The Bioeconomy Consultants

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Bio-based plastic: Opportunity and impact

Prepared for Bio-based and Biodegradable Industries Association

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NNFCC is a leading international consultancy with expertise on the conversion of biomass to bioenergy, biofuels and biobased products.

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1 Messages

The UK plastic industry is highly innovative, it adds considerable value to the materials it processes and is an important export industry. The production of bio-based plastic produced from sustainable renewable resources, designed for recycling or composting, can play an important role in realising the UK's 25 Year Environment Plan, its Green Industrial Revolution, and the ambition to build back better post COVID19.

- A supportive business environment for bio-based plastic could stimulate £524 million of capital investment, support 5000 jobs in the production of primary bio-based plastic and generate an aggregate gross value add of £390million.
- Government support and investment in synthetic biology and bioscience makes the UK ideally placed to develop, scale-up and capture licensing opportunities based on biotechnology.
- Establishing bio-based plastic production and value chains in the UK can act a base to capture export opportunities resulting from a growing international market.
- Bio-based plastic contributes to Net Zero. Bio-based plastic sequesters atmospheric carbon dioxide and avoids the release of fossil carbon dioxide at its end of life. The production of bio-based plastic also supports the potential of industrial biotechnology as a low carbon production technology.
- Compostable plastic in the form of bags enables the collection of food waste from households, hospitality, and the food service sector (over 2 million tonnes of which is unavoidable), it supports work towards eliminating food waste to landfill by 2030, thus avoiding climate warming emissions of methane and eliminates issues with plastic contamination of soil post food waste treatment.
- Compostable plastic provides a solution for hard to recycle food packaging items where the separation of food and plastic is difficult e.g., tea bags, coffee pods etc
- Biodegradable plastic helps to address plastic pollution, the use of biodegradable plastic in products designed for specific applications in the open environment (such as mulch films and tree guards) can reduce plastic contamination of land and sea.

2 Introduction

Plastic production is a strong and productive UK industry. It is the UK's third largest manufacturing sector in terms of employment (182,000 direct jobs), has a turnover of £25.5bn per year and exports products and materials worth over £8bn each year making it one of the UKs top 10 export sectors.[1] The plastic value chain (Figure 1) is complex with multiple stakeholders involved in the conversion of raw materials to plastic products. The value chain is completed through the recovery of materials, and their recycling into resources for further use. Plastics are cheap and easily processed, they are strong but also light materials. Plastics are highly functional, providing many benefits including a hygienic and safe, energy efficient form of packaging. However, despite the many positive attributes of plastic, it also has significant negatives. The plastic industry is essentially an oil- and gas-based industry, generating fossil greenhouse gas emissions during plastic production and when plastics are incinerated after use. It is also a highly visible cause of litter and serious source of pollution on land and in the sea. The need to address the climate impacts of plastic will only increase as consumption rises. At the current rate of market growth, plastics will account for 20% of total global oil consumption and 15% of the global annual carbon budget by 2050[1][2].

A paradigm shift from fossil-based plastic to plastics produced from renewable materials and designed to be recyclable or biodegradable (Figure 1), offers the potential to address the environmental issues with plastics while retaining its many benefits. The UK is renowned for its academic excellence and the recent investments made in bioscience and building a biotechnology and synthetic biology research community means the UK is well poised to take a leading role in bio-based technology innovation [3,4].

[1] (the budget needed to achieve the internationally accepted goal to remain below a 2°C increase in global warming).

