Compostable packaging: replacing Expanded Polystyrene in takeaway food and drink containers

DISCUSSION PAPER

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Executive summary

Background

The purpose of this discussion paper is to understand the issues of replacing Expanded Polystyrene (EPS) in takeaway food and drink containers, and by association other materials that are challenging to recycle, with compostable packaging. A number of issues related to takeaway packaging are encountered in both urban and non-urban areas, in particular littering, with a 59% increase recorded in fast food-related litter in England between 2004 to 2015.

Other issues are evident throughout EPS' lifecycle, with environmental impacts of its production including fossil fuel use and hazardous industrial waste, and with evidence of styrene, a potential carcinogen, leaching during use and after disposal. The low weight of EPS also makes it largely uneconomical to store and transport for recycling purposes, with the result that few facilities exist. Food contamination is often an issue where recycling facilities do exist.

Compostable packaging: an alternative material

While the replacement of EPS fast food and drink packaging by alternatives such as other plastics, paper or cardboard is feasible, these all have the same issues with food contamination and recycling. Paper and card packaging can also be problematic to recycle if made of a mixture of different materials, for example coated with plastic and chemicals, and are poorly regulated as a food contact material with the potential to cause significant health risks. As such, these alternatives are also destined for landfill, or at best incineration.

Compostable products have the potential to be a viable alternative and can be made from a wide variety of raw materials which are often waste products, such as corn-starch. Being manufactured from plants they are a natural and renewable resource, have a significantly lower carbon footprint than oil-based plastics, and offer a potential key to zero waste as certified compostable products can be recycled with food waste, removing the limitations imposed by contamination. In addition, businesses that use compostable packaging could save costs through reduction of their general waste stream

Barriers to implementation of use and collection of compostable packaging

Significant logistical challenges to the implementation of collections of food waste and compostable packaging exist through the nature of the fast food industry, where the product is taken away from the premises, requiring on-the-go recycling facilities.

At present, only the Scottish Government has specific regulations requiring the separate collection of food waste, with exemptions for businesses in rural postcodes. There is therefore limited regulatory incentive to have food waste collected, restricting the ability to collect compostable packaging at all.

Where food and compostable waste is collected, the bulk is processed at Anaerobic Digestion (AD) plants. The initial treatment steps at AD plants are mechanical and remove most if not all packaging, making it an unsuitable route for effectively processing compostable packaging. Commercial In-Vessel Composting (IVC) sites are limited and gate fees are higher than those for AD plants, offering no financial incentive.

Conclusions and Recommendations

There is an urgent need to provide alternatives to single use packaging that cannot be effectively or efficiently recycled, and compostable packaging offers a realistic solution once barriers to its collection and processing are addressed.

The following recommendations are central to this:

- Incentivising the use of alternative materials through a levy on fast food packaging with the vendor retaining enough to cover additional costs if using compostable packaging.

- Facilitating structural changes in food waste collection systems to allow compostable food packaging to be fully composted with food waste.

With fast food takeaways particularly prevalent in coastal tourist areas, an initial case study centred on North Berwick highlighted many of the barriers to substituting EPS packaging with a compostable alternative. However, it also highlighted possible solutions through the identification of the key issues and could serve as a pilot study for a fully compostable town.

Introduction

The use of expanded polystyrene takeaway food and drink packaging is prevalent in most towns and cities. Many encounter a number of issues relating to this form of takeaway packaging, including littering and limited opportunities for recycling. In addition, expanded polystyrene has numerous broader environmental impacts associated with it. Using a compostable alternative could be a possible way to eliminate and reduce these concerns. This paper discusses the feasibility of such a proposal, including associated legislation and logistics. It also introduces the idea of a 'compostable town', already evident in the USA where at least two cities, Richmond, CA and Oakland, CA, have banned EPS and stipulated the use of compostable packaging as alternatives[1].

As well as being a suitable substitute for expanded polystyrene, compostable packaging could be a viable alternative to other forms of plastic packaging used for take-away food and drink, such as plastic-lined coffee cups. This discussion is therefore timely in view of recent Environment Audit Committee inquiries into disposable drinks packaging, which focused on the damage being done to the environment by such coffee cups[2], and plastic bottles[3].

Background

Expanded polystyrene (EPS) is widely used for takeaway food and drink due to its heat-retaining properties and low cost. There has been substantial growth in the number of takeaway food outlets in recent years in the UK: a survey of 205 electoral wards in Norfolk with a total population of 796,728 showed a 45% increase in the number of fast food outlets from 1990 to 2008[4]. A subsequent England-wide study found a 59% increase in fast food-related litter for the period of 2004 to 2015, indicating correlation with increases in food and drink outlets[5].

Issues with EPS are also evident during its production and use, as well as its disposal and role as a litter item in the environment. The environmental impacts of EPS production include fossil fuel use and hazardous industrial waste, with potential occupational health exposures. It is hazardous if not stored properly due to its high flammability.

There are potential occupational health hazards from the use of styrene, which is the precursor of polystyrene. The US National Research Council's 2011 National Toxicology Program confirmed it as able to be "reasonably anticipated to be a human carcinogen"[6]. Styrene also presents a hazard to consumers as studies have shown it can leach out of takeaway food and drink containers[7].

