



Electronic assignment cover sheet

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INDIVIDUAL CONTRIBUTION

Meeting record			
Attendance	Duration (min.)	Task	Date
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all	60	finish details and record presentations	12.04.21

Nicolas Driol - 10521464

I was responsible for doing preliminary research on the specific construction environmental problems, industry growth, hemp global market and cultivation (in the appendix section). I had to identify the hemp construction material's features and benefits and write one third of the literature review (solution part). I had to do a small recorded presentation of "the solution". I attended every group meeting.

Jeremy Moolman - 10360037

I contributed to the overall collection of secondary studies used in the initial setup of the literature review, then using the literature review final product Giorgi and I focused on the formulation of the business proposal. I attended all the meetings and was there when it was required. All work was equally divided and done.

Giorgi Elmetashvili - 10504629

I have contributed to the overall research process for the literature review. Then I focused on the development of the business proposal along with Jeremy. I have

attended group meetings to share our progress and resolve any issue that came up along the way. All the work was equally divided and all members contributed equally.

Marcos Costa - 10537138

In this research, I was in charge of writing the Sustainability and Feasibility topics inside the literature review as well as review the same section as a whole. Also, I contribute to the Logistics section inside the Appendix. I have attended all the group meetings.

Conor Lalor - 10507670

My main focus was carrying out research and writing about constructions' negative impact on the environment. I also carried out research regarding the paris agreement and its impact. I attended all group meetings. All members contributed equally throughout the whole assignment.

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ABSTRACT

The interest of this study is to investigate the problems and solutions to the problems that the construction sector causes in terms of global warming. This research aims to increase the awareness about this issue by providing an in depth research. Our team has undertaken secondary research, which is presented in the literature review, as well as developed the business proposal which poses as the solution. Our study has shown that the environmental effects of construction are enormous. However, it is resolvable . We assume that further studies and campaigns will be required to comprehensively deliver the point to the societies.

INTRODUCTION

The consistent rhetoric that there is nothing that humans can do to save our climate is a misunderstood myth. With legislation changing on all three levels of government – locally, nationally and internationally in the form of “Climate Action and Low Carbon Development Bill 2020”, the “European Green Deal” and the “Paris Agreement” respectively, that points to a vision that business practices and processes need to adapt to a more circular economy.

With the use of secondary research, we analysed the construction industry’s impact on our environment, what hemp is capable of doing for the environment and lastly the feasibility of investing in the hemp construction industry.

The construction industry adds many pollutants to the environment, not just in the form of carbon emissions. In Ireland, there is an increase of construction demand (creating a larger effect on the environment than previously) due to the housing crisis. The legal status is shifting towards a carbon neutral world therefore it would affect the way the construction industry meets the demand for housing.

Hempcrete as an alternative construction material to concrete, is seen as the healthier option for the construction industry. One that is sorely needed and one that can help with the effects of the climate and potentially repair our past environmental mistakes. Hempcrete is a mixture of lime binder, hemp hurd and water. Hempcrete can be casted into bricks and sold or can be mixed onsite and used to pour into the mould of the desired building. Having their own benefits, secondary research revealed that hemp - from the moment it's planted - starts to create a better environment and even after 300 years of Hempcrete standing buildings they keep absorbing the CO₂ in the environment.

The hemp industry is growing in size as hemp legislation is changing. There is demand for socially responsible products. While most companies that are producing hemp products now are still small and don’t have a strong position in the market, it holds great potential to make a difference in the construction industry and at the same time create a green circular economy that works to improve our environment rather than to destroy it.

Ireland's climate is appropriate for the growth of industrial hemp which represents an opportunity of becoming a major international supplier. Leading to Ireland having a larger role to play internationally with its efforts for a greener circular-economy as Ireland's impact on the western culture is seen as one of the greatest strengths it holds (as Irish holidays and folklore are celebrated around the world). This is a great advantage while marketing a product of such importance. Therefore the literature review partly focuses on the feasibility of creating a company that will specialise in all things hemp, starting with the Construction Industry as it has the biggest effect on the degradation of our environment.

Hempcore, the business proposal at the end of the literature review, is the logical next step in creating a circular economy that is focused on fixing the environment. Using ancient materials mixed with modern technology, Hempcore will aim to gain competitive advantage to influence the construction industry in a more responsible way.

LITERATURE REVIEW

While carrying out our literature review on (title)we found that the number of academic papers in certain areas was quite limited, although the majority of our references are academic based we did have to gather some information from magazines or non-academic websites when it came to certain areas. Furthermore, we decided it was best to change from both primary and secondary research to only secondary research due to the scale of primary research that was required.

As the world's population continues to grow and we are seeing a shift in the population moving into urban areas (70% living in cities by 2050) (building for the future, 2021), the need for housing and infrastructure grows as well. However, this situation provides challenges for our environment. The impact of the construction industry is having a considerable and lasting effect on our environment. Although efforts have been made to develop a greener industry, these efforts have not resulted in any significant changes in mainstream building practices (Van Buren, 2007).

The effects of construction on our health and environment are felt from when construction of the building starts, throughout its lifetime and, as well as when the building is being taken down. In a report by the United Nations Environment Programme, it was said that roughly 4% of global energy use, 30% of energy related greenhouse gasses, 12% of water use and 40% of waste produced is a result of the construction industry (Linderoth, 2018). The following five aspects will give a detailed overview of the construction industry's negative contribution to the environment.

The first aspect is air pollution, which is a major impact that the construction industry has on the environment, being responsible for 11% of the global greenhouse gases. The production of one tonne of reinforced concrete results in 198kg of carbon

dioxide being released into the atmosphere, making it the third highest carbon producer in the world with 8% of global emissions (Wilson, 2021). This leads to particulates being released into our atmosphere. A high amount of these particulates being released contain hazardous materials such as dust, smoke and gases such as nitrogen. These particles that are released also cause land and water pollution. The effects of this are having massive consequences on our environment's ability to provide a naturally balanced ecosystem (Langford,1999).

The second aspect is construction waste, this ranges from a wide variety of materials such as concrete, cement, plastics, wood, glass, soil, plaster and anything related to the construction process. In Australia, around only 40% of construction waste ends up in dumps (Li, 2021) while in the US, only 48% from an estimated 600 million tonnes is being recovered (Sustainable Management of Construction and Demolition Materials | US EPA, 2020). In the UK, construction waste is estimated at 120 million tonnes (Osmani, 2012) and in the EU, estimated that around 1/3 of total waste is a result of construction waste(Construction and demolition waste, n.d.).

The third aspect is energy consumption. Buildings and constructions account for 36% of global energy use. In addition to the energy used in the construction of buildings, the biggest consumption comes during the building's lifetime. In the USA, buildings account for the biggest energy consumption (37%) and 65% of national electricity production. All this energy is used for heating, ventilation, lighting and other appliances. In fact, loss of heat due to open windows represents around 5% of a developed country's energy consumption (Operating Energy for Buildings, n.d.). The construction industry's high energy consumption also comes from consuming natural resources. The likes of machinery require resources such as electricity and diesel (Kochendoerfer, 2014), which also lead to pollution and greenhouse gases being released into the atmosphere.

Water pollution is the fourth aspect. Throughout the construction process, natural resources like water are heavily used. The construction industry accounts for around 16% of fresh water use and is responsible for polluting roughly 40% of the world's clean water due to its considerable amount of waste and pollution (Kochendoerfer, 2014).

The final aspect is deforestation, which can be defined as the clearing of trees for a change to non-forest land use (What Is Deforestation, 2021). Deforestation is having an alarming negative effect on our environment. It is estimated that we are losing tropical rainforests at a rate of roughly the size of Greece each year and in 2017, an estimated one football pitch every second (Deforestation - Forests - Environment - European Commission, 2021). These forests play a vital role in limiting climate change, soil erosion and removing gases like CO₂ from the air (Deforestation - Forests - Environment - European Commission, 2021). The construction industry

plays a major role in this through its need for timber and materials such as flooring and frames of houses (Heimpel, 2020).

HEMPCRETE AS PART OF THE SOLUTION

After raising awareness to the major environmental issue that the current construction industry represents, this study will have the purpose of exposing a practical and viable solution to the problem. The goal is to inform the public and the entrepreneur community on a specific solution: using alternative construction material. The following product is the center of numerous studies.

Hemp, also known as industrial hemp, is a variety of the plant “Cannabis sativa” which contains less than 0.3% of THC (psychoactive component) and 1% of CBD (medical use), as it is solely used for its fiber part. Unfortunately, Hemp is often confused with its cousin plant Marijuana due to its visual similarity.

Hemp has a very long history, finding traces dating up to 8.000 before Christ as explained in the “Hempcrete book” of William Stanwix. Currently it’s one of the biggest emerging agricultural and industrial markets due to its thousands of different beneficial product applications.

In this report we are focusing on the construction material that can be produced with Hemp in order to change the current construction industry. The Hemp plant fiber part is used specifically for industrial use and it has unique features that enable the transformation into thousands of different products.

According to Chris Magwood’s book “Essential Hempcrete construction”, Hemp construction materials can account for 80% of a construction (20% being consolidation material like steel, wood and piping in copper, aluminium or plastic). The walls can be made with hemp blocks (or bricks) and stuck together with a hemp lime binder (mixture with sand and water). Render, scratch and skim plaster coats for wall insulation are also made of hemp.

According to the European Industrial Hemp Association (EIHA) study “The future for Hemp” and Chris Magwood’s book, the following hemp features are beneficial to the construction industry which indirectly help the environment.

Hemp plant growth takes only 4 months which enables sufficient supply for international demand and It doesn’t require any pesticides, herbicides or fungicides additives that are harmful to the environment and lesser use of clean water (500 liters for 1kg). Also, it restores soil health due to it’s phytoremediation feature (clean land polluted by heavy metals).

Furthermore, this variety of Hemp has an excellent carbon sequestration and is considered carbon neutral, that means it absorbs more carbon that it produces during its harvest, transformation and transportation. During its growth it can absorb 15 tonnes of CO₂ per hectare. A study made by Tradical (UK hempcrete manufacturer) demonstrated that every cubic meter of hempcrete can absorb 110kg

of CO₂. In contrast to concrete that adds CO₂ in the atmosphere, this product decreases it more even efficiently than agro-forestry.

Hemp is also highly effective in terms of insulation. Firstly it has hygroscopic features, which means it regulates humidity naturally. It maintains its integrity in humid conditions by its ability to absorb moisture due to its porous fiber structure and release it when the conditions are less humid. A 2005 french study called "Bioclimatic envelopes made of lime and hemp concrete" showed that nearly 600kg of water vapor (93% of humidity) can be absorbed in 1 cubic meter of hempcrete without affecting the material's capacity. Therefore, the material is uniquely resistant to mold and can be used in both hot and cold climates.

Secondly, Hemp has a good thermal insulation performance. Tests all around the world have tried to measure it's R-value (thermal resistance per unit area), one of which was at Ryerson University, the average of the findings is considered more than acceptable, enabling a lower building energy consumption. Thirdly, Hemp has good acoustic insulation properties as it is able to dampen sound transmissions.

Another benefit of Hempcrete is its high resistance to fire. BRE Global in the UK and a canadian firm conducted fire tests and concluded that it can resist up to an average of 68 minutes, making it class A1 resistant.

