

Supplementary Material – Document S1

Further details on the WASTE FEW ULL Consortium and Bristol Urban Living Lab

International Consortium

WASTE FEW ULL brought together an international consortium of researchers and practitioners across four ULLs – in Rotterdam, Sao Paulo, Cape Town and Bristol - and six countries: Netherlands, South Africa, Brazil, UK, Norway and USA. Each of the ULLs had a different focus area: transition management and policy innovation in Brazil, scaling of circular economy businesses in Netherlands, rural water filtration and food growing in the Western Cape, and wasted nutrients (via food and sewage) and associated energy and water in Bristol.

ULL Partners

The Bristol ULL, which included both researchers and practitioners, was co-led by two local, non-academic research leads (*db+a* and the *Schumacher Institute*). The research team included a Norwegian climate institute, *CICERO* (macro-valuation), and the UK *Universities of Coventry* (consortium lead), *Bath* (micro socio-environmental valuation), *Reading* (town planning/'design thinking'), and, in the USA, *Santa Cruz* (knowledge exchange). Alongside the research team were three founding industry and third sector partners: *Wessex Water*, the city's wastewater operator (and a regional and international water and waste infrastructure company); the *Bristol Food Network*, a Community Interest Company that plays a leading role in the city's sustainable food transition; and the *Centre for Sustainable Energy*, a nationally recognized sustainable energy and fuel poverty charity. As the project developed, two other main agencies joined the group: *Bristol Waste*, the Council-owned waste processing company, and *Resource Futures*, a national consultancy in waste, also based in Bristol. Each of these organisations have been either leading or feeding substantially into the Bristol Green Capital Partnership, which represents 800 member organisations across the city, and the Council's One City Plan.

Additional research activity

In addition to the macro-economic market valuation and non-market microeconomic valuations, the Bristol researcher-practitioner group undertook a range of complementary methods to explore the challenge of reducing inefficiencies in Bristol's FEW nexus. These are published in separate papers and include:

1. Daily/weekly participatory action research engagement activities with stakeholder partners over the three year period to:
 - a. Map and understand challenge areas
 - b. Help identify most impactful areas of intervention
 - c. Identify key stakeholders
 - d. Develop and sense-check emergent solutions.
2. Six formal workshops with a wider, targeted groups of external stakeholder-advisors.
3. Development of FEW resource flow systems models using dynamic stock-flow modelling.

Note on sewage and energy

The focus on sewage was a core part of the initial proposal, and contact was made with leading experts in universities in Lancaster, Northern Ireland, the USA and Israel, but gradually receded given uncertainty around mineral deposits, geopolitical aspects, technological developments and current drivers focusing on water cleanliness.

Likewise, energy was also core to the initial discussions (e.g. powering the anaerobic digester, gas to electricity grid versus use in transport and shifting tariffs), but it also receded given limited time/resource available to the energy practitioner expert on the project and the clear desire to focus on food waste primarily.

The problem with biodegradable caddy liners

An early potential area of focus was the use of caddy liners in residential food waste. Though biodegradable, they take time to break down (<5 years), and hence lead to temporal contamination nonetheless, which not only leads to maintenance issues (e.g. blockages), but also prevents immediate reuse (Wessex Water face a similar issue with biodegradable plastics in the sewage system). However, given the challenge of shifting away from the use of liners (i.e. consumers being unwilling to handle degrading food), this issue was set aside.

The issue of plastic contamination in commercial food however appeared more manageable due to:

- A. Available data on plastic contamination
- B. Type of plastic being used
- C. One City Plan target related to single-use plastic in takeaway food.

Further issues regarding plastic in Bristol's food waste relate to:

1. Plastic contamination in the 'digestate' being injected back into farmland
2. Extraction of plastic from food waste once contaminated, especially the softer, thinner plastics (e.g. plastic film)
3. Lack of knowledge of 'upstream' issues relating to plastic usage in food processing (e.g. plastic vegetable packaging).

One City Plan - Target Exclusion Criteria

1. Where not explicitly related to nutrient waste, even though they were nonetheless potentially highly influential in terms of the city's nutrient flows (e.g. procurement practices, public investments, fertilisers and plastics in Bristol's waterways),
2. Had no explicit quantifiable end point (e.g. community food distribution "recognized", "significant" increase in number of urban farmers),
3. Were considered by stakeholder partners to be too challenging in terms of clarity of definition and data availability (e.g. "local" food),
4. Did not meet our core focus in terms of socio-environmental impact (e.g. residual food waste) – see Appendix A,
5. Ultimately became redundant given it is covered under end goal of Zero Food Waste City 2049 target (e.g. commercial food waste being treated as valuable resource).

