UNIVERSITY COLLEGE LONDON
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BARTLETT SCHOOL OF PLANNING

The potential for a circular food system in an urban environment – the case of four south London boroughs

Mark Thomlinson M.A.

Supervisor: Isabel Gutierrez Sanchez

Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc Sustainable Urbanism at University College London: I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

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Abbreviations

AD	-	Anaerobic digester
DEFRA	-	Department of Environment, Farming and Rural Affairs
GHG	-	Greenhouse gas
GLA	-	Greater London Authority
NFU	-	National Farmers' Union
NPPW	-	National Planning Policy for Waste
SLWP	-	South London Waste Partnership
WRAP	-	The Waste and Resources Action Programme

ABSTRACT

Cities in the UK largely operate according to an unsustainable, linear metabolism, requiring high levels of resource extraction and generating significant amounts of waste. Conventional agriculture, responsible for a large majority of the food that feeds these cities, is dependent on non-renewable inputs such as artificial fertilisers, and with close to half of all food eaten in Britain imported, it often travels long distances before consumption. At the same time, approximately a third of all food grown is wasted. In the UK, 70% of this waste originates from households. In a circular economy, products are not wasted but retain 'cascade' value before degrading, and in their least useful form are recycled into a new input.

In the food system, methods for achieving circularity already exist. Commercial and philanthropic 're-use' allows for surplus to be distributed efficiently, while recycling – through anaerobic digestion and composting – converts waste, including sewage waste, into an environmentally-friendly fertiliser. These tools reduce the need for non-renewable inputs and can significantly reduce environmental harm.

This paper will examine the potential for a circular food system in four London Boroughs: Merton, Sutton, Croydon and Kingston. These are chosen because together they form the South London Waste Partnership. The circularity of the present setup is assessed, through examination of the applicable policies at the national, regional and local level, combined with data review. It is shown that while some local policies are beneficial, there is significant scope for improving food recycling, while other system-wide changes would need a new approach by the national government.

1 INTRODUCTION

The global food system is a major source of environmental damage, including greenhouse gas (GHG) emissions, biodiversity loss, and pollution associated with fertiliser use (Springmann, et al., 2018). It is also amazingly productive, yielding enough food to feed everyone on the planet, and more (Kummu, et al., 2012).

The UK, which imports nearly half the food it consumes (National Statistics, 2020), is undeniably dependent on this global system. It is also an urbanised, and increasingly urban, country (UN Population Division, 2018). As the world population grows and urbanises, questions abound over how an urban population can be fed sustainably: in Britain – one of the world's advanced economies – despite significant emissions reductions in the power and industry sectors, food production is almost alone in making no emissions progress over the past decade (Committee on Climate Change, 2020). Data specific to London tell a similar story (Owen & Barrett, 2020).

Narratives calling for a new paradigm in the food system are not new (Kloppenburg, et al., 1996), but the emergence of urban food strategies as part of the discussion is recent (Moragues-Faus & Morgan, 2015). As tensions within the existing system grow, and with government recognition of the need for change (Foresight, 2011), scholars debate what form a more sustainable setup will take (Lang & Heasman, 2015).

This dissertation will apply the lens of the circular economy, a model of sustainability adopted in both corporate and government literature, to ask: what is the potential for a sustainable, 'circular' food system in an urban setting? As a case study, we will examine the key elements of the food system as relating to the four south London boroughs of Croydon, Merton, Kingston, and Sutton, which have chosen to work together in the South London Waste Partnership (SLWP). Analysis will reveal where potential exists for greater sustainability.

The research methodology is explained in Chapter 3. It takes the form of a policy analysis, considering national and regional government strategies, as well as those of significant non-government actors including the supermarkets and National Farmers' Union (the UK's largest representative body for food producers). This analysis is laid out in Chapter 4. Chapter 5 advances the policy analysis to the local level: the SLWP boroughs. Here, using a range of indicators, the circularity of the present food system is assessed. Drawing from this and the policy analyses, areas of weakness and scope for greater circularity are identified.

First, however, the context framing this discussion will be established through a literature review, which follows in Chapter 2.

Figure 1: the South London Waste Partnership boroughs in the context of London (SLWP, n.d.).

2 LITERATURE REVIEW

2.1 SUSTAINABILITY

Concepts of sustainability have been nuanced and adapted over time. The popular 'three pillars' model, balancing environmental, economic and social sustainability, was criticised for creating a setup of trade-offs (Campbell, 1996); a subsequent fix, the nested or 'Russian doll' version of this, created a false separation between layers (Levett, 1998); models of sustainability adding a 'governance' pillar misunderstood that governance was "a pre-requisite to sustainability rather than an objective" (Hickman, 2018, p. 313).

A common theme among many concepts of sustainability is that, whatever their strengths, they remain somewhat abstract and hard to operationalise in a way satisfactory to all stakeholders. "If both the World Bank and radical ecologists now believe in sustainability," wrote Scott Campbell, "the concept can have no teeth" (Campbell, 1996, p. 301). This has afforded wiggle-room to irresponsible powerful actors to co-opt the discourse and "cloak themselves in the language of environmentalism" (Hajer & Versteeg, 2005, p. 179), such as the enthusiastic declaration by Heathrow Airport that it has become 'carbon neutral', despite facilitating a carbon-intensive form of travel (Heathrow, 2020).

Facing these challenges, two concepts of sustainability that have been gaining ground in the past decade are arguably less susceptible to discourse capture, because both are measurable. They are (1) the limits-based approach, most famously manifested in Kate Raworth's *Doughnut Economy* (Raworth, 2017), and (2) the circular economy, perhaps best known through the work of the Ellen MacArthur Foundation (MacArthur, 2013).

The doughnut economy applies scientifically determined 'planetary boundaries' and internationally determined social minima that must be met to avoid "catastrophic environmental change" (Rockström, et al., 2009) while satisfying "life's essentials such as food, education and housing" (Raworth, 2017, p. 45). No country meets all the social requirements within safe planetary boundaries (O'Neill, et al., 2018) and so the doughnut economy perspective calls both implicitly and explicitly (Raworth, 2017) for a radical shift away from the status quo. In so doing, it brushes anti-capitalist narratives that reject the very prospect of sustainability under capitalism (Castro, 2004) and which declare impossible the notion of a "virtuous, win-win" scenario (Sekulova, et al., 2017, p. 161).

The Circular Economy is less explicit. It aims to be more 'business friendly' than the doughnut model, as evidenced by a glance at the Ellen MacArthur Foundation's 'Strategic Partners', which include large manufacturers like Renault and retailers like B&Q among their number (Ellen MacArthur Foundation,

2020). As a paradigm with support from a diversity of actors, and its appeal even to typically unidealistic sectors of society, the Circular Economy is a useful lens to use for examining real-world sustainability, and is particularly appropriate for the food system. We will now explore the concept in more depth and then consider its connection to food.

2.2 The Circular Economy

The circular economy concept (CE) has been embraced in a range of disciplines and has widespread traction. It has been discussed within academia for decades (Williams, 2019, p. 2748), but has also been said to emerge independently in policy circles (Murray, et al., 2017), popular as a way to operationalise the concept of sustainable development (Kirchherr, et al., 2017).

For example, it has a range of take-up extending across public, private and third sectors. CE has been incorporated into '100% circular' targets in large companies like Ikea (2020) and the H&M Group (2019); is formally advocated for by numerous think tanks, e.g. Chatham House and Green Alliance; and is embedded in government policies, including through the UK's Industrial Strategy (HM Government, 2018), London's Environment Strategy (GLA, 2018), and official guidance through the 2017 British Standard BS 8001; it is likewise a stated policy goal of the EU (Kristensen, et al., 2016, p. 758).

The familiarity of CE in different policy and corporate circles makes it a good area of focus with regard to sustainable food systems. Firstly, as a concept that already has significant buy-in from strategists and policymakers, the need for lengthy awareness-raising and advocacy is reduced. Secondly, CE's philosophy is borrowed from the natural world, making application to a system embedded in the natural world (i.e. food growing) logically coherent.

Defining the circular economy

In its simplest conceptual guise, the circular economy is a 'closed loop' economy: there is no end-of-life for materials, and even by-products of production are turned to useful purposes (Kristensen, et al., 2016) (Ingrao, et al., 2018). All outputs are fed back into the system in what is dubbed the 'cradle-to-cradle' approach, as opposed to the conventional cradle-to-grave, 'take-make-dump' mindset (Gregson, et al., 2015). In recognition of finite global resources, the circular economy mirrors natural systems as closely as possible. "Waste does not exist" (MacArthur, 2013, p. 7): it is simply another resource, in line with the adage that 'one man's trash is another man's treasure'. So it is with nature, the 'master farmer', with whose method "there is no waste anywhere" (Howard, 1943, p. 12). As such, the circularity metaphor is particularly relevant to food (Jurgilevich, et al., 2012).

In a common metaphor drawing an analogy between cities and organic systems, if the conventional economy operates according to a linear 'metabolism' (high-input, high-waste), CE is the manifestation of a circular metabolism, resulting in the 'regenerative city' (Girardet, 2010) or 'circular city' (Williams, 2019), as depicted in Figure 2.