After use, EPS has an environmental impact as a component of terrestrial and marine litter. Surveys by the UK Marine Conservation Society (MCSUK) have shown it to be a consistent component of

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[1] http://www.surfrider.org/pages/polystyrene-ordinances

[2] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/657/657.pdf

[3] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/339/339.pdf

[4] Maguire,E.R., Burgoine, T. & Monsivais, P. (2015) Area deprivation and the food environment over time: A repeated cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, 1990–2008. *Health & Place*, **Volume 33**, 142-147. ISSN 1353-8292, http://dx.doi.org/10.1016/j.healthplace.2015.02.012

[5] Keep Britain Tidy (2015) The Local Environmental Quality Survey of England 2014/2015. http://www.keepbritaintidy.org/Documents/Files/LEQSE%202015/KBT%20LEQSE%20Report%202015%20web.pdf

[6] National Toxicology Program, Department of Health and Human Services: Report on Carcinogens, Fourteenth Edition. https://ntp.niehs.nih.gov/ntp/roc/content/profiles/styrene.pdf

[7] Yanagiba, Y., Ito, Y., Yamanoshita, O. & Nakajima, T. (2008) Styrene trimer may increase thyroid hormone levels via down-regulation of the Aryl hydrocarbon Receptor (AhR) target gene UDP-glucuronosyltransferase. *Environmental Health Perspectives*, **116**, 740-745.

coastal litter over the last decade[8]. Additional compounds incorporated during production can be lost from EPS once it is disposed of, along with styrene[9]. These have the potential to enter the environment either by leaching from landfill or through degradation on land, in waterways and in the sea[10] [11]. Plastics in the marine environment also adsorb pollutants from seawater, which present an additional hazard to the additives already present and their degraded products[12].

Current policies and legislation

10 million tonnes of packaging waste are produced every year in the UK. Of this almost two thirds are estimated to be recoverable, leaving a significant amount to go to landfill. Packaging waste is regulated by two sets of regulations that fall under the **EC Directive on Packaging and Packaging Waste** (Figure 1). These extend the principle of "the polluter pays", ensuring the businesses who produce potential waste take responsibility for it at the end of its life.

Figure 1: Regulations under the EC Directive on Packaging and Packaging Waste

The Producers Responsibility Obligations (Packaging Waste) Regulations 2007 place requirements on all UK companies that have a turnover in excess of £2million and handle more than 50 tonnes of packaging per annum. The amount each business has to recover is determined by three factors: the amount of packaging the business handles, the business recovery and recycling targets for the year and the activity the business carries on packaging.

The Packaging (Essential Requirements) Regulations 1998 require that packaging should be minimised, that it should be capable of recovery and recycling and that it contain restricted amounts of certain hazardous substances.

These packaging regulations leave little responsibility to small and medium businesses in how their packaging is dealt with after use.

The **EU Waste Framework Directive** sets out five steps for dealing with waste, ranked according to environmental impact. It gives top priority to preventing waste, and when waste is created, priority goes to preparing it for re-use, then recycling, then recovery and last of all disposal (e.g. landfill). Targets set by Scotland's Zero Waste Plan require 70% of all waste to be recycled and no more than 5% to be sent to landfill by 2025, with a ban on landfilling biodegradable waste from the end of 2020.

EPS is specifically recognised as a potential threat to the environment in the **Regional Action Plan (RAP) for Prevention and Management of Marine Litter in the North-East Atlantic** (OSPAR Agreement 2014-1). The UK Government is a signatory to the RAP and has stated its intention to use this as part of its obligation for reaching Good Environment Status under the **Marine Strategy**

[8] http://www.mcsuk.org/downloads/gbbc/2016/GBBC_2016_Report.pdf

[9] Mato Y (2001).Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. *Environmental Science and Technology,* **35** (2), 318-324.

[10] Manalac et al (2010) Leaching behaviour of sulfonated polystyrene (SPS) from recycled Styrofoam. *International Journal of Environmental Science and Development*, **1(4)**, 368-370.

[11] Rani et al (2014) Hexabromocyclododecane in polystyrene based consumer products: An evidence of unregulated use. *Chemosphere*, **110**.

[12] Takada H, Mato Y, Endo S, Yamashita R, Zakaria M (2006). Pellet Watch: Global monitoring of persistentorganic pollutants using beached plastic resin pellets. *Marine Pollution Bulletin*, **52** (12), 1547-8.

Framework Directive (MSFD)[13]. The MSFD obligations apply to the whole of the UK – Wales, England, Scotland and Northern Ireland. Section 49 of the RAP states that Contracting Parties should:

> *"Investigate the prevalence and impact of expanded polystyrene (EPS) in the marine environment, and engage with industry to make proposals for alternative materials and/or how to reduce its impacts."*

Disposing of EPS

Consumer behaviour change

The lowest environmental impact to remove packaging from landfill would be to substitute it with reusable containers brought by the consumer or provide returnable containers. Both would require a significant behavioural change, and in the latter case would require resources to buy, clean and store containers. Although many takeaway drink providers now encourage consumers to bring their own cups, the drinks are still often prepared in a disposable cup and then decanted. This offers less risk of the cup reaching the environment as litter but puts it into the general waste stream, to landfill or incineration.

Recycling EPS

Re-use and recycling of EPS are both possible. Some companies that manufacture EPS products can re-use it by breaking it up and grinding it back to original beads to be used again in new products. View the list of UK sites that recycle EPS, here[14].

