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What the fork?

Food Waste Streams and Valorisation Pathways - Drivers and Barriers to a Circular Bioeconomy at UiS campus SiS Cafeteria "Optimisten"

Image 1: by Freepik

Abstract

This thesis explores the intricacies of sustainable food loss (FL) and food waste (FW) management in the context of Local Food Services (LFS) within the Stavanger region. The study investigates how knowledge-based policy instruments can facilitate LFS in improving FL and FW management to align with national Circular Bioeconomy (CBE) perspectives (Ortega Alvarado et al., 2021) and Sustainable Development Goal (SDG) 12.3 targets (Pradhan et al., 2017). This research employs a case study approach, focusing primarily on the innovative practices of the Studentsamskipnaden i Stavanger (SiS) Cafeteria, an exemplary case of FL and FW management within the LFS sector.

The study is framed within a Multi-Level Governance (MLG) framework, Multi-Level Perspective (MLP) and the inverted FW pyramid of CBE. These frameworks enhance the analysis by considering governance dynamics, the transformative processes associated with transitioning to sustainable FW management and the stages at which FW can be valorised.

Key findings highlight how policy instruments can significantly influence LFS practices and encourage the adoption of circular bioeconomic models. Regulatory authorities can either create barriers or facilitate these transitions. The case study demonstrates the potential of LFS to improve their social, environmental and economic standing through efficient FW management. Insights further suggest that effective knowledge-based policy instruments are essential for catalysing change at all levels, making significant contributions to SDG 12.3 objectives.

The research finds the importance of collaborative efforts, innovative technology, behavioural change and regulatory alignment. It offers valuable insights into the complexity of sustainable FW management and the need for comprehensive, knowledge-based policy instruments. The study's outcomes provide a foundation for devising strategies which support a sustainable transition within the FW landscape, offering a roadmap for future policies and practices in LFS and beyond.

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Thank you.
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Abbreviations

ABP – Animal By-Product

BBD – Best Before Date

BE - Bioeconomy

CBE- Circular Bioeconomy

CC – Climate Change

EU – European Union

F2F – From Farm to Fork Strategy

FL – Food Loss

FS – Food Safety

FSFS - Framework for Sustainable Food Systems

FW – Food Waste

FWiP – Food waste inverted Pyramid hierarchy model

IVAR – Inter Communal Water, Wastewater and Renovations company

LCA – Life Cycle Assessment

LFS – Local Food Service

MLG – Multi-Level Governance

MLP – Multi-Level Perspective

OFD - Online Food Delivery

SDG – Sustainable Development Goals

SiS – UiS Campus Student and Staff Café “Optimisten”

SME – Small and Medium Enterprises

WTS – Waste Treatment Systems

UiS – University of Stavanger

Keywords and brief explanations

The semantics of the terms Biochar, Biogas, Bio-digested organic waste and Compost, Food Waste (FW) and Food Loss (FL), Food Safety (FS) and Food Security, Circular Bioeconomy (CBE), Nudging and Systems Transition can, at times be confusing, often overlapping and vague even within scientific communities. Before engaging with the thesis and research presentations, the opening section is dedicated towards clarification, providing a brief explanation of the most relevant terms and how they are defined and operationalised in this thesis.

Biochar, Biogas and Bio-digest

Biochar is mostly produced from organic solid materials, such as agricultural waste, garden debris or FW. The waste is fed into an incinerator where access to air is removed and will reach temperatures from 3-400 and up to 1200 degrees Celsius (Xia et al., 2023) via a process, called pyrolysis. This produces a type of carbonised charcoal that "pops" similarly to popcorn, creating porous space. The process can remove nutrients and pollutants. To produce an activated biochar, soil-compatible and nutritious, the carbonized product undergoes a post-treatment through the technical terms "charging" or "loading" (Xia et al., 2023). This process involves mixing biochar with highly active compost or compost tea, liquid discharge from compost or similar active compounds (Waqas et al., 2018). The active biochar is fed into topsoil during seasonal fertilization routines. This is an excellent way to fix carbon back into the top layers of the soil while it also reactivates the micro-life and adds valuable nutrients (Cho et al, 2023).

Klitkou et al. describe Biogas and bio-digest as products from the anaerobe co-digestive treatment of bio-organic waste. They further define it by describing the feedstock to be of FW or other organic waste giving two products: "One output is biogas (…). The other output is bio-digest, which can be used as a replacement for artificial fertiliser" (Klitkou et al., 2019, 3). Biogas production and consumption are important factors in the National CBE Strategy and hold a significant role in reducing climate emissions and recycling FL from industry and Agri-/aquacultures and fisheries.

Bioeconomy (BE), Circular Economy (CE) and Circular Bioeconomy (CBE)

The Norwegian BE strategy was presented in 2016 (Dep, 2016) and was updated in 2021 under four overarching headings to "develop a circular economy through:

I: sustainable production and product design
II: sustainable consumption and use of materials, products and services,
III: toxic-free material cycles
IV: a circular economy and value creation" (miljødepartementet, 2021, 6).

BE and CBE are meta-sectors developed to stimulate the sustainable transition of the economy sector, guided by accumulated knowledge and knowledge-based processes using a systems approach in their design (Klitkou et al., 2019, 192). It is, however, an economic vision of little consensus and there are many competing definitions, as pointed out by authors of the anthology "*From waste to value: valorisation pathways for organic waste streams in bioeconomies*" (Klitkou et al., 2019). This thesis will be emphasizing the second and third perspectives outlined in their introduction: 2. "[T]he European Union's emphasis on the use of biomass resources, such as biological resources and waste, as inputs for food, feed, energy and industrial products;" and 3., "[E]nvironmental scientists' and NGOs' concentration on sustainability and planetary boundaries" (Kleinschmidt et al., 2014, cited by Klitkou et al., 2019, 2). The definition of BE used in this thesis will be borrowed from Klitkou et al., "as the set of economic activities related to the sustainable production and use of renewable biological feedstock and processes to generate economic outputs in the form of bio-based food, feed, energy, materials or chemicals" (Klitkou et al., 2019, 5). A CBE then becomes defined as "organic waste, co-products and by-products (…) treated as resources for the bioeconomy". If a CBE is adopted as a sustainable national strategy, it "can turn bio-waste, residues and discards into valuable resources and can create the innovations and incentives to help retailers and consumers cut FW by 50% by 2030" (European Commission, 2018, p.6).

Compost

Composting is a cyclical process of nature breaking down organic waste, such as grasses, leaves, branches and fruits from trees and animal remains and turning them into nutritious soil for new growth. Through mimicking nature's process, humans have found ways to improve composting techniques to reduce the time nature needs to complete its process and up the levels and availability of nutrients, structure and life in the soil to help us grow food (MLT, private archives). Understanding the full potential of compost and practising intimate knowledge of the process brings new life and beauty to its fullest in the flowering and fruitfulness of a well-nurtured regenerative garden or farm. Some even call it an art form (Lønning, 2019). Theatrical elements can be attributed to the art of composting. The setting of the stage (building a compost structure) involves drawing the choreography and scenography of the system. Then comes adding the text(ure) or matter (nutritious organic materials high in Nitrogen mixed with bulking agent high in Carbon). The motives (to break down) drive the protagonists ("good bacteria") to combat antagonistic ("bad bacteria") elements, providing an almost Aristotelian dramatic storyline in three main acts: A beginning – a dramatic build-up to climax – and an ending. The final product (the compost) can thus be of value to the entire community through fruitful or mortal twists, depending on nature's variables, to an ending as "tragedy" (total entropy) or "comedy" (absence of death).

In brief, aerobe composting requires the following elements to ensure a thorough transformation (MLT, private archives):

- Aeration
- Moisture
- Temperature (from 35°C to 65°C)
- A balanced C: N (1:3 to 4) ratio
- Time (26 - 52 weeks)

There exists a multitude of types and techniques for aerobe composting, using different organic matter, bacteria and microorganisms, worms and mechanical and automated types of containers and equipment. The heat generated during composting is primarily due to microbial metabolism.

> "The activity and growth of organisms produces vast amounts of heat and causes the temperature of a compost pile to rise quickly. This heat is essential to killing harmful pathogenic bacteria, fungi, protozoa, worms and other parasites as well as weed seeds in the pile and it can also tell us when the pile needs to be turned".
>
> Richard Mitchell, 2020.

Mesophilic bacteria operate between 30-45℃, while thermophilic bacteria grow and function best at 50-85℃ (Tankeshwar, 2019). Thermophiles must be monitored and controlled. If the composting temperatures reach above 65℃, beneficial microorganisms such as *mycorrhizal* fungi will die and there will be a significant loss of Nitrogen, leaving the compost incompatible with the soil microbial population and must then undergo further post-composting treatment (Aguilar-Paredes et al., 2023).

In the case of SiS, this thesis will be dealing with garden compost and vermicompost from Reve Kompost (*Om Oss | Reve Kompost*, n.d.). Vermicompost is produced by a specific type of earthworms, in a specialized habitat (Image 2) where the worms are fed certain vegetable leftovers such as salads, vegetable peels and cuttings in appropriate sizes. The waste produced by the worms is considered to enhance "soil biodiversity by promoting the beneficial microbes" and "indirectly by controlling plant pathogens, nematodes and other pests" and "may be used to promote sustainable agriculture (…) for the safe management of agricultural, industrial, domestic and hospital wastes which may otherwise pose serious threat to life and environment" (Pathma & Sakthivel, 2012, 1).

Image 2: Hungry-Bin from Reve Kompost AS (MLT, 2023)

Garden compost is a mesophilic composting process, although it may also reach thermophile growth. At UiS, garden compost is performed in concrete padded enclosures, assisted by machinery for the heavy operation of aeration by regular turning of the piles. Garden compost requires turning at “critical stages in the composting process exactly when the biological activity is reaching a crashing point, rather than turning a pile a prescribed number of times” (Mitchell, 2020). To ensure the right mixture of C: N and bacteria vs. fungi, it also requires a mixture of bulking agent from “logs, sticks, leaves and other woody material” as these have higher levels of “beneficial organisms, especially fungi” (Mitchell, 2020).

Food waste (FW), Food Loss (FL) and Food Safety (FS) and Food Security

Although the definitions of FL, FW, FS and food security are vastly different, we may also look at them through the deductive analysis of cause and effect. FS in Norway is ensured through the FS regulations of Mattilsynet’s control systems backed by the EU regulatory mandates for FS. Food security is a common, collective good and is recognized as a public responsibility (Dombu et al., 2021, 62). FL and FW account for almost one-third of “all edible foods produced globally” according to the UN Food and Agriculture Organisation (FAO, 2011). The ethical issues implied by this figure are a huge threat to global food security and represent more wasted food than could theoretically feed “[a]ll the starving and malnourished people around the world” (Klitkou et al., 2019, 253). Global food security could improve if the global zero-FW target were met. However, this also implies improved access, availability and affordability throughout globally infringed populations.

In this research, authors Szulecka et al. define FL as the loss of food meant for human consumption from the production and supply chain, while FW becomes waste at the consumer and retail levels. The authors claim “that the scale and occurrence of FW in the value chain depend on the economic situation, climate, local culture and consumer habits” and that this “is a very complex issue, requiring diverse and well-tailored governance measures” but add that reducing FL and FW “seems a win-win situation for consumers, our planet and industries” (Klitkou et al., 2019, 254).

Apart from the moral implications of securing our food systems, FL and FW also have an enormous impact on energy consumption at every level of the value- and production chains. Energy is consumed at every stage of production and consumption (or lack thereof) and when the Life Cycle Assessment (LCA) for FL and FW are accounted for, there is a significant value lost in energy. Fighting FL and FW therefore also becomes a fight for a more effective and efficient use of energy. The gross economic and energy losses from malfunctioning food systems therefore also become an important part of the green energy transition.

Nudges and other interventions

"Nudging and other interventions" are strategies to raise awareness. In a systematic review by Dhir et al. (2020), these non-intrusive interventions reduced FW in dining establishments. Practices include doggy bags, buffet plate reduction and "social cues," using table cards and posters. Expanding nudging to the food service community may involve workshops and materials for "learning for change" (L4C), a method fostering motivated, knowledgeable employees (Mehlmann et al., 2015).

Transition

The term "Transition" is used to describe a process involving a shift from one state, subject, or place to another, with an associated period during which such a change takes place (Merriam-Webster, n.d.). Another definition characterizes transitions as journeys marked by creativity, empowerment and the challenge of moving from the familiar to the unknown (Hopkins, 2019). In the context of this thesis, the concept of “Transitions” is crucial, as it embodies the profound changes required to establish sustainable FW management practices.

This study employs the Multi-Level Perspective (MLP), an analytical framework integrating evolutionary economics, sociology of innovation and neo-institutional theory to explore sustainability transitions, which involve transforming systems to provide societal functions or end-use services (Geels, 2019). This framework helps illuminate the intricate dynamics of transitioning from conventional, wasteful food management systems to sustainable, circular alternatives by addressing technological, regulatory, social and cultural shifts, fostering effective and enduring changes in FW practices.

Valorisation

Valorisation involves adding value to a product or waste stream that may have been considered of lesser value. In the context of FW, it refers to the process of turning FW into valuable resources or products for a CBE (Teigiserova et al., 2020).

1. Introduction: What the fork?

Food Waste Streams and Valorisation Pathways - Drivers and Barriers to a Circular Bioeconomy at UiS campus SiS Café "Optimisten"

The plate of delicately prepared food has, just moments ago, been served to the guest by professional hands from an authorized kitchen. However, the moment the guest drops the fork, this highly valued meal becomes leftovers, changes legal status and becomes waste. The waste from the plate is, according to the 2012 report for the Nordic Council of Ministers "*Prevention of FW in restaurants, hotels, canteens and catering"* (Marthinsen et al., 2012) defined as unavoidable FW. Marthinsen et al. divide FW into two different terms in their research. By their definitions, "avoidable FW» is «waste from the kitchen» while «waste from the guests", from the plate, is "[u]navoidable FW» and «not-edible» (Marthinsen et al., 2012). These definitions place FW from the plate into a lock-in situation. If FW from the plate is unavoidable, how can it be reduced? But, more interestingly, why does edible food on the plate, avoidable FW, change status to unavoidable FW when the guest is finished eating? And, how does the change in status affect the way we manage and treat FW?

The current and ongoing war in Ukraine may have added an extra amount of pressure on the socio-technical regimes (Geels, 2011) of food- and energy security. In Norway, we have also seen increased attention towards food security since the COVID-19 pandemic. The 2023 national budget responds by allocating 20 million NOK to establish 2–3-month emergency foodgrain storage systems (Matdepartementet, 2022) in addition to multiple efforts to diversify and improve self-sufficiency national food programs (Dombu et al., 2021). The EU and the EU countries are committed to meeting the Sustainable Development Goal 12.3 target to halve per capita FW at the retail and consumer level by 2030 and reduce FL along the food production and supply chains (*EU Actions against FW,* n.d.). The recent mobilization and organisation of transnational EU-funded programs such as The Green Deal, presents an open window of opportunity to envision a general and sudden shift in the regime, pouring knowledge, financial backup and legitimacy into national sustainability programs. The EU Mission programs aim to bring "Smart sustainable urban development and transition of Innovation systems" (Gebhardt, 2019) to the cities and places involved. The EU Missions' approach to reaching targets and goals set by the COP Paris Agreement and the SDGs combines policy, co-creation and innovation strategies under “the Horizon Europe research and innovation programme for the years 2021-2027” (Horizon Europe, n.d.).

One such EU Mission strategy embraces the CBE framework recently adopted by the Norwegian government, now found implemented in policy frameworks and affiliated directives, laws and regulations. It is expected that the CBE framework will eventually replace the depleting fossil-based economy and regenerate fresh approaches to sustainable innovative solutions (Tyrkiel, 2018).

Figure 1: Farm to Fork strategy wheel (*Farm to Fork Strategy*, n.d.)

Herein lies “The Farm to Fork” (F2F) strategy (Figure 1), “at the heart of the European Green Deal aiming to make food systems fair, healthy and environmentally friendly” (Farm to Fork Strategy, n.d.). The F2F strategy envelops regulatory and non-regulatory tools and targets and proposes a legislative framework for sustainable food systems to end FL and FW (Farm to Fork Strategy, n.d.). However, if the F2F strategy is a CBE program for sustainable agriculture and food systems, the circular loop is sorely missing. As such, the “Farm to Fork strategy” should be extended to include a “From Fork to Farm” approach, where FL and FW are returned to the soil through composting practices to complete the food cycle.

FL and FW are fairly new but increasingly growing concerns to both climate- and environment-risk analysts. The ethical and socioeconomic dimensions of FL and FW are causing similarly critical concerns. Such as signifying uneven distribution systems, through “procurement, labour and service costs, utilities and waste management costs” resulting in economic losses for restaurants and FS on the local level (Principato et al., 2018, 131). The current and projected population growth, intensified linear food production and distribution systems, along with widespread soil degradation and natural resource depletion, bring global importance to returning FL and FW into a circular loop, preventing the loss of valuable nutrients and minerals through unsustainable food supply chains and the prevailing linear waste treatment systems (WTS). However, system resistance from private and public WTS and stakeholder hesitance to correct practices along the entire food supply chain create barriers to returning FW into the circular loop.

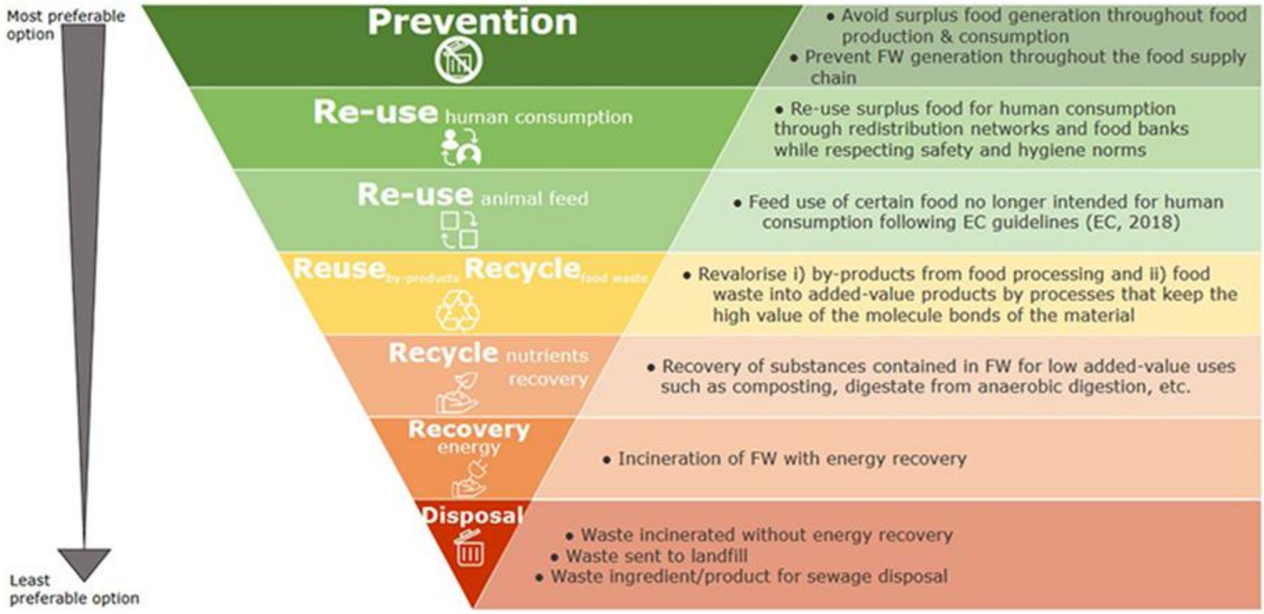


Figure 2: The FWiP hierarchy model revised (FW Measurement, n.d.).

In examining the main barriers to achieving more sustainable outcomes in LFS and the potential for achieving zero FW through on- or off-site composting practices, it is imperative to consider the FWiP presented in Figure 2, aligned with the principles of the CBE. The EU revised the FWiP in the “revised Waste Framework Directive” (EUR-Lex - 32018L0851 - EN - EUR-Lex, 2018) to better ensure its application in national FW reduction actions (FW Measurement, n.d.). The FWiP is now a seven-layer hierarchical inverted pyramid, with the introduction of two new sub-levels. The new levels divide re-use for human consumption from animal feed (levels 2 and 3 from the top) and (in levels 4 and 5) discern high-value by-product revalorisation (upcycling) from nutrient and low-value use in compost and anaerobic digestate substance recovery (recycling). This revision now precedes prominent reports such as those by NOU (2002), MD

(2013) and the Ministry of Climate and Environment (Klima og Miljødepartementet, 2017), where compost and biogas were seen as the best pathway for FW not fit for human or animal consumption. By preferring to revalorise into value-added products (Level 4 from top), before aerobe composting or anaerobe digestion (level 5 from top). The revision of FWiP lifts the unavoidable FW from plates and kitchen cuttings that are no longer suitable for human or animal consumption into a radical R&D niche development field for innovations.

The observed growing gap between the aspirational targets set at the supranational level for FW reduction and the prevailing, business-as-usual practices at the regional level within the consortiums of semi-private waste transporters and treatment facilities, partially owned by local municipalities, raises concerns. Brought to attention by one of the informants for this thesis, I#9, the regional waste treatment consortium of municipal owners (IVAR) downplays the importance of CBE FW to be developed by competitive radical niche companies. This divergence underscores the need for a critical evaluation of current practices and a re-evaluation of policies and strategies to bridge this gap effectively. Addressing these challenges is imperative to align the visions of waste management stakeholders with the broader goals of achieving a CBE and a sustainable future.

> The commission believes that for such a [climate] transition to succeed the full potential of the economy must be utilized. We have to rethink the use of resources in the production, value chains and business models and concerning decision-making processes in the public sector. Among other things, this requires a political understanding of the need for system level measures: more political solutions that include the society as a whole and fewer special agreements that do not contribute to the whole.

Klimaomstillingsutvalget (The Climate Transition Commission), 2020

Despite the existence of policies, strategies and concerted efforts aimed at promoting sustainable FW management practices, the practical adaptation of on-site or local off-site FW valorisation in Norway remains limited. This discrepancy raises critical questions about why the widespread adaptation to sustainable FW valorisation management practices has not yet scaled up within the LFS sector. It is crucial to identify and analyse the various barriers that hinder this transition, including regulatory, technological, financial, knowledge-related and psychological factors. The urgency requires governance on every level, including all societal, private and public stakeholders (Bock et al., 2022), which is why this study will also apply the viewing frame of the widely used MLG knowledge-based policy instruments.

In this context, "knowledge-based" policy instruments refer to strategic regulatory and decision-making tools designed with a solid foundation in knowledge and data. These instruments utilize a wealth of information and expertise to craft policies that are not only effective but also flexible and adaptable to evolving circumstances (Bock et al., 2022). "Knowledge-based" policy instruments are crucial for addressing “wicked problems” such as FL/FW by incorporating data-driven insights and leveraging expertise to inform impactful decision-making. In the context of achieving a faster zero FW plan of action, understanding and mitigating barriers are essential. The regulatory framework needs to be conducive and supportive of FL/FW valorisation initiatives at a local level. Technological advancements must be accessible, cost-effective and tailored to the specific needs and capacities of LFS. Financial considerations, including initial investments and ongoing maintenance costs, need to be balanced to incentivize businesses to adopt sustainable FW practices. Additionally, knowledge dissemination and awareness-raising campaigns are vital to ensuring that stakeholders are well-informed about the benefits and methodologies associated with sustainable FW management. Moreover, addressing psychological barriers such as resistance to change and the inertia of established practices is fundamental to driving a paradigm shift towards more sustainable FW management practices.

