved by heavy machinery into the chiper where it is debarked (the cork is used în the biomass burner) and made into small pieces (4-6cm) that are moved to the next process.

Figure 8. Heavy machinery loading wood into the chipper.

2. Drying

At this step the chips are moved în the drier which has the main objective of reducing the humidity at a consistent moisture level. At Alpha Wood before the drying the chips go again în a chiper where they are made chips at size of 4-6mm , after that are stored înto 2 different industrial 500 tons silos, and 1 for sawdust .

Figure 9. Pine logs and sawdust to be used in pellets.

3. The Pellet Mill

After drying, the sawdust is pressed through dies at high pressure. This process causes the sawdust to heat up and release natural lignins in the wood that bind the sawdust together. The mill also determines the density of the pellet, the diameter (6 mm), the durability, and the length. All of these characteristics are very important for consistent good quality pellets , the capacity of the mill at Alpha wood is 1 tonne per hour.

4. Cooling and Storage

The pellets come out of the mill between 200 and 250 degrees and are soft. A cooling tower is used to cool down and harden the pellets , the steam from cooling is bloun outside . After cooling, they go directly to pakanging after that is stored inside .

5. Bagging or Bulk

The pellets are put în bags în configuration of 72 Bags x 15Kg = 1080kg or industrial bags of 1000 Kg and are stored în the deposit until they are sold .

Figure 10. Packing machine (for bags of 15 kg into the pellets)

By controlling anc checking of the materials and all the steps that they go into the making of pellets they can be sure that the pellets have constant good properties that go to the final consumer. They have a number of 6 varieties of products that are under the A1 A2 and B certificates so we are sure that they respect the properties specified by the EN+ (fig 2) .

The properties of the final pellet is the main factor în deciding the materials and the processes that can be used so that they ensure that they produce pellets that meet the standard , out of recycled coffee grounds with a mix of wood most parameters seems to meet the required values for the A2 and industrial pellets (table 3) . Moisture content is one property that can be reduced by drying the coffee gouds at 100 degrees for 12 hours, the ash percentage which is high for A1 pellets but suitable for the A1 and industrial pellets.

Property	Unit	ENplus A1	ENplus A2	ENplus B	Testing standard [11]
Diameter	mm	6 ± 1 or 8 ± 1			ISO 17829
Length	mm	3,15 < L ≤ 40 [4]			ISO 17829
Moisture	w-% [2]	≤ 10			ISO 18134
Ash	w-% [3]	≤ 0,7	≤ 1,2	≤ 2,0	ISO 18122
Mechanical Durability	w-% [2]	≥ 98,0 [5]	≥ 97,5 [5]		ISO 17831-1
Fines (< 3,15 mm)	w-% [2]	≤ 1,0 [6] (≤ 0,5 [7])			ISO 18846
Temperature of pellets	°C	≤ 40 [8]			
Net Calorific Value	kWh/kg [2]	≥ 4,6 [9]			ISO 18125
Bulk Density	kg/m³ [2]	600 ≤ BD ≤ 750			ISO 17828
Additives	w-% [2]	≤ 2 [10]			-
Nitrogen	w-% [3]	≤ 0,3	≤ 0,5	≤ 1,0	ISO 16948
Sulfur	w-% [3]	≤ 0,04	≤ 0,05		ISO 16994
Chlorine	w-% [3]	≤ 0,02		≤0,03	ISO 16994
Ash Deformation Temperature [1]	°C	≥ 1200	≥ 1100		CEN/TC 15370-1
Arsenic	mg/kg [3]	≤1			ISO 16968
Cadmium	mg/kg [3]	≤ 0,5			ISO 16968
Chromium	mg/kg [3]	≤10			ISO 16968
Copper	mg/kg [3]	≤10			ISO 16968
Lead	mg/kg [3]	≤10			ISO 16968
Mercury	mg/kg [3]	≤ 0,1			ISO 16968
Nickel	mg/kg [3]	≤10			ISO 16968
Zinc	mg/kg [3]	≤100			ISO 16968

[1] ash is produced at 815 °C
[2] as received
[3] dry basis
[4] a maximum of 1% of the pellets may be longer than 40mm, no pellets longer than 45mm are allowed.
[5] at the loading point of the transport unit (truck, vessel) at the production site
[6] at factory gate or when loading truck for deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)
[7] at factory gate, when filling pellet bags or sealed *Big Bags*.
[8] at the last loading point for truck deliveries to end-users (*Part Load Delivery* and *Full Load Delivery*)

Table 3 . Threshold values of the most important pellet parameters.[2]

Calculation procedure of the % of ash in the finished product

Weight of capsule With Wooddust	Net weight of Wooddust	Capsule with ash	Weight of ash	Moisture of Wood dust %	Ash %	Average Ash %
5,3072	4,1304	1,2082	0,0314	5,6	0,8057	0,8084
5,3082	4,1282	1,2118	0,0318	5,6	0,8164	
5,2811	4,0961	1,2173	0,0323	5,6	0,8358	
5,3297	4,1534	1,2067	0,0304	5,6	0,7758	
5,4232	4,246	1,2176	0,0404	8,8	1,0435	1,0648
5,1584	3,9798	1,2168	0,0382	8,8	1,0526	
5,1391	3,958	1,2205	0,0394	8,8	1,0917	
5,1965	4,0225	1,2133	0,0393	8,8	1,0715	
4,9244	3,7396	1,2295	0,0447	9,6		1,2242
4,8949	3,7129	1,2212	0,0392	9,6	1,1674	
5,4601	4,2761	1,2304	0,0464	9,6	1,1998	
5,0137	3,8352	1,2204	0,0419	9,6		

Moisture Calculation

	Weight of capsule	Weight of capsule + wet sample	Weight of capsule + dry sample	Moisture	Moisture Average
PELLET 1	2,6122	29,8429	28,2112	5,99	5,6
PELLET 2	2,6739	17,0414	16,2789	5,31	
GROUND 1	2,6122	29,8429	28,2112	5,99	
GROUND 2	2,6739	17,0414	16,2789	5,31	
PELLET 1	2,7778	51,7311	47,2262	9,20	8,8
PELLET 2	2,6913	50,1339	45,9333	8,85	
GROUND 1	2,8295	16,4554	15,286	8,58	
GROUND 2	2,8086	17,2487	16,0035	8,62	
PELLET 1	2,6112	46,0287	42,0106	9,25	9,6
PELLET 2	2,7507	38,0038	34,5273	9,86	
GROUND 1	2,6112	46,0287	42,0106	9,25	
GROUND 2	2,7507	38,0038	34,5273	9,86	

Table 4 . Data from the test runs of the first and second sample at the Alpha wood

2.1.2 Properties of the Coffee Pellets

In this research a mix of wood provided by Alfa Wood made with 12% chips , 88% debarked pine at 8.2 humidity (this is a composition for their A1 pellets) and SCG with 30.1 humidity from a sample collected from a coffee shop and provided for test at their facility , were used as input material. SCG had high water content so the sample was left to dry outside for 12 hours .

Figure 11. SCG (coffee grounds) left to dry outside for 12 hours.

At first there was an attempt with 100% SCG pellet coffee , but they couldn't get them made with their dye , maybe because of the high humidity. În one of the papers there were made pellets with 100% SGC by reducing the water content of 6.50% by drying in a laboratory oven at 100 C for 12 h. [1]

Figure 12. Laboratory equipment used by alpha wood to make their daily test on the properties of pellets

The SCG was mixed with an appropriate amount of wood mix and the prepared material was then used to produce pellets in a vertical pellet press at the facility test lab. The samples were

made in the following proportions: 100% of spent coffee grounds (which didn't work), 20/80 and 50/50 of SCG/wood mix respectively.

First sample 80% wood and 20% SCG got some good results but didn't meet the A1 or A2 standards with the wood mixture because the mix had a humidity of 1.06 which is higher than the standard requirement . With the wood mixture if it is made with 100% pine the results are good for the A2 standard. Second sample 50% wood and 50% SCG can get good pellets for industrial use.

Figure 13. Sample 1 made with 20% SGC and with 80% wood mix and sample 2 made with 50% SGC and 50% wood mix.

2.2 Calculation and design of the Final solution

2.2.1 Coffee Shops-Waste in Drama

In this part we evaluate the quantities of coffee waste that can be obtained in order to see if it is a viable source of material for production of coffee pellets at a capacity that of alfa Wood to be considered an additional optional resource for pellets .

Alpha Wood has a yearly production of around 60,000 tons pellets for which it purchases around 120,000 tons of pine wood , a estimated quantity at ratio of 2:1 is lost during the first part în the making of the pelles where the pine wood is debarked and în the second part în dryer where the humidity is reduced .We estimated the quantities of coffee ground that are available based on some interviews with a number of coffeeshops în the city of Drama.

FID	Shape *	Name	Adress	Coordinate	X	Y
0	Point	196°c Coffee Roasters	Eth. Aminis, Drama 661 33	41.145684, 24.146916	512165,399	4554661,692
1	Point	Angolo Coffee Station	Geor. Papandreou 20, Drama 661 00	41.15019530872646, 24.148063784310473	512283,766	4555150,209
2	Point	Baroque cafe bar	Perikleous kavda, Ipeirou &, Drama 661 00	41.147162292726456, 24.148006723603036	512772,697	4554819,932
3	Point	Bite Me (Coffee & Bites)	Filippou 67, Drama 661 00	41.14801365739728, 24.154353532820927	512831,941	4554850,667
4	Point	Black Sugar	Drama 661 00	41.151508717821216, 24.14628960187665	512127,667	4555281,23
5	Point	cafe Di Marco	Velisariou 2-4, Drama 661 00	41.150862342802945, 24.14871769461895	512331,6	4555218,726
6	Point	Cafe Secerato	Armen 21, Drama 661 00	41.15138653014704, 24.14800152164385	512265,255	4555239,727
7	Point	Co.Me Coffee and More	Plateia Eleftherias 30, Δράμα 661 00	41.15020705427117, 24.14720758778819	512213,604	4555101,337
8	Point	Coffee Berry Drama 01	Ipeirou 33, Drama 661 00	41.14616116533856, 24.148198958557316	512295,036	4554686,861
9	Point	Coffee Berry Drama 02	Promitheos 17, Drama 661 00	41.15231050546654, 24.138092746573072	511444,41	4555391,287
10	Point	Coffee Brands	28is Oktovriou 1, Drama 661 00	41.14677886467486, 24.14788744128967	512267,918	4554776,291
11	Point	Coffee Island	Ipeirou 39, Drama 661 00	41.15327040085789, 24.13131062550869	510876,678	4555491,687
12	Point	Coffee Island 02	Dim. Gounari 46, Drama 661 33	41.15410413137559, 24.13132940030469 3	510877,52	4555583,979
13	Point	Coffee Lab Δράμα	El. Venizelou 133, Drama 661 00	41.15252660272384, 24.140282102260173	511603,476	4555390,961
14	Point	CoffeePlant	1is Iouliou 74, Drama 661 00	41.145215364408514, 24.15844455359711	513141,86	4554558,161
15	Point	Cookie Cafe Bar	Βαρδουσίων, Drama 661 00	41.15251145574231, 24.146086449480492	512271,303	4554822,34
16	Point	Court Cafe	Themidos 2, Drama 661 00	41.15296830713514, 24.147183568790997	512212,664	4555396,358
17	Point	CRAFT Coffee House	Eth. Aminis 5, Drama 661 00	41.14948546552027, 24.14717750952035	512214,719	4555130,038
18	Point	Double Black coffee and drink	Agiou Konstantinou 21, Drama 661 00	41.13547078070746 5, 24.14419185429065	511930,146	4553464,086
19	Point	Enzo cafe bar official	Π κάβδα &, Ipeirou, Drama 661 00	41.14716714908173, 24.148190063856426	512295,027	4554821,621
20	Point	Fileto meat restaurant	Papadiamanti 9, Drama 661 00	41.14966190384702, 24.143135077301135	511865,216	4555062,679
21	Point	Frankie Coffee Room	Κάβδα και, Ipeirou 14, Drama 661 00	41.14719897637108, 24.14788744128967	512268,039	4554819,952
22	Point	Fresco Bar	Drama 661 00	41.15072888790849, 24.1456827691723	512082,248	4555211,243
23	Point	Happy Coffee	19is Maiou 91, Drama 661 00	41.14985159162704, 24.1453407703438	512053,71	4555113,673
24	Point	Kafedio	19is Maiou 101, Drama 661 00	41.15023936896143, 24.145769923779298	512088,328	4555157,31
25	Point	Kozi Espresso Bar	Armen 21, Drama 661 00	41.15101539193319, 24.147716358962665	512252,442	4555244,391
26	Point	la griglia da Routsis	Kavda 39, Drama 661 00	41.14764035082364, 24.149613724726454	512412,821	4554869,063
27	Point	Meating	κάβδα, Περικλέους 5, Drama 661 00	41.14729078030526, 24.149298395692174	512386,425	455483,079
28	Point	Mikel Coffee	Zervou 2, Drama 661 00	41.150495143960136, 24.147286626479982	512210,261	4555152,181
29	Point	Rodóstamo	Agias Varvaras 13, Drama 661 31	41.150760603516424, 24.140281206955137	511624,086	4555168,388
30	Point	Sweet Coffee	Bank of Greece, Eiphnhs 23, Drama 661 00	41.151157216376504, 24.14593711506779	512097,426	4555249,436
31	Point	The Espresionist Drama	Ipeirou 22, Drama 661 00	41.14584821192988, 24.148009879129454	512272,215	4554661,816
32	Point	Tse Cafe	Skra 2, Drama 661 00	41.14981653476721, 24.148295137053385	512303,879	4555083,67
33	Point	VOG Coffee	1is Iouliou, Drama 661 00	41.14416118501089, 24.149110528580813	512392,018	4554476,014
34	Point	Wild Duck Coffee Roasters	Πατριάρχου Διονυσίου 4, Drama 661 00	41.14830637887959, 24.14241564934425	511801,782	4554929,167
35	Point	Καφέ Μπαρ Kaktus	Zervou 3, Drama 661 00	41.15048264779426, 24.147430234306224	512236,386	4555187,823
36	Point	тARTa coffee,sweets and more...	El. Venizelou 64, Drama 661 31	41.15084627629294 5, 24.144941121300803	512007,689	4555211,472

Table 5. Coffee shops in Drama referenced by GIS

The current number which we got from the city of drama (fig 7) is based on the 40 shops (table 5) that gave us a quantity between 4-8 kg of coffee grounds that they throw away . With an average quantity of 4.5 kg for coffee shops we get 180 kgs daily , 5580 kgs monthly and an estimated yearly of 66,960 kgs. By doing the same calculation with the region of drama we will have a number of 800 places that can provide spent coffee grounds , with the same average of 4.5 kg we get 3.600 kgs daily , 111,600 kgs monthly and an estimated yearly of 1,339.200 kgs.

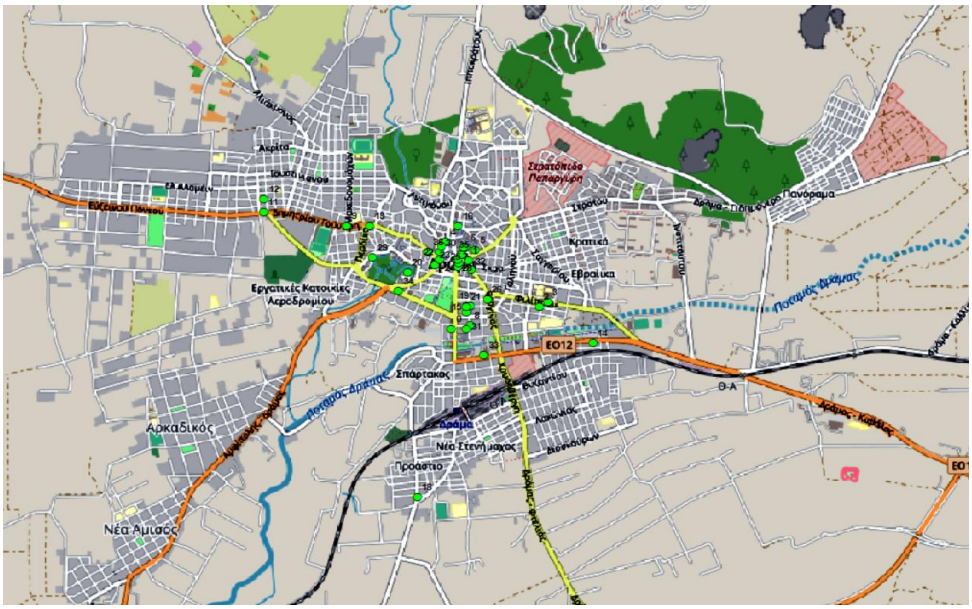


Figure 14. Coffee shops in Drama referenced by GIS

Alpha wood said that they change production every few days from A1 pellets to A2 pellets in the production process. Introduction of the wood coffee pellets can be made by a new product for when they produce A2 pellets or for when industrial pellets are made .

2.2.2 Introductión to the system

Aș a proposal from evaluating the current production process of the Alfa Wood company we see that the new system can be used at the final stage and the material can be inserted properly and also that they can collect the proposed source material from a close for a test run with the possibility of expanding.(fig 7)

The addition of the coffee pellets can be made without the introduction of a new production line , the spent coffee grounds will only need a introduction of a new dryer so they can reduce the water quantity and humidity level for an increase în quality and the results of the pellet properties . From the results at Alfa Wood we use than even with slight decrease în humidity by drying the spent coffee grounds outside the pellets made can meet the standard for A2 and industrial pellets. Aș for storage a small section from the facility storage can be used aș a place to collect it .