Whilst the sites listed in the link above exist, waste plastic polymers are usually collected together as the low weight of most makes it uneconomical to collect them independently but generally recycled separately. The collection and transport of EPS are particularly problematic due to its low weight: high volume ratio, making both uneconomical unless it is compacted. A major issue with the recycling process is that the use of EPS for takeaway food or drink results in very high contamination levels, requiring extensive initial treatment to produce a product clean enough to be recycled. Many of the companies in the UK that accept EPS for recycling specify a requirement for it to be clean[15].

Incineration of EPS

Incineration is widely used in Europe to recover the high calorific value of polystyrene. The US National Bureau of Standards Centre for Fire Research identified 57 chemical by-products released during the combustion of polystyrene foam[16]. Energy from Waste Recovery facilities is regulated by environment agencies, with emissions controlled by the Waste Incineration Directive and the Industrial Emissions Directive. A recent Department for the Environment, Food and Rural Affairs (Defra) report classed Energy from Waste plants as a low source of environmental pollutants and referred to the Public Health England view that any health effects resulting from their operation would be very small[17]. However, the processes do produce hazardous waste that needs to be disposed of or

[13] DEFRA (2015) Marine Strategy Part three: UK programme of measures. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/486623/marine-strategy-part3-programme-of-measures.pdf

[14] http://www.eps.co.uk/recycling/eps_recyclers.html

[15] http://www.eps.co.uk/sustainability/eps_recyclers.html

[16] http://www.earthresource.org/campaigns/capp/capp-styrofoam.html

[17] DEFRA (2014) Energy from waste. A guide to the debate. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/284612/pb14130-energy-waste-201402.pdf

treated for reuse[18]. There have also been issues with emissions, capacities and costs, with some proposed projects discontinued for financial or planning reasons[19]. A recent EU communication on Waste-to-Energy notes that circular economy proposals to increase waste recycling would result in a fall in feedstock for incinerators, with the result that public financial support for the recovery of energy from mixed waste may be phased out[20]. This indicates that incineration of EPS is not a viable long-term solution.

Landfill

The risk of chemicals leaching from polystyrene to the environment makes landfill an undesirable disposal method even in the absence of the Zero Waste Plan's target to reduce the proportion of waste reaching landfill to 5%.

Compostable packaging: an alternative material

Polystyrene fast food and drink packaging has in many cases been replaced by alternative materials such as other plastics, paper or cardboard. However, as with polystyrene, food contamination can cause problems with the recycling of all these materials, especially if containers are used for consumption away from households and therefore away from cleaning facilities. Mixed Paper and card packaging is often complicated to recycle due to being made of a combination of materials, for example card coated with plastic. In addition, paper and card food contact materials are currently poorly regulated and may pose significant health risks[21]. As such materials are also destined for landfill, or at best incineration.

Compostable packaging has the potential to be a viable alternative and can be made from a wide range of raw materials, which are often waste materials, such as corn-starch[22].

Compostable products are:

Renewable *– manufactured from plants that are natural and renewable resources unlike oil and synthetic chemicals used to manufacture plastics;*

Low in Carbon *– Plant based bioplastics emit less than half the CO2 during production than oil-based PET plastic and sugarcane fibre (bagasse) has 99% less embodied carbon than polystyrene;*

A potential key to zero waste *– unlike conventional food service packaging, certified compostable products can be recycled with food waste and remove the limitations imposed by contamination.*

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[18] http://www.endsreport.com/article/55372/hazardous-waste-to-continue-being-landfilled-after-government-u-turn

[19] Zero Waste Europe (2015) Air Pollution from Waste Disposal: Not for Public Breath. http://www.zerowasteeurope.eu/downloads/air-pollution-from-waste-disposal-not-for-public-breath/

[20] https://ec.europa.eu/transparency/regdoc/rep/1/2017/EN/COM-2017-34-F1-EN-MAIN-PART-1.PDF

[21] http://www.europarl.europa.eu/news/en/news-room/20160930IPR44566/health-risks-of-materials-in-contact-with-food-tighter-eu-safety-rules-needed

[22] Chen, G-Q & Patel, M.K. (2012) Plastics derived from biological sources: Present and Future: A Technical and Environmental Review. *Chemical Reviews*, **112**, 2082-2099

[23] http://www.green-alliance.org.uk/resources/Novel_Materials.pdf

[24] Mooney, B.P. (2009) The second green revolution? Production of plant-based biodegradable plastics. *Biochemical Journal*, **418**, 219-232.

So-called 'bioplastics' can be rated as degradable or biodegradable as well as compostable. Standards for measuring how plastics break down are still in development but international standards have been established by both ASTM International (formerly American Society for Testing and Materials) and the Switzerland-based International Organisation for Standardization (ISO). Figure 2 below sets out the, sometimes confusing, terminology associated with the breakdown of this range of plastic materials.

Figure 2: defining degradable, biodegradable and compostable

'**Degradable'**: chemical changes take place, maybe from sunlight or heat, altering a plastic's structure and properties, like fragmenting or going cloudy.

'**Biodegradable'** requires degradation from naturally-occurring microorganisms (bacteria, fungi or algae), but does not require the products to be non-toxic or make good compost.