Knowledge and behaviour patterns are of high importance to finding viable solutions to sustainable transition. “Design for Sustainable Behaviour” (DfSB) is a relatively new focus in scientific research, as exemplified in the Routledge Handbook of Sustainable Design, where author Casper Boks has studied how the research community is investigating the field of methodological frameworks for design to influence public behaviours (Egenhoefer, 2017, 319). In the same anthological collection, authors Ford and Norgaard ask “what are the missing links between concern and public engagement?” when “[k]nowledge and values alone are not sufficient to get people to change their behaviour” (Egenhoefer, 2017, 387).

In exploring the life cycle of our daily food — from cherished raw ingredients to devalued leftovers — a stark contrast emerges. From the lens of the farmer, producer, prepper, chef and restaurant owner, food is meticulously tracked, regulated and trusted, following stringent FS regulations set by Mattilsynet (Mattilsynet, 2023). The consumer lends trust to Mattilsynet and by proxy, the complete circle of production. Consumers place faith in the regulated process, culminating in a gratifying dining experience. However, this trust dissipates swiftly when the remnants on the plate transform into what is perceived as waste. When, at the instant of dropping the fork, the leftovers from the very same plate of goodness become something disgusting, degraded and dangerous. This shift initiates a distinct legal categorization, demanding a separate set of regulations and incurring social, economic and environmental costs in the pursuit of zero waste goals.

The derived category, the unavoidable FW, an inevitable byproduct, necessitates specific treatment methods due to its varied origins, incurring additional costs and regulatory complexities. Paradoxically, while the raw materials used for human consumption are carefully vetted and authorized by Mattilsynet, they lose their endorsed status once classified as FW. Notably, in the "*Assessment of treatment methods and validation criteria for composting and biogas facilities in relation to plant risk and the risk of spreading alien organisms*" the Norwegian Scientific Committee for Food and Environment (VKM) deems FW derived from compost feedstock materials approved for human consumption to carry low risk in terms of food hygiene and plant health. VKM further concluded that the target organisms "*Salmonella S.*, *Enterococcus f.* and *Ascaris s.* in the [compost] feedstock is unlikely" (VKM Report, 2021, 8). This dichotomy in treatment standards challenges the credibility and trustworthiness of the entire food production system, undermining the value of technical expertise and responsibilities attributed to pre-waste food products. This intriguing paradox drives the inquiry into potential resolutions, aligning with the recently proposed CBE strategy.

1.1. Problem statement and research questions

The growing gap between the urgent issues of FL and FW and SDG goal 12 "Responsible Consumption and Production", Climate Change (CC) and biodiversity loss signify the formidable barriers impeding LFS from contributing to local sustainability and climate targets. In the Stavanger region, efforts at the community level are fostering the co-creation of circular, reliable and sustainable FL/FW treatment systems to facilitate innovative niche services and technologies, aiming to bridge the theory-practice gap in this domain. However, this transition faces constraints at local, regional and national levels, lacking a rapid-action plan.

I regard the FW problem to harbour in the existing policies and regulations related to FW management. Informant I#9 states that the WTS regime, together with regulatory and financial burdens are hindering their vision for scaling up. Current regulations and policies create legal, knowledgeable, psychological, technological, financial and emotional barriers to local, proper and sustainable FW handling. These ambiguities and rigid policies could potentially deter LFS' from assuming higher levels of responsibility for FW production. An informant from the LFS sector emphasizes the need for authorities to allocate resources to help LFS acquire the necessary tools to measure and deliver according to regulatory demands, thereby enhancing CBE practices and finding valorisation pathways and closed-loop CBE perspective to reach SDG 12-3 targets (I#6).

Main Research Question:

How can a deeper understanding of drivers and barriers assist LFS in improving FW management?

Additional Questions:

A. What are the policy, regulatory, technological, knowledge and financial barriers obstructing LFS from adapting to national FW targets?
B. What are the drivers for LFS to adopt CBE business models in the Stavanger region?

1.2. A local case: SiS café Optimisten

The purpose of this study is to shed light on the intricate challenges faced in effectively managing FW within the LFS sector. Specifically, it aims to unravel the barriers hindering the widespread implementation of composting practices, both on-site and off-site, in LFS. By conducting an in-depth case study focusing on a specific LFS entity, SiS, the aim is to elucidate the complexities and nuances surrounding FW management. The case study serves as a practical illustration, allowing us to explore potential solutions and strategies to overcome these barriers and move towards a more sustainable FW management approach. SiS stands as an ideal case for evaluating diverse FW valorisation pathways, drivers and barriers within similar LFS establishments in the Rogaland region. The choice of SiS as a case study is grounded in its exemplary implementation of various FW valorisation pathways and its extensive collaboration with stakeholders across national, regional and local contexts. SiS actively engages in partnerships with student organisations and local start-up firms focused on FW valorisation, demonstrating a CBE approach. FW management contracts with vermicompost and edible mushroom production companies align SiS practices with CBE guidelines, encompassing multiple levels of the waste/resource inverted pyramid.

The chosen case study exemplifies a way to lead the CBE SME non-profit sector in reducing FW and FL. If they achieve this, other LFS should also be able to and should be permitted to follow their example. This thesis delves into the current regulations and laws concerning FW composting and the CBE practices conducted by SiS. After a thorough review of the main drivers and barriers for CBE on the community level, the thesis will demonstrate how LFS in Norway could convert their remaining FW into valuable byproducts to use as renewable resources. To this end, a simple-to-use composting guide will be produced as an attachment to this thesis. The guide can be easily customised by the company or organisation aiming for a more circular and sustainable future for LFS.

1.3. Background, Motivations and Expectations for Outcome

I first started practising garden waste composting with an SME gardening firm called Miljøhageservice (1993-1998). This led to cultivating an interest in the circularity of life in the garden. When the municipality of Stavanger introduced the “brown-FW-wheelie bin” for households along with an incentivising policy to reduce the renovation fees by 20% for households composting FW, I began household FW composting at home. Some years later I was employed as an Environment advisor in a national NGO called Grønn Hverdag (2005-2014). During some very productive years of NGO/municipal collaborations to assist Stavanger and neighbouring municipalities in their Environment- and Climate strategies and plans, I chaired task groups, boards and committees, and advised in sustainable policies and climate mitigation strategies. Among many topics, involving transition pedagogy (L4C), environmental certification processes such as Eco-lighthouse (Miljøfyrtårn) for SME and Green Flag (FEE) for educational institutions, I also began to teach thermal composting of household FW as a follow-up for the Stavanger municipal household renovation policy. I have designed composting systems and practised and taught composting in Norway, Eastern Europe and Africa. The composting course practice was continued although the NGO-municipality collaboration was discontinued in 2014 and I was asked to take over the courses on a private instructor level in 2018. As an instructor for the IVAR-connected municipalities composting courses held at Ullandhaug Økologiske Gård, I was also invited to hold similar courses around the region as an authority on the topic of home-composting of FW. This thesis draws on private archives and my professional experience by referencing to MLT, private archives.

The Circularity Gap report for 2023 highlights a concerning fact: “The global economy is now only 7.2% circular (…) driven by rising material extraction and use” (CGR, 2023, 8). Loss of biodiversity, depleting Nitrogen and Phosphorus biochemical flows, Land Systems Management and CC have pushed the world into a global overshoot. The global food system stands as “the largest driver of land-use change” significantly contributing to CC, nutrient overload and biodiversity loss (CGR, 2023, 32). Land use mismanagement and politics globally have led to severe soil degradation with potentially up to 70% of topsoil already lost (Lønning, 2019, 122). Chemical fertilisers based on Phosphorus, Potassium and Nitrogen (Pradhan, 2020), once hailed as miracle solutions are now critically depleting the soil’s quality. Continuous use of chemical fertilizers is responsible for the decline in soil organic matter coupled with a decrease in agricultural soil quality (Pahalvi et al., 2021). Future global food security is highly dependent on returning to nature-based regenerative soil management to restore minerals, structure, biodiversity and fertility (Rygiewicz et al., 2010). Regenerative agriculture, soil food web restoration, restorative forestry and permaculture food forestry are gaining traction as methodologies to reverse soil degradation (Rygiewicz et al., 2010; Brawner, 2015). Reintroducing carbon, fibres and minerals back into the soil through techniques like recharged biochar (Xia et al., 2023) and continuous thermophilic co-digestive composting of FW also aid in mitigating CC (Schulze, 1962; Pérez et al., 2023). The Circularity Gap report optimistically claims that “circular solutions have the power to reverse the overshoot of five planetary boundaries” (CGR, 2023, 30).

Composting FW is an effective way to restore most minerals and nutrients, aiding in regenerating local soils (Clemmensen et al., 2013). Furthermore, compost improves soil structure. Humus from compost crucially adds fibre and carbon to depleted topsoil. This practice is a sustainable alternative to conventional soil-structure improvement practices using peat and turf from wetlands, destroying wetland habitats and important biodiversity (Lønning, 2019). The humus from compost provides space for air and absorbs and contains moisture. The air pockets allow micro and macro-organisms to create continuous air flows, making the soil more available to the same organisms to produce more nutrients. The contained moisture reduces the negative effects of long-term exposure to evaporation and run-off of nutrients during heat waves or heavy rainfalls. By reducing these negative effects, the soil becomes richer in nano-, micro- and macro-life and we see the continuous, regenerating cycle of life improved (Lønning, 2019). Returning FW to the soil through composting is also vital for climate mitigation. Recapturing carbon from FW and returning it to the soil promotes a more climate-friendly FW treatment, significantly contributing to reducing CO2 levels in the atmosphere (Pérez et al., 2023; Xia et al., 2023). Finally, but not least, composting FW locally enables communities to grow food without relying on artificial fertilizers or foreign, synthetic growth mediums. This fosters community involvement, knowledge acquisition and preparedness for potential challenges, improving food security and self-sufficiency. Effective local composting can relieve the need to maximize climate - and societal risk management plans, reducing negative impacts on local communities (Lønning, 2019).

The Norwegian Food Authority (Mattilsynet) plays a crucial role in regulating the food production and food service industries. The Norwegian FW regulations are harmonised with EU FW regulations, covering FL and FW, ABP, organic fertilizer and compost. However, the strict approval system for composting FW by Mattilsynet poses a significant barrier to responsible CBE and sustainable LFS management. Household FW is considered low biological risk and is encouraged to undergo the lowest level of regulatory management through aerobe thermophilic composting at the household level. However, FW from LFS' is categorized at a higher risk level by Mattilsynet and the overarching EU regulatory framework, imposing financial, knowledge and technological burdens on the LFS sector. This creates a higher barrier to active participation in the green transition (Regulations (EC) No 1069/2009 and (EC) No 1774/2002 (ABP), 2019).

1.4. Structure

This thesis aims to discover and discuss variables affecting FW management and treatment and their impact on the decision-making processes of LFS regarding FW reduction and sustainable management. By applying various qualitative analytical methods, the study aims to provide a deep understanding of the drivers and barriers, as well as the nuances of governance and policy instruments that shape FW practices. Below is an overview of the sections that constitute the structure of this thesis.

Chapter 1 serves as a preamble, acquainting the reader with the intricate landscape of FL and FW. It articulates the research problem with precision and formulates the principal research questions that guide the inquiry. Chapter 2 meticulously examines existing scholarly works on FL and FW, CBE and policy instruments. This review underscores the theoretical bedrock necessary for an in-depth comprehension of the research domain. Chapter 3 introduces a robust conceptual framework that undergirds the entire research. It expounds on vital concepts, theories and models pivotal to this study. Chapter 4 exposes the research methodology employed in the study. It elucidates the research design, data collection techniques, analysis and methodologies essential for gathering and interpreting data. Chapter 5 represents the core of the research, dissecting the drivers and barriers that wield influence over FL/FW management in LFS. It conducts an in-depth exploration, encompassing political, regulatory, technological, financial, knowledge-based and behavioural dimensions. Chapter 6 involves a comprehensive analysis and Chapter 7, discusses the findings presented in the previous chapter. It offers valuable insights, interpretations and implications arising from the identified drivers and barriers. In the culminating chapter, Chapter 8, the thesis succinctly concludes by summarizing the research findings and underscoring their significance. Furthermore, it delineates actionable recommendations, shaping the way forward for policy, practice and prospective research endeavours.

2. Literature review

In the context of a global green transition encompassing various sectors such as energy, construction, food, waste and mobility, the literature review aims to provide a foundational understanding of the multidimensional factors influencing this transition. The renewable green energy sector is finding new pathways to establish new economies and employment opportunities. The transition is influenced by numerous stakeholders and societal considerations, necessitating a departure from traditional disciplinary boundaries (Earle & Leyva-de la Hiz, 2021). Moreover, this chapter will also present an overview of how main regulatory, political and policy-making authorities would benefit from adopting a bottom-up approach to reaching the overarching goals and targets of the COP Paris Agreement, the SDGs and the EU missions.

2.1. Gaps in FW research

The European Parliament report of 2011 notes that FW has historically received little attention due to the surplus of food available, resulting in significant quantities of waste, particularly in primary production and among consumers, but also due to a lack of standardized understanding of FW (Caronna, 2011). Scholars of the field of FL and FW find that it “is a very complex issue, requiring diverse and well-tailored governance measures” (Szulecka et al., 2019, 254). The five main gaps in prior studies related to FW identified in the study “FW in hospitality and food services: A systematic literature review and framework development approach” (A. Dhir et al., 2020) point future researchers in six main directions. These gaps prompt researchers to explore different geographies and food service establishments, advance quantification methods for measuring FW, utilize diverse research methods and variables, delve deeper into interventions and nudges to raise awareness about FW, incorporate improved theoretical perspectives and consider online food delivery (OFD) platforms in FW research.

Another related concern is how existing studies on FW primarily appear in environmental management and sustainability journals, with limited representation in tourism and hospitality management publications. This disparity is crucial, considering the differing perspectives of environmental and hospitality managers regarding FW. Hospitality managers tend to perceive FW management as a short-term cost-saving opportunity, prioritizing immediate profits, while environmental managers view it as vital for long-term business sustainability. Bridging this gap necessitates showcasing to the hospitality industry and LFS practitioners the immediate financial and reputational benefits of FW reduction. The scarcity of research from the hospitality management perspective may leave social scientists unaware of the significant implications of FW in this sector, highlighting the need to break academic silos and promote interdisciplinary collaboration for informed managerial and policy solutions (Filimonau & De Coteau, 2019).

Authors Tartiu and Morone explore another gap in the knowledge of “Tackling the FW Challenge” and how “Grassroots Innovations” contribute towards the sustainability transition (Morone et al., 2017). They address the role of grassroots movements and innovations in catalysing innovation within the FW domain (Morone et al., 2017, 303). By applying the MLP, the authors analyse the effectiveness of grassroots initiatives in fostering sustainable production and consumption systems and a more sustainable waste regime. The authors further claim that their findings “could support decision-makers in developing tailored strategies to minimize the amount of food waste along the supply chain” (Morone et al., 2017, 303).

2.2. Policy Context

The policy context plays a pivotal role in understanding the overarching frameworks and initiatives driving the green transition. The EU has adopted an MLG system-based approach that underscores the urgency of redirecting the food system towards sustainability. This approach necessitates policy coherence at both the EU and national levels (Bock et al., 2022). Comprehending the significance of governance at multiple levels is crucial for grasping how policies, regulations and practices intersect in FW management. Further insights into this intricate relationship between governance levels and their impact on FW management are provided in Chapter 3.2. Understanding this governance framework is pivotal for crafting effective strategies and policies to tackle FW challenges at the local, regional and national levels.

The EU is in the process of adopting a legislative framework for sustainable food systems (FSFS) in 2023. This framework is a flagship initiative that targets various aspects of the food system, including food production, processing, retail, consumption, FL and FW (European Commission, n.d.). It combines policy initiatives with targets and utilizes advisory, financial, research and innovation instruments. It also emphasizes building policy coherence at both the EU and national levels, involving relevant stakeholders in the consultation process.

The “EU Platform on Food Losses and Food Waste” is an initiative that connects the F2F Strategy to the Circular Economy. It aims to develop methodologies and indicators for measuring FW, clarify EU legislation, facilitate food donation and promote the use of former foodstuffs as animal feed (EU Platform on Food Losses and Food Waste, n.d.). The F2F Strategy is aligned with Sustainable Development Goal 12.3, which aims to reduce FL and FW by 50% by 2030. The F2F Action Plan encompasses twenty-seven policy initiatives targeting food production, processing, retail, consumption, FL and FW (Bock et al., 2022, 10).

The hospitality and food services sector, estimated to account for 12% of total EU FW, is predominantly composed of SMEs including microenterprises. Addressing the knowledge gap on FW is essential in this sector and interventions should focus on training staff and management to minimize FW across various processes, from procurement to waste management. Strategies like nudges, spatial design, communication, payment policies and awareness campaigns can help reduce FW (EU Platform on Food Losses and FW, n.d.).

The literature also explores the CBE strategies advocated by both the EU and Norway. The EU emphasizes a "smart" bioeconomy with a focus on sustainable natural resources, while Norway's strategy emphasizes innovative bioeconomy models based on forestry, agriculture, aquaculture, marine fisheries and subsea geology (Dep., 2016). In their article "Hva er Bioøkonomi og hvorfor trenger vi den?" (Burton et al., 2020), the authors present a vision of how transitioning to a bioeconomy can help Norway achieve the Paris targets and SDG goals while preserving nature and biodiversity sustainably. This peer-reviewed anthology provides foundational knowledge about the concept of the bioeconomy as a sustainable business model for Norway. The authors offer an optimistic outlook, realistic strategies and creative approaches in various scenarios for a decarbonized future, envisioning the bioeconomic society as the leading paradigm in Norway by 2050 (Burton et al., 2020, 242).

2.3. Knowledge and behaviours in societal waste practices in Norway

This section delves into societal waste practices in Norway, focusing on the barriers hindering waste reduction and sustainable consumption at both the household and commercial levels. A survey conducted by Ipsos (Figure 3) on behalf of Keep Norway Beautiful (Hold Norge Rent) and Waste Norway (Avfall Norge), highlights that seven out of ten Norwegian municipalities perceive inadequate budget allocations as a significant barrier to improving waste handling. This financial constraint impacts waste reduction efforts at the municipal level (Rom for bedre samarbeid om forsøpling, n.d.).

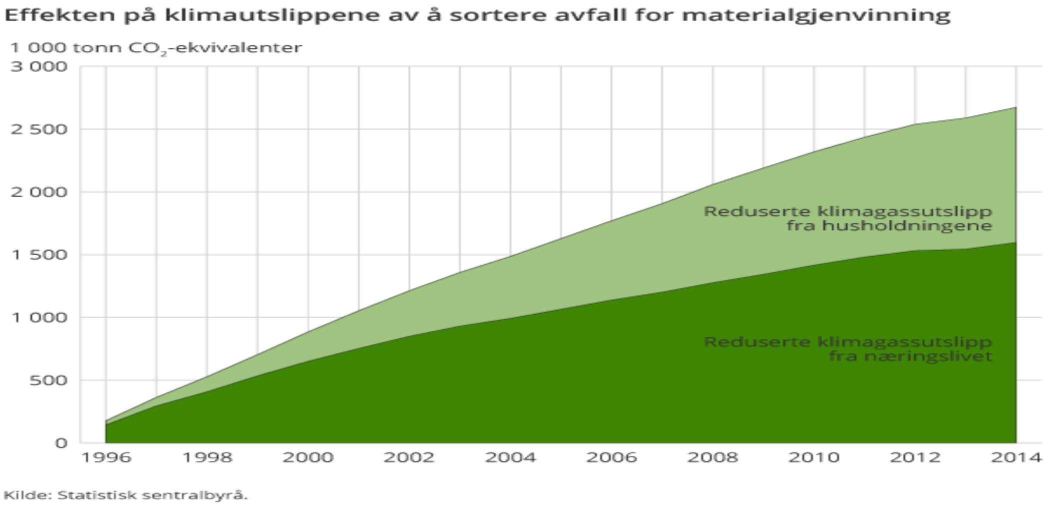


Figure 3: The effect on GHG emissions from sorting household (light green) and commercial (dark green) waste for material re-use/recycling (SSB, 2016)

These insights are applicable to addressing the overproduction of waste and fostering sustainable consumption, especially in the context of an unsustainable food system. By addressing emotional dimensions and incorporating sustainable design principles, it is possible to encourage behavioural shifts and reduce waste in both households and SMEs within the LFS segment. Moreover, acknowledging that some barriers may require more than voluntary efforts to overcome, as households might need incentives or mandates for rapid and comprehensive decarbonisation (Moberg et al., 2021), the same holds for LFS'. This thesis aims to demonstrate the applicability of this principle to LFS', advocating for knowledge-based policies that stimulate sustainable waste management practices in this sector.

The household level

The study "Barriers, emotions and motivational drivers for lifestyle transformation in Norwegian household decarbonisation pathways" addresses drivers and barriers to achieving deep emissions reduction at the household level. The authors emphasize the importance of sustainable alternatives, support networks, positive emotions associated with environmental impact and awareness of the highest contributors to CC as motivational levers to overcome barriers (Moberg et al., 2021, 3). The same study also finds that a main barrier to reaching targets is the knowledge gap of what types of waste are the highest contributors to CC and another is the relative cost-benefit attitude dominating what is considered traditional business culture.

A dual case study by Ford and Norgaard shows us that two very similar communities experience the CC risk factor differently. The Norwegian case-community continued their daily lives by collectively organised denial strategies while the off-grid community of North Americans chose to detach themselves from public and national services (Egenhoefer, 2017, 391). How can such coping mechanisms teach us anything about risk as a barrier in handling unavoidable, not-edible FW? My experience through 30 years of personal and professional thermal FW composting techniques tells me that the perception of risk always derives from the cultural context. Communities that work closely with food production give FW a very different risk status from soil-detached urbanised communities. A community garden provides differing perspectives to those of the regulatory authorities for LFS. Is that because the risk factor is different or because it is perceived differently?

The research by Ford and Norgaard compares the cultural and emotional responses to CC in two different, yet outwardly similar communities. They find disparate reactions despite similar threats, shedding light on emotional and cultural factors influencing responses to CC and environmental risks (Egenhoefer, 2017). In the first case, citizens from a Norwegian village "collectively ignore CC even as they outwardly acknowledge it as a concern" (Egenhoefer, 2017, 388). In the second case, "American participants of self-sufficiency movements (…) focus on decreasing their dependence on the institutions they hold accountable for putting them at risk" (Egenhoefer, 2017, 388). By asking "what accounts for these disparate reactions to similar threats?” the researchers explore some key features, such as both “groups observed are relatively privileged (…) members of the global middle class” putting them into similar cultural, social and economic contexts. Emotionally both groups experienced “complex, uncomfortable emotions” and “struggled to manage these emotions” using a “different set of cultural ‘tools’” (Swidler 1986, cited by Ford & Norgaard, in Egenhoefer, 2017, 389) and continued their daily lives by “collectively distancing themselves from disturbing information” by “socially organised denial” (Zeubavel, 1997 cited by Ford&Norgaard in Egenhoefer, 2017, 391). If, and whether people care, know and feel the risk does not seem to matter enough to incite action. If not the sense of risk, which other behavioural design pathways can incite action at the household level?

Habit Formation and Sustainable Consumption

Tang and Won explore the role of habit formation and change in encouraging sustainable consumption. Authors Tang and Won ask whether “designs that change our habits encourage more sustainable consumption” (Egenhoefer, 2017, 329) while studying social psychology and sociology behaviour aspects in “the process of habit formation and change”. They propose a holistic approach to bridge the intention-behaviour gap and emphasize the need to strengthen normative goals and align gain and hedonic goals with pro-environmental behaviour (Egenhoefer, 2017, 329). While “[t]here is still no agreement upon how habits should be conceptualized and operationalized in social psychology (…) there is a consensus that habits are formed through repetition (…) and reinforcement (…)” (Jackson, 2005 cited by Tang & Won in Egenhoefer, 2017, 331). The authors continue that “satisfactory accomplishment of a goal reinforces subsequent performances of the same behaviour” (Jackson, 2005; Schwanen et al., 2012 cited by Tang & Won in Egenhoefer, 2017, 331). If then, “people gradually learn associations between an action and a given context, the behavioural control transfers to cues in the context which triggers an automatic response: a habit” (Lally et al., 2010 cited by Tang & Won Egenhoefer, 2017, 331).

