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The circular economy of waste: recovery, incineration and urban reuse

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This article examines how the political economy of waste utility services is changing in response to circular economy programs. It focuses on the financial composition, economic position and geography of three sectors: waste recycling, incineration, and urban waste reuse. Building on an empirical analysis of these sectors in the Netherlands, specifically the Amsterdam city-region, it puts forward three key arguments. First, waste recovery corporations are becoming increasingly global and dependent on steady flows of waste. Second, incineration facilities play a central yet uncertain role in planning for the circular economy. Third, the circular economy is driving an emerging material reuse market in cities. The paper concludes by arguing that ongoing changes in waste markets run the risk of making (circular) economies even more dependent on wasteful consumption and production.

Keywords: circular economy; city-regions; political economy of waste; waste recovery; Amsterdam

1. Introduction

This paper offers an empirical account of the ongoing impact of circular economy programs on waste markets. In this way, it develops a political-economic critique of current attempts to realize circular economy principles and questions the extent to which they are effectively reducing waste.

Today, governments at all levels are devising policy programs with the aim of increasing resource productivity and waste recovery in different sectors (Gregson *et al*. 2015). In a green-growth framework, these programs are garnering broad support among corporations developing new business models for maximizing the recovery of secondary materials, as well as from civic enterprises active in waste reuse and reduction (Corvellec *et al*. 2020; Urbinati, Chiaroni, and Chiesa 2017). The concept of the circular economy is rapidly becoming ubiquitous in policy arenas. Across the spectrum of public and private actors, it is mobilized to devise infrastructural, social and institutional reforms oriented toward decoupling economic growth from resource depletion.

Circular economy models critique linear, sector-based production and consumption chains, which result in residuals of low or no value. They propose an approach geared toward maximizing resource productivity at all stages of production and consumption

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(Lacy and Rutqvist 2016). In practice, the circular economy is an umbrella term for a large variety of infrastructural, social and economic policies seeking to minimize waste (Blomsma and Brennan 2017; Fitch-Roy, Benson, and Monciardini 2019). It functions as a 'moral discourse' through which diverse actors justify very different resource efficiency strategies (Gregson *et al*. 2015; Friant, Vermeulen, and Salomone 2020). It is being mobilized to promote economic reforms in disparate sectors, from waste recovery to smart logistics, eco-consumption to material reuse. Being highly versatile, the notion of the circular economy takes paradoxical turns. On the one hand, it demands a radical project of socio-ecological change; on the other, attempts to realize its principles often rely on eco-modernization strategies (Reike, Vermeulen, and Witjes 2018). In sum, as Reike, Vermeulen, and Witjes, put it (2018, 247), 'the fundamental paradigmatic questions of [circular economy] conceptualization remain indeed unsolved'.

To understand the circular economy's potential for, and effects on, long-term economic production and consumption, it is crucial to move from elaborating conceptual prototypes of circularity to undertaking empirical analyses of how policy making and investment markets are adopting and reacting to this notion. The extent to which circularity can effectively reduce waste depends on how it is actualized in new regulations, infrastructures and consumption practices. Available studies show that the circular economy is slowly urging public governments to adopt more direct responsibilities in reaching targets of waste reuse, energy efficiency and water management (Bolger and Doyon 2019; Campbell-Johnston *et al*. 2019; Cramer 2020; Savini 2019; Savini and Giezen 2020). They also indicate that circularity is inspiring everyday practices of alternative waste reuse (Dembek 2020; Hobson and Lynch 2016). Some of these studies explicitly warn that the economic system emerging from these developments reproduces wasteful consumerism (Valenzuela and Böhm 2017). These studies show that circular economy discourses are having a variety of impacts on how households and municipal governments manage waste depending on the context at hand (Gregson and Crang 2015; Schramm and Thi Thanh Mai 2019; Zapata and Zapata Campos 2019).

Despite this evidence, these studies do not advance a critical analysis of circularity's systemic impact on the waste management sector in particular. Not only did current conceptualizations of the circular economy emerge from the waste management sector, but they have the most purchase in this policy area (Ragossnig and Schneider 2019). It seems that the circular economy is used primarily to valorize waste as a strategy of economic, social and environmental sustainability, positioning residuals and their reduction at the center of policy making and implementation. Many waste managers still understand circularity as an effective mode of recycling and waste recovery (Aguilar-Hernandez *et al*. 2019). What is more, the notion of the circular economy is deeply rooted in early prototypes of industrial symbiosis, which were adopted to valorize industrial waste as a secondary material for other industrial production processes (Chertow 2008). Despite waste's centrality to resource efficiency, studies looking specifically at circularity's effect on the waste recovery market are surprisingly scarce.

To address this empirical gap, this paper shows how the waste market has adapted to the growing prominence of circular economy targets over the last two decades. To that end, it traces the evolution of three key waste sectors in recent years: waste recovery, incineration and urban materials reuse. Across these sectors, it focuses on three dimensions of the circular economy of waste: the waste industry's financial composition, the position of waste recovery processes in economic development and the geography of waste infrastructures. In attending to the case of the Netherlands, and honing

in on the Amsterdam city-region, the paper traces the changing political economy of waste markets from the early 2000s to late 2019. It shows that the waste-processing market is using three main strategies to adapt to notions of circularity: consolidating a multinational and integrated sector of waste collection and processing; increasingly diversifying activities relating to waste-to-energy incineration infrastructures, and; fostering a nascent, albeit marginal, sector of urban waste recovery.

The article beings by explaining its analytical framework, contextualizing the three dimensions of the following analysis in relation to economic, institutional and geographical trends in the waste sector between the early 2000s and today. After outlining the study's methodology, it presents the analysis of each of the three identified waste sectors. The article concludes by analyzing specific trends in the changing waste market, questioning the extent to which they make that market better suited to addressing circular priorities of waste reduction.

2. The financial composition, position and geography of waste markets

The first dimension of the waste economy analyzed in this paper concerns how waste management and waste utilities are financed and economically sustained. This strand of my analysis problematizes changes in monetary flows of credit and debt in the funding of waste infrastructures, the articulation between governmental and corporate services in the provision of waste utilities and calculations of risk that underlie corporate strategies for maximizing the value of residual materials. The second dimension of my analysis, the position of waste recovery processes in economic development, points instead at the relationship between waste management and other economic sectors. It examines the extent to which waste infrastructures and policies are being variously integrated into, or isolated from, other innovation and investment sectors, such as logistics, data technologies and the built environment. It also grapples with the question of how legislation is enabling synergies between the waste sector and these other domains. Finally, in looking at the geography of waste infrastructures, the third dimension of my analysis uncovers the shifting scales and distribution of waste markets and infrastructures. In so doing, I mean to capture the extent to which waste-to-resource flows are reshaped geographically across local, national and international borders. These three dimensions are interrelated and influence each other. The waste industry's changing financial composition shapes connections among different sectoral investments and waste's position amid economic and financial flows. In turn, these financial flows materialize geographically as new waste infrastructures.

