



Waste, Recycling and Entrepreneurship in Central and Northern Europe, 1870- 1940

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Abstract

This working paper examines the role of entrepreneurs in the municipal solid waste industry in industrialized central and northern Europe from the late nineteenth century to the 1940s. It explores the emergence of numerous German, Danish and other European entrepreneurial firms explicitly devoted to making a profitable business out of conserving and returning valuable resources to productive use, while maintaining public sanitation and in many cases offering nascent environmental protections. These ventures were qualitatively different from both earlier small-scale private waste traders, and the late twentieth-century integrated waste management firms, and have been neglected in an era that historians have treated as a period of municipalization. These entrepreneurs sometimes had strikingly modern views of environmental challenges and the need to overcome them. They initiated processes for sorting and recycling waste materials that are still employed today. Yet it proved difficult to combine making profits and achieving social value in accordance with the “shared value” model of today. As providers of public goods such as health and sanitation and a cleaner environment the entrepreneurs were often unable to capture sufficient profits to sustain businesses. Recycled-goods markets were volatile. There was also a tension between the constant waste stream on the collection side and a seasonal/cyclical demand for recycled products. The frequent failure of these businesses helps to explain why in more recent decades private waste companies have been associated with late entry into recycling, often trailing municipal governments and non-profit entities.

Waste, Recycling and Entrepreneurship in Central and Northern Europe, 1870-1940

This working paper examines the role of entrepreneurs in the municipal solid waste industry in industrialized central and northern Europe, especially Germany, from the late nineteenth century to the 1940s. This unglamorous business has been neglected by business and economic historians, and management scholars more generally, although it has recently received attention in an important new comparative study of the German and British waste industries after 1945 by Stokes, Köster and Sambrook.¹ There is also an older literature on the United States.² A central concern of much of this literature has often been the role of municipal governments and the state, but this working paper focuses primarily on the role of private business.

The efficient and appropriate collection and disposal of solid waste has been recognized as essential to the hygiene and health of urban societies since the nineteenth century. Over the course of the twentieth century, sanitary engineers and the broader public also came to understand that the inappropriate treatment of waste could cause major environmental degradation, while recycling could contribute significantly to environmental sustainability. A key question for this industry, therefore, was whether such social value could be combined with the pursuit of profitable opportunities. This issue was a long-standing one in the history of capitalism, recently revisited by Porter and Kramer in the concept of “shared value.”³ Could private-sector firms improve sanitation and environmental sustainability while turning a profit? Which firms and entrepreneurs consciously attempted to combine these two goals, and when?

Traditional accounts of the development of waste management in Europe and the United States do not lend themselves well to answering these questions. Historians of the industry have highlighted the process by which municipal authorities gradually took control of waste collection

and often disposal activities in large cities during the decades before World War I, or they have focused on the history of waste management infrastructure and technology.⁴ They have had relatively little to say about the private sector between the age of nineteenth-century horse-cart haulers and peddlers, and the rise of large, vertically integrated waste management corporations after 1970. In particular, the history of recycling has left the impression that recycling enterprises that advanced beyond informal, small-scale waste trading and peddling were primarily non-profit goodwill organizations, community volunteer efforts and state-led wartime scrap drives.⁵ Meanwhile, studies of the late twentieth-century global waste management companies have suggested that the profitability of landfilling made the private sector reluctant to consider recycling activities.⁶ Critics have argued that the companies' involvement with environmental protection after 1970 combined grudging acknowledgment of public concerns over the growing volume and toxicity of waste with the attempt to use environmental regulation to capture market share from smaller competitors who could not afford to deploy costly pollution control systems. Further, the waste management giants' claims to perform environmental services have repeatedly run afoul of laws on pollution and toxic waste. Even their recycling and energy-recovery operations, these critics say, serve to perpetuate a wasteful society by promoting planned obsolescence and throwaway packaging for consumer goods to keep the waste stream at a steady and profitable volume.⁷

Without venturing to assess these criticisms of post-1945 waste management, this working paper argues that the late nineteenth and early twentieth centuries saw the rise of numerous German, Danish and other European entrepreneurial firms explicitly devoted to making a profitable business out of conserving and returning valuable resources to productive use while maintaining public sanitation and in many cases offering nascent environmental

protections. These firms were different in scale and technology from the small private haulers of the nineteenth century with their carts and open dumps. They were often founded by engineers and natural scientists as well as by socially marginalized individuals, and they initiated many of the processes for sorting and recycling waste materials that are still employed in refined forms in recycling facilities today. Large-scale single-stream and source-separated recycling, conceived as a technical and organizational activity rather than a cultural and ideological program, thus predated both state-sponsored wartime scrap drives and the 1960s environmental movement. The golden age of municipally-operated waste management was also the age of the first private recyclers who moved beyond small-scale, traditional salvage practices. Unlike the late twentieth-century garbage multinationals, these firms cannot be accused of “greenwashing” their operations by introducing forms of recycling, since they operated in an era without widespread environmental consciousness. Where the entrepreneurs expressed a desire to end the wastage of valuable resources and to avoid polluting nature and the human environment, therefore, they were expressing personal beliefs and goals rather than trying to capitalize on the cachet of a “green” reputation. These public benefits often motivated them and formed a major part of how they spoke about their businesses to customers and the public in general.

These firms are little known, not just because historians have paid greater attention to public-sector waste service providers, but also largely because the companies discussed below were typically unable to achieve sustained profitability and many disappeared after a few years in business. This was the real impediment to their creation of “shared value.” It was not for lack of attempts by entrepreneurs, nor for lack of commitment to social benefits; the absence of sustained private-sector recycling activities until the late twentieth century owed instead to the economics of recycling waste rather than dumping or burying it. As providers of public goods—

health and sanitation and a cleaner environment—those firms that collected and prepared wastes for reuse were unable to capture as profit enough of the value they created to maintain their operations in recycled-goods markets notorious for their volatility. They were confronted, too, with a constant waste stream on the collection side and a seasonal and cyclical demand for their recycled products on the disposal side. Under these conditions, even the innovative processes these entrepreneurs designed were not capable of achieving economic sustainability. Cost-reducing technological changes or cultural conditions more favorable to public subsidies on the basis of environmental benefits, both of which arose in the late twentieth century, were required for sustained participation by private-sector actors.

Despite their failures, these early European recycling businesses are noteworthy for two further reasons. First, although the economics of public goods might suggest that markets would fail to supply recycling services like those described in this working paper, continuing waves of entrepreneurs attempted to do so. This pattern, and the explicit commitments of many of these entrepreneurs to combining public and private benefits, may help to shed light on the phenomenon of entrepreneurship as partly determined by extra-economic motives. Second, the failure of these businesses may help to explain why private waste companies have been associated with late and reluctant entry into recycling activities, often trailing municipal governments and non-profit entities in the 1970s and 1980s. Those private waste firms that survived and prospered in the postwar era did so on the basis of their control over relatively cheap sanitary landfills, allowing them a level of profitability that fed expansion during an era of booming consumption and eventually permitting the introduction of recycling into large-scale diversified enterprises. The relative lack of specialized recyclers after 1945 reflected competitive and evolutionary selection processes, the specific characteristics of markets for waste services

and recovered resources, and public attitudes about the waste problem, rather than any absence of interest on the part of entrepreneurs.

