Journal of Cleaner Production 328 (2021) 129672

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Waste treatment company decision-making in a complex system of markets influenced by the circular economy

Stien Snellinx [a,b,*], Jef Van Meensel [a], Siavash Farahbakhsh [a], Liselot Bourgeois [a], Anouk Mertens [c], Ludwig Lauwers [a,b], Jeroen Buysse [b]

[a] Flanders Research Institute for Agriculture, Fisheries and Food, Burg. van Gansberghelaan 115 b2, 9820, Merelbeke, Belgium
[b] Ghent University, Faculty of Bioscience Engineering, Dept. of Agricultural Economics, Coupure Links, 653, 9000, Gent, Belgium
[c] KU Leuven, Faculty of Bioscience Engineering, Dept. of Animal and Human Health Engineering, Kasteelpark Arenberg 30, 3001, Leuven, Belgium

ARTICLE INFO

Handling Editor: Yutao Wang

Keywords:
Circular economy
Waste treatment
Market interactions
Technology investment

ABSTRACT

As waste treatment companies are pivotal for a shift towards the circular economy, more insight into their decision-making process is needed. This paper explores how waste treatment companies make decisions facing the circular economy by using a qualitative research approach (semi-structured interviews, workshop, focus group) with 10 companies and experts across the EU in a framework of four interrelated markets. We found that the circular economy will exacerbate competition across markets, which creates difficulties for both public and private waste treatment companies to make the shift towards the circular economy in a changing technology landscape. Furthermore, there are institutional contradictions that arise due to lagging support mechanisms, leaving waste treatment companies with significant uncertainties concerning their transfer to a circular economy. Therefore, waste treatment companies will require a regulatory framework that meets their needs across various markets.

1. Introduction

Circular economy (CE) arises as an alternative to the current linear economy (European Commission, 2014; Korhonen et al., 2018b; Webster, 2017), widely criticised for its pursuit of economic growth while ignoring the resulting environmental damage (Geissdoerfer et al., 2018; Millar et al., 2019). The concept prescribes the closing of material loops and the increase of resource efficiency (Moreau et al., 2017; Zink and Geyer, 2017) and it even promises to be a model to decouple economic growth from resource extraction (Ellen MacArthur Foundation, 2017a). Waste management is therefore a crucial element for achieving a circular economy (Ranjbari et al., 2021). Despite its promising goals, the CE concept lacks analysis concerning the feasibility of its implementation (Millar et al., 2019), which could result in continued resource extraction and possible rebounds (Zink and Geyer, 2017).

In the waste management sector, governmental authorities are investing heavily in the CE (Gutberlet et al., 2020) and the European Commission has included a waste management hierarchy in its CE strategy (Waste Framework Directive, 2008/98/EC). The focus of this paper will be on municipal waste: even though it only makes up 10 per cent of overall waste, it is the most polluting and each municipality has the responsibility to manage it (Weghmann, 2017). Household organic waste and wastewater sludge used to be landfilled and incinerated. Today, in the EU, it is often composted and treated through anaerobic digestion (Luttenberger, 2020). The next step would be to increasingly recycle materials into high-value products rather than merely recovering energy.

More in particular, how WTCs can implement CE practices is highly relevant. Since the European Commission envisions businesses to be a driver for the shift towards circularity (European Commission, 2015) and understanding of the firm-level is often overlooked when considering innovation systems (Wilde and Hermans, 2021), it becomes indispensable to explore how WTCs make decisions regarding the CE. Moreover, publications by the Ellen MacArthur Foundation depict flows of goods from manufacturers to consumers and again to manufacturers, in which the transfer from one actor to another appears to be easy and without losses or barriers (Ellen MacArthur Foundation, 2015; Korhonen et al., 2018a). But, this conceptualisation does not adequately account for markets and the complexity that comes from market interactions (Korhonen et al., 2018a; Zink and Geyer, 2017).

* Corresponding author. Flanders Research Institute for Agriculture, Fisheries and Food, Burg. van Gansberghelaan 115 b2, 9820, Merelbeke, Belgium.
E-mail address: stien.snellinx@ilvo.vlaanderen.be (S. Snellinx).

https://doi.org/10.1016/j.jclepro.2021.129672
Received 1 July 2021; Received in revised form 20 October 2021; Accepted 8 November 2021
Available online 9 November 2021

The objective of this paper is therefore to investigate the decision-making of WTCs in a complex system of markets in order to gain insights into their transition to the CE. The case of the Volatile Fatty Acid Platform (VFAP) technology, developed and researched in the Horizon 2020 project Volatile (H2020 VOLATILE, 2020a) is used to collect information from the participating WTCs. Data analysis is done with Corvellec and Bramryd (2012)'s multiple market exposure framework to which the shift towards circularity and different ownership types will be added.

First, we present the framework (section 2) and the qualitative methodology (section 3). The results (section 4) are structured by the four markets (waste-as-material, technical, commercial and political market) and five market elements (commodity, area, buyers and sellers, competition and regulation). This facilitates discussion (section 5) along the following axes: increased competition across all markets exacerbated by the CE, incentives for public and private WTCs to make the shift towards the CE, the changing technology landscape and institutional contradictions. Finally, conclusions are drawn concerning uncertainties in WTCs' decision-making while shifting to a CE and the need for appropriate policies consistent with their needs across various markets.

2. Multiple-market exposure

To draw conclusions targeted to WTCs, a sector-specific approach is required to analyse the adoption of circular technology (Fichter and Clausen, 2021). Corvellec and Bramryd (2012)'s framework of multiple market exposure is chosen because it is derived from the practices of municipally-owned WTCs in Sweden. According to the framework, WTCs have three main activities: to attract waste as an input; to build technical expertise in processing waste flows in order to create marketable outputs; and to attain the ability to market those outputs. Based on these three activities, Corvellec et al. (2012) conclude that municipal waste companies have to be present and legitimise themselves on several interconnected markets because each activity supports the others and each activity needs the others to function. These four markets are the waste-as-material, technical, commercial and political market (Fig. 1). Accordingly, companies do not only compete in the marketplace, but also in the political-institutional context (Van de Ven and Garud, 1989). Being present in these markets means engaging in marketing activities, such as market research, product development, pricing and service innovation (Corvellec and Bramryd, 2012).

The waste-as-material market is the first of four markets on which municipal WTCs are active. They need to access sufficient, good quality waste as an input for their processing activities in an increasingly competitive market. The unavailability of the required waste is a major constraint for investments (Aminoff and Sundqvist-Andberg, 2021). Household organic waste and wastewater provide an opportunity, as they are widely available sources. The heterogeneity of these types of waste can prove to be a constraint (Paul and Bussemaker, 2020).

Second, WTCs are active on a technical market. Choosing and investing in a certain processing technology allows a WTC to achieve its objectives or the objectives imposed by governments, such as recycling and material recovery targets (Corvellec and Bramryd, 2012). Making strategic choices in this market has become crucial since present choices determine future technological lock-ins (Aminoff and Sundqvist-Andberg, 2021; Corvellec and Bramryd, 2012; Seto et al., 2016). Because of their technical expertise, WTCs have a significant influence on the decisions made on the technical market and they can therefore act as coupling structures between the multiple markets (Bergek et al., 2015).