Figure 15. Two away for storage of the spent coffee grounds.[6]

Alfa Wood already produces A2 pellets so we suggest that this mix of wood and coffee can be used in a trial for years to check the certification quality consistency and the market acceptance of the new pellets. The possibility being explored could be a new small silo or a container for storage that can be used to feed the process with the new source material for the time that they switch production to the A2 pellets.

2.2.3 Overview of the final System

For the final overview of the system, we think of the whole multitraces program as a systemic project. From the figure 15 the strategy 1 tackles the introduction of the spent coffee grounds aș a new material source solution to the current alfa Wood Company system.

The Project proposes a collaboration with coffee and companies that produce coffee grounds (restaurant , bars , hotels and places that sell coffee) the company could get a constant source material of around 1440 tons of spent coffee ground that can be used în mix based 20% coffee grounds 80% wood giving a total of 7200 tons of Wood coffe pellets . A new product will come out of it, promoted as high-quality pellets made from wood and spent coffee grounds , that can be test for the market.

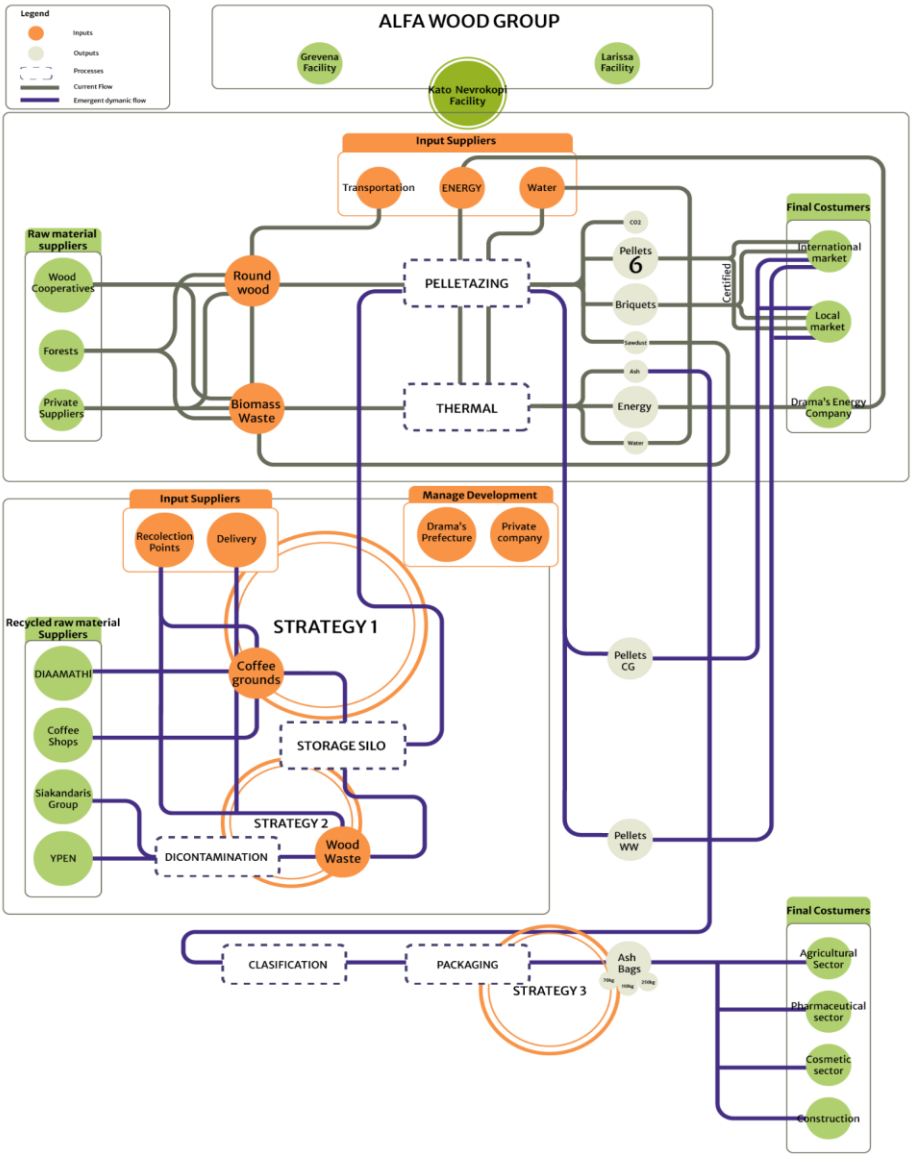


Figure 16. Multi Traces Program 2022 Systemic Project on the Alfa Wood Nevrokopi Company

2.4 Conclusion

Inn the calculation of the final design for the project “COFFEE GROUNDS AS AN ALTERNATIVE INPUT RESOURCE FOR MAKING PELLETS, ALFA WOOD FACILITY KATO NEVROKOPI CASE STUDY" , we first discussed about the properties of high-quality pellets as the main starting point for the new pellets since it has to meet companies standards. Here we made evident the properties which are more important for when making En plus pellets. The most important properties are the calorific value, ash percentage, and moisture content which are compared between the A1 pellets that they produce and the result from the 2 samples tested which gave us values from the sample 1 that meet A2 and B1 certification.

The possibility of the project is confirmed till that point, in the calculation related to the amounts available the number may vary high but the total amounts should be mostly constant . By using Greece waste recollection (spent coffee grounds are considered a biomass residue) system Alph wood can get quantities collected by them if they can collect them separately so that they can be transported from a single place reducing cost of transportation . This study invites on the number of spent coffee grounds and the quantities of pellets that can be made .

Aș for the final sistem introduction, with a low investment from part of the company , a parterensip with the local DIAAMATHI Greece waste collection system and the coffee shops businesses , the new source material can be acquired , in which the company wouldn’t have to take a major cost în the process of collecting the spent coffee ground waste, and simply go by as usual.

2.5 Reference

1. Nosek, Radovan; Tun, Maw Maw; Juchelkova, Dagmar (2020). Energy Utilization of Spent Coffee Grounds in the Form of Pellets. Energies, 13(5)
2. ENplus Handbook, Part 3 -Pellet Quality Requirements ENplus Quality Certification Scheme Part 3: Pellet Quality Requirements. (n.d.). https://enplus-pellets.eu/en-in/component/attachments/?task=download&id=103
3. Pellet - ALFA WOOD GROUP - PELLET & BRIQUETTE INDUSTRY. (2018). Alfapellet.gr. https://www.alfapellet.gr/en/pellet-mpriketa/pellets.html
4. Pellet fuel https://en.wikipedia.org/wiki/Pellet_fuel
5. How pellets are made https://www.woodpellets.com/heating-fuels/pellet-processing.aspx
6. Bio beans https://www.bio-bean.com/elements/pellets/

3. Investment cost and profitability analysis

CATEGORY	COST	VALUE
	Shipping, transport and logistics	40
	Packaging	24€
	Commodities	160€
	Employee salaries	44000
	Taxes and deductions	24
Direct costs	TOTAL	44224
	Bank interests	3%
	Depreciation of machinery	10%
	Indirect material for production	85€
	Energy bills	20€
Indirect costs	TOTAL	119€
Intangible costs	Productivity losses	10%
	MIx 1 (50% 50%)	
	40 coffee shops	4.464,00
	200 coffee shops	22.320,00
	800 coffee shops	89.280
	Mix 2 (80% 20%)	
	40 coffee shops	11.160
	200 coffee shops	55.800
Benefits	800 coffee shops	223.200
Total costs	60.452€	
Total costs (20%)	12.090	
Net cost-benefit	6	
Net present value	309548	

Conclusion:

This table shows the costs and benefits involved in the production of pellets made from the mixture of coffee waste and raw materials.

On one hand, for this purpose the costs have been quantified and classified into direct, indirect and intangible costs.

On the other hand, the benefits have been quantified, which have been divided into two groups (mix 1 and mix 2) . These are the two types of pellets that the company plans to produce which contain different % of pellets and coffee ground. Depending on the % of coffee and raw material it contains, a higher or lower profit will be obtained, as obtaining the coffee residue is not worth the same as purchasing the raw material (the higher the % of coffee residue, the higher the profit).

Mix 1 and Mix 2 are also divided into 3 groups. These groups belong to the estimated number of coffee shops that the company will be able to cover, and an average of 4.5 kg of coffee waste per day per coffee shop has been calculated. Therefore, several hypotheses have been made in the profits, depending firstly on how many coffee shops we are talking about (how much coffee ground is available) and secondly on what kind of mix is being produced.

CASH FLOWS				
Years	Investment	Income monthly	Expenditure	FCA
0	1000	0	0	0
1	0	5.000,00	12.090	-7.090,40
2	0	15.000	12.090	2.910
3	0	40.000	12.090	27.910
4	0	80.000	12.090	67.910
5	0	230.000	12.090	217.910

This table represents the cash flow. We can see how profitable the project will be over a period of time (in this case 5 years) and we can see how it will vary over time. As we can see:

- investment: is minimal as the company has everything it needs.
- Monthly income: increases as the years go by, as it is expected that the coffee collection radius will be opened up and, consequently, a greater volume of coffee ground will be available.

- The expenses have been calculated in the previous table and it is estimated that the company will dedicate 20% of its efforts to this project, so 20% of the total costs have been calculated and it is assumed that these will not vary.
- Cash flow: we can see that it will not be profitable for the company if they are only able to cover around 40 coffee shops. But as they are able to cover a larger number of coffee shops, the profit will increase exponentially. In the hypothetical case, if they manage to collect 4.5kg from around 800 coffee shops, they will be able to earn around 218,000 in approximately one month.

Sum of income	370000
Sum of expenditure	60452
Cost Investment	61452
C/B	6,02

In this table we can see the total income, the total expenses, the total investment cost (total expenses plus initial investment of 1000 €) and finally we obtain the cost-benefit, which indicates according to the hypotheses that after 5 years for each € invested 6.02 € will be obtained.

Number of coffee shops:	Average of kg recolected per day	Total Kg obtained per day	Total Kg obtained per month
Area of the Drama has 40 coffee shops	4,5	180	5580
200 coffee shops	4,5	900	27900
800 coffee shops	4,5	3600	111600

The following table shows the three hypothetical cases that have been considered. Table that answers the question of how many kg we will obtain per month depending on how many coffee shops the coffee ground will be collected from, estimating 4.5kg for each coffee shop.

Commodities	€/ton
Coffee Ground estimation	15€/ton
Raw material acquisition costs	160€/ton

In this table is reflected how much costs to the company obtain the 2 materials that are needed in the process of pelletization. As we can see, coffee ground is way cheaper than the raw material because of the fact that is obtained recollecting the waste of different coffee shops around the region of Drama (city in which is the company based) giving a new and eco-friendly use.

Cost for obtaining 1 kg of mix 1 and 2:	Quantity (gr)	price €
Raw material	1000	0,16
	1000	0,015
	500	0,0075
Coffee ground	200	0,003
MIx 1 (50% raw material +50% coffee)		0,0875
Mix 2 (80% raw material + 20% coffee)		0,131

This table shows how much it costs the company to produce 1kg per each kind of mix. This information is extremely useful in order to calculate fast how much profit are we going to obtain depending on the kg recolected.

Mix 1 (50% 50%)		
	5580kg	raw material
	5580kg	coffee ground
	11160kg	total
	744 packs	packs
40 coffee shops	4464	monthly profit
	27900	
	27900	
	55800	kg totales
	3720	paquetes
200 coffe shops	22320	Monthly profite
	111600	
800 coffee shops	111600	

	223200	Kg totales
	14880	paquetes
	89280	monthly profit

MIX 2 (80% 20%)		
	5580kg (20%)	
	22320kg (80%)	
	27900	total kg
	1860	packs
40 coffee shops	11.160	monthly/profit
	27900kg (20%)	
	111600kg (80%)	
	139500 kg totales	
	9300	pack
200 coffe shops	55800	beneficio/mes
	111.600kg(80%)	
	446.400 kg (20%)	
	558.000	total kg
	37200	pack
800 coffee shops	223200	beneficio/mes

In the tables above show the two kinds of mixes that will be produced by the company.

In addition each mix is divided in 3 hypothesis (depending on how many coffee shops will cover the harvesting) based on that we can know how much the Alpha wood company will earn per month.

The byproducts of ash and the production of biomass energy and its possibilities for a new circular economy system.

Mentors:

International Hellenic University:

Vassiliki KAZANA,
Dimitris RAPTIS

ALFA WOOD group S.A.

Dimitris Lazos

Students:

Andrea Rordríguez
youremailhere@gmail.com

Comîrlă Rareș-Ionuț
mcomirla@gmail.com

Jesús David Ortiz
j2.idesigner@gmail.com

Nicolás Mondelli
nicolasmfavaloro@gmail.com

Silvia Moreno
Silviamorenomanas25@gmail.com

Trăistaru Ștefan-Iulian
traistarustefan10@gmail.com

Content of the project

1. Executive summary 91
1.1 Project overview 93
1.2 Introduction to the Problematic 93
1.3 The Prefecture of Drama 93
1.4 State of art ..... **Error! Bookmark not defined.**
1.4.1 Historical framework of the context 97
1.4.2 Existing solutions 98
1.5 Description of the chosen solution 99
1.6 Marketing plan 99
1.6.1 Strategic management planning and marketing 99
1.6.2 Analyzing the marketing environment 100
1.6.3 Setting marketing objectives 104
1.6.4 Developing marketing strategies 105
1.6.5 Implementing and controlling the marketing plan 107
1.7 Conclusion 107
1.8 References 108
2. Calculation and design of the system/ installation/equipment 108
2.1 Input data of the project 108
2.1.1 Kato Nevrokopi & the prefecture of Drama 108
2.1.2 Properties of the ash/The data analysis of the ash from the company 109
2.1.3 Where is the ash most useful? 114
2.1.4 Mapping of the ash chain use 116
2.1.5 What field needs the ash the most? 117
2.1.6 Where is it sold? 123
2.1.7 Equipment needed to process and pack the ash 125
2.2 Calculation and design of the Final solution 127
2.2.1 Calendar solution for the use of ash 127
2.2.2 Importance of Ash 128
2.2.3 Packaging of the ash 131
2.3 Benefits of the solution from point of view of Circular Economy 132
2.3.1 Project overview 134
2.3.3 Impact on the Territory /The analysis of the region 135
2.4 Conclusion 138
3.7 References 139
Chemical and mineral composition of ashes from wood biomass combustion in domestic wood-fired furnaces 139

1. Executive summary

Quick overview

The following paper pertain to the culmination of the Multitraces European program for the International Hellenic University. The program promotes the collaboration of multidisciplinary students from 4 different countries, universities, and career paths, all with the purpose of developing projects with local companies from a circular economy and systemic approach. The presented case for this paper relates to the Alfa Wood Group Company, one of the biggest wood treatments in Greece, in a specific one of the companies belonging to the group, Alfa Wood Nevrokopi. The company located in the prefecture of Drama, in the vicinity of the town of Kato Nevrokopi works on the production of wood pellets and briquettes. They gladly collaborated with this program to provide their knowledge and assistance for the development of 4 different projects. The developed project portrayed in this paper relates to the following project and that is the Ash Project which aims to solve one of the company problems that they have since the beginning of their activity in the wood industry, that being what to do with the ash and where it can be used , what sectors can benefit the most from the ash being used in their different processes and products that they have and do , showing the positive impact of it .

Systemic Analysis

The Territory of Kato Nevrokopi inside the prefecture of drama represents at first glance an advantageous location strategy for the amount of forest that covers the terrain. Being in a high green alternatives environment , with such a rich amount of resources that can be used in various sectors from which they get various products of biomass , one of them being the ash they comes from burning all the materials , leftovers or wood based materials.The issue is that all the ash that is collected as an output for the system they have , after they burn all the materials at the facility , is that they don't have any purpose for the ash , therefore currently the ash is just sitting on the plot of land they designated to stored it , without exploiting the full potential of the ash and all the possibilities it brings for the company but also for the various sectors that the ash can be used in.

The ash is endorsed by many nations in the world and a perfect replacement for many product ingredients , and also in a high demand lately in the world era where there is a much need for green , easy to get and natural alternatives to all various products.

Systemic Project

The project for the "**The byproducts of ash and the production of biomass energy and its possibilities for a new circular economy system.**" aims to give purpose for the

ash that is stored at the facility currency sitting there without having its full potential exploited and the possibilities it gives for the company and the various sectors that the ash can be sold in.

The ash coming from the burnt materials , will be sorted and stored on differently therefore a;ways having a constant supply of ash with constant properties which can be used in the sectors mentioned above

Methodology & Implementation

For the development of this project and papers the systemic design methodology was proposed. This implies the elaboration of 5 stages which are part of a holistic diagnosis of the company and the territory, identification of challenges, identification of opportunities, the development of the system, and the analysis of the outcomes. For the program in question, due to the duration stipulated for it, the methodology was adjusted. The program also proposed the elaboration of 4 different papers, made from projects given by the company, through the formation of groups according to the number of students, this case 8 students, 2 for each paper/project. For the adaptation and the proper development of a systemic project the next approach was taken, in order to obtain a complex multidisciplinary result we decided on working together on each of the 3 papers, this excluded the national team that developed the fourth project which was stipulated from the beginning as a side project. this meant the proper implementation of the different disciplines for each of the papers. This way a Gantt chart was produced for the general production of the 3 papers. This divided the work into different phases. The methodology was adapted due to the previous information at hand which included the holistic diagnosis and the challenges and opportunities that were already given by the company. Our phases were the following: Project Conception and Initiation & Planning, Research Phase, Conceptualization & Analysis, Work Assessment & Design Phase, Project Elaboration Experimentation, and Project Deliverables. Each of these was divided by week and culminated in the delivery of the papers and the presentation on the 28 of July 2022.