'**Compostable'** goes further: the ISO and ASTM definitions specify that the microorganisms' breakdown products must give "CO^2, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials, and leave no visible, distinguishable or toxic residue", such as heavy metals

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Use and collection of compostable packaging with food waste

The Waste (Scotland) Regulations 2012 require that from the end of 2016 all businesses and organisations that produce over 5kg for food waste per week and are in an urban area to present it for separate collection[27]. At present this requirement does not apply to those with a rural postcode[28]. Eventually the regulations will bring into effect a ban on biodegradable waste being sent to landfill from 2020, yet it is unclear whether exemption under a rural postcode will still apply. There are no such requirements for businesses based in England, Wales or Northern Ireland, with voluntary objectives deemed sufficient. At present all four Governments hold a voluntary agreement with food retailers and manufacturers called the Courtauld Commitment[29]. An enquiry, Food Waste in England, was conducted by the EFRA (Environment, Food and Rural Affairs) Committee was concluded in April 2017 and a report published [30]. One of the conclusions was that WRAP (Waste and Resources Action Programme) and Government should increase efforts to encourage participation in the Courtauld process. In addition, a national food waste target was recommended to ensure a continued focus on reducing food waste. Another recommendation was that Government requires food businesses and retailers to separate food waste. The uptake of both recommendations would be an important opportunity to develop a suitable infrastructure in England for collecting compostable packaging with food waste.

Based on feedback from businesses, in-house collection of compostable packaging for food and drink outlets is likely to take place separately to food waste. This would be most effective in the front-of-house accessed by customers, rather than in the service area. Although the regulations use weight as

[25]ISO 17088:2012(en) Specifications for compostable plastics. https://www.iso.org/obp/ui/#iso:std:iso:17088:ed-2:v1:en

[26] ASTM International Designation: D 6400 – 04. Standard Specification for Compostable Plastics. http://www.e2efoodpack.com/PDF/ASTM%20D%206400.pdf

[27] The Waste (Scotland) Regulations 2012 http://www.legislation.gov.uk/ssi/2012/148/regulation/2/made

[28] http://faq.zerowastescotland.org.uk/ruralsearch/

[29] http://www.wrap.org.uk/category/initiatives/courtauld-commitment

[30] https://publications.parliament.uk/pa/cm201617/cmselect/cmenvfru/429/42902.htm

a marker, waste collection vessels and charges are based on volume. For example, businesses are charged for the volume of wheeled bin and the frequency with which it is emptied, irrespective of weight. Food waste collection units are small due to the heavy weight, which contrasts with compostable packaging which is light and therefore will require large volumes. By collecting the food waste together with compostable packaging, larger bins could be used to collect food waste, with the same frequency and similar charges. Removing fast food packaging from the general waste stream would then require lower volume general waste bins. In addition, the removal of food from the general waste could enable less frequent collections, as there would be no issues with organic waste decomposition.

By the nature of the product, fast food businesses have most of their packaging removed from the premises and as such are unable to control how it is recycled. Working alongside Councils to recover any compostable packaging removed from premises could be coordinated with 'on the go' collection of both compostable packaging and food waste. 'On the go' (i.e. street bins) recycling could be located in areas where concentration is high (at the beach front, outside chip shops etc.). This could be an innovative development for 'on the go' recycling which would serve as an example to other bodies interested in banning polystyrene.

On the street (municipal) collections of compostable packaging could benefit from smart solar bins, which compact rubbish and inform when they are full. An example of this in the UK can be seen in the city of Nottingham[31] (Figure 3).

- The city of Nottingham has deployed 'BigBelly' solar powered compactor rubbish bins to replace stainless steel bins in the city centre after complaints that some street bins, particularly those near fast food outlets, overflowed at weekends.
- Each bin can hold up to eight times more waste than standard bins and sends out an alert over the cellular GPRS data network to maintenance crew mobile phones and a central office to indicate that it is ready to be emptied.
- The initial order of 130 bins was the largest outside the US at the time. There are now 170 bins in the city centre
- Overall weekly collections have reduced from 4,400 to just 260 and there have been significant reductions in the need to pick up street litter.
- Each bin costs £3,500 compared to around £400 for a standard bin – this is funded through a leasing arrangement which costs £98,748 per annum. Revenue is generated by the sale of space on the side of the bins for advertising.

Processing of compostable packaging with food waste

Food waste and compostable packaging both constitute organic material that can be used as feedstock for anaerobic digestion and composting (Figure 4). To be recovered by either process, packaging must conform to the European Standard EN 13432.

It should be noted that anaerobic digestion will not fully break down compostable or biodegradable packaging as this requires oxygen, however, it can be part of the treatment process. The behaviour of compostable plastics in anaerobic conditions varies depending on temperature, solids retention

[31] https://iotuk.org.uk/smart-bins-as-a-service-in-nottingham/

time, composition of the material, shape and thickness of compostable items[32]. The typical 8 to 12 weeks required for composting raw feedstock may be reduced to as little as 2 to 3 weeks for digestate because the material has been partly decomposed in the digestion process, making it easier for the composting organisms to break it down to stable compost. Experience in Europe has shown that the overall throughput time for material going through anaerobic digestion and digestate composting can be reduced to 5 to 8 weeks. This is a substantial reduction in time (about 40%) which produces a concomitant reduction in both the capital and operating costs for processing the same amount of material.

