Feasibility Assessment and Implementation Analysis for Low Emission Packaging

Candidate: 5688E

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1.Summary

In the previous poster, I have outlined the proposal of transition from the traditional food/drink packaging (glass bottles, HDPE/PET plastic containers) to more sustainable packaging solutions. (Tetra Pak style cartons, Canadian style milk bags, new polymer/paper based flexible packaging etc.)

The following report will give more detailed analysis on the feasibility of this proposal, evidence for the achievable carbon emission reduction, and studies on shareholder reactions/implementation pathways.

2.Life Cycle Assessment (LCA) on food/drink packages [1]

A ***comprehensive life cycle assessment*** of consumer packaging for food/drink and analysis on global warming potentials (CO_2 equivalent) of different packaging was carried out by a reputable French sustainable development consultancy.

The total emission of different packaging quoted below will include all carbon emission within ***system boundaries***, including package production from raw materials, distribution (to wholesaler, to retailer, to consumer), consumer usage, end of life disposure etc.

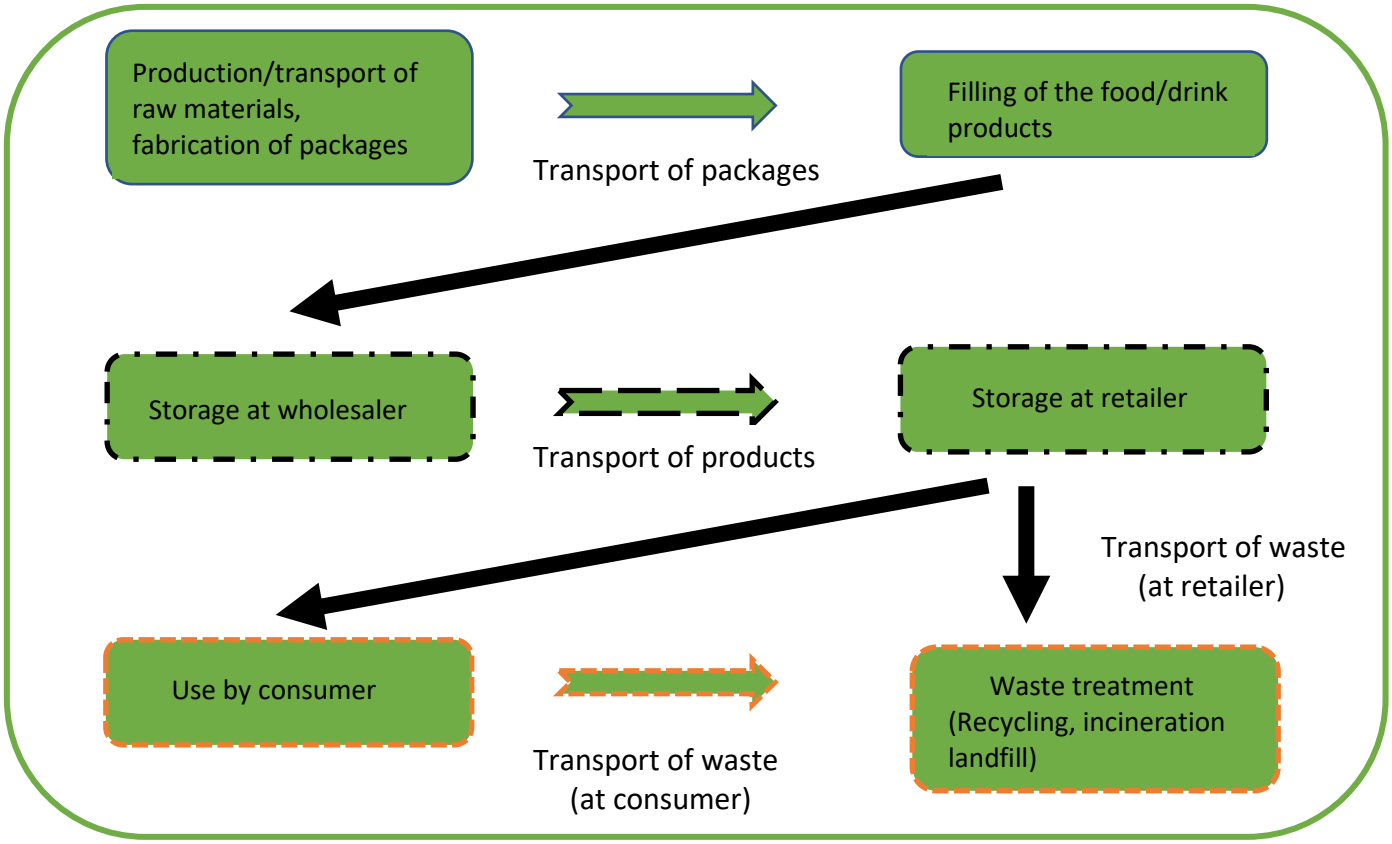

Figure 1. System boundaries for LCA

[1] https://www.tetrapak.com/content/dam/tetrapak/publicweb/gb/en/sustainability/documents/lca-nordic-wine-comparative-2010.pdf

Packaging system	Description	Total Weight (incl. caps)	Picture
PET bottle 750 ml	Bottle made of blown PET with LDPE screw cap, a good oxygen barrier.	54.4 g	
Glass bottle 750 ml	Glass bottle made of melted/formed silica, with natural cork and aluminium screw cap.	479.5 g	
Bag in Box 3 L	A plastic bag made of double-layer barrier film (outer: EVOH, aluminium; inner: PE) sitting in a cardboard box.	179g	
Stand up Pouch 1.5 L	Sealed bag made of thin multilayer laminate films (normally PET, aluminium, LDPE), tap and gland made of LDPE.	34.8g	
Beverage Carton 1 L	Paperboard (75%) laminated with a thin aluminium layer (4%) and LDPE layer (21%). Average results of Elopak and Tetra Pak are used in LCA.	38.1 g	