Third, WTCs need to position themselves in a commercial market. Selling recycled materials and energy is part of a municipal WTC's public service mission. This leads companies to engage in marketing activities on intensely competitive markets, where the focus is on quantity, price and quality, rather than fulfilling a public duty (Corvellec and Bramryd, 2012). WTCs need to think strategically about how they operate in the commercial market. Especially when considering a shift towards new technology, WTCs need to connect their innovations to their business models to ensure sufficient profitability (Teece, 2010; Tongur and Engwall, 2014) when their decision-making focus lies on economic indicators (Tura et al., 2019).

Finally, WTCs operate in a political market. In order to continue operations, WTCs need to maintain institutional legitimacy (Wang and Ching, 2013). Municipal WTCs need to achieve the operational, environmental and economic goals set by their owners (Corvellec and Bramryd, 2012). Exploiting waste as a resource and selling end-products can provide economic legitimacy. Additionally, municipal WTCs have to meet the ideological expectations of their owners; stay in line with their

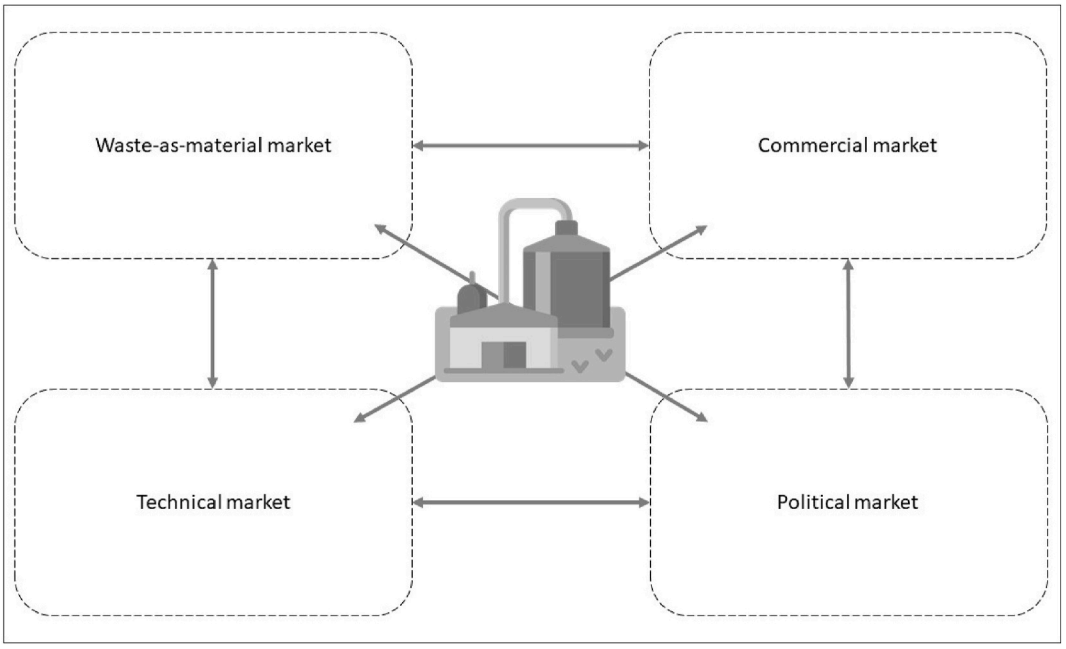

Fig. 1. Visual representation of the four markets described by Corvellec and Bramryd (2012). The waste treatment company in the centre needs to deal with the demands of all markets and, through its influence in the technical market, it can influence the development of the whole system.

political agenda (March and Olson, 1989; Wang and Ching, 2013).

As the CE is redefining waste management (Rashid and Shahzad, 2021) and because WTCs are a key driver to develop the CE (European Commission, 2015; Ranjbari et al., 2021), it is important to understand their challenges. Making decisions to service the company's goal means balancing trade-offs in multiple markets (Bergek et al., 2015). A company's capacity to understand and exploit the dynamics of a market and the interlinkages between markets determines its capacity for innovation (Corvellec and Bramryd, 2012), also described by Antonioli and Massarutto (2012) as a key competitive factor.

Furthermore, waste management can be organised in many ways and depends on national traditions (Demuth et al., 2018). (Corvellec and Bramryd, 2012) derived their framework based on municipally-owned WTCs. In some EU countries, waste management is mainly organised by public enterprises, while in others a significant amount is delegated to private companies (Antonioli and Massarutto, 2012). In most countries, waste processing activities are provided by a mixture of public and private enterprises. Therefore, to make conclusions about circularity in the EU waste treatment sector as a whole, several organisational forms need to be taken into account.

3. Methods

To investigate WTCs' decision-making in a complex system of markets influenced by the CE, we use information obtained from 10 waste treatment-related companies as well as technology experts developing the VFAP technology. This technology can be integrated into current anaerobic digestion plants and allows to extract, after a short period of digestion, volatile fatty acids (VFAs) that can be used as chemical building blocks in the chemical industry (and others). This process does not only allow to generate high-value products from resources currently regarded as waste but also to provide a sustainable alternative to the fossil-based and sugar-based chemical building blocks that are traditionally used.

3.1. Data collection and participants

3.1.1. Formal interviews

Throughout 6 countries, 10 companies were involved and 16 interviews of on average 1 h were formally recorded (Table 1). The interviews were conducted with management-level employees as well as local plant operators. Our sample predominantly consists of industrial WTCs that treat wastewater sludge or (organic) municipal solid waste or both. One company is a food production company that is interested in treating their own food waste, but does not yet have the infrastructure. The sample consists of five public companies, one public-private partnership and four private companies. As some of the companies differ from the type of company used to determine the multiple-market exposure framework (Corvellec and Bramryd, 2012), differences as well as similarities between public and private companies, will be discussed in our results.

The primary aim of the interviews was to explore current operations and decision-making in waste treatment plants. Information was obtained during plant visits in the form of participant observation (Spradley, 2016) as well as recorded interviews. The interview questions concerned current operations, the inner workings of a waste treatment plant and the company as a whole. As the data from the interviews yielded – next to technical explanations – also a lot of information on decision-making related to waste collection, competition (for both waste as an input and the sale of end-products), profitability, ownership and legitimacy, they appeared useful to be analysed in the multiple market exposure framework. Further inquiry on decision-making showed information about company hierarchy, the relationship with municipalities, options in the technical market, the origin of inputs and the type of marketable end-products.

Table 1
Overview of conducted interviews.

Interviews & on-site visits	Companies interviewed and/or visited	Recorded interviews
Romania	2	8
Greece	1	1
Spain	1	2
Portugal	1	2
The Netherlands	2	2
Belgium	3	1
Total	*10*	*16*

3.1.2. Workshop and focus group

To support and validate the information received through interviews, a workshop and a focus group were organised. The workshop, June 2019, brought together WTC representatives and technology experts to discuss different topics in groups: technological requirements and barriers of producing end-products out of waste and validation of the socio-economic feasibility. Insights were obtained on uncertainties, on which companies need information before considering an investment.

The focus group, November 2019, was held with 29 people who are technological experts, representatives of WTCs and legal experts. The goal of this focus group was twofold: first, validating the conclusions we had made about VFAP technology adoption in waste treatment plants so far, second, receiving input regarding scenarios in which the WTC would possibly invest in the VFAP technology. Participants were asked to make suggestions, grouped accordingly in economic, environmental, social and technical scenarios. The importance of each scenario was voted on using an online voting system and finally discussed in group.