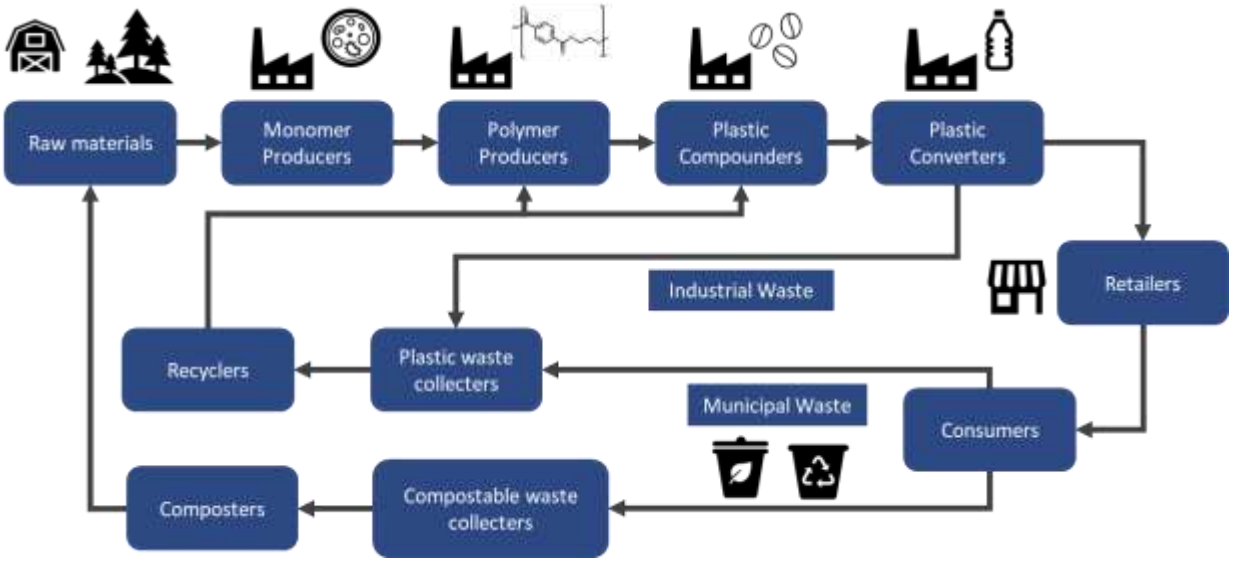

Figure 1. Plastic Value Chain

3 The opportunity

The UK plastic industry consumes around 3.3 million tonnes of raw materials per year. Approximately 1.7 million tonnes of plastics raw materials are produced domestically. The UK industry is therefore heavily reliant on imports of raw material, amounting to around 1.6 million tonnes per year [1]. Targeting 10% of this deficit for replacement with bio-based plastic raw material gives a market target of 160,000 tonnes. There is an opportunity to use domestically sourced renewable raw material to sustainably produce the materials we currently import and to develop new materials with improved function and performance. Such raw materials can also include agricultural wastes and by products, as well as using widely grown sources such as sugar beet and starches abundant in the UK and used for multiple industrial purposes, creating a new market opportunity for farmers.

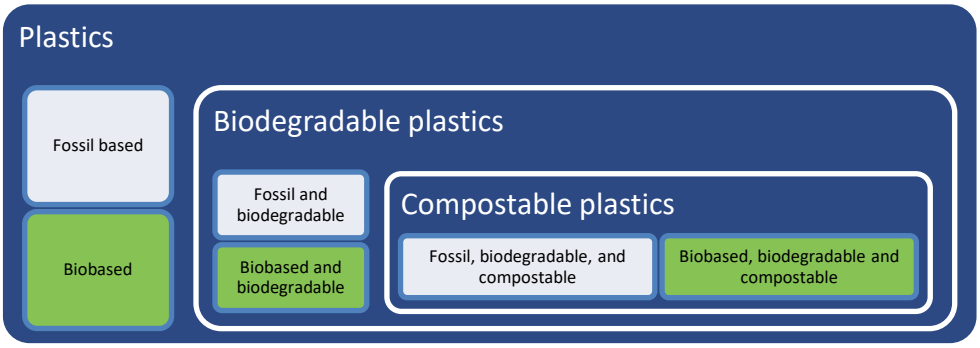

Figure 2. The position of compostable and biodegradable plastic within plastics

This 160,000 tonnes of bio-based plastic raw materials could target a wide range of plastic applications from construction and automotive to packaging or textiles. An immediate UK opportunity for the bio-based plastic sector is in the production of compostable plastics supporting the roll out of national food waste collections, reducing plastic contamination of food waste and enabling the aspiration to eliminate food waste to landfill by 2030 [5]. Compostable plastic products such as shopping bags, caddy liners, food service products and food packaging are an enabling technology which allow the efficient and effective collection of unavoidable food waste. Food waste collections will be obligatory across the UK from 2023 [5]. It provides a solution to the growing issue of soil pollution through the spreading of contaminated compost and digestate, created by the collection of food waste in durable plastic bags [6]. This is a major issue currently restricting applications for treated digestate and reducing opportunities for nutrient recycling and soil conditioning; the Environment Agency has estimated that annually around 600 tonnes of plastic fragments are spread to soils through digestate alone [6]. The compost

standard PAS100 PAS 100 allows every tonne of final compost to contain the equivalent of 150 non-compostable plastic bags, a situation which the Environment Agency has deemed unacceptable [6]. The use of compostable plastic in food applications addresses issues associated with difficult plastic-food separation e.g., tea bags and coffee pods [7]. The use of compostable plastic is supported through UK and international standards[2] since 2000 and their effectiveness has been demonstrated through real world application and testing [9]. Compostable plastic provides an effective means to keep durable plastic residues out of soil and conversely food residues out of plastic recycling plants.

Industry stakeholders believe that with appropriate legislation and a supportive business environment there is scope for domestic production of 120,000 tonnes of compostable plastic. This volume of production would support the collection of the 2.8 million tonnes of unavoidable food waste generated by UK households each year [10] and the 920,000 tonnes of food waste generated by hospitality and food service outlets each year [11] while significantly reducing plastic contamination of these streams and the associated problems in processing and durable plastic removal.