Table 1. Packaging chosen in LCA reference scenario

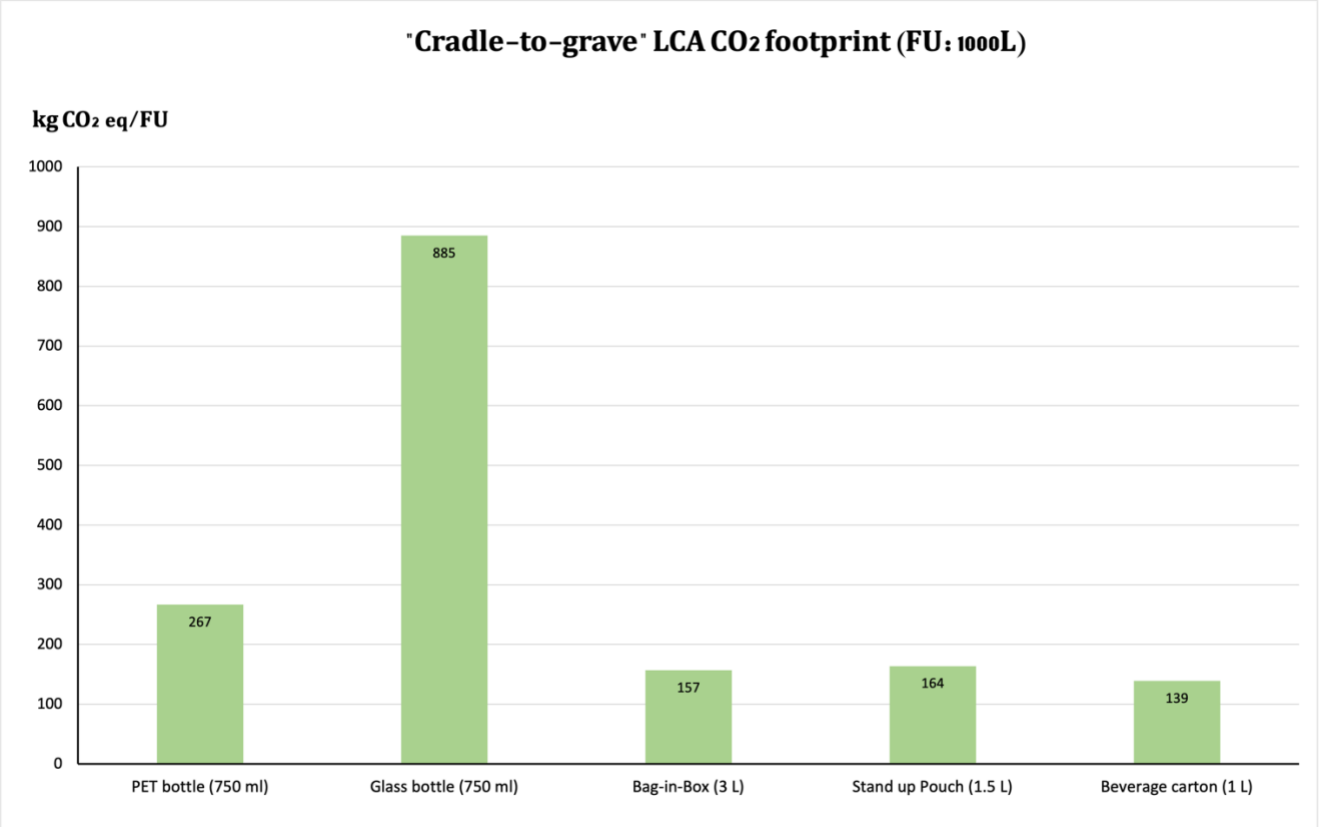

Figure 2. Breakdown of global warming potentials (carbon emissions) of referenced packaging.

	Milk	Juice	Bottled water	Common liqueur	Jam
UK annual production/consumption (million litres)	15,000	930	3,000	1500	90
Assumed packaging transition	PET → carton	PET → carton	PET → carton	Glass → Pouch	Glass → carton
Carbon emission saving ($MtCO_{2\,eq}$/yr)	1.920	0.120	0.385	1.082	0.067

Table 2. Estimation of achievable CO_2 emission reduction
(Data obtained from www.statista.com)

From Table 2. Even without considering some other consumer products which can clearly put though similar packaging transitions (e.g., shampoo and detergent bottles made of HDPE), when fully implemented, the proposed transition in consumer packaging has the potential of delivering a net reduction in UK carbon emissions of around 3 $MtCO_{2\,eq}$/yr.

3. Recyclability of beverage cartons, glass/plastic containers.

- Currently, around 50% of household glass packaging doesn't get re-melted back to glass. Much is crushed and used as cheap landfill cover or incinerated.[2]
- Glass production process involve more layers of transportation compared with other raw materials. Sand must be collected, transported for melting, transported again for conditioning and finishing, transported again for washing and sterilisation, then finally transported for sales use.

[2] https://www.britglass.org.uk/our-work/recycling/bottles-and-jars

- The recyclability of PET plastic bottle is highly dependent on the relative floating market prices of virgin PET and Recycled PET (RPET).
  The post pandemic economic recovery has resulted in an acute PET shortage in Europe, and a 10-year high in virgin PET price.
  The recent hike of energy price has contributed to higher cost of RPET production (bottle bale-to-flake conversion cost). In the last quarters of 2021, price of RPET flakes has surpassed virgin PET in the European market. (data from S&P Global Platts)
- UK waste management giant Biffa has invested £27.5 million in a dedicated PET bottle recycling facility in County Durham.[3]
- Recycled HDPE (rHDPE) is considered has "positive value" in the recycling market and is relatively accurately sorted and recycled. (in 2010, 76% of HDPE milk jars were recycled). rHDPE has reached food grade in existing UK reprocessing facilities.

