Sancroft

Making food waste collection effective and efficient while protecting and enhancing the nation: choice of liners for food waste collection

As DEFRA designs the new waste collection system for England, we are faced with the opportunity to shape the future we want, or find ourselves locked into an ineffective, unsuitable system for decades to come. We have prepared this paper to provide evidence to help in decision making on the most effective solutions. This research for this paper has been funded by the members of the Bio-Based and Biodegradable Industries Association, Novamont, Sphere Group, Compostable Bag Company, Cromwell Polymers and Biome Biotechnologies, but the conclusions are our own, based on an objective review of the evidence.

We believe the overall aim of any waste collection and treatment system should be creating the most value for the nation and minimising costs across collection, treatment and the damage to ecosystems and human health that waste can create.

Therefore, to help evaluate the options for the nation, we have outlined the principles we believe any option would need to meet. Combined, these should ensure smooth running of food waste treatment in the existing Anaerobic Digestion (AD)-led system and a pathway for it to scale up with universal food waste collections to achieve even better yields and outputs.

Principles for managing food waste:

1. **Cost effective in collection and treatment:** the system must find efficient and effective ways to collect food waste that balance direct costs on local authorities with long-term systems costs.
2. **Encourages collection of high volumes of food waste:** bringing the wide range of benefits, from reducing costs of landfill and incineration in residual waste, to re-using bioresources and reducing methane emissions from decay in landfill.
3. **Encourages collection of food waste with little contamination:** the system will be more efficient and effective if contaminants are reduced, by supporting a simple system that can be easily communicated to households
4. **Minimises agricultural and health risks for the nation:** contaminants like plastics, especially hard to separate microplastics, have an impact on soils and plants. While full evidence for the long-lasting impact is not yet available, the risk of constantly increasing quantities of plastics in soils - and the risk this could create to human and animal health from their ingestion - require a precautionary approach (see below for the ongoing academic research).
5. **Minimises GHG emissions:** through combustion and waste management.
6. **Increases circularity, including returning nutrients and organic carbon to the soils:** it is a stated aim of the government to move "towards a more circular economy". Composting, alone or in tandem with AD, as a form of recycling, is preferable to landfill/incineration. The nation's soils are degrading and it is important to return nutrients and organic carbon, to improve crop yields, reduce inputs from non-renewable resources, and support carbon cycles within soils and their resilience.

Based on these principles, we have evaluated options for collecting domestic food waste, using different choices of liners (or no liners) for household caddies, to understand the most effective option. Focus is on AD as the current preferred policy option. In-Vessel Composting (IVC) is covered briefly – though changes in incentives would alter the picture. The cost modelling is contained in the attached Excel file.