Tang and Won have found that habits can change our actions if “pro-environmental behaviour may be stimulated by strengthening normative goals or by making gain and hedonic goals less incompatible with normative goals and behaviour change” (Egenhoefer, 2017, 331). Does a change in definition to unavoidable FW also alter the way we see and react to risk? Is it possible the risk factor is aggregated by our habit formation?

Emotional Obsolescence and Sustainable Design

The preceding sections have delved into drivers, barriers, habit formation, emotional responses and cultural reactions in the contexts of FW, waste management, environmental risk and CC. These insights can shed light on the issue of waste overproduction, seeking to mitigate the conflict between profit-seeking motives and hedonic goals. For instance, in an unsustainable food system, overproduction can lead to practices like food dumping to manage excess supply during periods of low prices or the overestimation of buffet quantities in anticipation of higher sales, even potentially under the guise of a new "sustainable brand" (Egenhoefer, 2017, 349)

Chapman and Marmont, in their work on "Design and Emotional Obsolescence" (Egenhoefer, 2017, 348), highlight the complexities associated with integrating "sustainability" into design. They argue that when sustainability is connected to production or consumption, challenges arise. They draw from Bocock's insights to portray the modern consumer as driven by perpetual desire, characterized by a constant craving for what is not possessed, as they highlight “[c]onsumption is founded on a lack – a desire always for something not there” (Bocock, 1993, 46 cited by Chapman & Marmont in Egenhoefer, 2017, 349). The authors then claim that to balance the “insatiable cycle of desire for the new” and to mitigate the unsustainable culture of social acceptance of the “single-use” and “throw-away” society, we need to look at obsolescence “in its emotional – rather than functional – dimension” (Egenhoefer, 2017, 350). This insatiable desire for the new fuels a culture of disposability and single-use acceptance, a culture that necessitates examining obsolescence from an emotional rather than functional standpoint.

The concept of emotional obsolescence, as defined by the authors, centres on a rupture primarily shaped by a person's intentions and attitude, encompassing a shift towards outdated and unused status. This extends beyond material possessions, embracing an unspoken dialogue and a mutual exchange of use experiences between users and the used. While initially conceived in the realm of evolving product designs and lifetimes, this concept can aptly describe the obsolescence of habitual use of unsustainable products or systems. For example, it could explain the mutual preference of chefs, customers and kitchen assistants for sustainable waste management practices, which alleviate guilt, shame and other complex emotions tied to unsustainable behaviours.

2.4. Composting practices

In this section, various composting practices are discussed, including vermicomposting, on-site composting of restaurant organic waste and continuous feeding thermophile bioreactors. Composting is nature's way of decomposing organic matter. In his second book on soil, *Jordboka II* subtitled "Nærare naturen – Inn i det kompostmoderne" ("Closer to nature – into the compostmodern" translation by MLT) the author recycles the old phrase "it can take up to 1000 years to build five centimetres of topsoil" (Lønning, 2019, 121). By "it" he refers to "nature" and the natural process of reproducing topsoil. While nature needs significant (from the perspective of humans) time to produce natural compost, the human-aided production time is reduced by technical equipment and good management (Lønning, 2019).

Vermicomposting

Often bypassed by the admirers of technological wonders, one of nature's creatures takes on an impressive task. "Vermicomposting is a non-thermophilic, biological oxidation process" in which "earthworms and associated microbes" reduce the "decomposition process by 2-5 times" turning hazardous and non-hazardous biodegradable organic wastes from "crop residues, municipal, hospital and industrial wastes" "into valuable biofertilizer and produces much more homogenous materials compared to thermophilic composting" (Pathma & Sakthivel, 2012, 4).

On-site Composting of Restaurant Organic Waste

Feodorov et al. present a case study of on-site composting of mixed FW in Romania. The study demonstrates that correct handling and processing of FW through composting can eliminate pathogens, resulting in high-quality compost suitable for agricultural use. The study emphasizes proper process conditions, including controlled temperature ranges and aeration, to ensure the composting process is effective and safe (Feodorov et al., 2022).

What is particularly interesting about this case study is the processing conditions. Especially since the temperature is controlled between 55-65 °C, allowing the thermophilic bacteria to "decompose it by aerobic respiration" through "forced aeration" while the organic material is rotated inside the semi-automatic composting equipment. The process is operated by trained personnel using protective clothing. This ensures proper routines, correct C/N mix of input materials, number of rotations and quality control protocol to prevent malfunction, contamination and spreading of unwanted bacteria or pathogens while feeding the composter. Their findings conclude that "If FW is sterilized using chemicals, pesticides, cold, heat, or ingredients that inhibit bacterial growth before being put into the composter, the biological process will not properly function, lowering the composting capacity" (Feodorov et al., 2022, 6). In other words, if heated above the controlled temperatures of 55-65 °C, the heat will damage the process and give a poorer quality product. The overall conclusions of the study reveal that even if the bacteria and pathogens are found in a test sample after incomplete or incorrect processing, this batch will undergo a second composting process and can then be found safe for use as organic fertilizer for green areas if vetted as healthy after the second process. This shows us that "when quality management is followed, there are advantages that support a circular bioeconomy (…) no need to purchase chemical fertilizers and the quantity of water and energy needed is also reduced" and that "[f]rom a social point of view, this method of composting works to create a greener and safer environment" (Feodorov et al., 2022, 8).

Continuous Feeding Thermophile Bioreactors

In contrast to a nature-modelled composting system, the Norwegian main providers of composting technology and composting services are the continuous feeding thermophile bioreactor models, i.e., the "BioSpeed" module illustrated below (Figure 4). The BioSpeed M1 model is available on the Norwegian market at a cost price of NOK 350.000-550.000 and is referenced to illustrate and represent similarly performing composting systems. The BioSpeed M1 is a semi-automatic, stainless steel compost reactor with movable paddles and adjustable feeding and emptying intervals, a digital panel and an emergency stop button. The raw material is mulched and dehydrated before it is heated up to 80°C, at a capacity of 80-160 litres FW per day and reduces FW volume by 70-90%. It comes with a 1-year product guarantee, an optional service agreement, optional odour-reducing systems and lift mechanisms for wheelie bins.

The bioreactors dehydrate and heat the organic FW materials to 70-80°C and the end-product is reduced to a brown, fibrous powdery material with visual and textural similarity to peat/humus. But, most importantly, it is approved by Mattilsynet, to be used in fertiliser and soil-improvement products for agricultural purposes. It is, however, not to be confused with a living, nutritious and soil-compatible compost. The EU definition of composting is "a process of controlled decomposition of biodegradable materials (…) which allow the development of temperatures suitable for thermophilic bacteria as a result of biologically produced heat" (Institute for Prospective Technological Studies (JRC), 2014, 6). Biologically produced heat and not technically induced heat.

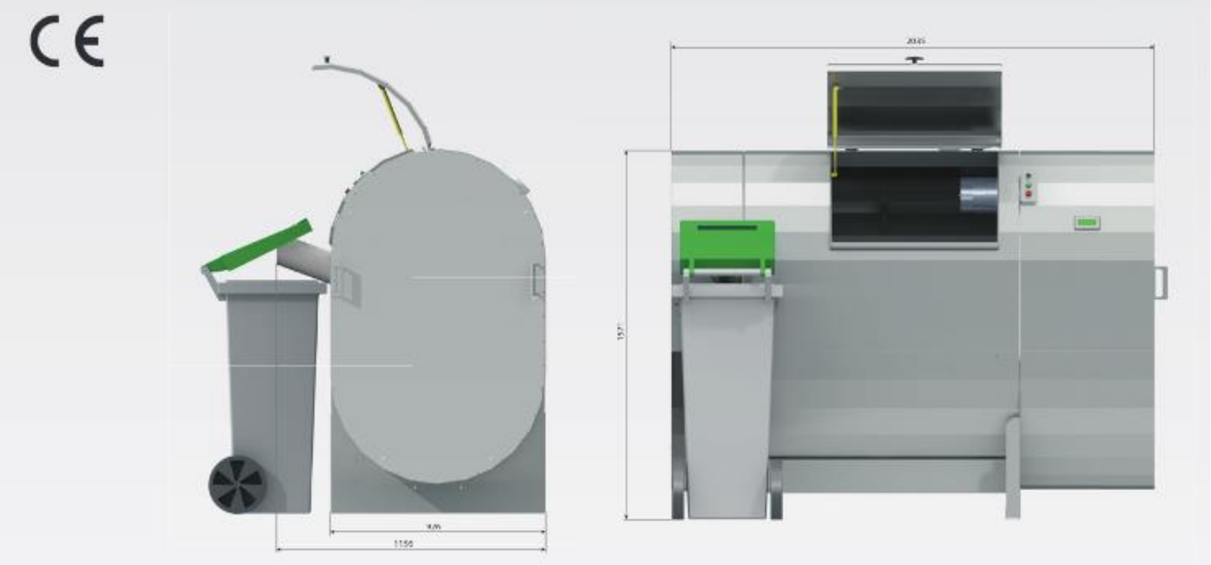


Figure 4: BioSpeed M1 bioreactor (*Produkter – BioCotech*, n.d.)

Composting and Soil Microbial Activity

Composting plays a vital role in maintaining soil microbial activity, aiding in biomass transformation, nutrient cycling and plant growth. Fungi, especially during the mesophilic phase, contribute to compost degradation by producing enzymes that break down complex plant tissues. If, however, temperatures rise above 65°C, fungal growth is severely inhibited (Aguilar-Paredes et al., 2023). The authors emphasize the role of temperature in composting and microbial activity. Their findings support that a “balance and maintenance of ecosystem services, such as biomass transformation, nutrient cycling, plant growth and health, are directly dependent on soil microbial activity”. This can be obtained by the “ancient technique that favours soil biodiversity” from the “production and application of compost” (Aguilar-Paredes et al., 2023, 1). However, they also point out that “high-throughput sequencing technologies has provided a means to elucidate the soil microorganism communities present in the composting process” and while nutrients, minerals and bacteria have important roles in producing compost for healthy soil biota, “the role of fungi within the composting process is equally relevant, as they produce a large quantity and variety of extracellular enzymes that allow the degradation of recalcitrant plant tissues, such as cellulose and lignin” (Aguilar-Paredes et al., 2023, 2). The crucial factor lies in “the thermophilic phase when the temperature reaches more than 65 ◦C, a significant development of fungi is not found. Temperature is one of the most principal factors affecting fungal growth. Most fungi are mesophilic with an optimal temperature of 25–30 ◦C” (Aguilar-Paredes et al., 2023, 5).

Microbial Conversion and Biofertilizer

Research by Tsai et al. shows that microbial inoculation enhanced the degradation of FW increasing the total nitrogen and germination rates (Tsai et al., 2007, 904). Their conclusions read that "biofertilizer prepared with food waste using thermophilic lipolytic microbes is a feasibile [sic] and potential method for the future" and that "[s]uch biofertilizers are not only suitable for use as a soil conditioner and fertilizer but can also suppress soil-borne and foliar plant pathogens" (Tsai et al., 2007, 913). The research was performed in three batches in semi-automatic bioreactors with variables for frequency and amounts of raw FW materials, bulking agent, frequency of agitation (rotations), days of pre-treatment and experiment days and rise and fall of temperatures. However, none of the batches were exposed to more than 50°C, allowing both mesophilic and thermophilic bacteria to be at work. The resulting biofertilizers were found to be effective soil conditioners and suppressors of plant pathogens (Tsai et al., 2007).

The presented composting techniques align with respective national laws and regulations for biodegradable waste treatment. However, there is a need for further research to optimize these methods and address knowledge gaps for better waste treatment and sustainable food production. Future research should explore natural bio-degraders to enhance waste treatment systems for FL and FW in Norway, considering biodiversity and sustainable food management for future generations. These gaps and future research suggestions will be discussed further in Chapter 7.6.

3. Theory and Analytical frameworks

The application of MLG and MLP frameworks are used to analyse how the current WTS regime hinders the transition towards a sustainable CBE in Norway, especially in the Stavanger region. MLP is used to explain the workings of the sociotechnical levels of landscape, the regime and the innovative niches over time. MLG is used "to capture the changing nature of policymaking and policy implementation", particularly in the "growing complexity of tailoring accurate policy measures in modern states" of the EU (Hooghe & Marke, 1996, cited by Szulecka et al. 2019, 255). The CBE is one such policy strategy and the FWiP introduced in Figure 2 is a tool to identify the policy instruments to apply when planning for the "best to worst" waste/resource treatment in a CBE framework.

3.1. The FW inverted Pyramid (FWiP) hierarchy

The EU commission advises developing a “smart” CBE, where the singular sectors melt together to improve biotechnical streams of knowledge, the use of biomass and raw materials and convert that which is considered waste from one sector into useful raw materials for another (Burton et al., 2020, 23). A CE manages its resources well, keeping the cyclical loop, for as long as possible. It recycles, re-uses and recovers energy before anything is discarded as waste (Burton et al., 2020, 58 & 64-65).

Practised under other names and titles for decades, the circular economy makes use of the basic model often referred to as the “inverted waste pyramid”, otherwise called “the waste hierarchy model”, first used by the EU in 1975 (Papargyropoulou et al., 2014, 11). The five-level hierarchy of the pyramid prioritizes the treatment of waste from top to bottom, indicating the best to worst waste treatment options. The modern adaptation of CBE understands that the path towards zero waste starts at the source (top-level). Preventing waste at the source is the most efficient use of resources and reduces overconsumption and environmental risk. The FWiP (Figure 2) is adapted to the case study (Figure 11) of this thesis to provide the reader with a visual model to see how FW from the SiS case study can be categorised “from ‘best’ to ‘worst’”. The top-down, five descending levels respond to distinct categories of FW management. However, every category represents multiple means and measures and variable scales of impact on ethics, socio-economic, environment, biodiversity targets and GHG emissions far beyond the scope of this thesis.

The authors Bugge, Dybdahl & Szulecka describe the *FW hierarchy inverted pyramid model* as “a framework created to define, prevent and manage waste” (Klitkou et al., 2019, 53). The combined sustainability perspective of the inverted FW hierarchy pyramid provides the LFS with a tool to prioritize and effectuate their FW management while considering “the definition problem” which often arises between different FW definition types. Considered a “strict definition”, “The Norwegian definition puts FW as anything below re-use, while the FUSIONS [Food Use for Social Innovation by Optimising Waste Prevention Strategies – under EU Commission Framework Programme 7] definition sets the boundary closer to the recycling stage” (Klitkou et al., 2019, 257-258). When implemented in daily routines, as a practical tool, the model can therefore assist the kitchen and floor managers to optimize their approaches to FW by compartmentalising, relieving them from complex analysis of food cuttings, byproducts, leftovers from prepping and FW from customer plates at busy peak hours.

3.2. The Multi-Level Governance Framework (MLG)

The MLG framework is a way of organizing diverse levels of government and various stakeholders in decision-making processes. It is both an analytical framework and “a strategy to better policy implementation” (Gollata & Newig, 2017). In their comparative analysis of governance policies and tools in Scandinavian countries, Szulecka et al. apply the MLG framework to view how the three different approaches of Norway, Sweden and Denmark have dealt with the case of FW. (Szulecka et al., 2021). The three Scandinavian countries, although having similar government structures and democratic parliaments, have chosen quite different approaches. Denmark and Sweden are both EU members, however, Norway has chosen to not become a member state but abides by EU waste management regulations through its EEC/EFTA membership.

Findings from Szulecka et al.’s expert interviews show “FW governance in Sweden is closer to the traditional centralised forms of steering” and in Denmark, it is “a civil society-driven framework” (Szulecka et al., 2021, 268) but “in Norway ‘it started with the industry’” believing that this would “bring cheaper and more effective solutions” (Szulecka et al., 2021, 266). This puts Norway in a “type II [MLG] framework with the industry taking the lead” without any government-led hierarchical responses or “clearly defined accountability of the actors in the common goals”. Szulecka et al. support the analysis given by Halloran et al. that “sustainable solutions to the reduction of FW (…) must include multi-stakeholder collaboration, especially public-private partnerships at the global level”. The much debated and delayed FW law has been put on hold since its first parliamentary proposition in 2017. However, the 2023 budget negotiations will finally deal with the anticipated and legally committing national FW law proposal (Miljødepartementet, 2023), “despite Norway’s tradition for co-regulation, (…) lawmakers continued to pressure the government for a binding law, with a clear move from initial industry self-regulation towards state-steered regulation” (Szulecka & Strøm-Andersen 2022, 86).

At the EU level, the F2F strategy sets out several targets and initiatives that aim to reduce the environmental impact of food production, promote sustainable agriculture and improve the health and well-being of European citizens (Bock et al., 2022, 23). These include targets to reduce pesticide use, increase organic farming and reduce FW. At the member state and regional levels, governments are responsible for implementing these targets and initiatives and for developing policies and programs that support sustainable agriculture and food systems. This may involve providing financial incentives for farmers to practise sustainable farming, support local food systems, or promote public awareness of the benefits of sustainable food production and consumption. At the local level, communities and consumers play an important role in shaping the food system by supporting local farmers, choosing sustainable food options and advocating for policies that promote sustainable agriculture and food systems (Bock et al., 2022, 23).

In the context of the F2F strategy, this means that the MLG policy system of the EU is collaborating with member states, regions and local communities, as well as farmers, consumers and other stakeholders to develop and implement policies that support sustainable food production and consumption (Bock et al., 2022, 18). Overall, the F2F strategy and the MLG policy framework provide a comprehensive approach to creating a more sustainable and resilient food system that involves all levels of government and stakeholders in decision-making processes.

3.3. The Multi-Level Perspective (MLP)

“Transition refers to a discontinuous shift to a *new* trajectory and system” (Geels & Kemp, 2007). Transition theory guides the understanding of where, when and how academia, government, industry and society relate to and conjoin the transition trajectory. Transition theory also provides us with a background for analysis to assist in finding the barriers, drivers and lock-ins created by the ruling regime of consolidated firms and private-public market-oriented politics. MLP offers a structured approach to understanding the essential shifts in technology, regulations, social norms and culture necessary for lasting changes in FW practices. This analytical tool is pivotal in devising strategies for achieving sustainable transitions in the FW landscape. In the case of this thesis, I will be looking for the main dynamics and barriers obstructing or slowing down the transition to a sustainable and zero FW management system for LFS in the Stavanger region.

The MLP is a middle-range analytical framework to understand how sustainability transitions develop across time and space. The triple-nested, hierarchically embedded (Figure 5) dynamic framework consists of the socio-technical landscape, socio-technical regimes and radical niche technology innovations (Geels, F.W., 2011). The shift is placed within the regime level and the transition requires a simultaneous, multi-dimensional and Multi-Level led alignment between the three non-linear levels. In the new regime, the niche technologies can be networking in clusters, collaborating with eco-systems and other major players or actors (Geels, F.W., 2011).

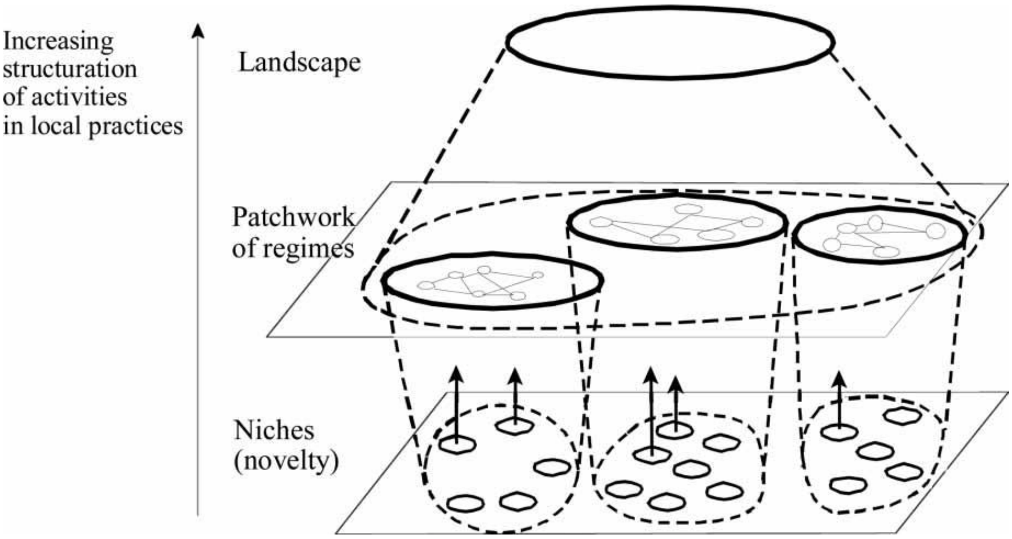


Figure 5: Multiple Levels as a nested hierarchy (Geels, F.W., 2002, 1261, ref. by Schot & Geels, 2008)

To put this theory in a local context, these three analytical levels will be described and juxtaposed on the problem of WTS for FL and FW in Stavanger. The framework will assist in describing the process, the barriers and the drivers to obtain the objectives of the “ideal” model for the sustainable, “smart” community and the overarching goals defined above.

The Socio-Technical Landscape

The socio-technical landscape (Figure 6) represents the larger exogenous environment that sets the backdrop for transitions. Major forces or events, such as CC, wars, or pandemics, can influence and destabilize the socio-technical regime. In the case of this thesis, the landscape is defined by significant global concerns, including CC, the COVID-19 pandemic and the urgent need for sustainable practices (Geels, 2002; Schot & Geels, 2008). In the case of this thesis, the landscape-level problem of FW elaborated above is distilled to the point of critically endangering our lives and habitats. The landscape level of FW is regulated by the EU Mission, the Paris Agreement and the SDGs. It is further induced by a post-pandemic depression and the ongoing national energy crisis, heavily influenced by European economic inflation and geopolitical energy disputes. It is an image of multiple and serious concerns.