(See Figure 4.) When beverage cartons got recycled at dedicated recycling plant, wood fibre from cartons is separated through hydra pulping process at a pulper and converted into pulp sheets to make paper and paper products. The residue polyethylene and aluminium are transformed to composite roofing boards.

- Top carton manufacturers council jointly founded trade associations (Carton Council (US)[4], ACE (UK)[5]) committed to grow carton recycling and to drive both recycling technology and local collection programs.
- ACE directly manages a dedicated carton recycling facility in Halifax, which is capable of recycling up to 40% of the cartons manufactured each year in the UK.
- ACE incentivises local authorities to initiate cartons kerbside recycling and provide Brink Banks by offering a stable price per tonne for cartons delivered.
  ACE also offering advice and support for local authorities and community recycling networks (CRN) wishing to collect cartons.
- In the UK, carton recycling rates have increased 350% from 2007.[6]
- In 2007, only 20% of all Local Authority areas were collecting cartons for recycling; today it's 93%.

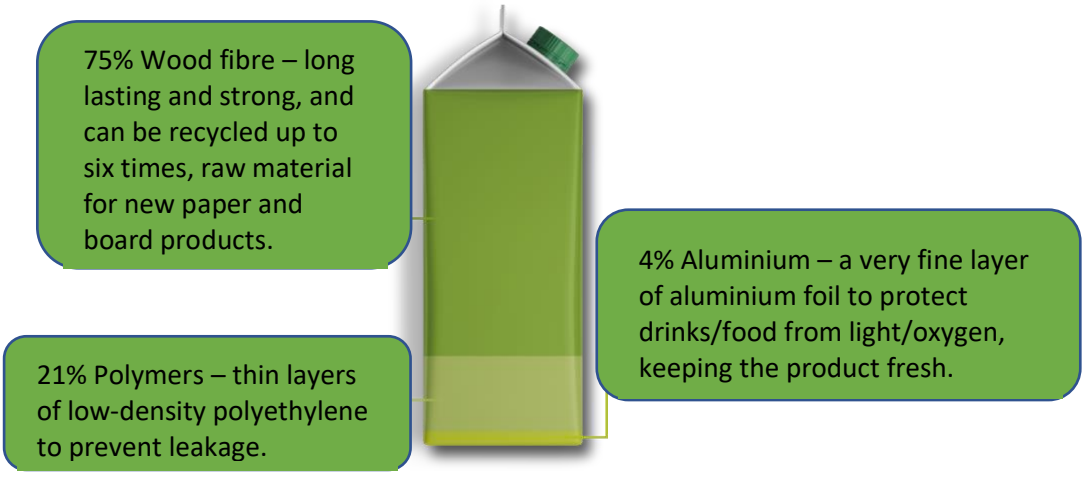

Figure 3. Compositions of a typical beverage carton.

[3] https://resource-recycling.com/plastics/2020/01/29/uk-waste-giant-opens-large-pet-recycling-facility/
[4] https://www.recyclecartons.com/about/
[5] http://www.ace-uk.co.uk
[6] https://www.tetrapak.com/en-gb/sustainability/planet/choose-cartons/carton-recycling-in-the-uk