Biodegradable and reusable, Hemp waste also avoids non-recyclable waste in landfills that have their own set of negative environmental issues.

Hemp is non-toxic indoor which means it doesn't release any harmful gas in contrast to the concrete emitted indoor pollutants. In addition to anti-moisture, the material is antimicrobial and antifungal.

It is a light material that doesn't require massive logistics means, therefore reducing construction's logistics pollution.

Hempcrete is UV resistant so it is not affected by long term sun exposure degradation.

A few advantages even though much spoken of are up to debate. Multiple studies such as Epicomtree, affirm that Hemp blocks are three times stronger than concrete ones and their structure is earthquake-proof because they are three times more elastic than concrete constructions. It is said that the buildings can survive hundreds of years because the hemp blocks become petrified rocks with time. Also it's not clear why the material is resistant to termites.

Using hemp as an alternative construction material to concrete would radically lower the impact of the construction sector on the environment on the five main aspects exposed above, therefore improving environmental sustainability and the next generation's well being.

SUSTAINABILITY

Around the world, after decades of ignoring environmental problems, people are putting more emphasis on socially responsible business models. Because of this increasing demand, corporations are putting a lot of effort to invest in sustainable ways to run their business and, what was supposed to bring only costs, is now exceeding expectations.

An article published by The European Journal of Accounting, Auditing and Finance Research (Osisioma and Emeka-Nwokeji, 2019) demonstrated that financial returns provided by sustainable practices offset the costs in the long run. Additionally, they also become more attractive to investors and stakeholders.

This is happening because companies that have more sustainable processes are becoming more noticed by customers, making them more visible and boosting their profits. In this context of sustainability, Hempcrete offers a new option to the traditional construction materials, providing products with less stages of production that can also benefit local suppliers, allowing them to be sustainable as well as lucrative.

With this new mentality added with hemp and its benefits being widely spread over social media and traditional communication channels, awareness about hempcrete will naturally grow. This attention can generate more interest by the public and attract more clients towards the product. "At the heart of a buzz is an understanding that the natural, spontaneous networks that comprise the social universe are the most effective means of reaching people in a meaningful way" (Salzman, Matathia and O'Reilly, 2003).

The world is shifting not only its views on how the world is seen but how businesses conduct their operations. With Europe elaborating more ambitious goals, China entering the Paris Agreement and the USA going back to the pact, the world has now the majority of countries committed to create a better environment. Discussed below are three pieces of legislation that have a major impact on Hempcore' success, as well as the success of a sustainable circular economy.

CLIMATE ACTION AND LOW CARBON DEVELOPMENT BILL IN IRELAND

In order to promote more green ways to do business and create a more sustainable environment for future generations, Ireland provided a new plan in form of legislation to reduce its impact on greenhouse gas emissions.

This scheme was designed to make Ireland a carbon neutral economy by 2050, creating a good foundation for other environment focused laws to be proposed over the years. Between the key presented goals are:

- The first two five-year carbon budgets should represent a total reduction of 51% emissions until 2030.
- Preparation of a Climate Action Plan by local authorities, including mitigation and adaptation measures, updated every five years.
- Strengthens the role of the Climate Change Advisory Council in proposing carbon budgets.
- Introduces a system of successive 5-year, economy-wide carbon budgets starting in 2021.

EUROPEAN GREEN DEAL

Aligning business strategy with Ireland is important for the growth of Hempcore, however it's important to note that the single market opens up potential businesses and customers in other parts of Europe. The Green Deal is a growth strategy that hopes to transform the economy into a “modern, resource efficient and competitive economy where”:

- There are no net emissions of greenhouse gases by 2050;
- Economic growth is decoupled from resource use;
- No person and no place is left behind.

The Green Deal is the heartbeat of a sustainable European economy – by turning these challenges into opportunities. In total, there will be available €1trn – creating financial tools that will see €100bn invested in the public sector until 2027 – for investments in environmentally friendly technologies, innovations by industries and the decarbonisation of the energy industry. Before carrying on, it's also important to put perspective in how the money will be raised in Europe.

In basic terms, this legislation will help move the EU to a circular economy with the use of reusable resources that lowers pollution and restores biodiversity. Hemp will not only do this – but more (*See benefits of Hemp*). Hempcore looks at this legislation with the cultural effects of Ireland's influence over the whole world. Irish culture is rich in the western society and, even though their carbon footprint might be small, their influence stretches across the USA, Australia and other parts of the world. As mentioned, Ireland being part of Europe opens up the single market countries and also UK borders.

PARIS AGREEMENT

The “Paris Agreement” is a global world arrangement whereas the countries involved are committed to reduce emission of gases, curbing the release of greenhouse gases. With the USA going back and China joining in the agreement, there is a big expectation that it will finally work.

A well-known measure is the one that sets out objectives and commitments for 188 countries to reduce their anthropogenic greenhouse. On that measure, according to the scientist Andrei Sokolov, emissions by 2030 will have a significant impact on

reducing surface air temperature. However, if kept in place until 2100 it's still expected to be at least one degree above the target.

While important to gather important measures against climate deterioration, the efforts put forth in this agreement may not be sufficient and this makes the social entrepreneurship contribution even more important.

FEASIBILITY

According to a study from The United States Department of Agriculture (Mark et al., 2020), while hemp can now be grown legally in a good part of USA territory, its long-term economic viability depends on aspects that go beyond plantation. Besides the care about the crop itself, the research affirmed that companies and investors have to pay attention on

- The competition with other traditional crops (soy, corn, orange, etc);
- Other countries already settled as a hemp markets;
- Market information and transparency and;
- Regulatory environment.

While those elements above were applied in an American context, researchers used data from different locations (Europe, Canada and China), making the study relevant to other countries, including Ireland.

With other analysis like this being produced, that old fashioned idea of Hemp often related to negative stereotypes are being left behind. However, benefits by themselves wouldn't be enough if hemp didn't provide a financial return.

According to Feldmann et al. (2020), the hemp industry is projected to reach US\$ 75 billion in sales by 2030. Seeing this as an opportunity to increase income, private banks, wealth management and institutional investors are becoming the main investors behind the boom of hemp business in North America, a result of good forecasts that the industry has been providing.

This success wasn't unnoticed in Ireland. In 2020, local investors gained the first opportunity to invest in an Exchange Traded Fund (ETF) specifically geared towards the hemp industry, providing opportunities to companies in the hemp business to get the necessary capital to be launched in the country.

These investors are coming due the losing of some restrictions related to Cannabis. Currently, Ireland allows to grow hemp under a licence from the Health Products Regulatory Authority (HPRA) and shops selling products derived from Hemp are not hard to see in a short walk around the commercial centre. Said that, the current business environment is favourable to Hempcrete growth.

Also, competitors are scarce. In Ireland, the main organisation selling this kind of product is Hempbuild, company based in Kells that offers a wide range of hemp construction materials such hempcrete itself and other complementary products

tailored to support projects using the material, such as plasters, mortar adhesives, angles, lintels and brackets. Besides that, the company also offers workshops and specific training to professionals that have interest in work with materials originated from hemp.

Their materials are manufactured by IsoHemp, a company based in Belgium, and then brought to Ireland to be commercialized. As the only one offering the product, Hempbuild also has the monopoly of distribution.

An organisation that desires to enter in this kind of business could invest in the organisation of seminars in fairs, universities and festivals to make Irish society aware of the benefits of the materials. This could reduce the stigma around the theme, reach potential clients and attract new investors.

Also, as part of an integration effort, it would be crucial to become a member of Hemp Cooperative Ireland, an organisation that targets the improvement of the infrastructure for farmers and local business in order to develop the local hemp industry. Companies could use their network to access more suppliers, clients and even support legislative lobbying.

As discussed before, the world doesn't afford the current level of consumption and waste produced by humanity. A collapse is the most suitable scenario if real measures aren't put in place.

Hempcrete and other construction materials derived from hemp offer a sustainable option with more benefits and a higher quality in comparison with traditional components. Besides that, the demand created and the positive coverage also have the potential to make Irish Hemp companies very successful.

CONTINUED WITH BUSINESS PROPOSAL



HEMPCORE

***BUSINESS
PROPOSAL***

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EXECUTIVE SUMMARY



With a growing concern that our society is leaning to a more greener environment, with sustainable choices that not only gives back to the environment but that also generates income. There isn't a success formula that can specifically pick out a successful venture - but having not only are Ireland's laws shifting (in the form Climate Action and Low Carbon Development Bill 2020) but also the EUs (in the form of The European Green Deal) plays a big role in the timing of Hempcore.

Hempcore looks to create a sustainable green circular economy that helps fix the environment and takes advantage of the lack of movement and care that is found in the construction industry by supplying a greener and healthier option for not only the environment but for the health and future of humans. By supplying hempcrete and a building option that uses 3D machinery.

The most important benefits of Hempcrete that fight climate change are:

- Co2 sequestration
- Air circulation
- Biodegradable and reusable

Hempcore looks to start producing hempcrete that can be mixed on site but also in the form of pre produced bricks. These products are made to build the traditional way by substituting concrete. The 3D printing allows for a faster and safer way of building and does not require the same labour intensity that traditional ways do. Creating houses in under 24 hours.

This proposal includes a business problem, a solution, product strategy, operational process, competitor analysis and marketing plan which thoroughly outlines the benefits Hempcore can offer to the society while leaning on the natural benefits that hemp brings to the environment. The initial investment without the 3D printer would look to be around €606,800 and with it around €1,606,800. It should be noted that with the 3D printer that:

- Building costs start at €49,653 for a 1 storey house
 - Can be sold for €100,000
- Building costs start at €99,306 for a 2 storey house
 - Can be sold for €200,000

Creating a great income for Hempcore but also a great competitive advantage as the buildings can be built within 24 hours.

BUSINESS PROBLEM



Climate change

Common knowledge that our climate is changing - a change that is altered by human contribution. This is due to the increase of CO2 emissions that are released into the atmosphere, the construction industry plays a 50% share in this contribution.

Climate change is a natural process and the earth's climate has changed many times. However what has also changed throughout the decades is the human contribution, that takes up a major role and accelerates the process. CO2 or otherwise known as Carbon Dioxide is the major contributor to the process with the share of 81%, along with Methane, Nitrous oxide and Fluorinated gasses. The construction industry has used the natural resources/raw materials throughout the decades and polluted earth through processing them. Concrete is the major contributor to the emission of greenhouse gasses which represents a huge contributor to climate change.

Legislation

Climate Action and Low Carbon Development Bill 2020 has come into force which mandates the businesses to conduct their activities in an environmentally friendly manner. This will force the business to shift to the more eco-friendly operations. The EU gives a high importance to environmental sustainability. The European Green Deal commands the EU countries to follow the guidelines to transform their economies into a "modern, resource efficient and competitive economy" where there are no net emissions of greenhouse gases by 2050, economic growth is decoupled from resource use and no person and no place is left behind.

Ireland's Housing Crisis

Ireland's housing crisis represents the major problem the nation faces. In March, 2019 the Department of housing issued a report which outlined 6484 adults and 3821 children living in an emergency accommodation. Ireland is in the list of countries with the highest rent prices, which directly points to the accommodation shortages and can be taken as a sign of further construction demands.