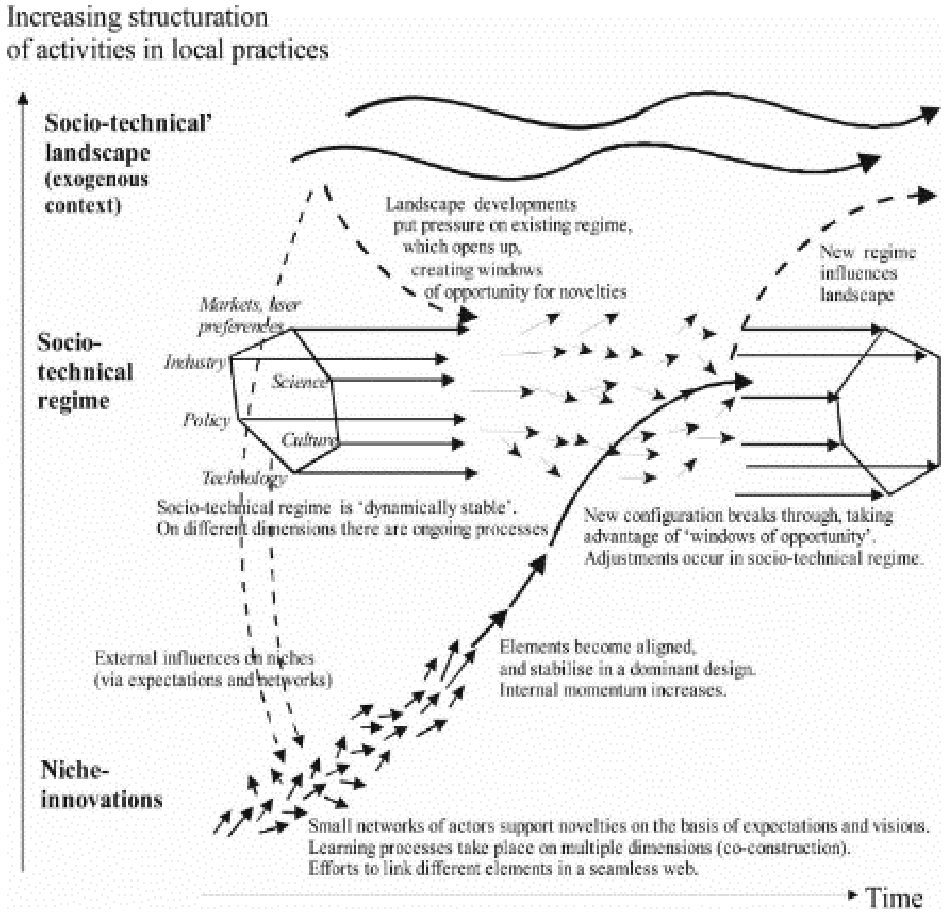


Figure 6: MLP on transitions (adapted from Geels, F.W., 2002, 1263, ref. by Schot & Geels, 2008)

The Socio-Technical Regime

The socio-technical regime (Figure 6) encapsulates the established structures of society, including technologies, institutions, policies, industry and cultural norms (Geels, 2002; Schot & Geels, 2008). In the context of the Stavanger region, the regime is characterized by the dominance of fossil-based industries, petroleum-related technologies, intensive agriculture and a culture that is both aware of environmental challenges and maintains unsustainable practices. Key actors and institutions like Mattilsynet play crucial roles in maintaining this regime. The regime of Food production systems and its WTS for FL and FW in Norway is "dynamically stable", bound by Mattilsynet's regulatory authority harmonised with the EU waste directives. The cultural norms are based on consensus creating a "split" cultural duality where on the one hand, people are well informed of the climate-, environment- and biodiversity crises, while continuing their daily unsustainable practices, practising emotional distancing through collective denial strategies (Egenhoefer, 2017, 391). The WTS regime in Stavanger is represented by IVAR, Renovasjonen IKS and private renovation companies under public contracts.

The Niche

The niche is an area of experimentation and innovation, where recent technologies, practices, or approaches emerge, often organised in clusters, innovation ecosystems or social entrepreneurship hubs (Figure 5). These radical innovations have the potential to challenge the existing regime and lead to a transition (Geels, 2011). Destabilization, shock or longstanding pressure from the landscape level opens a window of opportunities for niche innovations to gain momentum and level up (Geels, 2011). In the context of sustainable waste treatment for food in the Stavanger region, various niches are emerging, including digital apps addressing FW reduction, urban farming collectives, vermicomposting ventures and start-ups focusing on CBE value chains. Examples of niche developments in the case of SiS and the urban, smart city parameters for Stavanger include digitalised Apps, such as TooGoodToGo (TGTG), Olio, Goodify, Yelp, Throw No More (TNM), No Waste (NW) etc., Urban farming collectives (ByAuk, Frivilligsentralen), Reve Kompost AS, facilitating and producing vermicompost and two new start-up companies called WasteUp and Topp Sopp. Topp Sopp grows edible mushrooms in coffee grounds collected from regional LFS and the former collects the waste from the Topp Sopp mushroom production to develop animal fodder. This complete cycle presents a full CBE value chain.

4. Research Design

The research design for this thesis involves a case study approach, focusing on the SiS café “Optimisten” (SiS) located on the UiS campus. Through this case study, the research aims to shed light on effective strategies for valorising FW, reducing waste generation and promoting sustainable practices within the LFS sector. The research will also explore how policy frameworks and transition theories can facilitate and enhance the internalisation of sustainable FW management practices in LFS, contributing to a more sustainable CBE. The research design evolved to encompass an in-depth analysis of SiS’ FW reduction strategies, evaluating the transition policies and practices within the CBE context and identifying and discussing the drivers and barriers for sustainable FW management in the LFS sector.

4.1. The Research Process

The research process has evolved through multiple phases, culminating in a detailed case study on the SiS café at the University of Stavanger:

1. Preliminary Scoping Phase: Initially, the research aimed to develop an on-site FW composting system for three collaborating companies within the food services sector. This phase involved comprehensive assessments of these companies, including waste types, regulatory frameworks, and potential designs for composting systems.
2. Refocusing Amidst Challenges: Various barriers—such as regulatory, financial, technological, knowledge-based, and psychological factors—posed difficulties in implementing the original case study plan. Consequently, the research shifted focus towards identifying a more suitable case study, leading to the selection of the SiS cafeteria. SiS has notably overcome many of these barriers, making it a promising subject for deeper exploration within the research questions of this thesis.
3. Engagement with SiS Cafeteria: The decision to engage with SiS cafeteria arose due to its advanced approach to FW valorisation and its innovative strategies for waste reduction, rendering it a viable and insightful case study.
4. Adjusted Research Design: The research design was consequently adjusted to centre on the SiS cafeteria's FW valorisation pathways, transition policies, and policy tools facilitating sustainable FW management.

Case study: the research approach

In alignment with Yin's standard approach to case studies, this thesis embarks on a single-case study exploration aimed at understanding the transformative potential within the LFS sector (Yin, 2018). Initially envisioned as an investigation into how three companies within the LFS sector transitioned into a closed-loop CBE, the research direction evolved beyond a triple-embedded case study. The shift occurred as the exploration expanded to assess the broader regional context of Stavanger, where limited engagement in on-site composting was observed among LFS entities.

The case selection process was shaped by a realisation of the necessity for fostering an enabling environment that would encourage LFS participation in sustainable practices. Initial efforts involved collaborating with experts from regulatory bodies such as Mattilsynet and specialised laboratories to delve into composting methodologies. However, as the research progressed, the focus naturally shifted towards investigating transition policy literature, political strategies, and policy tools on FW valorisation pathways within the LFS sector.

Collaboration with Professor Kumar redirected the study towards SiS, an exemplar in successfully implementing FW measures and pioneering change in CBE approaches. The subsequent scoping phase honed in on SiS, steering the study to analyse the expanded circles of FW valorisation within this context (Figure 7). SiS emerged as a pivotal and distinctive single-case study due to its departure from traditional norms, allowing for a meticulous examination of barriers and lock-ins restricting FW valorisation within the CBE trajectory.

Illustrating the distinct circular systems of SiS (Figure 7) along with their drivers and barriers for change serves the purpose of identifying pertinent policy tools. This analysis aims to fortify the foundations for a sustainable LFS sector not only in Stavanger but also in the surrounding region. The unique critical insights found in this investigation resulted in a departure from the original explorative triple-embedded case study, leading this thesis to manifest as a singular critical case study.

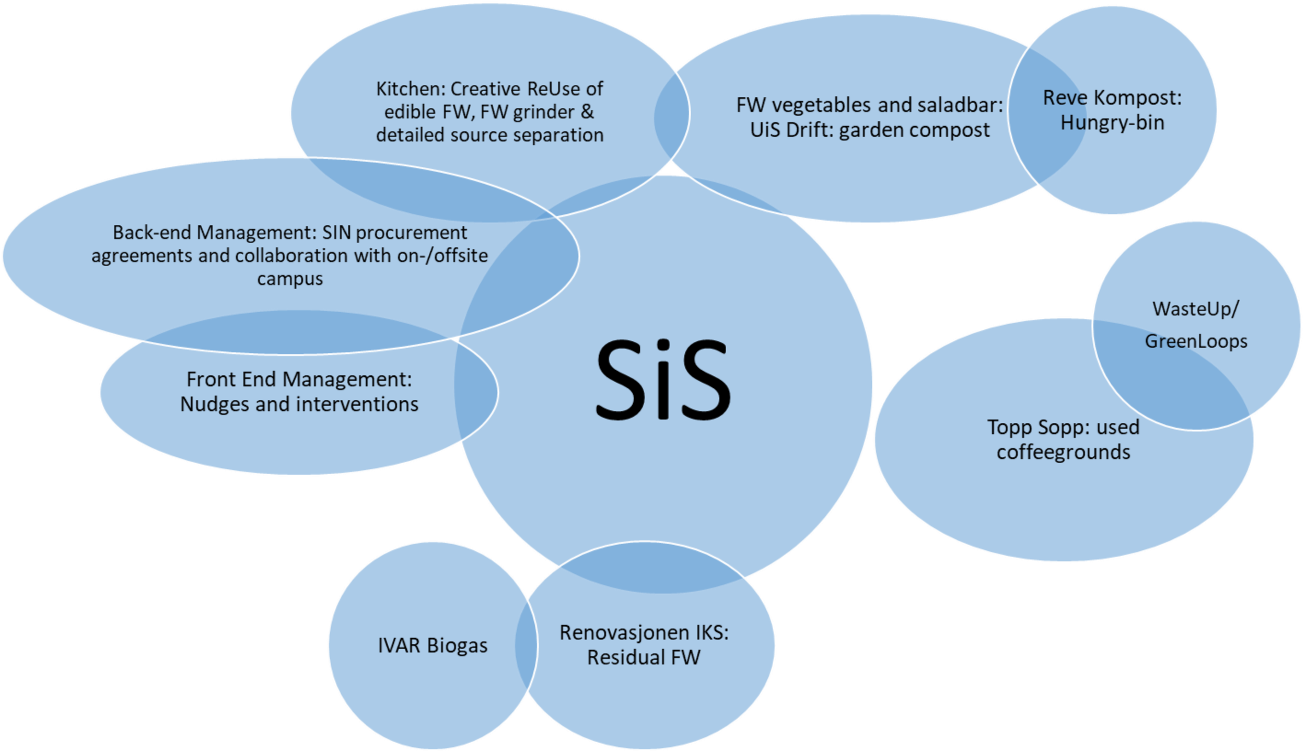


Figure 7: SiS FW cycles (MLT, 2023)

4.2. Methods

The research design employs qualitative methods, focusing on a singular critical case study approach. The methods encompass primary data collection by direct field observations and expert interviews to thoroughly understand the FW valorisation pathways. The methods further include secondary and tertiary data collection and document analysis, triangulating peer-reviewed research articles, policy documents, regulatory frameworks and legal documents related to LFS FW with primary data. Complementary data sources include emails, meeting minutes and informal dialogues, providing a comprehensive understanding of the particular case and the LFS sector, and contributing to the robustness of a broader and nuanced understanding of LFS FW management.

4.3. Data collection, Translation and Transcription

I have chosen an inductive qualitative approach, utilizing post-positivist strategies to gather and analyse data. The SiS case study employed a comprehensive data collection approach, utilizing various communication methods such as emails, phone calls and in-person meetings to engage and interact with informants. The methods involve direct explorative field observations conducted within SiS' kitchen facilities, focusing on organisational routines, source-separation systems, FW reception and composting procedures. Additional methods included semi-structured expert interviews, using a questionnaire/interview guide, loosely altered according to the given replies and the intended outcomes from each encounter/visit/interview. This allowed observation and listening to the subjects, reconstructing follow-up questions throughout interviews and field visits. Open-ended questions brought me deeper layers of information and more detailed explanations of the points of interest. The interviews were conducted in both English and Norwegian, collected between March and July 2023. Notes were transcribed and translated to English for analysis, ensuring that the context is preserved and anonymized where necessary. These transcriptions and translations, referred to by “MLT2023”, are a crucial aspect of the research, enabling effective analysis and referencing.

Primary data collection

In addition to the case study data collection, other primary data collection methods included telephone expert interviews, face-to-face informal conversations, email exchanges and a small survey conducted during a local food festival. These approaches aimed at comprehensively understanding regulatory practices, alternative approaches, challenges and solutions within the SME LFS and niche circular bioeconomic companies in the region. This comprehensive approach to data collection ensured a well-rounded understanding of the subject, incorporating insights from both formal interviews and informal dialogues.

Semi-structured interviews

Semi-structured qualitative interviews were conducted by using an interview guide with open-ended questions. The informants, except certain SMEs and LFS, allowed the study to use their positions at the companies. Interviews were conducted with representatives from Mattilsynet, UiS, SiS, Statsbygg, two LFS from Stavanger, a bio-reactor company sales representative and a local entrepreneur representing three CBE companies: Topp Sopp/WasteUP/GreenLoops. The interviews lasted between 30 to 60 minutes. Due to the exploratory nature of the early rounds of interviews, it became necessary to focus on specific issues and narrow the scope of the key informant interviews. Key informant follow-up interviews were held between August and November 2023.

Table 1: Key Informants of semi-structured interviews

I#1	Key informant from Mattilsynet
I#2	Key informant from UiS
I#3	Key informant from SiS Adm
I#4	Informant from SiS staff
I#5	Key informant from Statsbygg
I#6	Key informant from LFS Stavanger
I#7	Informant from LFS Stavanger
I#8	Key informant from Bioreactor product company Global-Enviro AS
I#9	Key Informant from Topp Sopp, WasteUp and GreenLoops

Informal Dialogue Interviews

Informal dialogue interviews, characterized as unstructured and conducted in natural settings, provided additional insights. These interviews were held during public and private events and gatherings. Although not transcribed, they were referred to as supportive of the discussion and were used to enhance the dialogue further. The selection was made from various events and gatherings and was documented through informal notes.

Table 2: Informal Dialogue Interviews

D#1	LFS1	Informants from 3LFS Sola
D#2	LFS2	Informants from 12 LFS Stavanger during Gladmat 2023
D#3	Informants from SiS staff	

Secondary and tertiary data collection

The research incorporates a rich array of secondary and tertiary data sources, spanning various domains. These sources include:

1. Official Statistical Data: Bureau of National Statistics (SSB) data provides a foundational understanding of key statistical information.
2. Regulatory and Policy Documents: Data from Mattilsynet, Stavanger Municipal CEP Action Plans and associated status reports offer critical insights into regulatory aspects and policy directions.
3. Smart Applications Data: Utilization of data from smart applications to discern patterns and behaviours in FW management.
4. Scientific Articles and Reviews: Scholarly research articles from reputable journals, particularly in sustainable transition theories, governance, policy theories and behaviour theories.
5. National CBE Strategy: Strategic insights from the National CBE strategy are employed to contextualize the study.
6. University and SiS Websites: Information from UiS and SiS websites provides a comprehensive understanding of their initiatives and approaches.
7. Literature Search: Extensive literature searches were performed using scholarly research engines like Google Scholar and Oria, covering articles, reviews and anthological literature.
8. Government and NGO Documents: Online white and green papers from the Norwegian government and EU Commission websites, national regulatory authorities and various NGOs offer valuable insights.
9. Technical Fact Sheets: Publicly available technical fact sheets from public- and private-sector companies contribute to a detailed understanding of technical aspects.
10. Media Excerpts: Relevant information from media excerpts enriches the study with contemporary perspectives.
11. Private Archives: The researcher's private archives from three decades of household composting and 18 years of teaching on composting provide valuable historical and experiential context.
12. Pilot Projects and Transition Models: Manuals, reports and documents from pilot projects, 'best practice' models and examples of incentivized local policy programs offer perspectives and context.

4.4. Data Analysis

The purpose of triangulation in a case study is that it “relies on multiple sources of evidence, with data needing to converge in a triangulating fashion” (Yin, 2018, 46). The objective of triangulating is to obtain a convergence of multiple sources of evidence from a single case study, open-ended interviews, expert interviews, scholarly research and legal documents. The comprehensive analysis of the data collected unveils insights and patterns regarding the key variables influencing FW management in LFS. The analysis aimed to shed light on critical challenges in FW characterization, quantification and management within the SiS case study. The qualitative analytical methods used in this study aim to provide a deeper understanding of the drivers and barriers, as well as the nuances of governance and policy instruments that shape FW practices. This analysis serves as the cornerstone for developing strategies to facilitate the transition towards sustainable FW management in LFS.

Case study on SiS – methods used

The SiS data was analysed using the CBE inverted FWiP focusing on various levels and approaches within SiS' waste management system. Data from semi-structured and informal dialogue interviews were analysed using close reading techniques and organised in an Excel sheet (Table 6). This involved identifying FWiP hierarchical levels, values and their attributed practices related to FL and FW management from managerial, kitchen and customer perspectives. SiS' initiatives for FW reduction have then been integrated into the FWiP hierarchy model, while its CBE approach is outlined, specifying the goals, involved companies and methods for encouraging guests, employees and management to reduce the SiS FW footprint (Figure 10). Field notes, interview notes and journal entries played an integral role in documenting and supporting the study. Furthermore, active participation in local events, festivals, conferences and personal experiences like home mushroom cultivation enriched the understanding of the LFS system. Additionally, the scoping circles' data was analysed through the MLP and MLG frameworks, aiming to identify regime structures and policy restrictions that influence the transition to a sustainable FW management system.

Triangulation of Insights

This study employed triangulation to ensure robustness in the findings by cross-verifying data from multiple sources, such as case studies, interviews and secondary and tertiary data. The factors and variables identified in the SiS case study were compared and integrated to achieve a converged understanding, aligning with the inverted FW pyramid's levels. The secondary and tertiary data were analysed using the close reading technique to extract relevant information and insights related to FW management, CBE, policies and regulations. These sources enriched the understanding of the broader context and supported the case study's findings. Triangulation was achieved by incorporating scientific and regulatory documents, email correspondence, semi-structured interviews and field observations.

The triangulation of data from qualitative interviews, observations and document analysis highlights the multifaceted nature of the challenges and opportunities faced by the LFS sector. The findings emphasize the need for tailored and practical solutions to address FW within SMEs and call for collaboration, innovation and adaptability. Moreover, the regulatory environment plays a crucial role in shaping the strategies employed by LFS businesses, indicating the need for policy adjustments and support. The insights from the case study contribute to the development of a broader understanding of the drivers and barriers for transitioning towards sustainable FW management within the LFS sector. These insights serve as a foundation for policy recommendations and future research directions, aiming to propel the sector towards circular bioeconomic practices and contribute to the global sustainability agenda.

4.5. Validity and ethical concerns

Construct validity requires an operational set of measures that match the concepts of FL, FW and related constructs. The thesis opens with chosen definitions of terms and background information stating the propositions and objectives for the study. The chain of evidence is presented based on the theoretical frameworks chosen from relevant and peer-reviewed studies, objective databases, open-ended interviews and field observations following the case study protocol. In addition to complying with the code of research ethical standards for data storage and treatment (SIKT, 2023), this thesis has taken extra considerations to allow informants from interviews and dialogues to remain anonymous except for their workplace information. Expert interviewees have been named. All participation has been voluntary by confirmation.

Internal validity reasons have turned the research design twice, expanding and narrowing it to find the more appropriate case and focus. Inferences such as "Case study FW levels were higher before the intervention of "scales" was introduced, leading to focusing on the behaviours that led to such change. Shortcomings to internal validity have shown measurement and reporting inconsistency in baseline settings. The first years of reporting FW in the MFT reporting system have not distinguished between FW and residual waste. Source separation of FW commenced in 2022 after some anomaly pandemic years combined with improved source separation systems for kitchen and guests. These discrepancies have been addressed and SiS is operationalising 2022 as the baseline year for FW figures for future reference.

The unstructured, direct, active field observations were performed by appointment. This means that preparations could have been made to give a “best” scenario impression on the day of the visit. However, having seen the same routines performed as a regular customer of SiS, I have concluded that the observation is not likely to have been arranged in such a way.

The LFS questionnaire was considered a possibility to reach out to a representative selection of SMEs in LFS and FP. Unfortunately, this micro survey did not catch on with the exhibitors and no replies were received. Although this result does not prove disengagement in the topics or questions on its own, yet another approach was attempted by sending a friendly reminder email to all the exhibitors a few weeks later with the questionnaire attached. This also resulted in 100% “no reply”. It is therefore possible to induce some pattern of disengagement in the general selection of LFS and could be an interesting topic for future study.

The data has been analysed using value-neutral and objective research analysis. There is no intentional bias towards any policy, political strategy or incumbent system for change. However, my 30 years of personal and professional dedication to environmental practices have necessarily affected my interest in the field and taught me to be humble, inquisitive and open to knowledge. I have adapted all measures to ensure a broad and open-minded query, widening and closing the scope and focus of this thesis according to the accumulated knowledge from the research. I have used this opportunity to look deeper into the barriers of change, reflecting on behaviour and the soft skills required to shift the transition into a higher gear.

4.6. Reliability

The study maintains reliability by implementing systematic methods for data collection and analysis. The processes used are replicable, allowing for consistency in obtaining similar results under similar conditions. The structured approaches in data gathering and analysis contribute to the study's overall reliability, enhancing its credibility and dependability. A case study protocol, research logistics, case study reports, interview reports, relevant readings, field notes and data collection procedures are collected in a temporary, secure database for the duration of this study.

5. Findings

The exploration of sustainable FW management and the intricate interplay of factors in its implementation has led to a profound understanding of the complexities that underlie the endeavour. Chapter 5 provides detailed insights into the LFS landscape, waste treatment systems and the drivers and barriers that influence sustainable transitions. The following sections encapsulate the core findings derived from these chapters, shedding light on the transformative processes essential for achieving sustainable FW management.

The findings reveal that the LFS sector, epitomized by SiS, holds significant potential for driving sustainable FW practices. SiS' multifaceted approach towards FW reduction, which encompasses diverse valorisation pathways, stands as a remarkable example of the CBE paradigm. This approach extends beyond waste management to foster synergistic collaborations among various stakeholders, including student organisations and local start-up companies.

Moreover, the assessment of waste treatment systems exemplifies the importance of evolving policies and regulations. In-depth analysis underscores the critical role of knowledge-based policy instruments in facilitating the transition towards sustainable FW management. By aligning regulatory practices with ecological principles and CBE models, substantial progress can be made in reducing FW and enhancing its value.

The examination of drivers and barriers, outlined in 5.3, elucidates the intricate factors that both obstruct and facilitate sustainable transitions. Understanding the nuances of regulatory, financial, technological, knowledge and psychological barriers is vital for devising effective policy tools. Such tools can serve as catalysts in surmounting these barriers and paving the way for the widespread adoption of CBE practices.

In summary, the findings presented in this section underscore the transformative potential of sustainable FW management. By embracing innovative valorisation pathways, evolving policies and navigating the complexities of drivers and barriers, the LFS sector can play a pivotal role in the broader mission of building a CBE.

5.1. FW on the national level in Norway

In 2021 the national TV channel NRK published an article stating that one out of 10 municipalities have no system for FW collection from households (Lindback, 2021). The current National status of FL and FW from households (*Matavfall og matsvinn*, 2022) is 216 100 T. Although an insignificant reduction is registered from 42.6 Kg per person in 2016 to 40.3 Kg in 2020, Norwegian households throw away almost half of the total 450,000 T of wasted edible food for human consumption in 2022, valued at NOK 8.000.000 per year. The largest segment of this type of FW is leftovers from the plate 31.1% (Figure 8), while fruits and vegetables (21.9%) and Bakery goods (18.2%) follow closely behind. Retail and LFS amount to approximately 100,000 T, almost half of the households.