Financial Highlights

- It will be a pretty big investment but the profit will be greater
- the investment is about 87 000 euros but that can be exceeded by the profit
- The ash will be used and will not stay stored without a purpose
- Every sector besides the company will benefit from the idea after it will be implemented

1. Project overview

1.1 Introduction to the Problematic

As we all know the company faced different problems from the shortage of supplies to keep the materials rolling in order to continue producing the products that they produce , to the wastes that are left over from the processing of wood and the production of pellets to finding different uses to the ash that is daily collected from the facility and then stored on the plot of land designated by the company , not having any uses and just sit there , adding and adding daily , monthly .

The main problem that we tackle in this paper is the possible uses for the ash that is collected from the facility and the probability of selling it to different sectors in order to further different product such as cement , animal bedding alternatives , pesticides , cosmetic products , or pharmaceutical products such as different ash ingredient based treatments for various health issues.

The issues further encountered were , where to sell it , if they can sell it and what comes out of it , if it's plausible or doable .

The amount of ash that is produced is around 500 mtons and around 41,7 tons a month which keeps on adding up , without being used for anything.

Therefore we came up with different solutions in order to tackle the problem and help the company to develop their company even more through those chosen solutions which are detailed each one of them in their respective papers.

Finding the solutions was a problem by itself because it wasn’t that easy , we needed to search the internet for previous attempts to the problems , previous results to see if is possible to implement here but at the end we prevailed and succeeded in finding the perfect solutions for the problems that the company was facing and that kept them bogged .

We still need to see if the solutions found are all successful in the future but I have faith and I am confident that all the solutions chosen by us to tackle the different problems will be successful and thrive in the future giving the company more options and a bigger footprint on the market in more sectors then they are present into now.

The Prefecture of Drama is the territory of focus for this study since Alfa Wood Nevrokopi is located in one of its municipalities. It is located in the northwestern part of the country and it belongs to the bigger Region of Eastern Macedonia Thrace. It borders Bulgaria to the north, the Regional Unit of Kavala to the south, the Regional Unit of Rhodope to the east and the Regional Unit of Serres to the west.

The surface area of the territory is 3466km2. Its majority is dominated by big mountain masses (about 70%). The southern part of the Prefecture is shaped by big contiguous plains extending over 431km2.

The political division of the prefecture consists of five municipalities, Prosotsani, Doxato, Paranesti, Drama (which is where the capital of the prefecture is located by the same name of the municipality), and at last Kato Nevrokopi which is where the company is located, Figure 3.

The population of the prefecture is 98287 people according to the 2011 census.

The land uses in the prefecture are agriculture and forestry covering 74% of its territory. The forests of the Drama area are composed of several deciduous and coniferous species, in pure and mixed forms, being of great attraction to a wood treatment company whose main source of materials are coniferous. They under the management of the National Forest Service, and they ar managed mainly for wood production, based on selective loggings in order to protect the forest soil properties. The productive forests of drama occupy approximately 173303 ha of about 49,97% of the total area.

The agricultural land in the Drama regional Unit is approximately 67557 ha. The main agricultural crops in Prefecture of Drama include cereals, cotton, tomatoes, tobacco, vineyards, fruits and vegetables. The agricultural sector provides significant revenue to the region, contributing about 0.5% to the national GDP and about 1.5% to the total country agricultural production. The forestry sector as a primary sector of production is also significant in the prefecture of Drama. Despite the fact that the forest area of Drama represents only 2.6% of the

country's total forest area, it contributes approximately 11% to the total produced wood at national level.According to the Forest Service of Drama the total woody volume of the 173303 ha of the Drama forest land is estimated to 16,061,470m3.

A great economic asset with high economic potential also in the Regional Unit of Drama is the marble exploitation, which is carried out through the extended quarries' network of the area. About 80% of the total marble exports at national level originated from the 80 active quarries of the Regional Unit of Drama, which comprise about 40% of the country's active quarries.

The secondary sector of the area's economy includes mainly industries of small-medium size and fewer big ones established in the area during the past few years, in the fields of marble processing, metal and wood processing, as well as food and beverage production.

The tertiary sector of the area's economy includes mainly businesses operating in the fields of transportation, storage, communication, social activities, wholesale and retail trade, catering services and financial services. Tourism is not well developed in the area although the alternative tourism potential has been well recognized by all the concerned stakeholders of the area.

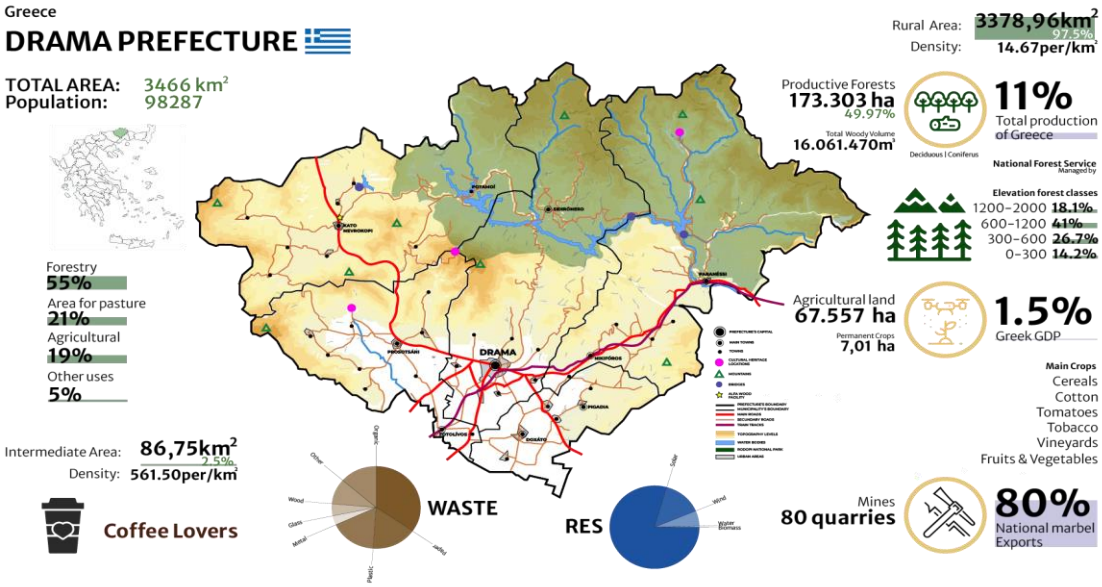


Figure 3. Drama Prefecture Giga MAP

1.3 The Prefecture of Drama

The Prefecture of Drama is the territory of focus for this study since Alfa Wood Nevrokopi is located in one of its municipalities. It is located in the northwestern part of the country and it belongs to the bigger Region of Eastern Macedonia Thrace. It borders Bulgaria to the north, the Regional Unit of Kavala to the south, the Regional Unit of Rhodope to the east and the Regional Unit of Serres to the west.

The surface area of the territory is 3466km2. Its majority is dominated by big mountain masses (about 70%). The southern part of the Prefecture is shaped by big contiguous plains extending over 431km2.

The political division of the prefecture consists of five municipalities, Prosotsani, Doxato, Paranesti, Drama (which is where the capital of the prefecture is located by the same name of the municipality), and at last Kato Nevrokopi which is where the company is located, Figure 3.

The population of the prefecture is 98287 people according to the 2011 census.

The land uses in the prefecture are agriculture and forestry covering 74% of its territory. The forests of the Drama area are composed of several deciduous and coniferous species, in pure and mixed forms, being of great attraction to a wood treatment company whose main source of materials are coniferous. They under the management of the National Forest Service, and they ar managed mainly for wood production, based on selective loggings in order to protect the forest soil properties. The productive forests of drama occupy approximately 173303 ha of about 49,97% of the total area.

The agricultural land in the Drama regional Unit is approximately 67557 ha. The main agricultural crops in Prefecture of Drama include cereals, cotton, tomatoes, tobacco, vineyards, fruits and vegetables. The agricultural sector provides significant revenue to the region, contributing about 0.5% to the national GDP and about 1.5% to the total country agricultural production.

The forestry sector as a primary sector of production is also significant in the prefecture of Drama. Despite the fact that the forest area of Drama represents only 2.6% of the country's total forest area, it contributes approximately 11% to the total produced wood at national

level.According to the Forest Service of Drama the total woody volume of the 173303 ha of the Drama forest land is estimated to 16,061,470m3.

A great economic asset with high economic potential also in the Regional Unit of Drama is the marble exploitation, which is carried out through the extended quarries' network of the area. About 80% of the total marble exports at national level originated from the 80 active quarries of the Regional Unit of Drama, which comprise about 40% of the country's active quarries.

The secondary sector of the area's economy includes mainly industries of small-medium size and fewer big ones established in the area during the past few years, in the fields of marble processing, metal and wood processing, as well as food and beverage production.

The tertiary sector of the area's economy includes mainly businesses operating in the fields of transportation, storage, communication, social activities, wholesale and retail trade, catering services and financial services. Tourism is not well developed in the area although the alternative tourism potential has been well recognized by all the concerned stakeholders of the area.

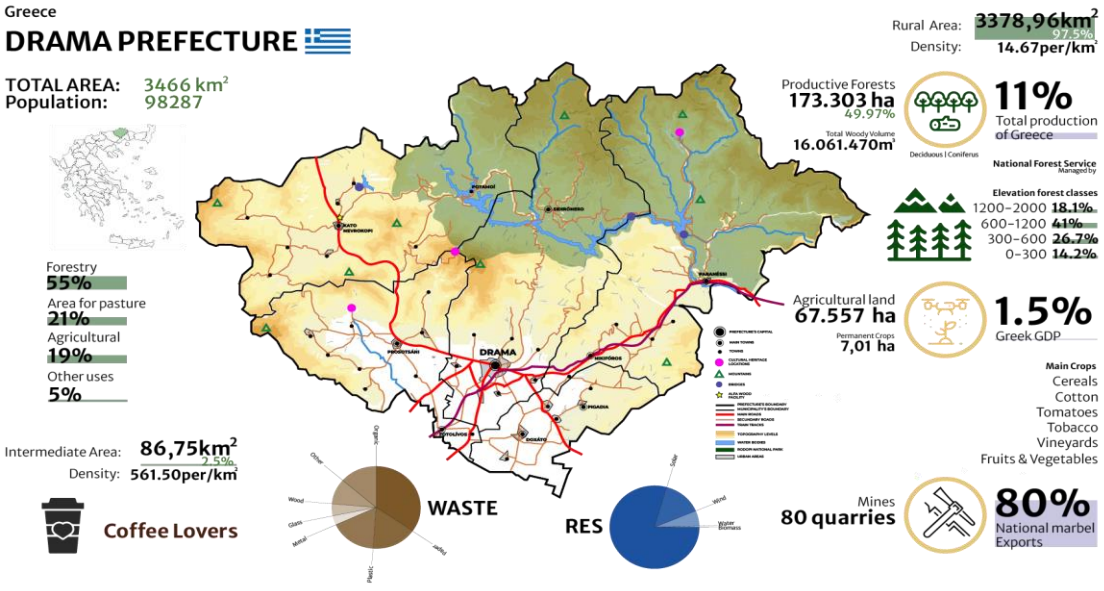


Figure 4. Drama Prefecture Giga MAP

1.2 State of art

1.2.1 Historical framework of the context

In order to find a solution to get rid of the ash produced by the company. After a long period of time in which we have done our research , trying to figure out solutions for the ash that comes out of the facility after the process of burning the different materials for example : tree bark , branches or many different materials , we have found certain problems that we addressed in this paperwork , like where can we use the ash ? In what specific field works best

? What are the properties of the ash ? Is it beneficial to the plants as fertilizer ? as cement ingredient or as pesticide , even as a medicinal product ?

In our search for the answers , and all the materials that we need , we have found out that the ash can be used in many different fields , as fertilizer , as animal bedding , medicinal product or even as pesticide , a natural solution against insects , worms ,ticks and many other parasites that can affect the life of any plant or any animal , including the humans , because everything that gets affected eventually will affect us , coming full circle .

The solutions that we found during the research were those mentioned above , the use of ash is wide , and has many applications in different fields , such as animal bedding , as fertilizer , pesticide and as a medicinal product .

1.2.2 Existing solutions

The existing solutions that we have found are that we can use the ash in different fields , and recycle it as different products for insects as pesticide , as fertilizer , or animal bedding , including medicinal use , for bruises and many others .

The problem with ash is that it comes with impurities and it depends on what they burn that day in the burner , or with what they are burning the other materials with , like they can burn wood with nails , or wood panels that were treated with different substances , in the burning process everything is cleansed but is still a probability that some impurities remained , making the ash unusable for certain types of applications like as a fertilizer or as animal bedding because it affects the plants and the animals , on one hand the plants may die off , on the other hand the animal may try to eat it and get sick because of it - that’s why we came up with a plan for the ash , a calendar that checks a certain day for every week of the month every year , for a certain type of material to be burned that is needed for a certain field , as example first week of the month they can burn tree bark excellent to be used as a fertilizer or in a mix with fresh compost or other natural treatments .

The other week of the month they can burn any other type of material , not needing to worry about the impurities inside of them , because they are not high enough in order to damage the cement mixture in the case of using the ash as cement replacement or add on in the mixture to give it strength and durability , but most importantly reduced curing time and reduced permeability making it more resistant to weather conditions.

Doing so every week of the month it can be created a cycle in which a constant flow of various ash types can be stored on the plot of land , having always a constant type of ash with constant properties .

Another solution is to use it as a cosmetic ingredient in the cosmetic sector or pharmaceutical sector to make natural products that are not harmful to skin or the health of the population in general.

But for the ash to be properly sorted, that is one of the multiple solutions that the company needs to take in order to properly do every step of the packaging process of the ash in order

not to get to complicated or to risk selling the wrong type of ash , one that is full of impurities and risk jeopardizing the company name and make a bad reputation for it.

That's why it is really important to implement a type of calendar in which in acertain week a type of material is burnt in order to collect the ash for a specific sector thus keeping safe and harmless for the chosen industrial sectors.

1.3 Description of the chosen solution

We have chosen those solutions for the problems at hand because during the extensive research that we have done during this period of time that we spent here in Drama , and at the company analyzing the problems that they encountered during the years since the company was first established fitted the best for the needs they have .

The solutions chosen had the best outputs and results then any other solutions that we thought of during the research and can be the most embraced in a world where there is a high need of natural based solutions for various industry problems , like the agricultural sector , the construction , pharmaceutical and cosmetic sector .

The options and the extensive impact of the chosen solutions makes them perfect for the problem that we have found during the period of time that we have spent here .

Profitability and expanded expertise gained from implementing the solution is high , and in time the costs of executing the solution will be dampened in time , regaining the amount of money spent doing so .

The applications from the solution are almost endless , for the ash and the other byproducts solutions we have found , like the coffee as a pellet material replacement during the periods of time in which the company runs low on raw material or biomass to burn or to produce pellets is perfect , because it works wonderfully as a pellet material replacement , better than expected by the company itself .

Also the applications of ash are a lot , in a lot of sector especially the ones that we found to be the most suitable to implement into currently and maybe during the next few years after the current solutions gain traction which will definitely do , the company may expand towards different other solutions and sectors , thus increasing the profitability and the xpertise making the company even more important on the market , having multiple options and sectors that they are active into.

Strategic management planning and marketing

The aim of this section is to create a marketing plan which is an organized and structured document that defines the business objectives to be achieved in a given period. The object of this document is to detail the strategies and actions to be undertaken in order to achieve the final project (sell all the ash generated in the production of pellets and briquettes to give it a "second chance" and use them in a circular economy creating uses for this ash) within the planned time frame.

Analyzing the marketing environment

Macroenvironment

In this section, we would focus on the macroenvironment, which consists of large societal drivers of change that are not directly related to the activity of the Alpha wood company but have the potential to affect it.

Once we studied the company and the environment in which is involved, the most significant factors are:

Firstly, **political** factors such as the amount of pollution that the company can emite legally, in order to comply with the limits established by the government to all the companies in the country to collaborate with corporate social responsibility.

Secondly, the **economical** factors related to the budget of the company and its expenses to produce pellets and briquettes with the certificates ENPlus A1 and ENPlus A2 according to the high-quality European standard ENplus.

The third factor is the **social** environment of the company. Alfawood is a family-run business and its values are shaped by their faith in humanity and the world. Its most important values are dynamism, loyalty, sense of responsibility and reliance.

The fourth factor is **technology**. This factor is related to the machines and automated processes that the company has in order to produce pellets and briquettes and bag them into packages.

The fifth factor is the **environment**, related to the purpose of a circular economy with the aim of reducing pollution using biomass and recycled wood and materials.

Finally, the last factor is the **legal** one, which includes regulations and rules from Greece and the European Union in order to create an organized environment between companies in which everyone should participate following the rules to achieve its goals legally.

Internal Analysis

In this Internal Analysis we refer to the controllable elements inside an organization that influence how well the organization operates. Taking into account Internal strengths and weaknesses may lie in different types of assets that are tangible and intangible. The classification made for Alpha Wood is:

- **Geographical location:** The company is located in Greece, a city in the northwest of Greece. We can say that the location of the company is good because on the one hand, its main purchasing point is Bulgaria and on the other hand the most common sales destinations of the company are Greece, Albania and Italy. Furthermore, the group

develops an extensive network of warehouses and distributors of pellets and briquettes so that the consumer has a close access to the point of sale.

In short, the geographical location gives the company a great advantage as it is relatively close to Bulgaria and the countries to which it exports.

