Exploring the potential for organic and more environmentally friendly plastics in the building industry

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Abstract. Modern building techniques, materials and methods open possibilities for rediscovery and new applications of organic and more environmentally friendly solutions in multiple sectors of the building industry. As more scientists and engineers are looking at sustainable resources, the possibilities for managing the potential weaknesses of making more environmentally friendly building and product materials are bringing new materials and methods to the market at a rapid pace. The new biodegradable solutions are looking into natural fibres, or crops and wood. Hemp-based materials are already well-established in multiple environmentally friendly products in the building industry. Hemp-lime, hemp insulation or hemp plastics are materials with low carbon footprint which are successfully being used in construction, replacing successfully non-renewable building materials. In cars, the BMW i3 has for several years featured hemp and kenaf, and Hunton Nativo wood fibre insulation is another example from the building industry of how renewable climate friendly materials can easily replace non-renewable materials. This article aims to highlight some existing solutions, and possible improvements to products in the building industry.

1. Introduction
In our modern times, most industry is generally designed to achieve economic growth. This is coming at the expense of other vital concerns, human health and environmental, cultural, and social unbalance. The purpose of the industrial development did probably not intend to bring such devastating effects, over the natural environment, as waste, pollution, crude products (defined as not designed for human and ecological health) With overcrowding, space limitations, physical and psychological needs and desires, economic appetency, including patent right consequences, humans have created a rapid competition for getting new, exclusive, convenient, advanced products with material and chemical properties with side effects or unintended consequences which can lead to severe global disasters, including advanced. Many of these negative consequences are the result of a lack of knowledge about Life-cycle assessments. LCA involve cradle-to-grave analyses of production systems and provide comprehensive evaluations of all upstream and downstream energy inputs and multimedia environmental emissions. The "life-cycle" impacts include the extraction of raw materials; the processing, manufacturing, and fabrication of the product; the transportation or distribution of the product to the consumer; the use of the product by the consumer; and the disposal or recovery of the product after its useful life [1, 2].

Humans have over millennia found, utilised, shaped and discarded, including opted out materials and chemicals to increase their chances of survival and prosperity. They have found natural materials that
came with good and bad consequences and opted out of using many that turned out to be severely negative. The last couple of centuries have driven innovation at such a breath-taking speed, with such a wealth of physical and scientific tools, methods, possibilities and materials. Alongside such an instant ability for also uncritical communication, and with globalisation such a historically unique opportunity to drive one class of product and material as the solution to all problems, "petroleum" has received a market share which has quenched most alternatives, even when there have been equally as good or better alternatives.

2. Oil based plastics, problematic and consequences

With global warming facilitating severe weather changes, global thermal contrasts, more frequent storms, rises of sea levels, shifts in seasons, it demands a rethink of the industrial development approach. Incinerating fossil fuels contributes microscopic particles of soot to the environment, causing respiratory and other health problems [3].

Plastic materials over the last 40 - 50 years have become problematic for the natural environment, human habitat and most alarming for the world’s oceans, with its long time of decay in nature. Currently, the world plastic production is mainly based on non-renewable resources, and non-biodegradable. The million tonnes of plastic litter that end up in the oceans every year are one of their most visible and alarming signs of these problems, causing growing public concern.

The plastics industry is very important to the European economy, and increasing its sustainability can bring new opportunities for innovation, competitiveness and job creation, in line with the objectives pursued by the renewed EU Industrial Policy Strategy [5].

A smart, innovative and sustainable plastics industry, where design and production fully respect the needs of reuse, repair, and recycling, brings growth and jobs to Europe and helps cut EU’s greenhouse gas emissions and dependence on imported fossil fuels [5].

3. Methods of evaluation. Alternatives of biodegradable plastic

On the path of transition to Circular Economy (CE), in a sustainable economic growth, EU is supporting all partners to develop an European plastic industry, based on bio-plastic.

“A new but growing industry, bioplastics can play an important role in this transition. Encompassing a whole family of materials with different properties and applications, bioplastics can be made from
renewable resources such as crops and wood, or from waste streams such as the residues of food processing [6].