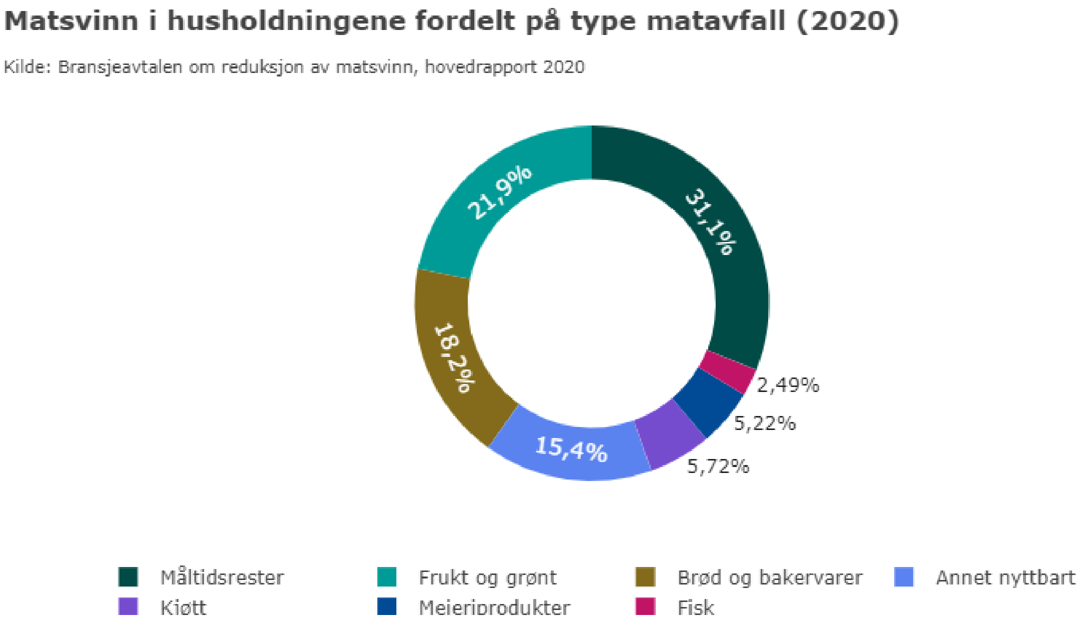


Figure 8: FL from households distributed by type of FW (Bransjeavtalen om reduksjon av matsvinn, Hovedrapport, 2020)

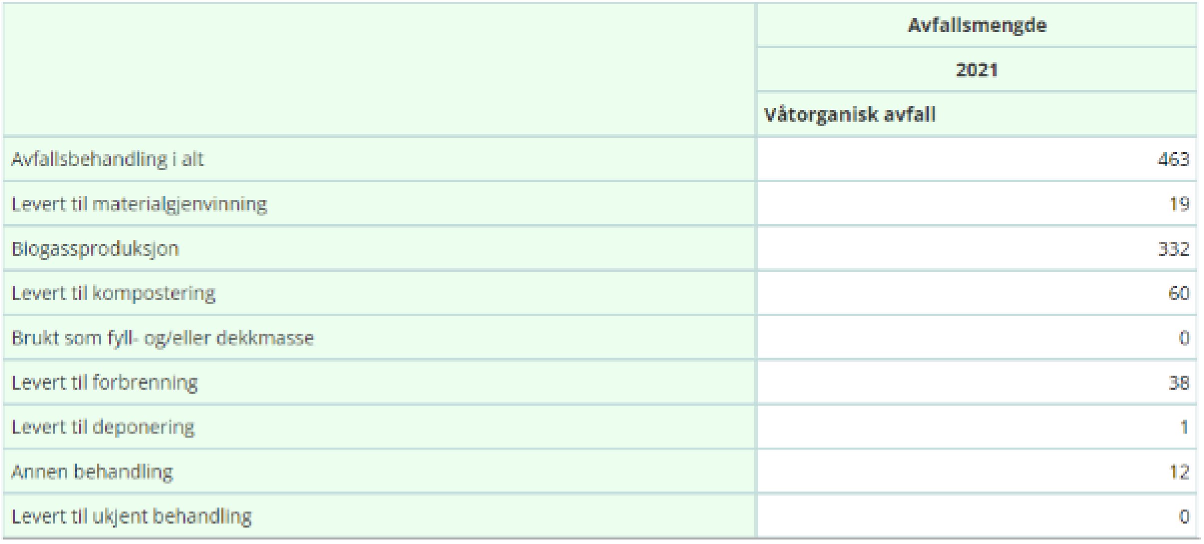
Real data from all sectors of the food industries are unfortunately strongly under-representative, considering that the Industry Agreement on Reduction of FW (Bransjeavtalen om reduksjon av matsvinn: Hovedrapport 2020) states that registering FL and FW from LFS is still voluntary (Miljødepartementet, 2021). 107 companies from the food value chain have registered and the data on FL and FW is improving across all sectors. However, as Table 3 shows, FW from households and wet-organic waste from LFS have moved in opposite directions over the past years. While numbers from LFS show a decline, numbers from households have had a slight increase (Matavfall og matsvinn, 2022).

Table 3: National Household FW vs. Wet-organic waste from companies (Miljøstatus, data collected from SSB, 13136)

	2015	2016	2017	2018	2019	2020	2021
Matavfall hus...	180 503	189 313	191 540	200 565	208 905	209 949	212 094
Våtorganisk fr...	133 697	123 437	166 317	191 100	174 719	100 963	101 657

A total of 463,000 Tons of wet-organic waste from all Norwegian sources was registered in 2021. The National Statistics Bureau (Table 4) shows that 19,000 T were treated as material recovery, 332,000T were turned into Biogas and bio-digest and 60,000 T were composted (SSB. 10513, n.d.).

Table 4**:** National wet-organic waste treatment numbers (SSB, 10513, n.d.)

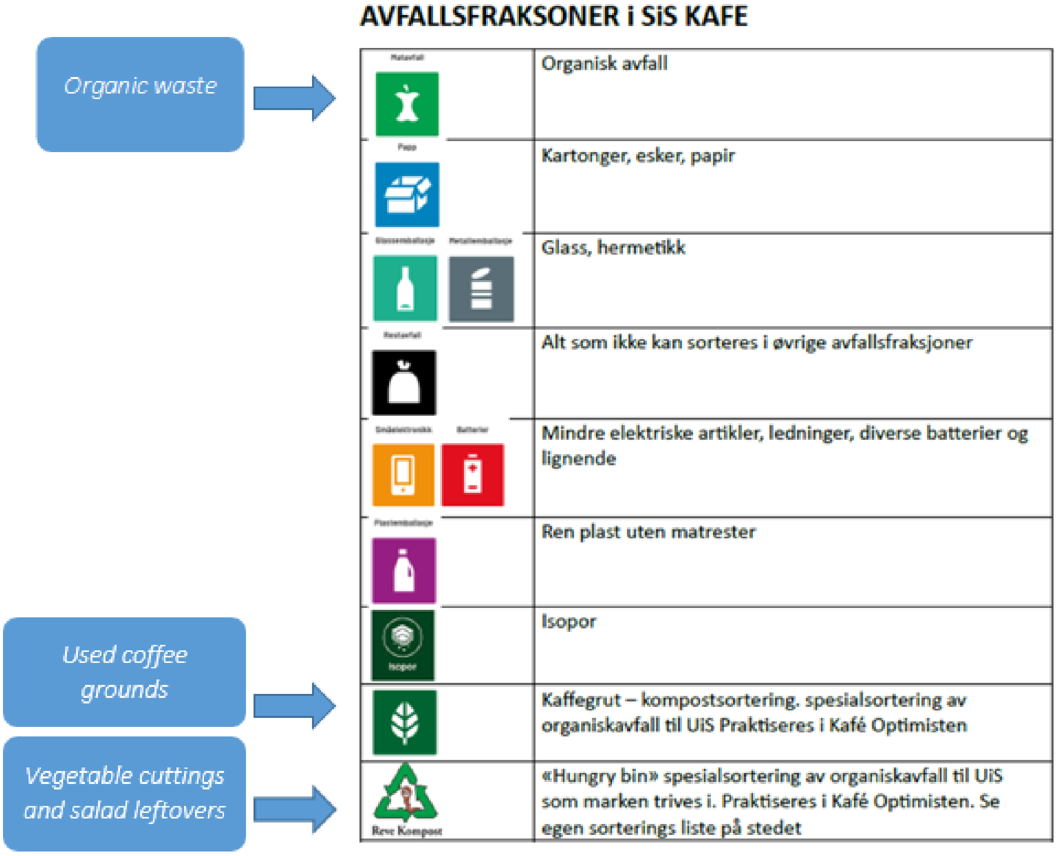


	Avfallsmengde
	2021
	Våtorganisk avfall
Avfallsbehandling i alt	463
Levert til materialgjenvinning	19
Biogassproduksjon	332
Levert til kompostering	60
Brukt som fyll- og/eller dekkmasse	0
Levert til forbrenning	38
Levert til deponering	1
Annen behandling	12
Levert til ukjent behandling	0

In Stavanger, 7 526 T of FW was collected from household and company FW wheelie bins, all of which were transported to the IVAR Biogas facility in Grødaland (IVAR, 2018). The prices for delivering FW or wet-organic industrial waste to IVAR vary by its attributed quality. However, IVAR Ryfylke's online pricelist states the price for company FW is NOK 2550 per Ton (*Priser på gjenvinningsstasjoner - IVAR Renovasjon Ryfylke*, 2019). The same list shows that the price of delivering residual waste to the same facility is NOK 1760 per Ton. This price difference provides less incentive to separate FW from residual waste and a strong financial barrier against complying with source-separation regulations for companies and industries.

5.2. The Case study: SiS Cafeteria “Optimisten”

SiS is the largest UiS campus cafeteria, providing warm- and cold buffets with meats, fish and vegetarian options, a fresh salad bar and hot/cold snacks and drinks to students and staff (SiS, n.d.). The food is made from scratch, with fresh produce, to ensure good quality, healthy and nutritious “fuel” for active students. The daily warm buffet menus are advertised inside the cafeteria along with daily updates on the website and the minSiS App (*Kafé Optimisten – Min SiS*, n.d.). It is also possible to book catering and refreshments for in-house meetings etc. Opening hours are from 8.30-15 all weekdays. The Kitchen source separates nine waste fractions (Figure 9), three of these (marked with arrows) are sourced FW. FW from the plate is also sourced in the customer waste-disposal area.



AVFALLSFRAKSONER i SiS KAFE

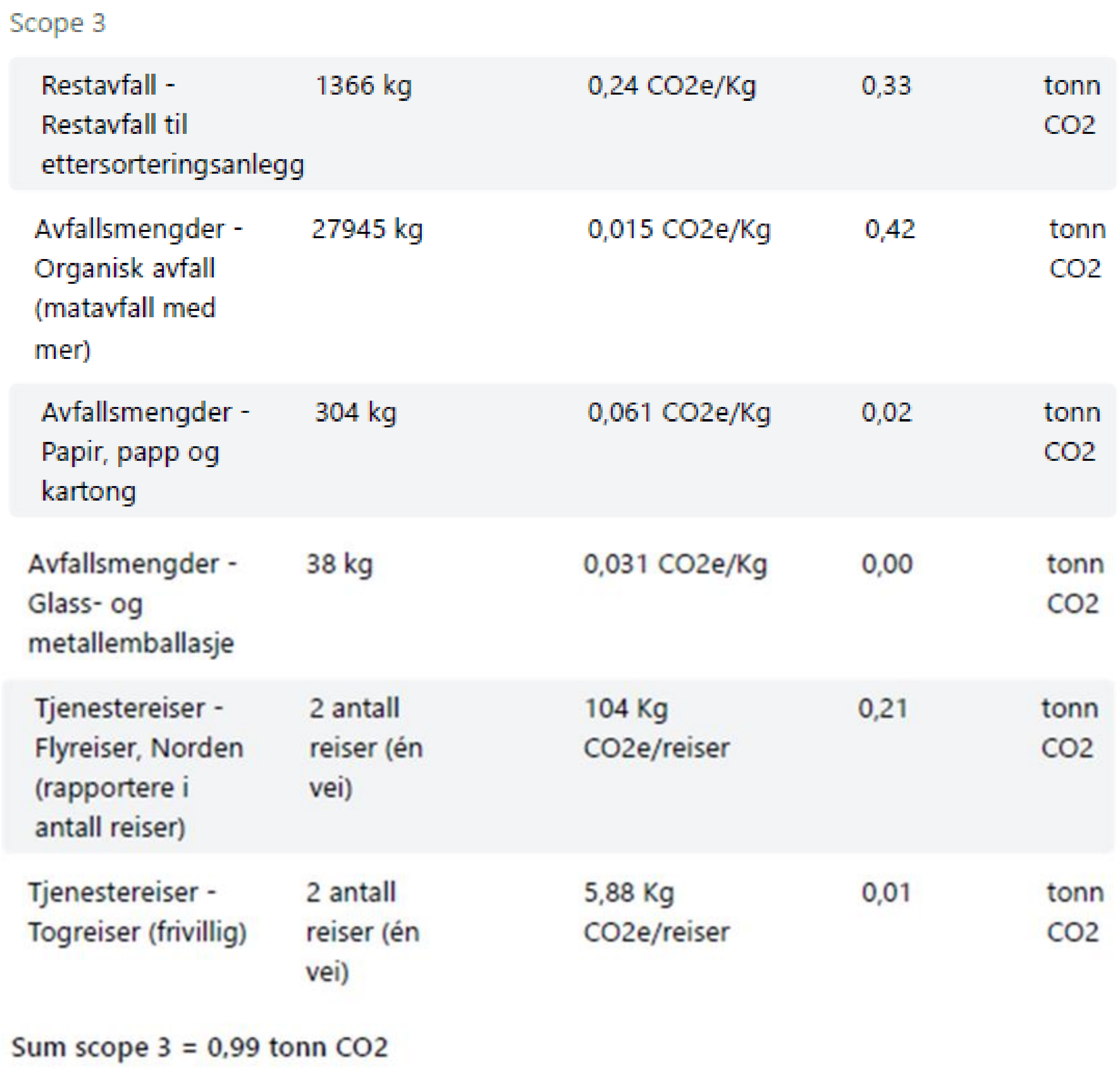
	Organisk avfall
	Kartonger, esker, papir
	Glass, hermetikk
	Alt som ikke kan sorteres i øvrige avfallsfraksjoner
	Mindre elektriske artikler, ledninger, diverse batterier og lignende
	Ren plast uten matrester
	Isopor
	Kaffegrut – kompostsortering. spesialsortering av organiskavfall til UiS Praktiseres i Kafé Optimisten
	«Hungry bin» spesialsortering av organiskavfall til UiS som marken trives i. Praktiseres i Kafé Optimisten. Se egen sorterings liste på stedet

Figure 9: SiS source separated waste fractions (I#3)

Miljøfyrtårn/Eco-Lighthouse FW reporting

UiS and SiS received Eco-Lighthouse (MFT) certificates (Mft, 2017) in 2019 for reporting on environmental and climate targets in 2018 (SiS, n.d.). Historical tables will not be brought into this case study considering 2022 was the first year the MFT reporting distinguished between organic, residual and recyclable waste. Yet another reason is that 2019-2022 should be considered unusual due to the pandemic situation, with abnormal routines, production and customer situations. FW is reported in MFT's reporting platform under Scope 3 (Table 5).

Table 5: MFT reporting Scope 3, 2022 (I#3)



Scope 3

Restavfall - Restavfall til ettersorteringsanlegg	1366 kg	0,24 CO2e/Kg	0,33	tonn CO2
Avfallsmengder - Organisk avfall (matavfall med mer)	27945 kg	0,015 CO2e/Kg	0,42	tonn CO2
Avfallsmengder - Papir, papp og kartong	304 kg	0,061 CO2e/Kg	0,02	tonn CO2
Avfallsmengder - Glass- og metallemballasje	38 kg	0,031 CO2e/Kg	0,00	tonn CO2
Tjenestereiser - Flyreiser, Norden (rapportere i antall reiser)	2 antall reiser (én vei)	104 Kg CO2e/reiser	0,21	tonn CO2
Tjenestereiser - Togreiser (frivillig)	2 antall reiser (én vei)	5,88 Kg CO2e/reiser	0,01	tonn CO2

Sum scope 3 = 0,99 tonn CO2

The MFT Scope 3 reporting includes all types of waste and waste treatment, along with residual and recyclable waste and work-related travel. In 2022, the total SiS (including all on-/off-site cafeterias and coffee shops) reported a total amount of FL and FW to be 27945 Kg. SiS cafeteria "Optimisten" is responsible for approx. 50% of this amount (divided by m2 of service area). The figure to represent the case study more accurately will be 14,000 Kg (I#3). 14 Tons of FW represents approx. 0.21 Tons CO2e (0,015 CO2e/Kg) and is a significant contribution to the overall CO2 emissions calculated for scope 3 (Table 6). The 12.89 per cent of CO2e emissions from the waste and re-use section is the second largest, only summited by the energy consumption of 83.12 per cent (Figure 10).

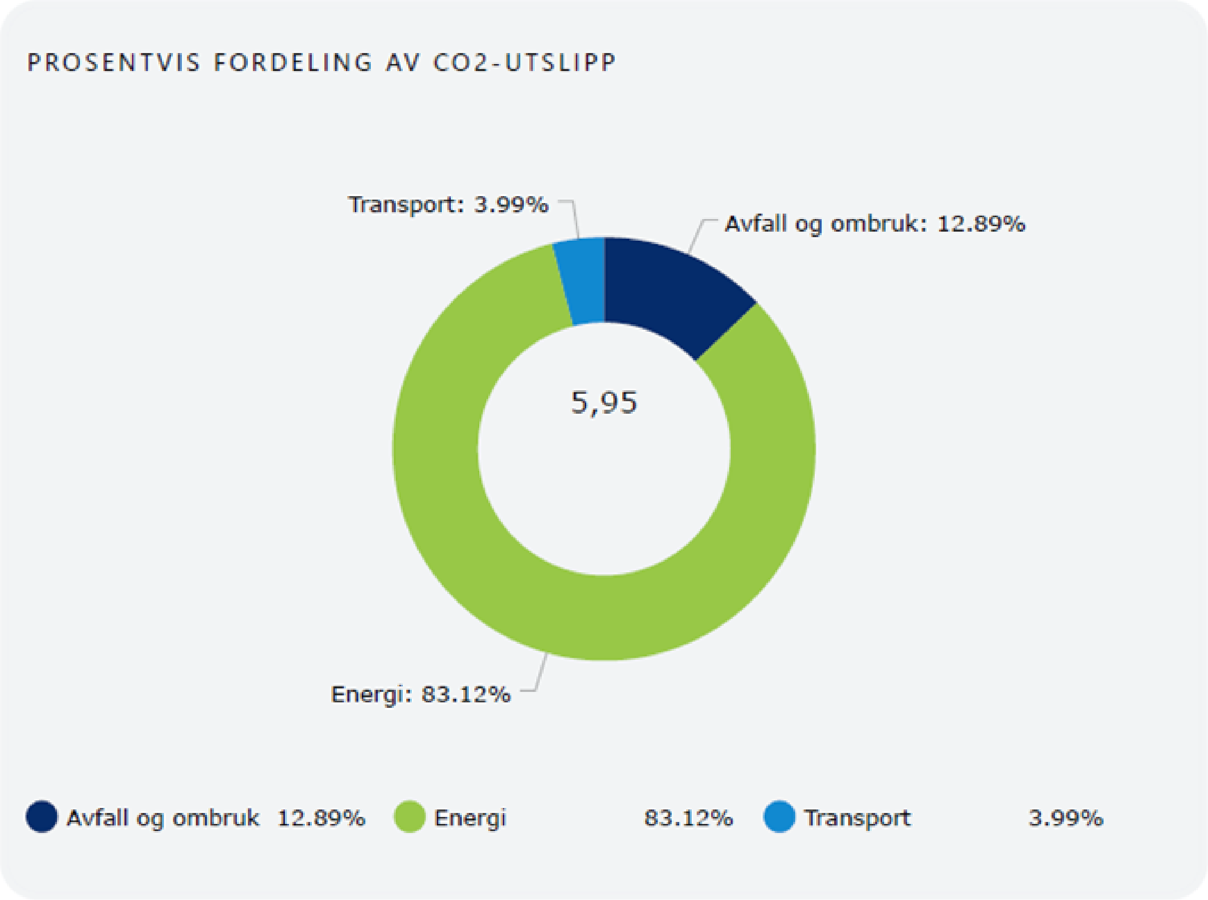


Figure 10: Total CO2e percentages of all three scopes reported to Mft in 2022 (I#3)

Seven Levels of revised FWiP model for SiS

The top (first) level of the inverted FW pyramid (Figure 11) is considered to prevent FW by avoiding and minimising the accumulation of FW. On this level, SiS has a returnable contract with their suppliers of meats, fish and vegetables to avoid FL and FW from the chain of logistics, storage and procurement errors (I#3). SiS chefs and management have carefully planned their menus according to seasonal activity, the SiS catering booking system and the SIN procurement cooperation.

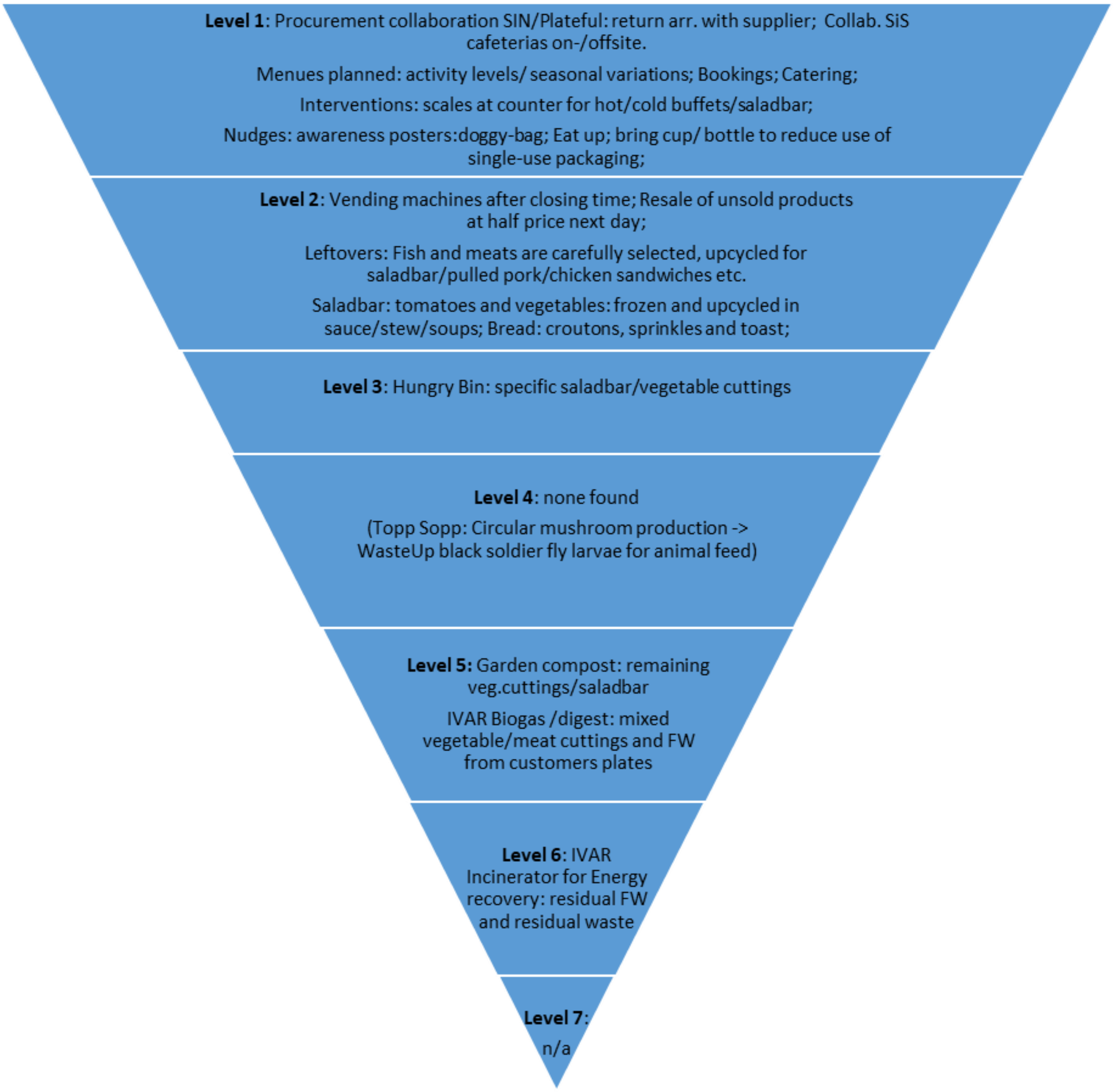


Figure 11: The revised FWiP hierarchy model for SiS (MLT, 2023)

The SiS procurements are organised through a collaborative procurement network “SIN” with other student organisations in Norway. Their contract with Plateful (*Plateful Gjør Det Enkelt å Velge Smart*, n.d.) allows them to return raw materials that have not been used before its BBD (Best-Before-Date). Plateful’s digital platform then offers the returned pre-BBD products to other LFS in their customer networks (I#3).