Figure 4: Anaerobic digestion and composting

Anaerobic digestion is the biological decomposition of organic material, predominantly food waste (with some other types of organic material) in the absence of oxygen or in an oxygen-starved environment in a fully enclosed structure. Anaerobic digestion systems can vary, for example material may be fed into a reactor in distinct batches, or in a continuous flow. The entire digestion process occurs in tanks or other sealed containers. The products are biogas (consisting primarily of methane and carbon dioxide) and digestate, the solid and/or liquid residual material remaining after organic material has been digested. The biogas is stored and can be used for any of the following: refined further into biomethane for vehicle fuel or for injection into the gas grid; burned in a combined heat and power engine to produce electricity and heat; burned in a gas boiler to produce heat for local use such as district heating or heat for an industrial process. Digestate solid fractions can be processed further on site by being put into a composting operation for further processing or used directly on land. Liquid digestate can also be used on land as a biofertiliser. In Scotland if the digestate complies with both PAS110 and SEPA's regulatory position statement on the 'Regulation of Outputs from Anaerobic Digestion Processes', it may be spread on land without waste management regulatory control.

Composting is the biological decomposition of biodegradable solid waste under controlled, predominantly aerobic conditions. Composting can be done at small-scale on-site facilities or at large-scale commercialized facilities that handle high volumes of organic material. Compost facilities can range from the very simple 'open windrows' (large heaps) to sophisticated computer controlled in-vessel composting systems (IVCs). All process compostable organics (mostly agricultural and green material) into finished compost. End uses of the compost product include: soil amendment, fertilizer and mulch. The most common markets are agriculture and horticulture markets.

In-vessel composting can be used to treat food and garden waste mixtures. There are many different systems, including containers, silos, agitated bays, tunnels, rotating drums, enclosed halls. A range of product grades are produced for various end uses such as soil conditioning. If the compost complies with PAS100 and SEPA's 'Regulation of Outputs from Composting Processes' regulatory position statement, it may be spread on land without waste management regulatory control. The compost produced can be used in a range of places including in gardens, on brownfield sites, for landscaping and in agriculture.

High quality recycling of food waste is defined in the Scottish Government's statutory Guidance on applying the waste hierarchy[33], as:

[32] Garaffa, C. & Rhodes, Y. (2012) Managing compostable bags at anaerobic digestion plants. *BioCycle*, **53**, p.37. https://www.biocycle.net/2012/09/18/managing-compostable-bags-at-anaerobic-digestion-plants/

[33] http://www.gov.scot/Resource/0042/00420711.pdf

- **Anaerobic digestion** (AD) of source segregated food waste with energy recovery and production of PAS110[34] compliant outputs.
- **In-vessel composting** (IVC) of source segregated food waste where PAS100[35] standards are met.

Not all materials are suitable for application to agricultural land meaning AD and composting cannot process all packaging materials. Some 'biodegradable' materials for example would not be suitable (Figure 2). SEPA's Regulatory Position Statements on the Regulation of Outputs from Composting and Anaerobic Digestion Processes provide the exemptions and limits for physical contaminants [36] [37] [38].

Scotland's Circular Economy Strategy indicates that Scotland could become a leader in anaerobic digestion (AD) in parallel with the drive to reduce food waste[39]. Recent figures in Scotland show 51 operational AD plants, of which 8 are classed as municipal/commercial, and 29 active composting sites[40]. On a UK scale there are 578 operational AD plants of which 100 are classed as municipal/commercial, and 169 composting sites.

Furthermore, there is concern that the use of chemical fertilisers can have negative effects on the environment. The growing movement to develop new agricultural practices without environmental costs could incorporate the use of organic fertilisers made from secondary raw materials such as food waste or compost[41]. These are expected to become more important, as the reserves of non-renewable materials such as rock phosphate are often poorly documented and may become scarce[42].

AD and composting: current suitability

A major challenge of using biodegradable packaging is keeping it separate from conventional plastics packaging. It is vital that biodegradable and compostable materials are not mixed with fossil fuel-based or biobased plastics and sent for recycling into new plastic products. Any collection and sorting scheme must ensure that all biodegradable or compostable packing cannot enter conventional plastic recycling schemes.

Screening for contaminants takes place in both anaerobic digestion and composting. In composting, this is usually carried out manually and can be relatively selective, with the result that compostable packaging can be retained if easily identifiable, i.e. by labelling or branding. In AD the initial treatment process involves automated de-packaging of the food waste, with the majority of packaging including compostable materials removed. As this is an automated function there is no facility to distinguish

[34] PAS110 is the British Standards Institutions (BSI) Publicly Available Specification for Anaerobic Digestate, to verify it is of consistent quality and fit for purpose.
[35] PAS100 is the BSI Publicly Available Specification for Composted Materials, to verify it is of consistent quality and fit for purpose.
[36] SEPA position statement: Regulation of outputs from composting processes. http://www.sepa.org.uk/media/219843/wst-g-050-regulation-of-outputs-from-composting-processes.pdf
[37] SEPA position statement: Regulation of outputs from anaerobic digestion processes. https://consultation.sepa.org.uk/operations-portfolio/food-waste-mananagement-in-scotland/supporting_documents/Regulation%20of%20Outputs%20from%20Anaerobic%20Digestion%20Processes.pdf
[38] SEPA Guidance: Food Waste Management in Scotland. https://consultation.sepa.org.uk/operations-portfolio/food-waste-mananagement-in-scotland/supporting_documents/Food%20Waste%20Management%20Guidance.pdf
[39] Scottish Government Publication 2016 Making Things Last – A Circular Economy Strategy for Scotland. 8. Recovering value from biological resources. http://www.gov.scot/Publications/2016/02/1761/12
[40] http://adbioresources.org/about-ad/ad-map
[41] Hasler, K., Olfs, H.-W., Omta, O. & Bröring, S. (2016). Drivers for the Adoption of Eco-Innovations in the German Fertilizer Supply Chain. *Sustainability*, 8(8): 682. DOI: 10.3390/su8080682.
[42] https://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/mcs-2016-phosp.pdf