The Emergence of Waste as a Problem

Prior to the twentieth century, it is sometimes maintained, ordinary citizens in Europe and the United States generated little waste in an absolute sense. They practiced a “stewardship of objects,” in which re-use was nearly universal owing to the pressures imposed by economic necessity under conditions of low incomes. The scarcity even of basic resources made it economical to reuse old metal, textiles, leather, wood, and so forth in the production of new goods, while organic kitchen waste and animal carcasses were used for fodder, soap or glue and bodily wastes as fertilizer. A second, technological, factor promoting preindustrial patterns of reuse in the home, farm, or workshop was the relative simplicity of the materials from which most goods were made: without complicated alloys, synthetic or artificial materials, or the combination of multiple materials in a single product, collection and treatment of old materials for reuse was unproblematic. What could not be reused was generally burned for heat in fireplaces, or was in any case biodegradable.⁸

In reality, the above description was a better fit for the countryside than the cities, and it was in the new industrial cities of the nineteenth century that waste first became a problem to be “managed,” and a domain which attracted profit-seeking entrepreneurs. There appears to have been a common pattern of development in urban Central Europe. Sanitation in the cities changed relatively little for centuries before the 1830s, when European-wide cholera epidemics induced health professionals and city officials to consider measures to improve urban water and sewerage infrastructure, but solid waste management efforts generally lagged several decades behind.⁹ Government officials in the eighteenth and early nineteenth centuries generally dealt with the

problem of solid waste by issuing municipal ordinances prohibiting inhabitants from dumping their household waste in the streets or public squares. Where these ordinances were actually observed, residents unloaded waste in unsanitary “collecting pits” (or *Sammelgruben*) in the interior courts of their apartment houses. These were emptied periodically by small entrepreneurial disposal firms—often simply a single man with a horse and cart—which would contract with a household to transport its waste from the city to the outskirts, where the firm would then deposit it or more often sell it to local farmers as fertilizer.¹⁰ Some cities, such as Hamburg, offered a smaller number of firms concessions for wider-scale waste removal and street-cleaning, based on the lowest bid for services. In a handful of cases, such as Hamburg between 1850 and 1869, towns charged entrepreneurs for the right to pick up and re-sell the wastes in the countryside.¹¹ In other cases, such as Nuremberg, the waste was removed by local farmers themselves.¹²

Three main factors led to the decline of such early, agriculturally-based waste “recycling” systems during the second half of the nineteenth century: first, it was subject to the growing scruples of health professionals; second, the rapid acceleration of urbanization in industrial cities led to increases in the quantity of waste that overwhelmed the existing infrastructure and local agricultural demand; and third, the content of urban wastes changed. Farmers’ use for urban waste diminished as the proportion of glass and metal packaging increased, and as the cities’ sewer systems expanded, thereby reducing the proportion of organic waste useful as fertilizer just as lower-priced chemical fertilizers were also becoming available.¹³ The waste business did generally remain in private hands even after the 1870s, despite some large cities’ increasing municipalization of water provision, sewerage, and street-cleaning functions.¹⁴ Berlin, for instance, was estimated to have some sixty such disposal firms still in the early 1890s.¹⁵ But

there was growing discontent with both collection and disposal. The small traditional waste haulers reportedly began to neglect their obligations in areas of the city best served by municipal sewers, as they had difficulties covering the cost of frequent pick-ups when they were no longer able to sell the waste in the countryside.¹⁶ Meanwhile, the indiscriminate dumping of wastes not wanted by farmers could be only a temporary expedient as it raised questions both of space and of sanitation.

City governments, responding to the public and to health officials, debated ways of removing the rapidly increasing quantity of refuse which would ensure a higher degree of uniformity and sanitation across the urban population. Frequently, after 1890, this meant establishing a municipal department. But many cities opted instead to contract with a small number of private firms—or often a single firm, as in the cities of Leipzig, Dresden, and Chemnitz—to attain a uniform, regulated collection pattern and to ensure that certain hygienic standards were met.¹⁷ By 1910, out of German cities with populations over 25,000, 77 had municipalized trash collection, while 44 had contracted with private firms, and 48 had not made any specific arrangements.¹⁸ The disruption of the old system by economic, demographic and technological development and by increasing political involvement led to substantial changes in the industry and a profusion of experiments during the period from 1890-1930. Some of the new strategies in major cities served as predecessors for modern waste collection and recycling enterprises.

“Dust-Free” Waste Collection: Berlin, 1895-1933

During the late nineteenth century practices changed both in collection and in disposal. Among the more interesting strategies was the effort to keep cities cleaner through *staubfrei* or “dust-free” collection. In 1895, Berlin, one of the fastest growing cities in Europe, decided to

combat the plague of dust and ash generated in the streets by trash pick-ups and open-topped trash wagons by enacting an ordinance requiring all waste removal firms to adopt “dust-free” collection practices using closed containers which the firms, not the residents, were now obligated to provide.¹⁹ This commitment to dust-free collection put Berlin in the vanguard, as other German cities did not adopt it until at least the 1920s, while elsewhere, as in Britain, the spread of dust-free systems awaited post-1945 rationalization of waste management.²⁰ Complying with the 1895 ordinance put many of the smaller Berlin firms out of business or forced them to raise prices to such a high level that the “Wirtschaftsgenossenschaft Berliner Grundbesitzer,” (WBG) a recently formed group of the city’s property-holders, entered the market as a cooperative waste disposal company, the Berliner Grundbesitzer GmbH. Initially intended simply to negotiate terms with the existing private firms, the WBG began to purchase its own containers and fleet of collection wagons. Soon after 1895, the market was dominated by four firms—the WBG, the Staubschutz GmbH, the Vereinigte Müllabfuhrunternehmer, and B. Röhrecke—all of which employed patented collection systems using one of two methods. In the *Sammelkastensystem*, the firm provided trash cans which closely fit into openings in a covered collection wagon, thereby avoiding spillage, and in the *Wechseltonnensystem*, the collection wagons contained empty cans which were exchanged each time with households’ full cans at the pick-up point.

The Staubschutz company, whose very name implied its commitment to the new dust-free mandate, represented the *Sammelkastensystem* in the city. Its emphasis on “the requirements of modern hygiene” and the avoidance of fire, dust, and the spreading of spoiled and sickness-causing garbage quickly gained it market share.²¹ Between its start of operations in 1895 and October 1898, the company expanded to supply collection services by multi-year contract to

2750 properties in Berlin and 600 in Charlottenburg, a neighboring wealthy suburb that subsequently became part of the city.²² Aware that most Berlin waste was destined for dumping in the countryside, Staubschutz not only provided for a dust-free interface between individual garbage cans and its collection wagons, but also designed the wagons to allow for the direct loading of their separable containers into trains or barges. The company was particularly successful in its cultivation of public clients and government ministries, boasting numerous state officials in its testimonials.²³

The WBG, which by contrast used the *Wechseltonnensystem*, was serving 11,224 properties in Berlin in 1903, a number it claimed to be approximately half the total in the city.²⁴ The following year, the city's decision to require by ordinance that all wastes be transferred "dust-free" to the rail cars which carried them out of Berlin and to dumping grounds in the countryside had a radical effect on the WBG and other companies. Ultimately the 1904 ordinance contributed to the WBG's market control by raising costs even further for the remaining for-profit firms, but in the meantime it required a risky program of major capital expenditures and acquisitions. Because of its collection system, which required the emptying of many thousands of small individual trash cans into open rail cars, the WBG could not comply with the ordinance without changing its system. It consequently bought Staubschutz GmbH, the only one of its main rivals which operated on the *Sammelkastensystem*, allowing for fewer, larger containers and thereby easier dust-free rail transfer, and it ordered thousands of new trash bins and the wagon systems suited to the new method. It also purchased two of its other largest rivals, the Berliner Abfuhrgesellschaft and Hermann Scheller, both of which had approached WBG about being acquired, presumably because of inability to comply with the new ordinance.²⁵ At the conclusion of the calendar year 1904, the firm counted 14,533 Berlin

properties among its clients, while the following year it captured much of the rest of the market, reaching 23,284 separate properties.²⁶ By the initial months of World War I in 1914, the WBG could count some 90% of Berlin households as clients dispersed across 39,680 properties in the growing capital. Its continued positive earnings, effective management of strikes, and maintenance of the lowest prices in the city allowed it to outcompete and purchase its remaining rivals, and to boast a total of 31 other acquisitions of collection businesses across its two decades of operation.²⁷