Secondly, “Nudges and other interventions” are put in place to improve customer awareness. One such intervention developed over a longer time frame is the instalment of scales at the cashier points. Before the turn of the century, the kitchen staff would serve the customers' plates from behind a counter at 750g per plate and the prices would be fixed. The self-service salad bar was priced at a fixed price per bowl. This was considered the norm. Unfortunately, it often resulted in large volumes of FW from the plate/bowl. However, after visiting other canteens and cafeterias during conferences and events, they observed an innovative approach (I#3). A trial phase was introduced where SiS installed scales for the self-service salad bar in 2005. Customers could now serve themselves and only pay for the actual amount of food they chose to put on their plates. Staff had concerns regarding popular and expensive ingredients (I#4). However, this concern did not become a negative issue (I#3). Customers who paid by the weight from the salad bar did not leave any leftovers (I#4). By 2020, scales at the cashpoint included self-service from the warm and cold buffets. The result is truly little leftovers (I#3).

A nudge is backing up this intervention, the “doggy-bag” packaging. It is advertised on a poster and visibly available so customers may bring home whatever leftovers they do not finish from their plate. A second poster recommends using Chinaware/silverware unless the customer wants the “take-away” option. These awareness posters encourage customers to not use avoidable packaging, such as “doggy-bag” packaging for other than its intended purpose.

SiS provides another waste-reducing awareness and incentivising intervention, by reducing the cost of coffee by NOK 5 per cup for customers who bring their own cups to the cashier. Although this may not reduce the amounts of used coffee grounds, it reduces wasted single-use cups otherwise creating residues of leftover hot/cold drinks to contaminate residual/source sorted paper/plastic waste for recycling (I#4).

The second level from the top is all about bringing unsold and prepped food back to the kitchen to upcycle or reuse. SiS have discovered that they can reduce economic loss and FW by upcycling menu items from unsold products (I#3). The kitchen staff at SiS are trained in household economics and have professionalised the craft of recreating new ingredients and upcycling menu items from their unsold products from the salad bar, the warm or cold buffets and the pre-packed sandwiches. A) Vending machines are filled with leftover prepacked sandwiches and salads after SiS closing hours. B) Leftovers from vending machines are sold at half price the following day in SiS. C) Leftovers from the hot/cold buffet and salad bar are returned to the kitchen to evaluate what can be upcycled for another day, frozen or re-prepped into new menu items. Tomatoes become pasta- or pizza sauces, vegetables become soups or stew and bread is turned into croutons or the popular toasted SiS gratin sandwich. Fish and leftover meats are carefully rinsed, re-prepped and upcycled into salad fish/meats or pulled pork/chicken sandwiches (I#4).

When approaching the third level there are no further approved uses for FW to become fit for human consumption. But herein lie the challenges of turning FW into feed or fodder for aquaculture, animal farming or compost. The UiS campus site management department at Statsbygg initiated the collaboration. Statsbygg's campus crew collect source-separated vegetable cuttings from the collection point in the SiS kitchen. The campus crew then feed several *Hungry-bin* (Reve-Kompost, n.d.) vermicomposting units with specific vegetable cuttings that are eventually turned into highly nutritious compost. By feeding the worms through the vermicompost system only twenty meters outside SiS, the UiS campus site manager uses the vermicompost to produce organic fruit and berries on-site, intending to offer students and staff access to campus-grown fresh fruits, vegetables and berries (UiS, 2023).

Level four became grounds for particular close observation and further analysis. When asked about the used coffee grounds arrangements with a local niche operator highlighted in a SiS public statement (I#3) the said statement was directly opposed by I#4 and D#1. This barrier will be further highlighted in chapters 6.5 and 7.3.

The fifth level involves remaining vegetables and used coffee grounds incompatible with vermicompost and are brought to the on-site garden composting system, used for campus horticultural garden beds (I#5). The fifth level also includes FW remains from the plate or incompatible kitchen remains from animal byproducts (ABPs) which are collected from FW wheelie bins by Renovasjonen IKS (Renovasjonen IKS, 2017) and transported to the IVAR Biogas facility at Grødaland (IVAR, 2018). Here it is turned into biogas for transport fuel and biodigest to replace artificial fertilizers in agriculture.

Level six leaves a small amount of unsorted residual FW contaminating recyclable plastics or paper and after being collected as residual waste, fuels the IVAR energy recovery facility at Forus (*Forside | Forus Energigjenvinning*, n.d.).

Finally, level seven no longer applies to the Norwegian Standards of Waste Management (Avfallsdeponering-kommentarer - Miljødirektoratet, n.d.), considering FW disposal to land fills/-deposits has been illegal since 2009 in the Stavanger region.

All these smaller and wider circles of once-called waste are now sections of a full-scale CBE system for inspiration. By taking a closer look at the larger- and smaller circles of their daily practice, SiS prove it possible to reduce their FW and their CO2 emissions, while simultaneously feeding the campus soils with leftovers from the plates of students and staff. SiS now intend to upscale this practice to all their other campus facilities.

Table 6: SiS Findings and FW reduction activity/collection practises

Inverted Waste Pyramid level	**SiS case findings**	**Activity/collection practise**	**Specifics**
1. Prevent avoidable FW	Planned menu design	Seasonal activities	Student calendar, events, local produce
		BestBeforeDate (BBD)	Check and Prioritize inventory
		UiS/SiS booking systems	Events, reservations and catering
	Un-used rawmaterials	Returned to supplier	Supplier agreement with Plateful.no
	Un-used, prepped but unserved	Freezer	Packaging, marking and storage space
		Upcycled to warm/cold buffet: broth, soup, sauce or stew	Experienced and creative chefs, cost-cutting
		Pulled pork/chicken sandwiches	Experienced and creative chefs, cost-cutting
		Fish is rinsed and served at saladbar/cold buffet	Experienced and creative chefs, cost-cutting
	Nudges and interventions	Posters	Social cues to raise awareness
		Scales at counter	Pay for what you take
		Doggy-bag	Take-away leftovers
		Packaging (cup/bottle)	Discounted if bring your own
2. Re-use for human consumption	Unsold pre-packed	Discount counter	Discounted Yesterday's sandwiches and salads
		vending machines	After hours access to food
	Unsold Saladbar	Upcycled to warm/cold buffet: broth, soup, sauce or stew	Experienced and creative chefs, cost-cutting
		Freezer	Packaging, marking and storage space
	Unsold from warm/cold buffets	Upcycled to saladbar	Experienced and creative chefs, cost-cutting
		Pulled pork/chicken sandwiches	Experienced and creative chefs, cost-cutting
		Freezer	Packaging, marking and storage space
		Fish is rinsed and served at saladbar/cold buffet	Experienced and creative chefs, cost-cutting
	Unsold Bread	toasted sandwiches, croutons, sprinkles	Toast , crunchy sprinkles and croutons in soups and salads
3. Re-use for animal feed	none	none	none
4. Re-use by-product or Recycle FW	Coffee grounds	Kitchen collection point	Intended coll. Topp Sopp; currently garden compost, UiS Drift
5. Recycle nutrients recovery	Unsold from saladbar, unfit for levels 1-2	Kitchen collection point	Hungry Bins Reve Kompost, UiS Drift
	Vegetable peels/cuttings	Kitchen collection point	Hungry Bins Reve Kompost and garden compost, UiS Drift
	FW grinder, unfit for levels 1-2	Kitchen collection point	Garden compost, UiS Drift
	Unsold from buffets, unfit for levels 1-2	Kitchen collection point	Garden compost, UiS Drift
	FW from customer plate	customer separation system	Renovasjonen IKS - IVAR Biogas
	FW unfit for levels 1-3	kitchen separation system	Renovasjonen IKS - IVAR Biogas
6. Recover energy	Unsorted contaminated packaging	kitchen and customer separation systems	Renovasjonen IKS - IVAR Incinerator
7. Dispose unavoidable FW	Sludge and grease from kitchen sinks	Wastewater capture of liquid FW	Wastewater capture - IVAR Sewage and biopellets

Insights from Interviews

The interviews conducted with I#6 have shed light on critical insights regarding sustainable practices in LFS. I#6 emphasized the importance and popularity of addressing the topic of FW, especially as the industry evolves. They mentioned that there is a growing need within LFS industry to not only discuss but also implement sustainable practices. I#6 provided examples of companies that already practice internal Bio-reactor treatment of all FW, indicating that these practices are viable and effective within the sector.

The interviews also highlighted the emergence of local entrepreneurs who engage in the practical production of value-added products from FW, such as compost and gourmet mushroom production (ToppSopp, n.d.), primarily using coffee grounds. Furthermore, I#6 stressed that the LFS often lack the organisational infrastructure for sustainability initiatives, including measurement and reporting of carbon emissions and other sustainability-related metrics. There is a clear need for tools and resources to enable LFS to assess and improve its sustainability performance, not only to meet regulatory requirements but also to enhance its overall sustainability efforts. I#6 pointed out that for sustainable FW management to succeed, it is crucial to align practices and policies to cater to the unique dynamics of the LFS sector. Despite the evident importance of these initiatives, I#6 stressed that the existing regulatory and operational frameworks do not adequately support businesses' efforts to make meaningful strides in sustainable FW management. The interviews also mentioned the need for further research to identify the practical needs and challenges faced by the LFS industry in terms of sustainability and FW management. These insights underline the complex and dynamic nature of implementing sustainable practices in the LFS sector, necessitating a multifaceted approach when addressing these challenges. In addition to insights from I#6, interviews conducted with I#3 revealed valuable information about historical developments, procurement strategies, financial considerations, creative approaches and working environment dynamics in SiS. These insights provide a deeper understanding of the case and contribute to the broader context of sustainable FW management.

5.3. Drivers and Barriers to improved FW management

This chapter delves into the core challenges and facilitators of transitioning toward sustainable FW management within the context of LFS. Analysing the drivers and barriers the thesis aims to comprehensively understand the complex dynamics that shape the industry's sustainability efforts. The exploration of these factors is vital for crafting effective strategies and policy instruments that can guide LFS towards more sustainable practices, contributing to broader environmental and social goals. The subsequent sections uncover and discuss these drivers and barriers, providing a comprehensive view of the multifaceted landscape of sustainable FW management in the sector. Below (Table 7) is a table summarizing the drivers and barriers to improved food waste management based on the findings of this study. This table outlines the influence of various factors, categorized into drivers and barriers, on different aspects like economic viability, technological advancements, social and cultural awareness, and supportive policy measures for improved food waste management. The symbols (+, -, /) denote the degree of influence or impact of each factor on these aspects. (+) indicates a positive influence, (-) represents a negative influence, and (/) indicates a neutral or mixed impact.

Table 7: Drivers and Barriers to improved FW management

	Economic Viability	**Technological Advancements**	**Social & Cultural Awareness**	**Supportive Policy Measures**
Drivers				
FW Valorisation Projects	+	+	+	+
Collaboration Initiatives	+	+	+	+
Sustainable Regulations	+	/	+	+
Circular Economy Vision	+	+	+	+
Barriers				
Lack of Financial Support	-	/	-	-
Technological Limitations	/	-	/	-
Resistance to Change	-	-	-	-
Ineffective Policies	-	-	-	-
Limited Stakeholder Collab	-	-	-	-

Barriers to improved FW management

The comprehensive analysis conducted in this study identified several significant barriers hindering effective FW management within the LFS sector. These barriers encompass a range of challenges that impede the implementation of sustainable FW management practices.

Understanding and addressing these barriers are crucial for fostering a more effective and sustainable approach towards FW reduction. The key barriers are identified in Table 8 below:

Table 8: Barriers to improved FW management

No.	**Barrier**	**Description**
1	Lack of Awareness and Education	Insufficient knowledge or understanding among individuals and businesses about FW.
2	Inadequate FW Collection and Processing Infrastructure	Insufficient or outdated infrastructure hinders FW collection and processing.
3	Absence of Supportive Regulatory Framework	Inadequate or absent policies and regulations supporting effective FW management.
4	High Costs and Limited Financial Resources	Financial constraints inhibiting the implementation of FW management practices.
5	Technological Limitations and Constraints	Inadequate or outdated technologies hinder effective FW management solutions.
6	Resistance to Behavioral Change	Challenges in altering behaviours or habits contributing to FW generation.
7	Ineffective Policy Implementation and Enforcement	Poor execution and enforcement of FW-related policies and regulations.
8	Limited Stakeholder Collaboration	Lack of collaboration and coordination among stakeholders affecting FW management.
9	Lack of Investor Interest in Early-Stage Market	Investors' reluctance to invest in the early stages of the market's development.
10	Regulatory Compliance Challenges	Challenges in meeting stringent regulatory requirements for FW management expansion.
11	Inhibitive Influence of Competing Actors	IVAR Biogas obstructs FW valorisation product development and competition.
12	Lack of Dedicated Reporting Systems	Absence of specific FW reporting systems, hindering monitoring and reporting of FW waste streams.
13	Challenges in Implementation due to Infestations	Hindrances caused by infestations like flies in Hungry Bins impact FW reduction efforts.

Barrier 1: Lack of Awareness and Education

Insufficient knowledge and understanding prevail among individuals and businesses regarding the significance and methodologies associated with FW management. This dearth of awareness often results in a lack of commitment to sustainable FW reduction practices and inhibits broader adoption.

Barrier 2: Inadequate FW Collection and Processing Infrastructure

Outdated or insufficient infrastructure for collecting and processing FW poses a substantial hurdle in effective FW management. Inadequate facilities and equipment hinder the proper collection, segregation, and processing of food waste, leading to increased waste generation.

Barrier 3: Absence of a Supportive Regulatory Framework

The absence or inadequacy of policies and regulations supportive of efficient FW management contributes significantly to the prevailing challenges. The lack of a robust regulatory framework diminishes the incentives for businesses to adopt sustainable practices and leads to inconsistent approaches to FW management (I#6).

Barrier 4: High Costs and Limited Financial Resources

Financial constraints emerge as a major impediment to the implementation of FW management practices. The high costs associated with adopting new technologies, infrastructural upgrades, and compliance with regulations often exceed the available financial resources, hindering progress (I#3, I#9).

Barrier 5: Technological Limitations and Constraints

Outdated or insufficient technologies pose significant challenges in addressing FW management effectively. The lack of access to modern, efficient technologies restricts the ability to adopt innovative solutions for FW reduction and processing (I#5, I#3, I#6).

Barrier 6: Resistance to Behavioral Change

The challenge of altering established behaviours and habits among individuals and businesses constitutes a notable barrier. Resistance to behavioural change affects the generation and segregation of FW, obstructing efforts towards sustainable management practices (I#5, I#6).

Barrier 7: Ineffective Policy Implementation and Enforcement

Poor execution and inadequate enforcement of existing FW-related policies and regulations contribute to the ineffective management of FW. Inconsistent implementation often leads to non-compliance and undermines the intended impact of regulations.

Barrier 8: Limited Stakeholder Collaboration

Insufficient collaboration and coordination among stakeholders involved in FW management hamper progress. The absence of cohesive efforts and collaboration limits the efficiency of FW reduction initiatives and sustainable management practices (I#3, I#5, I#6, I#9).

Barrier 9: Lack of Investor Interest in Early-Stage Market

Investors are hesitant to allocate funds for research and development (R&D) in nascent markets. They exhibit reluctance to invest in the initial stages of the market's development due to perceived risks and uncertainties (I#9).

Barrier 10: Regulatory Compliance Challenges

Meeting regulatory requirements poses a significant challenge for scaling up GreenLoops. Complying with stringent regulations demands substantial investment capital for acquiring expensive equipment, testing, and R&D processes, creating barriers to expansion (I#9).

Barrier 11: Inhibitive Influence of Competing Actors

IVAR Biogas impedes wider research, development, and product expansion of FW valorisation products. Despite GreenLoops' success in managing complex waste, IVAR's lack of interest in collaboration creates barriers against local competition, hindering the development of a CBE for FW (I#9).

Barrier 12: Lack of Dedicated Reporting Systems

LFS and SMEs often lack specific FW reporting systems, hindering comprehensive monitoring and reporting of FW waste streams and potentially affecting effective management strategies (I#3, I#5, I#6).

Barrier 13: Challenges in Implementation due to Infestations or odours

Bad odour and infestations, such as flies in Hungry Bins, pose challenges and hurdles in implementing FW reduction practices (I#5).

Drivers for improved FW management

Improved FW management is bolstered by various drivers (Table 9) that collectively contribute to fostering more effective waste reduction and management practices.

Table 9: Drivers for improved FW management

No.	Driver	Description
1	Increased Public Awareness and Education	Enhanced knowledge and understanding among individuals and businesses about FW, fostering a culture of waste reduction and management.
2	Development of Advanced Collection Infrastructure	Establishment or enhancement of efficient infrastructure for FW collection and processing.
3	Supportive and Enabling Regulatory Framework	Implementation of effective policies and regulations supporting and incentivizing FW management practices.
4	Financial Incentives and Funding Opportunities	Availability of financial support and incentives encouraging investment in FW management initiatives.
5	Technological Advancements	Advancements in technologies facilitate more efficient and effective FW management solutions.
6	Promoting Behavioral Change	Encouragement and facilitation of behaviours or practices contributing to reduced FW generation.
7	Effective Policy Implementation and Enforcement	Strong execution and enforcement of FW-related policies and regulations at local and national levels.
8	Collaborative Stakeholder Engagement	Enhanced collaboration and cooperation among stakeholders for comprehensive FW management.
9	Investor Interest in Market Expansion	Investor willingness to invest in the market's growth and development of FW valorisation products.
10	Improved Regulatory Compliance	Compliance with regulatory standards and practices for expanding FW management strategies.
11	Encouragement of Healthy Competition	Competition among organisations fostering innovation and development in FW valorisation practices.

Driver 1: Increased Public Awareness and Education

Enhanced knowledge and understanding among individuals and businesses about FW plays a pivotal role in cultivating a culture inclined toward waste reduction and efficient management practices.

Driver 2: Development of Advanced Collection Infrastructure

The establishment or enhancement of efficient infrastructure for FW collection and processing is vital for the effective management and processing of food waste.

Driver 3: Supportive and Enabling Regulatory Framework

Implementation of effective policies and regulations that support and incentivize FW management practices is crucial for driving positive change.

Driver 4: Financial Incentives and Funding Opportunities

The availability of financial support and incentives encourages investment in FW management initiatives, enabling the implementation of innovative solutions.

Driver 5: Technological Advancements

Continuous advancements in technologies facilitate the development of more efficient and effective FW management solutions, contributing to improved waste handling.

Driver 6: Promoting Behavioral Change

Encouraging behaviours or practices that contribute to reduced FW generation among individuals and organisations is essential for sustainable waste management.

Driver 7: Effective Policy Implementation and Enforcement

Strong execution and enforcement of FW-related policies and regulations at local and national levels ensure the adherence and success of FW management initiatives.

Driver 8: Collaborative Stakeholder Engagement

Enhanced collaboration and cooperation among stakeholders foster comprehensive and integrated FW management approaches.

Driver 9: Investor Interest in Market Expansion

Investor willingness to invest in the growth and development of FW valorisation products drives innovation and market expansion in FW management.

Driver 10: Improved Regulatory Compliance

Compliance with regulatory standards and practices is crucial for expanding FW management strategies effectively.

Driver 11: Encouragement of Healthy Competition

Healthy competition among organisations fosters innovation and development in FW valorisation practices, driving progress in waste management.

Policy and Political Barriers

When policies obstruct the transition towards a more sustainable waste treatment regime, the MLP alone is not an adequate framework to address existing barriers hindering the objectives. By studying national, regional and local policy efforts through the MLG framework it is possible to compare existing political measures and policy tools. This chapter will observe the policies of Stavanger Municipal waste management under the Climate and Environment Plan (CEP) and its main objectives for 2018-2030 and place the SiS case study into the local, regional and national policy.

Although the municipal CEP Action Plan governs all public and public-private LFS companies and collaborations, it does not specifically govern private LFS companies and their waste management or CO2 emission cuts. The private sector is governed by the national regulatory authorities of each sector and corresponding departments. However, as (most) guests and employees of SiS are municipal inhabitants, the municipal policy tools are targeted towards them in the below-mentioned campaigns and knowledge diffusion activities.

Serving most municipalities in the southern part of the county of Rogaland, on the regional level, IVAR is the main WTS provider of LFS and households of the neighbouring municipalities. IVAR is public-privately owned by Stavanger and neighbouring municipalities, paid through local taxes to provide cost-priced renovation services for municipal household waste. Within this field of operation, IVAR also provides a manual waste-sorting facility for the public. The private sector pays for their services by differential pricing for their specific waste types. Waste type quality and proper source separation are considered the main pricing factors.

IVAR opened a “state of the art” optical waste sorting plant (WSP) in Stavanger in 2019. The WSP facility is situated right next to the region’s largest waste incinerator, also operated by IVAR, along with several other specialized waste management facilities, such as the Biogas facility in Grødaland, park- and garden waste composting and Wastewater and Sewage treatment within reachable distances. However, they no longer (after 2014) facilitate aerobe composting of household, agricultural, fishery, industrial or company FL or FW.

The current FL and FW operating system by IVAR is to bag and store FL and FW in a wheelie bin for up to two weeks. A transport company collects and transports the FW to the IVAR

Biogas facility in Grødaland, approx. 50 km southwest of Stavanger. On arrival, the collection truck is weighed, and its content is unloaded at a storage facility where it awaits the first step of treatment. The plastic bags containing FW are ripped open and emptied. The process is part mechanical and part manual. The plastic bag is separated and returned to the IVAR incinerator and the contents are fed into the anaerobe biodigester, where it produces biogas and biodigest. The biodigest is dehydrated and sold as a soil improvement product to agricultural and horticultural industries. The biogas is sold for fuel, making IVARs FW treatment a linear waste treatment journey, to be exhausted as CO2 into the atmosphere.

Climate and Environment Plan (CEP 2018-2030) main objectives

Stavanger Municipality's CEP revised plan for 2018-2030 (Stavanger Kommune, 2018) states four main objectives to pursue:

- to cut greenhouse gases by 80 per cent by 2030 compared with 2015 and to be a fossil-free municipality by 2040.
- to ensure it is safe to eat fish and seafood from all marine areas in Stavanger by 2030
- to ensure clean air for all residents
- to protect the living conditions of plants and animal life and increase biodiversity.

CEP's summary of challenges to reach climate and environmental goals clearly states that "Reducing GHG emissions is a challenge that will require comprehensive measures within transport, energy, *waste management*, agriculture and other areas". The CEP further states "The municipality wants to help ensure raw materials, used materials and energy are properly managed in line with the principles of the circular economy".

Although presently, SiS have no system in place for weighing accumulated or reduced FW in general, they plan to invest in digital scales and a smart registering system to report these figures to E-smiley (I#3). E-smiley is a SMART digital platform system for reporting FW and is built especially for professional LFS, restaurants and hospitality services (e-Smiley, 2022). SiS does not report their FW, FL or other waste figures to the municipality, along with the majority of LFS FW and FL. However, strong signals from the professional waste community are on the horizon (Image 4), preparing for the EU-obligatory FW source separation from all sectors (Avfall Norge, n.d.). This will become the most important driver for LFS to comply with FW reduction and treatment policy and national regulations.