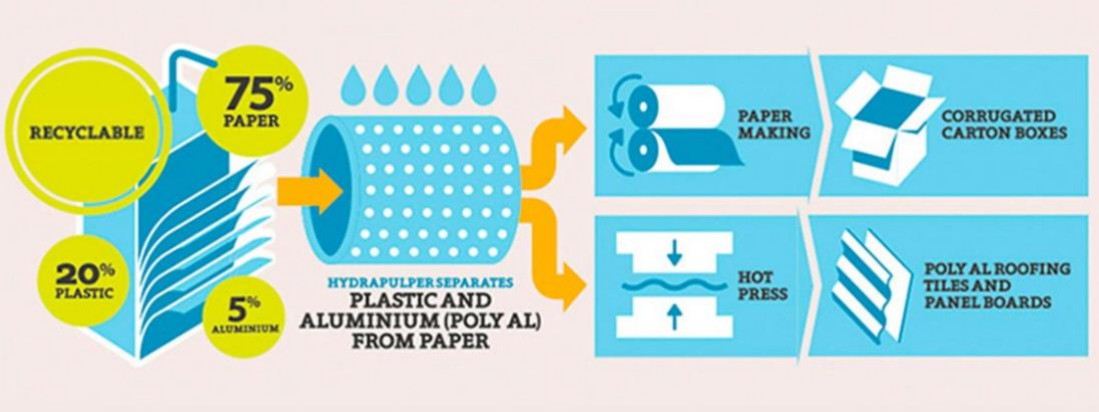

Figure 4. Overview of food/drink cartons recycling process.

4.Analysis of the shareholders involved:

1.food and drink cartons manufacturers.

2. industry body (formed by manufacturers).

3.waste management company

4.local authorities

5. dedicated carton recycling facilities

6.pape mill

7. Research institute in sustainable polymer packaging.

8.PET/HDPE plastic industry

9. Consumer glass container businesses

Figure 5. Overview of key shareholders involved in the proposed packaging transition.

***3.Waste contractors**:*
All non-household waste in the UK is collected and managed by waste contractors.

+ The annual ~3% increase in UK landfill tax gives a strong incentive for waste management companies to reduce solid waste disposure.[7]
The stable price ACE carton recycling centre pays for every tonne of cartons delivered is a more profitable option compared to the fluctuations on the global recycling market. Private waste contractors are also benefited by carton recycling through reductions in their landfill taxes/gate fees.

***4.Local Authorities**:*
All local governments have statutory duty to collect household waste, provide access to bring banks, household waste recycling centres and must meet certain weight-based recycling targets on yearly basis.

+ All recycling statistics are subjected to reviews by the Department for Environment Food & Rural Affairs. [8]Recently with recycling amount of common recyclable materials reaching saturations[9], local authorities found it increasingly challenging to meet those targets.
ACE's carton kerbside carton recycling and expanding bring banks scheme help local authorities to increase overall material recycling percentage as more residents participate in recycling.

− Facilities like bring banks can be costly for local authorities. (~£900/unit + land usage)

6. Paper mills
Carton fibres provide an ideal raw material for industrial strength core board manufactured at the paper mills on the recycling site.

+ Sonoco, a global market leader in the paper industry operates a paper mill next door to ACE Halifax carton recycling facility. It has been successfully using recycled carton fibre to make
industrial cores and tubes onto which paper, fibre yarns are wrapped around for industrial applications since 2013. [10]

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[7] https://www.gov.uk/government/publications/rates-and-allowances-landfill-tax/landfill-tax-rates-from-1-april-2013
[8]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966114/Statistics_on_waste_managed_by_local_authorities_in_England_in_2019v3_accessible.pdf
[9] https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials
[10] https://sonocoeurope.com/industrial-solutions/paper-tubes-and-cores/

Fibres produced from beverage cartons are strong, and the printing/writing-grade paper tubes/cores made from them can be fully recycled multiple times, making them an attractive raw material for the paper industry.

7. Chemical research institutes & forward-thinking PET/HDPE packaging manufacturers

Mitsubishi Chemical together with the paper industries, flexible packaging giant Amcor (world's largest rigid PET container producer in 2002) etc, have been innovating on more sustainable packaging made of paper-based barrier material, conventional PE, and other vinyl-alcohol polymer.

+ Those new lightweight packaging with minimal O_2 permissibility, puncture resistance, deliver up to 70% carbon footprint over their lifecycles, helping grow manufacturers' profits by increasing products shelf appeals. Innovators in this field are rewarded by market advantage (though pioneering new market, IPOs) and most importantly a sustainable transition for the traditional rigid plastic packaging industry.