My analysis is rooted in the political-economic critiques developed by regulation theory in geography and planning studies (Boyer 2018; Jessop 2001). Devised to study how capitalist economies cope with economic crises, this theoretical framework makes it possible to observe how particular institutional, political and economic contexts mediate emergent approaches to development. It allows researchers to problematize the ways in which ambitions for sustainable development – which might involve renewables or resource productivity – are institutionalized as new systems of production (While, Jonas, and Gibbs; 2004, While, Jonas, and Gibbs 2010). Honing in on 'modes of regulation' (the institutional architecture that gives shape to markets), this theoretical framework adopts a historical approach to dissecting shifting 'regimes of accumulation', that is, the modes of production and consumption that prevail in given periods. As such, it grasps a particular economic system's contingent industrial composition –

the articulation among markets, financial circuits, technologies and institutions. In so doing, this framework opens up critical reflection on possible contradictions in emergent economic models.

In adopting this framework, this paper is motivated by an urge to grasp what many expect to be the huge impact of circular economy models on the current system of commodity production and consumption, in particular the waste sector. The waste sector has very peculiar features, which demand that circular economy programs are seen in the context of the ongoing institutional, financial and economic restructuring of the waste market from the late 90 s onward.

The European 'landfill directive' (1999/31/EC) in particular signalled a turning point in the evolution of the waste market in Europe. It set a common waste hierarchy that incentivized a recovery of materials and set the grounds for circular economy programmes (Fitch-Roy, Benson, and Monciardini 2019). From the late 90s, the financial composition and the position and the geography of the waste industry has been progressively changing toward three directions: a) the codependency of public utilities and private waste services; b) the institutional upscaling toward national and European regulatory frameworks, which coincide with the emergence of an economy of scale in the waste sector; c) the sub-urbanization of waste infrastructures.

Despite the growing presence of private players in the waste market since the late 1970s, public authorities have remained central actors in processing, collecting, regulating and co-funding waste infrastructures. The waste market was liberalized relatively recently, compared to telecommunications, energy, water and housing (Massarutto 2007; OECD 2000). The higher risks involved in waste investments for both public and private players slowed down full liberalization. The adaptation of the waste sector to circular economy principles is influenced by the inherent instability of waste flows across time and the long periods necessary for recuperating the substantial investments in the logistics and infrastructures for distributing, storing and processing, combined with the very low marginal values of processed waste. Until the late 90s, the value of recovered materials from waste remained much lower in comparison to the more convenient prices of imported raw materials. Producers had – and still have – less incentive to switch to secondary materials because raw material costs have a low impact on overall production costs (Wilting and Hanemaaijer 2014). The price difference between recycled materials and raw materials remained stable until ten years ago, when the prices of the critical raw materials necessary for high-tech infrastructures shot up (European Commission 2018).

Because of these risks and costs, waste remained a tightly regulated service with a strong presence of public authorities or, in some cases, an attractive sector for illicit and illegal activities (D'Amato *et al*. 2018). It also remained relatively disconnected from other sectors of economic development, particularly real-estate, finance and the knowledge industry. Public authorities (also in the Netherlands) operated the most costly and difficult steps of waste recovery, such as collection of household waste at the source as well as separation and incineration (de Jong and Wolsink 1997). Large cities in particular, with their complex fabrics, congested infrastructure and diversity of economic functions, require a broad, capillary collection service, which is costly.[1] Capillary collection of recyclable waste requires a system of daily transport and human labor (door-to-door), while it generates low yields in terms of 'purity' of waste, an important factor for the financial returns of waste recovery. Private waste management companies have generally preferred to invest in the industrial, non-household waste

market (Hall and Nguyen 2012). In the commercial waste sector, streams are often more homogeneous and less territorially dispersed, with a steady flow assisting the long-term business planning.

Under conditions of low raw material prices, the conversion of waste into energy, primarily through WtE, remained a preferred solution for municipalities after the EU landfill directive. From the early 2000s, incineration capacity has been growing across the globe, with 300 new incinerators worldwide and a 6% increase in the EU between 2007 and 2013. Today, northern and western EU countries incinerate 50–75% of all waste (Wilts and von Gries 2015).

Municipalities still see waste-to-energy plants as a long-term investment on post-fossil sources of energy. Yet, the long-term investments necessary to set up these facilities do create significant lock-ins: the production of energy and heat from incineration requires steady waste flows and clashes with waste reduction targets. Such a lock-in is essential to understand the functioning of waste markets at large. The long-term guarantee of adequate waste flows is crucial in a market that requires large investments. The waste materials market is somehow the opposite of financial markets, where quick transactions are strategic for profits. Waste processing suffers downturns in supply and demand because investments have very long repayment times. These investments involve deployment of large-scale technologies, land use permission and preparation, storage and distribution facilities, as well as the process costs of dealing with all the regulations involved in waste management.

Since the 1990s, governments at all levels of scale engaged in a series of regulatory actions to ensure long term stability in the waste sector and open up opportunities to specialize the waste market. Regulations at EU and national level were homogenized to build a common waste hierarchy (Fitch-Roy, Benson, and Monciardini 2019; Gaballah and Kanari 2001). National requirements not only homogenized the standards for waste processing (from collection to recovery) but also structured the sector by creating specialized accountancy models of waste. The European frameworks on common waste induced member states into schemes of waste accountancy that regulate different sub-categories of waste, including common recyclables, such as paper, glass, biomass, metals, but also highly specialized waste, such as tires, mattresses, batteries, chemicals, tapes, and paint.

As the formally recognized waste categories multiplied, the waste market became more fine-grained, creating opportunities to monetize each waste sub-stream (i.e. mono-streams). Yet, sub-stream recovery requires an international market that can tolerate the risks of long-term investments in capillary and specialized materials recovery. Private investors did welcome and actively demanded these regulations, to enable them to extract value from their composite waste streams.[2] The main examples are the electronics sector, the sub-components of building and demolition waste, the precious metals in integrated circuits and the processing of electronic parts.

These regulatory reforms changed the position of the waste industry within national and international economic development policies. Waste management companies started to locate themselves not only as necessary actors in dealing with the increasing flows of waste, but also as economic groups of multinational corporations that could effectively combine different kinds of utilities. They started to slowly diversify their portfolio to capture the more remunerative mono-stream businesses (Worrell and Reuter 2014).

This new position also started to reshape the geography of waste utilities, as markets simultaneously localized and globalized. Within city-regions, public-private partnerships in waste processing emerged to set up a more cost effective and integrated management of waste (Davoudi 2009).

The mid-1990s EU regulations initiated a bifurcation in the geography of waste. On the one hand, the most undesirable streams (or those that could not be processed because of limited infrastructure capacity) where delocalized to far-flung points of the planet (Gregson and Crang 2015). European common waste regulation overlapped with the building of a European and intercontinental waste market. Waste types that were very difficult (and costly) to process on site were shipped to countries with low manual labor costs and weaker environmental standards (Gregson and Crang 2015)

On the other hand, the waste streams that could be processed on site were more strictly regulated and thus less profitable to recover. The outcome was regionalization, as waste sites for specialized processing multiplied around urban agglomerations. Waste streams coming from city regions were re-localized to storage and processing sites closer to the source, particularly in dense urban agglomerations with available industrial facilities (Davoudi 2000; Gandy 2014). The 'wastelands' of the 2000s started to look like healthy industrial sites close to urban agglomerations, rather than areas of dumping and landfills that triggered NIMBY reactions throughout the 70 s. From a *wasteland* they turned into *wastescapes* (Amenta and Van Timmeren 2018): areas unlocking the unexplored economic potential of the waste sector. Today, these locations are strategic hubs for a specialized waste market because they provide proximity to industrial facilities, integrated processing and accessibility to national and international logistics networks. These areas offered industrial synergies for the monetization of residual materials and became the testbeds of the early prototypes of the circular economy.