House Building Process

Building a traditional house is a very time and resource consuming process that usually takes months. This represents a significant problem when it comes to efficiency

BUSINESS SOLUTION



Hempcrete

Hempcrete is a direct non-toxic substitute for concrete that is used in construction and unlike concrete it is a nature based product, which translates into eco-friendliness. Hempcrete is produced from Hemp which is a plant used as a material for many products throughout the centuries. By introducing hempcrete based solution we intend to directly respond and contribute to the climate degradation. We assume that hempcrete is a great solution for a greener, brighter, cleaner and more sustainable way of development.

Futures products mentioned

While processing different hemp products would need more investment, the type of investment won't be to just make one different product but multiple. Processing Hempcrete is the cheapest and best way to begin fixing the climate. With a focus to create a circular economy Hempcore would look to gather investment for future projects to help them penetrate the following industries/or help to create a different type of product with the same cause. The industry/products are Biomass, Insulation, Animal hurd, Plastic, Pape, Glass.

Ireland's housing crisis

The hempcrete has a huge potential to solve the housing crisis that currently exists in Ireland. The new developing technology that is based on 3D printing using hempcrete is becoming the easiest and cleanest way of construction. The human interaction is completely eliminated from the process, except setting up the system to build the house. A hempcrete house can be built within a day timeframe, using only a printer and hempcrete. This process can solve Ireland's housing crisis in an effective and efficient way.

Future of the construction

Hempcore solves the problem that the construction sector will face in the future. As we have mentioned in the business problem section the legislation mandates the businesses to conduct their operations in an environmentally sustainable way. These laws will severely affect the construction sector. Hempcore proposes the solution aligned with the legislation.

Another solution that Hempcore offers considers automation, which has become widespread in many other sectors. Hempcore enables labour free operations, which gives several benefits such as cost reduction and prevention of safety related issues.



PRODUCT

Price Strategy

The strategy that will be used to calculate the product will be Competition-Based Pricing Strategy. As the name suggests it's the average price of the competitors that produce similar products.

Product Benefits

It should note that hempcrete's overall characteristics help the building contain heat better and has a low level of energy consumption. This helps buildings that use hempcrete to reach the building standards more easily and at a cheaper rate.

<i>Benefits</i>	
Building	<ul style="list-style-type: none">• Earthquake-proof• Class A1 resistant to fire• Resistant to termites• Anti-moisture• Anti-microbial• Antifungal
Environmental	<ul style="list-style-type: none">• Biodegradable and reusable• Excellent carbon Sequestration• Growing Hemp cleans air, producing concrete pollutes
Other	<ul style="list-style-type: none">• UV resistant• Hemp is non-toxic indoor pollutant

Product List



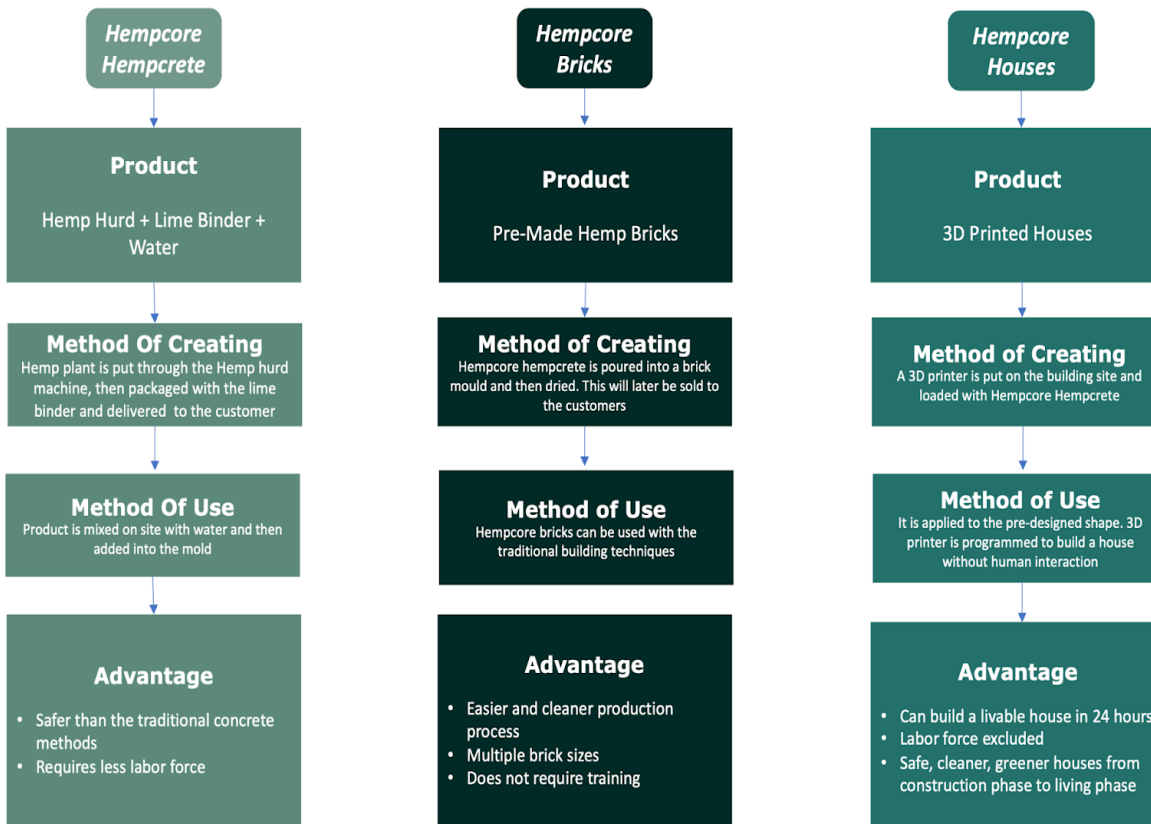
HEMPCORE

Product	Description	Specifications	Price
<u>Hempcore Blocks - 1 Pallet</u>	<i>The Hempcore blocks are used for interior and exterior insulation. It ensures strength with highly guaranteed thermal comfort.</i>	<ul style="list-style-type: none"> 60mm, 90mm, 120mm, 150mm sizes No. of Blocks per pallet: 50 Blocks Pallet dimensions: 120x100x145 Pallet weight: 500Kg -610Kg Storage Life: 2 Years 	60mm- €450 90mm- €480 120mm- €520 150mm- €550
<u>Hempcore Insulation sheets</u>	<i>High quality insulation, made from industrial Hemp. The unique thermal and acoustic features of Hemp fibre contributes to healthy living environment</i>	<ul style="list-style-type: none"> Available in sheets of 40mm, 60mm, 80mm, 100mm, 120mm sizes Each pallet contains 10 packages of sheets 	40mm- €450 60mm- €490 80mm- €530 100mm- €550 120mm- €580
<u>Hempcore felt Flooring Underlay</u>	<i>Flooring underlay is an insulation material made from industrial hemp that contributes to a healthy living environment. Used as a levelling and soundproofing material. Suitable for laminate and wood flooring.</i>	<ul style="list-style-type: none"> Available in 3mm, 5mm, 7mm, 10mm sizes 1m wide and 15m long 12 rolls per pallet 	3mm- €700 5mm- €750 7mm- €790 10mm- €830
<u>Hempcore adhesive mortar</u>	<i>Specifically developed for the implementation of Hempcore blocks. Used for exterior and interior applications. Hempcore adhesive mortar is made from lime and is a replacement of traditional mortar.</i>	<ul style="list-style-type: none"> 25Kg bags Max weight of a pallet - 1T Stores for 6 months away from moist in dry conditions 	25Kg bag - €25.00
<u>Hempcore lime binder</u>	<i>Intended for manufacture of hemp blocks. Ready-to-use product, therefore onsite applications are possible.</i>	<ul style="list-style-type: none"> 20Kg bags Max weight of a pallet-1T Stores for 6 months away from moist/dry conditions 1 pallet - 48 Bags 	1 pallet - €1000

Manufacturing and Operations Process



There will be a few stages before Hempcore reaches its construction potential. The first being supplying the traditional construction companies with hempcrete, this would be in the form of precast bricks that could be laid upon each other in the formation of the house being built, or to send a mixture of hemp hurd and lime binder that can be mixed with water on site. The next stage would be to disrupt the construction market with the use for the 3D Printer. Which would be the only service that is provided as this is what creates Hempcore's competitive advantage making building a lot cheaper and would be a great answer to Ireland's housing crisis. The cost for the machine would be the initial obstacle however to build houses the machine requires a lot less labourers and would result in saving costs with wages and salaries.



3D Printing Costs



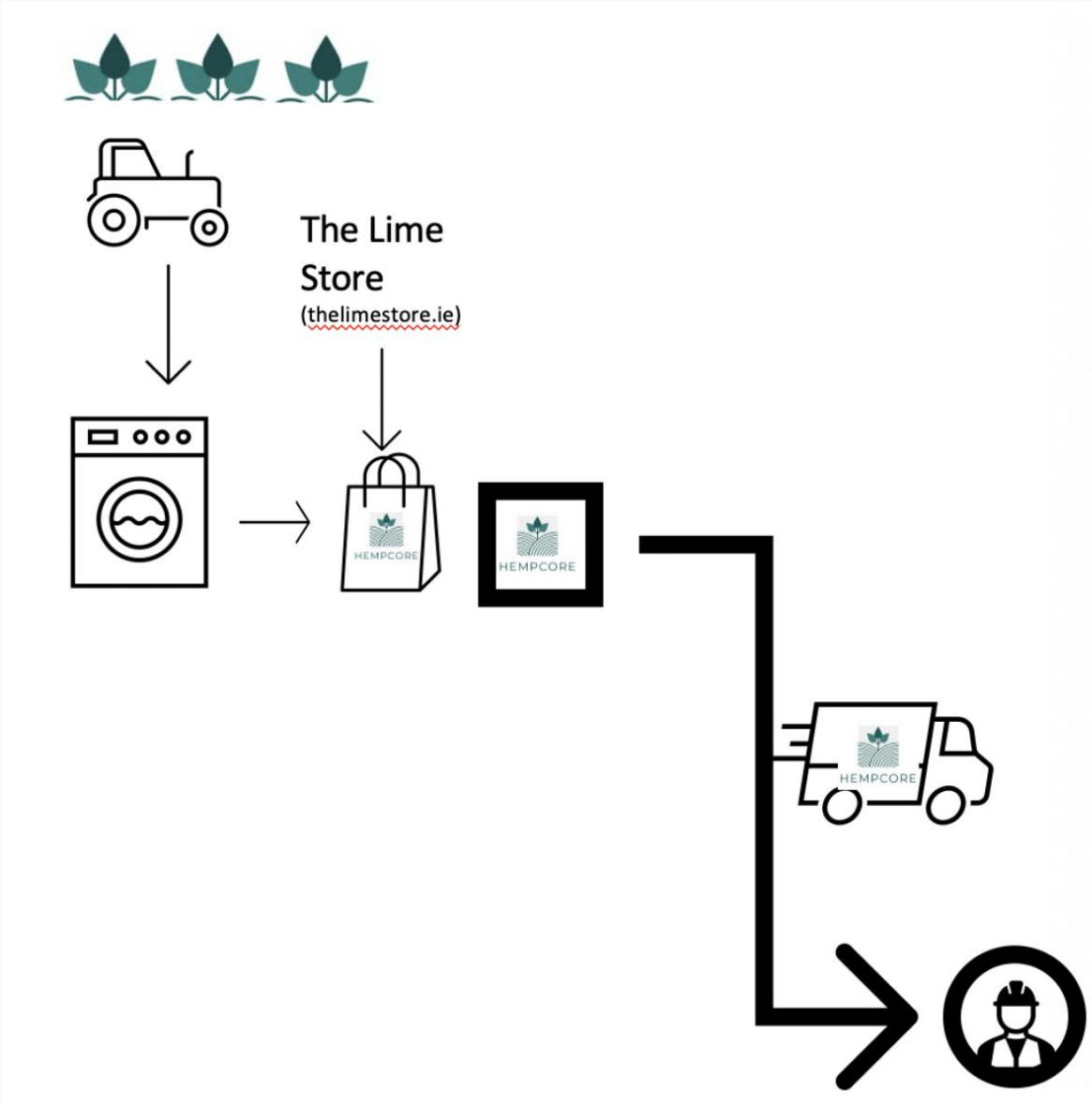
Listed below is the amount it would cost to build a house made out of the hempcrete binder that Hempcore would offer. Using the formula that it costs €613 for a 1m² of hempcrete. Using the average m² for a house in Ireland was also assumed to be 81m².