With the emergence of more sophisticated materials, applications, and products, the global market is already growing by about 20 to 100% per year. By 2021, it is expected that Europe will possess around a quarter of the world’s bioplastics production capacity” [6].

European Bioplastics (EUBP), as part of the European Bioeconomy Alliance (EUBA), an informal alliance of 12 leading European organisations is currently representing sectors active in the bioeconomy in Europe, has formulated specific policy asks for the revision of the EU Bioeconomy Strategy to help stimulate the bioeconomy in Europe [7]. Sustainably, efficiently and competitively produced and recycled biomass from the agricultural, forestry and marine sectors, and from waste sources can contribute significantly to Europe’s climate commitments as well as to socio economic targets, such as creating more jobs, growth and viable rural areas. It can also help reducing Europe’s dependence on imports while increasing the security of supply. In addition, it can enhance biodiversity through sustainable management of land and resources [7].

Despite of some limitations, LCA is a used method to evaluate the bio-plastic products, including the big range of raw natural resources.

LCA thoroughness and accuracy will depend on the availability of data; gathering of data can be problematic; hence a clear understanding of the uncertainty and assumptions is important.

Classic LCA will not determine which product, process, or technology is the most cost effective or top-performing; therefore, LCA needs to be combined with cost analysis, technical evaluation, and social metrics for comprehensive sustainability analysis.

![Figure 2. Main stages and typical inflows and outflows considered in lifecycle assessment [2].](image)

The utilization of LCA method can help in the following [8]:

- searching for the most available life cycles, e.g., those with minimal negative impact on environment,
- assuming the decisions in industry, public organizations, or NGOs, which determine direction and priorities in strategic planning, design or design product, or process change,
- choosing important indicators of environmental behavior of organization including measurement and assessment techniques, mainly in connection with the assessment of the state of its environment,
- marketing with the link on formulation of environmental declaration or eco-labeling.
A vast array of plastic products cannot easily, affordably and often actually be replaced with biodegradable alternatives. In applications of extreme stress, rough weather, many chemical, medical and other applications there are few if any more environmentally friendly alternatives to oil-based plastics.

The environmental footprint of these oil-based plastics can be reduced by better managing the materials, by choosing more suitable plastics for the various products and tasks they are designed for, and by recycling more of the plastics. Recycling of plastics is of course a complicated field as there are often uncertainties surrounding the material properties of a plastic mix, which makes it very risky for manufacturers to take the chance on reusing previously molded plastics.

When wanting to help save the environment it is important to delve into the details and understand the challenges associated with recycling. In many cases the cleaning processes, the transport and additives that will be used when recycling plastics and making it ready for being shaped or molded again, can have equally as resource intensive environmental footprints or even worse than using new plastics.

For a wide array of plastic products there are however options, and enormous potential for improvement and more environmentally friendly life cycle footprints by switching to biodegradable products, organic, waste based or even the most easily reusable of petroleum-based plastics. Innovations in similar types of plastics to oil based using as an example AirCarbon with its methane-based production provide more environmentally friendly versions of the types of plastics which it is hard to replace with more traditional plant based or organic alternatives.

AirCarbon has recently been certified as carbon negative by the Carbon Trust [9].

Biodegradable plastics is not with the annual needed volume of material for plastic manufacturing, a solution which can be quickly established without negative consequences along the human and animal food chain as an example. However, by changing the mentality of the designers, and making slight changes to the product specs for many low stress/loads products then resources can be saved in the millions of tonnes of materials + energy annually.

Challenges for companies designing products and manufacturers exists in needing their products to hold up to very high material standards to feel secure about not having to replace products. This is a reasonable way of thinking as many products aren't used in accordance with the intentions, and many users do not read instruction manuals or try to follow them.