Biodegradable plastics have an important and specific role in addressing plastic contamination of land in agriculture. Each year 45,000 tonnes of non-packaging agricultural plastic, predominately plastic mulch films and silage wrap, is sold in the UK [12]. Through its use this plastic becomes contaminated, primarily with soil, resulting in the production of around 90,000 tonnes of difficult to recycle plastic waste, giving rise to issues with illegal waste disposal [13]. Additionally, these durable plastic products inevitably degrade leaving plastic fragments on agricultural land. The adoption of biodegradable mulch films[3] meeting national and international certified standards, would eliminate these issues.

4 Capital Investment

The capital investment required for chemical intermediates and polymer production is dependent on the complexity of production process, the scale of production, location and the nature of the site being developed. Disclosed and modelled capital investment values for chemical intermediate production typically range between £1000 and £4000 per year of installed capacity [15]. A value of £2000 per tonne of installed capacity is a reasonable estimate of the capital investment[4] required for a 40,000 tonne per year plant. **The total capital investment costs for 160,000 tonnes of installed capacity are estimated to be around £320 million.**

Polymerisation plants have a capital investment requirement of £1000 and £2000 per year of installed capacity. A value of £1700 per tonne is a reasonable estimation of the capital investment[5] required for a 60,000 tonne per year plant [16]. **The total capital investment costs for 120,000 tonnes of installed capacity are estimated to be around £204 million.**

The UK currently has limited conversion capacity for transforming compostable polymers into compounded final materials. Further capital investment in equipment and facilities would be required to realise the full extent of opportunity across the value chain**.**

5 Job creation

An intermediate chemical plant with an installed capacity of 40,000 tonnes can be expected to employ around 70 people (not including construction jobs) [17]. **Therefore, based on 160,000 tonnes of installed capacity, a total of around 280 jobs would be created.**

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[2] Product standard BS EN 13432:2000 [8] describes the requirements for packaging to be recoverable through composting and biodegradation. The Association for Organics Recycling operates a certification scheme aligned to the requirements of BS EN 13432 certifying that a packaging item is an acceptable input material to commercial composting systems, including those that comply with BSI PAS 100 for composted products as well as the Compost Quality Protocol.

[3] Product standard BS EN 17033 (biodegradable mulch films) for use in agriculture and horticulture specifies the necessary requirements and test methods. The standard is applicable to films intended to biodegrade in soil without creating any adverse impact on the environment.[14]

[4] Includes inside and outside battery limits investments and working capital.

[5] Includes inside and outside battery limits investments and working capital.

A polymer plant with 60,000 tonnes of capacity can be expected to employ around 90 people [18]. **Therefore, based on 120,000 tonnes of installed capacity, a total of around 180 jobs would be created.**

The total direct jobs created in the production of plastic in its primary form is therefore around 390. Applying a type II employment multiplier for the sector [19]**, the total jobs created in the production of 120,000 tonnes of plastic in its primary form would be around 5,000.**

Furthermore, a significant number of jobs will be created in the downstream compounding and conversion of plastic into final products. The majority of these jobs will be created in start-up and existing SME enterprises.

6 Economic impacts

Based on an indicative sales price of £3.11 per kg[6] for compostable plastic in its primary form this represents a direct output contribution to the UK economy of £373 million. Additionally, for every £1 increase in direct output, the economy-wide increase in output due to direct, indirect and induced impacts is £2.63, this provides an aggregate direct output of **£982 million**. The production of 120,000 tonnes of plastic in its primary form would provide a direct gross value add of £109 million; accounting for indirect and induced effects[7] gives an **aggregate gross value add of £390 million**.

7 Call to action

There a several immediate policy actions which would create a conducive business environment for bio-based plastics stimulating private investment, namely

- Treat bio-based content as equal to recycled content within the Single Use Packaging Tax or as a minimum exempt compostable plastic.
- Mandate the use of compostable food waste collection bags to avoid durable plastics entering treatment biowaste facilities and leaking to soil.
- Support the use of compostable materials for items that cannot otherwise be recycled and contain food.
- Restrict the use of durable plastic in the open environment applications e.g., mulch films and tree guards, where effective alternatives (supported by national standards) exist.
- Support capital investment in the UKs nascent bio-based plastic value chain covering new monomer and polymer production, and downstream investment in plastic compounding and converting capacity.

[6] Based on an indicative price of €3.50 per kg for compostable plastic in its primary form. Assuming no inflation in prices and an average 2020 Euro to Pound exchange rate of 1.125, gives an indictive price of £3.11 per kg [19].
[7] Based on a type II GVA multiplier of 3.58 for compostable plastic in its primary form [19].

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