Norge må kildesortere matavfallet

Etter enighet i EU om nye mål i revidert avfallsregelverk, må landets kommuner, næringsaktører og innbyggere forberede seg på obligatorisk kildesortering av matavfall fra 2023.

Av: Avfall Norge | **Publisert:** 22. desember 2017

Image 4: Norway aligns with EU revised waste regulations to source separate FW (Avfall Norge, n.d.)

CEP Action Plan 2018-2022 Chapter 3

The primary and secondary objectives for the CEP Action Plan Chapter 3 (Handling- og økonomiplan 2022-2025 – Stavanger commune, n.d.) relevant to the CBE, FW and FL topics are presented in Tables 10 and 11 below.

Table 10: CEP Action Plan 2018-2022 main objectives

Primary objective Resources are reused, recovered or destroyed with as little environmental impact as possible and volumes of waste are kept as low as possible.

Secondary objective F1 Resources are kept in circulation for as long as possible.

- The municipality’s procurement should be based on the circular economy principle
- The proportion of wet organic waste in residual waste should be below 20 per cent. Material recovery of bioresources must be prioritised over incineration and used as locally as possible. Consideration must be given to whether the carbon proportion of biowaste can be stored permanently in the form of biochar.

Table 11: CEP Action Plan 2018-2022 Indicators

ID	**Measures**	**Responsibility**	**2018-19**	**2020-22**
F1	Arrange courses in home composting	Environment and Refuse Collection	x	x
F2	Provide support for the purchase of warm compost bins	Same as above	x	x

F5	Assess waste advice outreach for households based on experiences from other cities	Same as above		x
F13	Develop Matsentral Rogaland (in Sandnes) so it becomes operative in 2018	Same as above	x	
F14	Arrange information campaigns aimed at consumers about how to buy and safely store food, as well as how to use leftover food	Same as above	x	

CEP Status Report 2022, Chapter 3

Each municipal department submits its progress updates through the CEP Annual Status Report for 2022 (Årsrapport 2022). Within this report, I came across the Properties (Eiendom) department of Stavanger Kommune, which focuses on enhancing the management of public FW and FL originating from municipal kitchens and employee cafeterias.

In the context of nursing homes, there is a shift towards digital reporting, revealing that 88% of dinners and 89% of desserts were consumed. This reflects an improvement from the 2021 statistics, which reported 86% for dinners and 84% for desserts. Despite these gains in the 2022 report, there remains untapped potential for further enhancements. Conversely, school kitchens have encountered challenges in implementing digital reporting for FW and FL. The figures from employee cafeterias indicate that merely reporting progress is not sufficient to reduce FW. Their report highlights an average of 64 grams of FW per guest, which currently exceeds the industry standard by 50%.

The CEP Status Report for 2022 highlights a reduction in household waste from 462 kg per inhabitant in 2020 to 425 kg per inhabitant in 2022, marking a slight improvement from the 2021 figure of 429 kg per inhabitant. Nevertheless, there remains a gap in achieving the target of 300 kg per inhabitant.

Regulatory Barriers

To enable the design of an on-site composting system for event and cafeteria FW within Mattilsynet's regulations, I consulted a specialist, referred to as I#1. I#1 responded to a list of questions via phone and email (MLT, 04.05.23). This led to further inquiries, resulting in a clarifying phone interview. The key insights are summarized below.

Norwegian composting regulations require FW to be treated at 70°C for a minimum of 60 minutes with a maximum particle size of 12 mm. If an LFS does not comply, they must demonstrate that their procedures yield a safe end product. For alternative methods, adherence to ABP regulations (forordning 142/2011 vedlegg V Kap III avsnitt 2 nr 3) must be documented. ABP regulations are consistent across EU/EEC countries. Mattilsynet cannot approve non-standard composting facilities without proof of sufficient biological risk (I#1).

I#1 provided a detailed summary of the national ABP regulations and guidelines for compost facilities (Mattilsynet, 2021) also translated into English below.

"Processing parameters for ABP regulations ensure infection-reducing measures during composting. Therefore, rules have been laid down regarding conversion parameters. These are to be considered hygienisation. For a composting facility to be approved, the conversion process must ensure that the final product is safe. According to the animal by-product regulations, the standard requirement is that the composting facility must have a composting reactor where, through heat treatment, harmful infectious substances are inactivated and disease transmission to animals and humans is prevented. But it is also possible to approve facilities with alternative conversion parameters. According to standard requirements (Cf. Ordinance 142/2011 annexe V Chapter III section 1 no. 2), the material to be composted must pass through a composting reactor that maintains a minimum of 70°C for a minimum of 60 minutes with a particle size < 12 mm. A company can introduce steps that are stricter than the standard requirement for hygiene. Pressure sterilization can, for example, be included as hygiene. Standard requirements for hygiene are then met. A facility that has pressure sterilization as hygiene instead of a reactor at 70 °C for 60 minutes can also accept category 2 material because the processing requirements for category 2 material will be met.

A composting facility can also have alternative conversion parameters approved upon application (ordinance 142/2011 annexe V Chapter III section 2 no. 1, first sentence). It must be documented that the conversion parameters provide a sufficient reduction of biological risk for such a facility to be approved. There are three possibilities for getting approval for a facility with alternative conversion parameters. However, there may be limitations to the raw material and the use of the end product. The conversion parameters must be validated Cf. requirements in regulations. 142/2011 annex V Chap. III section 2 no. 1). Such compost can be marketed in the EU/EEA Cf. Ordinance. 142/2011 annex V Chap. III section 2 no. 4. Waste Norway has validated that large vine composting1 where the raw material consists of 80% kitchen and FW, 10% animal manure and 10% other animal by-products in cat 3 meets the requirements for hygiene in the animal by-product regulations at 55 °C for four weeks at three twists and turns. A composting facility that receives horse manure as the only animal by-product can also be approved with this hygiene method as it is unlikely that horse manure alone poses a greater risk than horse manure mixed with kitchen and FW and other animal by-products.

The conversion parameters must have a similar effect (as the standard requirements) when it comes to the reduction of disease-causing substances (Cf. requirements in Ordinance 142/2011 annexe V Chapter III section 2 no. 2. Marketing of the bio-residue is limited to other EU/EEA states that have approved the same conversion parameters (cf. Ordinance 142/2011 annexe V Chapter III section 2 no. 4). Other requirements for transformation parameters can be approved by Mattilsynet provided that:

- ✓ the starting material has a low risk and poses no risk of spreading serious diseases to humans and animals.
- ✓ the starting material is comprised of a) kitchen and FW used as the only animal by-product in a composting plant and b) mixtures of kitchen and FW with the following material: i) animal manure, ii) stomach and intestinal contents separated from the digestive tract, iii) milk, iv) milk-based products, v) products made from milk, vi) colostrum, vii) colostrum products, viii) eggs, ix) egg products,
- ✓ that the compost is considered unprocessed material that must be managed under regulations for unprocessed animal by-products.
- ✓ that turnover abroad is limited to other EU/EEA states that have approved the same conversion parameters. To monitor the composting process and document that the requirements have been met, representative samples must be taken during or immediately after the transformation (sanitization). The samples must meet the requirements for either E. coli or Eccinococcaceae as stated in the regulations. 142/2009 annex V Chap. III section 3 no. 1 letter a). It is especially important to document this at the start when the business is establishing methods and operating routines. Then each batch (in the case of batch-wise production) should be analysed. When there is continuous production, the starting point should be either a suitable volume or a suitable production time that gives a suitable volume. As the business has established good routines, the sampling frequency can be reduced. The business must assess and justify its choice” (Mattilsynet, 2021, MLT23).

Whether or not the regulatory authorities of Norway or the EU see the importance of local, on-site or off-site composting based on nature-modelling compost systems, it is clear that any form of composting or local FW management is not encouraged by law or regulations for the LFS.

Technological and Financial Drivers and Barriers

An increasingly popular activity available to households in Stavanger and neighbouring municipalities region are the 8-16 per annum composting courses held at the Ullandhaug Organic Farm in Stavanger. I have been an instructor for these courses since 2018 and have personally had the pleasure of seeing the participation numbers grow over the past 5 years. The training in composting also builds skills in source separation at the household level, becoming an important driver in reducing the problems of contaminated plastics and residual waste in municipal waste treatment. Participants who actively compost all their organic waste and stop using the brown (organic waste) wheelie bins receive an incentivising 20% renovation fee reduction. However, the initial investments for approved composting systems can provide a financial barrier for households and companies. One basic thermal composting bin approved for urban FW for households has a market price of NOK 7.500 (Byggmakker, n.d.). This composter unit will normally cover the FW composting needs of a regular household of 2-4 people. A company investment will exceed NOK 350,000-550.000 (BioCotech, n.d., I#8). The technological equipment, installation, organisation, maintenance and training can not be easily estimated as this will differ from company to company, depending on factors such as amounts of FL and FW produced, FL and FW skills and awareness within the organisation, available space, human resources and technological knowledge.

A financial incentive working in the wrong direction is the obvious pricing difference for wet-organic waste types from the industry (IVAR Renovasjon Ryfylke, 2019). It provides less incentive to separate FW from residual waste, creating a strong financial barrier against complying with source-separation regulations for SMEs and the food industry at large.

Smart green food and non-food services to reduce FW and FL

The growing number of smartphone applications dealing with food-sharing and saving food from becoming waste all have commonalities concerning providing information on where, how and why avoiding the waste of foods and non-foods is both important, obtainable and socially smart. The platforms introduced below include smart apps that counter FL and FW, stimulating share-communities in recycling and re-giving, from residents, households and local companies globally and of course, locally. By opening up one's refrigerator and food storage to the local neighbourhood, the smart App *Olio* helps members redistribute excessive food-/non-food products with their communities. Encouraging each member to share positive stories further encourages other members to creatively combat the negative emissions connected to FW and other lifestyle-related products and habits. Another App, *Too Good to Go (TGTG)* opens access to "surprise-packaged" left-over pre-packed-/prepped and unsold menus from i.e., restaurants, grocery stores and bakeries. Both evaluate "saved" GHGs and environmental impacts, allowing the user to share their goals on their favourite SoMe platforms. In achieving their personal goals, the Apps have a playful, gaming interface where the user is rewarded personal badges, improved levels and digital currencies to unlock new rewards or to obtain more products, resulting in "rescuing" more food from waste.

Knowledge and Behaviour-led Drivers and Barriers

Drivers and barriers connected with knowledge and behaviour-led change are a wide group, covering corporate-, technical-, public-, sectoral-, intellectual-, individual-, collective-, relational-, psychological-, emotional- and cultural types of knowledge and skills. Soft skills and knowledge and hard skills and knowledge are often placed on opposing levels of hierarchical scales. Placing hard skills (how to monetise or measure, as in business-, technology-, academia- etc.) over soft skills (inter-relational, psychological, cultural, emotional skills) is the backbone of a merit-based, capital-oriented business and financial system, such as representing most Northern democracies. Whether they are real barriers, or merely perceived as such, may not impact behaviour as much as regime resistance to following the individual's environmental risk concerns such as "structural constraints that might discourage individuals from acting" (Egenhoefer, 2017, 388).

6. Data Analysis and Triangulation of Case Study Findings

Triangulation of data and analysis in this chapter serves as a vital mechanism to draw meaningful insights from the multifaceted case study. Beyond merely collecting and documenting facts, the analysis will be informed by the MLG and MLP frameworks and the inverted FW pyramid of CBE. Through this multidimensional lens, the case study findings are enriched and deepened, providing a more comprehensive understanding of the barriers, drivers and opportunities for transitioning towards sustainable FW management.

Data Analysis within MLG, MLP and FWiP Frameworks

Within the MLG framework, the case study findings illuminate how governance on different levels plays a pivotal role in shaping FW management practices. At the local, regional and national levels, diverse regulatory and policy measures impact the decision-making processes of LFS and their ability to contribute to a CBE. The data reveals that regulatory authorities create legal, knowledgeable, psychological, technological, financial and emotional barriers to local, proper and sustainable handling of FW, hampering the potential for transition.

The MLP analysis delves into the dynamics of transitioning from conventional, wasteful food management systems to sustainable and circular ones. The case study brings to light the transformative changes needed to achieve sustainable FW management, emphasizing the technological, regulatory, social and cultural dimensions at play. By applying the MLP framework, it becomes evident that different actors, including the LFS, regulatory authorities and consumers, operate within various niches, regimes and landscapes. Their interactions and influences shape the path of FW management transitions. The data reveals that the challenge lies not only in the technical aspects but in the socio-technical systems and behavioural aspects as well.

The inverted FW pyramid of CBE provides a structured approach to understanding the shifts in FW practices. Analysing the case study findings within this pyramid helps identify the stages at which FW can be valorised, whether through reduction, reuse, recycling, or recovery. This framework highlights the potential for LFS to boost their social standing, improve the local environment and participate in reducing FW and correlating CO2 emissions while increasing potential earnings from innovative CBE systems. Through the inverted FW pyramid, the data reflects the interconnectedness of FW practices and their contribution to CBE.

The integration of MLG, MLP and the inverted FW pyramid into the triangulation process offers a holistic perspective on the barriers, drivers and opportunities for sustainable FW management. By considering governance, transitions and CBE principles, this analysis enriches the insights gained from the case study and lays the foundation for strategic policy recommendations and future studies.

Insights from Qualitative Interviews

Qualitative interviews played a pivotal role in unravelling the experiences, perceptions and opinions of key stakeholders within the LFS sector. Through these interviews, several crucial insights have emerged. The informants, represented by I#6 and I#3, emphasized the pressing need for not only discussing but also implementing sustainable FW management practices. They highlighted the growing significance of bridging the gap between rhetoric and action, especially for SMEs within the sector. The interviews underscore the multifaceted nature of the challenges and opportunities within the LFS sector, including the role of innovation, collaboration and adaptability in addressing FW.

I#6 conveyed the challenges faced by small and medium-sized LFS businesses, pointing out the absence of organisational structures dedicated to sustainability and the need for guidance on how to measure and achieve sustainability goals. Furthermore, it became evident that certain barriers deter LFS businesses from implementing CBE strategies, indicating that the sector requires tailored solutions. I#3 shared the evolution of FW practices in their establishment, from plate-serving to self-service buffets with scales for monitoring food portions. This transition to self-service resulted in a substantial reduction in FW, offering valuable insights into the role of technology and operational changes in FW management.

Observations and Fieldwork

Observations and fieldwork conducted within the kitchens and working environments of SiS provided critical insights into the practical aspects of FW management. The introduction of scales for buffets in 2020 at SiS exemplifies how even simple technological changes can significantly reduce FW. The emphasis on cost-efficiency, quality and the importance of streamlining production processes highlights the multifaceted approach required for successful FW reduction. Furthermore, the collaborative and adaptive culture at SiS was reflected in the willingness to listen to guest and staff feedback and the openness to modify practices accordingly. However, as was observed during one informal dialogue (D#1), the staff, the management and D#1 seem caught in an inert situation. I#3 explains that coffee grounds from SiS are collected by Topp Sopp, but the staff and D#1 disagree and explain that “this arrangement has never materialised”. Chapter 7.3 will analyse the inert situation and discuss the potential of such dissent.

Document Analysis

Document analysis enriched the understanding of context, regulations and policy frameworks that shape FW management within the LFS sector. In particular, the transition towards sustainable FW practices is influenced by a complex interplay of European Union directives, Norwegian regulations and local operational guidelines. A key insight from document analysis is that regulations need to be adapted to accommodate the diverse needs and constraints of LFS businesses, especially SMEs.

7. Discussion

The preceding chapters of this thesis have explored various aspects of sustainable FW management within LFS. The discussion serves as the culmination of this journey, where key findings are synthesized to connect the dots and provide a comprehensive understanding of the challenges and opportunities in sustainable FW management. By weaving together the threads of LFS characteristics, WTS, drivers and barriers, transition and knowledge-based policies an illuminating path forward emerges in building a more circular and sustainable future. In summary, the following chapter aims to provide a holistic perspective on the multifaceted journey undertaken in this thesis.

This discussion will focus on themes such as the importance of the CBE paradigm in redefining FW management and the role of policy instruments in enabling sustainable transitions. By drawing on the insights from previous chapters, the discussion aims to shed light on the challenges and opportunities in LFS and offer a path towards a more sustainable future.

7.1. Digital Smart Solutions

The digital age has ushered in a realm of transformative technologies and smart applications. While these innovations have the potential to revolutionize FW management, the findings unveil a complex scenario. On one hand, the advent of AI and digital currencies might pave the way for more efficient FW tracking and management. However, this transformation is not without its challenges, as it can contribute to the proliferation of electronic waste and exacerbate environmental problems. The technologies investigated in this thesis provide an opportunity to connect the FWiP with digital, smart solutions, aligning the FWiP with innovative digital tools. Moreover, the findings elucidate the significance of making these solutions accessible and affordable for LFS SMEs. High initial costs and complex digital systems can be prohibitive, especially for smaller businesses. This aspect highlights the need for regulatory support and incentives to bridge the financial gap and ensure a more equitable adoption of digital, smart solutions in the FW management landscape.

7.2. Transitioning to CBE

The transition to a CBE is a key theme that resonates throughout the findings. This transition is vital for achieving sustainable FW management, especially in LFS. The identified knowledge gaps and regulatory barriers challenge the progress towards circularity. A central finding is the discrepancy between supranational sustainability targets and the actual practices at the regional and local levels. Local consortiums and waste treatment facilities often prioritize traditional practices, creating a growing gap between the CBE vision and on-ground reality.

The obtained insights also underscore the relevance of policy instruments in supporting this transition. While policies exist to drive sustainability, they often lack the fine-tuned specifics necessary to bridge the gap between intent and practice. To address this challenge, we need more tailored and knowledge-based policy instruments, informed by the practical experiences and needs of LFS SMEs. This aligns with the findings, highlighting the necessity for an integrated and adaptive policy framework that harmonizes national and local sustainability objectives.

In particular, the regenerative nature of composting offers a direct contribution to climate mitigation and environmental restoration. To address the pressing ecological issues, we must advocate for more encompassing methods such as community-based composting facilities. These models align with the emerging smart applications that have gained prominence over the past half-decade. While GHG reduction measures like "having one fewer child," "living car-free," "avoiding aeroplane travel," and "eating a plant-based diet" appear to be more effective on a per capita GHG emissions basis than recycling or composting FW, the complex nature of climate targets necessitates a more comprehensive approach (Wynes & Nicholas, 2017).

7.3. Emotional Obsolescence and Sustainable Design

Incorporating the insights from chapter 5.3.5 findings, delving deeper into the realm of emotional obsolescence and sustainable design, the investigations reveal that individuals' emotional and cultural responses play a substantial role in shaping their approach to FW. The awareness of environmental risk and CC is often overshadowed by the habitual desire for more, perpetuating a culture of waste. This finding underscores the need for strategies that target emotional obsolescence, making sustainable practices more appealing to consumers and businesses alike. The role of material dialogues, introduced through Chapter 2.3 behaviour-related investigations, extends beyond physical products to encompass habitual practices in LFS. Businesses can encourage behaviours that align with sustainability by fostering a dialogue between users and used materials. By introducing sustainable habits that resonate emotionally with individuals, we can break the cycle of waste and encourage more responsible FW management practices.

However, the wish to express and perform outstanding climate-friendly and consumer-conscious behaviours may sometimes get in the way of daily management and practical, financial or logistical challenges in daily routines. For whichever reasons, not identified during this study, the I#3 and D#1 information about the logistics and circularity measures for used coffee grounds from SiS are in dissent. The coffee grounds have been the subject of a published interview, and the news has been dispersed through UiS and SiS' websites, claiming "While the (…) coffee grounds are sourced for (…) Mushroom production by Topp Sopp" (Surgautaite, 2023; MLT23). While D#4 and D#1 demented the claim based on an internal document between a UiS SoMe employee, Surgautaite and I#3, the official story is false. Speculations may interpret a form of denial culture described in Chapter 2.3. Or it is merely a question of time management or other logistical matters. The motivation of this study is not to reveal a single observation as a revelatory barrier, but to point out how easily a great intention can slip away amongst the multitudes of daily tasks of otherwise well-managed, circular LFS'.

In addressing Norwegian household decarbonization pathways into changing dietary patterns and food consumption, authors Moberg et al. suggest that certain "barriers can be overcome with motivational drivers such as the availability of more sustainable alternatives, support networks and by the positive emotions felt when having a positive impact on the environment" (Moberg et al., 2021, 202). However, Moberg et al. also claim that "The current policy approach, aimed mostly at nudging for voluntary mitigation actions, is wholly inadequate to achieve significant emission reductions" and their study indicates that "these can be overcome by strengthening government policies targeting the patterns and, importantly, volumes of household consumption". The authors show us how socially and politically unpopular high-impact GHG reductions can lead consumers "to abdicate their responsibility for consumption and place it at the hands of energy or material suppliers". They then suggest "behavioural determinants” to be targeted by policy interventions in balancing “carrots and sticks” to reach the overall needed GHG reductions called for by the Paris Agreement (Moberg et al., 2021). A presentation of a handful of such political tools follows in chapter 7.5.

7.4. Multi-Level Governance Framework

The profound influence of governance mechanisms on sustainable FW management is introduced using the MLG framework and findings reinforce its relevance. Observing that governance decisions impact the adoption of sustainable practices by LFS at the local level, the insightful findings from the SiS case study align with the MLG framework, emphasizing the need for coordination and collaboration among stakeholders across different governance levels. Incorporating findings, the pivotal role of governance lies in shaping the transition to sustainable FW management. Regulations and policy instruments must be redefined to harmonize with the CBE. The findings highlight the importance of policy adaptability and the necessity for a more comprehensive and integrated approach to address the multifaceted challenges encountered by LFS. This discussion integrates these insights and calls for more responsive and inclusive governance structures to facilitate the transition towards sustainable FW management.

7.5. Drivers and Barriers for Transition

In the quest for understanding the transition to sustainable FW management, a web of drivers and barriers playing a pivotal role in shaping the path ahead are encountered. These drivers and barriers, extracted from the findings throughout this thesis, are multifaceted and multifarious. An interesting observation was revealed during the research process, proving historically preconceived attitudes wrong, that only positive replies to the questions asked concerning external and internal motivations were received. I#3 and I#6 replied in similar wordings that they were confident the transition or green shift is inevitable, imminent and invited.

Regulatory Barriers: The investigation reveals that regulatory hurdles often obstruct the transition to sustainable FW management. The lack of harmonized definitions, as identified in Chapter 3.2, is a fundamental challenge. LFS are hindered by regulatory ambiguities and rigid policies. The absence of knowledge-based policy instruments, as outlined in Chapter 3.3, creates a barrier to more effective waste management. These regulatory gaps can deter LFS from taking on more responsibility for FW. Regulations must evolve to keep pace with the evolving landscape of sustainability.

Technological Barriers: Technological obstacles, as observed in Chapter 5.1, can be significant impediments to the transition. While digital and smart solutions offer immense potential, the high initial costs of adoption can stifle progress, particularly for SMEs. These technologies must be made more accessible and affordable to bridge this gap.

Knowledge Barriers: Knowledge gaps, as elucidated in Chapter 3.3, can inhibit the transition to sustainable FW management. LFS often lack the information and understanding necessary to navigate this complex terrain effectively. Bridging these knowledge gaps is a key driver for change.

Emotional and Cultural Barriers: As revealed in Chapter 5.2, emotional and cultural responses significantly shape individual and institutional behaviour regarding FW. Overcoming ingrained habits and desires for more is a substantial challenge, often hindering the adoption of more sustainable practices.