The WBG, then, grew as a highly successful co-operative business venture in waste, skilled in relations with the municipality and able to acquire and absorb competitors. However World War I was a major exogenous shock. Like other private firms and like municipal waste departments in Germany, the WBG suffered from severe labor shortages as the war dragged on and many employees left for the front or for more pressing industrial service. Initial attempts in 1915 to substitute war prisoners for German collection workers led to indifferent results owing to an understandable lack of motivation, and the WBG was compelled to increase its fee by 25% to cover growing costs.²⁸ 1916 brought even greater difficulties, now including transportation problems: horses were requisitioned and horse fodder became scarce, as did railroad cars available for the removal of wastes from the city, while staffing problems continued and service fees increased again.²⁹ The next two years saw continually decreasing capacity and performance, and after the German surrender the cooperative despaired of its ability to provide anything resembling adequate services without workers or equipment and with the freeing of the war prisoners by the revolutionaries in the winter of 1918-19, although it continued to try to serve some 37,701 households by the last day of 1918.³⁰

If the WBG barely survived the war and the immediate aftermath, it did not survive the period of instability and inflation that succeeded in the early 1920s. It failed in 1922.³¹ Its successor, the Berliner Müllabfuhr AG (BEMAG), was a private firm with a substantial share of public ownership which would be transformed into permanent municipal control in 1927. The short-lived company embodied the tensions inherent in most waste collection services in major cities between the goals of preserving city sanitation and public health, providing residents with efficient service, and controlling costs.³² Building on the heritage of the monopolistic WBG, with which they had close connections, the businessmen behind BEMAG argued that a city-wide private firm with special privileges and public oversight was the only effective way of reconciling these tensions. As a private company, they suggested, BEMAG would avoid the “bureaucratic narrowness” of municipal departments and benefit from decades of private-sector expertise in the industry. But the simultaneous involvement of the city would extend from partial capitalization of the enterprise to supervision by city officials who could represent the “general interest” in matters of public health and hygiene, alleviating the traditional concerns about conflicts of interest between profit and health.³³ Taking advantage of these fears and residents’ familiarity with the market dominance of the WBG, BEMAG claimed that only a large firm, and not a congeries of smaller competing firms, could be said to represent the common interest, and it secured a legal monopoly through a city ordinance requiring Berlin households to contract with the company for collection services.³⁴ Managing an enterprise serving some 60,000 properties in the 1920s required an office staff alone of approximately 220, mostly for making fee assessments, fee collections, and bookkeeping and filing, and some 35 inspectors who monitored the daily activities of the collection workers.³⁵ In addition to its high working capital needs for its labor-intensive business, BEMAG particularly relied on the infusion of public

capital in order to rebuild and modernize its collection infrastructure, above all through the motorization of collection vehicles. Motorization was seen as a way to provide more regular and economical service than the WBG in its declining years, and, importantly, to achieve a measure of profitability.³⁶ The public ownership of BEMAG gradually increased during the 1920s from an initial 25 percent to over 85 percent in 1927. It would be reorganized as a city government entity under the Nazi regime after 1933.³⁷

The need to provide dust-free service, first in Berlin and then in the 1920s in other cities, generated demand for the manufacture of new equipment to supply the collection companies. The best-known firm to enter this market was the sheet metal products manufacturer Schmidt & Melmer, which became a producer of metal receptacles for the various systems and itself a patent-holder for several of the most successful.³⁸ The company managed to renew its success in selling trash container systems in various eras of Germany's turbulent history; pre-World War I success was duplicated in the 1920s with the new "Es-Em" system, a variant of the *Sammelkastensystem* adopted in many large German cities and used in Hamburg, Frankfurt, Mannheim and many others until the 1950s.³⁹ Schmidt & Melmer was hardly the only firm to produce the equipment designed for collection systems, however, let alone garbage cans for non-systematic collection. Other companies in German-speaking Europe such as Berlin's Lutocar and J. Ochsner of Zürich served pre-World War I private and municipal collection service clients, and post-war companies, such as Hermann Franken A.G. of Gelsenkirchen, embraced the possibilities of manufacturing motorized collection vehicles.⁴⁰ One prominent firm, Peter Bauer Fahrzeugfabrik of Cologne, produced both street-cleaning vehicles and various "dust-free" waste pick-up wagons, selling them to cities like Cologne and Hamburg prior to World War II.⁴¹ These companies uniformly emphasized that their products allowed the adoption of a systematic

response to the growing waste problem that was hygienic, economical, convenient, and modern. They promoted a vision of the urban environment that was healthier, cleaner, and more aesthetically appealing, and as such they presage later concerns with environmental protection in some ways.⁴² They were not, of course, designed to reduce the amount of waste generated.

Disposal: Seeking Profits in the Reuse of Wastes

There were three principal approaches to the disposal of those wastes that were collected: dumping in the countryside (the most common practice, used by the Berlin collection firms and many others), incineration, and some form of salvage or “recycling,” each of which had advocates on economic or sanitary grounds.⁴³ Doctors and public health officials during the late nineteenth century preferred incineration, as pioneered in the 1870s in Britain (the destination of numerous German city government inquiry commissions after 1889), owing to its elimination of materials seen as key contributors to epidemic disease.⁴⁴

Incineration and Its Byproducts

In 1900, as today, there was controversy over the question of whether incineration plants helped solve the waste problem in a more useful and less destructive way than did dumps or landfills. Aside from their imputed sanitary advantage, advocates pointed out that incineration did not just “remove” garbage from space-deprived cities—or in reality, greatly reduce its weight and volume, producing air pollution in the process—but also generated useful byproducts.⁴⁵ Principal among these were energy and clinker to be used as building material, for instance in the construction of roads. The first incinerator in Germany was built in Hamburg in 1896, after the major cholera epidemic of 1892 had fast-tracked the movement away from countryside dumping. In Britain around the same time, emphasis shifted from incineration simply as a way of addressing the waste issue to generating electricity from the burning of refuse, with its relatively

high concentration of leftover coals; the first incineration plant in Britain directly linked to an electrical power plant was constructed in 1897.⁴⁶

The German plants under consideration at the time benefitted from being privy to these developments across the English Channel. The Hamburg city government discussions took into account the new plant's benefits of generating energy and clinker, although they tended to ignore the conflicting voices in the public discussion that argued that incineration wasted potentially valuable materials which could be removed and reused or employed as fertilizer.⁴⁷ Not all cities were equally capable of incinerating their refuse, however; Berlin had particular trouble owing to the low calorific content of the burned bituminous coal [*Braunkohl*] and the higher-than-usual levels of ash generated by Berlin residents, and other cities like Potsdam and Magdeburg faced the same problem.⁴⁸ Although the incinerators were municipal projects, city officials relied on entrepreneurial engineers, who had patented some four basic types of incineration facilities taking into account the specific needs of German cities (based in part on the calorific content of the refuse in these cities), for construction and operation of the plants.⁴⁹