3.1.3. Questionnaires

Two questionnaires were sent to companies in the waste treatment and biogas industries (H2020 VOLATILE, 2019; H2020 VOLATILE, 2020b). The first questionnaire asked respondents about the importance of certain decision-making criteria (such as capital expenses, the existence of a market and land requirement) on investment decisions. This questionnaire was completed by 57 respondents affiliated with the biogas industry. The second questionnaire posed decision-making dilemmas for respondents, for example about choosing a technology that was progressive compared to choosing a technology compatible with current infrastructures. This questionnaire had 15 respondents from companies with a waste management background. The analysis and conclusions of these questionnaires were written down in questionnaire report deliverables. Conclusions found after analysing the questionnaires can be used to support opinions expressed during the interviews.

3.1.4. Expert interviews

In addition to the feedback given by technological and legal experts during the workshop and focus group, three formal expert interviews were conducted. This additional type of participant is relevant as different types of actors will be able to identify different drivers and barriers from their point of view (Salmenperä et al., 2021). The first interview, March 2019, aimed at understanding the workings of a waste treatment plant better. During the interviews at waste treatment plants, the information was often very specific. This interview gave us a better overview of the sector in general. The second interview, January 2020, gave more insight into how WTCs find technologies and, how networks between WTCs are constructed. The goal of the third interview, September 2020, was to further articulate the scenarios in which a company would possibly start investing in the VFAP technology. These three interviews were not recorded, but detailed notes have been made after the meetings.

3.2. Data analysis

After data collection and processing, several types of textual data are to be analysed: interviews, workshops and focus groups were transcribed verbatim, resulting in rather unstructured textual data. Expert interviews, project meetings and informal notes resulted in a list of bullet points. Finally, the questionnaires resulted in reports with already formed conclusions. All this information was organised per company and analysed with the coding software NVivo 12.

The first round of coding began with a grounded theory approach: starting with open coding (Corbin and Strauss, 2012; Mortelmans, 2013) to classify the unstructured textual data into different concepts, which resulted in 50 unstructured nodes. The second round of coding helped to group all concepts into four overarching themes: social interactions, economic reasoning, technical considerations and government & environment. These themes can be considered the main talking points during the interviews. However, since the interviews were not specifically designed to reflect company decision-making, too much information was still contained within the concepts and themes.

Next, for the third round of coding, literature was taken into account. First Pache and Santos (2013), to further define the concept of company management. And second Corvellec and Bramryd (2012) to gain a deeper understanding of the context in which waste treatment companies operate. In our data, we found five defining elements and interactions that characterise each market. These elements are (1) the commodity, the good or asset that is traded in each market; (2) the area, the geographical scale on which a good or asset is relevant; (3) the buyers and sellers, the actors with which WTCs interact in each market and the nature of that interaction; (4) competition, its presence in each market calls for strategic decision-making by WTCs; and (5) regulation related to each market, to which WTCs are subjected. These five components will be used to structure and analyse the behaviour of WTCs in each of the four markets. Assessing the decisions a WTC needs to make in each market by looking at each of these components, shows which actions can be taken by WTCs. It allows us to identify drivers and barriers for WTCs to move towards a more circular waste management practice.

Despite our rather diverse sample of companies (different types of waste, sizes and ownership), many similarities in company reasoning can be found. During the final coding phase in NVivo 12, we focused on the similarities in reasoning rather than their differences. For example, both public and private companies that are specialised in waste treatment, are institutions with considerable technical expertise. They are both delivering a public service and exist both in a political context where the CE is heavily promoted.

4. Results

The results presented in Table 2 and explained below are the outcomes of our qualitative research.

4.1. Waste-as-material market

Commodity. Both the quantity and the quality of the waste received affect technology adoption decisions. Attracting sufficient and consistent volumes of waste is of primary importance for a WTC, first, to keep operations running smoothly and secondly, to safeguard the potential to profit from economies of scale, especially when considering an investment in the production of commodities for the CE. Even though the waste generally comes from households in the area in which the WTC is active, there is limited control over the quality and heterogeneity of the waste (see CWA 17484:2020 for more information on the VFA potential of different types of waste). There are, for example, seasonal differences in organic waste and wastewater sludge related to eating habits, or collection regulations are not followed as strictly as they should be (e.g. non-organic matter in organic waste bins). WTCs will benefit from further regulation and ways to raise awareness regarding waste separation.

Table 2
Overview of the results and interconnections described in the paragraphs below.

	Waste-as-material market	Technical market	Commercial market	Political market
Commodity	*Household waste & wastewater sludge. Importance of quantity and quality.*	*Waste treatment technology*	*End products produced*	*Political legitimacy*
Area	*Locally oriented*	*Neighbourhood effect*	*Local vs. global markets*	*On many scale levels*
Buyers and sellers	*Public or private WTCs and municipalities*	*WTC (agency in choice) and technology providers*	*Increasingly active on commercial markets dominated by other players and uncertain demand*	*WTCs and municipalities and their citizens*
Competition	*Public WTCs: monopoly on household waste. Private WTCs: more competition through tendering*	*Technology lock-ins*	*Need to be profitable*	*Adequate, safe waste treatment as well as profitability*
Regulation	*Waste management hierarchy (DIR, 2008/98)*	*Search for adequate investment support*	*Lagging support mechanisms*	*Political agenda*

Area. Since waste collection and treatment evolved as a response to local nuisance, it is often still locally sourced waste that is treated in WTCs. But also excess waste of other regions can be imported. Municipal waste in the EU is not supposed to go very far from its origin, because of the self-sufficiency principle (DIR, 2008/98). WTCs are generally oriented towards providing their local service. This mindset could shift when investments in the CE are considered: WTCs will need to attract sufficient good quality waste to produce high-quality end products as well as to benefit from economies of scale.

Buyers and sellers. Waste can be collected by the company that processes it, or by another entity. In any case, the processing company receives a gate fee paid by the municipality from which the waste originates (through taxation). When WTCs were asked whether they believed the quantity of organic waste received from municipalities would increase or decrease in the future, opinions varied. Some expected an increase, either because of population or economic growth or because of increased separate collection. Municipally owned WTCs will receive all household waste generated within their boundaries. Whenever there is excess treatment capacity or excess waste in one municipally-owned WTC, agreements are often made with nearby municipal WTCs to treat each other's waste. Furthermore, it is possible for WTCs to look for alternative sources of organic waste. In our sample, several WTCs have experience with food or food-processing waste.

Competition. Other WTCs expect variation in the amount of waste they could attract. The supply and the potential gate fee of organic waste depend on the waste-specific treatment capacity in the region and tendering contracts that tend to run over short term periods (less than 10 years). Therefore, they expect that constantly attracting sufficient waste of a certain quality will become more difficult in the future. There will be increased competition in this market, according to private WTCs. Public WTCs have expressed fewer views of increased competition on the waste-as-material market because of their municipal ownership that

comes with a monopoly position on receiving household waste in their territory. Nevertheless, both publicly and privately owned WTCs recognise the increasing importance of attracting good quality waste (CWA 17484:2020) – waste out of which energy or materials can be recovered – in order to follow recycling and CE trends on top of providing the public service of removing and processing waste.

Regulation. Household waste created within a municipality becomes that municipality's responsibility. They are obliged to organise collection services (DIR 75/442) and become the owner of the waste afterwards, which has resulted in a monopoly on waste by municipally-owned WTCs. An advantage of this regulation is that municipally-owned WTCs work with a relatively steady supply of waste on which they can build their business model and marketing activities. At the same time, other important regulations related to the waste-as-material market, are CE strategies and action plans. More needs to be done with waste and therefore, WTCs are looking for new green, sustainable and feasible technologies to adopt. The waste management hierarchy (DIR, 2008/98) incorporated in those strategies, calls first and foremost for the reduction of waste, before reuse, recycling and recovery.