In what follows, I will zoom into the specific context of Amsterdam city-region to show in detail how the changing financial composition, position and geography of the waste market has changed parallel to the popularity of circular economy discourses. To do so, I will analyze separately three key waste sub-markets: the sectors of waste recycling and recovery, incineration and urban waste reuse[3].

3. Methodology

The research at the base of this paper asked the question 'how have waste markets reacted to the ambitions of resource efficiency proposed by circular economy programmes in the last decade?' It was carried out through three subsequent steps, undertaken between late-2017 and late-2019. First, archival research on the evolution of the waste market in the last 20 years was conducted. Documents on waste utilities were retrieved from online archives and libraries, to study the changing geography of waste infrastructures. This phase identified the key companies and governmental bodies for the interviews of the next phase. Second, the researcher conducted 16 semi-structured interviews with different actors active in waste management. Interviewees represented the major waste utility providers in the region and the startups in circular consultancy: waste corporations and their institutional representatives (i.e. the association of waste management companies); public waste utility companies managing waste collection points, the incinerator and its related companies; and consultancy firms that advise public governments on material efficiency and the circular economy (see Table 1). Third, after the interviews, the yearly financial reports of the interviewed companies were scrutinized to obtain an overview of their business strategies and their costs and returns. These findings were cross-checked through a close analysis of media articles from financial investigations dealing with the waste sector.

Table 1. List of interviewed organizations.

Interviewed organization	Type	Date of interview
Ministry of Infrastructures and Environment	Policy	November 2017
Port of Amsterdam company	Logistics	November 2017
Alderman at Amsterdam city council	Policy	March 2018
Waste collection service Amsterdam	Public waste management	March 2019
SUEZ	Private waste management	April 2019
Dutch institute for public health and the environment	Regulator	April 2019
Dutch Directorate General for Public Works and Water Management	Regulator	April 2019
RENEWI	Private waste management	May 2019
Circular business research hub (Amsterdam)	Research	May 2019
Amsterdam Electronic waste consortium	Private waste management	April 2019
Dekker Group	Private materials provider	April 2019
WASTED	Logistics	October 2019
Metabolic	Consultancy	November 2019
Circle Economy foundation	Consultancy	November 2019
Dutch Directorate General for Public Works and Water Management	Regulator	November 2019
Amsterdam Waste and Energy Company - Incinerator	Semi-Public waste management	November 2018 November 2019

In order to reveal the key factors that shape the business case of private and public companies, the interviews were coded along an operational definition of the three analytical dimensions financial composition, positionality and geography: a) the investment corporate strategies of the companies, b) the relationship between these corporations and the public authorities, including the response to regulatory reforms; and c) the strategies of integration between different waste investments.

4. The internationalization of waste recovery markets

In the Netherlands, the circular economy entered the mainstream policy discourse just five years ago, as a political response to the growing concerns with resource scarcity (for a geneaology of the idea in Dutch policy making see Savini 2019). Here I show that this increase in popularity was parallel to a changing financial composition, positionality and geography of the waste recovery market in specific directions: the economic renewal and expansion of the sector through corporate mergers; the acquisition of a more central position within the whole range of utility services and the geographical repositioning through integrated industrial hubs next to urban denser areas.

As discussed above, waste has always been an appealing commodity for the waste disposal sector, but investments in waste have become much more central to governments and private corporations since early 2000s. As an interviewee reported, the growing economic output of the Netherlands, the increase in consumption and the changing EU regulations to promote recovery led to an increasing optimism in the waste sector that stimulated investments in the long-term improvement of waste facilities, with a large increase in the financial capacity of waste companies[4].

In the aftermath of the 2008 financial crisis, however, the sector faced decreasing waste volumes due to the downturn in production and consumption (Namlis and Komilis 2019). The 2008 to 2015 period witnessed a deep readjustment of the sector, characterized by a rush of fusions, acquisitions and mergers. The Dutch *Het Financieele Dagblad* defined this period as 'the stage of a fusion wave'[5] driven by the combined decrease of margins of waste companies, the relatively stable Dutch economic context and the low interest rate. Investment repayments were ensured by mergers and acquisitions of waste management firms leading to the diversification of their portfolios by integrating waste with other utilities (water, logistics), the enlargement of their geographical reach (multinational) and the strengthening of their capacity to deal with different regulatory contexts (cross-country and inter-continental) (see also ING 2020).

The story of one of the biggest waste management companies in the Netherlands gives insights on these processes. Today, RENEWI-ICOVA (RENEWI from now on) is one of the largest waste management companies in the country. It is a listed multinational corporation, active in nine countries with about 8,000 workers, and is the premier private and commercial waste processor in the region of Amsterdam. Like all waste management companies, RENEWI is presenting itself as a leader in the waste recovery and recycling sector, with about 14 million tonnes of waste processed annually in the Netherlands – an ecosystem of services covering all steps from collection to recovery (RENEWI 2018).

The genealogy of this company is representative of how waste recovery has been changing since the early 2000s to improve efficiency. The company is the result of the 2016 fusion between the formerly largest Dutch waste group van Gasenwinkel and the English utilities group Shanks. This was the last step of a series of mergers and acquisitions aimed at addressing the difficulties of the Afvalverwerking Rijmond (AVR). In the early 2000s, AVR was the largest public waste management company in South Holland (processing one-third of all waste in the country) and owned the second largest incinerator in the country.

In 2006, AVR was sold for EUR 1.4 billion to an international private equity investment fund made up of three companies: the English CVC capital Partners, the American KKR private investment fund and the Dutch Oranje Nassau Investment funds[6]. The enlargement of the financial reach of the firm was driven by the high expectations of the sector at that time. The sale was followed by a doubling of the debt of the company due to the increasing investments in facilities to respond to the anticipated increase in waste volume. One year later, AVR grew even further, buying the Dutch waste management company van Gasenwinkel, holding a large loss, and forming the van Gasenwinkel Group. The Group became internationally active in water, energy, infrastructure and waste sectors. The rising debts, the steady low prices of raw materials, and the low increase of waste streams due to the economic recession put the Group under severe strain. As a result, in 2013 the AVR incinerator of the Group was sold to a Chinese investor, Cheung Kong Infrastructure, for about EUR 950 million (almost half the 2006 purchase price). The Chinese investment group was already active in the port infrastructure and retail sectors in the Netherlands and now added the country's largest private WtE power station to its portfolio. In 2016, the other half of the van Gasenwinkel Group was sold to the UK company Shanks for about half a billion euros.[7]

Today, RENEWI is a private group of several mono-stream companies with facilities strategically located next to dense urban agglomerations. The group manages several steps of the waste recovery chain, obtaining waste, transporting it to their own

subsidiaries, selling it (when possible) to their own waste processing companies, and finally selling the secondary materials. RENEWI owns four mono-stream firms. Mineralz processes demolition waste at nine locations across the Netherlands and Belgium, producing concrete in combination with other raw materials. Coolrec manages electronics, plastic, and non-ferrous materials in seven countries in Europe and owns one-third of the European Advanced Recycling Network for WEEE. Maltha recycles glass in 8 locations in Europe. It also owns Orgaworld, the largest mono-stream firm treating biomass, bioenergy and gasification to produce electricity and supplying heating providers (RENEWI 2019).