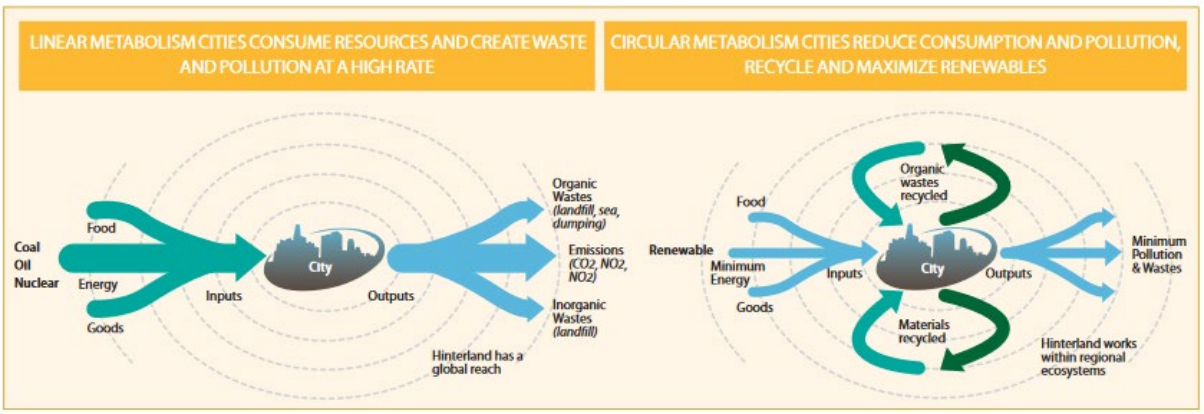

Figure 2: (Girardet 2010, p. 11)

In the CE paradigm, unlike most existing business practice, every product component or process is deliberately conceived so as to minimise resource use, maximise resource recovery, and render disassembly for reuse easy. Symbiosis and commercial synergy, beyond individual companies, are central tenets (Williams, 2019) (MacArthur, 2013).

Further, 'cascades' create additional value steps before a product becomes wasted or incinerated for energy recovery. In textiles, for example, "cotton clothing is reused first as second-hand apparel, then crosses to the furniture industry as fibre-fill in upholstery, and the fibre-fill is later reused in stone wool insulation for construction" (MacArthur, 2013, p. 7). For the food system, an example cascade sees leftovers being fed to animals before the step of composting. Landfill, in its linearity, is avoided.

2.3 FOOD SYSTEM SUSTAINABILITY

For most of human history, towns and their hinterlands were formed in a setup Girardet dubbed the 'Agropolis' (2010), characterised by a symbiotic relationship between settlements and the surrounding landscape. Here, productivity and fertility were largely maintained through the recycling of organic material – 'waste', including human waste – to the same lands they were harvested from. (Bateman, et al., 2011, p. 1146) (Pinderhughes, 2004, p. 194). The system was thus more or less circular. The relative balance of pre-industrial agriculture has been replaced by farming dependent on the application of artificial fertilisers, use of fossil-fuelled machinery, and long-distance transport. These form part of linear processes, explained below.

Artificial Fertilisers

Large-scale agriculture in developed economies is monocultural and dependent on artificial fertiliser and energy-intensive engineering (Lang & Heasman, 2015, p. 30). The essential elements on which plants depend, nitrogen (N), phosphates (P), and potassium (K), are sufficiently extracted or synthesised in natural systems (Howard, 1943), but British farmers apply fertilisers, containing these elements, to 97% of cereal farms, 94% of other cropping farms and 93% of dairy farms (DEFRA, 2020).

Artificial fertilisers are heavily dependent on non-renewable sources and therefore render conventional agriculture un-circular. Nitrogen fertiliser requires natural gas to synthesise, releasing between 0.6kg and 2.0kg CO_2e emissions per 1kg of product (Wood & Cowie, 2004), while phosphorous and potassium are both extracted from finite reserves embedded in the earth's crust, the reserves of which may expire between 30 and 300 years from now (Cordell & White, 2011). Fertiliser use, of 113kg per hectare (DEFRA, 2018), is estimated by the Soil Association – which campaigns for organic agriculture – to amount to 1.1% of the UK's total annual carbon emissions (Soil Association, 2008).

Sustainable alternatives to conventional agriculture & the importance of the local

Alternate, more sustainable visions of the food system include the organic method, agroecology, permaculture and others (variations on a theme), each emphasising the importance of rejecting artificial, non-renewable inputs and embracing 'natural' or biomimicking techniques instead. These replicate circularity in the food system: compost and manures – 'waste' – are recycled as the inputs used in place of the artificial fertiliser found in conventional systems. More circular food systems will therefore place greater emphasis on this type of food production. In the urban setting, where consumers are unlikely to know precisely the source of their food, organic certification is a good indicator of greater circularity.

But sustainable alternatives often go beyond method alone. Academic literature in the field also "strongly engages the geographical concepts of 'global' and 'local' and emphasizes this antinomy," and typically proposes localisation as a solution to the problems encountered (Allen, et al., 2003, p. 63). The UK, even if it were to abandon the artificial fertilisers mentioned above and adopt a fully organic approach, would continue to remain dependent on global supply chains: almost half (47% by value) of food consumed is imported (National Statistics, 2020). This introduces another linearity within the food system.

'Metabolic rift' (Foster, 2009), first espoused by Abraham Lincoln's economic advisor Henry Carey and adopted by Marx, starts from the observation that shipping food/nutrients far from their point of origin leaves no scope for recycling the nutrients back to the soil from where they originated. This

imbalance is played out through empirical observation, and has led to proposals for physical redistribution of nitrates and phosphates, both nationally and globally (Bateman, et al., 2011). Such large-scale redistributions would reconstitute an element of circularity in the food system, but this remains in the realm of fantasy.

Allan described the similar problem of 'virtual water' (1998), which follows the same logic of creating imbalances through the export of elements embodied in crops, this time water. This is a threat to water-poor regions recognised by the UK government (Foresight, 2011, p. 58).

Metabolic rift and virtual water both reveal a linearity in global trade. Therefore consumption of domestically-grown food will be an indicator of greater circularity. But at the most local scale, urban agriculture, as regards our case study, actual food production in London is very limited (Biel, 2016, p. 100). Proponents of localisation carry the argument beyond food production itself. Global trade tends to a rationalisation of supply chains (Curtis, 2003) (Foresight, 2011, p. 54), and indeed just four companies run as much as 73% of the global trade in grain (Murphy, et al., 2012, p. 9). The purchase of food through anonymous intermediaries engenders a disconnect between people, producers and nature (Dehaene, et al., 2016), arguably evidenced by the removal of 'no longer relevant' words from the Oxford Junior Dictionary, including *acorn, dandelion, kingfisher, newt* among others (Macfarlane, 2016, p. 3). This leads us to a 'black boxing', in Latour's sense (Latour, 1987), of nature and food production, in which the entire process becomes mystified and something 'other' (Hajer & Versteeg, 2005).

Urban denizens can open the black box and learn to choose a more "sustainable plate" through food growing in community gardens and allotments (Martin, et al., 2016). Localism helps "communities and cultures [to] understand the vital significance of the local eco-system" to the economy (Curtis, 2003, p. 86). As such, counts of allotments and community gardens in our south London case study are used as proxies not only of food production (which is limited) but also of participation and socio-environmental sustainability.

2.4 Combining the Food System and Circularity concepts

As noted above, CE and the food system are natural bedfellows. However, only a limited amount of literature was found that evaluates the two together. Analyses of the food system typically divide its constituent parts into five different phases: Production, Postharvest, Processing, Distribution and Consumption (Vilariño, et al., 2017) (Kummu, et al., 2012). In one example combining CE and the food system, Jurgilevich and colleagues convert these steps of the food system into three categories: Production, Consumption, and Waste (Jurgilevich, et al., 2012).

It is possible to align the Jurgilevich categories with the 'R' framework common in CE literature, often known in its 'reduce, reuse, recycle' form[1] (Van Buren, et al., 2016). Throughout this paper's analysis we will consider food Production under 'reduce' (i.e. reducing surplus and the non-renewable inputs associated with growing food); Consumption under 'reuse' (i.e. ensuring maximum repurposing of food, via surpluses donated to food banks, or leftovers given to animals), and Waste under 'recycle' (i.e. composting food waste back into usable nutrients).

2.5 URBAN FOOD POLICY

Setting these ideas within the urban context, it is noteworthy first of all that historically, food has not been considered within the remit of municipal responsibilities (Moragues-Faus & Morgan, 2015, p. 1568), and the earliest urban food strategies date back only to 2006 (Sonnino, 2016, p. 193). Even quite recently, planners rarely integrated food production and supply within their work, considering it varyingly as outwith their responsibility, as a rural concern, a market concern, or simply professing lack of knowledge on the topic (Pothukuchi & Kaufman, 2000). Food's links to waste, transport and energy – sectors with considerable CO_2 emissions – have been underplayed or ignored (Pinderhughes, 2004). This has been labelled "the missing link" (Cabannes & Marocchino, 2018, p. 18).

This is starting to change. In the UK, with the lack of a national strategy for over 75 years (National Food Strategy, 2019), cities began to develop their own policies (Moragues-Faus & Sonnino, 2019). Food strategies now exist in Cardiff, Edinburgh, London and Belfast – all the UK's capitals – and numerous smaller towns and cities in the land. Globally, in some places, like Milan, strategies can be well-established and inspire others (Quaglia & Geissler, 2018). In others, like efforts in Lima to promote urban agriculture, they can be killed off after a change in political power (Santandreu, 2018).

The research in this paper considers the national, regional, and local context, with particular attention to the strategies and capacities of local authorities – Croydon, Kingston, Merton and Sutton in particular – to create a more circular system. Reflecting the discussion above, we will consider that the key indicators of circularity include: (1) reduction in use of non-renewable inputs, mainly artificial fertilisers; (2) more locally-grown food; (3) maximising cascades: high human consumption of surplus, or failing this, its use as animal feed; (4) recycling of food waste, via composting or anaerobic digestion, back onto farmland; (5) recycling of wastewater 'sludge' back onto farmland. We return to these in detail in section 5.2.

[1] Up to nine 'R's have been identified, but these are the three base Rs.