In general, WTCs need a steady supply of sufficient, good quality waste in order to keep their operations running. In this way, they can remain economically viable companies that are in line with European, national, regional and local political agendas. Many governments have made the CE an important part of their waste management strategy for the future. Thus, WTCs that attract waste out of which materials and energy can be recycled and recovered, can obtain new economic opportunities and will fit well within the government's strategy. At the same time and somewhat contradictory, local authorities will need to encourage the reduction of waste production.

4.2. Technical market

Commodity. In a technical market, WTCs are faced with the choice of technology to invest in. The WTCs in our sample are currently operating an anaerobic digestion plant and are interested in converting their operations in the future by integrating a VFAP into their operations. This would mean material extraction from waste in addition to the current energy recovery, a step in the right direction according to the waste management hierarchy (DIR, 2008/98). However, there are a multitude of technologies on the market that could have a similar outcome for a WTC. It is up to technology providers to show a technology's readiness, adaptability and performance – both physically and economically, but the technology also needs to correspond with broader strategies and political agendas.

Area. While choosing a technology, WTCs often look to similar neighbouring companies. Not only because of regional support or legislation but also because of waste substrates that can vary significantly across regions. Therefore, getting a technology up and running could cost more time and effort if regional specificities are not yet factored in. WTCs in the same region that treat the same type of waste with the same technology generally exchange their experiences. The network through which companies find out about technological advances has, next to that very important local component, also a broader scale component, e.g., through international projects, conferences or acquaintances. Another important element is choosing a technology that provides outputs that can be used locally. This is especially important for remote companies, as transport costs could diminish profitability.

Buyers and sellers. WTCs create public tenders for technology providers when they have chosen the type of technology they want to go with. This selection is based on the estimated investment costs, the ease of integrating the technology into current operations or the provider's knowledge of local waste treatment. It is noteworthy that in this market, WTCs are making an active choice. In all markets, WTCs can convey their substantiated opinion. But especially in the technical market, their input matters in decision-making because of the technical expertise that has been built within the company.

Competition. In a technical market, various technologies are in competition with one another. Many WTCs find it important that a new technology is compatible with current infrastructure and most find it important that a technology is sustainable and future proof. That can of course mean many things. For example, some companies are investing in the purification of the biogas produced through anaerobic digestion so that waste collection trucks can drive on Compressed Natural Gas (CNG). This is a locally useful solution. It is, however, in competition with the VFA platform technology, which produces building blocks for the chemical industry that can be sold on the world market. Indeed, extracting VFAs results in lower biogas production, which means less CNG for waste collection trucks. Depending on what a company needs or focuses on, technology choices are made and can create lock-ins. Subsequently, those technology lock-ins affect a company's competitiveness in other markets as well, since societal needs for certain technologies can change over time.

Regulation. What is future proof depends on dominant political ideologies and agendas. WTCs generally do not have a voice in the political agenda of their owners or commissioners, except perhaps through lobbying activity. However, they can launch their ideas and suggestions for innovation, following the hierarchy of the company. All companies prioritise a favourable cost-benefit analysis. Once this analysis has been carried out, the next steps in the exploration of new technologies can be taken. WTCs actively participate in the discussion and exploration and seek out subsidies and investment schemes. Especially for brand new technologies, it can be difficult to find adequate support.

Essentially, the choice of technology depends on three elements. First, the waste that is received, as well as the quantity and quality to be attracted in the future are important. Second, the end-products that are created and need to be marketed. And third, the political climate in which the technology choice is made.

4.3. Commercial market

Commodity. In WTCs with anaerobic digestion technology, the main outputs are digestate with the potential for composting and biogas to be converted into heat and electricity. In a case where the VFAP technology would be adopted, that would be VFAs or end-products that can be derived from these VFAs, such as omega-3 fatty acids, bioplastics and single cell oil. Residues resulting from the anaerobic digestion process can still be composted and often marketed as well. For some WTCs, digestate can be a source of profits as it can be composted and sold. For others, the contents of or the regulatory framework around digestate prevent them from commercialising it. Of major concern for WTCs, is the change in company goal that the production and sale of these end products entail. A company previously oriented towards providing a public service, should now increasingly become involved in commercial markets. Concerns about this have been expressed by public as well as private companies: heightened attention to the commercial side could jeopardise the central task of treating waste. Nevertheless, both types of companies see the value in making additional profit as a means to secure the future of their company. Increased profit, or reduced costs, are valued by shareholders. Municipally owned companies pursue the ideal of reducing costs for society by the means of their commercial activities.

Area. Biogas, heat and electricity are mainly used locally, out of necessity but also because the use of electricity and heat exists everywhere. Often, WTCs use (some of) these recovered products themselves, especially wastewater treatment companies that are drying their sludge use a lot of heat. Converting biogas into CNG to fuel waste collection trucks is another example of local use. Although it is not excluded, VFAs and derived products are mainly aimed at the global market, rather than local use, even though local use is not excluded. Therefore, while larger-scale initiatives regarding the CE may call for this type of technology, local authorities could be more hesitant to invest in this technology since it means reducing the amount of locally useful resources produced.

Buyers and sellers. Waste treatment companies sell or need to discard various products and end up engaging with many actors in these markets. The electricity that is not used by the company itself, is put on the grid and used by many customers. Residues that are composted can be sold to farmers or other customers. Wastewater treatment companies that dry their digestate can find a customer in cement factories that use it as a combustible, which is preferred to landfilling. Currently, it's already a big challenge to find a market for an end product. When becoming involved in new end-product markets, it will require additional insights for each new market: involvement with new buyers, prices, market size, global and local trends that support or inhibit the demand for the product. For products derived from waste with brand new technology, this poses some risks and uncertainties that can discourage waste treatment companies from investing.

Competition. The electricity market is of course a well-established one. Many actors on this market are solely committed to generating electricity, whereas WTCs often see it as a by-product of their main goal, which is waste treatment. Nevertheless, to remain economically and politically viable, this by-product is highly desirable. In this market, WTCs enter into competition with other actors that produce electricity at a much larger scale. Therefore, the market price for electricity is often found rather low compared to its production cost (which also includes waste treatment costs). The same logic rings true for other end products: WTCs will need to produce products at competitive prices in order to ensure a place in the market.

Regulation. Without gate fees and/or subsidies for electricity production from biogas – which is provided in several countries – it would not be profitable to produce electricity and sell it on the existing market. Biogas production is stimulated by the EU because more biogas production means higher rates of waste processing and energy recovery. However, a focus on stimulating biogas also reduces the incentive of WTCs to take further steps up the waste management hierarchy ladder. At the same time, discontinuation of operational subsidies for anaerobic digestion plants after around 10 years, triggers WTCs to look for innovations that can fill that gap. In this market, it becomes imminent that institutional focus on one type of waste treatment practice can create a lock-in or at least lead to a slowdown of further innovation. For the large scale adoption of the VFAP to work, support will need to be oriented towards the recovery of materials out of organic waste, rather than energy, as is the case with electricity and heat production from the incineration of biogas.

Overall, WTCs – public or private – need to find a competitive edge in this commercial market, but also in the other markets. Engaging in CE activities can bring that competitive edge, or niche market, in the sense that recovered, recycled or circular products are popular and in demand. Nevertheless, in the case of WTCs making that transition now, means creating products that compete directly with non-circular goods, which usually have lower production costs.