A further justification for the exclusion of the 2025 One City Plan (OCP) target to 'Reduce residual household waste below 150 kg per person' is due to its relative lack of ambition. The population in 2025 is 485,073, if the

same annual growth rates between 2023 and 2028 are assumed in the projection based on mid-2018 population. That being the case, this OCP target means that total residual household waste in Bristol should be less than 72,761 tonnes in 2025. This implies the total residual household waste should be reduced by more than 6% (or 1.3% annually) during the decade from 2015 to 2025 as the residual household waste in Bristol is 77,761 tonnes (or 173 kg per person as the population is 450 640) in 2015. This target is therefore less ambitious than both: the national target set by WRAP to reduce household food waste by 20% from 2015 to 2025. The WRAP 20% target corresponds to 2.2% annual reduction in food waste from 2015 to 2025 (which is very close to the rates of reduction during 2015-2018); the national historical record of 1.6% annual reduction from 2007 to 2015. If the historical annual reduction rate (1.6%) is assumed, then the food waste from households in Bristol would be reduced by 15% from 2015 to 2025.

Rationale for sector selection for options ‘not re-spending’ and ‘re-spending’

According to the Office of National Statistics, the primary commodities or services that UK household disposable income is spent on includes (ONS, 2018) - see 'Supplementary Material' in appendices: food and non-alcoholic drinks (11%), rent (9%), mortgage and council tax (8%), household goods and services (furniture, textiles, appliances, cleaning) (7%), operation of personal transport (6%), holidays abroad (6%) and purchase of vehicles (5%). Other notable areas are: electricity and gas (4%), clothing and footwear (4%), public transport (3%), internet and phone (3%), restaurant and café meals (3%) and with the following all at 2%: alcohol, water and hair products/toiletries. Around 25% of the remaining is spread across a wide range of other areas at 1% or below (e.g. pets, sport, audio-visual items, health). At one extreme we could model an equal re-spending across all areas. This seems unlikely on an individual case, but across a population more credible. At another extreme, we could select just one, or a few of the more likely areas (given that for the purposes of this exercise, we are more interested in whether this approach might offer useful findings in principle). Given that we are using Standard Industrial Classification (SIC) categories in our modelling, we do need to select those areas closest to those categories. We also include energy, water and food given the focus on the FEW Nexus. The sector of plastic is separated as no single-use plastic in food waste is one of the OCP targets we consider. The sector of cloth is included to check to what extent households might increase their spending on other daily goods. We also include transport and trade as both sectors play a key role in food supply chain.” As such, there are a number of assumptions we can make to narrow this selection:

1. We can exclude the first – food/non-alcoholic drinks - and restaurant/café meals, given our focus is already on food waste (it’s conceivable people may choose to re-spend on different food and drinks, or treat themselves to more meals out with their savings, but we are assuming consistent spending behaviours in this case, and are estimating commercial food waste reduction too).
2. We can also exclude the 25% of the remaining given they are too spread out (we need a smaller number to assess the scale of the impact and who the beneficiaries might be).
3. We might also assume that the savings are insufficient to radically alter significant areas of spending (e.g. the house you live in, the associated bills (elec/gas/water/internet/phone), the car you drive, its operating costs and generally how you get around (rail/bus)).

This leaves what you might call the more luxury items – holidays/tourism¹ (SIC: 45-47; 49-52; 55; 77; 79), clothing/footwear (SIC 13-15), alcohol (SIC 11.01-05) – which is a small enough sample for our purposes and fits with the notion that, with additional modest income, consumers may treat themselves. On the above basis, we might assume two extreme scenarios - either that:

- a. Households will not re-spend that saving elsewhere, or
- b. Households will re-spend that saving on other goods (e.g. holidays, clothing)

We underline that these are two extreme cases only, and are being used as illustrations only of potential future scenarios. There will be multiple different cases between these two extremes.

¹ The SIC sectors included in holidays/tourism are transport, trade, services of accommodation, rent and lease, and travel agency. These sectors are closely related to household expenditure during their holidays/tourism although considerable shares of household spending in some of these sectors (e.g. transport and trade) are not related to holidays/tourism activities so the same caveats apply.