between different types of packaging. East Lothian recently changed from the use of compostable bags for the collection of domestic food waste to plastic bags to enable easier removal of the packaging. The physical properties of compostable bags resulted in stretching during the initial treatment of food waste, rather than shredding. When stretched they frequently caught in machinery and required manual removal. The plastic bags used as replacements disintegrate more readily, can be easily removed with other packaging and are suitable for energy recovery from incineration.

This suggests that currently only composting is a suitable route for food waste containing compostable packaging. With a general trend towards higher gate fees for organic waste at IVCs, more organic waste is likely to be processed at AD plants where available. 2013-2014 figures showed a 1.2% increase from 411,000 to 416,000 tonnes input to composting sites, which had a capacity of 512,000 tonnes. Figures from the same timescale for AD plants showed a 40% increase from 132,000 to 185,000 tonnes, with a capacity for 246,000 tonnes[43]. The continuing trend of lower gate fees for ADs, as shown in Table 1, may account for the discrepancy in scale of increase between the two years at the different types of processing plant.

Table 1: Summary of UK gate fees: 2016 (£/tonne)[44]

Treatment	Material/Type of Facility/Grade	Median	Mode	Range
Materials Recycling Facility	All contracts (4 materials or more)	£15	£0 to £5	-£77 to £90
Organics	Open-air windrow (OAW)	£24	£20 to £25	£9 to £57
	In-vessel composting (IVC)	£46	£45 to £50	£28 to £60
	Anaerobic Digestion (AD)	£29	£35 to £40	£0 to £65
Mechanical Biological Treatment	Household residual waste	£88	£80 to £85	£66 to £170
Energy from Waste	All	£83	£50 to £55	£26 to £144
	Pre-2000 facilities	£56	£50 to £55	£26 to £90
	Post-2000 facilities	£91	£80 to £85	£50 to £144
Wood Waste	All Grades/tonne collected from Household Waste Recycling Centres (HWRC)	£35	£45 to £50	-£7 to £80
Landfill	Non-hazardous waste including landfill tax	£107	£99 to £104	£89 to £149
	Non-hazardous waste excluding landfill tax	£22	£15 to £20	£5 to £64

[43] Zero Waste Scotland (2016) A survey of the organics reprocessing industry in Scotland. http://www.zerowastescotland.org.uk/sites/default/files/2014%20organic%20survey%20Final%20%2801-07-2016%29.pdf

[44] WRAP (2017) Gate fees report 2017. Banbury, Comparing the costs of waste treatment options, prepared by Anthesis. http://www.wrap.org.uk/sites/files/wrap/Gate%20Fees%20report%202017_FINAL_clean.pdf

At present, AD is the preferred treatment method for biodegradable waste and takes about 30 days to turn food waste into energy. Compostable packaging takes 12 weeks to break down and so is considered a contaminate for the food waste process in AD plants. However, this can change if AD can become part of an integrated waste management strategy for the organic fraction of municipal solid waste and used in combination with other processes. In addition, recent research suggests that combining different compostable materials can increase rates at which items break down, and the development of materials better suited to AD treatment may not be far off[45].

Recommendations

There is potential for significant steps to be made to both reduce the impacts associated with expanded polystyrene (and other packaging materials which don't fully breakdown) and improve the current infrastructure to create a truly circular economy for food and drink packaging.

The following recommendation are intended to contribute to the existing discussions taking place on packaging and the circular economy.

1. **Expanded Polystyrene ban**: over 100 US cities and counties have implemented bans. EU legislation states that all packaging which complies with Directive 94/62 on packaging and packaging waste must be able to circulate freely in the EU, so excluding a ban in principle. However, the guide to the application of the Treaty on free movement of goods implies protection of the environment as an overriding mandatory requirement, justifying a ban[46].

2. **Expanded Polystyrene levy**: The Directive on packaging and packaging waste was amended to reduce the use of plastic bags by way of taxes or otherwise. It could also be amended for EPS packaging, with charges on single-use fast food containers being implemented. There are a variety of ways a levy could be implemented: incentivising use of alternative materials through a levy on all fast food packaging with the vendor retaining enough to cover additional costs if using e.g. compostable packaging, and for those using EPS all levy goes back to government, or an environmental levy is imposed on the vendor which cannot be passed on to customers [47].

3 **Facilitating compostable packaging collection with food waste**: implementing a 'Food on the Go' type scheme where vendors have waste bins outside their premises and sponsor waste bins at strategic points which can be collected and fed into local food waste collection services.

4. **Facilitate structural changes to food waste collection systems**: To ensure compostable materials are composted, incentivise the use of In-Vessel Composting processes as opposed to Anaerobic Digestion or Energy from Waste, for example through subsidising gate fees charged to waste companies.