These companies are all located in the port of Amsterdam, just 5 km from the city center, which offers good potentials for industrial synergy, with a concentration of installations processing biomass from residual oil. Orgaworld is located in the so-called Greenmills complex in Amsterdam, an industrial symbiosis of different firms involved in residual oil collection, tank cleaning and biodiesel. This complex includes four companies owned by the Simadan Group, the largest bio-diesel producer in England, (Noba, Biodiesel Amsterdam, Tankstorage Amsterdam), and also includes the company Rotie, which manages expired food, owned by Orgaworld itself. This infrastructure of integrated firms is able to capture the most capillary sources of waste and is setting up startups in circular products, such as the reuse of orange skins to make essential oils and animal food (i.e. Peelpioneers). This capillarization is enabling these firms to collect waste right at the source, particularly in dense urban areas, where it joins the advantages of an emerging market of urban waste reuse (please see below).

Other Dutch waste management companies have followed identical pathways. In 2015, Remondis, a EUR 7 billion multinational giant of waste and ecological services in 34 countries, purchased the Dutch company Dusseldorp Groep, specialized in the reuse of building materials. SUEZ, the French giant in water, waste (43% of its business) and environmental services entered the Dutch market in 2015 by buying 35% of shares of SITA Netherlands, a company managing waste from half of all Dutch municipalities. INDAVER, a waste management company in North Holland, was bought by the Swedish multi-utility company DELTA N.V, the Belgian venture capital investor Vlaamse Milieuholding, and a group of industrial shareholders.

This overview shows the financial consolidation of the waste market in the country and Europe. A network of companies owned by multinational investors that link different regional forms for each waste category. The interviewees of these companies all reported that it is only through this integrated system of companies that it is possible to deliver effective waste recovery despite the relatively lower value of secondary materials on the market and the relatively low price of primary materials. As one of those epitomized 'you need the largest volumes to start up a process, not the small scale. Some people say, small is beautiful but it is hard to start'[8]. The mergers, however, also allowed many companies suffering under oversupply of processing capacity and volatile waste volumes to secure the necessary resources for setting up integrated systems of waste recovery. Today, these groups are at the forefront of circular resource management, a sector in full expansion. Waste flows are growing due to the booming Dutch economy. Revenues are also growing because of the consequent undersupply of processing capacity in the country and the stringent regulations against incineration. A new wave of investments is underway, especially in efficiency technology, circular reuse of materials, specialization of the mono-streams and further capillary development (RENEWI 2019; SUEZ 2018).

5. The rise (and fall) of waste to energy

Waste-to-energy (from here WtE) has been and still is the main modality of waste management in The Netherlands because it is used as a source of energy and heat. It is therefore important to look at the changing financial composition and positionality of this sector to understand if and how circular economy models are having an impact on integrated waste and energy systems. While circular economy models may consider WtE as the least desirable strategy for waste recovery, the role of incinerators is much more complex in European circular economy ambitions (Malinauskaite *et al*. 2017; European Commission 2017). Such ambivalence is visible in Amsterdam's circular economy measures, which did not question incineration at large but rather repositioned it within the economic development of the city-regions.

Amsterdam WtE sector underwent a progressive diversification and strengthening of its position within regional waste utility services and regional urban economic development. In the Netherlands, the increasing waste volumes combined with the undersupply of processing facilities and the steadily low taxation on incineration resulted in higher gate fees for waste incineration (i.e. the price that waste producers pay to the incinerator). These higher yields further stimulated long-term investments in WtE infrastructures, with the incineration of industrial waste increasing by 40% between 2011 and 2014 (ADEME 2017). The national government-maintained taxes on incineration remained low throughout the 2000s to spur transition away from landfilling and incentivize district heating and electricity production (Hanemaaijer, Rood, and Kruitwagen 2014).

The Amsterdam Waste and Energy Company (Afval- en Energieberdrijf, from now on AEB) followed a path of financial expansion and infrastructural enlargement. It repositioned itself as a central player in the city-regional energy policy by changing its profile from its core business of incineration to a larger variety of projects, spin-offs and experiments in the field of circularity. The first WtE station opened in Amsterdam Harbor in 1993, on the site of an incinerator built in 1919. It started to provide district heating in 1999, when together with the energy provider NUON – at that time a public energy provider – the AEB funded the Holding Westpoort Warmte, the first residual heat provider for the city. The success led the company to expand its stations, opening a new high-efficiency station in the port of Amsterdam in 2007. To supply these facilities, from the mid-2010s AEB established trans-national import routes. In 2016, the total capacity of the Dutch WtE market was 7.5 million tonnes, with a total national supply of 6.5 million tonnes (Rijkswaterstaat 2016). In 2017, the Amsterdam WtE plant covered about 20% of its capacity (270,000 tonnes of 1,350,000 tonnes total) through imports of UK waste, recovered only 10% of the total processed waste, and produced about 70% of the total 'sustainable' energy used in the city through incineration of organic material (AEB 2017).

The year 2012 marked the peak of business optimism in the Amsterdam WtE market. In the words of the former alderman for economic affairs, Carolien Gehrels, "Our waste-to-energy plant is a money-making machine. So, I always say garbage is gold".[9] Circular economy policy programmes were an opportunity to stimulate the AEB in light of the accumulated investments since the mid-2000s. The earliest policy programmes for integrated waste and energy infrastructures aimed at repositioning AEB at the center of the city's transition in both the energy and waste sectors as a key player in the circular economy of the city (Municipality of Amsterdam 2014).

Since 2012, Amsterdam's WtE sector mutated in two ways. On the one hand, the increased price of raw materials and the enlargement of waste recovery (see above)

made incineration a less profitable means of waste treatment. On the other hand, the available WtE plants provided an existing infrastructure to address the increasing pressure from central government to scale up sustainable energy production. Just before the publication of the National Energy Agenda in 2016 (Ministry of Economic Affairs 2016), Amsterdam's municipal government decided to reduce the use of natural gas to zero by 2050, thereby opening up a new market for the biomass sector as an alternative to coal and ground gas (Municipality of Amsterdam 2016). The ambition to supply up to 140,000 homes with heat from biomass incineration led the AEB to relabel its incineration business as 'green energy' and to diversify its activities.

To set the institutional capacity for this transition, the AEB became a private entity with 100% public shares in 2014. The privatization was expected to give AEB flexibility to invest in the budding circular economy, to sign contracts with suppliers, to invest in new biomass stations, to explore secondary materials sub-streams, and consolidate the residual heat infrastructure.[10] From 2016, AEB planned the expansion of its residual heat holding Wespoort Warmte, with plans to increase its infrastructure from 140,000 to 350,000 homes by 2050, strengthened with a further investment of EUR 35 million in underground infrastructure toward the northern and eastern areas of the city.