<i>Storey</i>	<i>Average size in Ireland</i>	<i>Cost to build</i>	<i>Sell for</i>
1 Storey	81m ²	€49,653	€100,000
2 Stories	162m ²	€99,306	€200,000

As stated before this list only has the cost of hempcrete per m². Taking away the finishing touches, and with the use of the 3D building printer these estimated amounts are accurate, but most importantly the building process would only take a day or two to finish. Using the analysis that we produce houses at capacity rather than what is demanded is because the housing crisis is at an all-time high and doesn't look to waiver any time soon. Credit sales in the cashflow summary shows the amount of income a year that could be made with selling Hempcore Houses at these rates.

Distribution Channels

Using the 'Just In Time' supply chain, Hempcore will look to purchase supplies when the order for more hempcrete comes in. The main reason for this is because the laws for industrial hemp become easier to overcome when there is a trial of orders that request for the product. The diagram below shows how the product will arrive, be processed as discussed in the Operational Process section, and delivered to the customer.



Analysis

SWOT

Strengths, Weaknesses that Hempcore has plus the Opportunities and the Threats that will be faced during Hempcore operations.

SWOT	
S	<ul style="list-style-type: none">• Social Media (see Advertising)• Green Movement• Legal Changes• Hempcrete benefits• Effective and Efficient• Eco-Friendliness• Increased Environmental awareness
W	<ul style="list-style-type: none">• Can't build big apartments• Non benefits of Hempcrete• New entrant business• Inexperienced directores• New product, therefore times needed to form awareness
O	<ul style="list-style-type: none">• Future of construction industry (3D Printer)• Education of Industrial Hemp has increased• Hemp can be used in various industries: Clothing and biomass to name a few• International reach (directors all have access to their country of origin's market)• Competition hasn't solidified position in the market• Industrial hemp Laws are shifting quickly• Access to the single market in Europe• Quickly can solve housing crisis
T	<ul style="list-style-type: none">• Concrete industry is strong• "Boomers" would need to be more convinced• Competition is in the market already• Importing due to covid may be difficult• Government Policies

Competitors

As stated in the Products section, the pricing strategy used was largely based on the average price of the competitors. As this is a growing industry the scope of competitors was seen on an international level to help distinguish if there were competitors in other countries, namely South Africa, Brazil and Georgia. The diagram below shows the competitors that sit locally, nationally and internationally.



Set Up Summary

Initial Costs

Category	Sub-Category	Costs	Total	Grand Total
Machinery				
	3D Printer	€1,000,000.00		
	Hemp Block Machine	€12,000.00		
	Hemp Block Dryer	€5,000.00		
	Tools	€10,000.00		
	Hemp Hurd machine	€15,000.00		
				€1,042,000.00

Working Capital				
	Initial Capital	€300,000.00		
	Company Cars	€20,000.00		
			€320,000.00	

Registration Costs				
	CRO Application	€500.00		
	Hemp Association	€2,000.00		
	Registration for Electricity, Gas, Water	€1,500.00		
	Tax Registration	€300.00		
				€4,300.00

Properties				
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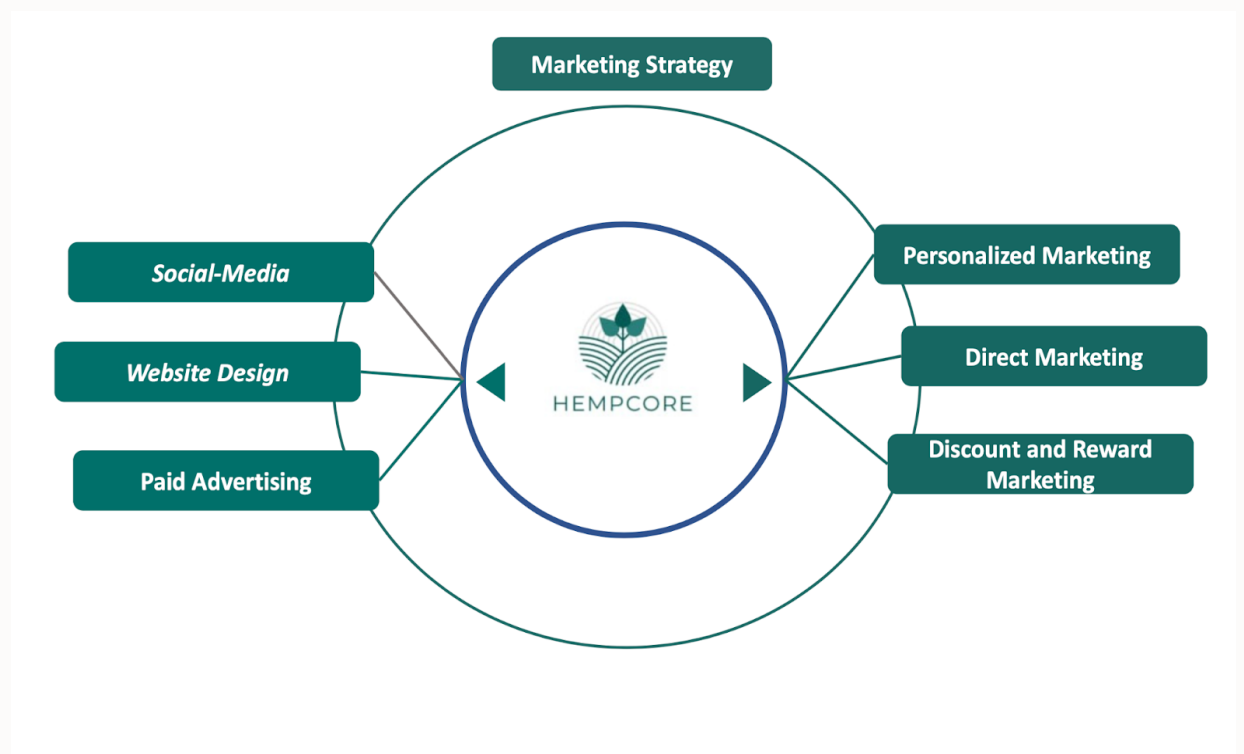
Cash Flow Forecast

Assuming that the purchasing of the 3D Printer at the price of €1,000,000, and that a house is built every day at the selling price of a 1 storey house is average €100,000 that would equate to €36,500,000 we put this under credit sales as this would vary on a number of factors:

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash Inflows					
Investment	€1,606,800.00	€0.00	€20,000.00	€0.00	€13,000.00
Cash Sales	€20,000.00	€200,000.00	€420,000.00	€500,000.00	€750,000.00
Credit Sales	€18,250,000.00	€36,500,000.00	€36,500,000.00	€36,500,000.00	€36,500,000.00
New Capital	€0.00	€40,000.00	€15,000.00	€25,000.00	€20,000.00
Total Inflows	€19,876,800.00	€36,740,000.00	€36,955,000.00	€37,025,000.00	€37,283,000.00
Cash Outflows					
Machinery	€525,000.00	€525,000.00	€0.00	€0.00	€0.00
Maintenance	€3,000.00	€2,000.00	€2,500.00	€4,000.00	€5,000.00
Suppliers	€40,000.00	€50,000.00	€60,000.00	€55,000.00	€52,000.00
Registration fees	€4,300.00	€0.00	€0.00	€0.00	€0.00
Legal and Professional fees	€20,000.00	€20,000.00	€20,000.00	€20,000.00	€20,000.00
Payroll	€175,000.00	€175,000.00	€175,000.00	€175,000.00	€175,000.00
Bank fees	€2,000.00	€1,500.00	€2,000.00	€2,000.00	€1,500.00
Electricity, Water, Gas	€5,000.00	€3,000.00	€5,000.00	€3,500.00	€4,100.00
Insurance	€40,500.00	€40,500.00	€40,500.00	€40,500.00	€40,500.00
Set up Online Sales (website, etc.)	€5,000.00	€0.00	€0.00	€0.00	€0.00
IT Maintenance	€2,000.00	€2,000.00	€3,000.00	€3,000.00	€3,000.00
Total Outflows	€821,800.00	€819,000.00	€308,000.00	€303,000.00	€301,100.00
Net Cash flow	€19,055,000.00	€35,921,000.00	€36,647,000.00	€36,722,000.00	€36,981,900.00
Opening Balance	€0.00	€19,055,000.00	€16,866,000.00	€19,781,000.00	€16,941,000.00
Closing Balance	€19,055,000.00	€16,866,000.00	€19,781,000.00	€16,941,000.00	€20,040,900.00

Marketing Strategy

Hempcore looks to take advantage of society's "fear" of climate change. Pushing for the facts and theories that prove climate change while only mentioning that hempcrete can counteract these fears with the "Help of Hempcore" this is known as "fear-based" marketing. A technique that has proven to work in the past when the right circumstances are present. Hempcore believes that with the society focusing on the "Need for Climate Change", this has put pressure on governments to look for a viable option and strategy. Therefore social media platforms like Facebook, Twitter, Instagram will hold a massive influence and the use of "Through the Line" marketing technique will be focused on heavily as it involves the use of digital marketing. This is the easiest and cheapest way to advertise. Hempcore's social media platforms will be of an informative nature only posting content based on the severity of climate degradation. While the website will be present on each platform consisting of the product list, prices and how to use them.



Terms & Conditions

While the financial statements that were added, there was little time to research what the real prices would be and therefore an estimation of the prices was done. The machines and the cost of the product were all researched and can be verified from specific suppliers. To build each house would cost roughly more than what was estimated but the amount of houses would be sufficient per year as the 3D machine is capable of 24 hours of building.

The 3D Printer amount would be a good example of this. Most of the benefits and secondary research was used in the Literature Review that is provided with the business proposal, and in that Literature Review the references that are used are also listed there.

While the legal changes are still on going, as of April 2021, the laws changing to defend the environment have already come into action and therefore the assumption can be made that soon Industrial Hemp will start to become legalised on many levels.

It should be noted that this is a business proposal and is not for the use of the person(s) reading it but for the creators and distributors of this document. Any ideas that sit in this document are our own and cannot, should not, be used without the consent of the writers of these documents mentioned.