4.4. Political market

Commodity. By conceptualising political interactions as market interactions, legitimacy becomes the commodity to be traded in the political market. For a WTC to obtain enough legitimacy to continue its activities, it needs to treat waste in a safe and relatively profitable way, leading respectively to environmental legitimacy and economic legitimacy. Environmental legitimacy can be derived through safely operating waste treatment activities, but it also depends on the image of the technology and operations. Furthermore, economic legitimacy is derived from profitability: the goal of WTCs is to reduce the costs of waste treatment for municipalities and citizens. Obtaining this legitimacy is imperative for WTCs in order to attract funding and maintain their level of expertise, which in turn supports a company's position in the waste as material and technology markets. The adoption of the VFAP is a valid option when this technology can further contribute to a company's legitimacy. This technology has the potential to do so because of its premise, material recovery, but also because of its potential for commercial activities that fit well within the CE and current political agendas, resulting in economic legitimacy.

Area. WTCs exist to provide their services to local municipalities with the objective to adequately treat all waste generated within their borders. The focus of WTCs is thus on locally generated waste and cost reduction for the local municipalities. Nevertheless, legitimacy needs to be obtained at different levels, albeit through complying with directives or participating in strategic plans. In terms of CE, there are global as well as regional and local initiatives for the future that can be of help for a WTC needing to make an investment decision.

Buyers and sellers. For municipally owned WTCs, the sellers of legitimacy are the municipalities and their citizens. For privately-owned companies involved in the treatment of household waste, both the providers of waste to be treated (the municipalities) and the shareholders need to perceive the company as legitimate. Achieving legitimacy can therefore be different for municipally owned and private enterprises. In general, we found that private companies put more emphasis on the return on investment and payback time of a technology. Nevertheless, being profitable is also a prerequisite for a municipally owned WTC: serving the needs of municipalities and households comes with responsibilities to cut costs for them. High profit rates are not a necessity in this case. Furthermore, legitimacy is not only exchanged through profit, it can also be embodied by an image. With its growing popularity, the CE provides WTCs with an opportunity to cater to the needs of current political ideologies regarding waste. For WTCs, considering investment in VFAP technology brings forward an opportunity to align with CE strategies.

The **competition** in this market is the WTC's struggle for greater legitimacy compared to other WTCs. To secure waste as well as operational and investment funding, WTCs need to try to legitimise themselves as a valid option. On the one hand, municipally-owned WTCs can focus more on adequate, safe waste treatment while on the other hand, privately owned WTCs need to put more emphasis on profit, as required by their shareholders. Also, to attract additional waste when treatment capacities exceed the inputs received, companies need to offer affordable but quality waste treatment. It is therefore in the interest of WTCs to choose a future proof technology, that is supported by their shareholders and is able to attract waste and make profitable end products.

Regulation. Waste legislation comes with obligations for the operations. For example, companies with waste treatment as their primary function, are obliged to test and report more than other WTCs. WTCs that comply with waste treatment regulations and directives can assert a certain legitimacy and have an advantage when it comes to attracting good quality waste.

In general, competition for legitimacy is directly related to competition in all other markets, since outcomes on those markets affect profits and image. For municipal WTCs, a circular technology such as the VFAP technology represents an approach for the higher valorisation of waste in order to reduce costs, rather than becoming a producer of products for the CE. Providing citizens and municipalities with the service of waste treatment is their primary objective. Privately-owned companies may put more emphasis on the marketing of new products for the CE and the potential profit to be derived from it, however, when engaged in contracts to provide municipalities with waste treatment services, they have to fulfil the same purpose as municipally owned companies. The new economic opportunities that come with the idea of the CE are important for both types of WTCs because these opportunities represent legitimacy as well.

5. Discussion

The results section shows many aspects concerning WTCs' reasoning and decision-making towards circular technologies in the context of four complex markets. The significance of regionally and nationally differentiated constraints and opportunities is highly context-specific (Tura

et al., 2019). Therefore, we have aimed to, with the framework of multiple market exposure, frame regional constraints within the larger issue of facing the demands of multiple interconnected markets. For example, whether or not digestate can be composted and sold or needs to be landfilled because of regulations or a lack of demand, has a particular impact on local WTCs. However, that type of impact is reflected in each of the four markets: it relates to the type of waste, technologies used, end-product sales and regulation.

In the following sections, we reflect on what can be learned about the implementation of the CE in the four markets relevant to the waste treatment sector. They explore four interrelated aspects that are important for the feasible implementation of CE ideas in waste treatment plants.

5.1. Increased competition

Waste treatment companies are entities that provide an essential service and they need to legitimise themselves within the current economic paradigm and CE strategies. The competitive market environment of WTCs increases the challenges for new technologies such as the VFAP that aim to move waste treatment towards a CE. This competition happens in multiple markets. First, there will be increased competition for inputs. The quality of inputs will determine the outputs and consequently the profit to be made. When one of the other goals of the CE – reduction of waste production – is to be fulfilled, waste treatment companies may need to work with fewer good quality inputs to make their renewable end products. Secondly, through investing in new technology for the CE, like the VFAP, waste treatment companies increase their involvement in competition in commercial markets. These companies are increasingly becoming hybrid organisations by adding a commercial logic to their initial social welfare logic (Pache and Santos, 2013). For municipally owned companies, this, in particular, means moving away from or adding something new to their initial goal of providing a public service, addressing local needs. They can produce goods that are not necessarily for local use to obtain an economic surplus to be appreciated by their owners. For materials produced following CE ideas to enter already established markets, they will have to be priced competitively, which is often hard to achieve (Paes et al., 2019). Notably, waste treatment companies need to keep performing their public service and build technical expertise, while also being profitable to obtain the legitimacy they need to keep attracting waste and find funding for technologies that can help them retain their legitimacy.

Moreover, recycled or recovered materials need to replace primary resources for the environmental benefits envisioned by the CE to take effect. Therefore, circularly produced goods must compete on the same market as linear goods (Korhonen et al., 2018a). When prices of circular products are too high (unable to compete with primary production) or too low (leading to increased consumption), the circular activity can lead to a rebound (Zink and Geyer, 2017). The CE rebound refers to the argument that circular activities can increase production in general, which can counterbalance their environmental advantages (Valenzuela and Böhm, 2017; Zink and Geyer, 2017). Zink and Geyer (2017) mention that it is unlikely that sustainable CE practices are appealing to for-profit companies and may be impossible for publicly owned corporations. The CE principle of maintaining the highest possible value of materials means that cost-effectiveness contributes to the choice of circular activity, probably ruling out options that are more sustainable environmentally or socially (Moreau et al., 2017). Therefore, the non-institutionalised introduction of the CE into free markets and for-profit companies is likely to result in a rebound (Zink and Geyer, 2017). And efforts made by WTCs in competitive markets, to be in line with CE strategies, may not have the desired outcome of increased sustainability.

5.2. Public and private WTCs' incentives to adopt

According to our data, the need to be competitive and obtain legitimacy is remarkably similar for municipally owned and privately owned WTCs. Even though their ownership and thus the demands of their owners differ, they are involved in the same four markets and therefore face the same challenges. At first sight, the goal of a public and private WTC is not the same: a public company is synonymous with a public service mission and that is not the case for a private company. However, once a private WTC has a contract with a municipality to safely and correctly treat its waste, it needs to fulfil that contract and, to get other contracts in the future, it will need to comply with the same standards as other waste treatment companies. Additionally, private WTCs are expected to be more efficient, even though that is often just an image (Demuth et al., 2018; Weghmann, 2017). Both types of companies have built technical expertise that needs to go through a hierarchy of different management levels before reaching the final decision-makers, albeit municipalities or other stakeholders.