In the last four years, AEB also became more active in the waste market, initiating a series of projects in the field of smart infrastructures and integrated waste and energy services. In 2017, AEB invested EUR 35 million to open a post-collection separation facility for household and commercial waste, the Recycling Service Centrum, expected to double in size by 2021. In addition to this investment, the company introduced several programmes for sub-stream specialized recycling: a programme to reuse diapers together with Procter & Gamble, a certification programme for electronic waste and to process the chemicals in paint residuals. Since 2018, AEB is also realizing plans to establish a carbon capture and utilization programme to deliver the CO_2 emitted from incineration to OCAP, the underground pipe transferring CO_2 from North Holland to the glasshouses in South Holland. Finally, also in 2018, the AEB announced the decision to invest EUR 75 million in building a biomass power plant, Bioenergie Central, to deliver 900 GJ of energy.

This supply-led strategy was based on the expectation that by increasing and diversifying waste processing capacity AEB would become a competitive player in the circular economy of the region. As a former circular economy strategist at AEB declared during an interview, "Incineration should end. But the fact that we have incineration to make predictable profits makes it possible to make plans for the transition to a new waste management plan".[11]

To enable a transition toward a circular economy, AEB and the Municipality of Amsterdam embarked on a risky path of investments that, while diversifying its recovery facilities made these facilities codependent on a steady supply of waste. In 2018, in light of the persistently insufficient returns on the investments, AEB's executives and the City Council decided to refinance the company with a new stream of loans and to detach the AEB from the municipal budget. Combined with the increased taxes on incineration, the AEB turned 'from a waste dream to a ticking bomb'.[12] The same year, the court of audits of the metropolitan region Amsterdam warned the city of the imminent financial risks of a fully privately owned company that, on the one hand, operates as a private investor in the waste market and, on the other, enjoys an exclusive right to process waste in the city (Rekenkamer Metropool Amsterdam 2018). The

report problematized the vicious circle incentivizing the exploitation rather than the reduction of waste that ties the public interest in waste disposal to the return expectations of a private corporation.

In July 2019, AEB triggered the biggest waste crisis of the country, when due to a technical problem the facility had to close four of its six ovens for almost five months. The partial interruption of activities revealed the fragility of its investment strategy, which counted on the continuous expansion of the waste market. Amsterdam waste was redirected to landfills, the company was put on sale, the enlargement plans for the recycling facility have been put on hold and the construction of a biomass station has been stopped. Today, the AEB is concentrating on its core business of WtE.

6. The emerging urban economy of waste reuse

As illustrated above, from the mid-2000 onwards, ambitions of resource efficiency pushed waste management companies dealing with monostreams to expand and fueled investments in the Dutch WtE market. However, it also generated a parallel circuit of urban waste recovery with original features. On the one hand, the urban waste recovery market started to largely diversify both geographically and financially. It features a constellation of small and medium firms that are highly specialized in the recovery of specific waste fractions and types, mostly present in cities. On the other, this emerging market started to play a crucial role in the strengthening of the circular economy as a policy program of infrastructural, social and economic reform at different levels of scale. While operating at an urban and neighborhood scale, it also links the national and global waste value chain.

In 2015, a report published on the economic benefits of the circular economy first highlighted the economic position of such a sector within the national economy. The study referred to the compensation of a partial loss in terms of new manufacturing (due to reuse of products) with an increase in jobs and GDP from sectors related to urban repair, component retrofit, maintenance and upcycling (EUR 3.3 billion and 25,000 jobs) (TNO 2013). Such study captured the expected economic benefits of the earliest urban experiments in circular materials reuse in urban areas during the deepest years of the global financial crisis. Between 2013 and 2015, Amsterdam became a hotbed of startups in the field of waste recovery and material reuse. In contrast to the frozen real estate sector, in 2014 more than one-third (35%) of all new firms operated in the handicrafts market, with 60% producing consumables with, among others, reused materials. This sector grew ten-times faster than the national economy (Municipality of Amsterdam 2015). This creative economy, generally known as the ‘makers industry’ (Morozov 2014), took the shape of a network of mini startups active in DIY production, self-building, repair and digitalized manufacturing.

The attractiveness of these economic opportunities in times of financial downturn motivated a wave of urban experimentation geared at stimulating new forms of sustainable urban economies around the notion of circular development. Politically advertised as the new ‘resource economy’ of the city (*grondstoffeneconomie*), the first circular economy visions benchmarked the strategic importance to invest in circular living labs at micro-urban scale (Municipality of Amsterdam 2016). Buiksloterham, Schoon Schip, de Ceuvel and other bottom-up, community initiatives of off-grid, circular construction became flagship projects of this circular business development strategy. They combined principles of sustainable living, DIY, and waste material

recovery. These projects resulted in the first framework for circular building procurement in 2017 (Municipality of Amsterdam 2017), which set requirements for real estate developers to use at least 50% of secondary materials in construction. The consultancy firms involved in these projects rapidly became frontrunners in policy consultancy for city governments searching for solutions on how to reuse urban waste as close as possible to the source. Examples of these consultancy firms include Metabolic and Circle Economy, which today are active all over the country with more than 40 employees each. They connect circular economy principles with urban policymaking, in order to devise solutions for the circular use of materials at urban and neighborhood levels.

These initiatives trace the emergence of a finegrained market of micro-firms that bridge design, waste reuse, research and policy. The members of these firms interviewed[13], presents their work as the much needed alternative to the established transnational circuits of waste processing such as incineration, landfilling or backfilling. The sector is highly specialized, with startups primarily looking at organic waste, metals, construction and demolition waste, electronics and textiles because these types of waste can be more quickly reused in the urban consumers' market. Organic and food waste is perhaps the most dynamic market and the one most frequently identified with eco-consumption. Examples of initiatives that try to localize waste reuse are the compost stations for groups of at least five households and city neighborhoods (Warmhotel), the multitude of cafés that recover eatable food (Taste before you waste, In Stock, resQ Club), and the several neighborhood-based textile and electronics reuse and repair initiatives (LENA clothing library).

The extent to which this emerging market of urban waste recovery will redirect waste streams from a global to a more local circuit is uncertain. The steadily low recycling rates of household waste in Amsterdam (19%) show that the extent to which this market is actually reducing waste production is even more uncertain. Nonetheless, the manner in which this market is evolving in Amsterdam suggests that it may be an additional, parallel circuit of waste recovery to the international waste recovery and incineration outlined above. Many R&D activities in the sectors of bio-plastics, reused glass, bio-chemicals, 3 D printing, concrete smart crushing and recovered wood architecture are built on partnerships between consolidated waste processing companies and emerging startups. The success of these firms in the five years between 2013 and 2018 was built around partnerships between governmental institutions, logistic providers, waste management companies and data companies around the notions of circularity in the city. Examples are the so-called city deals, which are programmatic agreements sponsored by the national government to stimulate new partnerships between different productions. The 2017 City Deal Circular City (i.e. City Deal Circulaire Stad) was a milestone in the building of a national coalition of urban actors around strategies of waste recovery in cities. With this deal, nine city governments, the ports of Amsterdam and Rotterdam and their numerous waste-processing industries built a nationwide coalition with startups in the lifecycle, data and logistic sector to initiate a circular living lab in each city.