[45] Narancic, T. et al (2018) Biodegradable plastic blends create new possibilities for end-of-life management of plastics but they are not a panacea for plastic pollution. *Environmental Science and Technology*, **52**, 10441-10452. https://pubs.acs.org/doi/10.1021/acs.est.8b02963

[46] European Commission (2010) Free Movement of Goods: Guide to the application of Treaty provisions governing the free movement of goods. ISBN 978-92-79-13478-4
doi:10.2769/24937

[47] Sherrington, C., Darrah, C., Cole, G., Hogg, D. (2014). Report I: Migratory Species, Marine Debris and its Management: Review Required under CMS Resolution 10.4 on Marine Debris.

Annex

CASE STUDY 1: Could a town become fully 'compostable'?

East Lothian Council (ELC) believe that returns from the waste haulage contractor used for municipal waste collections demonstrate a distinct pattern and concerns within North Berwick. There is a significant difference in the tonnage per m^3 of mixed waste between North Berwick and ELC's other 5 operational centres. This shows as 15.4 m^3 of mixed waste per tonne in North Berwick versus 6.58 m^3 per tonne average in the other 5 clusters[48]. The cubic meter figure is based on number and cubic capacity of skips and suggests that twice as much bulk is collected from North Berwick as from the 5 other clusters. The only explanation ELC have for the anomaly is the high volume of polystyrene collected from street litterbins. With a large number of businesses providing takeaway food and drink, and a busy tourist season, a polystyrene ban would be unfeasible without the use of alternative materials.

ELC have expressed interest in using cardboard as an alternative food and drink packaging, due to its ability to be compacted more readily than EPS, recycled if not heavily contaminated and biodegraded if in the environment or landfill. However, there is little cardboard packaging that is certified for use as a food contact material if it is not lined with plastic, which then affects its ability to be recycled or biodegrade. Compostable packaging appears to offer a solution to this, as being plastic-free it could be collected and processed with food waste. However, due to the fact that commercial and domestic food waste collection in East Lothian is presently processed through ADs, compostable packaging will be diverted to landfill or incineration. With a system that can successfully collect compostable packaging and food waste together, and then process them to produce compost, North Berwick could become a 'compostable town' in terms of fast food and drink packaging. This could be used as a promotional aspect of the town as a tourist destination.

It is understood that many of the take away businesses in North Berwick will have the packaging removed from the premises and as such won't be able to control the recycling of that packaging. Working alongside East Lothian council, perhaps with some funding from Zero Waste Scotland, to implement 'on-the-go' recycling for compostable packaging and food waste should be considered. Areas where concentration is high (at the beach front, outside chip shop etc.) could be a focal point. This could provide a case study from which other communities could replicate and learn from. Such a project would involve the following stages:

1. Identifying key stakeholders, agreeing project aims and objectives;
2. Getting businesses on board, and making the switch;
3. Communicating to the community;
4. Implementing recycling 'on the go'.

Keenan's Recycling, a Scottish organic waste collector based in Aberdeen and currently covering food waste collections in North Berwick, would like to see efficient processing of compostable packaging with food waste. They have expressed interest in being involved in exploring effective collection systems, including branding of packaging and collection points. At present they can only take compostable materials to their IVCs in Aberdeen, which is unfeasible for Southern Scotland. Gate fees at other sites such as Levenseat, the nearest alternative for East Lothian, are prohibitively high. Keenan's have a site in development at Linwood, Paisley near Glasgow, with which they intend to service Southern Scotland.

In early 2017, Keenan's Recycling ran a trial in Glasgow in association with compostable packaging supplier Vegware, with collections being taken to GP Green Recycling in Blantyre. The trial found high

[48] Stuart Pryde, East Lothian Council Amenities Officer, pers.comm.

levels of contamination in the collections, with all collections rejected by the receiving site. A notable finding during the trial was that businesses using Vegware were reluctant to take part. Many viewed the use of Vegware as sufficient action and were not concerned with the end of life of their packaging.

Vegware subsequently registered as a waste broker and ran a recent trial of the collection of its products with food waste from its own offices and selected businesses in Edinburgh and Glasgow. The trial was deemed successful and has led to permanent waste collection streams collecting compostable packaging with food waste. The nominated collector, Cauda Ltd, used for the trial collects dry recycling from a large supermarket chain but has space to collect food waste and is licensed to do so. Collections are again taken to GP Green Recycling based in Blantyre.

Following the trial, in September 2017 Vegware launched a composting collection service called Close the Loop which collects used Vegware and food waste for industrial composting[49]. However, there is no incentive for businesses to take part in areas designated to have a rural postcode and therefore exempt from the 2016 change in legislation requiring businesses with over 5kg of food waste to have separate collections.

A review of suitable suppliers of compostable packaging would be required. Vegware is already used locally (Case Study 3) and as a company can support businesses in sourcing suitable compostable alternatives to current products and give advice on a suitable distributer to purchase through. A possibility would be to partner with one of Vegware's existing distributers in order to reduce the impact of deliveries with all businesses sourcing from one supplier – adding more environmental benefits to the project. Vegware's initiative The Food Waste Network can advise businesses on establishing a food waste collection route for used packaging and food waste. Ideally, businesses in close proximity could all be serviced by one collector, creating a carbon friendly collection route.

Businesses in Scotland can benefit from consultation support offered by Resource Efficient Scotland, to cut costs and increase resource efficiency[50]. Funded by Zero Waste Scotland, it can help with implementing changes in small to medium sized businesses (SMEs) by offering up to 5 days consultation free of charge, provides help with grant applications and has 0% interest loans available to implement changes.