- **Human resources:** Alfa wood employs over 40 local employees and many more in the supply chain. It is the definition of "GREEN GROWTH", even though it operates in a remote area. This company brings career opportunities to people with values, morals and ambitions. It is a strength of the company due to the fact that they invest in people who are passionate about work and motivated to achieve the company's goals.
- **Technological resources:** ALFA WOOD GROUP A.E.V.E. is dedicated to the wood sector. The evolution of the group reveals inner and natural energy that constantly sets new goals and carries them out. Today we can say that it is a leading company in the industrial processing of wood, which contributes to the development of the national economy. In order to obtain pellets of high quality which require high demand in the field of technology, technology must be combined with economy and ecology.
- **Physical facilities:** The facilities in the industrial area of Larissa cover 50.000 m2 with the factory comprising 29.000m2. The premises in Grevena are located on a privately owned plot of 107.000m2, with the buildings occupying 27.200m2. The facilities at Nevrokopi are spread over an area of 228,000m2 of which 15,300m2 are factory premises. The Nevrokopi unit is active in the production of bio-fuels and green energy
- **Relationships with suppliers:** This is the systematic approach to assessing the suppliers that provide goods, materials and services to the company by determining each supplier's contribution to the success and developing strategies to improve their performance. Currently, the company is not in a very comfortable situation, since due to covid 19 on the one hand, and on the other hand, the war that is being fought between Ukraine and Russia complicates the relationship with suppliers, which translates into a shortage of raw materials for manufacturing.
- **Corporate reputation:** In terms of the image projected by the company and its perception towards its stakeholders, we can say that they could improve it by investing in this project framed within the circular economy, as at the same time as they increase their profits, they could generate a greener and more sustainable image. Alfa wood is distinguished for its entrepreneurial spirit, the ability to adapt and adhere to the requirements of its partners.
- **Ownership of strong brands in the marketplace**: "The company was founded in 1981 and has been following a continuous upturn, making it the largest Wood Processing Industry in Greece and one of the most significant in the Balkans. Together, they have successfully established the ALFA WOOD group in the Greek and international markets".

- **Financial stability:** It is a condition in which the financial system is capable of withstanding economic and financial shocks and smoothly performs its intermediation role.
- **Available production capacity:** The factory has a high production capacity since it can reach 60,000 tonnes of pellets per year, unfortunately due to the shortage of raw material the company is currently (July 2022) producing only 45,000 tonnes, which means that they are producing at 75% of their production capacity.
- **Ownership of strong brands in the marketplace:** The company has to work on its competitive advantages in order to define the company as a coherent company to ensure that consumers identify it and trust it.

1.3.1 SWOT Analysis

Once the previous study has been carried out, where the objective was to analyze the company internally and externally (both the environment and the sector), we can carry out the diagnosis, in which the strengths and weaknesses as well as the opportunities and threats of Alfa Wood are summarized in a table. In order to have a snapshot of the business project to ensure the success of the project.

	EXTERNAL	INTERNAL
POSITIVE	OPPORTUNITY	STRENGTH
	- Internal market maturity level - Consumer preferences - New products emergence	- Geographical location - Technological level - Brand/company image
NEGATIVE	THREAT	WEAKNESS
	- Technical barriers (certificates or approvals) - Existence of emerging markets - Transport system	- Available production capacity - Commercial network/external contacts - Financial resources

Marketing information system (MIS)

- **Internal reporting system:** Alfa wood group employs 350 people and has a network with 10 distributors in Greece and 39 points of sale through local partners in other

countries. The company exports about 40% of its annual production in 39 countries, some of them are: Albania, Algeria, Bulgaria, Croatia, Cyprus, England, Egypt, Italy, Kosovo, Morocco, Vietnam, Turkey, etc.

Alfa wood produces on average 60,000 tons of pellets and 7.000 tons of briquettes per year with a quantity of power output of 2 mw. In addition, the company proudly states that through the green energy it produces by re-using about 75.000 tons of biomass every year provides electricity to 6.000 homes on an annual basis, while saving approximately 200.000 tons of carbon dioxide (CO_2) every year.

- **Marketing intelligence system:** Firstly state that, one of the most important aspects that can cause a huge impact on the company is the ability to stay ahead of the market having a comprehensive understanding of its competitor, the industry or the changing consumer landscape, among others. We can prove that Alfa Wood is trying their best to be at the forefront of the sector, always framed in the values of sustainability and high quality.

  Secondly, nowadays with the new technologies is really easy to find useful data which can help the company, some of this tools are:

  - Chambers of Commerce (http://www.plancameral.org)
  - Jetro (http://www.jetro.go.jp)
  - International chamber network (http://www.worldchambers.com)
  - World trade organization (http://www.wto.org)
  - Ministry of Trade Country Channel (https://comercio.gob.es/es-es/paginas/index.aspx)
  - Commercial Guides Countries Embassies USA (https://www.export.gov/ccg)

- **Marketing research system:** It is the systematic collection, organization, analysis and interpretation of the primary or the secondary data to find out the solutions to the marketing problems. This allows you to state a specific problem as your current business goal and investigate all the details necessary for developing its solution. If you are thinking of developing a new product, you should conduct marketing research. Then, based on your findings, you'll manage to create a solution.

  For instance, the case of selling all the ash generated by the company to use it in other different ways. Before carrying out this action, it is important to do research and study what uses can we give to that waste of ash and what companies or organizations can we sell it to.

  After doing this research, we have found that the ash can be used for construction, pesticide, fertilizer and medical fields.

- **Marketing models:** These models are highly important because of their attempts to show us what the outcome should look like if we change variables of the company. In

other words, marketing models can give the company the answer to different hypotheses to know certainly what will happen.

Setting marketing objectives

Once the Alpha Wood company has a thorough understanding of the marketing environment, we have to proceed on developing the marketing objectives. In a few words, the marketing objectives state what the marketing function must accomplish in order to succes in the project.

These objectives can be quantitative or qualitative. In order to succeed they have to be specific, measureable, attainable, relevant and time-based.

The aim of this project is to make a profit by selling the ash waste generated in the production of pellets and briquettes of the company, in order to give it a "second life" and use it for other purposes. How can we achieve this?

- Studying the quantity of ash generated by the company.
- Studying the quality (i.e. the components) of the generated ash.
- Looking for possible alternatives/products that need this ash.
- Choosing which of them is the most feasible one.
- Finding out to which companies or countries we can sell the product and how much it would cost.

1) Classification

The first step that we have to take is to classify the ash in order to know the properties to assure that this ash is available for the purpose.

As the company Alfa Wood let us know, they burn the different waste made by the company in order to make the trash disappear. In order to do that they obtain different ash with different chemical properties depending on what is burned. The aim of this project is to prove that through a circular economy we can achieve an efficient balance between economic development and environmental conservation is undoubtedly one of the great challenges facing today's societies.

Giving a new life to the ash produced by the company will contribute a grain of sand in the fight against climate change while promoting and maintaining a strong and growing economy, which requires concrete measures and actions.

2) Packaging

The second step that should be taken is the process of packaging the different kinds of ash depending on what was burned. The company already has a machine that is being used for bundling (pellets or briquettes) but they can use the same machines so they will not have to invest money on that. Regarding to the kilograms we would like to offer three different options in order to give to the customers different quantities this are: 70kg, 110kg and 250 kg

3) Final Consumers

In the third and last step is to find the right customers, in this project we agreed that in order to take the most possible advantage of the ash regarding to the properties and the economical part, the sector are:

- Agriculture
- Pharmaceutical
- Cosmetic
- Construction

Developing marketing strategies

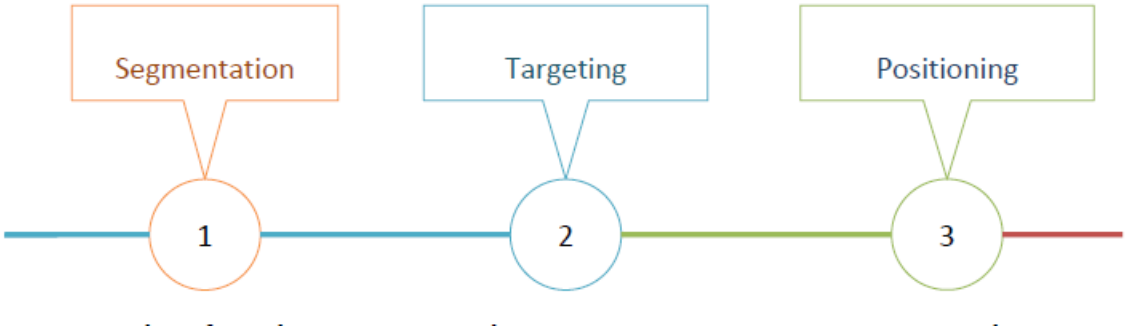
In short, developing marketing strategies means deciding which markets to target and how to develop the marketing mix to reach that market. There are 2 steps that should be done:

1) Firstly**, Selecting a target market.** Alpha wood must assess the potential demand of the market segment related to the ash (segmentation) and create a competitive advantage in the minds of these consumers (positioning).
2) Secondly, **developing marketing mix programs**: product, price, placement and promotion. These four functional areas become the "basic box" for almost all marketing decisions.

In terms of segmentation is a fact that markets are not homogenous and the company has to make an effort to recognize that they cannot target all the consumers in the marketplace, depending on their needs and purchasing patterns, so they could be grouped according to their characteristics. The purpose of this section is the process of dividing large and heterogeneous markets into smaller and homogeneous segments to reach more efficiently and effectively.

In this case, we can consider that this product is involved in market segments, because there exist homogenous groups of consumers sharing one or more similar characteristics that cause them to have relatively similar product needs and buying characteristics. In other words, the company has to identify which suppliers came from the different sectors (Agriculture, Pharmaceutical, Cosmetic, Construction) in order to know the sector and know how to get the message across to that sector, as perhaps the packaging or advertising should be changed depending on the sector to be addressed. Llegados a este punto nos podemos plantear cuales son los beneficios de este punto, pues bien estos se pueden clasificar en:

- Highlights existing business opportunities (markets with unattended needs) and allows the company to respond quickly to even slight changes in what target customers want.
- Helps to set priorities (given limited resources).
- Facilitates competitors analysis (focusing on the immediate ones deciding about the kind of competitive advantage to seek).



The criteria for developing the marketing strategies are:

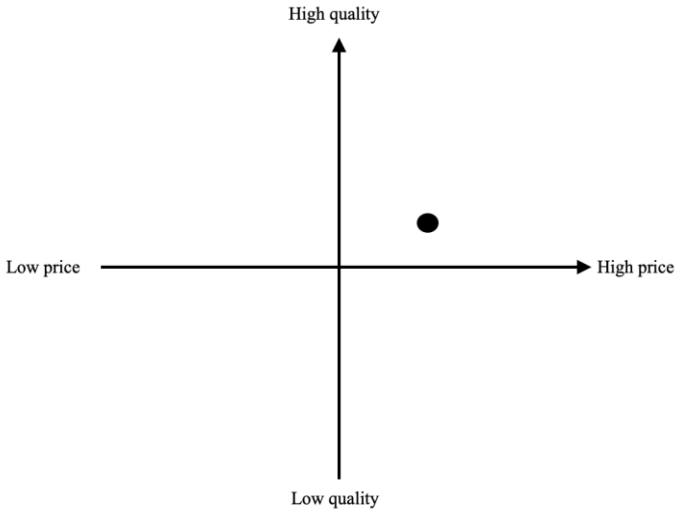
When evaluating different market segments (TARGETING), the company must take into consideration the segment's overall attractiveness and its own resources and goals. Then, the company needs to decide how many segments it can serve best. In this case the best solution is the concentrated way because the company targets one specific market segment or a few of them, ignoring the whole market. It means that the company goes after a large share of a small market segment or niche, instead of pursuing a small share of a large market.

1. **Product**: It has to create different packaging/models for the different existing segments.
2. **Price**: Obviously depending on the quality of the ash content and the kilogram per package will affect the final product.
3. **Distribution**: Different distribution channels for different segments. Although the company subcontracts the distribution to another company, it has to take into account the cost and time involved in sending the packages depending on the sector to which they are sent.
4. **Communication**: Different communication strategies for different segments.

Another way of developing marketing strategies is by positioning the products in the market. The positioning consists of arranging for a market offering to occupy a clear, distinctive and desirable place relative to competing products in the minds of target consumers. It is what the company does to the mind of customers, so companies position the product or the brand in the

customers' minds. The result of this strategy is the creation of a customer-based value proposition, the reason why the target customers should purchase the product.

In this case, the positioning of Alfa wood with the sale of ash to other companies can be classified as ash with not a very high quality but enough to be able to use it for construction, pesticide, fertilizer and medical fields. And also, this ash has to be sold at a price at which the company earns a good profit. it can't be very high due to the fact that the quality is not the best, but neither can it be too low because the company needs to make profit from it.



Implementing and controlling the marketing plan

Implementation means putting plans into action.

There are several ways to organize the marketing function:

- Functionally (separates marketing into distinct components –sales, advertising...-).
- Geographically.
- By product (brand, product line...).

Controlling means measuring actual performance, comparing it to planned performance, and making necessary changes in plans and implementation.

This process requires that marketing managers obtain feedback on whether activities are being performed well and in a timely manner.

1.4 Conclusion

The ash coming from the burnt materials , can be sorted and stored on different ways, therefore always having a constant supply of ash with constant properties which can be used in the sectors mentioned above.

1.5 References

Dimos Dramas available at:https://dimos-dramas.gr/en/

2. Calculation and design of the system/ installation/equipment

2.1 Input data of the project

2.1.1 Kato Nevrokopi & the prefecture of Drama

Kato Nevrokopi is a facility of the Alfa Wood Group that is situated in the prefecture of Drama , on a pretty big plot of land , with separated areas for different type of wood , wood products and different wood waste like saw dust , wood chips , tree bark , or many other waste that comes in the yard of the Alfa Wood Group facility .

Each of the areas is separated to not mix up , because they are used in different products or different processes , each of them needing to be kept separated .

Before everything gets inside the processing machines , once the material arrives at the yard , is tested before by them in the oven , for moisture and other properties , and by the European Pellet Committee (EPC) , to check if what they get is up to the standards so everything is good to go.

Everything that comes in after being stored in the different designated areas of the facility yard , a wheel loader comes picks up the wastes or wood , depending on what they feed the processing line outside , for example , they feed the wood on top of a collector , that goes in and debarks the wood , the bark afterwards either comes out along the outputs of the line or is stored in the big siloz outside , which are three , each of them holding up to 500 tons of material from debraking the wood or other like wood chips .

Afterwards the material travels to be processing machines that are situated inside the facility , where they are split between a wood pellet making machines and the briquette making machines that can produce up to 200 tons a day leading up to a capacity of 34,306 tons a year of pellets , 466 tons of big bags and 1.361 tons of briquets.

After they pack it on pallets , they put it in trucks and ship it across the country or abroad like Italy which is one of the biggest markets that they target to sell their products and are currently selling their products , besides Italy , they also sell to bulgaria , north macedonia and serbia.

2.1.2 Properties of the ash/The data analysis of the ash from the company

The properties of ash differ from batch to batch every time they burn something the output ash is different in properties , fluctuating , therefore the idea of a calendar which every week of the month something else is burnt in the furnace , therefore it will be a constant supply of a certain type of ash adding up every week of the month giving the company enough time to clean it up and they restart the furnace in order to burn a different material , for every specific field that it can be used such as construction , pesticide , fertilizer , and medical field.

The ash typically comes from the ash tree which is one of the best wood trees for ash , being very easy to process and the ash is excellent , besides this other types of wood works also for ash .

Table 1. Ash Properties from the tests at the facility

Parameter	Testing method	Limit of determination	Estimated value	Threshold value for inactive aggregate waste	Threshold value for not dangerous waste	Threshold value for dangerous waste
Arsenic	ET-AAS	0.001	<0,002	0,1	0,4	6
Calcium	Volume	1,5	120	550	10000	17000
Cadmium	Flame AAS	0,01	<0,02	0,03	0,6	3
Chloride	Photometry Light estimated	0,01	<0,02	0,2	4	25
Lead	Flame AAS	0,04	<0,08	0,2	5	25
Mercury	CV AFS	0,0002	<0,0004	0,003	0,05	0,5

Niquel	Flame AAS	0,04	<0,08	0,2	5	20
Zinc	Flame AAS	0,01	0,38	2	25	90
Sulfates	Photometer	3	110	560	10000	25000

The table above shows the properties of the ash, that was tested from the facility, of Alfa Group Wood , and it shows different impurities and metals are found inside the ash that is collected every day from the burner of the facility, and it proves even though everything is burnt and most of the impurities are gone, there are still some left afterwards, which is not good for every application, especially as fertilizer because for the fertilizer use, the ash doesn't need to have metals or toxic impurities in it ,m therefore the idea of a calendar in which a certain type of material such as tree bark may be burnt so that specific day every week it can be collected and used to produce fertilizers or as a add on for natural compost or any other natural solution used for plants

But as it is the ash can be used against insects or against worms or other parasites that resides in the animal bedding, or may occur during the time that the animal stays in the stall, layed down because in time dirt and other junk may build up from the animal being dirty, from where it came from when ti went out. Using it as animal bedding underneath the straw bed or other types of bedding, keeps the worms, parasites and other microorganisms from forming or appearing, keeping the animal bedding sanitized and safe for the animal such as cows, horses, or even dogs or other animals.

Even though the ash doesn't have constant properties every time that they test and burn the materials, each time of ash that comes out can arranged to be used for different applications based on the idea of a calendar, as explained before, which each day of the week is a different ash from a different material that was burnt collected, and added to the specific pile that was designated on the patch of land.

And from there it can be picked up and sealed up in simple transparent bags with the company label and what ash is it, the ash may be packed in different sized bags for different application, for example if is needed for the agricultural field as fertilizer it can be packaged in big bags, industrial sized bags, or medium sized bags, if its needed for gardening in small bags, or also medium bags and if is for the use against insects or parasites it can also be packed in small or medium bags, or industrial ones, therefore what we want to show from this is that packaging is simple.