Other processes were developed to increase the yield of useful materials from incineration.⁵⁰ The machinery manufacturer BAMAG-Mequin, which licensed the right to manufacture in Germany the proprietary system of the British company Heenan & Froude of Worcester—one of “the oldest and most widespread” systems, used in over one hundred locations in Britain alone—supplemented its incineration equipment with salvage or recovery systems in the 1920s.⁵¹ These included the magnetic separation of ferrous metals from the waste stream and forced-air separation of paper for recovery.⁵² The company targeted principally municipal governments, portraying “The Recovery of Household Waste as the Future Form of Waste Disposal for Middling and Large Cities,” in the title of a company booklet.⁵³ Like other

incineration engineering firms, BAMAG portrayed landfilling as outmoded, pointing out that it could lead to unsanitary conditions, vermin, and the spreading of disease, as well as the increasing costs of transportation to the countryside and the removal of such land from use for other possible purposes.⁵⁴ Explicitly placing the use of its system in the context of the movement toward “rational” management and efficiency of the 1920s, following the disasters of the war and the inflation, the company contended that incineration with materials recovery should take its place alongside other municipal facilities like gas, water, and electricity plants and sewage systems.⁵⁵ Conversion from basic incineration to this combined recovery process was the “modern” approach to incinerating wastes.⁵⁶

While granting that municipalities did not expect to profit from the services they offered residents, BAMAG advertised its waste recovery plants as capable of yielding income in the course of providing their key service—protection of public health.⁵⁷ Not only could the removed metals, rags, bones, paper and other materials provide “value” and contribute to controlling costs and making the city’s operations economical, but the removal of metal boxes and other metal items from the incineration portion of the process helped prevent unnecessary increases in the energy required for full incineration.⁵⁸ Like other sorting systems discussed below, BAMAG’s facilities used sieves, magnets, and air ducts for sorting purposes, but fittingly for an incineration engineering firm, the principal goal remained the preparation of the garbage best suited to burning.⁵⁹ The sorting operations could be adjusted to each city’s particular needs and to the characteristics of its waste (e.g., the quantities of various potentially recyclable materials and the unburned portions of coal in its ash), as well as to the desired number of operating personnel for those municipalities conscious of labor costs.⁶⁰ The company emphasized the output of the incineration process in steam for heating or electricity generation and in clinker for reuse in

building materials and road construction, as some 60-90% of wastes were destined not for salvage but for the ovens.⁶¹ BAMAG aimed to provide systems that generated income above the level of 15-20 tons of waste per day in cities with populations of thirty to forty thousand.⁶²

One especially enterprising engineer in Berlin in the 1920s, Kurt Gerson, made it his personal mission to improve on what he saw as the wastefulness inherent in generating only two main byproducts from incineration.⁶³ Gerson agreed with incineration's critics that the traditional procedure destroyed valuable commodities within the waste stream and yielded only expensive steam and equally expensive and unnecessary clinker-based building materials.⁶⁴ To solve this problem, he founded the publicly traded company Müllverwertung AG in Berlin in 1925, taking over the failed BEMAG incineration plant on the "Red Island" in Schöneberg in order to produce not only clinker and energy but what he called "Müllwolle" (literally, "garbage-wool") made from cellulose and animal fibers within the refuse gathered for the plant. Gerson had accumulated many patents over the years, particularly for mechanisms or processes designed to separate organic and nonorganic wastes. The organic, fibrous elements of the plant's waste input, when processed as "Müllwolle," could be resold for use in paper and paperboard making, lightweight building material (with cement), tar-based chemicals, and heating briquettes, while dust and ash produced in the process could be set aside toward inclusion in synthetic fertilizers or in macadam.⁶⁵ Gerson also aimed to produce a form of synthetic silk (*Kunstseide*) to be used for consumer products like women's stockings. Foreshadowing the ideas of a much later period such as Michael Porter's conception of "shared value," Gerson argued that economic value from waste could be captured alongside social gains by preventing pollution and damage to the human and natural environment. As he wrote in the company prospectus:

"The Gerson procedure signifies a refinement of the raw material known as garbage and up until now perceived as burdensome. All of the value contained in it is once more made

serviceable for the economy by a simple and, in comparison with incineration or other suggest[ed procedures] relatively inexpensive, technical means. A new economical solution is brought to bear on the whole municipal waste and sewage problem; river courses and groundwater tables are cleaned; garbage dumps disappear; and for small cities the usage of all municipal wastes offers the possibility of profitable industry.”⁶⁶

Gerson’s processes received the approval of other engineers as practicable and cost-effective, and the company operated throughout the rest of the 1920s, probably employing approximately thirty-five workers and a small office staff.⁶⁷ It is, however, unlikely to have achieved Gerson’s estimate of a 300,000-mark annual profit and return on invested capital of 40 percent. Despite widespread attention to the company in the Berlin newspapers in the late 1920s, the history of Müllverwertung AG during the following decade is unknown. Gerson was last heard from in 1933 and his control over the enterprise did not outlast the Nazi advent to power. Ominously, the same industrial site was occupied during the mid-1930s by a firm known as Aretz Faserstoffplatten GmbH, run by the chemist and Nazi party member Willi Aretz, which aimed to generate many of the same products out of city waste. Though praised by the Nazi press for his work in contributing to national recycling goals, the neighboring population (and even the neighboring power plant to which he sold energy from incineration) apparently complained about the intensifying pollution and odors. Aretz’s firm was mainly known for its attempt to make building board (*Bauplatte*) for construction and a product known as “Bodenkulturmatte,”⁶⁸ though the poor quality of the building materials produced may have been the main reason for the firm’s failure in 1937.⁶⁹

Müllverwertung AG was a full-blown recycler *avant la lettre*, but it was not the first. There were several types of salvage or recycling businesses which developed in the aftermath of the urban population explosion of the late nineteenth century. Some of these were entirely new, and some—such as the scrap trade and the fertilizer business—were ancient but saw large

changes in scale and organization. Although the value of urban wastes as fertilizer had declined by 1900, many farmers still used the old system.⁷⁰ The opponents of incineration, including farmers, protested that it robbed them of a principal source of fertilizer, and both farmers and the scientific community recognized that city wastes contained a varying amount of useful nutrients, especially nitrogen, phosphoric acid, potash and lime.⁷¹ But there were also efforts to provide new, more hygienic means of using waste for fertilizing cropland. One of these means was most popular in France. In Paris in the late 1890s, two firms (Société des Engrais Complets and Société des Engrais Organiques) were founded to produce more sanitary and more concentrated fertilizer through crushing and pulverizing semi-sorted municipal waste. Although these firms generated a product containing 7-10 kg of nitrogen, 6-8 kg of potash and 6-8 kg of phosphoric acid per 1000 kg of pulverized rubbish—by contemporary estimates approximately 15-18 francs per ton—the market price never allowed either firm to reach profitability without regular subsidies from the city of Paris. In part, this disconnect between a market price which fell as low as 1.5 francs per ton and the price of the equivalent amounts of these nutrients in other chemical fertilizers owed to the seasonal nature of agricultural needs for the product and the constant, year-round production of city waste. The pulverized product, however sanitized, did not keep for very long and created an odor which made long-term storage difficult.⁷²

Composting

Other efforts at waste disposal concentrated on composting rather than pulverizing. Popular especially in the Netherlands, where facilities were run by city governments and, after 1929, by a state-controlled joint stock company, the Vuil Afvoer Maatschappij (VAM),⁷³ composting also gained a foothold in Germany around the turn of the century. One of the

principal Berlin waste collection entrepreneurs mentioned above, Bruno Röhrecke, tested various crops of vegetables, grains and flowers on land fertilized with composted Berlin waste in the late 1890s.⁷⁴ In Cologne, an entrepreneur named Schleicher attempted to allay the sanitary objections to the use of waste fertilizers through chemical purification, and the farmers' objections to strewing sharp objects in their fields by removing the main dangers to farm livestock in a basic sorting process.⁷⁵ There were also wartime composting efforts; for instance, a facility was erected at Neumünster in 1915, which operated successfully for a decade and then faced decreasing prices as the fertilizing value of its product declined, leading it to go out of business in 1930.⁷⁶