3 METHODOLOGY

3.1 RESEARCH DESIGN

To understand the paradigm within which the food system operates, and the rules that govern it, a qualitative policy review was conducted as the first part of this research. This considered government policies, where they exist, at the national (England), regional (London) and local (council) level including strategies on Planning, Environment, Waste, Wastewater, and Food. The policies of significant non-state entities strongly connected to the food system, namely supermarkets and the National Farmers' Union, were also evaluated. An evaluation of these policies permitted an assessment of which areas were facilitators of, or impediments to, of greater circularity. For clarity, the policy review is split into two chapters: Chapter 4, regarding National and Regional policies, and Chapter 5, policies of councils in the South London Waste Partnership (SLWP) area itself.

Complementing the first part of this research, a second part of Chapter 5 uses quantitative data from a range government sources, non-government sources (such as the Soil Association, responsible for organic certification), and relevant parties (including supermarkets and Thames Water) to present a snapshot of circularity in the four-borough area. Where detail at the local level was not available, such as the amount of produce bought that is imported, national data was used as a proxy.

Incorporating the qualitative conclusions from part one, the snapshot then becomes an analytical tool where data and policy can be assessed together, revealing the potential for greater circularity in the food system becomes apparent. In some cases, European comparators are used as a reference. Some background interviews were conducted (see Table 15) to add understanding to the analysis.

3.2 LIMITATIONS

The policy review considered a large number of official documents, but since food as a topic touches on many aspects of life, it is possible that minor policy niches were missed. Additionally, some datasets either did not reach the level of detail desired (e.g. organic food sales), were said to be commercially sensitive (e.g. food waste received by Severn Trent), or gave conflicting detail (e.g. the GLA and local authorities present slightly different numbers regarding allotments); where applicable, information from the more local level was used; where data was not available, the closest proxy was used. The present research is not, however, a material flows analysis and it is thought that any nuances that more granular data could yield would not affect the overall analysis.

3.3 ETHICS STATEMENT

This research was undertaken in full compliance with the UCL Research Ethics Committee. Interviews, where conducted, were recorded with the participant's knowledge and consent. Anonymity and attribution were discussed and is presented per the participant's preference.

4 POLICY REVIEW

4.1 INTRODUCTION

National policies frame the overall potential for a circular food system: they set out the subsidy scheme and regulations for commercial food production, and set the boundaries for planning and waste policies at the regional and municipal level. The potential of municipalities to influence food circularity is found in their powers on planning and waste, and through local food policies, such as concerning procurement. Thus, to set the context for the chapter 5 case study, this chapter will review policies at the national level and the regional (London) level. This chapter will also examine policy among influential non-government entities, namely supermarkets and the National Farmers' Union.

4.2 NATIONAL LEVEL

The key documents at the national level are the 25-Year Environment Plan; the Industrial Strategy; the Agriculture Bill (expected to become law in 2020); and, regarding land use, the National Planning Policy Framework. For the most part, these concern food production. Government Buying Standards regulate procurement and are also relevant. No over-arching Food Strategy exists[2].

Food reuse – i.e. the use of surplus food via donation or commercial resale – is only governed by the Animal By-Products Regulations, brought in after the 2001 foot-and-mouth outbreak, which bans household and catering food waste (i.e. leftovers) from being fed to animals or people. England's Waste and Resources Strategy allocates grant money, disbursed by WRAP, to promote redistribution of surplus. Municipalities and charities bid for this money. In the UK – as alluded to in section 4.4 (supermarkets) – the distribution of surplus is quite efficient: an estimated 3% only of total food waste is linked with retail waste (WRAP, 2020).

Food recycling (waste) comes under the EU Waste Framework Directive, and the National Planning Policy for Waste, along with the Waste and Resources Strategy. Meanwhile, relating both to food waste and production, the use of biosolids (sewage) in agriculture is governed by the Sludge (Use in Agriculture) Regulations 1989.

These are summarised below in Table 1, which also depicts the principal policies at London and council level.

[2] One was recently commissioned. Part Two, concerning the sustainability of the food system, is due to publish in 2021.

Table 1: Policy environment

Stage in Food Cycle	Main applicable national law/policy	Main sub-national policies
Food Production	25 Year Environment Plan 2017 UK Industrial Strategy 2018 Agriculture Bill 2020 National Planning Policy Framework 2019 Guidance: Nitrate Vulnerable Zones Guidance: Rules for farmers and land managers to prevent water pollution Government Buying Standards (procurement)	London Food Strategy 2018 London Plan Supplementary Planning Guidance Municipal food policies Local Plans
Food Surplus Reuse	Animal By-Products Regulations 2003 Waste and Resources Strategy 2018	London Food Strategy 2018 Municipal food policies
Food Recycling (waste)	National Planning Policy for Waste 2014 Waste Framework Directive 2009 Waste and Resources Strategy 2018 Urban Wastewater Treatment Directive 1991 Sludge (Use in Agriculture) Regulations 1989 Cross Compliance Rules (agriculture)	London Environment Strategy 2018 South London Waste Plan

Examining some of these, it is noted that the UK's Industrial Strategy advocates for the circular economy, speaks of 'transforming' the food system (HM Government, 2017, p. 47) and placing the UK as a sustainability leader on food (p. 47); but no details are presented. The subsequent 25-year Environment Plan, by contrast, discusses food production through the lens of *improvement* – not transformation (HM Government, 2018). It acknowledges that existing production methods have caused environmental damage of varying types (see, e.g., pp. 39, 40, 43). But nowhere in the document is there discussion of alternative approaches to agriculture such as agroecology, permaculture or even organic methods. Through references to "*low emission* fertiliser" (p. 39, emphasis added), no ambition is set for complete circularity. However some steps in that direction are included, including objectives to reduce GHG intensity of food and drink (p. 89), engaging retailers in food waste reduction (the Courtauld Commitment), and an undefined plan to "work toward" zero food waste by 2030 (p. 90).

On procurement, national regulation is unambitious. Government Buying Standards require some seasonality and that 10% of the value of raw ingredients be farmed according to 'Integrated Production', 'Integrated Farm Management'[3] or Organic standards (DEFRA, 2015). But their ability to shape more sustainable food production, with England's public sector spending over £1 billion per year on food and drink (DEFRA, 2014, p. 2), is mostly unexploited.

[3] The 'integrated' standards are more sustainable than conventional farming, but not necessarily circular, since they involve fertiliser and other non-renewable inputs.

Farming regulations place limits on the use of fertilisers, but only in proximity to water courses and in 'Nitrate Vulnerable Zones'. As such the concern is not with the food system itself. The Agriculture Bill, by contrast, proposes a new system to replace the EU's Common Agricultural Policy. This will mean the payment of subsidies with "public money for public goods" (DEFRA, 2020b), rather than the existing setup in which money is distributed mainly according to the amount of land owned. Through the lens of circularity, a shift in approach to subsidies, which are central to farmers' profit (Full Fact, 2016), could have profound benefits.

In the planning system, food is largely unconsidered. The National Planning Policy Framework, which the London and council plans must conform with, requires only that policies enable "access to healthier food and allotments" (Ministry of Housing, Communities and Local Government, 2019, p. 27) and suggests, almost dismissively, only that the potential for food growing in undeveloped land should be "recognised" (p. 35).

Wastewater (sewage) is an important constituent of the food cycle. Indeed, whatever food is consumed by humans will end up, if not absorbed into the body, flushed into the sewer system[4]. Wastewater processing as a whole is regulated by the Urban Wastewater Treatment Directive 1991, but the recycling of 'sludge' is governed by the Sludge (Use in Agriculture) Regulations 1989. Practical use of it is subject to Cross Compliance, which is a set of rules that must be met to receive agricultural subsidies. This specifies limits to the use of treated sewage for the purpose of farming, including minimum time gaps between application and harvest and maximum permitted mineral concentrations. A recent government policy paper notes, regarding sewage, that "the most sustainable option is to recycle [it] to agricultural land" (Environment Agency, 2020). Approximately 80% of sludge is currently recycled to farmland (Ofwat, 2015).

The National Planning Policy for Waste (NPPW) stipulates that local authorities should work in groups in order to achieve more sustainable waste management (DCLG, 2014). For this reason – but also for reasons of economic efficiency – the South London Waste Partnership (SLWP) was formed, although it holds no statutory basis. The same NPPW document emphasises driving waste management up the waste hierarchy – i.e. making it more circular – which is itself a principle drawn from the EU's Waste Framework Directive. Meanwhile the Resources and Waste Strategy for England dedicates a full chapter to food waste (HM Government, 2018). This considers two approaches for reducing waste: one for food companies to 'do more', and the other for consumers to 'waste less'. On the food company side, key elements include promoting the Courtauld Commitment (a voluntary agreement

[4] This is the case for the present study, but would not apply where other infrastructure (such as composting toilets or sceptic tanks as used in some rural and peri-urban areas) is in place.

aiming to reduce food waste by 20% between 2015 and 2025); government funds proposed to support existing food redistribution efforts; and the appointment of a 'Food Surplus and Waste Champion', effected in December 2018 (HM Government, 2018, pp. 100-106). For consumers, measures include a commitment to review labelling regulations and packaging sizes and requirements – which Kummu et al. (2012) observe in their Table 1 as an effective waste-reduction tool – and a recommendation to local authorities to pilot new initiatives. In practice, these labelling measures are implemented in coordination with supermarkets (see section 4.3) and campaigns on consumer waste reduction are implemented by councils. The scope for the four SLWP boroughs in question to develop independent policies with regards to food waste is determined by:

- Formal targets – a maximum of 35% of biodegradable waste sent to landfill compared to 1995 levels by 2020, according to the Landfill Directive 1999/31/EC;
- Ambition – in Wales, for example, stricter targets apply than in England and accordingly 99% of households benefit from food waste collections (The Environment, Food and Rural Affairs Committee, 2017, p. 24). In England, it is up to each council to set its ambition;
- Finance – for example, Luton council stopped its separate food collections in 2013, citing costs (ibid).