	Low cost for taxpayers: includes liner costs and collection/disposal costs	**Encourages collection of high volumes of food waste**	**Encourages collection of high quality of food waste**	**Minimises risks for the nation**	**Minimises GHG emissions**	**Increases circularity, including returning nutrients and organic carbon to the soils**
Polyethylene bags, sent to AD, separated bags/adhered food sent to energy from waste	Variable costs: **£25/tonne** of food waste (Liner costs plus separation/ disposal costs of liners and contaminants)	Simple approach, supports collection	Having plastic in collection makes it challenging to tell households not to include plastic in caddies, studies indicate this increases contamination[1]	Increases amount of plastics into the soil. Weaker messaging and compliance will increase other contamination	Significant amounts of plastics filtered out then sent for incineration	**76% recycling** of original food waste No composting, only digestate, controls required to limit ammonia emissions and on digestate application to avoid pollution of water courses
Compostable biobags sent to AD, separated bags/adhered food sent to IVC	Variable costs: **£28/tonne** of food waste (Liner costs plus separation/ disposal costs of liners and contaminants)	Simple approach, supports collection	Clear messaging enabled: only food waste and compostable materials in caddies	Fully composts liners, messaging supports avoidance of other plastics	Minimises incineration of waste	**86% recycling** of original food waste Digestate from food waste and food adhered to bags contributes to compost production
Paper bags, send to AD, bags shredded alongside food waste and digested within AD	Variable costs: **£42/tonne** of food waste (Liner costs plus separation/ disposal costs of liners and contaminants)	Bags degrade much faster making them harder to handle during collection and not preferred by users	Clear messaging enabled: only food waste and compostable materials in caddies	Fully composts liners, messaging supports avoidance of other plastics	Minimises incineration of waste	**86% recycling** of original food waste (likely lower due to compliance issues mentioned). Digestate from food waste and food adhered to bags contributes to compost production
Naked - no use of bags/liners in household caddies, waste sent to AD	Variable costs: **£77/tonne** of food waste. (Related to low collection, more food waste to residual stream and inefficient collection)	WRAP estimates this leads to **50% less food waste collection** after 3 years, which undermines the purpose of the whole system[2]	Clear messaging enabled: only food waste, no packaging, no bags/ liners	No liner to compost, messaging supports avoidance of other plastics	Significant reduction in amount of food captured means high GHG emissions from methane breakdown in landfill/greater risk of toxic emissions from combustion	**43% recycling** of original food waste - low food waste yields mean more landfill of food, significantly reducing circularity
Compostable biobags sent to IVC	Higher costs for IVC under *current* incentive structure (**£45/tonne** gate fee vs **£27/tonne** for AD)	Simple approach, supports collection	Clear messaging enabled: only food waste and compostable materials	Fully composts liners, messaging supports avoidance of other plastics	Minimises incineration of waste	Slow release of nutrients and higher quantities of organic carbon to the soils compared with digestate, lower ammonia emissions and nitrate challenges compared with AD

As can be seen from the analysis, the most promising option appears to be compostable bags, sent to AD then separated out and sent to IVC. Below is the evidence this draws on – we have focused on the variable costs that can be modelled into the system, since we know this is critical for DEFRA and is always a priority. First, we wanted to highlight the challenge of plastics pollution, which is a risk too big to ignore.

[1] https://www.eunomia.co.uk/reports-tools/relevance-of-biodegradable-and-compostable-consumer-plastic-products-and-packaging-in-a-circular-economy/.
[2] As referenced in the Defra 'Consistent municipal recycling collections in England Impact assessment', p.55 https://consult.defra.gov.uk/environmental-quality/consultation-on-consistency-in-household-and-busin/supporting_documents/recycleconsistencyconsultia.pdf

Critical context: the risk of plastics contamination to soils

Plastic contamination in food waste is a source of plastic pollution to soils, from the digestate and compost created.

We know that compost and digestate is contaminated with both smaller and larger pieces of plastic. Our particular focus is that of microplastics, because these tiny fragments are almost impossible to remove once they have entered soils and which, due to their size, can easily be ingested by a range of animals and plants, having potentially damaging results. For consistency, we use the European Chemicals Agency definition of microplastics as those where all dimensions are between 1nm and 5mm. Whilst we focus on microplastics, we know that visible plastic contamination is also passing into soils through contaminated compost and digestate.

There are currently some safeguards to reduce plastic contamination e.g. PAS 100 standards which limit plastic contamination where those pieces/fragments are 2 mm and larger – and recommendations that these limits are tightened, like in Scotland. Existing AD, compost and IVC plants have processes in place to screen and filter materials to help reach these standards. However, this does not solve the issue, both because fragments below 2mm are not covered and since not all compost and digestate is currently certified to these standards. Therefore, the more non-compostable plastic that goes into food waste – including the plastic caddy liners for collecting food waste – the greater the risk. This is why using Polyethylene (PE) liners for caddies in food waste – which fragment but then do not biodegrade – creates a great risk of plastic pollution, especially where they confuse the message about putting plastics into food waste.

One particular challenge is that of microplastics in soils – tiny particles created when plastics fragment during processing and attempted removal, which are then almost impossible to remove once they have entered soils. The impact of microplastics in soils is a subject of significant ongoing research. The challenge is that we are aware of some risks, as we have identified below, but that we do not yet have complete, holistic evidence – as many studies are currently ongoing. We should employ a precautionary principle and work to reduce potential environmental burdens and risks.