8. UK PET/HDPE Plastic Industry

UK Plastic Industry has an annual turnover of over £27 billion and employs approximately 182,000, 44.3% of UK's plastic consumption is packaging related. [11]

− The overall number of plastic processors in the UK has been decreasing, and most big plastic processors and raw material supplier are located at Northern England. Any changes in the packaging market will cause disruptions to all 3 major sectors of the plastic industry, and possibly impact employment in Northern England. Transitions into producing new polymer/paper-based packaging will also see the cost of retooling, supply chain reorganisations etc.

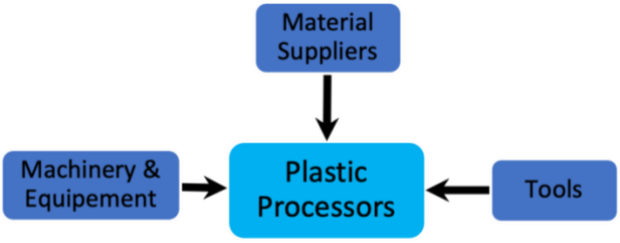


Figure 6. 3 core sectors that make up the plastics industry.

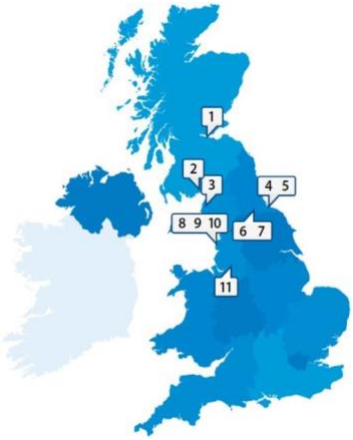


Figure 7. UK's largest plastic manufacturers mapped, most of which located in Northern England.

9. Container glass and glass recycling businesses

UK has only 6 glass container manufacturers (bottles, jars), they produce glass containers for the most high-end liqueurs to kitchen sauces. The largest glass recycling company in the UK employs around 70 people.

Container glass manufacturers could refocus their business and refit some of their equipment towards other range of glass products, e.g.:

Flat glass (glazing), Scientific hollow glass (tubing, vials), Photonic components.

[11] https://www.bpf.co.uk/industry/default.aspx

UK's glass recycling industry (centred in South Yorkshire) has been investing millions of pounds in specialist machinery, specially built bottle banks etc. No new food/drink glass containers production will cause capacity redundancy in the business.

Figure 8. Spouted stand up alcohol packaging bags with features like clear windows, handles have already appeared on the market.

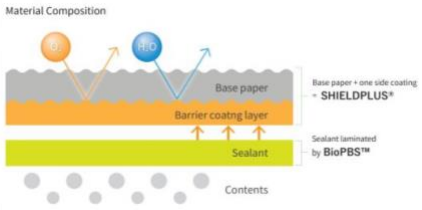
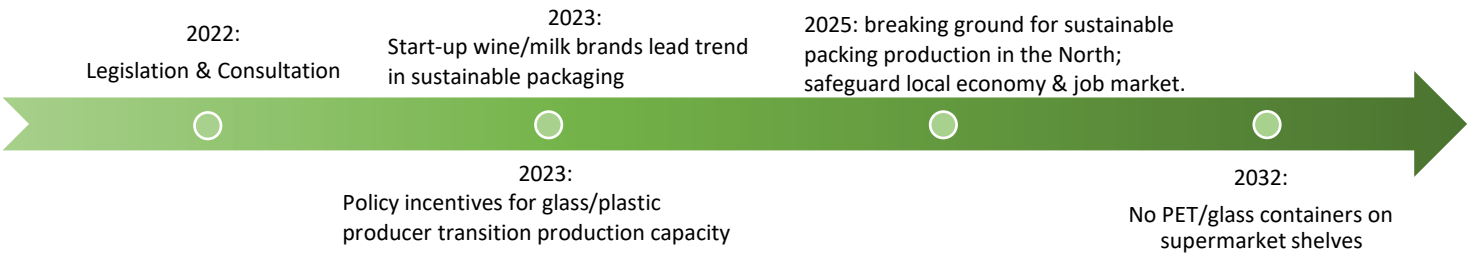


Figure 9. (above) Plastic laminated biodegradable-compostable packaging currently on the market. (made of thin PLA-PVOH films, a synthetic polymer that's soluble in water)

(below) Paper/polymer laminated biodegradable-compostable packaging developed by Mitsubishi Chemical.