Table 2. Ash chemical properties

Barium	Photomet	0,2	1,1	7	30	100

	er					
Copper	Flame AAS	0,01	0,05	0,9	25	50
Molybdenum	Flame AAS	0,02	< 0,04	0,3	5	20
Antimony	Hydride AAS	0,001	< 0,002	0,02	0,2	2
Selenium	Hydride AAS	0,005	< 0,01	0,06	0,3	4
Fluoride	Photometer	0,02	0,8	4	60	200
DOC	APHA 5910B	0,3	110	240	380	480
TDS	ALPHA 254C	17	1540	2500	40000	70000

The resulting properties may differ a bit from other tests that were done for different ash batches across the world, from various different fields and materials.

But most of them have the same amount of impurities or metals in them, from calcium to copper, chloride, fluoride or many others such as this batch test that we found during our research across the internet.

Reference 1

Test Parameter	**Result(%)**
Alumina (Al_2O_3)	9.85
Silica (SiO_2)	62.87
Calcium (CaO)	10.35
Iron (Fe_2O_3)	4.45
Magnesium Oxide (MgO)	4.18
Sodium (Na_2O)	0.035
Potassium (K_2O)	1.71
Loss on ignition	5.85

This is one of the tests found, showing the metals that the ash contains in this batch. "According to testings found on the internet done by others on ash , if the temperature of the furnace or any other chamber that the combustion is done in, from 538 to 1093 degrees celsius the ash yield decreases by 45%, that means the output ash that comes from the furnaces that the material is burnt in drops drastically and not much ash remains after the material is burnt.

The substances such as potassium, sodium and zinc decrease whilst the metal ions or other substances that are metal based increases or decreases depending on each batch of ash and at what temperature is burnt at. In this case the ash leachate had a percentage of 92% hydroxide and 8% carbonate which doesn't make it any good for aquatic environment nor for any other applications except as pesticide".

Reference 2

In this paper it shows the results of another test done at a different facility in a different area and the properties resulted from the test done on the ash batch.

"The paper presents the results of studies on ashes produced from burning wood biomass in closed wood-fired furnaces, in individual household furnaces (Silesian Province, Poland). Dry sieve analysis and detailed granulometric analysis were performed with the Analysette 22 Micro Tec plus analyser. Content of the basic elements (Al, Si, P, Na, K, Mg, Ca, Fe) and potentially toxic elements (As, Pb, Cd, Zn, Cu, Ni, Cr, Hg) was determined by atomic absorption spectrometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS). Relative enrichment factors (REFs) were calculated for the elements (Pb, Cd, Zn, Cu, Ni, As, Hg, and Cr), and the emissions (E) of Pb, Cd, Hg, and As to the environment were estimated. The carbon content (40.2%–45.8%), H (3.7%–6.1%), O (46.2%–50.2%), N (0.12%–0.32%), and S (0.11%–0.96%) in wood biomass varies and depends on the wood species and drying period. The content of volatile parts in wood biomass ranges between 69.3 and 81%. Ash content varies between 2.6 and 18.3%. The wood calorific value ranges from 13.6 MJ/kg to 17.4 MJ/kg. Moisture content in the wood biomass ranges from 13.7% (briquette) to 46.7% (fresh birch). Identification of mineral composition and phases yields a high share of calcite, monetite, fairchildite, and quartz in the examined ashes. The combustion of wood biomass in fireplaces results in increased emissions of Pb and Cd to the atmosphere and may be the cause of introducing pollutants to waters and soils during ash storage."

Reference 3

Based on further research, it is proved even by the world health organization that burning wood, and the ash from burning wood is not dangerous to the health of humans, animals or the environment, that means the specific ash that is used for fertilizer or any other natural treatments that are used to fertilize, enrich or add to a compost or for the plants in the agricultural or gardening field, is absolutely natural and harmless, and that is everything

related to wood, tree bark, wood chips, many types of wood ash as presented in this paper down below.

"Individual domestic furnaces in open and closed fireplaces mainly generate ash from burning wood and briquettes produced based on hardwood and coniferous wood. Ash from burning wood biomass is widely recognised as potentially harmless to the environment. In Poland, in 2018, the consumption of biomass from wood in individual fireplaces reached 13.2% (GUS 2019), while in other EU countries it was about 16% (Faraca et al. 2019). It is estimated that pollution emissions from wood combustion in residential buildings account for approximately 45% of PM2.5 dust and may have a significant impact on the air quality in a given region (Martin et al. 2013; Daellenbach et al. 2016; Maasikmets et al. 2016; Corsini et al. 2017; Czech et al., 2018b, a; Trojanowski and Fthenakis 2019).

The World Health Organization (WHO) believes that such emissions are one of the major global environmental risk factors (Carvalho et al. 2016; Tao et al. 2016; Vincente and Alves, 2018; Padilla Barrera et al. 2019). In the process of wood biomass combustion, inorganic components can be distributed between the gaseous product and the solid ash fraction (Thy et al. 2017). It is estimated that almost 70% of PM2.5 comes from wood burning in fireplaces and 30% from wood boilers (WHO 2015). The contribution of wood burning to air pollution varies and according to WHO (2015) during the heating season, PM2.5 emissions range from 30 to 90% and PM10 emissions range from 10 to 81%. In Denmark, PM2.5 emissions from wood combustion are around 67%. The highest share of PM2.5 from wood combustion was found in the winter season in Australia (Launceston) with 95%, followed by the USA (Fairbanks) with values ranging between 60 and 80%. In the southern part of Germany, PM2.5 emissions from wood combustion account for around 59%. In Italy, wood burning in urban households causes an increase in particulate matter from 18 to 76%, and in rural areas from 40 to 85% (Siergiej and Jędrak 2019). A typical fireplace for seasoned wood emits up to 1350 mg of particulate matter/m3 and up to 2180 mg of particulate matter/m3 when burning damp wood, while a fireplace complying with emission standards only emits about 40 mg of particulate matter/m3 (Kubica and Kubica 2016).

According to Alves et al. (2011), the emission factor for biomass combustion in residential buildings is 17.3 g/kg PM2.5 (Maenhaut et al. 2012; Martin et al. 2013; Cincinelli et al. 2019). Considering the chemical composition of ash and its potential applications, attention should be paid to the content of alkaline and potentially toxic elements (Czop and Kajda-Szcześniak 2010, 2013; Kajda-Szcześniak 2014). According to Vassilev et al. (2012), dried wood contains: 49.5% C, 6.3% H, 44.2% O, 0.04–0.26% N and 0.2–2.3% mineral compounds. Natural biomass is enriched with such elements as: Ca, Cl, H, K, Mg, Mn, O, and P (Vassilev et al. 2010; Michalik and Wilczyńska-Michalik 2012; Mirowski 2016). CaO, SiO2, K2O provide for the largest share in wood biomass (Vassilev et al. 2010; Ban and Ramli 2011; Garcia et al. 2015). Ashes from wood combustion also contain potentially toxic elements, such as As, Cd, Ba, Cr, Cu, Ni, Pb, and Zn (Cuenca et al. 2013; Vassilev et al. 2014; Berra et al. 2015; Uliasz-Bocheńczyk and Mokrzycki 2018). According to Jukić et al. (2017) ash from wood burning is characterised by high Zn and Cu content and low Cd and Hg content. The phase composition of ashes from biomass mainly includes of calcite, sylvite, arcanite, apatite,

anhydrite, periclase, hematite, and unburned carbon (Vassilev et al. 2013; Magdziarz et al. 2018)."

2.1.3 Where is the ash most useful?

Ash as we know ash comes from different materials that were burnt such as wood, and wood vary from wood ash , to hardwood , and many other types of wood, but ash is not all the same, because of the places that it comes from, for example depending on the material that was burnt it can contain different impurities, metals or ions, toxic wastes or many other stuff that won't be good for anything, and may harm animals or plants, varying where the ash can be used, that's why the ash needs to be filtered and stocked based on where is most useful and where it will be used in the nearby future .

The ash is very useful though for many applications , in many fields such as agriculture as fertilizer, for animal bedding underneath the straw bedding or just as is, for the properties it has against worms, parasites or other microorganisms.

Also ash is useful as pesticide, against insects, that may harm crops, plants, in the garden or other various regions that are the most affected, it acts as a natural pest repellent against insects protecting the plants and crops from being destroyed and losing everything.

In the agricultural field, against pests, a lot of methods have been tested to see their effectiveness against insects, larvae, eggs, different parasites, most of them proved to be pretty useful but on the long term and were hard to maintain, especially hand picking the larvae, pests from grain different crops, in the past methods like bajagun weed or, cow-dung or clay mixture were tested in which a paste of cow urine and clay was applied to the crops, it was useful more for treating wounds in the past and repellent some pests but wasn't a long term solution because of the smell and therefore this solution was dropped a long time ago, some old folks still use it but is very very rare in few location in any country, other solution was using kerosene against rats or the bajagun weed mentioned above that were used to repel pests like rats, monkeys or birds to keep them away from the crops that were protected.

One of the best solutions that is still used to this day is the use of ash .

Reference 4

"It is a common practice to sprinkle wood ash on vegetable crops, especially growing in kitchen gardens and to spread it around plants to ward off pests and to enhance nutrient status of the soil. To achieve this a thick layer of ash is spread on the soil around plants and it is also sprinkled on foliage to protect it against a variety of pests. This is because it is a source of phosphorus for plants and it also acts as a physical poison usually causing abrasion of epicuticular waxes and thus exposing pests to death through desiccation. It also interferes in the chemical signals emanating from the host plants thus obstructing the initial host location by pests. The treated foliage further becomes unpalatable for foliage feeders like cutworms, caterpillars, grasshoppers, etc. But since ash provides only temporary protection against pests, insecticides which have quick knock down effects have replaced the use of wood ash today."

Even though the use of ash has been replaced by modern day pest repellent which have a quicker knock down effect and long term, they are also full of toxic substances which can affect the life in the long term and cause various health issued shortening the life expectancy by a couple of years, making some of the plants and soil toxic in time. Therefore the use of ash as is or as a add on to other natural pest repellent solution is the best way because is natural and won't harm the health of humans or animals, even the soil and plants will be fine in the long term, making the whole entire chain that we are always connected to safe.

It also protects wood or plants from fungi or other diseases that affect crops in big batches or small batches, furthermore making the ash a very good natural solution.

The ash doesn't have only the use as a pesticide but also as a fertilizer, by using it as is or as a add on to other natural solutions such as compost, it can raise the ph of the soil making the soil arable and healthy again good to be used for agricultural crops planting increasing soil fertility, therefore every time the crops need to be replanted before that the farmers can use ash to rise the ph and fertility. Also the ash can be used for everyday use, be it any person, such as an ingredient for baking, cooking food, preserving food or many others. Ash can also be used to make soap, natural and safe for the skin, removing bacteria doing the same exact job as the soap from the commerce.

2.1.4 Mapping of the ash chain use

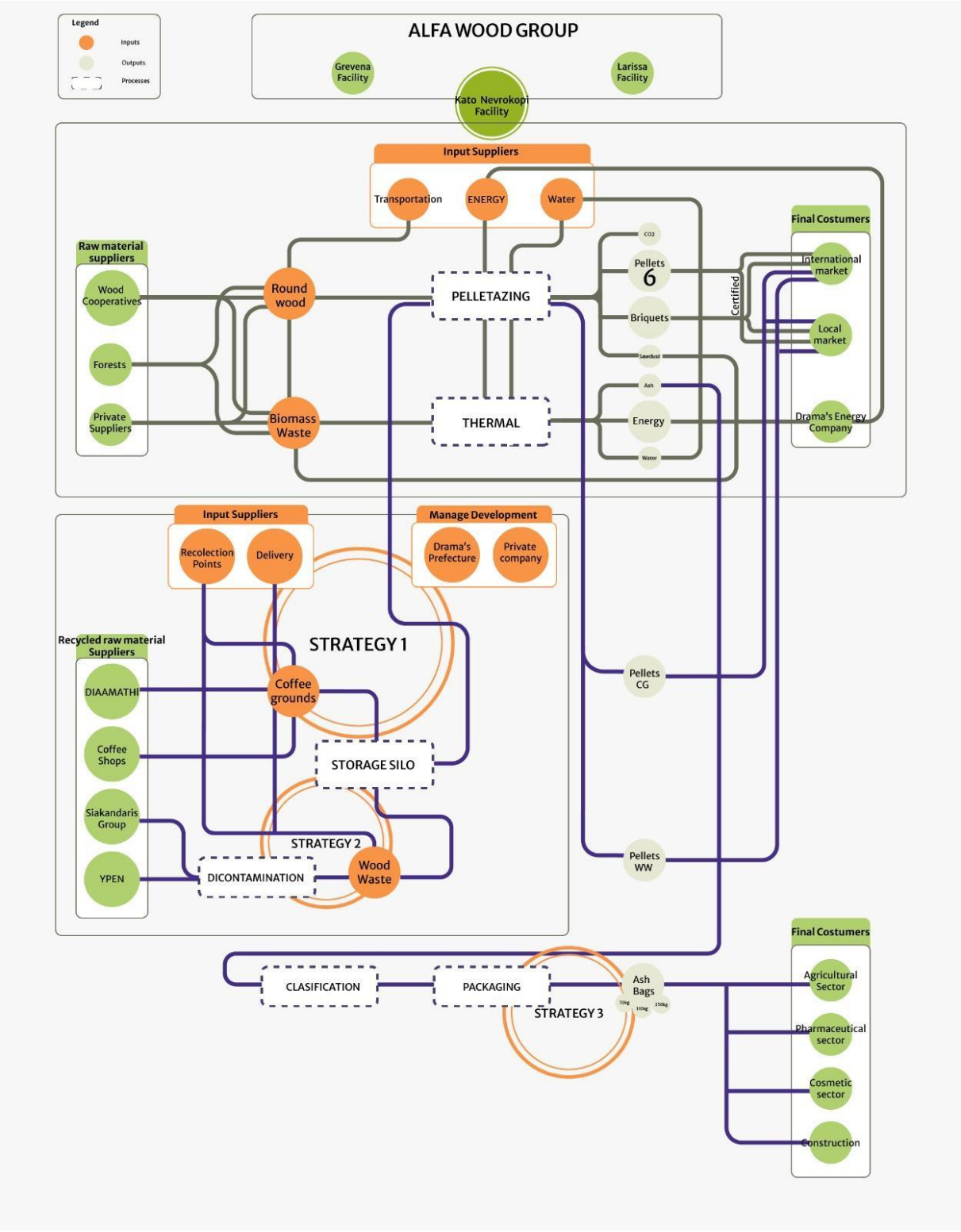


Figure 4 The ash chain use

2.1.5 What field needs the ash the most?

As it was mentioned earlier in the present paper, the ash will be sold in four different sectors, in the construction sector, in the agricultural sector, in the cosmetic sector and in the medical sector in 3 different sized bulk bags with various volumes and weights, I have chosen those sizes because based on our research on the standardized sizes of bulk bags the smallest standardized size in the world that can be sold is 35 inches tall and 35 inches wide, and the biggest one can reach up to 80 inches tall and 48 inches wide, based on this information found about the standardized bulk bags sizes, we have created 3 different sizes that will be available to be sold to the four different sectors mentioned previously.

In the current project about the the byproducts of ash in the production of biomass energy and its possibilities for a new circular economy system we chose these three sizes for the ash to be packed in, because it will make it easier for the buyers to buy the amount they need and to have multiple options in case they don't need to buy that much ash, but a certain amount for a certain operation or process they need to use at.

Besides this it will make it easier for the company to pack the ash, being in simple transparent thick bags with a label of the company and the ash that wa packed, and to sell it, because they don't need to do any other process to it, except sort it in specific patches on the plot of land that they usually store the ash on and collect it afterwards from there, bring it to the facility designated area for packing and from there store it and then sell it to the customer, for example the 4 sectors that were chosen to be sold at.

The sector that needs the ash the most is all four of them, but the most needed is for the following sectors, specifically the construction and agricultural ones, why? - because in the construction sector they are in need of alternatives for the diminishing resources in the world needed to produce cement or used in the process of mixing the cement in order to give it strength and durability.

Ash is very important in the construction sector because it cuts the costs and energy in the process of cement manufacturing, it can be used as a partial replacement of cement or as an admixture in the concrete mixture.

Reference 5

"Fly ash is used to lower the cost and to improve the performance of PCC. Typically, 15 percent to 30 percent of the Portland cement is replaced with fly ash, with even higher percentages used for mass concrete placements. An equivalent or greater weight of fly ash is substituted for the cement removed.

Having this high importance for this sector, the ash is the best natural replacement, easy to produce making it a good solution and investment. Benefits to Fresh Concrete. Generally, fly ash benefits fresh concrete by reducing the mixing water requirement and improving the paste flow behavior. The resulting benefits are as follows:

Improved workability. The spherical shaped particles of fly ash act as miniature ball bearings within the concrete mix, thus providing a lubricant effect. This same effect also improves concrete pumpability by reducing frictional losses during the pumping process and flat work finishability.

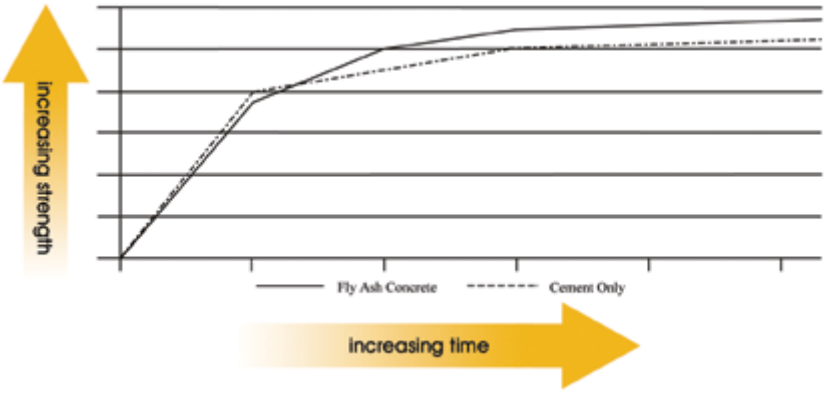
Decreased water demand. The replacement of cement by fly ash reduces the water demand for a given slump. When fly ash is used at about 20 percent of the total cementitious, water demand is reduced by approximately 10 percent. Higher fly ash contents will yield higher water reductions. The decreased water demand has little or no effect on drying shrinkage/cracking. Some fly ash is known to reduce drying shrinkage in certain situations.