The optimum diversion from landfill, according to the UK government, sees food waste sent to an AD, where it is converted into compost and biogas, which is used to generate electricity (Gregson, et al., 2015). The compost is certified for use in agriculture, appreciated by farmers for its organic content, is cheaper than artificial equivalents (Severn Trent, 2020) and, for our purposes, has the added benefit of circularity. However, 'diversion from landfill' does not guarantee circularity: an alternative is incineration (energy from waste), which generates electricity but loses the nutrients. Setting diversion targets may help, but these are rather blunt instruments that do not always achieve the desired outcomes (Gregson, et al., 2015). The SLWP approach is discussed in section 5.1.3 but it can be noted here that it uses both incineration and AD.

Finally, in legislation, a clause is inserted in section 27 of the 2020 Agriculture Bill to regulate for "fair" contracts that deny purchasers, such as supermarkets, the option to make last-minute changes or cancellations, which have in the past led to the wasting of entire crops.

4.3 LONDON LEVEL

The London Environment Strategy (GLA, 2018) does not consider sustainable food production in its 'Environmental challenges' (pp. 13-15). Food growing receives two glancing mentions within objective 5.1 (to make more than half the city green), but greater emphasis is given in chapter 7, Waste, where

food is identified as one of five priority areas. But if an ambitious target of zero biodegradable waste to landfill by 2026 is stipulated, the Mayor simultaneously concedes "very limited direct powers" here (p. 25).

The 2018 London Food Strategy is the second iteration of a food policy for the capital. The first, in 2006, stated that "the environmental consequences of the way London's food is grown, processed, transported and disposed of are profound and extensive" (London Development Agency, 2006, p. 17). If the more recent version slightly moderates its language, the strategy nonetheless devotes one chapter, out of six, to the environment and notes that "almost 10 per cent" of the city's consumption-based GHG emissions are associated with food and drink (GLA, 2018, p. 12). The key topics which touch on the circularity of the food system (production, reuse of surplus, and waste) are addressed, with proposals for action set out in seven points (p. 21), grouped here into four central themes:

- reduction of food waste (points 1 and 2 in the strategy; and point 5, which concerns behaviour change campaigns, funded by the Mayor and Boroughs),
- procurement of sustainable food within the GLA (point 3)
- offering citizens more choice of seasonal and local food via markets (point 6)
- provision of more water fountains to reduce plastic bottle waste (point 4)
- encouraging local councils to adopt campaigns on healthier food (point 7, not relevant here).

Indeed, policy at the London level relies more on influence than direct authority, which explains a focus on 'campaigns', 'choice' and 'encouragement'; it is only in Planning, via the requirement for boroughs to develop documents "in general conformity" with the London Plan, per the Planning and Compulsory Purchase Act 2004, that the Mayor wields significant power.

Here, we see mixed messaging. The London Plan (GLA, 2016) requires in policy 7.22 that boroughs should protect existing allotments and identify "other potential spaces" for food growing, either commercially or by communities, and Supplementary Planning Guidance relating to "Sustainable Design and Construction" (GLA, 2014) asks councils to provide, "where possible", food growing space, including as a 'meanwhile use', suggesting use of section 106 negotiations to achieve this. Guidance for the All London Green Grid (GLA, 2012) notes one of the grid's main functions as to "promote sustainable food production" while not actually discussing sustainability in the text (p. 67). Further, the London Planning Statement (GLA, 2014b), which says it highlights priority issues for the Mayor, makes no reference to food and confines its discussion to sustainable growth.

Taken together, these documents reveal only one clear policy – to protect existing allotments. The language concerning the addition of new food growing spaces is soft, leaving ample scope for

developers to argue against any insistence on the issue from planners. The Institute for Fiscal Studies calculates a fall by over 50% in funding for planning departments in the eight years to 2018 (Amin-Smith & Philips, 2019, p. 6), suggesting that even enthusiastic planners would struggle to implement an urban agriculture agenda.

Procurement offers possibilities for stronger impact by shaping market demand, and arguably through influencing what policies local authorities adopt. Yet the commitments are vague. For comparison, a strong example can be found in Malmö, which targeted all food purchased by the municipality to be organic by the end of 2020 (Moragues-Faus & Morgan, 2015, p. 1562).

4.4 Non-government actors: supermarkets & the National Farmers' Union

The major supermarkets, as a group of ten companies responsible for approximately nine in every ten pounds spent on food purchases (National Statistics, 2020c) – and therefore with considerable bargaining power vis-à-vis food producers – could play a key role in the food system's sustainability. Their relationships with suppliers and consumers, and how this nexus feeds into sustainability discourse, is a topic worthy of a research paper in itself, especially in light of suggestions that corporations "may be more important in shaping food systems than governments" (Lang & Heasman, 2015, p. 2).

For this paper's analysis, the policies of the largest chains were examined and, given their dominant market share, were considered largely representative of the situation of food retail in the SLWP area (see Table 2); indeed "most urban consumers [in England] shop in supermarkets and use smaller, local retailers less often than rural consumers" so the market share may in fact be higher (Khan & Prior, 2010, p. 162).

Table 2: UK market share of food retail 2017-18. Data taken from (National Statistics, 2020c)

Retailer	% market share
Tesco	21
Sainsburys	11
Asda	10
Morrisons	9
Aldi	8
Lidl	5
Marks and Spencer	4
Waitrose	4
Co-op	4
Iceland	3
Via internet	7

Big supermarkets* *assuming identical supermarket share of internet sales, the distribution of which was not specified	84.5

The different retailers have published policies on reducing waste and food waste, and improving sustainability. While space prevents a case-by-case review, the approach of the market leader, Tesco, is an indicative example. Corporate literature specifically addresses agriculture – responsible for over 60% of Tesco's emissions – including "optimised application" of fertiliser, "energy efficiency" and "building soil organic matter" (Tesco PLC, 2020).

Waste fat and oils are converted into biofuels (Tesco PLC, 2020b). Food surplus is either offered for redistribution ("48 million meals since 2016"), sold to staff, or where these measures are unsuccessful, "remaining bakery, produce and dairy surplus [are sent to] animal feed" (Tesco PLC, 2020c). Nothing specific related to organic food was found. This is relevant because there is some evidence to suggest that the more a country depends on supermarkets for its food purchases, as in the UK, the lower the proportion of organic food bought (Willer, et al., 2018).

All the supermarkets redistribute their surplus, although only Tesco and Sainsbury's to a significant degree (see Table 9, appendix 3). Major distribution channels include resale apps Olio and TooGoodToGo, and charities FareShare, Trussell Trust and Felix Project, along with myriad local partners. An author analysis of published data from the larger companies revealed that an important majority, estimated around 62% but possibly higher, of surplus food ends up in anaerobic digestion (AD), and that the amount of food waste sent to landfill is close to zero (see Table 9, Table 10, Appendix 3).

The large retailers all take steps indicative of greater circularity, such as reducing fossil fuel-derived packaging, and schemes that reduce food overproduction by selling 'wonky' vegetables – offered in certain shops by Aldi, Asda, Lidl, Morrisons and Tesco – or, like in the case of Sainsbury's, using these elsewhere (e.g. using wonky potatoes for mashed potato). These are coupled with targets on emissions reductions, and adherence to the Courtauld Commitment by all the brands in Table 2, in addition to a number of other voluntary social responsibility measures such as commitments to 'zero deforestation' food sources (see e.g. Wm Morrison Supermarkets Plc, 2020, p. 26; Tesco Plc, 2018).

But the 'consumer' is seemingly not trusted to prioritise sustainable (i.e. more expensive) food. This is revealed by the reluctance of individual supermarket companies to act unilaterally: commitments refer to own-brand products, harmful third-party products are not phased out, and pledges come with generous time-lags. The Chief Executive of Tesco calls for strong regulations on deforestation, food

waste reporting and mandated emissions reductions, inter alia (Lewis, 2020), but reduces corporate risk by limiting his own company's pace of change. The approach of taking minor steps, while calling for a stronger regulatory regime to shift to more sustainable practices, is also detectable in the position of another group of non-government actors: farmers, as represented by the National Farmers' Union.

National Farmers' Union

The National Farmers' Union (NFU – representing farmers in England and Wales) proposes three 'pillars' that will improve the sustainability of agriculture, which are: (1) improving productivity; (2) carbon sequestration into soils and vegetation; (3) building a bioeconomy to replace fossil fuels with biofuels (NFU, 2019, p. 6). These are played out in practice through an accompanying 'Doing Our Bit' document that showcases examples of these pillars being put into practice, such as one farmer buying rapeseed rather than imported soya to feed his cows, or another farmer stating his ambition to move to 'no-till' cropping (NFU, 2020).

The NFU claims that voluntary, industry-led actions like these have improved environmental outcomes (NFU, 2017). The extent to which voluntary changes can lead to greater circularity is, however, questionable, because in lacking market or government incentives, these measures depend on actions of individual farmers like those who are 'doing their bit'. This likely explains why the NFU also pushes for a shift in subsidy regime that rewards good environmental stewardship (ibid). It is worth recalling that the lion's share of income in UK farming is derived not from sales but from subsidy, according to a fact-checking charity (Full Fact, 2016).