Name: _____

Surname: _____

Date: _____

BIBLIOGRAPHY

WEBSITES

- Grand View Research, 2020. Industrial Hemp Market Size, Share & Trends Analysis [online]. Available at: https://www.grandviewresearch.com/industry-analysis/industrial-hemp-market?utm_source=prnewswire&utm_medium=referral&utm_campaign=cmfe_27-feb-20&utm_term=industrial-hemp-market&utm_content=rd1 [Accessed 11 March 2021].
- Hempbuild, 2021. The Experts in Hempcrete Construction [online]. Available at: <https://www.hempbuild.ie/> [Accessed 11 March 2021].
- Jami, T., 2018. 5 Reasons Enterprising Builders Should Consider Hempcrete. [online] Entrepreneur India. Available at: <https://www.entrepreneur.com/article/322594> [Accessed 11 March 2021].
- The One Brief, 2016. Why Environmental Sustainability is Becoming Big for Business [online]. Available at: <https://theonebrief.com/why-environmental-sustainability-is-becoming-big-for-business-2/> [Accessed 11 March 2021].
- Walker, O., 2019. Canadian cannabis fund returns 50% in two months. [online] Financial Times. Available at: <https://www.ft.com/content/059c1c62-b78f-3510-a767-c738e46f926b> [Accessed 12 March 2021].
- Walker, O., 2021. Irish investors to get access to cannabis fund. [online] Irish Times. Available at: <https://www.irishtimes.com/business/personal-finance/irish-investors-to-get-access-to-cannabis-fund-1.4131611> [Accessed 12 March 2021].

- Ec.europa.eu. 2021. Deforestation - Forests - Environment - European Commission. [online] Available at: < <https://ec.europa.eu/environment/forests/deforestation.htm> > [Accessed 5 April 2021].
- Damassets.autodesk.net. 2021. building for the future. [online] Available at: < https://damassets.autodesk.net/content/dam/autodesk/www/solutions/architecture-engineering-construction/docs/20190322_Autodesk_Whitepaper.pdf > [Accessed 5 April 2021].
- Wilson, C., 2021. the future for hemp. [online] Ec.europa.eu. Available at: < [https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20\(EIHA\).pdf](https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20(EIHA).pdf) > [Accessed 5 April 2021].
- Heimpel, E., 2020. Industries and sectors driving deforestation: what you need to know. [online] Ecologi. Available at: <<https://ecologi.com/articles/blog/industries-and-sectors-driving-deforestation-what-you-need-to-know> > [Accessed 5 April 2021].
- Li, R., 2021. Sustainable Construction Waste Management in Australia: A Motivation Perspective. [online] research gate. Available at: < https://www.researchgate.net/publication/286292716_Sustainable_Construction_Waste_Management_in_Australia_A_Motivation_Perspective > [Accessed 5 April 2021].
- Kochendoerfer, B., 2014. An evaluation of environmental impacts of construction projects. [online] Available at: < https://scielo.conicyt.cl/scielo.php?pid=S0718-50732014000300002&script=sci_arttext&tlnq=en > [Accessed 5 April 2021].
- Rdmc.nottingham.ac.uk. n.d. Operating Energy for Buildings. [online] Available at: < https://rdmc.nottingham.ac.uk/bitstream/handle/internal/112/Engineering%20Sustainability/64_operating_energy_for_buildings.html > [Accessed 5 April 2021].
- Environment. n.d. Construction and demolition waste. [online] Available at: < https://ec.europa.eu/environment/topics/waste-and-recycling/construction-and-demolition-waste_en > [Accessed 5 April 2021].
- Osmani, M., 2012. Construction Waste Minimization in the UK: Current Pressures for Change and Approaches. [online] research gate. Available at: < https://www.researchgate.net/publication/257715686_Construction_Waste_Mi >

[nimization in the UK Current Pressures for Change and Approaches](#) > [Accessed 5 April 2021].

- US EPA. n.d. Sustainable Management of Construction and Demolition Materials | US EPA. [online] Available at: < <https://www.epa.gov/smm/sustainable-management-construction-and-demolition-materials> > [Accessed 5 April 2021].
- Van Bueren, e., 2007. Establishing sustainability: Policy successes and failures. [online] RESEARCH GATE. Available at: < https://www.researchgate.net/publication/231359131_Establishing_sustainability_Policy_successes_and_failures > [Accessed 5 April 2021].
- Youmatter. 2021. What Is Deforestation?. [online] Available at: <<https://youmatter.world/en/definition/definitions-what-is-definition-deforestation-causes-effects/>> [Accessed 6 April 2021].
- UK Hempcrete, 2020. “Frequently asked questions: hempcrete” Online Available at: <https://www.ukhempcrete.com/wp-content/uploads/2016/11/Hempcrete-FAQs-UK-Hempcrete.pdf> (Accessed 2.3.21)
- Hemp cooperative, 2018. “Sustainable construction “ Online Available at: <https://hempcooperativeireland.com/7-pillars-of-hemp/sustainable-construction/> (Accessed 2.3.21)
- Roders, M. “The central role of the construction sector for Climate change adaptations in the built environment” Online Available at: https://www.irbnet.de/daten/iconda/CIB_DC27235.pdf (Accessed 2.3.21)
- Wilson, C. “The future of Hemp” Online Available at: [https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20\(EIHA\).pdf](https://ec.europa.eu/environment/forests/pdf/respondents-additional-inputs/European%20Industrial%20Hemp%20Association%20(EIHA).pdf) (Accessed 2.3.21)

- Runestad, 2021. “Congress introduces bill to legalise hemp cbd supplements” Online Available at: <https://www.naturalproductsinsider.com/regulatory/congress-introduces-bill-legalize-hemp-cbd-supplements> (Accessed 1.3.21)
- Havens 2021. “2021: the year of positive cbd policy change” Online Available at: <https://hempindustrydaily.com/2021-the-year-of-positive-cbd-policy-changes/> (Accessed 1.2.21)
- Drye, 2021. “CBD and Hemp legal and regulatory roundup“ Online Available at: <https://www.jdsupra.com/legalnews/cbd-and-hemp-legal-and-regulatory-9156636/> (Accessed 1.2.21)
- Factsheet, 2007. “HEMP and Ireland:(useful)” Online Available at: https://www.teagasc.ie/media/website/publications/2010/862_Hemp.pdf (Accessed 1.2.21)
- Mammuth, 2021. “THE FULL SPECTRUM POLITICS Of HEMP IN IRELAND:(useful)” Online Available at: <https://www.healtheuropa.eu/the-full-spectrum-politics-of-hemp-in-ireland/102986/> (Accessed 1.2.21)
- Gallagher, 2019. “AN EXAMPLE of strict law regarding CBD” Online Available at: <https://www.irishtimes.com/news/crime-and-law/garda%C3%AD-crack-down-on-shops-and-cafes-selling-cbd-products-1.3895925> (Accessed 1.2.21)

BOOKS

- Langford, D.A., Zhang, X.Q., Maver, T., MacLeod, I. & Dimitrijeic, B. (1999). ‘Design and managing for sustainable buildings in the UK’, in Profitable partnering in construction procurement, CIB W92 (Procurement Systems) and CIB23 (Culture in Construction), Joint Symposium, S.O. Ogunlana, (Ed.), E & FN Spon, London, pp. 373–382 (accessed: 12.3.21)

- Stanwix W., Sparrow A. 2014. "The Hempcrete book" First edition. (accessed: 22.2.21)
- Ahlström J. 2015 "Corrosion of steel in concrete at various moisture and chloride levels". Available online: <https://energiforskmedia.blob.core.windows.net/media/21240/corrosion-of-steel-in-concrete-energiforskrappport-2015-133.pdf> (accessed: 13.3.21)
- Magwood, C. 2016 "essential hempcrete construction: step by step guide" .Available online: https://books.google.ie/books?hl=en&lr=&id=wE2HDAAAQBAJ&oi=fnd&pg=PP1&dq=Hempcrete+financial&ots=f83NIwL40z&sig=1GkwsZHx-I8q5Nee3Q6rEKEOoc&redir_esc=y#v=onepage&q=Hempcrete%20financial&f=false (accessed: 10.3.21)
- Adams M. 2018. "Bringing embodied carbon upfront". Available online: https://www.igbc.ie/wp-content/uploads/2019/09/2.-WorldGBC_Bringing_Embodied_Carbon_Upfront_CONFIDENTIAL_180919_media-release-v4-with-IGBC-logo.pdf (accessed: 3.3.21)
- Miller B. 2020. "Greenfield Agriculture: Project Planning for a Business in the Industrial Hemp Industry". Available online: <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1244&context=honorstheses> (accessed: 1.3.21)
- Ivanov Peev P. 2012 "Is industrial hemp a sustainable construction material?" . Available online: <https://www.ukhempcrete.com/wp-content/uploads/2016/11/Hempcrete-FAQs-UK-Hempcrete.pdf> (accessed: 1.3.21)

APPENDIX

THE CONSTRUCTION INDUSTRY GROWTH

World population is growing by an estimated average of 1% per year, which will be 8,2 billion in 2025 which creates continuous demand growth in construction as urbanization increases in the same time. (Worldometer, 2021)

The construction industry is booming and experts expect growth to continue. The Bureau of Labor Statistics and a report from Timetric's Construction Intelligence Center (CIC), project the construction industry to be one of the fastest growing industries into 2020. Construction has a 4.5% projected growth rate over the next several years. (Tradesmen, 2017)

This fact shows that the following environmental issues coming from the construction industry will only increase.



(UK construction blog, 2019)

ENVIRONMENTAL IMPACT FROM CONSTRUCTION INDUSTRY

The construction industry has a huge impact on many aspects of the environment (air, water, wildlife, soil, health) and is responsible for **50%** of climate change. This due to our current way of doing by which we mean the choice of raw material, the materials production methods, the buildings manufacturing techniques as well as the buildings maintenance. The following 5 aspects will give a clear explanation of the man-made negative contribution to the environment.