Reduced heat of hydration. Replacing cement with the same amount of fly ash can reduce the heat of hydration of concrete. This reduction in the heat of hydration does not sacrifice long-term strength gain or durability. The reduced heat of hydration lessens heat rise problems in mass concrete placements.

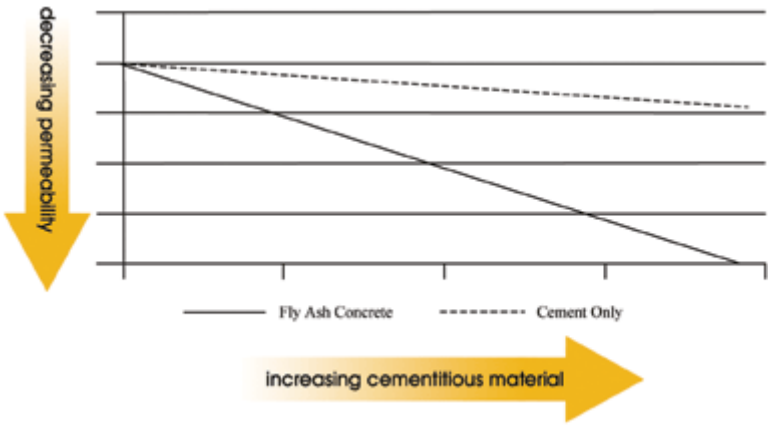
Benefits to Hardened Concrete. One of the primary benefits of fly ash is its reaction with available lime and alkali in concrete, producing additional cementitious compounds. The following equations illustrate the pozzolanic reaction of fly ash with lime to produce additional calcium silicate hydrate (C-S-H) binder:

		(hydration)
Cement Reaction:	C_3S +	H → C-S-H + CaOH
Pozzolanic Reaction:	CaOH +	S → C-S-H
		silica from ash constituents

increased ultimate strength. The additional binder produced by the fly ash reaction with available lime allows fly ash concrete to continue to gain strength over time. Mixtures designed to produce equivalent strength at early ages (less than 90 days) will ultimately exceed the strength of straight cement concrete mixes “It also reduces permeability so the water doesn’t slip too easily into the concrete as it does usually in the normally made concrete as it is shown in the graphic scale below



It also increases the cementitious compounds and improves the strength of the cement



Besides the increased cementitious compounds present in the cement , and the decreased permeability which helps the cement to last longer that the usually made cement without ash against the different weather conditions , it also doesn't need that much water as the normally made one , it reduces the need of retarders in the mix and increases durability.

The other important sector in which the ash is the most needed is the agricultural sector , because the numerous chemical based products that are used in the agricultural sector are toxic and mostly harmful for the human health and for the animal health, because we are connected to the food chain and what in the food chain is affected , we are also affected because the food that we procure and get from the various agricultural areas gets affected based on what we use to either protect from harmful pests and parasites or either from what substances we use in order to help the crops grow even in harsh conditions.

Therefore the use of the ash increased making it another very good solution for another very important sector , the most important sector because one provides jobs and houses and the other provides food and keeps the population fed.

Reference 6

"Though in the last four decades various alternative energy sources have come into the limelight, the hyperbolic use of coal as a prime energy source cannot be counterbalanced.

Disposal of high amounts of fly-ash from thermal power plants absorbs huge amounts of water, energy and land area by ash ponds. In order to meet the growing energy demand, various environmental, economic and social problems associated with the disposal of fly-ash would continue to increase. Therefore, fly-ash management would remain a great concern of the century. Fly-ash has great potentiality in agriculture due to its efficacy in modification of soil health and crop performance. The high concentration of elements (K, Na, Zn, Ca, Mg and Fe) in fly-ash increases the yield of many agricultural crops. But compared to other sectors, the use of fly-ash in agriculture is limited. An exhaustive review of numerous studies of the last four decades took place in this paper that we found during our extensive research, which systematically covers the importance, scope and apprehension regarding utilization of fly-ash in agriculture. The authors concluded that though studies have established some solutions to handle the problems of radioactivity and heavy metal content in fly-ash, long-term confirmatory research and demonstration are still necessary. also identified some areas, like proper handling of dry ash in plants as well as in fields, ash pond management (i.e., faster decantation, recycling of water, vertical expansion rather than horizontal), monitoring of soil health, crop quality, and fate of fly-ash in time domain, where research thrust is required. Agricultural lime application contributes to global warming as the Intergovernmental Panel on Climate Change (IPCC) assumes that all the carbon in agricultural lime is finally released as CO2 to the atmosphere. It is expected that use of fly-ash instead of lime in agriculture can reduce net CO2 emission, thus reducing global warming also."

Table 3 List of countries that use the fly ash or ash in the agricultural sector

Country	Fly-ash production (million tons per year)	Fly-ash utilization (%)
India	112	38
China	100	45
USA	75	65
Germany	40	85
UK	15	50
Australia	10	85
Canada	6	75
France	3	85
Denmark	2	100
Italy	2	100
Netherlands	2	100

This is the list of countries in the world that use the fly ash or ash in the agricultural sector partially or extensively , from 38% to 100% like Netherlands or Italy and Denmark does .

This proves the reliability and usefulness of ash or fly ash in the agricultural sector making it one of the best solutions for this sector included.

During the extensive research done on the physical properties of ash used in this sector in other areas of the world we found that the physical properties of fly-ash vary widely depending on the coal type, boiler type, ash content in coal, combustion method and collector setup. Fly-ash generally has a silt loam texture with 65–90% of the particles having a diameter of less than 0.010 mm . Ash from bituminous coal is usually finer as compared with that of lignite one. Fly-ash particles are empty spheres (cenospheres) filled with smaller amorphous particles and crystals (petrospheres). The cenosphere fraction constitutes as much as 1% of the total mass and gets easily airborne . In general, fly-ash has low bulk density (1.01–1.43 g cm−3), hydraulic conductivity and specific gravity (1.6–3.1 g cm−3) . Mean particle densities for non-magnetic and magnetic particles are 2.7 and 3.4 g cm−3, respectively, while the moisture retention ranges from 6.1% at 15 bar to 13.4% at 1/3 bar.

By virtue of its physical characteristics and sheer volumes generated, fly-ash is a serious problem. Some of the aspects of the problem are :Due to heavy disposal, fly-ash particles both as dry ash and pond ash occupy many hectares of land in the vicinity of the power station.

Because of its fineness, it is very difficult to handle fly-ash in dry conditions. Flying fine particles of ash corrode structural surfaces and affect horticulture.

It disturbs the ecology through soil, air and water pollution.

Long inhalation of fly-ash causes various serious diseases like silicosis, fibrosis of lungs, bronchitis, and pneumonitis.

Oxides of iron and aluminum present on the surface of the fly-ash particles attract toxic trace elements, such as Sb, As, Be, Cd, Pb, Hg, Se, and V, and they are found to be concentrated largely on the surface of fly-ash. A study was conducted by Hicks and Yager with six bituminous, sub-bituminous and lignite coal-fired thermal power plants to measure the amount of airborne respirable crystalline silica in the breathing zone of workers engaged in fly-ash-related operations.

It was found that in the bituminous, sub-bituminous and lignite coal-fired plants, the air samples (60%) collected during maintenance-related work exceeded the threshold limit. Similarly, in the case of normal production-related activities, the samples from bituminous (54%) and sub-bituminous (65%) coal-fired plants surpassed the limit. In the bituminous/sub-bituminous and lignite coal, the minimum crystalline silica contents were observed to be 7.5% and 1.7%, respectively.

Table 4 physical properties of fly-ash

Properties	Fly-ash[a]	Soil[b]
Bulk density (g cc^{-1})	<1.0	1.33
Water-holding capacity (%)	35–40	<20
Porosity (%)	50–60	<25
Major elements in percentages		
N	–	0.01–1.0
P	0.004–0.8	0.005–0.2
K	0.15–3.5	0.04–3.0
Ca	0.11–22.2	0.7–50
Mg	0.04–7.6	0.06–0.6
S	0.1–1.5	0.01–2.0
Al	0.1–17.3	4–30
Na	0.01–2.03	0.04–3.0
Fe	36–1333	0.7–55
Trace elements in mg kg^{-1}		
Mn	58–3000	100–4000
Zn	10–3500	10–300
Cu	14–2800	2–100
B	10–618	2–100
As	2.3–6300	0.1–40
Cd	0.7–130	0.01–7.0
Co	7–520	1–40
Cr	10–1000	5–3000
Hg	0.02–1.0	–
Mo	7–160	0.2–5.0
Ni	6.3–4300	10–1000
Pb	3.1–5000	2–100
Se	0.2–134	0.1–2.0

Based on those properties compared to the ones we have from the company facility we found that they are pretty similar in impurities and other material that it may include, of course not every batch of ash is the same because it depends on what material is burnt and when it is burnt.

The Ash from the company facility may have less impurities , but also it depends on what material is burnt in the furnace .

But the ash is useful and good for the agricultural sector if only a certain type of material is burnt that is toxic waste and impurities free in a specific week of every month .

The ash is also very important in other sectors like the pharmaceutical and cosmetic sectors , because there are many products that are based on ash , especially the natural ones which are very searched for and bought.

Making the ash also more valuable and profitable , increasing the market need for it and therefore one more reason for the ash to be used because it has a lot of potential that can be exploited from which both the company and the customer can benefit from.

Ash in the cosmetic sector is really useful against pimple and really good for exfoliating the skin , although is not recommended to put it on with water mixed in because it makes a strong alkali solution which can deeply damage the skin all the way through the entire thickness of the skin , causing necrosis and various other damages .

It's also useful against irritation or prone acne skin, which helps the irritation go down and protects the skin.

Ash has application in the pharmaceutical sector too for various ash based natural treatments or pills like the ones that uses ash or coal to absorb the acid from the stomach calming the level of acidity in the stomach , and helping the person sleep during the night without the fear of choking on the acid from the stomach because it reaches up until the neck and can actually cause the person to throw up during the night in the sleep .

Not only that the ash is used in the making of treatments like the one for the stomach but also is used in the household product manufacturing like the soap , or other cleaning products .

Those further information adds value to the ah making the ash so much more important especially in a world where natural products , safe and harmless products are very often searched for besides the alternatives for other various sectors.

2.1.6 Where is it sold?

The ash that the company gathers after every time they burn something is not sold anywhere for now , no sector , neither construction sector nor the agricultural sector or any other sector .

But in the future the company can sell the ash to various sectors such as construction , agricultural or pesticide sector , even the medical sector , therefore expanding their possibilities and the profit that comes out of it , including their expertise in the future .

Selling the ash in various sectors not only will not occupy the plot of land without any purpose to it but it will bring fresh new possibilities for the company group and will increase their profits for the next few years .

Making the company even more profitable and expanding their expertise even more in new sectors .

The company doesn't need to produce anything in order to sell the ash , the company just needs to pack the ash in different sized bags in order to sell to various companies that needs the ash to produce various products based on ash that are natural and harmless , therefore the price of packing the ash is low , using just transparent bags with a label on it with the company name and amount of ash that it contains and for what is for , so when a company

goes on the website or comes at the company facility they know what to buy and for what they need to buy it.

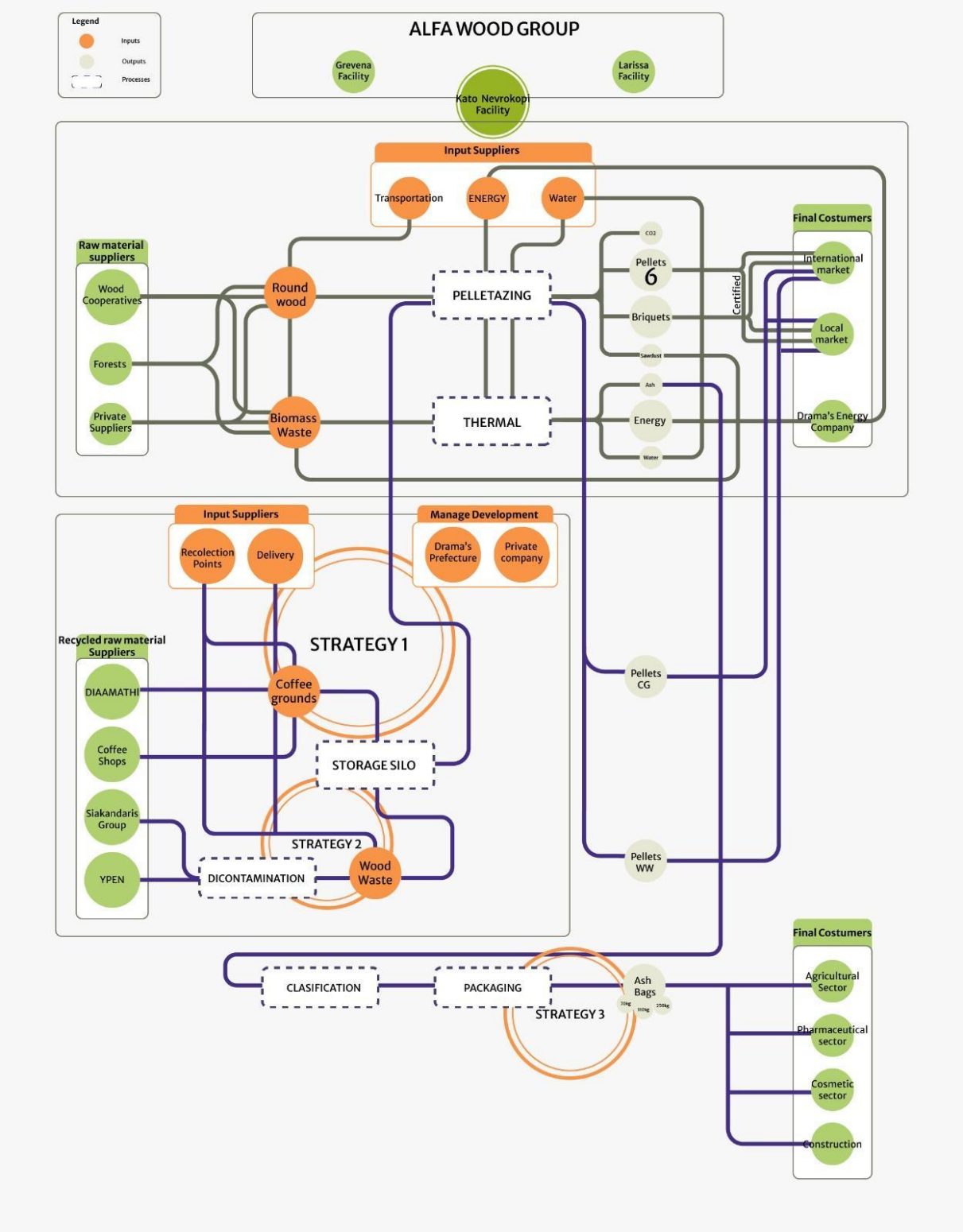


Figure 5 Production chain

As shown in the scheme above everything is connected to each other working seemingly every step of the processes from palletising to packaging and the selling to the customers.

2.1.7 Equipment needed to process and pack the ash

The ash is a very fine dust and it cannot be pressed or made into pallets of different pressed products that are based on the ash , because of the ash being so fine , it can sip through the machines and not even reach the final destination of the process , clogging the equipment and rendering it useless , costing the company money , which will not be good at all financially .

Therefore the company can use a different simple feeding line into a packaging machine which only gets feed from above into a funnel into a machine which brings the ash on a conveyor belt on another funnel type machine from where is fed into begs , sealed up and then transported with a conveyor belt to a labeling machine from where the different sized bags are labeled with the company name , the ash from what plot of land was taken and what kind of ash is it , for fertilizer , for animal bedding that means clean ash from wood based materials without toxic waste or impurities , or the ash for pesticide which can be any ash from anything because the only job of that type of ash is to repel pets and rodents , from basements , backyards etc.

If the customer wants to use the ash for repelling pests from the crop fields he can use the ash for fertilizer because it is clean and non toxic, safe to use for the plants .

The principle is simple , there is no processes needed for the ash , just separated from the day was collected , based on the material that was burnt and then from there collected fed to the machine , packed , sealed up and then labeled , just as usually is done for the normal pellets packages , from the smallest one to the industrial sized one .

Just as shown here in the scheme below .

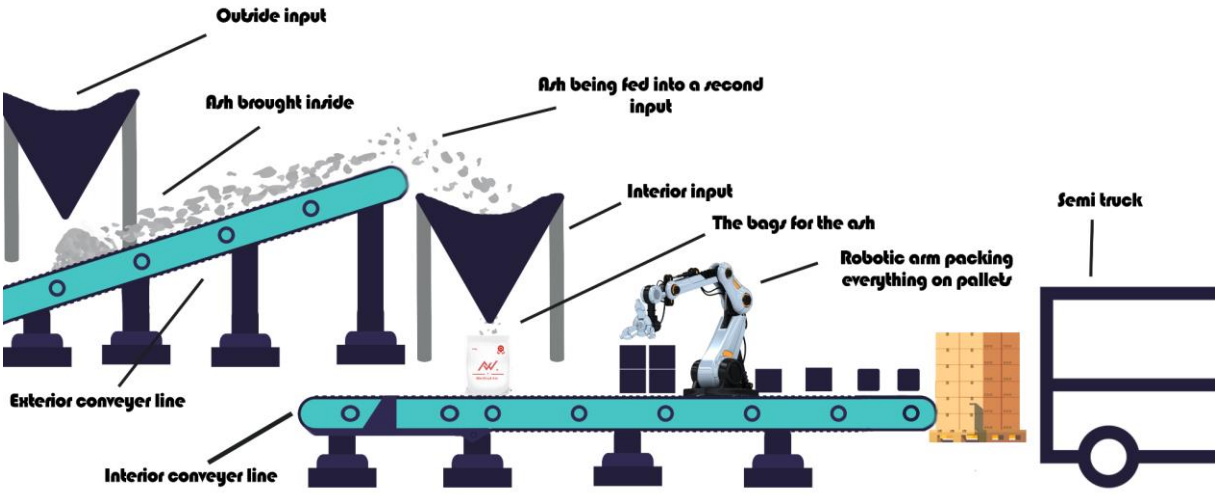


Figure 6 Equipment to process and pack the ash

The equipment prices vary from fresh new equipment to second hand equipment, for conveyor belts , packaging machines , feeding machines , or the handling equipment .