One of the most successful efforts to use composted waste for farming owed not to the initiative of officials or those in the waste trade, but to the entrepreneurial farmer Arthur Schurig. Known as a restless innovator who experimented with crops and intensified mechanization wherever possible on his farms, Schurig took the unusual step of returning to urban waste fertilization—on a massive scale.⁷⁷ Starting in 1907, he purchased organic kitchen wastes from the Charlottenburger Abfuhrgesellschaft (a company discussed below) as the sole fertilizer for his estate in Etzin. Schurig's farms came to use some 20-25 tons of composted and uncomposted Berlin household refuse *each day* by the 1920s. He eventually owned or leased five agricultural estates, often including formerly unproductive sandy soil or moorland, and as he expanded, he also used unsorted, previously composted Berlin garbage to create a loamy surface on moor and sandy soil for later planting. Given the chemical composition (especially of ash) of this fertilizer, the reclaimed land was especially suited to certain types of planting, such as hemp and sugar beets. Schurig bucked the trend toward dairy and other animal-based farming in the area and became the largest vegetable producer in Germany, and supplier for much of Berlin.

Though it is unclear how long his farms continued to purchase and use Berlin waste after Schurig's death in 1932, the Nazi insistence on more intensive reuse of waste at the source, and their preference for using organic waste for pig-farming, led to a decline in the quality of the fertilizer delivered—as well as to a decrease in the quantity of scrap materials amidst the waste, whose collection and resale had formed part of Schurig's model for profitability.

Composting also attracted a few chemists, biologists, and engineers who sought to profit from their understanding of both agricultural science and the treatment of urban wastes. Franz Boerner Müllverwertung, for example, was established by the eponymous Dr. Boerner of Franz Boerner Chemische Produkte in the Prussian city of Breslau in the 1920s. Boerner sought to “completely solve the waste recovery question” while simultaneously improving agricultural soil through a patented chemical additive to waste-based fertilizers called Kulturin.⁷⁸ Sympathizing with critics of incineration, Boerner observed that focusing on production of agricultural fertilizers from waste would save the expense of adding extra coal to incinerators to deal with the large portion of household waste already constituted of ash, merely in order to gain costly clinker for building. Instead, he suggested employing a waste-sorting system of the kind discussed below, in which ash and other particulate matter in household waste was separated out, subjected to germicidal treatment, and enriched with his patented “Kulturin” to generate effective fertilizer.⁷⁹ “All the mysterious power of plant nutrients is concentrated in sifted household waste (fire ash and sweepings),” he wrote in his company prospectus, “and contains potash, bicarbonate of soda, calcium, magnesium, iron, manganese, sulfur, phosphorus, chlorine, fluorine and humus.” Kulturin was to be added at a ratio of about one unit to every 4-6 units of sifted household waste ash to kill any spoilage-causing parasites and fungi, after which the mixture could be plowed into any land to improve or fertilize it. Unlike other composting

advocates discussed below, Boerner did not combine the promotion of waste-based fertilizers with advocacy of organic farming and the protection of humus, arguing instead that Kulturin-enhanced fertilizers would *prevent* the spread of organisms like snails and earthworms in the soil, seen as pests rather than part of the soil ecosystem.⁸⁰ He did, however, make the argument common to most of these waste reutilization businesses that profitability could be combined with the solution of the waste problem and the “common good.” As he wrote to prospective investors and customers, “With a proper use of this household waste—salvage [*Verwertung*] for the common good of the German people and the agricultural economy[—]you will soon recognize that in offering a good fertilizer produced in this way, not only will the complete costs of municipal waste disposal be coverable, but also a considerable surplus (profit) will emerge and many workers will find employment and bread.” Like so many of those who promoted waste reutilization, he remarked that such profits represented “money which till now has been lying in the street.”⁸¹

Just over the German border with Austria, a limited partnership known as the Edaphon-Müllverwertung Commanditgesellschaft was established in Salzburg to utilize the patented composting processes of the biologist R.H. Francé, former director of the Biological Institute of Munich. Although little is known about the operations of this firm, which were conducted by Salzburg businessman K.F. Höller, Francé wrote and spoke widely on the need to make use of urban wastes in creating natural fertilizers for organic farming that preserved humus and soil biota endangered by modern chemically-intensive agriculture. Francé had established in the 1920s that it was not just bacterial activity but the activity of all soil organisms which enriched the soil with the requisite minerals for agricultural productivity and kept it aerated.⁸² By 1930 the company formed to utilize his patents was marketing a non-synthetic, sanitary and purportedly

“odorless” fertilizer to early organic farmers, which aimed to promote a regular nitrogen “cycle” through the right mix of soil-preserving organisms rather than by adding synthetic phosphates and nitrogen to the soil. Appropriate for farms, gardens, and orchards alike, the fertilizer was advertised with expert validations from scientific trials claiming a 30-100% increase in yield as well as faster plant growth, healthier plants, better tasting produce, and better fodder for animal raising.

The company claimed that economies of scale required factory production of composted material for the Edaphon fertilizer, as local composting could not suffice for large agricultural establishments. Edaphon’s method was to take in municipal solid waste, street sweepings, and sewage as its raw material; the product thus also “transforms garbage into something useful [*Nutzen*] and contributes to the cleaning of cities.” As the question of waste recovery (*Müllverwertung*) remained without adequate solution, the company promoted the licensing of its patents to local Edaphon plants, either for-profit or municipal, for fertilizer production that would also serve as a (partial) solution to the waste problem for many cities.⁸³ Assuming a waste input rate of 7,000 tons annually, a plant in an average German city would require one foreman and about 8-10 workers to service its sorting, sieving, transport and processing, as well as a clerical worker, a technical supervisor, and an office manager; if a licensee was to distribute the product, several sales representatives would be required as well.⁸⁴ Emphasizing that their product represented a scientifically tested, practically demonstrated way of “reforming” agriculture, the Edaphon boosters argued that the consequent opportunities for profit would be more “sustainable” the sooner production was undertaken, given the contemporary intensification of agricultural production during the 1920s. The most effective

form of organization would be a “great European concern,” but in the absence of heavy capital investment, individual plants would also be profitable.⁸⁵

The Edaphon company’s business plan rested on a number of assumptions. It assumed that governments wanted to promote the growth of agricultural production, and would consequently support Edaphon. It maintained that synthetic fertilizers were inferior to natural fertilizers, that it was an “open secret that the life in the soil is killed off by the exclusive use of artificial fertilizers.” Edaphon also argued that it could play a substantive role in the removal and reuse of city waste and sewage, which had remained an unsolved problem. The company proclaimed that ten years’ practical testing of Francé’s procedure and scientific studies had been conducted at the prestigious agricultural bacteriology institute at the College for Soil Culture in Vienna, which had proven its effectiveness. It maintained that the sorting out of valuable scrap allowed approximately 9% of total waste taken in to be resold, while the remaining 91% was purportedly usable under the Francé composting procedure. It was acknowledged that production costs for Edaphon fertilizer would vary slightly from city to city, but was asserted that they would lie in the vicinity of 20-25 Marks per ton, while a resale price of 36-40 Marks would still allow it to compete at a fraction of the price of synthetic fertilizer. This was said to allow a middle-sized city producing some 25,000 tons annually to cover its total waste management costs and still yield a profit. An additional benefit was that the agricultural produce of the surrounding area would be substantially improved by this cheaper and more effective organic fertilizer. The company offered to license the procedure to those wishing to try it out commercially, with Prof. Francé and his colleagues supervising and providing technical support. Indeed, Prof. Francé put his reputation behind the production process and the final product, and offered to provide quality controls and advertising promotions.⁸⁶