1. WASTAGE ISSUES



(Averda, 2020)

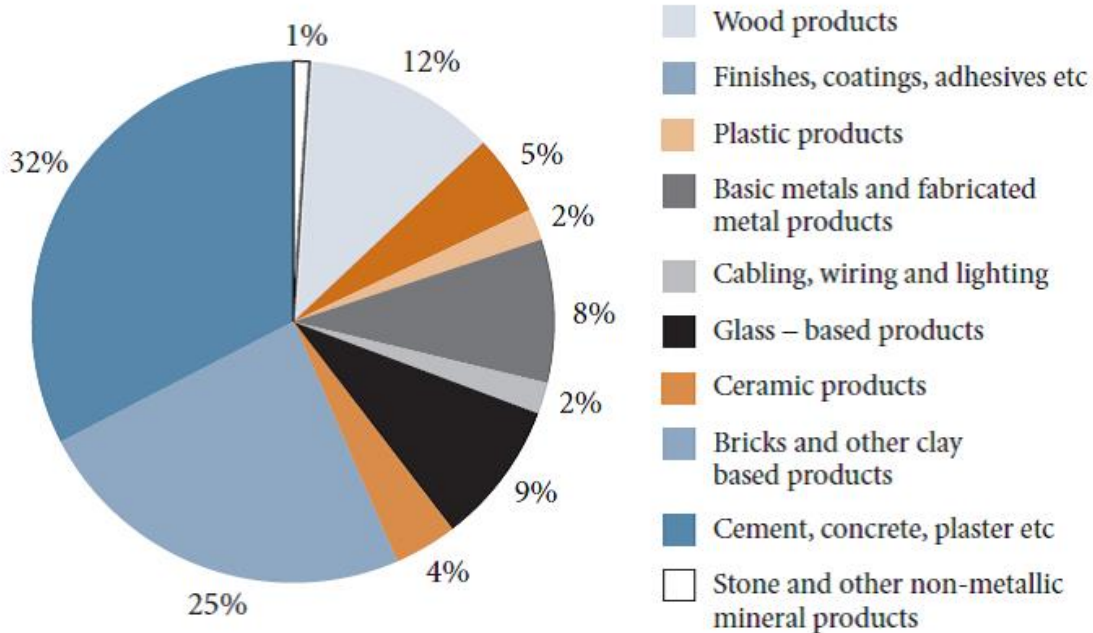
Construction waste is any substance, matter, or thing that is produced as a result of construction work and is abandoned. This waste can be a mixture of surplus materials resulting from site clearance, construction, excavation, renovation, refurbishment, demolition, and even road works. Construction waste includes a huge variety of materials. Few of which can be recycled and few cannot, in addition to this there are some waste which are hazardous in nature. (Smart bricks, 2019)

The UK construction sector uses more than 400 million tons of material a year, and 100 tonnes of it becomes waste. (Hertfordshire, 2015)

Construction activities worldwide consume 3 billion tonnes of raw materials each year, which is 40% of total global use, 2 billion tons of which becomes waste. (University of Nottingham, 2019)

85% of construction wastes are non-hazardous and recyclable therefore reusable if used properly, however 15% are non-recyclable and partly hazardous (contaminated soil, leftover paints, solvent, aerosol cans, asbestos, paint thinners, striping paint, contaminated empty containers, etc).

Wastes from construction materials and products industry, kt (excluding quarry wastes)



(sourced from ORBEE under a [Creative Commons License Attribution-Noncommercial-Share Alike](#), 2019)

As seen above, the majority of construction waste is concrete and is difficult to recycle. Gypsum drywall is widely used in combination with concrete as a default for inner walls, it is nearly impossible to recycle (an average of 2% is recycled).

According to construction blog Bimhow, the construction sector is responsible for **50%** of landfill (dump site) wastes. Landfills, although regulated, have 4 negative impacts on the environment. Asbestos, the highly toxic isolation material for construction contributes to all these issues.

Air pollution: Part of waste is biodegradable and releases methane gas in the air which traps 20 times more heat in the atmosphere than CO₂ (according to EPA) which contributes to global warming.

Biodiversity and soil fertility impact: The landfills change the ecosystem. Animals don't survive in the new conditions and move to new locations. Local vegetation of the surrounding areas can also be permanently altered as to decrease soil quality.

Groundwater pollution: As rain falls, the water collects highly toxic chemicals (high levels of toxic metals, ammonia, toxic organic compounds and pathogens) which can contaminate local groundwater and endanger aquatic life if it reaches rivers or lakes.

Health impact: landfills become bacteria breeding grounds to which the exposure, in addition to hazardous waste and chemicals, creates disease or cancer, respiratory

illness and birth defects. For example, gypsum drywall's mining dust weakens the lungs which can create silicosis and lung cancer. It's storage in landfills creates hydrogen sulfide which is toxic in high concentration. (Sciencing, 2019)

2. AIR POLLUTION

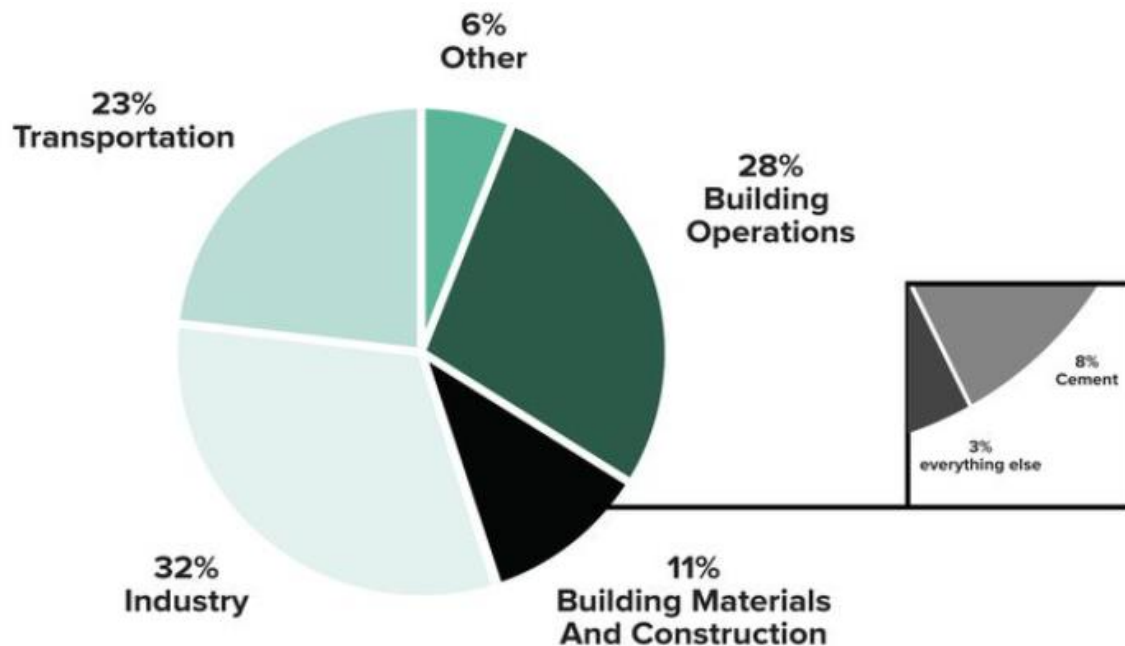
The construction industry produces **11%** of global greenhouse gas emissions, which is very big (4 times the aviation sector's emissions). 8% of it comes from the production of concrete (the most used resource after water, used since roman empire).



(TRS, 2020)

This material is the third highest carbon producer in the world. A ton of cement produces between 0.65 and 0.92 tonnes of CO₂. (Shlanger, 2020)

Global CO₂ Emissions By Sector



(global alliance for buildings and construction, 2020)

The 3 other percent come from other smaller factors. Sand mining (6 tons required for each ton of cement) pollutes the air. The use of machinery and construction vehicles (bulldozers, excavators, dumpers, etc) which generally work on diesel engines and aren't as regulated as other vehicles by the authorities. Dust emission due to land clearing and demolitions. finally chemicals from products like paint, glues or oils that emit noxious vapours.

All these invisible pollutants will impact first the health of employees and local residents and secondly our atmosphere.

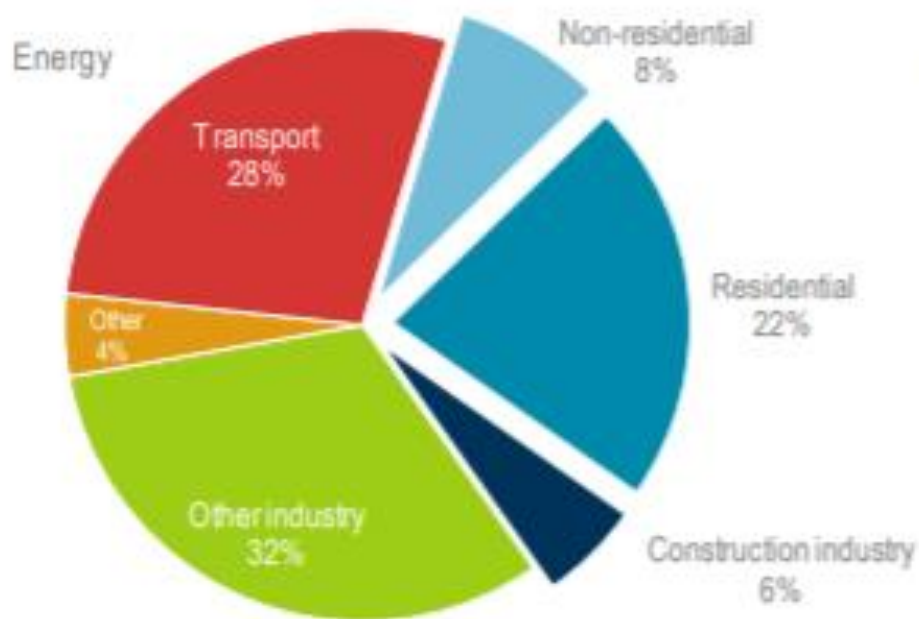


(Guzder, 2019)

In addition, concrete buildings generate nano-pollutants indoor that are harmful to population health in the long term (Dust, Toxic mold, fiberglass, formaldehyde, lead paint, bacteria, fungi, radon, chemicals, dander, carcinogen, etc) that can trigger asthma. (Mana, 2020)

3. ENERGY CONSUMPTION

The buildings and construction sector accounted for **36%** of global final energy use. In addition to the energy used in the construction of buildings, the biggest consumption comes during the building's lifetime.

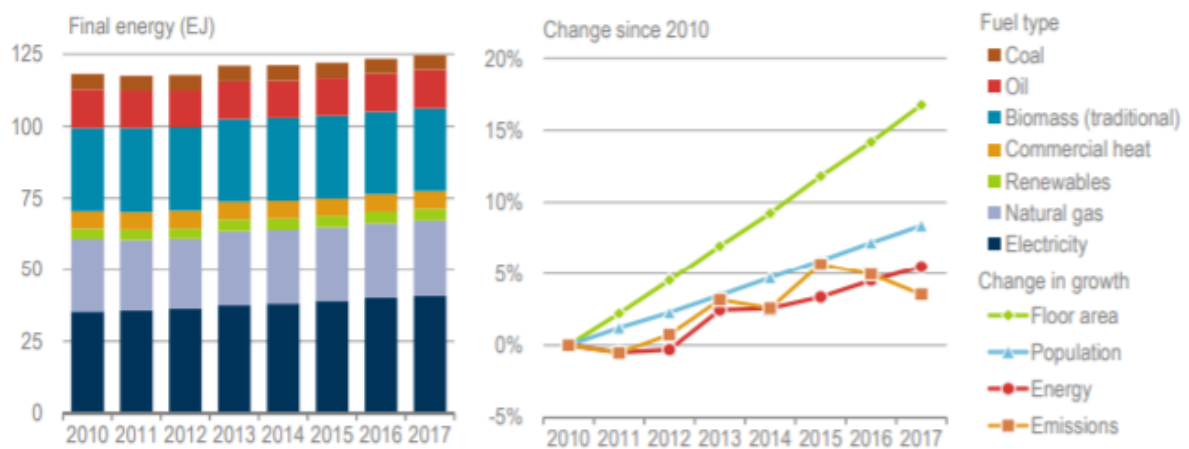


(International Energy Agency and the United Nations Environment Programme, 2018)

In the USA, buildings account for the biggest energy consumption (37%) and 65% of electricity. It is used for heating (mostly), ventilation, lighting and other appliances. In fact, loss of heat due to open windows represents around 5% of a developed country's energy consumption.