However, every year that goes by as a nation, we are permitting more plastics to enter the soils which will not naturally degrade, compounding the problem for every year after it is obvious we will never be able to remove those plastics.

Therefore the risk requires evaluating and precautionary measures - and is worth guarding against, especially when our findings suggest that using compostable bags, which would eliminate the risk from the use of plastic bags, has either marginal or net neutral impacts on system costs. Unless action is taken, we knowingly keep polluting the soils we rely upon for food production.

In 10 years' time, after another decade of compounding the issue – likely increased by arrival of universal food waste collection, therefore more processing of plastic bags – we could have done irreparable harm to our many agricultural areas throughout our country.

Here we offer a hypothesis to help understand the implications. Studies already suggest potential impacts on crop yields e.g. where microplastics impede germination (see below for

details). So, what if this plastics contamination of soils reduced agricultural yields by even 0.1%? This 0.1% is not derived from any single study as the data is still being gathered and analysed to understand the true impact but is used as an indication for the type of result possible. The NFU estimates that agricultural production was worth £23.85 billion to the UK economy, so even at a 0.1% reduction, this would be a £23.85 million cost to the economy every year, that would likely increase and compound annually.

Microplastics impacts on organisms – examples from ongoing research:

- Research currently being submitted from Staffordshire University is exploring the way microplastics in soil can delay the germination time of some plants, potentially leading to a reduction in survival or increase in the volatility of crops, with likely negative impacts on crop yields.[3]
- Microplastics are now found within edible crops.[4] While the impact of ingesting microplastics on human health has not yet been established, there are many causes for potential concern related to organ function, leached chemicals etc. with many ongoing studies examining these potential threats.[5]
- We should recall that consumer plastics often contain bromides, chemicals that are both carcinogenic and damaging to our endocrine systems. As plastic bags (including those used for food waste collections) can be obtained from 100% recycled plastics, we have no way of knowing which potentially toxic substances they may contain and which may therefore be leached to soil and into the water and food systems.[6] Currently non-compostable plastic bags are allowed for collecting food waste in some areas based on local decision making. If this policy were to be continued, at a minimum they would need to meet strict standards for being non-toxic to soils, like those that have been established for compostable products.
- We have already seen the impact on animals, which could impact ecosystems that sustain our crops – for instance microplastics in crustaceans lead to a decrease in reproductive rates.[7] Other impacts have also been found on land-based animals - microplastics in soils lead to a reduction in size and weight of earthworms - with potential implications for soil structure that affects plants.[8]
- Meanwhile there are concerns that plastics can have significant impacts on complex animals – potentially endangering human health, not to mention our livestock. Nanoplastics have been found to pass the blood-brain barrier and have a behaviour-changing impact on fish.[9] We also know that additives such as phthalates can leach

[3] Paper forthcoming, discussed in conversation with the Forensic Fibres and Microplastic Research team at Staffordshire University who are currently collaborating with the National Farmers' Union on research projects to better understand the impacts
[4] https://www.sciencedirect.com/science/article/pii/S0013935120305703
[5] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7068600/
[6] https://www.researchgate.net/publication/317264386_Bromine_in_plastic_consumer_products_-_Evidence_for_the_widespread_recycling_of_electronic_waste
[7] https://royalsociety.org/-/media/policy/projects/microplastics/microplastics-evidence-synthesis-report.pdf
[8] Ibid.
[9] https://www.igb-berlin.de/en/news/underestimated-threat-land-based-pollution-microplastics

out of plastic particles and that these can disrupt the hormone system of vertebrates and invertebrates.[10]

Estimates for cost impact

Overview:

The full model for cost impacts can be found in the supporting Excel document. This lays out the assumptions that look to define how the systems cost would vary based on the different models.

The variable costs are the ones that differ between the options – the main variable costs that drive the model are:

- The cost of the liners
- The cost of disposal of extracted liners by incineration (for PE bags - £89/tonne)
- The cost of treatment of extracted liners via IVC (for compostable plastic bags - £45/tonne – offsetting higher liner unit costs)
- For the no liner option, the reduction in household participation and therefore higher levels of food waste stent to energy from waste and higher collection costs.