The company was still attempting to connect the waste problem and the need for organic fertilizing practices using composted waste during the 1930s and in the aftermath of World War II. Francé promoted his Edaphon plants to audiences in Salzburg and elsewhere, and succeeded in having the process implemented there, in Munich, and in Milan.⁸⁷ “Garbage is everywhere treated as an onerous waste; it forms a burden for the cities and a costly task,” he observed. But, he added, despite the various attempts of cities like Hamburg, Cologne and New York to simply dispose of the problem through dumping or incineration, “There is value in this garbage which one throws away, instead of reusing [*verwerten*] it and returning it to the economic cycle [*Wirtschaftskreislauf*].”⁸⁸ Coupled with waste sorting systems like those discussed below, the Edaphon process aimed to capture this value by improving the profitability of utilizing organic wastes apart from the more profitably recycled metals, glass, paper, rubber, and other valuable scrap materials.⁸⁹ For Francé, this usage of waste, and especially the preservation of the soil which would result, was a duty so high that it called for religious language and metaphors of rebirth and resurrection. City wastes were, chemically speaking, just as much a part of the natural cycle as those that remained on the farm; indeed, they must “be included in the cycle of composition and decomposition. Their comparison with the fertilizers of the farm’s own [internal] economy is therefore imperative and their orderly return to the soil a duty.”⁹⁰ The composted fertilizer product itself was advertised using language with a very modern feel; an advertisement from the 1930s testified that “Edaphon Humus Fertilizer is a pure natural product and contains no artificial chemical salts.”⁹¹

The environmentalist, even religious, discourse of Francé and Edaphon were echoed by the Danish engineering and machinery maker DANO Ingeniørforretning og Maskinfabrik, based in Copenhagen. From its founding in 1912, DANO principally manufactured furnaces or other

combustion equipment for multiple industrial uses, and it diversified into the production of equipment for waste incineration. However, over time the firm came to the conclusion, as it observed in a memo written in 1943, that “incineration of waste rested on an unhealthy foundation when seen from the perspective of local government or national economic considerations.” Incineration’s costs were too high and its byproducts also unduly expensive compared to other sources of energy and building materials. Instead, the firm looked to history. “Before the beginning of pronounced industrialization, household waste was returned to nature, and found thereby a use as fertilizer for the soil. Through industrialization, however, [household] waste is in its raw state no longer immediately usable for fertilizing. It became clear to us meanwhile that the only rational thing would be to find a solution to the waste problem which brought with it a return of the household garbage materials to nature, and we therefore set ourselves the goal of solving this assignment.”⁹²

Years of experimentation resulted in the “DANO-System.” The system began with separation of scrap materials such as metals, textiles, bone, and so forth, and then put through an “equalizer mixing silo” and a rotating “egsetor” [sic] which was apparently a grinder for reducing the compostable materials. After further processing, the end product, which represented 80-90% of the waste input by weight, was DANO compost, a “brown, granular, earthlike mass which fulfills the hygienic and aesthetic requirements which are set for the solution of the waste problem...” The company claimed that the construction and operation of the facility were both cheaper than that of incineration facilities, and that the compost itself had various uses in improving and fertilizing land, and in making sewage sludge usable for farming purposes. By the 1940s, the system was already in use by the communal governments in Gladsaxe and Esbjerg in Denmark, and was under consideration by multiple other city governments in the country,

while British and Dutch companies had licensed the necessary operating procedures and patents, and Germany's first such facility had already been built in Berlin-Spindlersfelde.⁹³

During the 1940s the Danish company positioned itself within the ideological context of Nazi Germany. A document on "Modern Perspectives on Waste Processing and Waste Recovery" situated the waste problem in the context of increasing concerns about hygiene and of the Nazi government's recent emphasis on the full recovery of useable substances from waste materials in the form of scrap. However the firm also positioned itself within the context of organic farming. Its publications warned that "continued and one-sided use of artificial fertilizer alone destroys the microbial life in the soil so important for plant growth." DANO compost, on the other hand, maintained "the right biological microbial life in the earth, such that it becomes particularly well suited for plant cultivation."⁹⁴ The company observed that the traditional "organic" fertilizer, horse manure, had become scarce under conditions of modern agriculture, while municipal solid waste was "an extremely difficult, unappetizing and unhygienic material to work with." In contrast, DANO compost was easier to work with and saved labor as well as unpleasantness. The environmental language was explicit: "The substances which are found in municipal waste derive originally from the earth. What is more natural than to bring these substances back to the earth, just as it occurs in nature's own household economy? It is precisely this which happens when DANO-compost is used." And the consumer was a socially responsible person: "When you use DANO-compost, you do yourself and society a service, since you are in fact a part of keeping your town clean and taking action in the fight against rats and flies—you are a part of solving the municipal waste problem in your town. And who will not take pride in being a part of making his town as clean, hygienic and modern as possible, when one can even benefit oneself directly and indirectly at the same time?" DANO illustrated its marketing

materials with striking visual depictions of the disruption of natural cycles by modern urban civilization and of the way in which DANO compost could restore harmony to the cycle.⁹⁵

Scrap

Sorting and re-selling useful scrap material was the basis both of the traditional scrap industry and of the new recycling plants which sprang up in various cities beginning in the 1890s. Like the waste-to-fertilizer industry, the scrap trade had ancient roots but underwent substantial changes in the late nineteenth and early twentieth centuries throughout western Europe and North America. Prior to intensive industrial production and technological changes in such scrap-using industries as steelmaking and papermaking, scrap had been gathered on a small scale by large numbers of scavenger firms and by peddlers trading new goods for rag, bone, old metal, and other worn-out objects from households.⁹⁶ Paris was famous for its “rag-pickers” or *chiffoniers*, gathering old textiles for use in the paper industry, but the trade existed even in the smallest localities. There were an estimated 7500 *chiffoniers* in the Paris of 1884, who formed a sort of open guild, and established procedures for sorting useful scrap from trash containers on the streets. Even more than in the organized sorting facilities we will discuss shortly, the health risks to these independent workers were very high, particularly from infected rags.⁹⁷

In Germany, such scavengers were known somewhat ironically as “*Naturforscher*,” or naturalists, and generally specialized in a particular product (rags, glass, bone, metal, etc.). As in Paris, they operated on the streets but also in dumps, where in some cases they were hired by small-scale entrepreneurs who leased the right to sort through stored garbage from the disposal firms.⁹⁸ In Vienna, such work tended to be carried out by women, who worked from six a.m. to six p.m. for low wages.⁹⁹ A contemporary expert on the waste industry, the Hungarian

businessman Etienne de Fodor, suggested in 1911 that independent sorting and resale had been replaced by a more organized, wage-based system, though the employers may themselves have begun as *Naturforscher* or peddlers as did many of the major scrap dealers in Europe and the United States.