5 CASE STUDY: THE SOUTH LONDON WASTE PARTNERSHIP AREA

5.1 SLWP BOROUGHS: POLICY ANALYSIS

Within the context of national and regional requirements laid out above in section 4, we can now proceed with an analysis of the policies directly controlled by the boroughs in the South London Waste Partnership. Sutton, Merton, Croydon and Kingston each have distinct Local Plans (often called Core Strategies), which are important from the 'Reduce'/food production perspective as they describe how land is, or is not, protected and allocated for local food growing. This is discussed first. Subsequently, food policies – which can drive sustainable procurement and encourage food re-use and community gardening – are analysed, although it is noteworthy that none of the councils has a specific strategy regarding the food sustainability. Food waste policies, including waste collection, is examined next. In this case, the strategy is determined jointly by the South London Waste Partnership, underpinned by an inter-authority agreement. The final section provides detail on wastewater but, as noted in section 5.4, this is not subject to municipal control.

5.1.1 Food Production

The higher-order planning documents, at the National and London level, frame the environment and set the boundaries within which local plans are written. As we have seen, the relevant documents do not offer powerful terms for protecting and promoting food-growing space, and local councils must largely fend for themselves. Considering that the draft new London plan, once approved, would raise housing targets considerably – by 223% in the case of Merton (Merton Council, 2019) – some further modesty is required, with urban municipalities facing significant constraints on land. Further, if a best-in-class city like Singapore provides for 25% of its own vegetable needs (Girardet, 2008, p. 239), then London's high point during World War Two saw allotments provide 'only' 10% of all needs (London Borough of Sutton & idverde, 2018). In other words, the context must be borne in mind when reviewing the capacity of local authorities to improve food circularity at the level of production.

As it happens, discussion of food growing in Sutton's plan is scant. Reflecting the London Plan approach, allotments and community food-growing spaces are seen positively, but, as discussed in Policy 25, only "where practicable" and only to the extent of "encouraging" developer provision, and existing allotments are open to decommissioning in a situation of 'no demand' (London Borough of Sutton, 2018).

Merton, for its part, offers unambiguous protection for allotments in policy 21.7 of its Core Strategy, but like Sutton only "encourages" the use of land for food growing (London Borough of Merton, 2011).

Merton recognises the positive role of food growing for environmental sustainability in its Allotment Strategy (London Borough of Merton, 2006).

In Croydon, the discourse is somewhat more developed – its plan includes a specific policy (7.5) on Productive Landscapes (London Borough of Croydon, 2018). This states that the council will protect and "enhance" allotments and community gardens, and discusses options for 'meanwhile uses' of space for food growing as well as edible planting. This said, the language remains limited to "encouraging" these actions; and limited resources could be an impediment as noted in section 4.3. The listed benefits focus on health and community cohesion rather than a consideration of the sustainability of the food system – a common theme that nonetheless plays a part in promoting public support for greater circularity.

The approach in Kingston is perhaps the most thought-through. Its 2012 Local Plan, called the Core Strategy (The Royal Borough of Kingston, 2012), while using the same language of 'encouragement' seen in other plans, goes further in its analysis by linking food growing to wider environmental objectives:

> *"The promotion of local food growing in the Borough will have numerous benefits for residents and supports the objectives of the Kingston Plan. It will reduce the carbon footprint of food production by minimising CO2 emissions produced from transporting food and therefore is beneficial for air quality and the reduction of pollution levels. It supports healthy living by enabling residents to make more sustainable food choices, protects local ecosystems and helps generate new communities" (section 6.15).*

Unlike in Sutton, Kingston's protection of allotments is far clearer, less conditional, and its vision for 2027 includes "increased local food grown with more allotments provided". Table 3 summarises the SLWP boroughs' approaches to food growing.

Table 3: SLWP planning for food spaces

Borough	Allotments (area if available)[a]	Community Gardens[b]	Planning approach[c]
Sutton	36 (?ha)	10	Allotments not protected if demand is gone; more food growing *only* if other Local Plan policies are not compromised
Merton	18 (26.52ha)	5	"Will protect" existing allotments; 'encourage' use of land for growing food
Croydon	17 (?ha)	5	Protect and enhance allotments and community gardens
Kingston	23 (41.7ha)	2	Any loss must be recuperated elsewhere; 2027 vision for more local food and allotments

a: (Croydon Council, 2019) (RB Kingston Upon Thames, 2012, p. 119) (Merton Council, 2006) (Sutton Council, n.d.)
b: manual count by author using geo-pins/postcode checks, from mapping by (Capital Growth, 2020). Note: community gardens not registered with Capital Growth are likely to exist.
c: own summary based on Local Plans as discussed in section 5.1.

In review: all boroughs afford some protection of allotments in their Planning documents. Sutton's vision on food growing spaces is the weakest, Merton's approach fairly neutral, while Croydon and Kingston show stronger enthusiasm. Kingston's prioritisation is also reflected in Food Strategies, discussed next.

5.1.2 Food re-use

Food strategies take different names ('charters', 'plans', 'policies'), yet in the SLWP area, no specific strategies from the past ten years relating to the sustainability of food system were found during research. It is probably unfair, and even undesirable, to expect specialist policies: fixing the cohort of problems involving socio-economic inequalities, ecological stress, urbanisation and waste "entails a shift from the conventional tendency to address single issues to the adoption of a systemic perspective that takes into account the interrelatedness of the whole food chain and of the whole food cycle" (Sonnino, 2016, p. 193).

SLWP policies addressing food, and not specific to waste (see section 5.1.3), emphasise reducing food poverty or improving health. Municipal influence is largely expressed through persuasion rather than legal authority. Merton council, among its 13 objectives for reducing food poverty, "encourage[s] businesses" to work with food redistribution organisations such as FareShare and Plan Zheroes, and seeks to "build partnerships" that will encourage community food growing (Merton Council, 2017), while Kingston's official food poverty action plan proposes "improved distribution of surplus" through engagement with supermarkets and smartphone apps – one of 26 recommended activities (Kingston Voluntary Action, 2018). In Croydon, efforts include a mapping exercise of food points and of professional services so that residents can be better supported (Croydon Council, 2017). No plan was found for Sutton.

This reveals an active landscape of work that connects food insecure people with spare resources, involving a lively network of voluntary organisations, retailers and spatial hubs (such as schools), often bridged together by municipal official. All create 'cascades' (see section 2.2) and contribute towards greater circularity.

Food procurement – notably with schools – is another opportunity area. Evaluation by the organisation Food For Life (part of the Soil Association) awards 'badges' in this regard. For example, a Gold Badge is awarded when, among other criteria, 15% of food in an establishment is organic certified (Foor For Life, 2020). Kingston and Sutton score well here (see Table 4). But no council-wide procurement policies favouring organic or sustainable food were found during an assessment by the author, for any of the four boroughs (again Table 4; and Table 8 for breakdown, in Appendix 2), suggesting that successes are *ad hoc*. While Croydon and Kingston have, or are soon to have, targets

on contracting from local businesses, only general references to environmental sustainability are made.

Table 4 aggregates information from this section, including an additional column attributed to policies on community food growing as assessed by Capital Growth, a food growing network supported by the Mayor of London, to give an overall picture.

Table 4: Council scores on food growing, procurement and surplus redistribution

Borough	**Community Food Growing**[a] (best=3)	**Food For Life**[b] (best=3)	**Council-wide organic minimums** (1= has policy)	**Food surplus redistribution?** (1= has policy)	**Total out of 8**
Merton	2	0	0	1	3
Sutton	2	2	0	0	4
Croydon	3	0	0	1	4
Kingston	3	2	0	1	6

a: tabulation of Capital Growth's review of each council's approach (Sustain, 2019, p. 7). *Detailed in Appendix* 2
b: tabulation of Food For Life (FFL) review of each council's procurement (Sustain, 2019, p. 10). *FFL awards local and organic ingredients in school meals* (Sustain, 2019, p. 10). *Detailed in Appendix* 2.

Thus it can be seen that the SLWP councils' approach to community food growing is quite developed, and Kingston reveals itself as a good performer both in food strategy and in Planning. But all can strengthen their procurement policies. In an example of success set by Preston, tenders for school meals were broken down into nine sub-categories, rendering the contracts small enough for local businesses to compete (Steel, 2020, p. 169).

5.1.3 Food recycling

The four boroughs of this case study jointly formed the South London Waste Partnership in 2003, seeking financial efficiencies, but such partnerships are also driven by national legislation (see section 4.5). Bound by an inter-authority agreement with legal force, its role is to collect and dispose of waste, including food waste. Food waste collection by local authorities in England can play a significant role in improving the circularity of the food system. This is because, when it comes to food waste, households are the main contributors, holding responsibility for an estimated 70% of the total food thrown away (WRAP, 2020). This is not true everywhere in the world (Kummu, et al., 2012)[5].

In England overall, only 46% of households had access to food waste collections in 2014/15 (WRAP, 2016), but the four SLWP boroughs do provide this service. The waste is collected by Veolia, who deliver it to an AD facility in Chertsey, operated by Severn Trent. The most recent data show 26.5kt of food waste collected during the year 2018/19, all of which is sent for digestion (SLWP, 2020). The author calculates this as 21.8% of household food waste in the borough (Table 6, Appendix 1). This

[5] In the FAO's Africa region, households are associated with less than 10% of waste (op cit, Figure 4)

means a large majority of food waste is not digested. Rather, it is converted into electricity via incineration at a new facility in Sutton run by Viridor. Thus even though put to use, such waste does not contribute to circularity in the food system. The best performing boroughs achieve rates that approach 70% (WRAP, 2016, section 3.2). Thus there is significant room for improvement among the four SLWP councils.