The following graph shows the different types of fuel production and use (5% increase in 7 years) between 2010 and 2017 with the current solutions.



(Global alliance for buildings, 2019)

4. WATER POLLUTION

The construction industry is responsible for **40%** of the world's water pollution due to its considerable amount of waste and pollution. This happens because of toxic components such as asbestos that end up in rivers or lakes through drains or soil; this can happen due to rain and meteorological conditions or simply corporate lack of standard. The source of these chemicals can be diesel, oils, cement, glues, etc. Once the chemicals go into the groundwaters, it can contaminate drinking water which is harmful for the living.



(Kolkata, 2019)

5. DEFORESTATION

The construction sector is responsible for the removal of trees either to gain space for building sites or to get raw material. Every tree contributes to the cycle of absorbing CO₂ and creating oxygen, therefore cutting trees indirectly increases the amount of carbon dioxide in the air. It is estimated that the global forest carbon stock has decreased by 1% in 5 years which contributes to global warming. Deforestation also affects biodiversity, increases aridity, creates desertification, and numerous other consequences. (Wikipedia, 2020)



(Progressive party, 2020)

In summary, the building sector environmental issues are: Pollution of water and soil, impact on the fauna and plants health, high consumption of final energy and

most importantly air pollution due to the main precursor of climate change. The air pollution has a double impact on earth as it directly impacts our health and indirectly contributes to global warming which itself has it's set of consequences.

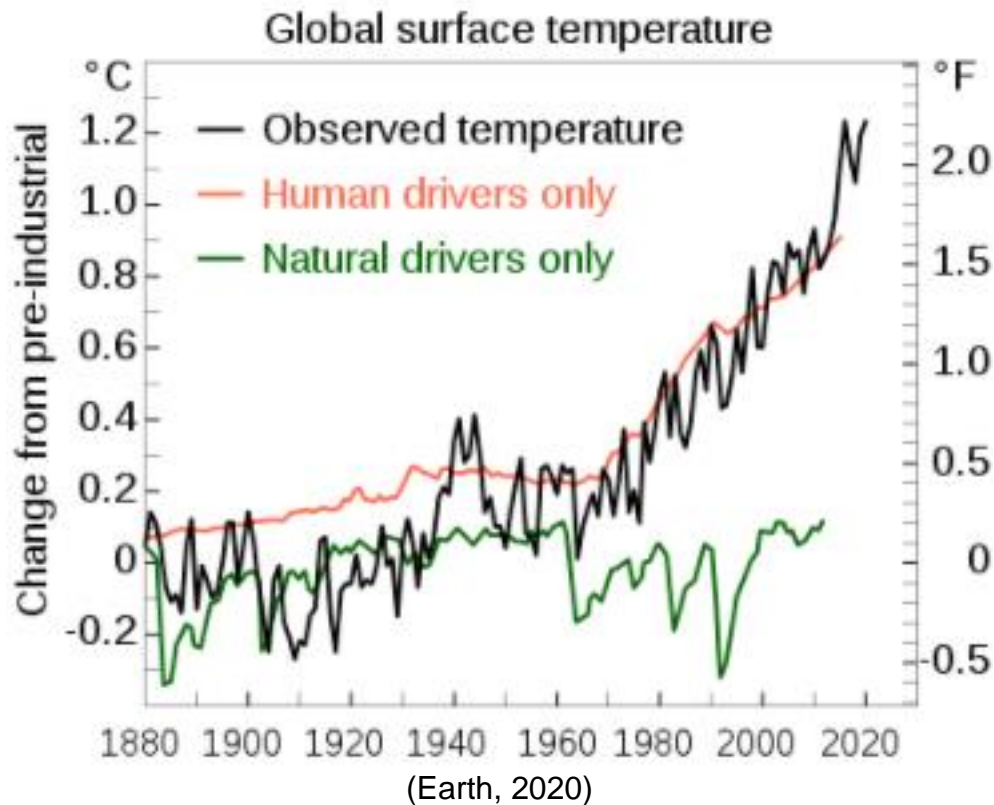
CLIMATE CHANGE

As mentioned and explained above, the construction sector is responsible for 50% of climate change. Climate change includes global warming and the large-scale effects on weather patterns and climate systems.



(Swanson, 2021)

Global warming refers to the long-term increase of the planet's temperature which is caused by heat-trapping gases (greenhouse gases: water vapor, carbon dioxide, methane, nitrous oxide, ozone) in the atmosphere created mainly by human activity. The level of these gases are now the highest since 800'000 years. Human greenhouse gas emissions have increased by 45% since the industrial revolution primarily due to the burning of fossil fuels (oil, coal and gas) for energy consumption. Agriculture, deforestation and manufacturing also contributes. Studies show that the average surface temperature has risen by 1 celsius since 1880.



The increase in temperature consequences are numerous. Regarding nature, there is desert expansion, heat waves, wildfires, intense storms and weather extremes due to evaporation, arctic melting which increases sea levels, ecosystems impact (extinction, relocation), flooding, extreme heat and infectious disease increase. Regarding humans, it creates food and water insecurity, economic losses and displacement.

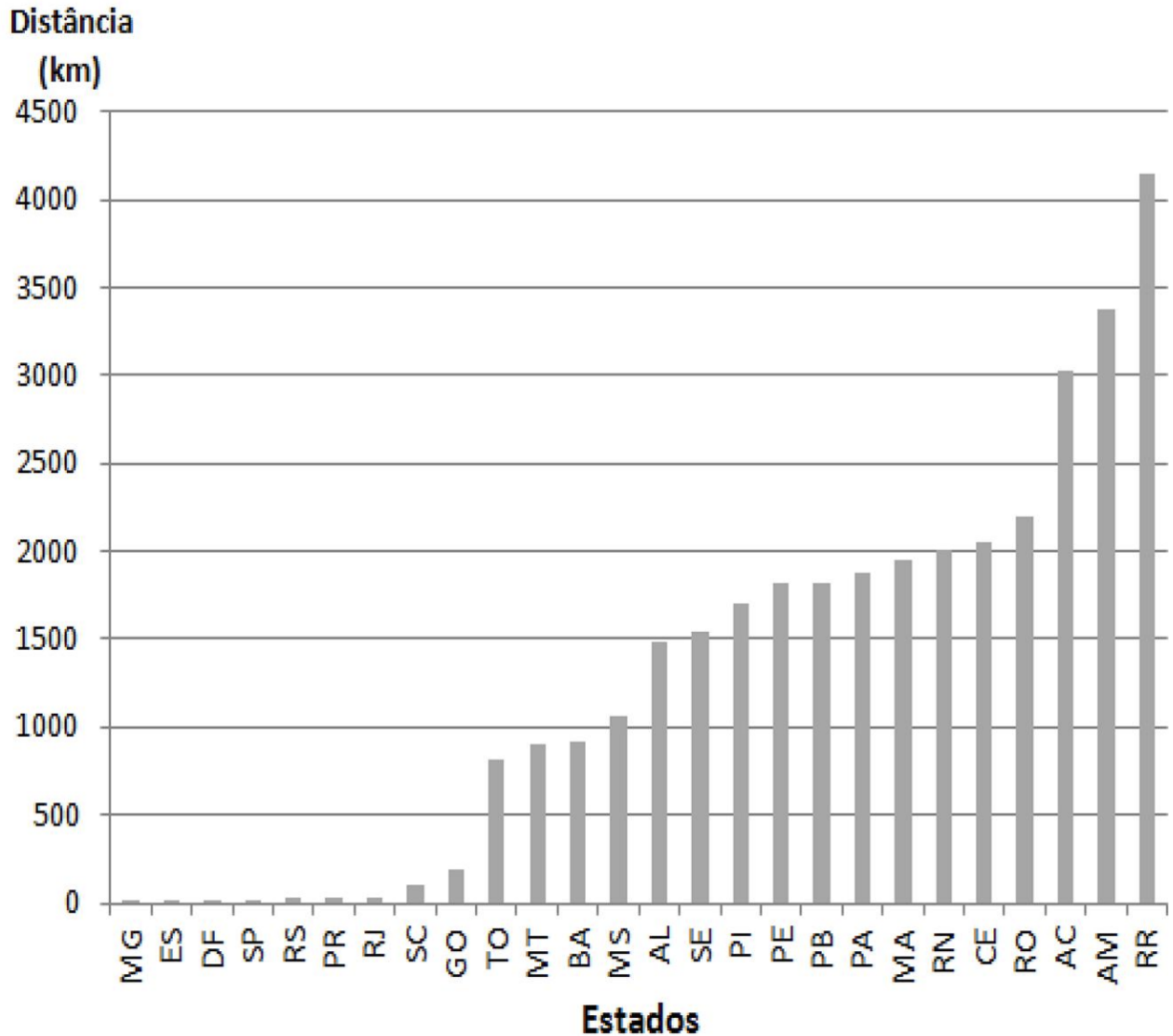
According to the World Health Organisation, climate change is the biggest threat to global health in the 21st century. Therefore the industry sector is half responsible for the main threat for humankind.

The last 5 years have shown that 70% of the adults between 18 and 34 are concerned about global warming and have protested all around the world to ask for change. (Darby, 2019)

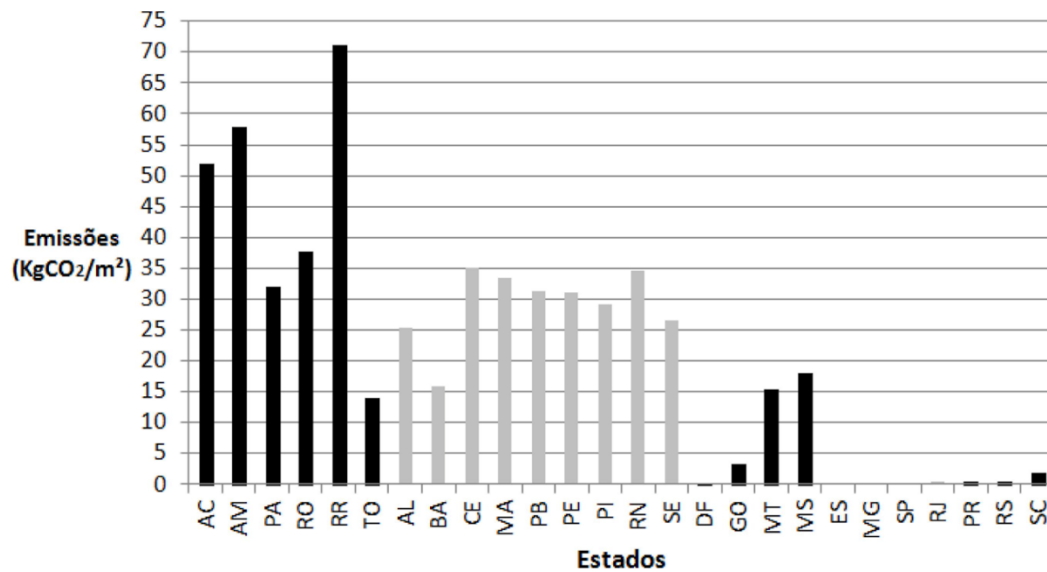
Politics have started to act and have voted national policies such as the carbon tax or international agreements like the Paris accord to push to a lower-carbon economy. Even though it shows progress, it is highly insufficient as we are approaching a limit to which there is no come back. The United Nation has warned in 2018 that, according to their studies, we have 12 years to limit the catastrophe. (Watts, 2018)

According to data from the National Confederation of Transport (CNT) (CONFEDERAÇÃO, 2015), road freight transport represents over 60% of the transport used in Brazil, and this load includes much of the construction materials used in buildings.