North Berwick businesses are currently exempt from the food waste regulations, independent of their size or the amount of food waste produced, due to the rural postcode classification used by the Scottish Government. However, collections are now available through Vegware's Close the Loop scheme. Getting food businesses recycling their food and compostable packaging on a town wide scale might encourage the government to reconsider the rural / non-rural classification.

CASE STUDY 2: Whynot Café, North Berwick

A not-for-profit community café in North Berwick initiated its own recycling system in 2017 for its takeaway food and drink packaging. Its owners implemented the scheme having witnessed the high levels of litter in North Berwick street bins. They consulted with their waste collector, Max Recycling, on types of takeaway food packaging that it could recycle. Suitable packaging was then sourced, at a greater cost to that being used previously.

The scheme asks customers to return the all takeaway food and drink packaging to the café, which will take it back and add it to its own dry recycling bin. The customer receives a 10% discount to be used in the café or the associated delicatessen. To cover costs of the discount and the more expensive packaging, the café has instigated a 5p increase on its coffee prices. According to the owners this has

[49] https://www.vegware.com/close-the-loop/info_50.html
[50] https://www.resourceefficientscotland.com/

not been commented on by customers. The scheme was started in July 2017[51]. Despite little take up in the first month, the owners plan to keep the scheme in existence.

CASE STUDY 3: Vegware's Close the Loop with Steampunk and Acherfield Walled Garden

Vegware's 'Close the Loop' system has been taken up by two local businesses, Steampunk in North Berwick and Archerfield Walled Garden. Both have found that using the system has encouraged them to examine their waste streams and make changes that have saved costs.

Elly Douglas-Hamilton, Director of Archerfield Estates Ltd, comments "Working together with other local businesses like Steampunk means that we can share information and ideas and start translating these ideas into practical reality. I hope this is something we can encourage other businesses in doing and help us all to realise that perceived barriers are perhaps not as great as they seem."

Furthermore, Vegware lids and cups can now technically be accepted by facilities that process garden waste across the UK, although they will announce when consumers are able to use this option on a region by region basis [52].

SUCCESSFUL EXAMPLES

New York City EPS ban

New York City's Mayor, Bill de Blasio, announced that from January 2019 a ban on all EPS products will go into effect. This means that manufacturers and shops will be unable to sell products such as food trays, clamshells or cups anywhere in the city, as well as 'packaging peanuts', without incurring penalties as a result.

Mayor de Blasio expressed that "there's no reason to continue allowing this environmentally unfriendly substance to flood our streets, landfills, and waterways"[53].

Oxford county reusable cups

Keep It Green for Oxfordshire sells reusable cups through Beanbags Coffee company and all profit goes towards supporting environmental initiatives. Cafes and restaurants who buy the reusable cups receive a free window sticker to show that they support the country-wide campaign.

Freiburg city reusable cup scheme

FreiburgCup estimated that around 300,000 disposable cups were consumed every hour in Germany, each one being used for an average of 13 minutes, before being thrown away – usually to landfill.

As a result of these statistics and the ubiquitous influx of takeaway cups in the city, Freiburg embraced a voluntary scheme of reusable cups through a deposit-return scheme. This scheme asked customers to pay €1 for a reusable cup, which they can take back to any one of the 100 participating business.

Seattle disposable packaging

In 2009 Seattle introduced a ban on the use of EPS products. Since then, the city has continued to lead by example with disposable food and drink receptacles. A further ban on non-recyclable and non-compostable food packaging was brought into effect in 2010, and the recent ban on all plastic straws and cutlery in July 2018 has demonstrated their continued commitment.

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[51] http://www.eastlothiancourier.com/news/15423416.Bid_launched_to_tackle_town___s_food_litter_issues/

[52] https://www.vegware.com/news/2018/07/31/newsflash-vegwares-cups-lids-now-allowed-at-uk-garden-waste-composting-facilities/

[53] https://www1.nyc.gov/office-of-the-mayor/news/295-18/mayor-de-blasio-ban-single-use-styrofoam-products-new-york-city-will-be-effect

The City of Seattle requires that all food service businesses must use either compostable or recyclable packaging, provide suitable bins for staff and customers, and are signed up for their waste to be collected by a suitable service provider.

Bern's Bring Back Box

In the Swiss city of Bern restaurants that support the Bring Back Box scheme charge consumers a 10-franc (£8) deposit for a solid, reusable plastic takeaway box. When customers have finished their takeaway meal, they return the box to any participating restaurant so they can be washed and redistributed, and they will receive their 10-franc deposit back.

What next?

To encourage North Berwick to look at available solutions and alternatives, Fidra is acting as a catalyst for change, alongside other businesses, community groups and individuals. Through this collaboration, an event, 'Waste Expectations: Trash Talk with Businesses', was held in January 2019 which brought together a variety of stakeholders throughout North Berwick.

You can download and read a summary of this event on Fidra's Food Packaging webpage, here.

As a result of the discussions that took place at this event, a number of solutions that the town could use to transition away from the use of unsustainable materials in takeaway food and drink receptacles were suggested. This included a reusable cup scheme (similar to the FreiburgCup mentioned above); compostable products to be implemented with a town-wide collection of compostable waste; and a Steering Group to oversee such a project.

If you would like to be involved in this project, please get in touch with Fidra on info@fidra.org.uk.