Just like BMW, Mercedes, Bentley, Volkswagen and others are making revolutionary changes to the car and manufacturing industries by deliberately seeking to go green by including materials like hemp and kenaf, the building sector still has a huge potential for replacing energy intensive, toxic, polluting and resource intensive products with more sustainable alternatives [10]. Products like spacers, casings, housings, decorative fixtures, ventilation pipes, furniture, kitchen utensils, handles, fans, clothing hooks, bath mats are just a few examples of products that can be made with easily degradable plastics based on organic or biodegradable plastics. Innovative products like QMilch, AirCarbon, algea based bioplastics and many other alternatives can increase the array of possible products and applications, where more sustainable plastics can replace more problematic ones.

4. Hemp industry
There is considerable potential for using environmentally friendly plastics in the building industry.

Hemp plastics is one easy to use solution in this regard, where it can be used in much of the packaging materials for building sites, and for example n products like spacers, baseboards, chair rails, door casings and crown moldings.
The hemp industry provides alternatives to pure fossil fuel-based plastics. The industrial hemp plants (which although they are in the Cannabis sativa plant family, are different from Marijuana, as it contains less than 0.3% tetrahydrocannabinol, THC, and will not create a psychoactive effect) contains cellulose fibers and shiv which is the woody core of the hemp plant. Extracting hemp cellulose from the raw industrial hemp material by crushing the stems and separating the cellulose fibers from the shiv, the cellulose can be used to make fabric, paper, concrete, bioplastics and biofuels. Utilising the hemp for cellulosic ethanol, the hemp plant provides a good alternative to the oil or sugar that is currently used for the majority of fuel.

The hemp shiv is a very porous material with a low bulk density. This makes it a good product for use in insulation both for acoustic and thermal applications [11].

The hemp industry is continuing growing and is proving its efficiency alongside eco-friendly bioplastic, bringing the opportunity to manufacture plastics products that are more earth-friendly. They are also starting to do this at a comparable price to their fossil fuel-based counterparts.

Key Features of Hemp Plastic Bioplastics:
- a near term solution to a customer’s sustainability objectives,
- colours - ‘earthy’ appearance,
- 10% lighter than many other filled plastics
- immediately Positive – Reduce CO₂ and Consume Waste,
- consume a massive and growing industrial waste problem [12].

The products feature significant improvements in CO₂ sequestration, use renewable sustainable materials, and, in some cases, are compostable and are generally designed to be drop-in replacements for conventional fossil fuel-based polymers.

The cost factor related to hemp and kenaf is currently impacted by the availability, but both plants grow very fast, have a wide array of use, and has the potential for significant economic benefits for both farmers and customers. With the highly underemphasized petroleum-sector subsidies being phased out, the costs of the alternatives could start evening out more, but there can be little doubt that the COVID-
pandemic effects on the oil prices, and the emergence of electrical alternatives for transport and heating, are not help
the sustainable alternatives. If the oil prices remain low over time, then the environmentally friendly alternatives may need help from support schemes, or fees, taxation, unless one sees the same type of consumer demand initiatives which impacted palm oil in household products in the Nordic countries [13]. Hemp has a significant potential for producing biofuel that can directly fuel the vast majority of current car types [14].

Kenaf is used in engineered wood, fibre boards, insulation, packing material and more for the building industry, while hemp is used in bricks, hempcrete, hemp wood and insulation to mention a few products. A key product for households where there could be good reasons for switching from petroleum-based plastics is growing mats for plants.

5. Conclusions

By better handling our resources, and finding materials that are good enough for their applications, rather than always over shooting for the strongest and deemed safest materials, energy, material, processing and pollution reductions can be made in the millions of tonnes annually. Many sustainable plastic types have advantages over many of the oil-based plastics in less toxicity, less allergies, less negative health consequences, reduced shrinkage when shaping and less environmental consequences when the product wear over time. Products in the building industry have a significant potential for being made from environmentally friendly and/or biodegradable plastics. These are perfectly suited for use in many indoor and limited weathering spaces in buildings, and can bring both considerable emissions and pollutions reductions and improve the indoor climate of buildings.

Changing our habits and the way we design products is possible today, and can bring substantial environmental and economic improvements for tomorrow.

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