The SLWP already offers a separate food waste collection, shown as important for good performance (Bees & Williams, 2017). Partnership minutes show that aside from working together for the collections, the SLWP bids jointly for funds to support publicity campaigns promoting waste prevention and waste recycling, which is supplemented by community engagement work from contractor Veolia (SLWP, 2019). These campaigns appear to have an effect: the overall amount of waste has fallen since 2016, yet the amount of *food* waste collected has risen (SLWP, 2020). But work by WRAP shows further increases are possible: up 40% in Norwich, largely through providing free liners for food caddies and adding 'no food waste' stickers to refuse bins (WRAP, 2020b). Neither of these are currently offered in the SLWP. If a continuation of publicity campaigns were combined with the adoption of new policies like those trialled in Norwich, food circularity would be likely to increase.

5.1.4 Wastewater

Thames Water operates the water treatment facilities covering the four-borough area under study, with the relevant facilities at Beddington, in Sutton; Crossness, in Bexley; Hogsmill, in Kingston; and Long Reach, in Dartford (South London Waste Planning Authorities, 2019). All produce 'biosolids', the term used by Thames Water to describe sewage that has been converted into fertiliser, which are sold to farmers for application on their fields. In theory, this is an excellent example of circularity in the food system. Everything produced by Thames Water is used (Perry, 2020).

However, the total potential mass of biosolids is reduced during processing. Some is lost through dehydration, performed to deliberately reduce the weight and therefore transportation cost. The larger part is lost when sludge is incinerated prior to digestion, as occurs at Beckton and Crossness plants (Thames Water, n.d.). This allows for more electricity to be produced compared with digestion (Tan, et al., 2014). Subsidies for renewable electricity generation, regulatory incentives placing increasingly stringent limits on the use of biosolids, and commercial imperatives are leading to a downward shift in biosolid outputs, according to Thames Water (Perry, 2020). From the perspective of food system circularity, this would constitute a backwards step – biosolids are, in the water industry's own estimation, a "necessary" part of sustainable resource use and needed for "safeguarding the future food security in the UK" (Bangor University, Water UK & ADAS, 2014, p. 2).

5.1.5 Summary

If planning allows for the protection and expansion of food-growing space, the SLWP authorities only go so far. They face considerable pressures to release land for construction. In light of this, the commitment of each authority, supported by London's regional strategy, to protect allotments is worth praising but does pose questions about the capacity of municipal authorities to shape circularity from the perspective of production. The most important element of food growing may be the stimulation, through engagement, of higher demand for more sustainable food (section 2.3).

Through procurement policies, where the SLWP councils are weak, and food strategies, where policies are established, they have more scope to increase circularity in the food system. The most significant contribution, however, is framed by the approach taken for diverting food waste from landfill, as required by London targets. The majority of food is currently incinerated, and so nutrients are lost. However by already implementing separate food waste collections for delivery to a digester, and by engaging in publicity campaigns, the SLWP has taken steps that improve circularity. But more can be done.

5.2 CIRCULARITY INDICATORS

This section contains data, represented in a table of indictors and a flow diagram, to help advance our analysis of the SLWP area. The table of indicators, Table 5, contains metrics used to assess the circularity of the food system, as well as a 'comparator': an example from elsewhere in Europe that scores well. The rationale behind each metric is explained in Table 11, Appendix 4. They include, to give some examples, (i) the market share of Organic food, (ii) SLWP procurement policy, and (iii) the amount of food waste collected for anaerobic digestion. Respectively, these are indicators of (i) food grown using renewable inputs, (ii) how the public sector does (/not) stimulate higher supply of Organic food, and (iii) the extent of recycling-to-fertiliser that takes place. The table does not purport to count all material flows. Rather, it is an analytical tool that reveals the areas of strength and weakness.

The flow diagram serves to illustrate the fundamental parts of the food cycle with selected data included to help visualise the strengths and weaknesses of the food system in the SLWP area.

Table 5: Circularity indicator table

		Indicator	Data (year of information)	Circularity	Competence	Comparator
Reduce	1	Amount of land in UK dedicated to Organic farming (England)	2.7%	Poor	National	22% (Austria)
	2	Proportion of farmland adopting precision farming, green manuring & soil nutrient monitoring (England)	24% precision farming, 17% green manures, 27% soil software	Poor	National	-
	3	Proportion of fertiliser used that is organic: i.e. renewable (England)	7.56% (N), 31.25% (P), 50.91% (K)	Poor	National	-
	4	Policies on fertiliser use (England)	Limits for Nitrate Vulnerable Zones and near water courses	Poor	National	Biofertiliser promotion; carbon farming (EU)
	5	Proportion of food imported; 'indigenous-type' food grown domestically (UK)	47%; 77%	Poor; Medium	National	>100% (Hungary)
	6	Proportion (%) of overall food consumed that is Organic (UK)	2.97%	Poor	National/ SLWP	10% (Denmark)
	7	Food from urban agriculture (England/SLWP)	3-5% (SLWP: 94 allotments, 22 community gardens)	Poor (*but limited space)	SLWP	33% (Netherlands)
	8	Capital Growth score on promotion of community food growing (SLWP)	10 (out of maximum 12)	Good	SLWP	*('Good' achieved)*
	9	Planning policy to protect/promote local food production (SLWP)	Medium to Good	Medium-Good	SLWP	Strong (Milan)
	10	Public procurement policy requirements for Organic food (SLWP)	Same as national requirements	Poor	SLWP	100% min. (Malmo)
	11	The UK electricity grid fuel mix (UK)	36.9% renewable (2019); 14% of electricity needs related to food and farming (2020)	Medium	National	54.6% (Sweden)
Reuse	12	Food surplus to food banks or sold to staff (UK)	7%	Poor	-	-
	13	Food surplus to animal feed (UK)	7%	Poor	-	-
	14	Active policies to promote re-use (SLWP)	3 of 4 SLWP boroughs	Good	SLWP	*('Good' achieved)*
Recycling	15	Unsold surplus recycled into fertiliser (UK)	62%+	Good	-	*('Good' achieved)*
	16	Unsold surplus wasted at landfill (UK)	0-1%	Good	-	*('Good' achieved)*
	17	Household food waste collection percentage (SLWP)	21.8%	Poor	SLWP	70% (UK)
	18	Councils financially supporting home composting? (SLWP)	Yes	Good	SLWP	*('Good' achieved)*
	19	Sewage converted to biosolids	~80%	Good	Thames Water	*('Good' achieved)*
	20	Biosolid sales	131kt	-	-	n/a
	21	Surplus wasted before leaving farm	2mt surplus + 1.6mt wasted	Good	-	*Minor diff.* (E. Asia)

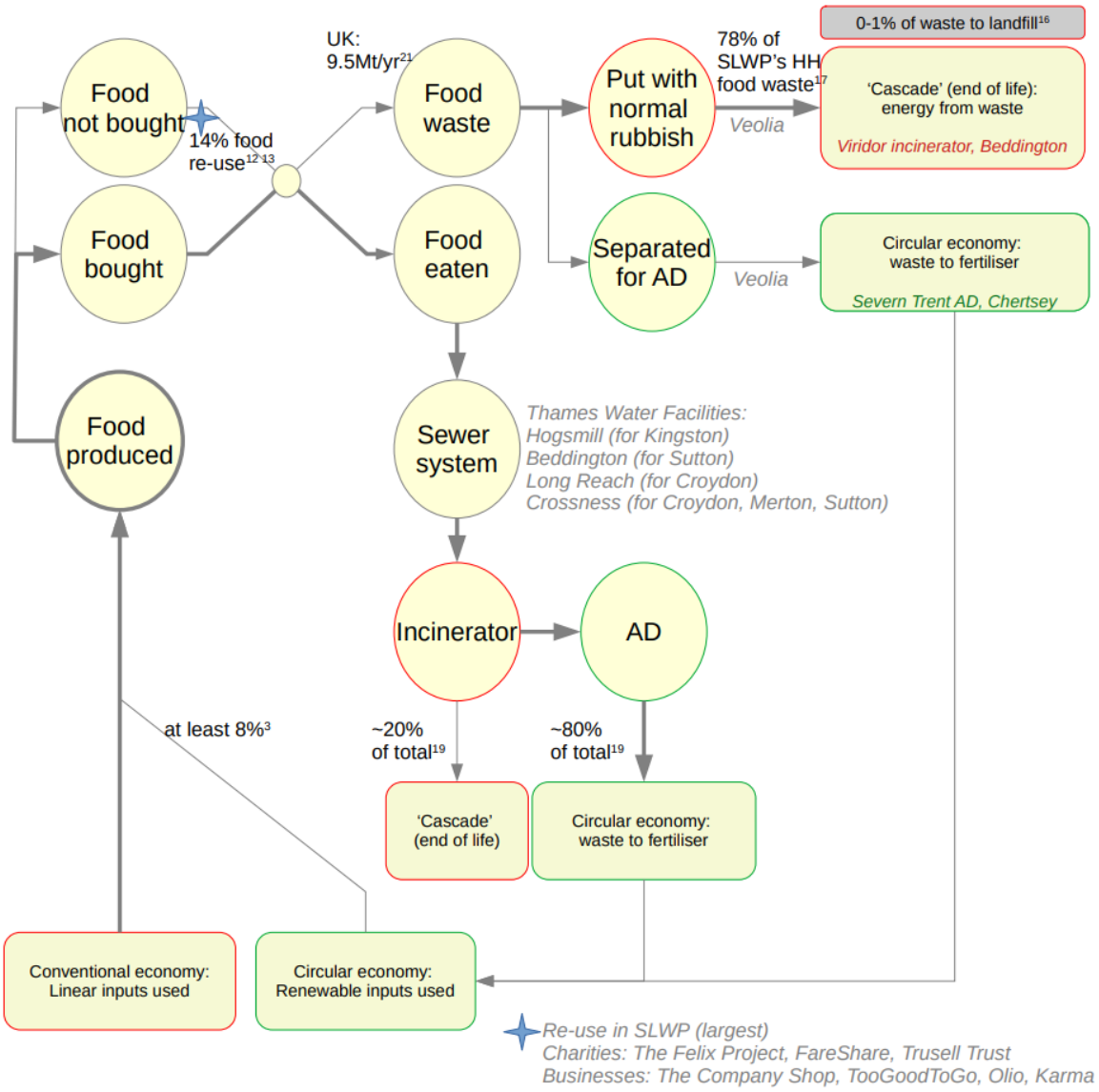

Figure 3: Flow Diagram
Source: author; data sources are indicated by numbers in superscript, which reference a row number in Table 12
HH = household. AD = anaerobic digester. SLWP = South London Waste Partnership

Entities in italics indicate stakeholders

Analysis

Study of table 5 shows that the highest level of circularity in the SLWP area can be found in the Recycling phase, notably through sewage recycling. Yet despite this, there are weaknesses. This is best represented via the flow diagram: the main weakness relates to the poor participation of households in separating food waste from general refuse, with 78% of household food waste going to incineration in the SLWP – which can be significantly improved by drawing lessons from other English authorities. Potential for greater circularity exists and is achievable.