The exact boundaries of the urban circular economy in the Amsterdam region today are difficult to delineate because this urban waste market is not separated to the existing circuits of waste management. Rather than a particular business sector, the circular economy works rather as an overarching narrative to display anything that is considered sustainable, green, smart and social – from the smallest, bottom-up social

Table 2. Summary the three sectors.

Dimension of analysis	Waste recovery	Incineration (WtE)	Urban waste reuse
Financial composition	Enlargement Financial mergers	Diversification Public-led	Start-up
Economic position	Integrated utility services	Core-business Incineration coupled with diversified recovery services and energy provision	Wide-ranging partnerships with other sectors of the economy
Geography	Multinational Local clustering	City-regional	Urban, neighborhood

project to the largest waste recovery stream. As a most recent evaluation of the circular economy market in the city of Amsterdam shows, the market of circular startups include all kinds of projects that while presented as the way to 'end waste' are primarily related to waste reuse and build on partnerships with other investment and production sectors in the city (Circle Economy & Municipality of Amsterdam 2019). These partnerships are, in fact, crucial to provide these companies with the essential resources for their business, the specific streams of urban waste itself. This sector combines emerging startups in the building sector, organic waste, consumables, electronics producers consortia, sail-boat producers, biomass companies, mobility providers, waste management firms and many more (Circle Economy & Municipality of Amsterdam 2019; Municipality of Amsterdam 2020). It includes examples that are very different from each other, from circular luxury pavilions (CIRCLE) to car-sharing (car2go), from social housing renewal (Co-green and REHAB) to community supported agriculture and smart food logistics (Pluk!).

7. Conclusions

Waste markets are central to circular economy programs. Realizing ambitions for the circular economy requires specific political, economic and infrastructural changes that are set to occur in the waste sector in the coming years. As a new paradigm of green economic growth, the circular economy taps into twenty years of transformation in the waste market. Still, while conceptual models of the circular economy are proliferating in the literature, there is a dearth of detailed, case-based empirical research looking at how waste markets are evolving in response to resource efficiency discourses. In addressing this gap, this article gives a context-specific empirical account of a particular case study, the shifting political economy of waste markets in the Netherlands.

The present study has shown that the waste sector is diversifying and integrating into other sectors of industrial production and urban consumption in order to establish infrastructural and financial conditions for maximizing the economic value of waste and residuals. It has surveyed waste services' altered financial composition, shifting position in economic development and multiple geographies. Three waste sectors in particular seem especially central and dynamic in the Netherlands' circular economy today (see Table 2).

The waste recovery sector (which retrieves secondary materials from waste) is taking the features of an expanding multinational industry of integrated waste-processing

services. To address ambitions for circular material recovery, this industry has boosted its infrastructural and logistical capacities, processing ever-larger volumes of waste in more effective and profitable ways. Its financial composition results from the long-term investments necessary to recover waste and the great economic risks involved in dealing with secondary materials. The sector is characterized by an increasing functional integration of waste services in global utility services (water, energy, logistics etc.) and a geographical clustering of these services in the industrial peripheries of city-regions. While globalizing, this sector is also becoming more capillary, exploring ways of accessing specific waste streams in cities and further developing an integrated infrastructure of waste logistics in urban areas.

The WtE sector remains one of the most ambiguous and contingent components of circular economy programs. On the one hand, plans for the circular economy identify incineration as the least desirable mode of recovery. On the other, incinerators' infrastructural, economic and geographical central position in the provision of energy and heat to city-regions allow this industry to undertake circular investments. Amsterdam's incinerator has positioned itself prominently in the city's transition toward a post-fossil economy, even though a large part of what is incinerated is of fossil origins. Initiating ventures in heating and energy provision, it has diversified its operations to recover different types of urban waste. That said, the coupling of WtE with other recovery services seems highly problematic and fragile.

Circularity is also stimulating an alternative circuit of waste services. The financial composition of this sector is based on startups and micro-agencies. These position themselves economically as partners of, and linkages between, waste services and other urban investment sectors, such as real estate, food, fashion and mobility. They also link these sectors geographically, connecting regional and national arenas of circular economy policy making with waste-reuse practices in neighborhoods and cities. Policymakers welcome these practices as the beginning of an emerging form of urban circularity, which can bring economic benefits and radically change the relationship between households and waste. Nonetheless, as of yet, it is unclear whether this sector will in fact indent the very source of waste in cities: wasteful consumerism as such.

The three sectors analyzed in this paper show that ambitions for establishing circularity are diversifying waste services as a means of increasing resource productivity from multiple waste streams in city-regions. It seems, though, that these waste services are competing with each other for their key resource – waste itself – while converging toward a similar strategy of diversification of waste services. Herein lies the innate contradiction of the circular economy, in which attempts to reduce consumption are subverted by the expansion of waste infrastructures, which – as this article notes – depends on the volume and quality of residual streams. If the ambition of circularity is to reduce waste altogether, then realizing this would undermine these sectors' financial and economic stability.

The challenge of future research on the circular economy is to move beyond conceptualization and examine how the double-sided relationship between waste reuse and waste reduction evolves. This will make it possible to find manageable ways of implementing ambitions for resource efficiency in waste services, which is especially urgent when it comes to waste reduction in city-regions. This paper's findings are limited by its geographical focus (the Netherlands) and historical reach (from 1999 to 2019). Nevertheless, it suggests two possible trajectories in the evolution of circular economy programs. On the one hand, if circular economy programs explicitly focus on reducing

waste flows, then these sectors under study here will engage in fierce competition: incineration will progressively shrink and global waste recovery will localize in favor of local of waste reuse and reduction economies, possibly built tackling wasteful consumerism. On the other, if circular policy programs stimulate a further expansion and diversification of waste services at large (recovery, incineration, reuse etc.), then this market will likely become even more dependent on processing an ever-increasing supply of waste materials. As this paper has shown, the economic and infrastructural configuration of the waste recovery and WtE sector demands a steady supply of waste. This market is clearly at odds with the more ecologically oriented understandings of circularity, which explicitly aims for an overall reduction of waste in consumption and production.