Where costs and benefits are incurred equally e.g. gate fees for AD plants, total biogas generation, finding outlets/markets for digestates, they are not included since the focus here is upon what is different.

Note these costs rely on the gate fees for IVC/energy from waste as reported by WRAP – and so can be easily updated when new figures come out. We believe that energy from waste costs in particular have risen recently, which will make the PE liner option more expensive.

It should be noted that a major benefit of effective universal food waste collection is in making other waste streams cleaner and easier to manage. This is true across almost all the modelled options – however the option of no liners is associated with weaker participation from households, based on WRAP research, so there are additional costs here related to a higher proportion of food waste arisings being put in residual rather than food waste bins. [11]

Assumptions around AD/IVC and their interaction

Given the variety of different AD models available and in operation in the UK, we have taken the approach of using average industry level figures, rather than modelling on the basis of a small number of individual sites. Given we are reflecting the UK, we have therefore not explicitly considered scale use of dry AD (high solids AD), since it is not currently a scale solution in the UK, as reflected in the industry average figures.

This focuses on AD rather than IVC, as AD is the preferred policy option for separately collected food waste across the nation. There are significant benefits to using IVC as an alternative to AD, or as a second step for the digestate output from AD – including the benefit

[10] https://www.unenvironment.org/news-and-stories/story/plastic-planet-how-tiny-plastic-particles-are-polluting-our-soil

[11] As referenced in the Defra 'Consistent municipal recycling collections in England Impact assessment', p.55 https://consult.defra.gov.uk/environmental-quality/consultation-on-consistency-in-household-and-busin/supporting_documents/recycleconsistencyconsultia.pdf

of compost in returning organic carbon to soils and avoiding some of the challenges in managing storage and use of liquid digestates, such as ammonia emissions and restrictions on where and when it can be applied to farmed soils. However as this modelling here is focused on the economics for the majority of the system, and since IVC gate fees are currently c. £45 per tonne median compared with c. £27 per tonne median for AD, this is a separate and more fundamental discussion around incentive structures.[12] For instance there are various incentives which influence how we manage organic waste - where incineration has incentives for biomass burning, AD has incentives for biogas production but where there are not comparable incentives for composting. These could be given by recognising the value compost can create in delivering organic carbon to soils, restoring soils and improving their resilience, and acting as a significant carbon pool and weather-condition responsive part of our ecosystems which support plants. Were incentives to be reviewed again and give the issues covered in this paper higher weighting, the economics could change significantly. However as this is a complex discussion, we will not enter further into it here.

Needless to say, the findings for the difference in liner material will hold true for IVC - in fact they will even more heavily favour compostable liners, because IVC plants are generally not able or willing to accept waste in plastic and compared with compostable liners going to AD plants, separation costs would be lower as there would be no need for additional separation and treatment costs for these liners.

The model for compostable bags assumes a system where AD operators are able to trust that compostable bags have been used, therefore are worth extracting – which requires mandating the use of compostable bags. Otherwise if they suspect PE liners are still used, they will extract and burn all bags. Moreover, IVC plants will be unable to accept mixed compostable/plastic bags. Using compostable bags creates more flexibility in the system as the food waste can then be sent to either AD or IVC, meaning if policy positions change or there are innovations in processing technologies that change the cost equation, it will be easy to quickly adapt.

This also has potential benefits regarding the high costs of collection – as food and garden waste could then be collected in the same vehicle at the same time and sent on to IVC, rather than requiring two separate collections. Since we know from WRAP studies that household separation of food and garden waste results in higher quantities of food waste collected, the message to households can still be the same, but the processing can vary based on economics.[13] For instance if food waste is collected once a week and garden waste is collected once every two weeks, there could be a dedicated food waste collection one week and a comingled collection the next week, with no difference in experience for households, but where local authorities have the flexibility to choose the most cost-efficient option. Therefore, mandating the use of compostable bags in all food waste collection will support consistency in messaging for households (all households everywhere only use compostable bags, there are no variations in some using PE, some using compostable) in line with the principles of

[12] Note the gate fee for IVC used is the figure for food only based on contractors, rather than food only based on local authorities, since the local authority data is a small base, skewed to Scotland, where the contractor data skews to England, which is more appropriate for this study – see pp.9-10 https://wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf

[13] Higher food waste yields if separate food waste collections vs mixed with garden waste – see p.3 https://www.wrap.org.uk/sites/files/wrap/HH_food_waste_collections_guide_section_3_how_much_can_be_collected.pdf

consistent collections that DEFRA is also looking to achieve, which is in turn likely to enable better compliance.