The Reduce (production) phase does not perform well owing largely to extensive use of artificial fertilisers, a lack of policies to regulate this or promote renewable alternatives (these are national competencies), and limited attention given to procurement. On the latter, there is scope for SLWP intervention, which would stimulate greater circularity. This said, SLWP approaches to food production space and community food growing are adequate or good.

Food Reuse, despite council efforts to promote it, is not very high: most retail surplus is sent straight to anaerobic digestion. There is a missed opportunity, from the food system viewpoint, to strengthen this 'cascade' and retain value. Yet since only 0-1% of surplus retail ends in landfill, the circularity overall is good.

Most areas where circularity is assessed as 'poor' fall under the purview of national government. This does not excuse the SLWP boroughs from making improvements, options of which were outlined earlier. But it does reveal that a more sustainable system will only result from multi-scalar efforts, including national directives, regional support, and locally robust implementation.

6 CONCLUSIONS

While this paper has considered the potential for circularity within the existing food system, arguments for greater sustainability are often accompanied by demands for radical increases in municipal power (Lang, 2019) or people power (Biel, 2016), frequently in tandem with a paradigmatic shift in food production methods that rejects the incremental improvements of green growth, in favour of a holistic approach, e.g. agroecology (Duru, et al., 2015). That is an ongoing debate: whatever the future path, municipalities will have a role to play in the sustainability of the system.

This dissertation shows that within their area of responsibility, local authorities have significant potential to close the food loop, even within the confines of national governance. While subsidy schemes (say, to penalise artificial fertiliser use or to incentivise organic fertilisers) are the purview of parliamentary legislation and government, there is necessarily a link between low municipal recycling rates and the poor circularity of food production in the UK. Strikingly, the SLWP converts barely more than a fifth of its 122 thousand tonnes of household food waste to fertiliser, yet farmers' demand for organic fertiliser exceeds supply.

By learning from more successful authorities (e.g. Norwich (WRAP, 2020b)), food recycling rates can be driven up. Adopting bolder procurement policies (e.g. Malmo (Moragues-Faus & Morgan, 2015)) can stimulate greater supply of Organic food. Planning provisions, though always a balancing act where land is expensive, can protect and enhance urban food-growing space, following Kingston's positive example.

The gap between the relative linearity of the SLWP food system and a hypothetical, fully-looped food cycle can be shrunk by implementing measures that already exist, such as those mentioned above. Yet more research will be needed after the low-hanging fruit has been picked. Although WRAP conducted its own research on improving food recycling rates, academic study in this area remains limited and could reveal further avenues of pursuit. Additionally, UK supermarkets sell less organic food compared to their market share for groceries (Willer, et al., 2018, p. 247), suggesting that local shops benefit circularity. Research could examine this relationship and question if local planning designations should be used to promote local shops over supermarkets. Finally, a material flows analysis in the style of Bahers et al. (2019), determining the SLWP's "territorial metabolism" – a new area of research – could provide a visual mapping of all inputs and outputs: a useful complement to the present policy analysis, and a potentially compelling tool for policymakers.

Yet there is already sufficient information to state that the present food system operates according to a highly linear model. Despite this, even without an overhaul of the system, requiring national intervention, there is ample scope to improve circularity in the SLWP. The developing world of urban food strategies will likely continue to advance, offering further lessons. The potential for greater circularity is there – it remains only to be put into effect.

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9 APPENDICES

APPENDIX 1: BREAKDOWN OF WASTE STATISTICS

Table 6: Success in food waste collection 2018/19

South London Waste Partnership Area

	Tonnage	As %
Total HH waste collected	331,356[a]	
Total HH food waste	121,608*	36.7% of all waste[b]
Food waste collected for AD	26,542[a]	21.8% of food waste
Best realistic scenario (food waste collected)	54,508*	70.0% of food waste[c]

HH = household
Sources:
a = (SLWP, 2020)
b = assuming same proportion as all London in from Table 7: Household food waste compared with all household waste, 2017 (tonnes), below
c = (WRAP, 2016, section 3.2)
** = calculation based on percentages*

Table 7: Household food waste compared with all household waste, 2017 (tonnes)

	London	England	Wales	Scotland	Northern Ireland
Food waste (kerbside residual waste)	768,718	3,630,649	102,499	293,217	78,358
Food waste (kerbside recycling)	104,156	526,252	115,340	80,855	23,458
Sub-total 1	872,874	4,156,901	217,839	374,072	101,816
All waste (kerbside residual)	1,593,663	10,449,447	414,863	1,052,182	325,867
All waste (kerbside recycling)	786,770	7,232,374	509,370	704,677	248,723
Sub-total 2	2,380,433	17,681,821	924,233	1,756,859	574,590
Food waste (kerbside) as proportion of total	**36.7%**	**23.5%**	**23.6%**	**21.3%**	**17.7%**

Source: Author, with data from Tables 8 and 9 of (WRAP, 2019)

APPENDIX 2: COUNCIL POLICY EVALUATIONS

Council Procurement Document Analysis

Table 8: Council Procurement Policies

	Annual spend (£million)	Local purchasing requirements	Environmental concerns (including organic food)
Croydon[a]	500	Yes, for small contracts	General reference only
Merton[b]	200	Not mentioned	Not mentioned
Kingston[c]	not found	Under consideration	General reference only
Sutton[d]	175	Not mentioned	Not mentioned

Sources: a: (Croydon Council, 2019) (Croydon Council, 2019b) ***b:*** (Merton Council, 2018) ***c:*** (Kingston Council, 2020) (Kingston Council, 2020) *note: a consultation to update Commissioning policy recently concluded; the new policies are not yet written, but targets on local purchasing are cited as under consideration on the website. Note: 'ethical procurement' policy document could not be retrieved online.* ***d:*** (Sutton Council, 2015)

Community Food Growing score: Councils were assigned scores of 0, 1, 2 or 3 according to the analysis in Figure 4 below. Thus 'Council supports the work of Capital Growth through taking action in all of the above areas' (darkest green) scores 3; 'Council taking action in two of the above areas to encourage food growing' scores 2; and so on.

The action areas referred to are: "access to land; integration of growing in different council departments; provision of information and promotion of food growing; and building the capacity of growers."

(Sustain, 2019, p. 7)

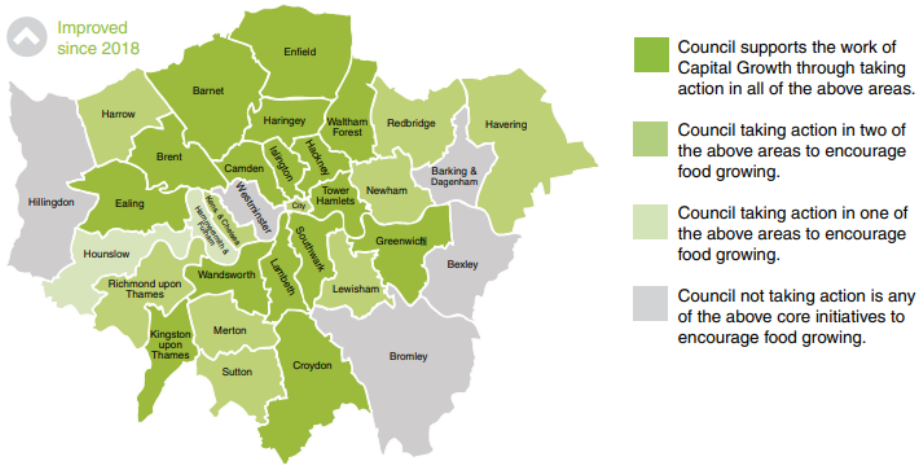

Figure 4: Community food growing scores according to Capital Growth

Food For Life score: Councils were assigned scores of 0, 1, 2 or 3 according to the analysis in Figure 5 below. Thus 'Borough has achieved Gold Food for Life Served Here for the majority of schools AND for one or more additional sector(s) of catering under council control' (darkest red) scores 3; each lighter colour receives one less point.

Gold reward criteria, for example, requires high use of local ingredients and "a minimum of 15% organic and 5% free range" food; full details are available online (Foor For Life, 2020).