Notes

1. (https://www.eea.europa.eu/data-and-maps/indicators/waste-recycling-1/assessment) see also (https://www.lwarb.gov.uk/wp-content/uploads/2016/09/LWARB-International-recycling-rate-comparison.pdf).
2. Interview with responsible editor of landelijk afvalbeheerplan at Ministry of Environment, October 2019.
3. While incineration is a form of waste recovery into energy, in this paper I will separate it. This is justified by the position that incineration assumes within circular economy models as the least desirable form of recovery.
4. Interview with AEB, November 2019. See also: https://www.cbs.nl/nl-nl/nieuws/2003/31/omzetstijging-afvalbedrijven.
5. *Het Financieele Dagblad*, Afvalsector is het toneel van ongekende fusiegolf; Handvol middelgrote bedrijven is bezig aan een opmars, 6 november 2015.
6. De Volkskrant: Van Gansewinkel zucht onder schuld, 19 August 2008.
7. ANP. Afvalverwerker AVR in Chinese handen. June 17, 2013.
8. Interview port of Amsterdam, November 2017.
9. Financial Times (2012) Waste opportunity: Creative management of landfill and recycling can transform landscape – and generate income, January 6.
10. Interview with project manager at AEB, November 2019.
11. Interview with AEB circular economy strategist, September 2018.
12. 'from waste dream to thiking bomb' (Ruben Koops en Bart van Zoelen. (31 augustus 2019 zaterdag). Vuilverbrander AEB: van afvaldroom tot tikkende tijdbom. Het Parool.nl.
13. Interview with consultancy firm Metabolic, November 2019.

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References

ADEME. 2017. "Etude comparative de la taxation sur l'élimination des déchets en Europe." Accessed March 25 2020. https://www.ademe.fr/sites/default/files/assets/documents/etude_comparative_taxation_elimination_dechets_europe_201703_rapport.pdf.

AEB. 2017. *Jaarveslag 2017. Amsterdam Afval en Energiebedrijf. (Amsterdam Waste and Energy Company)*. Amsterdam: AEB.

Aguilar-Hernandez, G. A., C. P. Sigüenza-Sanchez, F. Donati, S. Merciai, J. Schmidt, J. F. D. Rodrigues, and A. Tukker. 2019. "The Circularity Gap of Nations: A Multiregional Analysis of Waste Generation, Recovery, and Stock Depletion in 2011." *Resources, Conservation and Recycling* 151: 104452–104461. doi:10.1016/j.resconrec.2019.104452.

Amenta, L., and A. Van Timmeren. 2018. "Beyond Wastescapes: Towards Circular Landscapes. Addressing the Spatial Dimension of Circularity through the Regeneration of Wastescapes." *Sustainability* 10 (12): 4740–4765. doi:10.3390/su10124740.

Blomsma, F., and G. Brennan. 2017. "The Emergence of Circular Economy: A New Framing around Prolonging Resource Productivity." *Journal of Industrial Ecology* 21 (3): 603–614. doi:10.1111/jiec.12603.

Bolger, K., and A. Doyon. 2019. "Circular Cities: Exploring Local Government Strategies to Facilitate a Circular Economy." *European Planning Studies* 27 (11): 2184–2205. doi:10.1080/09654313.2019.1642854.

Boyer, R. 2018. "Marx's Legacy, Régulation Theory and Contemporary Capitalism." *Review of Political Economy* 30 (3): 284–316. doi:10.1080/09538259.2018.1449480.

Campbell-Johnston, K., J. ten Cate, M. Elfering-Petrovic, and J. Gupta. 2019. "City Level Circular Transitions: Barriers and Limits in Amsterdam, Utrecht and the Hague." *Journal of Cleaner Production* 235: 1232–1239. doi:10.1016/j.jclepro.2019.06.106.

Chertow, M. R. 2008. "Uncovering Industrial Symbiosis." *Journal of Industrial Ecology* 11 (1): 11–30. doi:10.1162/jiec.2007.1110.

Circle Economy & Municipality of Amsterdam. 2019. "Bouwstenen voor de nieuwe strategie Amsterdam circulair 2020-2025." Amsterdam. https://api.amsterdamsmartcity.com/storage/media/42/c_57814_7b4d83cd-9a5b-442e-be43-0f282a97e0d8.pdf

Corvellec, H., S. Böhm, A. Stowell, and F. Valenzuela. 2020. "Introduction to the Special Issue on the Contested Realities of the Circular Economy." *Culture and Organization* 26 (2): 97–102. doi:10.1080/14759551.2020.1717733.

Cramer, J. M. 2020. "Practice-Based Model for Implementing Circular Economy: The Case of the Amsterdam Metropolitan Area." *Journal of Cleaner Production* 255: 120255–120264. doi:10.1016/j.jclepro.2020.120255.

D'Amato, A., M. Mazzanti, F. Nicolli, and M. Zoli. 2018. "Illegal Waste Disposal: Enforcement Actions and Decentralized Environmental Policy." *Socio-Economic Planning Sciences* 64: 56–65.

Davoudi, S. 2000. "Planning for Waste Management: Changing Discourses and Institutional Relationships." *Progress in Planning* 53 (3): 165–216. doi:10.1016/S0305-9006(99)00023-9.

Davoudi, S. 2009. "Scalar Tensions in the Governance of Waste: The Resilience of State Spatial Keynesianism." *Journal of Environmental Planning and Management* 52 (2): 137–156. doi:10.1080/09640560802666495.

de Jong, P., and M. Wolsink. 1997. "The Structure of the Dutch Waste Sector and Impediments for Waste Reduction." *Waste Management & Research* 15 (6): 641–658.

Dembek, A. 2020. "Knitting an Action Net to Reduce Plastic Waste: Reusable Takeout Food Containers in New York City." *Culture and Organization* 26 (2): 159–174. doi:10.1080/14759551.2020.1718147.

European Commission. 2017. *The Role of Waste-to-Energy in the Circular Economy* COM/2017/0034. Brussels: European Commission. https://ec.europa.eu/environment/waste/waste-to-energy.pdf

European Commission. 2018. *Report on "Critical Raw Materials and the Circular Economy*. Brussels: European Commission.

Fitch-Roy, O., D. Benson, and D. Monciardini. 2019. "Going around in Circles? Conceptual Recycling, Patching and Policy Layering in the EU Circular Economy Package." *Environmental Politic*, 29 (6): 983–1003. https://doi.org/10.1080/09644016.2019.1673996

Friant, M. C., W. J. V. Vermeulen, and R. Salomone. 2020. "A Typology of Circular Economy Discourses: Navigating the Diverse Visions of a Contested Paradigm." *Resources, Conservation and Recycling* 161: 104917.

Gaballah, I., and N. Kanari. 2001. "Recycling Policy in the European Union." *Journal of the Minerals Metals and Materials Society* 53 (11): 24–27. doi:10.1007/s11837-001-0189-2.

Gandy, M. 2014. *Recycling and the Politics of Urban Waste*. Abingdon: Routledge.

Gregson, N., and M. Crang. 2015. "From Waste to Resource: The Trade in Wastes and Global Recycling Economies." *Annual Review of Environment and Resources* 40 (1): 151–176. doi: 10.1146/annurev-environ-102014-021105.

Gregson, N., M. Crang, S. Fuller, and H. Holmes. 2015. "Interrogating the Circular Economy: The Moral Economy of Resource Recovery in the EU." *Economy and Society* 44 (2): 218–243. doi:10.1080/03085147.2015.1013353.

Jessop, B. 2001. "Capitalism, the Regulation Approach, and Critical Realism." In *Critical Realism and Marxism*, edited by A. Brown, S. Fleetwood, and J. Roberts, 88–115. London: Routledge.

Hall, D., and T.A. Nguyen. 2012. *Waste Management in Europe: Companies, Structure and Employment*. European Federation of Public Service Unions (EPSU). London: University of Greenwich.