Policy Barriers: Chapter 3.4 underscores the limitations of existing policies, which lack specificity and adaptability. This can result in a disconnect between the intent of policies and their practical application. More tailored and knowledge-based policy instruments are required to bridge this gap, ensuring that regulations are responsive to the needs and realities of LFS.

Financial Barriers: Financial constraints, discussed throughout the thesis, can be a formidable barrier to transition. Investment in advanced technologies may be financially prohibitive for smaller businesses. Initiatives that bridge this financial gap are crucial drivers for change.

Collaborative Partnerships as Drivers: The case study on SiS, as presented in Chapter 5.3, reveals that collaborative partnerships with stakeholders on multiple levels can be powerful drivers for transition. The engagement of diverse actors, both within and outside the organisation, fosters an environment conducive to sustainable FW management.

7.6. Suggestions for valuable and relevant MLG tools

To enhance FW management in Stavanger's LFS, several effective policy tools have been identified, some of which are not yet fully integrated into local municipal plans. These tools can significantly improve the current system. Firstly, adopting a comprehensive FW prevention strategy, which includes source reduction measures, education and awareness campaigns, can help reduce waste generation. Full implementation of a digital reporting system for LFS kitchens and canteens can enable better data collection and analysis and can lead to targeted interventions. Establishing clear food donation guidelines and facilitating coordinated food rescue partnerships can ensure that surplus edible food is redirected to those in need. Furthermore, incentivizing the use of surplus food for animal feed can reduce disposal and promote circularity.

In addition, enhancing infrastructure and training for on-site composting, alongside providing incentives for LFS establishments to adopt comprehensive source separation, creative cooking with avoidable FW from buffets etc. and on-site composting practices, can divert a substantial portion of organic waste from landfills. This would involve creating easy-to-use composting facilities and offering training programs to LFS staff. Financial incentives or tax breaks could encourage LFS entities to embrace composting, reducing both FW and environmental impact. Finally, developing FW reduction targets, benchmarking progress and introducing incentives or penalties can encourage LFS establishments to take concrete actions towards waste reduction. Integrating these policy tools into the municipal plans can pave the way for a more efficient and sustainable FW management system in Stavanger.

By integrating these MLG governance tools, Stavanger can work cohesively with regional, national and EU-level entities to develop a robust and sustainable FW management system for its LFS. This collaborative approach enhances the likelihood of success and ensures that efforts are in line with higher-level policy objectives.

In conclusion, the discussion chapter synthesizes the insights from the preceding chapters, bringing together technology, transition, emotion and governance. Integrating these findings forms a more comprehensive understanding of the complex and multifaceted challenges of sustainable FW management in LFS. This approach provides an interdisciplinary perspective, offering valuable contributions to the broader discourse on sustainability and waste management.

8. Conclusions

This thesis embarked on a journey to explore the complex realm of sustainable FW management within the context of LFS. Throughout this academic voyage, valuable insights and outcomes have emerged, shedding light on critical factors that influence this transition. The primary findings and the key takeaways from this thesis are summarized below, followed by suggestions for future studies.

8.1. Insights and Outcomes

In the spirit of F2F, the findings echo the principles of the MLP and MLG frameworks, charting a course toward a CBE. As we "bring the farm back to the fork", this thesis envisions a future where FW is cherished as a valuable resource, illuminating the valorising pathways to sustainability within LFS in Stavanger.

A Comprehensive Perspective: This journey through the realm of sustainable FW management within LFS has uncovered a multifaceted landscape. While treading this path of change and transition, embracing the earthiness of agriculture – "the farm to fork" and vice versa, this intricate tapestry interweaves technological, regulatory, social and cultural elements, echoing the principles of the MLP and MLG frameworks.

Navigating a Complex Landscape: This research journey has revealed a complex landscape marked by drivers and barriers affecting the transition to sustainable FW management. This intricate web spans regulatory, technological, knowledge-related, emotional, cultural, policy and financial realms. Addressing this multifaceted terrain demands a holistic approach, recognizing the interconnectedness of these elements.

The Digital Revolution: The digital realm promises a groundbreaking transformation in FW management. Yet, substantial initial costs and limited accessibility pose formidable hurdles, especially for SMEs. To bridge this technology gap, policies must ensure that these tools and skills become accessible to all LFS.

Cultural and Emotional Resonance: Cultural norms and emotions wield profound influence over individual and institutional behaviours related to FW. Deeply rooted habits and an unending appetite for excess can challenge the adoption of sustainable practices. Recognition of these cultural nuances is pivotal, guiding the design of nuanced and effective interventions.

Revamping Policy: Existing FW management policies often lack precision, adaptability and a knowledge-driven approach. This divide between intent and execution must be bridged through tailored, knowledge-based policy instruments that harmonise regulations with the unique realities of LFS.

The Strength of Collaboration: Collaborative partnerships involving a diverse array of stakeholders hold immense potential for steering sustainable FW management. Engaging a spectrum of actors within and beyond organisations nurtures an environment conducive to efficient waste management.

8.2. Future Studies

This thesis provides a sturdy foundation for future explorations in the realm of sustainable FW management within LFS. It opens the door to several promising avenues for further research. Comparative studies can examine how the transition to sustainable FW management varies across different regions, accounting for local variables and sociocultural contexts. Impact assessments can quantify the effects of sustainable FW management practices, encompassing not only waste reduction but also their wider sustainability implications, spanning environmental, economic and social dimensions. The development and affordability of technology for FW management will remain a critical area of study, with a focus on evaluating the effectiveness, feasibility and scalability of digital and smart solutions, especially for SMEs.

Delving deeper into the emotional and cultural aspects that influence FW behaviours and habits can offer a more nuanced understanding, informing tailored interventions and strategies. Research into knowledge-based policy instruments and their effectiveness in promoting sustainable FW management can further refine policy approaches. Further case studies, akin to SiS, can unearth best practices and provide deeper insights into how collaboration and innovation can propel the transition to sustainability. This thesis sets the stage for a more sustainable future in FW management for LFS, guiding forthcoming explorations in this pivotal field.

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9. References

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Appendix 1: Interview Guide

Interview guide for MEES Master Thesis “What the fork?”

Interviewee information

Company Name: ______________________ Date: ______________ Time: _____________

Name of interviewee: ____

Department: ________________________ Contact details:

Position: ____

Questions and Notes Part I

Q1: Organisational Details about SiS Kafe

A) How many employees/staff work at Optimisten?
B) Organisational structure:
C) SiS Stavanger: Annual turnover:

Q2: Waste numbers delivered to Renovasjonen IKS/Topp Sopp/ others?

Source separated:

Questions and Notes Part II

Q3: **Management strategies and implementation of FW reduction policy**

A) When did SiS start to implement the FW reduction activities?
B) What were the management strategies for the implementations?
C) Is Sis MFT?
D) What are the motivations for reducing FL/FW and circular economy interventions?
E) Barriers? (Financial, Knowledge/technology/political/regulatory?)
F) Drivers?

Q4: **Employees reactions and behaviours towards new practices**

G) Did you try out any Smart Apps, or FW reduction activities that did not succeed/discontinued?

H) If so, do you have thoughts on why they did not catch on?

I) Did you use any incentivizing policies? How? What worked/not?

J) Have you implemented any measurable observations/reporting/targets/visions etc. to incentivize staff?

Q5: K) When introduced to a new idea, do the staff usually accept/not?

L) What happens if they do not accept the changes?

Questions and notes Part III

Q6: **Future FW management**

M) Are you aware that the EU revised waste regulations will make it compulsory to source separate FW?

N) Do you have any FW-related activities planned for further improvement?

O) Will/is SiS reporting FW/become an active part of the “stop FW” (i.e., matvett.no; kuttmatsvinn.no) programs?

Extra notes

Appendix 2: Information to respondents (Informasjonsskriv forskningsoppgave)

Takk for at du deltok i forskningsprosjektet!

What the fork? Food Waste Streams and Valorisation Pathways - Drivers and Barriers to a CBE at UiS campus SiS Café "Optimisten"

I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Forskningen inngår i en Master Thesis i emnet Energy, Environment and Society ved Universitetet i Stavanger og skal bidra til å få innsikt i småbedrifter som driver eller ønsker å drive med kompostering av matavfall til produksjon av jordforbedring og gjødselprodukter. Intervjuet blir brukt for å innhente opplysninger om ulike aktører, så som studenter, arbeidsgivere, kommunalt ansatte, kollegaer og nabolaget, som på ulike måter bidrar til å sette fokus på temaet.

Hvem er ansvarlig for forskningsprosjektet?

Institutt for Media of Samfunnsvitenskap (IMS) ved Universitetet i Stavanger er ansvarlig for prosjektet.

Hva innebærer det for deg å delta?

Du har deltatt i et kvalitativt uformelt intervju der jeg har oppsummert vår dialog og ettersendt det for din godkjenning. Denne godkjenningen var ikke tilfredsstillende ifølge Sikt - kunnskapssektorens tjenesteleverandør, og derfor bes du om å akseptere dette informasjonsskrivet og returnere til meg med din signatur. (Elektronisk eller ved å besvare eposten og skrive: Jeg godkjenner opplysningene i vedlagte informasjonsskriv vedrørende min deltakelse i forskningsprosjektet ***What the fork? Food Waste Streams and Valorisation Pathways - Drivers and Barriers to a CBE at UiS campus SiS Café "Optimisten"***)

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger.

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket. Opplysningene om deg vil beskyttes ved at referatet vil anonymiseres og oppbevares ikke sammen med intervjuet. Opplysningene vil lagres på Universitetets skylagring som er godkjent for lagring av ikke-sensitive opplysninger.

Det er kun min veileder, Institutt for Medie og Samfunnsvitenskap (IMS) og meg selv som har tilgang til dine opplysninger.

Hva skjer med personopplysningene dine når forskningsprosjektet avsluttes?
Prosjektet vil etter planen avsluttes når oppgaven blir levert, 12. desember 2023. Etter prosjektslutt vil datamaterialet med dine personopplysninger anonymiseres, ved Personopplysninger, kontaktinfo og –nøkkel vil slettes fra server og PC.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Universitetet i Stavanger har Personverntjenester vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Dine rettigheter.
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
- å få rettet opplysninger om deg som er feil eller misvisende
- å få slettet personopplysninger om deg
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

- Universitetet i Stavanger, Institutt for Medie og Samfunnsvitenskap ved Associate Professor Thomas Michael Sattich epost: thomas.sattich@uis.no telefon: 51832797
- Vårt personvernombud: Rolf Jegervatn Seniorrådgiver epost: rolf.jegervatn@uis.no telefon: 51833081.

Hvis du har spørsmål knyttet til Personverntjenester sin vurdering av prosjektet, kan du ta kontakt med:

- Personverntjenester på epost (personverntjenester@sikt.no) eller på telefon: 53 21 15 00.

Med vennlig hilsen

Thomas M. Sattich	May-Lise Talgø
Studieprogram ansvarlig	Master student Energy, Environment and Society

Appendix 3: Step-by-step guideline for Food Waste Management

Part 1: Getting started

Understanding the Local Context

Begin by familiarizing yourself with Stavanger's specific regulations and requirements related to FW and FL management. Check the latest reports and data on FW and FL in the region.

Assessment and Baseline Data Collection

Conduct a thorough assessment of your LFS, including cafeterias, event venues and kitchens. Collect baseline data on the amount and types of FW and FL generated.

Part 2: Infrastructure and equipment

Source Separation

Implement a clear system for separating FW from other waste at its source. Use colour-coded bins or containers to make it easy for staff to segregate waste. Create space and a process for keeping meticulous hygiene routines.

Staff Training and Awareness

Provide training to all staff members, from kitchen workers to servers, on the importance of FW and FL reduction. Highlight the economic and environmental benefits.

Part 3: Monitoring and documenting processes

Tracking and Documentation

Set up a system for recording FW and FL data regularly. Keep track of the quantities and types of food wasted. Consider using digital tools for efficient data collection.

Compliance with Regulations

Ensure that your composting process complies with Norwegian regulations. Maintain the required temperature and particle size standards.

Alternative Solutions

If your LFS is considering alternative composting methods, document how they meet the ABP (Animal By-Products) regulations. This documentation is essential.

Monitoring and Auditing

Periodically audit and monitor the composting process to ensure it aligns with the regulations and yields a safe end product.

Setting Targets

Set specific targets for reducing FW and FL in your LFS. Use the European Union's guidelines and targets as a reference for your goals.

Reporting

Regularly report your progress in managing FW and FL, as well as any achievements in sustainability and waste reduction, in your CEP Annual status report.

Part 4: Community and Communication

Public Awareness and Communication

Communicate your efforts and achievements in FW and FL management to customers and the community. Encourage their support and participation.

Collaboration and Stakeholder Engagement

Engage with relevant stakeholders, including Mattilsynet and environmental organisations, to ensure compliance and share best practices.

Continuous Improvement

Regularly review your data and processes. Identify areas for improvement and reduce the generation of FW and FL further.

Learn from Others

Stay updated with best practices and strategies for FW and FL management by studying successful cases in similar settings and locations.

Advocate for Policy Improvements

Engage with local policymakers to advocate for supportive policies that promote FW and FL reduction, composting and sustainability.

Source separation for LFS kitchen and guest spaces

Implementing comprehensive source separation of FW for LFS in Stavanger involves a well-structured process. Here is a basic instruction:

Assessment and Planning:

Start by assessing your LFS's current waste management practices, including where FW is generated and how it is managed.

Identify key stakeholders, including staff, management and external partners.

Develop a waste management team responsible for implementing source separation.

Plan menus according to BBD, storage and logistics, seasonal activity and re-use of salvaged FW.

Regulatory Compliance:

Stay updated on relevant regulations and compliance requirements regarding FW management.

Education and Training:

Educate staff and management about the importance of source separation and the environmental impact of FW. Encourage and facilitate re-use creativity for salvaged food from becoming FW.

Provide training on proper waste separation techniques and the use of designated bins and containers.

Incentives and Recognition:

Consider offering incentives or recognition programs for staff who actively participate in source separation.

Highlight your LFS's sustainability efforts to build a positive reputation in the community.

Infrastructure and Containers:

Ensure that you have separate, clearly labelled containers for different types of waste, including FW.

Place these containers strategically in areas where waste is generated, in kitchens, cafeterias and dining areas.

Collection and Transport:

Establish a regular schedule for collecting FW from these containers.

Depending on the volume of waste generated, consider compostable bags or bins for collection.

Choose a transportation method that complies with regulations and ensures the waste is securely transported to a composting facility.

Composting Facility:

Collaborate with local composting facilities or explore on-site composting solutions to process the collected FW.

Ensure that the chosen facility follows hygienic composting regulations and is in alignment with environmental standards.

Monitoring and Reporting:

Implement a monitoring system to keep track of the amount of FW collected, processed and diverted from landfills.

Regularly report your progress to stakeholders and make this information accessible to staff and the public.

Continual Improvement:

Periodically review your source separation program's effectiveness and make necessary improvements.

Explore recent technologies and practices to enhance your FW management process.

Public Awareness:

Educate your customers and clients about your source separation efforts and encourage their involvement.

Remember that successful source separation requires commitment, collaboration and consistent efforts. By following this basic instruction, LFS in Stavanger can contribute to a more sustainable and environmentally friendly approach to FW management.

Comprehensive On-Site Composting Guide for Local Food Services in Stavanger

Introduction:

Composting is a sustainable and eco-friendly solution for managing FW within Local Food Services (LFS) in Stavanger. This comprehensive guide provides step-by-step instructions for on-site composting while aligning with local regulations and policies and referencing the Multi-Level Governance (MLG) and FW pyramid for sustainability.

In the endeavour to foster sustainable waste management practices while adhering to the stringent requirements for mixed FW within the EU's ABP regulations, this thesis embarks on a journey where the end-product of the composting process can be transformed into a valuable fertilizer and soil improvement substance. The guiding principle here is to create a circular system where waste is not merely discarded but becomes a resource. In Stavanger, I had the privilege of tapping into a vibrant community of local companies, institutions and public departments eager to embrace this sustainable approach.

To kickstart your composting journey, you will need essential equipment and tools such as composting bins, shredders to break down organic matter, thermometers to monitor temperature and a secure system for record-keeping. The process involves careful source separation of mixed FW, ensuring it is free from contaminants and non-food items. Local examples of entities to engage with include Stavanger Municipality's Environmental Department, local restaurants and educational institutions like the University of Stavanger, which can serve as collaborative partners in your composting endeavour.

Step 6 is the pivotal moment where the "art of composting" comes into play. Motivating prompts can include encouraging staff and volunteers to actively participate in the composting process, turning this into a collective effort. They can be inspired to take ownership of the composting project, which brings a sense of responsibility and pride. Step 9, the "grand finale," revolves around reaping the rewards of your hard work. Here, you can emphasize the exciting potential to see your composting efforts materialize as a valuable fertilizer and soil improvement substance, benefitting local agriculture and contributing to a more sustainable Stavanger.

Step 1: Regulatory Compliance

Collaborate with regulatory authorities, local municipalities and relevant stakeholders to create a supportive ecosystem for your composting initiative. Ensure your composting operation aligns with local and national regulations for hygienic composting. In Stavanger, the Norwegian Standards for hygienic composting require FW to be treated at a minimum of 70 degrees Celsius for a minimum of 60 minutes, with a maximum particle size of 12 mm. If you deviate from these standards, document how your process ensures a safe end product.

Step 2: FW Pyramid Alignment

Use the FW pyramid (Image 1) as a reference for sustainable FW management. Source separation is the foundation, so educate your staff to segregate FW from other waste streams. Provide separate bins or containers for collection.

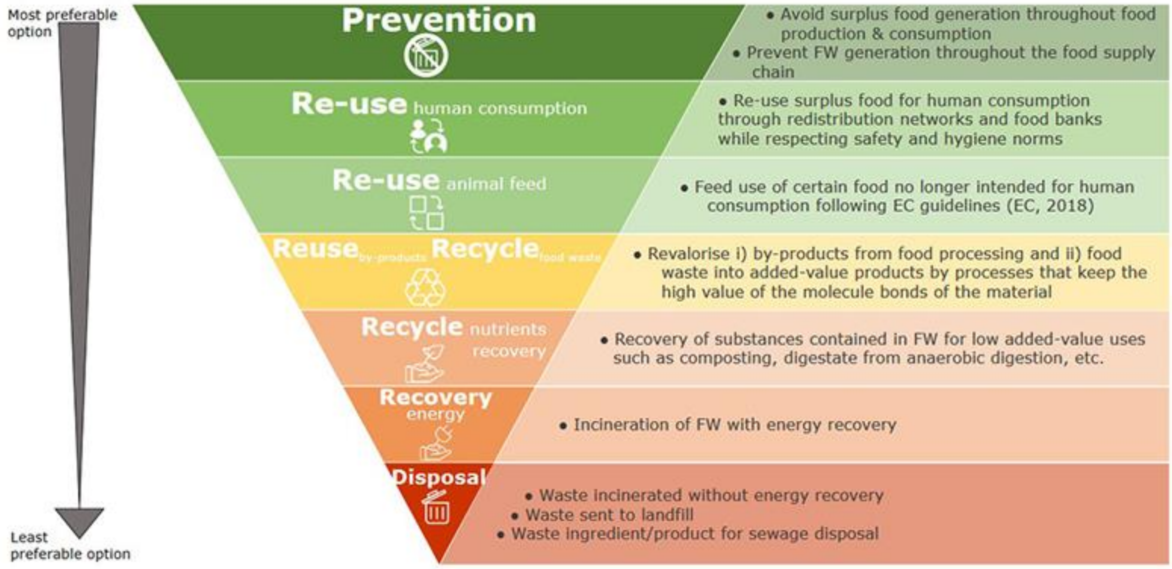

Image 1: Revised FW hierarchy (*Food Waste Measurement*, n.d.)

Step 3: Composting Infrastructure

Invest in the necessary composting infrastructure, including compost bins or systems. Install a source separating unit in every kitchen workspace. Ensure proper ventilation, temperature control and monitoring capabilities to meet hygienic standards. Install a FW grinder or create space and hygiene routines for preparing and chopping FW into appropriate sizes and systems.

Step 4: Composting Process

Please note that the success and regulatory approval of a composting facility will depend on adherence to all specified standards, hygienic practices and safety protocols outlined in the regulations provided by Mattilsynet. Follow a well-defined composting process.

Reduction of Waste

Shred or cut the FW to the approved size, which is typically around 18mm. Empty into approved containers and a source separation system for three FW fractions or more: 1. Coffee grounds, 2. FW mixed with ABP and 3. Biological FW for vermicomposting.

Waste Reception and Transportation

Transport the shredded FW from 2. Mixed FW with ABP to an approved reception area by manual or pre-installed automated piping/pump system.
Keep meticulous hygiene routines.

Maintenance and Cleaning

Regularly clean the composting container, kitchen waste disposer, piping system and raw material containers with approved cleaning agents. Prepare them for the next composting cycle. It is essential to comply with Mattilsynet regulations, including requirements related to hygiene, temperature monitoring, sampling, analysis, traceability and documentation throughout this process to ensure the quality and safety of the composted material.

Insulated Composting Container

The composting container should be well-insulated at the base and walls and should have an insulated, removable inner lid. It should also be equipped with an outer lid, ventilation vents, air channels and a drainage tap at the bottom.

Manual Transfer

Transport the mixed FW material containers and empty them into a composting container. If the FW mix contains excessive liquid, strain before adding. Keep the liquid in an approved container. It may be used for balancing out moisture levels later.

Carbon-to-Nitrogen (C/N) Balance Adjustment

Mix the waste with suitable dry materials like dried garden waste or purchased approved carbon sources (e.g., from a supplier like Felleskjøpet) to achieve the ideal C/N (Carbon to Nitrogen) ratio of 1:3.

Aeration

Ensure proper aeration of the compost pile by turning it or creating holes to allow for adequate airflow.

Liquid Separation

Open the drainage tap to collect liquid runoff in an approved container.

Activation of the Composting Process

Once the container is filled, initiate the hot composting process with an activation medium.

Activation Medium

Use a suitable activation medium, which can include stored liquid runoff from previously produced compost.

Temperature Monitoring

Monitor the temperature closely as it rises in the composting container. Once it reaches 55 degrees Celsius, maintain careful temperature monitoring.

Heat Treatment

Introduce a suitable heating element into the composting container, contributing to raising the temperature of the entire mass to a minimum of 70 degrees Celsius for at least 60 minutes.

Cooling and Emptying

Allow the composting container to cool down and then manually empty it.

Post-Maturation Treatment

Place the composted material in an appropriate area directly on the soil for further maturation and post-treatment, which may include adding biochar or other enhancement processes.

Step 6: Employee Training

Train your staff on the composting process, including how to sort FW and use the composting equipment properly. Provide regular refresher training to maintain best practices. Incentivising employees by employing “nudges” and interventions can be effective tools for motivation.

Step 7: Monitoring and Record-Keeping

Implement a monitoring system to track compost temperature, moisture and turning frequency. Keep detailed records of the composting process, including the amount of waste processed.

Step 8: Compost Utilization

Once your compost is ready, incorporate it back into your operations as a valuable resource for soil improvement or landscaping. This reflects the CBE strategy.

Step 9: Public Awareness

Educate your customers and clients about your composting efforts and their role in source separation. Engage them in sustainable practices.

Step 10: Evaluation and Improvement

Regularly evaluate the effectiveness of your composting program and make necessary adjustments to enhance performance. Collaborate with local authorities and research institutions for expert insights.

Conclusion:

Composting within Local Food Services in Stavanger is not only a regulatory requirement but also a sustainable choice for managing FW. By following this comprehensive guide, you can align with regulations, integrate the MLG framework and reference the FW pyramid for a holistic approach to FW management. Embrace the art of composting and contribute to a more sustainable future for your community.