Figure: (Sustain, 2019, p. 10)

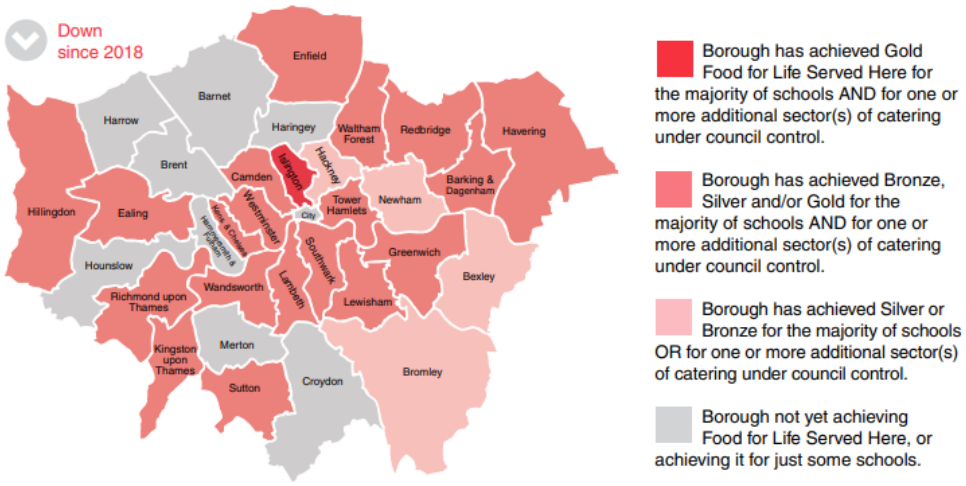

Figure 5: Food For Life scores according to Soil Association

APPENDIX 3: DESTINATIONS OF SURPLUS FOOD

Table 9: Major groceries' use of surplus food

	Asda[a]	Aldi[b]	Lidl[c]	Morrisons[d]	Sainsburys[e]	Tesco[f]
Market Share (>5%)	10%	8%	5%	9%	11%	21%
Destination of surplus						
Food donated/sold	4%	3%	1%	1%	8%	26%
Food to animal feed	0%	0%	0%	nd	23%	21%
Food to AD*	93%	97%	99%	nd	69%	ns
Waste to Energy	3%	0%	0%	nd	0%	ns
Other non-waste	1%	0%	0%	nd	0%	53%
Landfill	0%	0%	0%	1%	0%	0%
Total	100%	100%	100%		100%	100%

*AD = anaerobic digestion
Nd = no data
Ns = not specified
a: (Asda, 2020) b: (Aldi, 2020) c: (Lidl Great Britain, 2020) d: (Wm Morrison Supermarkets Plc, 2020) e: (Sainsbury's Supermarkets Ltd, 2016) f: (Tesco PLC, 2020c)
Where data was published in raw figures, these were converted to % by the author

Table 10: Estimated destinations of unsold food

Route of food unsold	Total (from major groceries)[a]
Tonnage total	377,280
For human consumption (min)†	7%
Animal Feed (min)†	7%
Food to AD (min)*	39%
Food to AD (midpoint)**	62%

AD = anaerobic digestion
a: sources are the same as used in Table 7
†: this is a minimum amount because tonnage from Morrisons is included, but Morrisons do not provide a breakdown for most of how their unsold food is used.
**The minimum amount excludes unsold food from Morrisons and Tesco (for whom specific data is not published) that is not donated or landfilled, but does include their total tonnage.*
***Assumes that 50% of Morrisons and 50% of Tesco's unsold food not landfilled and not donated is sent to AD. This is probably an under-estimate, given other companies' proportions of AD use (see Table7). Tesco state that 53% of their unsold food is either sent to AD or waste-to-energy, but the breakdown is not given. Morrisons state that 1% of unsold food is landfilled and 1% is donated. The rest is assumed to be sent for animal feed, to AD or waste-to-energy.*

APPENDIX 4: INDICATOR TABLE DETAIL

Table 11: Indicator selection rationale

		Indicator	Rationale
Reduce	1	Amount of land in UK dedicated to organic farming (England)	Organic farming uses renewable inputs, not fossil-fuel-derived fertiliser. The higher the % of land that is organically farmed, the more circular the system.
	2	Proportion of farmland adopting precision farming, green manuring & soil nutrient monitoring (England)	These methods reduce the amount of artificial fertiliser needed.
	3	Proportion of fertiliser used that is organic: i.e. not from artificial manufacturing (England)	Farming can use organic (small 'o') fertiliser, such as biosolids, that are not Organic (capital 'O') certified. Yet these are also renewable inputs.
	4	Policies on fertiliser use (England)	Policies to limit (artificial) fertiliser use, or to encourage (organic) fertiliser will lead over time to greater circularity
	5	Proportion of 'indigenous-type' food grown domestically (UK)	A higher number here indicates lower metabolic rift (see section 2.3)
	6	Proportion (%) of overall food consumed that is Organic (UK)	This includes imported produce (unlike indicator 1) and paints a picture of citizen demand for Organic
	7	Food from urban agriculture (England/SLWP)	A higher number indicates lower metabolic rift and greater connectivity between people and food, which is argued to stimulate higher environmental awareness (see section 2.3)
	8	Capital Growth score on promotion of community food growing (SLWP)	This will impact indicator 7, and possibly 6, over time
	9	Planning policy to protect/promote local food production (SLWP)	This will impact indicator 7, and possibly 6 (and to a small degree in 1, in Sutton, where there is agricultural land) over time
	10	Public procurement policy requirements for Organic food (SLWP)	Stimulates demand for Organic food, impacting indicators 1 and 6.
	11	The UK electricity grid fuel mix (UK)	Provides context for the overall impact of the food and agriculture industry
Reuse	12	Food surplus to food banks or sold to staff (UK)	A 'cascade' (retention of value) in circular economy terms. A higher number also reduces energy, transport requirements related to waste processing
	13	Food surplus to animal feed	As for number 12
	14	Active policies to promote re-use (SLWP)	As for number 12
Recycling	15	Unsold surplus recycled into fertiliser (UK)	Waste as an input: a higher number is more circular
	16	Unsold surplus wasted at landfill (UK)	Indicates a linear process. A lower number is more circular
	17	Household food waste collection percentage (SLWP)	Food waste that is collected will be recycled into fertiliser, but nutrients are lost from what is not collected. A higher number is more circular.
	18	Councils financially supporting home composting? (SLWP)	Reduces energy costs for food waste collection and allows local circularity within urban agriculture
	19	Sewage converted to biosolids	Waste as an input: a higher number is more circular
	20	Biosolid sales	Provides context for 19
	21	Surplus production or wasted before farmgate sale (point 3)	Indicates unnecessary inputs (which are mainly linear in the present system)

Table 12: Sources for Indicator Table

This provides the sources for Table 5: Circularity indicator table and Figure 3: Flow Diagram

		Indicator	**Source**	**Comparator Source**
Reduce	1	Amount of land in UK dedicated to organic farming (England)	(DEFRA, et al., 2019)	(Willer, et al., 2018)
	2	Proportion of farmland adopting precision farming, green manuring & soil nutrient monitoring (England)	(DEFRA, 2020c)	
	3	Proportion of fertilizer used that is organic: i.e. not from artificial manufacturing (England)	(DEFRA, 2020c)	
	4	Policies on fertiliser use (England)	Author analysis	(European Commission, 2018); (European Commission, 2018)
	5	Proportion of 'indigenous-type' food grown domestically (UK)	(National Statistics, 2020)	(Clapp, 2017)
	6	Proportion (%) of overall food consumed that is Organic (UK)	Table 13	(Willer, et al., 2018)
	7	Food from urban agriculture (England/SLWP)	(National Statistics, 2020b)	(Pinderhughes, 2004)
	8	Capital Growth score on promotion of community food growing (SLWP)	Table 4	
	9	Planning policy to protect/promote local food production (SLWP)	Table 3	
	10	Public procurement policy requirements for Organic food (SLWP)	Table 8	
	11	The UK electricity grid fuel mix (UK)	(BEIS, 2019); (National Statistics, 2019)	(Eurostat, 2018)
Reuse	12	Food surplus to food banks or sold to staff (UK)	Table 10	
	13	Food surplus to animal feed	Table 10	
	14	Active policies to promote re-use (SLWP)	Table 4	
Recycling	15	Unsold surplus recycled into fertiliser (UK)	Table 10	
	16	Unsold surplus wasted at landfill (UK)	Table 9	
	17	Household food waste collection percentage (SLWP)	Table 6	(WRAP, 2016)
	18	Councils financially supporting home composting? (SLWP)	Author analysis	
	19	Sewage converted to biosolids	(Ofwat, 2015)	
	20	Biosolid sales	Thames Water	
	21	Surplus production or wasted before farmgate sale (point 3)	(WRAP, 2020)	(Kummu, et al., 2012)

APPENDIX 5: OTHER TABLES

Table 13: Sales of organic vs total sales

	2018 (£billion)
Organic sales	2.2[a]
Total food and drink sales	74[b]
Organic sales expressed in %	2.97%

a: (Soil Association, 2018)

b: (Food and Drink Federation, 2020)

Table 14: Biosolid production from sewage

Sewage Treatment Site	**Wet tonnes to land 2019**
Beddington	22,980
Crossness	59,699
Hogsmill	24,666
Long Reach	23,427
Grand Total	**130,772**

Source: Thames Water (correspondence)

Table 15: Table of interviewees

The main purpose of interviews was to improve background understanding

Interviewee position	**Date**	**Question area**
Thames Water Biorecycling	30.07.2020	*General sewage-to-fertiliser system understanding *Artificial fertilisers vs biosolids *Relationship with farmers *Regulations *Data from the facilities relevant to the SLWP
Town planner, (preferred not to disclose which London authority), now in central govt	28.07.2020	*Council organisational structures & where food is considered *Competing pressures on planners *Why food is de-prioritised
Anaerobic digester in-charge, Calthorpe Community Garden	29.07.2020	*General AD systems understanding *Installation and maintenance, including costs *Constraints and obstacles facing smaller systems