The main difference we found between public and private companies and their activities in the multiple markets is that private companies have greater requirements for economic profitability (ROI, payback period, …) thus profitability of end product sales is more of a focus. Furthermore, the competition on the waste-as-material market was more of an issue for the private companies in our sample: they are consistently looking for tenders and longer-term contracts, while public companies – to a certain extent – experience a monopoly on waste generated within the territory of their municipalities. In this sense, privately owned WTCs are already more used to the potential changes the move towards circularity entails for them and therefore, they could be better equipped to deal with the difficulties in comparison to publicly owned WTCs. Nevertheless, investments in circular technologies have to remain cost-effective for them to be a viable option, both for public and private WTCs.

Additionally, Nutt (2006) mentions differences in risk-taking between public and private companies: public companies are more likely to make investments that come with some degree of uncertainty, because they base their decisions more on their network than on risk analysis, while private companies attach more value to such a risk analysis (Nutt, 2006). Our results do not confirm actual investment behaviour, since the VFAP technology that was considered as an investment in our data collection process is not yet ready for adoption. We did, however, find indications that interviewees at public companies talked more about the public service mission, while risk and uncertainty were more common themes during interviews at private companies.

5.3. Changing technology landscape

Choosing a technology is a very important decision for a WTC. It has the potential to determine their future in terms of processing activities and outputs produced, which affects their goals to provide a public service and create an economic surplus. Corvellec and Bramryd (2012) conclude that the technology market is the one where WTCs have agency, because of their technical expertise. Our results convey the same: waste treatment plant managers' opinions are valued in the technology market, even if it has to go through the hierarchy of the company. Other markets are subject to a broader context: how much waste is produced or what a commodity market looks like, and is out of control for a WTC. Neither are the needs of their shareholders in relation to political context.

Another important element in the decision-making of WTCs regarding technology, is their network. The multiple market exposure framework approaches the relationship between municipal WTCs, when it goes beyond the monopoly on waste within their territory, as a competition to obtain legitimacy and funding for their continued existence. These assertions are correct when it comes to technical expertise and technology decisions, but there is more to the relationship between

WTCs. WTCs are connected to others in their geographic vicinity and – to a lesser extent – other WTCs further away. In both instances, practical experiences and tacit knowledge are exchanged. Locally, collaboration relationships exist when for example there is excess waste or when technology malfunctions. But more important for investment decisions is the local specificity of waste treatment. A similar language and governmental support scheme are helpful, but also the specificity of waste substrates is an issue. Overall, learning about how new technologies work in practice will happen through a WTC's network. What they learn from their neighbours will, together with an economic feasibility analysis, contributes to investment decisions. The question now arises how these networks and cooperation relationships will change in light of the CE and the subsequently increased competition for waste. In any case, new collaboration relationships will need to be forged for the distribution of circularly produced end-products (Paul and Bussemaker, 2020).

Furthermore, large capital costs, equipment lifetimes and contradictory outcomes of competing technologies can cause technological lock-ins for WTCs. Currently, anaerobic digestion is a widespread treatment process for organic waste. This can cause a certain resistance to change since it is an effective waste treatment technology. Indeed it is economically feasible within the current legal framework and has gained social acceptance, as it processes waste while simultaneously producing energy.

Nevertheless, support schemes change and according to the waste management hierarchy (DIR, 2008/98) which serves as the basis of the CE strategy for waste management, there is a need to do more with waste than energy recovery. In the case of organic waste, material recovery is the next step. This could potentially be reinforced by subsidies focused on CO_2 reduction (EC, 2020). A multitude of technologies and applications are currently under development. The organic household waste treatment technology landscape, which currently mainly consists of anaerobic digestion and composting, will look very different and much more variated in the future. This allows WTCs to focus on local needs or, if their operations are large enough in scale, to make a profit on a global market. WTCs will therefore need to build new business models and analyse new markets and embrace a more commercial side in their mission. However, the technological immaturity of more circular innovations is often a barrier to building these business models (Geissdoerfer et al., 2017).

5.4. Institutional contradictions

Two major institutional contradictions are identified in our research: first, the conflict between waste management hierarchy and subsidies. And second, the contradiction in societal and corporate objectives.

The existence of a waste management hierarchy, imposing material reuse and recycling before energy recovery, contrasts with subsidies still oriented towards producing electricity out of biogas recovered from organic waste. To support the profitability of material recycling – from which WTCs can obtain economic legitimacy – subsidy schemes also need to shift focus. Although biogas production from organic waste has clear benefits as effective waste treatment practice that generates energy, by focusing on increasing biogas production rather than other aspects of the waste management hierarchy (DIR, 2008/98), EU policies create a certain resistance to change, which is in contradiction to the CE strategy. Mahoney and Thelen (2010) explain that institutional lock-ins are often intentional, and, conscious efforts of powerful economic, social and political actors that want to maintain the status quo.

The intensity of this energy recovery over material reuse lock-in is especially high because political factors are at play together with market forces (Pierson, 2000). Supporting mechanisms to aid profitability of electricity production from biogas exist, while new material producers must fend for themselves on the new markets they would enter. Nevertheless, intentional policy effort can result in institutional transition (Seto et al., 2016). For example, efforts in the German renewables sector have resulted in change, albeit slow and incremental (Jacobsson and Lauber, 2006). We can assume that widespread political support for the CE can be a window of opportunity for change (Kingdon, 2014).

Secondly, the waste treatment sector shows an explicit contradiction in the objectives of the CE. While the CE aims to reduce waste production (EMAF, 2017; Vilella et al., 2020) it is often directly coupled with using waste as a resource. For WTCs, this means the creation of new economic opportunities through business models of doing more with waste. In short, there is a discrepancy between the objective of reducing waste production and the objective to build business models based on waste supplies. In literature, concerns have been voiced about the feasibility of closed-loop recycling: an actual reduction in the production of waste has much more impact than an imperfect recycling system since there will always be losses (Korhonen et al., 2018a). Furthermore, the idea that waste is no longer a problem, but a resource, can shift the focus away from waste reduction as a priority (Corvellec, 2014). Ideally, waste production has to be minimised, however, while it is produced, its valorisation is essential for the shift towards the circular economy (Paul and Bussemaker, 2020).

No matter which way policy changes, any given policy can have different outcomes because of local specificities and requirements (Seto et al., 2016). Because multiple technology options, materials and applications exist for WTCs to focus on, this will result in different technology adoption patterns (Stenzel and Frenzel, 2008), which then leaves WTCs with a lot of uncertainties when shifting towards more circular practices (Bocken et al., 2018). Moreover, uncertainties regarding the regulatory environment have been proven to inhibit innovation adoption (Fichter and Clausen, 2021; Tura et al., 2019). When considering risk assessment, it is precisely those regulatory uncertainties that concern WTCs. Undefined governmental guidance of the search for new technology (Hekkert et al., 2007), which depends on the political and technical market, is tied together with regulations in the waste-as-material market and commodity market. Furthermore, creating new or entering existing markets entails risks for a WTC: assessing market sizes, customer preferences and market growth potential for products to be created with a technology that is currently only at technology readiness level 6, enlarges that risk.