Impacts that could not be modelled directly

We have also relied on the best available data but have flagged where the results may be even more pronounced than we calculate. For instance we are aware from conversations with industry experts that paper bags tend to result in lower compliance as they split regularly – reflected in the fact that they are not a choice at scale in other markets, unlike PE and compostable bags. However, since there were not specific figures for the reduction in yield (as there are for having no liners), we have not further reduced the yield associated with paper bags.

As indicated in the summary, there are studies that indicate that using compostable liners, rather than PE liners, reduces overall levels of contamination with plastics – it allows for clearer messaging and a more intuitive understanding that no non-compostable plastic should be put into food waste caddies. Quoting from a European Commission study on the matter[14]:

> *[T]here are indications that compostable bags reduce contamination and increase participation. The following examples of this are from two countries that generally have a low acceptance of compostable plastic and therefore the results may be more instructive. […]*
>
> *Research for the City of Copenhagen and a test study for the Danish Environmental Protection Agency comparing compostable and fossil-based plastic bags found that the compostable plastic bags have the following benefits:*
> - *The food waste collected with a compostable bag is less contaminated with other materials; […]*
> - *compostable bags provide a good signal to citizens to sort the food waste correctly*
>
> […]
>
> A recent study was performed by the Witzenhausen Institut in Germany where 13 cities and municipalities were examined for the factors which affect compost quality from household organic waste. One of the main conclusions was that:
> *"The widespread fear that the admission of biodegradable bags leads to an increase in impurities could not be verified during the analyses. On the contrary, the admission of biodegradable bags resulted in fewer impurities in biowaste."* (translated from German)
>
> The difference between municipalities that discourage or ban composable bags and those that recommend them is around a 30% decrease in impurities for the later. However, as this was a survey of existing practice it is not entirely certain that other factors do not contribute to this difference.

Since this 30% reduction in contamination is not certainly applicable at that level in an England context, we have not modelled it in directly. However if we did use that to increase the level of

[14] https://op.europa.eu/en/publication-detail/-/publication/3fde3279-77af-11ea-a07e-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=41957&WT.ria_f=5702&WT.ria_ev=search

contamination in the PE collected model by 30%, the system costs of PE liners would exceed that of compostable liners given the additional costs of disposal of more contaminants (£31.95/tonne of food waste for PE liners vs £28.21/tonne of food waste for compostable liners). This is not to mention the benefit of avoiding further contamination of plastics into soils.

We have seen Epsom & Ewell borough council suggest that compostable bags are harder to extract than plastic bags – but do not provide any figures for the cost, so this cannot be modelled.[15] Additionally, given the range of sites across Europe that are able to extract compostable bags, we believe this is a technological challenge related to existing processing that can be fixed as part of significantly upgrading the infrastructure in England to cope with the 3-4x increase in food waste that will be collected when collections are mandated.

Compostable bags also enable the use of ventilated caddies (which cannot be done with PE bags), which have a wide variety of benefits. We have not modelled this since use of ventilated caddies is not universal and data here is more indicative. These allow food waste in kitchens to dry out which has the benefit of reducing odour, slowing initial anaerobic digestion so biogas yields are better and reducing weight through evaporation by as much as 30% in a few days.[16] This means lower collection costs as the weight and bulk transported is lower, without a loss of any of the biogas potential/nutrients, as it is simple removing a fraction of water.