Related to the availability of materials and components is the distance travelled from the factory to the construction site; this directly impacts on CO2 emissions along the route, because the greater the distance travelled, the greater the amount of CO2 emitted into the atmosphere.



Above, the graph indicating how many kms concrete blocks travel depending on the location in Brazil



CO₂ emissions in the transportation of concrete blocks per state in Brazil. (SciELO, 2019)

The immediate consequence of transport activities on the environment where the cause and effect relationship is generally clear and well understood. For instance, noise and carbon monoxide emissions are known to have direct harmful effects. Indirect impacts. The secondary (or tertiary) effects of transport activities on environmental systems. They are often of higher consequence than direct impacts, but the involved relationships are often misunderstood and more difficult to establish. For instance, particulates are mostly the outcome of incomplete combustion in an internal combustion engine are indirectly linked with respiratory and cardiovascular problems since they contribute among other factors to such conditions.

Rocks, bricks and other material needs to be transported beside cement. This causes 7% of concrete's CO₂ with the trucks pumping CO₂ at the rate of 0.147 kg per tonne -mile. (The Economist, 2019)

HISTORY OF HEMP

- 16th Century Britain
- American Hemp
- Prohibition in America
- Historical and current uses
- Chinese hemp origins
- Hemp in the middle ages
- Hemp in Canada
- Hemp and north America: Prohibitions
- WWII: Hemp bans lifted, but TEMPORARILY
- HEMP then and now: 1937 to modern day

(Houlihan, 2019)

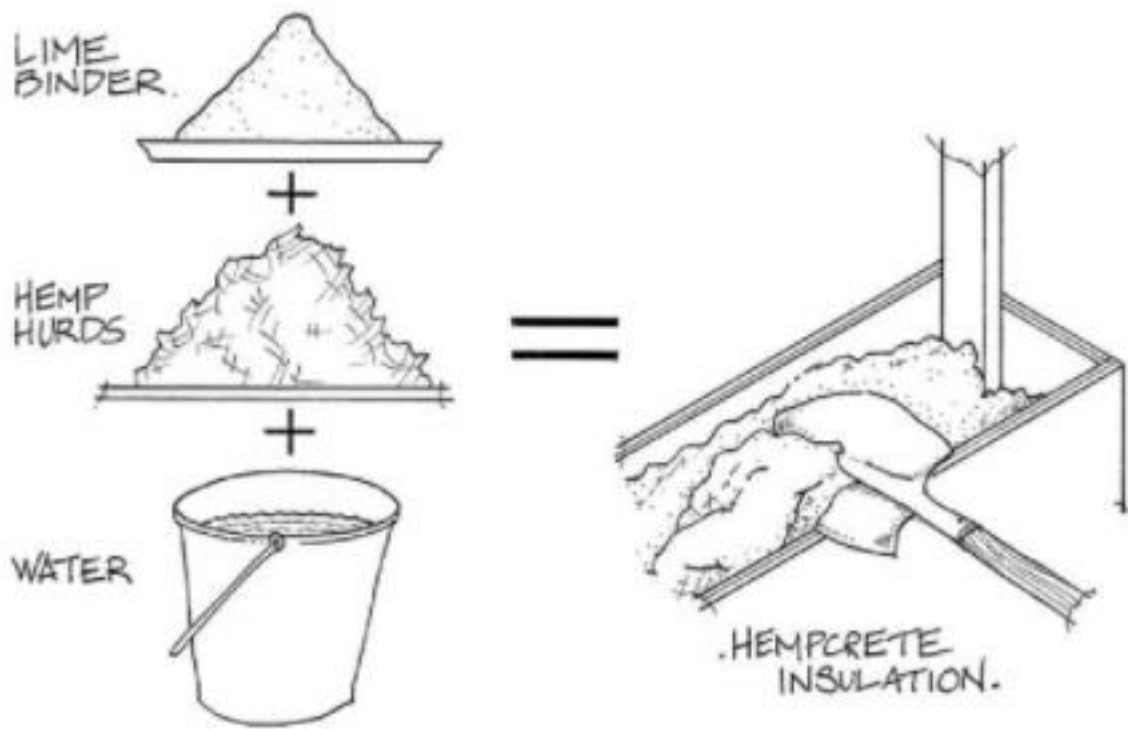


(Canapa, 2017)

HEMP CONSTRUCTION MATERIALS

- Hemp lime wall filler
- Hemp external Render
- Scratch coat
- Skim coat plaster

Info of the products: <https://www.hempirebuilding.net/index.php/products>



(Hempbuild, 2018)

ANCIENT HEMP STRUCTURE



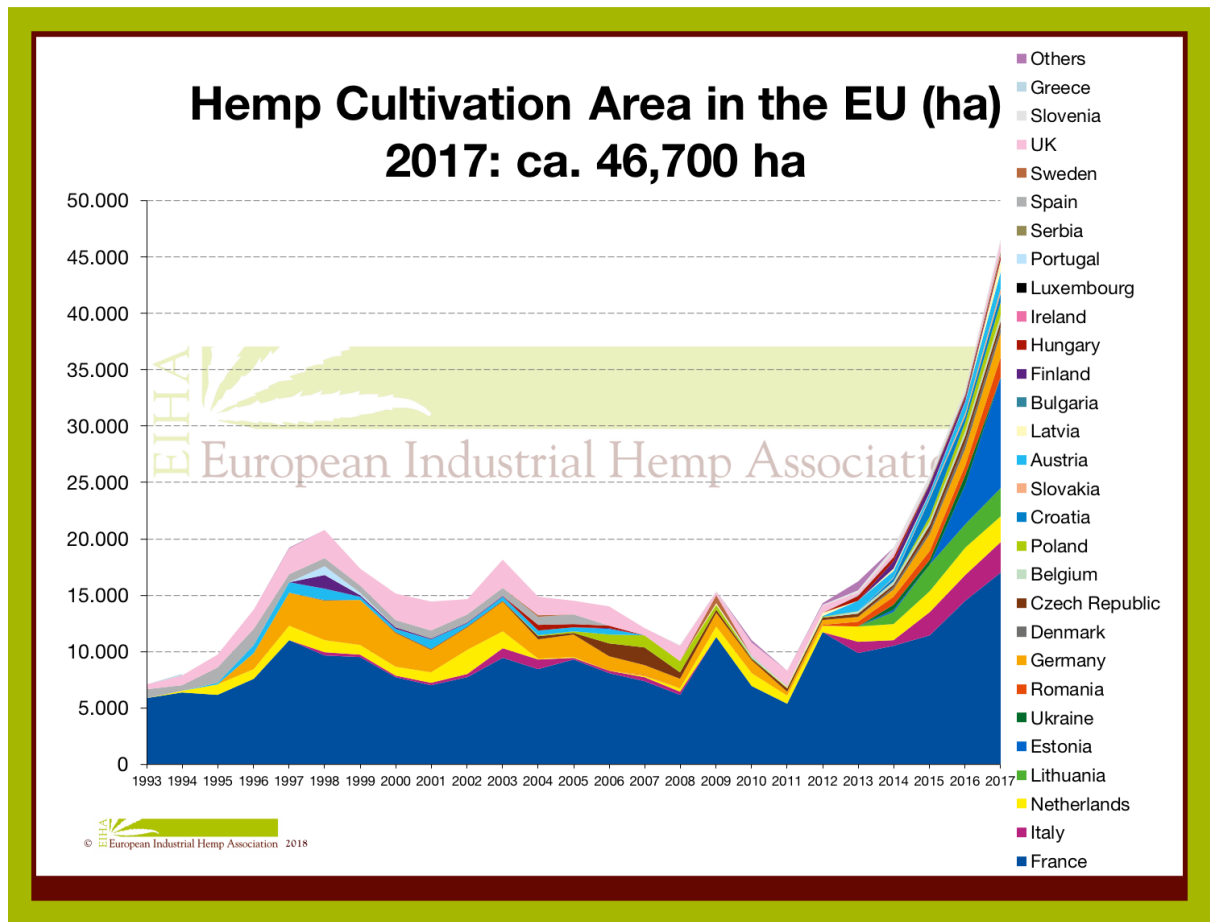
A 300 year old house made in hemp in Japan in 1698. (Cannalore, 2017)

HEMP GLOBAL PRODUCTION

The thousands of different products made of hemp represent numerous industries that represent a growing demand in hemp supply.

Currently the biggest Hemp producer in the world is China with 70% and France is the second biggest producer with around 25%, USA is in third place and Canada in fourth.

Over 30 countries produce industrial hemp for commercialisation: Australia, Ukraine, Austria, UK, Canada, Turkey, Chile, Thailand, Denmark, Switzerland, Egypt, Sweden, Finland, Spain, Germany, Russia, Greece, Romania, Hungary, Portugal, India, Poland, India, New Zealand, Italy, Japan, Holland and Korea. Proportionally to the market the production is consistently increasing.

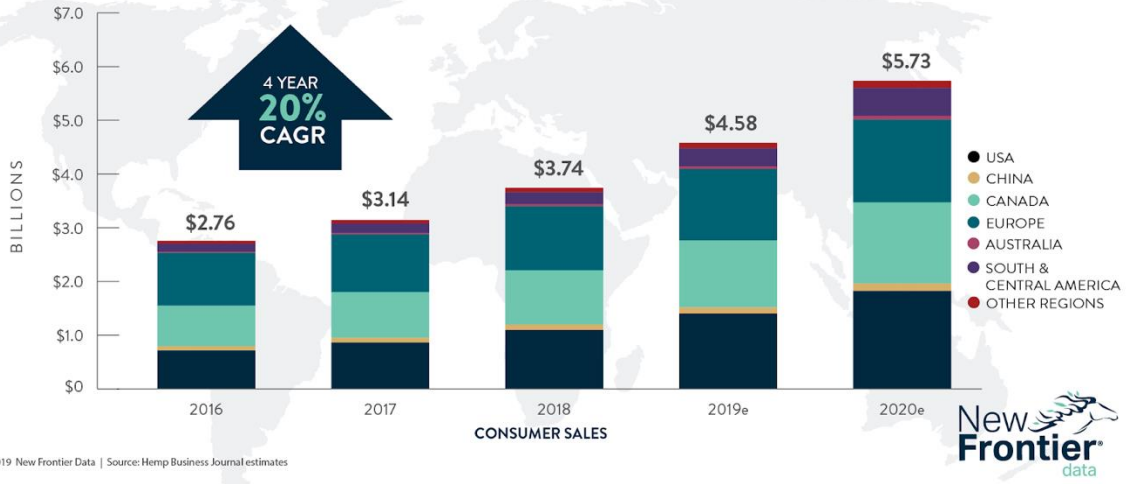


(EIHA, 2018)

HEMP GLOBAL MARKET

The average of 25'000 different products made of hemp and the changing legislation towards hemp commercialisation in numerous industries is creating a continuously bigger market size.

The market has doubled in 4 years, from 2.76 billion USP in 2016 to 5.73 billion USD in 2020, and is expected to continue growing.



(Cannabit, 2019)_