Hanemaaijer, A., T. Rood, and S. Kruitwagen. 2014. *Opties Voor Een Afvalstoffenbelasting*. The Hague: PBL. https://www.pbl.nl/sites/default/files/downloads/PBL_2014_Opties-voor-een-afvalstoffenbelasting_1406_1.pdf

Hobson, K., and N. Lynch. 2016. "Diversifying and De-Growing the Circular Economy: Radical Social Transformation in a Resource-Scarce World." *Futures* 82: 15–25. doi:10.1016/j.futures.2016.05.012.

ING. 2020. *Assetvisie Afvalbranche, Afval 2020: Meer Waarde Uit Minder Afval*. Amsterdam: ING Bank.

Lacy, P., and J. Rutqvist. 2016. *Waste to Wealth: The Circular Economy Advantage*. Basingstoke, UK: Palgrave Macmillan.

Malinauskaite, J., H. Jouhara, D. Czajczyńska, P. Stanchev, E. Katsou, P. Rostkowski, and N. Spencer. 2017. "Municipal Solid Waste Management and Waste-to-Energy in the Context of a Circular Economy and Energy Recycling in Europe." *Energy* 141: 2013–2044. doi:10.1016/j.energy.2017.11.128.

Massarutto, A. 2007. "Municipal Waste Management as a Local Utility: Options for Competition in an Environmentally-Regulated Industry." *Utilities Policy* 15 (1): 9–19. doi: 10.1016/j.jup.2006.09.003.

Ministry of Economic Affairs. 2016. *Energieagenda: Naar Een CO_2-Arme Energievoorziening*. The Hague: Dutch Government.

Morozov, E. 2014. *Making it: Pick up a spot welder and join the revolution. The New Yorker*, 1st January.

Municipality of Amsterdam. 2014. *De circulaire metropool Amsterdam 2014-2018*. Amsterdam: Municipality of Amsterdam.

Municipality of Amsterdam. 2015. *Amsterdamse Ambachtseconomie 2010-2014*. Amsterdam: Municipality of Amsterdam.

Municipality of Amsterdam. 2016. *Circular Amsterdam. Circle Economy and Municipality of Amsterdam*. Amsterdam: Municipality of Amsterdam.

Municipality of Amsterdam. 2017. Roadmap Circulaire Gronduitgifte. Amsterdam.

Municipality of Amsterdam. 2020. Amsterdam Circular Strategy 2020-2025. Amsterdam: Municipality of Amsterdam. https://assets.amsterdam.nl/publish/pages/867635/amsterdam circular2020-2025_strategy.pdf

Namlis, K.-G., and D. Komilis. 2019. "Influence of Four Socioeconomic Indices and the Impact of Economic Crisis on Solid Waste Generation in Europe." *Waste Management* 89: 190–200. doi:10.1016/j.wasman.2019.04.012.

OECD. 2000. *Competition in Local Services: Solid Waste Management*. DAFFE/CLP, 13.

Ragossnig, A. M., and D. R. Schneider. 2019. "Circular Economy, Recycling and End-of-Waste." *Waste Management & Research* 37 (2): 109–111. doi:10.1177/0734242X19826776.

Reike, D., W. J. V. Vermeulen, and S. Witjes. 2018. "The Circular Economy: New or Refurbished as CE 3.0?: Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options." *Resources, Conservation and Recycling* 135: 246–264. doi:10.1016/j.resconrec.2017.08.027.

Rekenkamer Metropool Amsterdam. 2018. "Grip op Westpoort Warmte Warme." Amsterdam, November 21, 2018. Accessed March 25 2020. https://www.rekenkamer.amsterdam.nl/onderzoek/grip-op-westpoort-warmte/

RENEWI. 2018. "Introduction to Renewi." Renewi Plc: Milton Keynes. Accessed March 25 2020. https://www.renewi.com/en/investors/investor-relations/reports-and-presentations

RENEWI. 2019. “Annual Report and Accounts 2019.” Renewi Plc: Milton Keynes. Accessed March 25 2020. https://www.renewi.com/en/investors/investor-relations/reports-and-presentations
Rijkswaterstaat. 2016. “Afvalverwerking in Nederland 2015.” Werkgroep Afvalregistratie, The Hague.
Savini, F. 2019. “The Economy That Runs on Waste: Accumulation in the Circular City.” *Journal of Environmental Policy & Planning* 21 (6): 675–691.
Savini, F., and M. Giezen. 2020. “Responsibility as a Field: The Circular Economy of Water, Waste, and Energy.” *Environment and Planning C: Politics and Space* 38 (5): 866–884.
Schramm, S., and N. Thi Thanh Mai. 2019. “Turning Waste into Resources and Resources into Waste: Centralised Waste-to-Energy Nexuses and Alternative Modes of Nexusing in Hanoi.” *Urban Studies* 56 (11): 2315–2332. doi:10.1177/0042098018797844.
SUEZ. 2018. “Recycling and Recovery in the Netherlands, Price Trends 2019.” Accessed March 25 2020. https://www.suez.nl/-/media/suez-nl/files/publication-docs/suez-prijsontwikkelingen-2019.pdf
TNO. 2013. *Kansen voor de circulaire economie.* R10864, TNO: Delft.
Urbinati, A., D. Chiaroni, and V. Chiesa. 2017. “Towards a New Taxonomy of Circular Economy Business Models.” *Journal of Cleaner Production* 168: 487–498. doi:10.1016/j.jclepro.2017.09.047.
Valenzuela, F., and S. Böhm. 2017. “Against Wasted Politics: A Critique of the Circular Economy.” *Ephemera* 17 (1): 23–60.
While, A., A. J. Jonas, and D. Gibbs. 2004. “The Environment and the Entrepreneurial City: Searching for the Urban ‘Sustainability Fix’ in Manchester and Leeds.” *International Journal of Urban and Regional Research* 28 (3): 549–569. doi:10.1111/j.0309-1317.2004.00535.x.
While, A., A. J. Jonas, and D. Gibbs. 2010. “From Sustainable Development to Carbon Control: Eco-State Restructuring and the Politics of Urban and Regional Development.” *Transactions of the Institute of British Geographers* 35 (1): 76–93. doi:10.1111/j.1475-5661.2009.00362.x.
Wilting, H., and A. Hanemaaijer. 2014. *Share of Raw Material Costs in Total Production Costs*. The Hague: Planbureau van de leefomgeving.
Wilts, H., and N. von Gries. 2015. “Europe’s Waste Incineration Capacities in a Circular Economy.” *Proceedings of the Institution of Civil Engineers: Waste and Resource Management* 168 (4): 166–176. doi:10.1680/warm.14.00009.
Worrell, E., and M. Reuter. 2014. *Handbook of Recycling: State-of-the-Art for Practitioners, Analysts, and Scientists*. Amsterdam: Elsevier.
Zapata, P., and M. J. Zapata Campos. 2019. “Cities, Institutional Entrepreneurship and the Emergence of New Environmental Policies: The Organizing of Waste Prevention in the City of Gothenburg, Sweden.” *Environment and Planning C: Politics and Space* 37 (2): 339–359. doi:10.1177/2399654418783205.