Following recent announcements about the new Plastic Packaging Tax which will apply from April 2022, government also intends to apply the tax to all liners that do not have at least 30% recycled content and not to exempt compostable liners. The renewable, bio-materials they are made from are not recognised for an exemption under this tax but government does intend to review this initial position it has taken. We have not modelled in this additional cost for two reasons.

- Firstly, because the net costs to taxpayers and the system are neutral – if bags are funded by the taxpayer, then these bags will likely cost more on account of the tax as manufacturers pass on some of the costs, which taxpayers will pay – but the value of the tax will be paid back into the Treasury, so there will be no net cost.
- Secondly, because there is no guarantee that the PE bags would or would not be exempt from the tax – as highlighted above, recycled material in PE liners at the moment can be made from plastic recycled after uses that could result in the carry through of ecotoxic substances to soils e.g. plastic bottles containing engine oil. If these PE liners had to meet guaranteed non-toxic standards, it is not clear whether they would therefore be able to use at least 30% recycled content and therefore whether or not they would be liable to the plastic tax.

The summary is shown over the page.

[15] https://www.epsom-ewell.gov.uk/why-it-ok-put-plastic-bags-food-waste-not-green-recycling-bin
[16] https://www.bpf.co.uk/topics/compostable_bags_for_organic_waste_collection.aspx

Summary:

	Overall variable costs per tonne of food waste	% of original tonne of food waste that is recycled/circular (vs incineration/ landfill)	Other costs that are harder to quantify	Conclusions
PE bags, sent to AD, separated bags/adhered food sent to energy from waste	£25.42	75.53%	Gate fees for energy from waste may be even higher since adhered food waste is wet and inefficient for energy from waste - unless there was an additional dewatering phase before disposal. Contamination under this scenario could be even higher. Using non-compostable plastic bags (e.g. PE) limits the ability to make strong and clear arguments around the need to have no non-compostable plastic contamination in kitchen caddies and food waste bins, since people see there is already plastic in there. As food waste collection scales up and becomes expected of all households, the contamination challenge is expected to grow, so anything that further increases risk of contamination needs to be addressed.	Closest to the current system - appears slightly cheaper, but is significantly less circular, making it harder to meet ambitions and hit recycling targets, reducing the nutrient value of digestate and increasing the gas scrubbing burdens on treatment steps that control emissions to air from Energy from Waste facilities. At the same time, it ignores the cost and risk to soils from plastics contamination.
Compostable biobags sent to AD, separated bags/adhered food sent to IVC	£28.21	85.70%	Greater potential to reduce contamination of plastics and non-compostables, by allowing significantly clearer and simpler messaging on adding no non-compostable plastics to caddies (compared to requiring no non-compostable plastics, but clearly using non-compostable plastics as the liner). Further cost reduction potential from allowing ventilated caddies that better retain biogas potential while reducing weight for transport.	The overall logical choice - based on current technology and standards, costs are almost equivalent to PE bags, while delivering a much more circular solution that supports a healthy bioeconomy where all resources are returned to the soil, avoiding the need for creating carbon-intensive fertilisers and burning valuable nutrients. It also guards against the significant risks of plastic pollution to the soil. In addition, when there is a higher volume of compostable plastics produced, this so far nascent industry will be able to reduce unit costs further by developing economies of scale.
Paper bags, shredded alongside food waste and digested within AD, no IVC or energy from waste	£41.81	85.70%	Additional costs to transport and store, because paper is significantly bulkier and heavier than compostable biobags and PE bags. Faster degradation of paper liners is likely to result in more liners being used and swapping them out more frequently. Increases costs related to cleaning as the bags are more likely to soak through and break. This will also likely reduce the level of participation of households as they are judged messy and dirty, therefore reducing the yields of food waste. Note this would be important to model but given that these bags are generally not considered suitable, there is little use and therefore no available data to model the impact.	Significantly more expensive, while not being a functional choice during collection given the degradability of paper and likely lower yields of food waste.
Naked - no use of liners in household caddies, waste sent to AD	£77.21	42.85%	Additional costs to wash home caddies, containers, trucks etc. at every stage of the journey and increasing health hazards related to exposure to mouldy food for workers in the supply chain.	Significantly more expensive since it undermines the aims of simply and efficiently collecting a large amount of food waste and diverting that from landfill, and efficiently turning it into valuable biogas through anaerobic digestion.