Finally, we found that WTCs are concerned about the sustainability of their practices and want to comply with and think ahead about regulations, specifically considering their choice of technology. Taking calculated risks to achieve technology goals is not regarded as impossible by WTCs, however, they require guidance. This alludes to a need for policies that are aware of WTC needs in all four of the markets they are involved in.

6. Concluding remarks

In order to legitimise itself in a political market, a WTC – either publicly or privately owned – can make the active choice to become more circular through the adoption of technologies that will subsequently increase the WTC's need to become more commercial by entering new markets for end-products. WTCs will experience a competitive environment on the commercial market as well as on the waste-as-material market since attracting sufficient, good quality waste is of increasing importance. The shift towards circularity exacerbates the already existing difficulties WTCs face when dealing with the demands of multiple markets. In particular, the increased competition, technological lock-ins and institutional contradictions form barriers for WTCs to become more circular in their activities. WTCs that are best equipped to deal with these difficulties and keep adapting, will be able to build sound business models on processing waste in a circular manner. In short, we conclude that WTCs face a multitude of uncertainties in light of the CE and will require a consistent regulatory framework that is aware of their needs across all markets.

While using a broad, sector-level framework to analyse WTC decision-making, useful conclusions can be made about the difficulties

these entities face in different markets. However, it does not allow us to take into account all local specificities (for example the local variability of waste-related regulations). Therefore we cannot lay out best practices for WTC managers or particular strategies for local policymakers, which are relevant topics for further research. Furthermore, we acknowledge that as different types of actors are able to identify different drivers and barriers, we may not have a complete overview of all potential drivers and barriers. A focus on WTCs was chosen because of their crucial role in the shift towards a circular economy, yet other types of actors (downstream processing of waste-derived products, eventual consumers, etc.) could have different views on what are the most important constraints. Especially with the low technology readiness level (TRL 6) of the technology considered in our case, it is difficult to get a view of the whole value chain and assess the risks that come with investing in this technology. With regard to risk assessment, our qualitative approach lacks the necessary data to calculate basic statistics. Indeed, CE-related technologies are often relatively new and lack successful examples and implementations, which is a constraint for research but also underlines the necessity of gaining more insight into WTC needs.

CRediT authorship contribution statement

Stien Snellinx: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Jef Van Meensel:** Conceptualization, Writing – review & editing, Supervision. **Siavash Farahbakhsh:** Conceptualization, Methodology, Writing – review & editing. **Liselot Bourgeois:** Resources, Writing – review & editing. **Anouk Mertens:** Investigation, Data curation, Writing – review & editing. **Ludwig Lauwers:** Conceptualization, Writing – review & editing. **Jeroen Buysse:** Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

All data collected and used for this paper was done as part of the Horizon 2020 project Volatile. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 720777. Disclaimer: The views expressed in this paper are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.

References

Aminoff, A., Sundqvist-Andberg, H., 2021. Constrains leading to system-level lock-ins - the case of electronic waste management in circular economy. J. Clean. Prod. https://doi.org/10.1016/J.JCLEPRO.2021.129029, 129029.

Antonioli, B., Massarutto, A., 2012. The municipal waste management sector in europe: shifting boundaries between public service and the market. Ann. Public Coop. Econ. 83, 505–532. https://doi.org/10.1111/j.1467-8292.2012.00475.x.

Bergek, Anna, Hekkert, Marko, Jacobsson, Staffan, Markard, Jochen, Sandén, Björn, Truffer, B., 2015. Technological innovation systems in contexts: conceptualizing contextual structures and interaction dynamics. Environ. Innov. Soc. Transitions 16, 51–64. https://doi.org/10.1016/j.eist.2015.07.003.

Bocken, N.M.P., Schuit, C.S.C., Kraaijenhagen, C., 2018. Experimenting with a circular business model: lessons from eight cases. Environ. Innov. Soc. Transitions 28, 79–95. https://doi.org/10.1016/j.eist.2018.02.001.

Corbin, J., Strauss, A., 2012. Basics of qualitative research. In: Techniques and Procedures for Developing Grounded Theory, third ed. Sage Publications, London. https://doi.org/10.4135/9781452230153.

Corvellec, H., 2014. Chapter 10: recycling food waste into biogas, or how management transforms overflows into flows. In: Löfgren, O., Czarniawska, B. (Eds.), Coping with Excess: How Organizations, Communities and Individuals Manage Overflows. Elgar Publishing, Cheltenham, pp. 154–172. https://doi.org/10.4337/9781782548591.00014.

Corvellec, H., Bramryd, T., 2012. The multiple market-exposure of waste management companies: a case study of two Swedish municipally owned companies. Waste Manag. 32, 1722–1727. https://doi.org/10.1016/j.wasman.2012.04.005.

Corvellec, H., Bramryd, T., Hultman, J., 2012. The business model of solid waste management in Sweden – a case study of two municipally-owned companies. Waste Manag. Res. J. a Sustain. Circ. Econ. 30, 512–518. https://doi.org/10.1177/0734242X11427944.

CWA 17484, 2020. Anaerobic Digestion Plants - Feasibility Assessment Methodology for Integrating a Volatile Fatty Acid Platform Technology, 2020. https://ftp.cencenelec.eu/EN/ResearchInnovation/CWA/CWA17484_2020.pdf.

Demuth, J., Friederiszick, H.W., Reinhold, S., 2018. Reverse Privatization as a Reaction to the Competitive Environment: Evidence from Solid Waste Collection in Germany. SSRN Electron. J. https://doi.org/10.2139/ssrn.3168551.

Ellen MacArthur Foundation, 2017a. Achieving growth within. ellenmacarthurfoundation.org/publications.

Ellen MacArthur Foundation, 2017b. Concept - what is a circular economy? A framework for an economy that is restorative and regenerative by design [WWW Document]. URL. https://www.ellenmacarthurfoundation.org/circular-economy/concept. accessed 3.7.21.

Ellen MacArthur Foundation, E., 2015. Towards a Circular Economy: Business Rationale for an Accelerated Transition. ellenmacarthurfoundation.org/publications.

European Commission, 2020. Innovation Fund [WWW Document]. URL. https://ec.europa.eu/clima/policies/innovation-fund_en. accessed 23.9.21.

European Commission, 2015. Closing the Loop - an EU Action Plan for the Circular Economy [WWW Document]. URL. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614. accessed 7.3.21.

European Commission, 2014. Communication from the Commission - towards a Circular Economy: A Zero Waste Programme for Europe. European Commission.

Fichter, K., Clausen, J., 2021. Diffusion of environmental innovations: sector differences and explanation range of factors. Environ. Innov. Soc. Transitions 38, 34–51. https://doi.org/10.1016/j.eist.2020.10.005.

Geissdoerfer, M., Morioka, S.N., de Carvalho, M.M., Evans, S., 2018. Business models and supply chains for the circular economy. J. Clean. Prod. 190, 712–721. https://doi.org/10.1016/j.jclepro.2018.04.159.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The Circular Economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.

Gutberlet, J., Bramryd, T., Johansson, M., 2020. Expansion of the waste-based commodity frontier: insights from Sweden and Brazil. Sustain. Times 12, 2628. https://doi.org/10.3390/su12072628.

Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: a new approach for analysing technological change. Technol. Forecast. Soc. Change. https://doi.org/10.1016/j.techfore.2006.03.002.