So after scouting the internet for the prices of every piece of equipment needed for the new production /packaging line I found the following prices for every each one of them :

The packaging equipment varies from 45 000 euros to 55 000 euros , for a brand new packaging machine for the weight we are looking for , the smallest one , and for the other two packed manually with a small loader .

The cost of the conveyor belt varies from 1570 dollars up to 5060 dollars depending on the length and width of the conveyor belt.

Table 5 Estimated pricing on Belt Conveyors

Estimated pricing on Belt Conveyors is as follows:

Overall Length	Belt Width	Overall Width	Drive Pulley	Supports	Price
10'0"	10"	14"	4"	28"-38"	$ 1,570.00
30'0"	10"	14"	4"	28"-38"	$ 2,200.00
60'0"	10"	14"	8"	28"-38"	$ 3,380.00
10'0"	16"	20"	4"	28"-38"	$ 1,720.00
30'0"	16"	20"	4"	28"-38"	$ 2,560.00
60'0"	16"	20"	8"	28"-38"	$ 4,110.00
10'0"	24"	28"	4"	28"-38"	$ 1,930.00
30'0"	24"	28"	4"	28"-38"	$ 3,050.00
60'0"	24"	28"	8"	28"-38"	$ 5,060.00

For the inclined conveyor belt the price varies from 4050 dollars up to 6710 dollars still depending on the length and width of the conveyor belt.

Table 6 Belt incline conveyor pricing

Belt Incline Conveyor Pricing

Estimated pricing on Belt Incline Conveyors is as follows:

Overall Length	Belt Width	Overall Width	Drive Pulley	Supports	Price
13'10"	12"	18"	4"	28"-38"	$ 4,050.00
29'10"	12"	18"	4"	28"-38"	$ 4,760.00
43'10"	12"	18"	8"	28"-38"	$ 5,380.00
13'10"	18"	24"	4"	28"-38"	$ 4,320.00
29'10"	18"	24"	4"	28"-38"	$ 5,200.00
43'10"	18"	24"	8"	28"-38"	$ 5,970.00
13'10"	24"	30"	4"	28"-38"	$ 4,740.00
29'10"	24"	30"	4"	28"-38"	$ 5,790.00
43'10"	24"	30"	8"	28"-38"	$ 6,710.00

The feeding stainless steel input point of the entire new packaging line is roughly around let's say 800 euros to 1000 euros .

The robotic arm that will be eventually used in the packaging line to pack on pallets the bags , is around 35 000 euros .

So the total costs of the entire processing line will reach an estimate of around 87,040 euros for the whole thing.

2.2 Calculation and design of the Final solution

2.2.1 Calendar solution for the use of ash

In order to fix the issues of the ash not being consistent in every case, after every time a material is burnt in the furnace, we all thought of an idea for this problem that we encountered when searching if the priorities of the ash we found on the internet that other companies use or get from their burnt material and the properties of the ash that the Alfa Wood Group gets from when they burn the materials that they put in the furnace are the same or not .

Doing so we found out that not all the time , properties of the ash can be consistent and it fluctuates quite often because the companies don't burn only one piece of material in the furnace every day during the month or year .

The companies burn different materials everytime , mostly just throwing everything inside , doing so it burns most of the impurities and toxic substances but not all the time , because the materials are burnt together , they mix , some impurities are still present in the ash that comes out of the furnace. The solution that we came up with during this research on the difference of properties between the ash that different companies use is to create a calendar scheme where the in a certain Week of the month a certain type of material is burnt and then it gets collected on the plot of land and stored separately from the other types of ash that came from other types of material which got collected in other separate days , like a week they burn pressed wood another week they burn tree bark from which the ash is very useful for the agricultural sector and the cosmetic sector but also for the pharmaceutical sector.

Week 1- Tree bark wood ash

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Type of ash						
Amount	Amount	Amount	Amount	Amount	Amount	Amount
Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level

Week 2 - Pressed wood panels and various other wood based products

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Type of ash						
Amount	Amount	Amount	Amount	Amount	Amount	Amount
Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level

Week 3 - biomass

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Type of ash						
Amount	Amount	Amount	Amount	Amount	Amount	Amount
Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level	Impurities level

And based on this every week the material that is burnt is changed , leaving enough time to clean the furnace and restart it in order to burn the different material that is going to be burnt the next week.

2.2.2 Importance of Ash

Ash has a very high importance in the world since the very beginning of early human civilization and during history , because it was used in pottery , cosmetics , back in the victorian era , and even earlier than that because back in that era everything os natural , mostly based on ash or other various natural ingredients especially for cosmetic products or cleaning products , it was a different era , but in the current days , in the big search for natural and clean sources for various fields , the ash is an amazing candidate.

Reference 7

“Wood ash is the inorganic and organic residue remaining after combustion of wood or unbleached wood fiber. The physical and chemical properties of wood ash vary significantly depending on many factors. Hardwoods usually produce more ash than softwoods, and the bark and leaves generally produce more ash than the inner woody parts of the tree. On average, the burning of wood results in 6 to 10 percent ashes. When ash is produced in industrial combustion systems, the temperature of combustion, cleanliness of the fuel wood, the collection location, and the process can also have profound effects on the nature of the ash material. Therefore, wood ash composition can vary depending on geographical location and industrial processes. This makes testing the ash extremely important. Ash is composed of many major and minor elements that trees need for growth (Table 1). Since most of these elements are extracted from the soil and atmosphere during the tree's growth, they are common in our environment and are also essential in production of crops and forages. Calcium is the most abundant element in wood ash and gives ash properties similar to agricultural lime. Ash is also a good source of potassium, phosphorus, and magnesium. In terms of commercial fertilizer, average wood ash would be about 0-1-3 (N-P-K). In addition to these macronutrients, wood ash is a good source of many micronutrients needed in trace amounts for adequate plant growth. Wood ash contains few elements that pose environmental problems. Heavy metal concentrations are typically low.”

The most heavy use of ash or fly ash is in the following sectors , the construction sector and the agricultural sector not only that but recently even in the pharmaceutical sector for pills against acidic levels in the stomach and many more that are useful and natural for the human health , not harming the health of the people in any case at all.

Especially in the pharmaceutical sector the ash has a very high importance in the making of cosmetic products that are natural because they don’t harm the skin , damaging it nor doesn’t create a skin infection , keeping the skin nice , clean and healthy .

The agricultural sector is in much need because of the natural pest repellent properties that the ash has , and that it can be used in combination with other types of animal bedding not only by itself .

Also the ash doesn’t release co2 like the limestone and has similar properties and elements as the limestone making it good especially for the agricultural sector as shown below.

Table 7. Range in elemental composition of industrial wood ash samples and ground limeston

Element	Wood Ash*	Limestone**
Macroelements	**- - - - - Concentration in % - - - - -**	
Calcium	15 (2.5-33)	31
Potassium	2.6 (0.1-13)	0.13
Aluminum	1.6 (0.5-3.2)	0.25
Magnesium	1.0 (0.1-2.5)	5.1
Iron	0.84 (0.2-2.1)	0.29
Phosphorus	0.53 (0.1-1.4)	0.06
Manganese	0.41 (0-1.3)	0.05
Sodium	0.19 (0-0.54)	0.07
Nitrogen	0.15 (0.02-0.77)	0.01
Microelements	**- - - - - Concentration in mg/kg - - - - -**	
Arsenic	6 (3-10)	-
Boron	123 (14-290)	-
Cadmium	3 (0.2-26)	0.7
Chromium	57 (7-386)	6.0
Copper	70 (37-207)	10
Lead	65 (16-137)	55
Mercury	1.9 (0-5)	-
Molybdenum	19 (0-123)	-
Nickel	20 (0-63)	20
Selenium	0.9 (0-11)	-
Zinc	233 (35-1250)	113
Other Chemical Properties		
$CaCO_3$ (%)	43 (22-92)	100
pH	10.4 (9-13.5)	9.9
Total solids (%)	75 (31-100)	100

2.2.3 Packaging of the ash

The ash will be packaged in 3 differently sized bulk bags like the ones illustrated below , in 3 different heights , widths , volumes and weights .

I chose those 3 different sizes because I wanted to give the customer multiple options when he wants to buy the cash from the company or when the company wants to show to a customer or other company what options they have and what they can offer for various prices or various sizes.

So when the customer comes and needs a certain amount of cash or a certain amount of bags he or the company in question has multiple options from which they can choose , at various prices , so they are not stuck with a single option , and they will not have extra , which they will not use in the future .

In the case of the agricultural sector the companies can buy the big bags because the owners have big farms with various animals , depending on what products they offer in return to the

masses , such as cows to offer meat and dairy based products or animals such as horses to use for racing or sheeps to get wool from them.

In all the cases they need them in big bags because they will eventually run out of it , having such a huge farm with so many animals , they use it a lot and eventually will run out.

They will buy it in big bags for sure , because that's how the farm companies , the big ones buy , so they will have enough for the future too , mostly they get extra too just in case it's a though period of time or something happened and they will not have time nor money to buy afterwards , and they buy it in big bags to be sure they will have enough for everything.

Differently sized bags used to pack the ash in.

Figure 7 Packaging alternatives

This can be applied to the construction sector which also needs a huge amount of materials in order to get everything they do done on time , and in enough quantities so they also in return satisfy the market and have enough to supply everyone with their much needed materials for constructions sites , various projects that need a huge amount of resources which they cannot provide without having themselves enough resources to produce them.

So the three chosen sizes scheme can be applied to every sector mentioned before like the agricultural sector , construction sector , cosmetic sector and pharmaceutical sector .

Besides the differently sized bags that we have created in order for the company to have multiple options for the various companies from the 4 sectors we have mentioned in the paper , we also came up with the scheme for the packaging process which is displayed below in the following graphical scheme of the packaging process that will take place in order for the ash to be properly packaged and then stored for it to be later picked up , put on a semi truck and delivered to the customer .

2.2.3.1 Packaging process displayed in detail

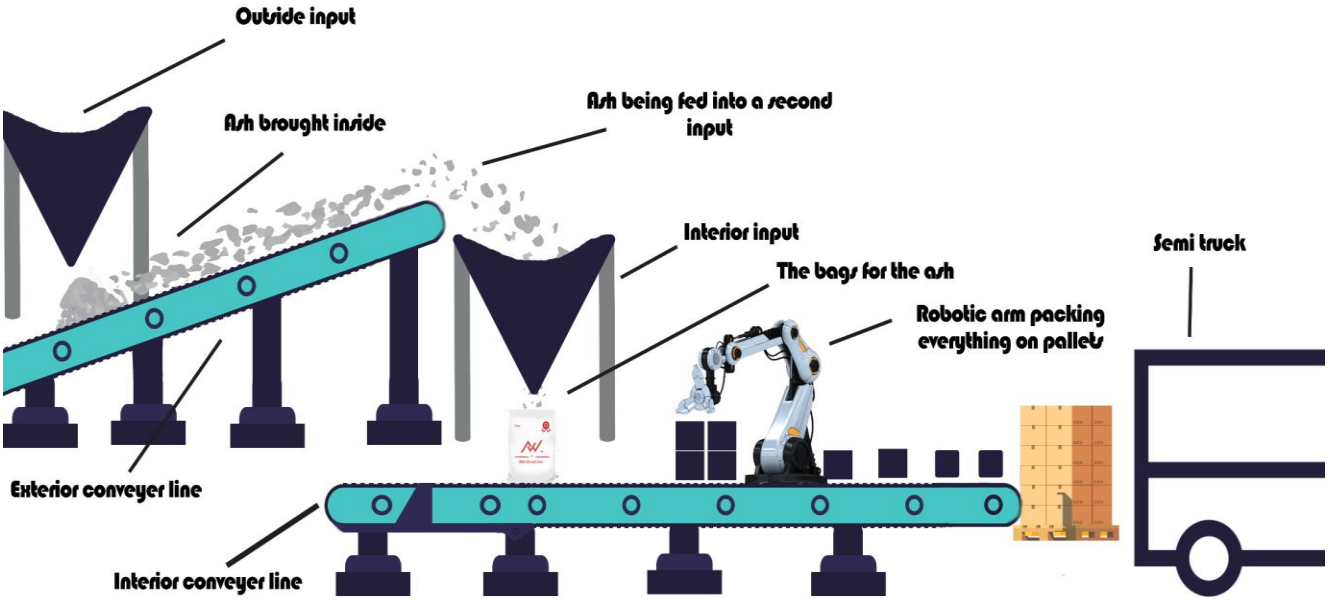


Figure 8 Packaging process

2.3 Benefits of the solution from point of view of Circular Economy

The benefits from the using the ash are various , from the construction sector , replacing the cement mixture percentage , reducing the curing time , making the construction of any building way faster , shortening the schedule , increasing durability , providing a natural

solution for the shortages of materials , making it safer for the environment because it doesn't produce co2 like the limestone or any other used in agriculture or construction .

The most important benefit from the point of view of a circular economy is that it creates a stable cycle circular economy meaning everything that comes in the facility , that will be burnt after there is no more need for them , will be end up being used in other products from other sectors , thus nothing is lost nor from a economical point of view nor from a logistical point of view , keeping everything safe for the environment , and for the human life .

Also another benefit from implementing this solution for the use of ash is that the company will increase the sectors where they work currently and furthermore their expertise increases the value of the company adding new products in their portfolio.

Opening more doors in the nearby future for more sectors and more products to produce

Other benefits that are coming from the chosen solution are a cleaner and safer environment helping to combat climate change by using ash and replace various harmful ingredients from products across the 4 sectors , maintaining the health of the population at a high level by also using ash in various products that we use to clean ourselves , treat ourselves , or to combat pests like in the agricultural sector.

2.3.1 Project overview

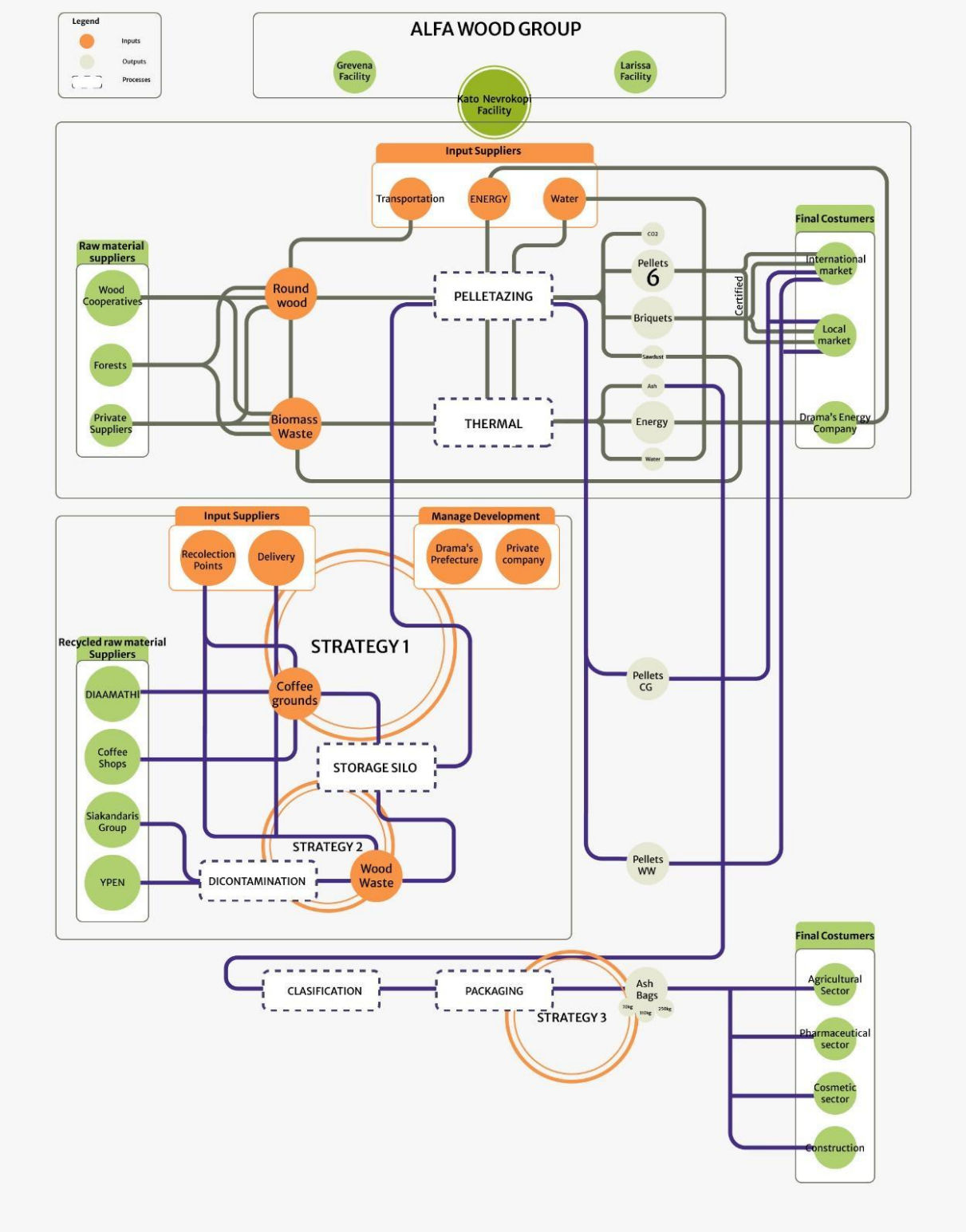


Figure 9 Project chain

2.3.3 Impact on the Territory /The analysis of the region

Ash has positive but also negative impact on the environment but most importantly on the soil , because ash contains a surprising array of heavy metals , not in a huge amount , or high concentrations thus not harming the soil or the environment in general but in high enough concentrations it can affect the environment not only that but even though the ash is not considered a toxic waste in many countries or states it can be become dangerous in contact with water because it becomes corrosive and can burn skin , affect metal and destroy the soil in big amounts.