The work was low-status and risky, and there were low barriers to entry, making it either a practice turned to in desperation, or an area where poor but entrepreneurial individuals could rapidly shape a successful business. In the United States the scrap trade from the last third of the nineteenth century was conducted mainly by immigrant firms, predominantly owned by Jews and Italians who faced prejudice and other obstacles to entering other businesses but wanted to work in independent, non-factory settings.¹⁰⁰ (In Chicago, the firm which would eventually become the industry-leading Waste Management, Inc. began as a Dutch immigrant business.¹⁰¹) This tendency to stem from a marginal or marginalized group held true in Germany as well, where scrap firms were often owned by Jewish minorities.¹⁰²

Although the industry continued to contain numerous small firms until at least the 1950s, scrap collection and dealing was powerfully affected by the pace and scale of late nineteenth-century industrialization, which led to the formation of larger scrap companies and more extended trade networks.¹⁰³ Technological changes in the paper industry in the mid nineteenth century allowed for rapid growth in productivity and a search among papermakers for ever larger quantities of cotton and linen rags, old paper, and other fibrous materials—eventually including wood pulp toward the end of the century when cellulose from wood began to replace rags as the favored input for the industry. Owing to inland transportation costs in the United States, a transatlantic trade in rags developed as the scale of manufacturing expanded; by the end of the nineteenth century, American papermakers were buying rags from Italy, Austria-Hungary,

Germany and elsewhere in Europe. Scrap metal was second only to rags in the late nineteenth century and soon grew to be the dominant branch of the scrap industry, as the open-hearth process allowed for higher temperatures in steelmaking which burned away phosphorus and other impurities and allowed for greater use of scrap iron (up to 90%) compared to the Bessemer process. Meanwhile, the demand for rubber to be used in the production of tires, machinery and shoes increased after the 1839 invention of vulcanization, and unvulcanized scrap rubber too increased in attractiveness for purchasing departments and thereby for scrap dealers. American firms like Goodyear and Hancock primarily used internally generated scrap. But rubber recycling collection efforts began at least by 1870 in the U.S., counting by 1915-16 some fifty large scrap enterprises, and large firms appeared in Britain, Germany and Denmark.¹⁰⁴

Scrap businesses were not always started by poor or marginal entrepreneurs; sometimes they developed out of existing merchant enterprises which became engaged in a sideline trade in scrap material. Such was the case for one of Denmark's biggest scrap businesses, then as now, H.J. Hansen A/S. Founded in 1829 as a small dry goods merchant in Odense by one J.J. Limkilde, the business prospered under his son in the mid-nineteenth century and began to carry on a trade in rags, bone, and scrap iron with its often rural customers.¹⁰⁵ Bought by H.J. Hansen in 1888 and taking his name, the firm quickly expanded its rag trade beyond exchanges with customers to buying from an army of small peddlers and reselling rags to Odense's Dalum Paper Factory, and eventually to other papermakers in Jutland.¹⁰⁶ As the number of firms making iron and other metal products in Denmark more than doubled between 1888 and 1897, to some 462, and Odense became the country's second major industrial city after Copenhagen, H.J. Hansen attempted to meet the expansion of demand for scrap, particularly after the mid 1890s. Expanding its industrial customer network into Germany, Norway, Sweden, and to a lesser

extent Britain, the firm met competition within Denmark principally from the two large Copenhagen firms Petersen & Albeck and Joseph Levin. Like all scrap firms, Hansen did well during World War I as prices of old metal shot up, and it weathered the dramatic drop in price following the war's end in part owing to its diversified product lines (having kept the dry goods business and expanded into the wine trade). By 1929, at the firm's hundredth anniversary, it was still the third largest scrap dealer in Denmark. As in the United States, the early days of low barriers to entry and a profusion of small firms had given way to a more oligopolistic setting in which the larger firms specialized in particular product lines and pursued large-scale contracts with their industrial clients.¹⁰⁷ The later 1930s and 1940s were a period of expansion for the firm, which benefitted both from Denmark's relative insulation from the world economic crisis and then again from the Second World War.¹⁰⁸ Crisis was rather good for the scrap recycling business.

In scrap metal particularly, some major corporations developed their own scrap divisions or subsidiaries, among them giant steel producers like Thyssen which treated the scrap business as an opportunity for vertical integration.¹⁰⁹ More easily recognizable as a modern recycling business was the subsidiary of the large family-owned Berlin/Essen chemical company Th. Goldschmidt, which in 1889 developed the "first technically practicable and economically exploitable method of the de-tinning of cans," allowing the firm to recoup the valuable tin used to coat the new packaged food products.¹¹⁰ A historian of the German waste trade, Köstering, argues that Goldschmidt's de-tinning business, like other early recycling efforts, owed its existence solely to economic rather than ecological reasoning. It first used electrolysis in a process patented by the chemist and partner Hans Goldschmidt, requiring a great deal of electrical power, and after 1905 the firm switched to a second process involving chlorine which

first made large-scale can-processing possible. Despite the dangers of toxicity in the latter process—recovered tin could not be used in cans, and caused a number of injuries and illnesses at the firm, including among the Goldschmidts themselves—this second process was used until 1943. The firm became a multinational owing to its need to secure a supply of used cans sizeable and steady enough to make mass processing possible, expanding to London, Paris, and Glasgow and operating purchasing networks throughout western Europe and the United States. Unlike other scrap businesses, world wars were very difficult for Goldschmidt AG (it became a publicly traded company in 1911) because of the complete disruption of its international purchasing networks; its Essen de-tinning facility was also destroyed in 1943. But the de-tinning subsidiary was also protected from the large price swings which threatened other scrap businesses because it was part of a large diversified firm. It was able to ride out the first net losses in the 1920s as secondary metal prices dropped and as concerns about the potential exhaustion of tin mines in Bolivia and Indonesia led can manufacturers to redesign their product and reduce the amount of tin used, causing Goldschmidt to redouble its efforts to expand its supply networks for used cans. De-tinning remained profitable for the firm until the 1980s, when high shipping costs and the ever-diminishing quantity of tin in cans and containers caused it to shutter the Essen facility in 1989.

Sorting Facilities for Salvage or Early “Recycling”

Firms like Goldschmidt, or Schurig’s agribusiness, which did not do their own direct scrap collection, relied on others to provide them with the right sort of materials. The newest types of firms in the recycling industry around 1900 were those which became involved in the large-scale collection and sorting of waste. Naturally, there are parallels between these firms and

the expanding scrap businesses we have discussed. However, they took their cue from the need to process waste as a quasi-environmental problem of pollution in the cities as much as from a desire to increase economic efficiency—though they still aimed to produce a profitable business model in doing so, a goal which nevertheless remained elusive.

Perhaps the first such facility in the world began operating in Hungary in 1895.¹¹¹ Budapest's city waste collection had been municipalized, but much of what was gathered found its way to the privately owned sorting facility originally on the outskirts of the city. Run by Lajos Cséry, the firm obtained a contract with the city of Budapest that was to last until 1912.¹¹² The Budapest sorting plant received the city wastes by means of closed horse-drawn carts whose containers could be removed by an electric crane and dumped into collecting pits. A freight lift then raised the collected wastes into the plant, where a bellows removed much lightweight material such as paper and straw. The waste was then sent through a turning, cylindrical sieve which mechanically sorted out the finer components such as ash and dust into bins underneath. Larger remaining materials passed along a conveyor belt through the sorting rooms, where workers (many young, many female) sorted out bone (200 wagons' worth per year), rags (80 wagons), paper (50), various scrap metals (50) and some ten wagons' worth of other materials such as rubber and cork into baskets. The plant sold the sorted kitchen scraps as fertilizer, generated its own energy from incinerating some of the fibrous material, and fired the locomotives used to transport the recovered items for resale using recovered coals.¹¹³