3. Legislation & Balancing Objections

The forementioned proposal will be introduced to the House of Commons by Halifax Labour MP Holly Lynch as a private member's bill because:

1. UK's only dedicated carton recycling facility is in her constituency, benefiting the local employment. The bill would be a major vote winner for her re-election
2. Herself has been a strong advocate on reducing emissions/climate emergency, and she was a shadow minister in Department for Environment.
3. Labour Party has committed on decarbonisation and Green Revolution is large part of the Party's manifesto.

Possible objections

For the draft bill to become a law, it has to go through the legislative process. (first reading, second reading, community/report stage, third reading, Royal Assent)

1. Objections from MPs represent Northern England are likely due to the large number of workers the top plastic manufacturers employ in the region.

2. The conservative government has committed to reducing carbon emissions in their manifesto (Election 2019)[12] , which means the House of Lords will not block the bill as per Salisbury Convention.
3. Trade association for the plastic and container glass industries (British Plastic Federation, British Glass) are likely to petition/lobby against the draft bill during public consultation stage.
4. Oppositions might try to argue most liqueur on the UK market are bottled overseas, therefore any regulations on alcohol packaging is difficult to enforce.

Objection mitigations:

1. Carton manufacturers likely expend their manufacturing and distribution facilities in the UK due to hiking demand. The government could incentivise companies focus their expansions on Northern England to boost local economy and employment.

   (Tetra Pak, SIG Combibloc, Elopak already have their UK HQs in Chester, County Durham and Manchester)

2. The government could offer tax incentive to the few companies in the container glass businesses to refit some of their equipment into making glass (optical) fibre, photonic components.

3. More research fund from leading carton manufacturers and the government into carton recycling technology and sustainable packaging research.

4. Tax incentives, and more news coverage for start-up companies first introducing sustainably packaged wine, jam, milk etc. (see Figure 8.)

5. Scientific research groups, environmental activist groups initiate media/social media campaign to educate the ***public*** about the high carbon emissions of common glass/plastic packaging, to create ***public sentiment*** against glass/plastic container usage, and to win ***public support*** on the bill. Increasing ***public awareness*** on the global warming potential of consumer packaging.

6. The government could employ tools like increasing import tariff or alcohol duties, to provide additional cost incentive for foreign alcohol producers to adapt more sustainable packaging. Clauses regarding imported food/drink packaging could be written into UK's international trade deals.

4.Additional factors

1. Depending on the industry, packaging can represent as much as 40 percent of the selling price of products. Lack of data on wholesale price of different packaging means it's difficult to study financial motivations for producers to conduct packaging transitions.

2. Carton manufacturers like Tetra Pak have put strong priorities in aseptic control, a long list of rigorous aseptic training services and solutions are provided to food producers.[13] (e.g., ultra-heat treatment, heated H_2O_2 bath for packaging, lab training for rough identification of bacteria). It is proved that cartons can keep food safe and flavourful for at least six months without refrigeration or preservatives.

3. Characters like OTR (oxygen transmission rate), shatter resistant, thermo-stability, strength of different packaging cannot be compared, due to lack of data in the public domain.

[12] https://www.conservatives.com/our-plan

[13] https://www.tetrapak.com/content/dam/tetrapak/publicweb/za/en/services/secure-food-safety-and-quality/tetra-pak-food-safety-catalogue-1506.pdf