It may become dangerous in big amounts too if it's used for cooking or if it is inhaled by accident not only by humans but also by animals thus affecting us because we consume the byproducts from animals like cows or sheeps.

It doesn’t only have negatives side , it also a positive one , and the positive one is that the ash can harmlesly help the soil and environment by raising the ph of the soil , making the soil fertile again , repelling pests and other various animals or parasites.

It can also be used to create natural products that are not harmful to the environment thus having a positive impact overall., it helps the construction sector to produce better cement , or cement mixtures in order to have sturdier buildings that can resist more against the weather and in time , in the agricultural sector against pests , diseases , parasites and also to keep the animals healthy and the bedding clean protecting them from diseases like lyme or many other diseases .

The plants that thrive with a dressing of wood ash are the following : **garlic, chives, leeks, lettuces, asparagus and stone-fruit trees; it** doesn’t leave behind any trace of toxic waste or other impurities in the soil if it’s done right.

Thus with all the information we gathered during the research we have done we reached the conclusion that the ash is safe to use and has a positive impact on the environment if it’s done right and in the correct measurements.

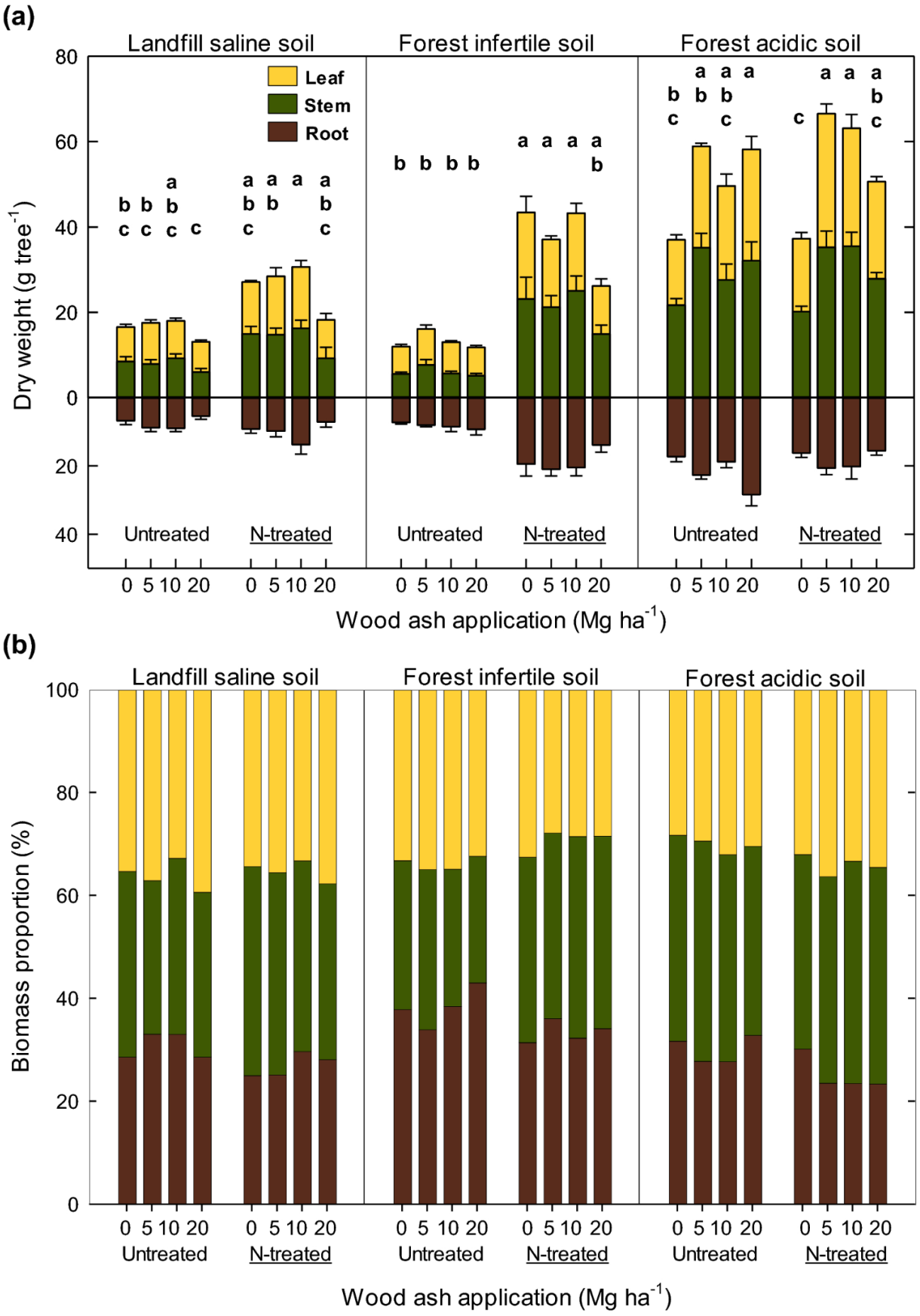


Figure 10 impact on soil by ash

The graphic above shows the impact on soil by ash.

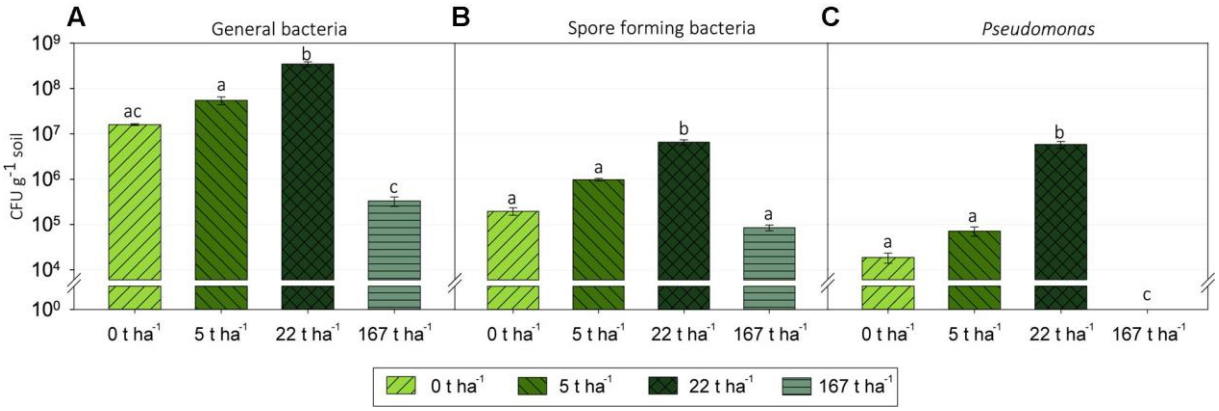


Figure 11 Ph levels on soil

The increased level of ph in the soil.

Different impact at different amounts on the crops in the agricultural sector.

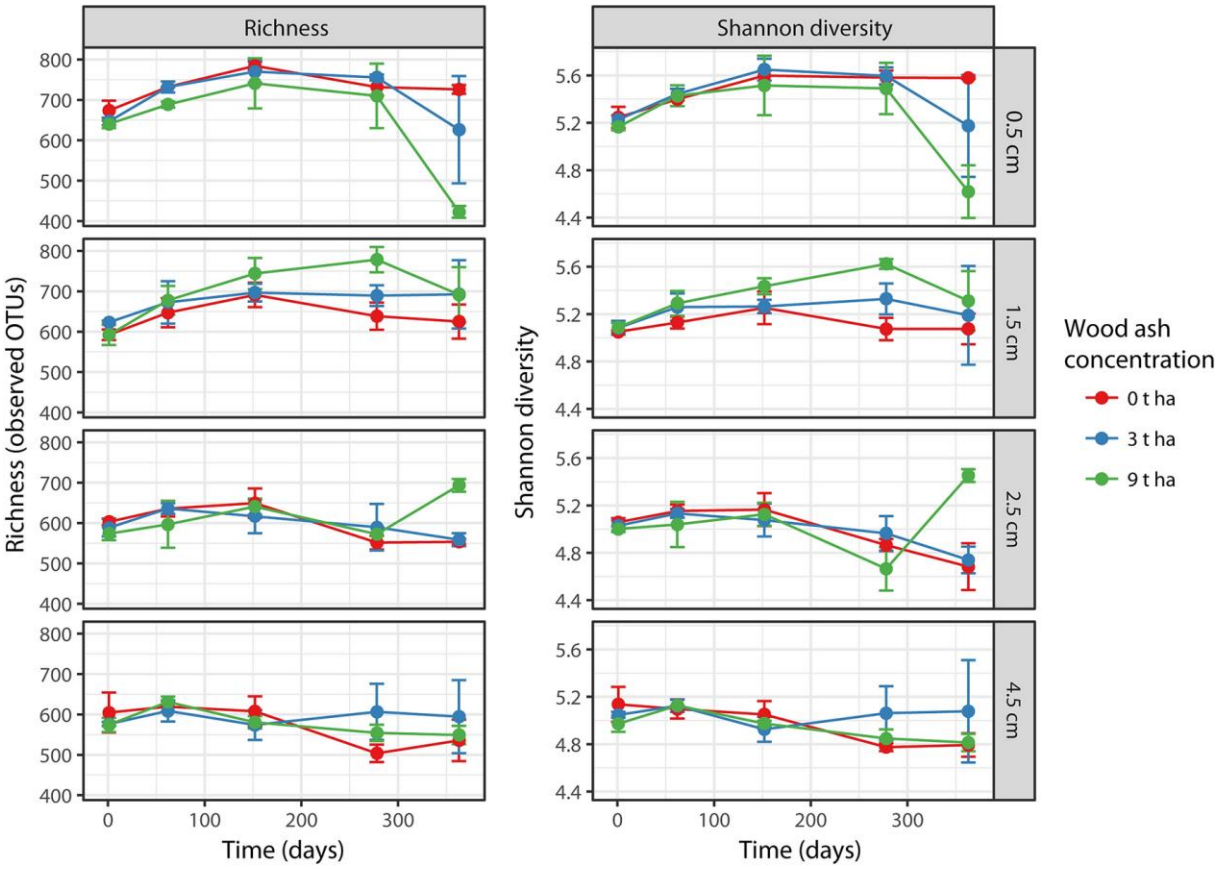


Figure 12 Impact in the agricultural sector

2.4 Conclusion

The conclusion that we have reached after finishing the entire project with each of the solution that we came up with to tackle the problems of the company is that , the ash is reliable , and fits well within the solution as a replacement for cement , as a standalone product sold by the company , to be used in different sectors .

We talked about the properties , benefits , what sector will benefit the most by using ash in their product , what costs will take , what cost will be reduced , how it can be balanced out in various sectors , what are the negatives and what are the positives , how can we properly use the ash in various products or food , any day to day household products .

We have shown the details of the impact of ash in the territory , on the soi , what percentage is safe to use for the soil in order to not permanently damage it , or render it useless for further crops to be planted.

Presented the marketing plan for the project what cost will take , in what period of time will the cost be dampened and covered .

But at the end even though it may be costly to implement the solution but it will be a good idea in the long term because the cost will be covered by the prices of the bags that will be sold to the different sectors , like the agricultural , construction , cosmetic and pharmaceutical sectors , which the ash has high importance and very good properties making it the best solution for natural products and so on , giving it high value , thus its worth investing in the solution.

Besides this in the near future this solution will the company a lot because , we are heading towards a future with green alternatives , natural products and non toxic substances , in the effort to curve the climate change and help heal what we destroyed in such a long time since the industrial era has started a long time ago firstly in england.

Apart from this the ash project even though it may be a new idea and uncharted territory with a bit of a heavy road ahead , it can beat all odds and prove to be a very good idea to implement and it will be worth the chance.

2.5 References

Reference 1 - L.Etiégni, A.G.Campbell-Physical and chemical characteristics of wood ash

Reference 2, Reference 3-Danuta Smołka-Danielowska & Mariola Jabłońska

Chemical and mineral composition of ashes from wood biomass combustion in domestic wood-fired furnaces

Refference 4-Use of wood ash on and around vegetable crops-Indigenous Technology Knowledge for Watershed Management in upper North-West Himalayas of India (PWMTA, 1998)-http://www.nzdl.org/cgi-bin/library?e=d-00000-00---off-0cdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0--4----0-0-11-10-0utfZz-8-10&cl=CL2.9&d=HASH083af43596dbe513371221.8.6&gt=1

Reference 5 - Fly ash is used to lower the cost and to improve the performance of PCC. Typically, [....] placements. An equivalent or greater weight of fly ash is substituted for the cement removed.- Fly Ash Facts for Highway Engineers-https://www.fhwa.dot.gov/pavement/recycling/fach03.cfm

Reference 6-ManishaBasu ManishPande P.B.S.Bhadoria S.C.Mahapatra - https://www.sciencedirect.com/science/article/pii/S1002007109001579

https://uvadoc.uva.es/bitstream/handle/10324/50650/TFM-D_00323.pdf?sequence=1&isAllowed=y

Reference-https://extension.uga.edu/publications/detail.html?number=B1142&title=Best%20Management%20Practices%20for%20Wood%20Ash%20as%20Agricultural%20Soil%20Amendment#:~:text=The%20ash%20was%20used%20mainly,as%20a%20raw%20material%20dropped.

- Best Management Practices for Wood Ash as Agricultural Soil Amendment
- From the University of Georgia.

3. Investment cost and profitability analysis

3.1 Benefits and Costs

The table below is an organized summary about the cuantificative data related to the project in order to know if it is worthy or not to adopt it and if it is, obtain an estimation about how much money it will be.

CATEGORY	COST	VALUE	Specifications
	Shipping, transport and logistics	40€	ton
	Packaging	24€	bolsa
	Commodities	0€	año
	Employee salaries	44000	mensual
	Taxes and deductions	24	%
Direct costs	TOTAL	54.639,36	monthly
	Bank interests	3%%	44.064,00
	Depreciation of machinery	10%	
	Indirect material for production	85€	
	Energy bills	20 €/ton	
Indirect costs	TOTAL	118,65	105
	Health and safety	40	monthly
Potenitial risk costs	TOTAL	40	
Total costs		54.798,01	
Total cost (2%)		1.096	monthly
Total benefits		5.213	monthly
Net cost-benefit		4.117	monthly
Net present value		307.270	
Cost-benefit ratio		52,301071	

There are different categories:

On one side the costs are divided by direct, indirect and potential risks. The total costs of the company are 54.798,01 but we assume that just 2% of the total efforts of the company will be focused on the Ash project. This is because the ash is not related with the main activity of the

company and this project has the objective to find a solution to the waste of ash produced by the company. For that reason the costs are reduced an 98%.

On the ther side, the benefits which are calcutated monthly and takig into account that the company sell all the ash produced per 1 month (3475) and if Alpha Wood sell it per 1,5€/kg then the benefit will be 5213 per month.

Cash Flows				
Years	**Investment**	**Income**	**Expenditure**	**FCA**
0	500	0	0	0
1	-	62.550	1095,9602	61.454
2	-	62.550	1095,9602	61.454
3	-	62.550	1095,9602	61.454
4	-	62.550	1095,9602	61.454
5	-	62.550	1095,9602	61.454

3.2 Profitability indicators- Net Present Value, Internal Rate of Return, Payback Period

In the table below we can also see the Net Present Value and Cost-Benefit ratio. This data showed how much money the company will earn in 5 years.

Net Cost-Benefit	4.117	monthly
Net Present Value	307.270	
Cost-Benefit Ratio	52,301071	

In the next table we can see how the income and expenditure and therefore the Cash Flow is going to increase or decrease as time passes. It is estimated that income and expenditures are fixed during the years because we assume that the company will produce the same ammount of ash and the expenditures would be the same, because they will keep focusing just the 2% of the efforts on this project. In conclusion the cash flow will be the same each year, being positive which is a great taking into account that the expenditures are minimun and this project means a solution for the company .

BENEFITS	
Pack/Kg	**€**
1kg	1,50€
70kg	105€
110kg	165€
250kg	375€
Total of ash produced 41.700kg	62.550€

Here it is shown for how much money the company will sell 1kg per ash. According to that, we can see the 3 divisions with different kg of ash regarding on how is going to be the package produced by the company. The last result highlighted is the total amount of kg produced by the company at the end of the year and how much they can earn selling it.

Sum of income	312.750
Sum of expenditure	5479,801
Cost Investment	5979,801
C/B	52,30107156

The table state the total of the income produced in 5 years as well as the expenditures. Furthermore explain the total investment cost (sum of expenditure + inversion).

3.3 Conclusion

The Profitability indicators show that in five years the company will earn 52€ per each 1€ invested.

Our profitability analysis proves that the project offers a marvellous solution not only taking away this type of the company's waste, but it also supports the environment and provides a positive image of the company that can be related to the corporate social responsibility.

3.4 References

Alfa Wood Accounting Office 2022. Economic Records (personal communication).