Note we have not taken into account co-mingled collection of garden and food waste because this waste will go to IVC where the use of compostable bags is notably preferable.

Ensuring collection of high-quality food waste with minimal contamination

Contamination is a serious challenge for any waste stream. Low contamination requires strong separation, collection and compliance on behalf of households. Given that citizens are very confused about how and what they should recycle, about the differences between conventional plastic, compostable plastics, biodegradable plastics, oxo-degradable plastics, and oxo-biodegradable plastics, simplicity and clarity are needed to ensure effective compliance.[17]

If there is uncertainty, or loss of faith in the recycling system as a whole it will set the entire recycling cause back significantly. Given popular limited understanding of recycling, even if this loss of faith applied only to the conventional dry recyclables stream, or to only the organic recycling system for biodegradable waste, they could both be adversely affected as all recycling could be tarred with the same brush. This would lead to significant additional costs and inefficiencies for all, for instance as user willingness to cooperate in segregating waste decreases if they do not trust the outcomes. We have already seen challenges raised – from the difficulty of obtaining accurate figures, to perceptions of the general public that recycling 'does not actually happen', that 'little is recycled' (in spite of robust evidence to the contrary, including in the organics industry) and that the problem is 'simply shipped overseas'.[18]

In this context, we cannot afford a system that confuses people further or alienates users. So, when we want to reduce plastic contamination in food waste, but collect it in plastic, it becomes hard to justify and communicate simply why plastic cannot be included in food waste collection. Therefore, avoiding any use or allowance of plastic bags is important.

Similarly, when there is confusion over compostable plastics and other types of biodegradable plastics, consistent and simple labelling and standards are needed both across the whole market and especially for any liners that are procured by local authorities, to ensure everyone can trust and choose the right materials. An appropriate standard to reach could be: compostable (BS EN 13432 or BS EN 14995), soil biodegradable (post digestion, to accommodate digestion in AD facilities which do not have a following composting phase and which might not arrange with an IVC facility to compost liners the AD operator has front-end removed).[19] Additionally, in following the direction of the Plastic Packaging Tax to drive plastics to have at minimum 30% recycled content, these materials could be specified to have at least 30% bio-based content – representing a renewable, infinitely recyclable material input.

[17] https://www.complydirect.com/news/inconsistencies-mislabelling-and-confusion-the-issue-with-recycling-in-the-uk/ ; https://environmentjournal.online/articles/public-warned-not-to-confuse-compostable-and-biodegradable-bags/

[18] https://www.telegraph.co.uk/news/2018/07/22/uk-recycling-system-open-fraud-error-watchdog-warns/ ; https://www.theguardian.com/environment/2019/aug/17/plastic-recycling-myth-what-really-happens-your-rubbish

[19] Current rules applicable to waste-derived digestates that achieve product status include that biodegradable liners/bags used for collection of food wastes must be independently certified compliant with BS EN 13432, ASTM D6400 or DIN V 54900, while similar rules for compost products derived from wastes require that compostable packaging and plastic waste items fed in are independently certified compliant with BS EN 13432, BS EN 14995 or ASTM D6400. These rules were reviewed by the Environment Agency in 2020 and revisions expected in 2021 may include updates on acceptable packaging and non-packaging items and alignment with what will be allowed under new permits to operate composting and AD facilities.

Conclusion:

The evidence shows that the most cost-effective option that delivers the biggest benefits for the nation is the use of compostable bags as a liner, as the most effective balance of reasonable costs, minimisation of plastic contaminants in the biodegradable waste stream and maximisation of total food waste collected and processed. Based on that logic, the priority is first compostable bags, then paper bags, then lastly no bags and PE bags, since both have significant downsides whether in plastics contamination or poor yields and high GHG emissions.

We hope that this analysis will prove a helpful support in reaching the ambitions and targets for a circular economy, balancing a challenging budget and protecting the land and human health from the potential threats of increasing plastic pollution.