H2020 Volatile, 2020a. Biowaste Derived Volatile Fatty Acid Platform for Biopolymers, Bioactive Compounds and Chemical Building Blocks [WWW Document]. URL. http://www.volatile-h2020.eu/. accessed 7.3.21.

H2020 VOLATILE, 2020b. Deliverable D9.16 - Fourth Questionnaire Evaluation Report, May 2020, 12p. URL https://www.volatile-h2020.eu/Open%20Access/Public%20deliverables/D_09_16_Fourth %20Questionnaire% 20Evaluation% 20Report.pdf (accessed 14.9.21).

H2020 Volatile, 2019. Deliverable D9.13 – third questionnaire evaluation report. March 2019, 33p. URL. https://www.volatile-h2020.eu/Open%20Access/Public%20deliverables/D_09_13_Third %20Questionnaire%20Evaluation%20Report.pdf. accessed 14.09.21.

Jacobsson, S., Lauber, V., 2006. The politics and policy of energy system transformation - explaining the German diffusion of renewable energy technology. Energy Pol. 34, 256–276. https://doi.org/10.1016/j.enpol.2004.08.029.

Kingdon, J.W., 2014. Agendas, Alternatives, and Public Policy. Pearson New International Edition, Pearson, London.

Korhonen, J., Honkasalo, A., Seppälä, J., 2018a. Circular economy: the concept and its limitations. Ecol. Econ. 143, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041.

Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E., 2018b. Circular economy as an essentially contested concept. J. Clean. Prod. 175, 544–552. https://doi.org/10.1016/j.jclepro.2017.12.111.

Luttenberger, L.R., 2020. Waste management challenges in transition to circular economy – case of Croatia. J. Clean. Prod. 256, 120495. https://doi.org/10.1016/J.JCLEPRO.2020.120495.

Mahoney, J., Thelen, K., 2010. "A Theory of Gradual Institutional Change" Explaining Institutional Change: Ambiguity, Agency, and Power. Cambridge Univ. Press.

March, J., Olson, J., 1989. The role of political institutions. In: Rediscovering Institutions: the Organizational Basis of Politics. The Free Press, New York.

Millar, N., McLaughlin, E., Börger, T., 2019. The circular economy: swings and roundabouts? Ecol. Econ. 158, 11–19. https://doi.org/10.1016/j.ecolecon.2018.12.012.

Moreau, V., Sahakian, M., van Griethuysen, P., Vuille, F., 2017. Coming full circle: why social and institutional dimensions matter for the circular economy. J. Ind. Ecol. 21, 497–506. https://doi.org/10.1111/jiec.12598.

Mortelmans, D., 2013. Kwalitatieve analyse. In: Handboek Kwalitatieve Onderzoeksmethoden. Acco Uitgeverij, Leuven, p. 568.

Nutt, P.C., 2006. Comparing public and private sector decision-making practices. J. Publ. Adm. Res. Theor. 16, 289–318. https://doi.org/10.1093/jopart/mui041.

Pache, A.C., Santos, F., 2013. Inside the hybrid organization: selective coupling as a response to competing institutional logics. Acad. Manag. J. 56, 972–1001. https://doi.org/10.5465/amj.2011.0405.

Paes, L.A.B., Bezerra, B.S., Deus, R.M., Jugend, D., Battistelle, R.A.G., 2019. Organic solid waste management in a circular economy perspective – a systematic review and SWOT analysis. J. Clean. Prod. 239, 118086. https://doi.org/10.1016/j.jclepro.2019.118086.

Paul, M., Bussemaker, M.J., 2020. A web-based geographic interface system to support decision making for municipal solid waste management in England. J. Clean. Prod. 263, 121461. https://doi.org/10.1016/J.JCLEPRO.2020.121461.

Pierson, P., 2000. Increasing returns, path dependence, and the study of politics. Am. Polit. Sci. Rev. 94, 251–267. https://doi.org/10.2307/2586011.

Ranjbari, M., Saidani, M., Shams Esfandabadi, Z., Peng, W., Lam, S.S., Aghbashlo, M., Quatraro, F., Tabatabaei, M., 2021. Two decades of research on waste management in the circular economy: insights from bibliometric, text mining, and content analyses. J. Clean. Prod. 314, 128009. https://doi.org/10.1016/J.JCLEPRO.2021.128009.

Rashid, M.I., Shahzad, K., 2021. Food waste recycling for compost production and its economic and environmental assessment as circular economy indicators of solid waste management. J. Clean. Prod. 317, 128467. https://doi.org/10.1016/J.JCLEPRO.2021.128467.

Salmenperä, H., Pitkänen, K., Kautto, P., Saikku, L., 2021. Critical factors for enhancing the circular economy in waste management. J. Clean. Prod. 280, 124339. https://doi.org/10.1016/J.JCLEPRO.2020.124339.

Seto, K.C., Davis, S.J., Mitchell, R.B., Stokes, E.C., Unruh, G., 2016. Carbon lock-in : types , causes , and policy implications. Annu. Rev. Environ. Resour. 41, 425–452. https://doi.org/10.1146/annurev-environ-110615-085934.

Spradley, J.P., 2016. Participant Observation, second ed. Waveland Press, Long Grove, Illinois. 1st ed 1980.

Stenzel, T., Frenzel, A., 2008. Regulating technological change-The strategic reactions of utility companies towards subsidy policies in the German, Spanish and UK electricity markets. Energy Pol. 36, 2645–2657. https://doi.org/10.1016/j.enpol.2008.03.007.

Teece, D.J., 2010. Business models, business strategy and innovation. Long. Range Plan. 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003.

Tongur, S., Engwall, M., 2014. The business model dilemma of technology shifts. Technovation 34, 525–535. https://doi.org/10.1016/j.technovation.2014.02.006.

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., Valkokari, P., 2019. Unlocking circular business: a framework of barriers and drivers. J. Clean. Prod. 212, 90–98. https://doi.org/10.1016/J.JCLEPRO.2018.11.202.

Valenzuela, F., Böhm, S., 2017. Against wasted politics: a critique of the circular economy. Ephemer. Theory Polit. Organ. 17, 23–60.

Van de Ven, A., Garud, R., 1989. A framework for understanding the emergence of new industries. Res. Technol. Innovat. Manag. Pol. 4, 195–225.

Vilella, M., Azurin, M., Tabrizi, S., Tangri, N., Recupero, R., 2020. SUSTAINABLE FINANCE FOR A ZERO WASTE CIRCULAR ECONOMY. Zero Waste Europe.

Wang, Y., Ching, L., 2013. Institutional legitimacy: an exegesis of normative incentives. Int. J. Water Resour. Dev. 29, 514–525. https://doi.org/10.1080/07900627.2013.787831.

Webster, K., 2017. The Circular Economy: A Wealth of Flows. Ellen MacArthur Foundation Publishing. https://doi.org/10.1038/531435a.

Weghmann, V., 2017. Waste Management in Europe. Good Jobs in the Circular Economy? A Report Commissioned by EPSU. Rep. Comm. by EPSU (European Public Serv, Union).

Wilde, K., Hermans, F., 2021. Innovation in the bioeconomy: perspectives of entrepreneurs on relevant framework conditions. J. Clean. Prod. 314, 127979. https://doi.org/10.1016/j.jclepro.2021.127979.

Zink, T., Geyer, R., 2017. Circular economy rebound. J. Ind. Ecol. 21, 593–602. https://doi.org/10.1111/jiec.12545.