In Germany, a comparable facility was built in the Munich suburb of Puchheim in 1898, with what contemporary commentators agreed were better sanitary conditions for the workers.¹¹⁴ Hausmüllverwertung München GmbH began to receive trainloads of Munich refuse in 1898, with the tally running to two trains daily of 30-40 wagons' worth. The operating procedure was

similar to that in Budapest, using pre-sorting by sieve and then hand-sorting on conveyor belts, though the facility included some (rather primitive) sanitary improvements for the forty or so workers in the sorting hall. Unlike in Budapest, an active ventilation system with fans removed some of the worst of the unavoidable odor; workers were provided with uniforms and gloves which were washed and disinfected once per week, while employees were required to bath at least twice a week; the floors were disinfected twice daily; and an infirmary reported that no outbreaks of infection had occurred during the first decades of the plant's operation. More so than in Budapest, the recovered materials themselves were treated and disinfected before being resold, particularly bone, rags, paper and glass. Kitchen garbage was boiled and used as fodder for the firm's own piggery. Although the plant burned down in 1901, it was rebuilt and the city of Munich, pleased with the service, renewed its contract with the company several times. Financially, the firm was dependent on the payment of a subsidy from Munich amounting to 15.5 marks per 6.4 ton wagon of refuse (somewhat less than half of which went to cover transportation costs). The resale of the recovered scrap accounted for about three quarters of the cost of wages, quite aside from overhead. The firm also earned regular income from its own agricultural operations (the piggery and the use of remaining waste for the build-up of moorland).¹¹⁵ This operation was to all appearances the most successful of the early recycling facilities in Central Europe, lasting until World War II.¹¹⁶

Berlin, too, saw interest in establishing enterprises to sort and separate wastes in order to recycle them for use as resources. In 1910, investors promoted the MUK-Aktien-Gesellschaft by placing emphasis on the inevitably declining landfill space near major urban areas, the expense of transportation ever further from the city, and the general health and hygienic considerations requiring its removal from occupied areas. Open dumps and landfills, exposed to wind and

weather, not only took up increasing amounts of space “but also devalue[d] [*entwerten*] the surrounding terrain as much for housing as for farming.”¹¹⁷ MUK’s business model relied on the generation of two main byproducts from processing municipal solid waste: artificial heating “coals” or briquettes, and fertilizer powder, according to two patented processes, and the presumption that there would always be a ready market for their further distribution in the immediate vicinity of large cities.¹¹⁸ The fertilizer products were tested successfully on farms near Berlin for two years and the results reported in the scientific press, while the company expressed perhaps undue confidence in the conviction that there would always be a market for the glass, paper, metals, porcelain, and bone that it sorted from the waste stream. The remainder could be burned to produce energy or rendered harmless and low-volume for burial. Acknowledging that other such enterprises had struggled to profit under conditions of free competition, MUK actively sought out city government favors including guaranteed concessions, appropriate terrain for plant, and a monetary payment for taking the waste.¹¹⁹ Indeed, the company had high ambitions which were not to be fulfilled: it aimed to spread its operations quickly throughout Germany and then internationally, explicitly seeking monopoly status in urban waste management.¹²⁰ In Berlin alone for 1910, it sought a market capitalization of 1.2 million marks, and estimated gross margins of nearly 35,000 marks.¹²¹

Sorting facilities were not the only enterprises which aimed to solve the waste problem through reuse; collection firms, too, became involved in a several cases.¹²² Among the Berlin collection enterprises discussed above, Staubschutz GmbH sought early on to provide salvage or recycling services for both agricultural and industrial reuse of wastes. Using sieves to separate the dust and ash from the larger items, as in Budapest and Munich, the company also more innovatively added forced air systems to further remove ash and collect it, after which the

remaining waste was sent through a steam chamber for disinfection. Workers specializing in particular products (bone, metals, rags, glass, corks, paper, etc.) then processed it as it passed by on conveyor belts, while an air circulation system partially improved conditions for them, and organic wastes remained on the belt for final collection and agricultural use. The company emphasized that its disinfection process differentiated it from other contemporary sorting systems.¹²³ Compared to competing disposal solutions, such as incineration, the company claimed to base its salvage efforts on the “economically most rational foundations” and use the simplest, most proven methods, allowing it to provide the best solution for the intensifying urban waste problem, and to receive the active approval of the German Agricultural Society.¹²⁴

Over a decade later under threat of war in 1914, the WBG undertook an exploratory study of waste recovery based on a bipartite source-separation system (*Zweiteilungssystem*) that would keep food wastes separate from all other forms. Separating the Berlin market into two categories—the city itself (about 30,000 properties and two million residents) and greater Berlin (60,000 properties and three million residents)—the firm estimated the costs for special collection of kitchen wastes twice, three times, and six times per week, ranging from a low annual figure of 53,000 marks for Berlin alone twice weekly to a high of 1,210,000 marks for greater Berlin six times weekly.¹²⁵ Such a system would allow the collection of food wastes needed for animal fodder under conditions of blockade, and indeed the war years did see it carried out in various locales.

BEMAG in the early 1920s thus had reason to look beyond its remit for the collection of the city’s wastes to see “its principal task in the disposal of waste hygienically and cheaply for the general public, and to create from these waste materials the greatest economic value possible.”¹²⁶ Attempts were made to introduce the creation of heat and electricity, fertilizers, tar

products, and building materials from the wastes, and they were seen as practical efforts to ensure both the greatest profitability of the firm's services to Berlin residents and to respond to the consensus opinion within "expert circles" that "high-grade products are contained in the waste, which must be made usable for the economy."¹²⁷ Although the recycling or salvage (*Verwertung*) efforts were in the initial stages in the early 1920s, BEMAG's test runs were promising, and with the limited space available around the city for economical disposal, the salvage efforts were seen as holding great possibility. The capital city's waste monopoly came to regard the extension of Berlin's experience with collection and with salvage throughout Germany as an "unconditional necessity."¹²⁸

Source Separation: Carl von der Linde and the Charlottenburger Abfuhrgesellschaft

All but one of the companies which institutionalized salvage efforts as part of the management of urban wastes prior to World War I adopted a single-stream approach, using machinery to separate useful items from one another after they were collected from households. The exception lay in the sizeable and wealthy Berlin suburb Charlottenburg, then with a population of about 250,000. Following earlier developments in the United States,¹²⁹ the city hired the firm Charlottenburger Abfuhrgesellschaft (CAG) to introduce the "*Dreiteilungssystem*" or three-way source separation system for the recycling of household wastes.¹³⁰ After some experimentation from 1900 onward showed the adequacy of the system, city government officials were persuaded that a source separation and recycling system was to be preferred to any other method of waste management because it appeared to offer the best chance of recovering valuable materials from the waste stream and thus achieving efficiency. The system worked as follows: citizens were obliged by city ordinance to separate their waste into the three categories

of dust and ashes, garbage (organic waste, including animal and vegetable matter), and dry, bulky rubbish which was potentially commercially reusable. CAG provided residents with three corresponding bins in apartment house courtyards, or a tripartite container for an individual household complete with removable sacks, which was manufactured by Schmidt & Melmer. These wastes were collected by separate carts at least weekly, and taken by train either to a dump in the case of the ashes, or to the company sorting facility in Seegefeld where the rubbish was further processed much in the manner of the Munich-Puchheim facility. The firm owned its own piggery, for which it boiled the organic matter; it resold useful scrap materials and incinerated the rest for power generation.

The entrepreneur behind CAG, Carl von der Linde, wrote about the waste business and about his own firm, and it is worth examining his thoughts as a window into the motivations of those who sought to recover value from waste. Von der Linde saw his venture as a means of husbanding scarce resources and opposing disposal practices that gratuitously wasted postconsumer materials, and he shared with younger peers like Kurt Gerson a mix of economic, social, and incipient environmental goals. Like Gerson and others, he sought to find an effective solution to the increasing trash problem; to ensure that the solution avoided wasting perfectly good materials; and to provide service that was *both* sanitary (“hygienic”) and economical. He coupled these views with a strong dislike of incineration as wasteful.

In a pair of pamphlets from 1902 and 1906, von der Linde showed himself to be aware, very early on, of the environmental damage to ground- and surface waters and to human habitations caused by dumps, and concerned about the ways in which urban life had separated city-dwellers from the more “natural” conditions of the farm. He remarked on the potential danger of “contamination of the groundwater” from the use of city wastes to fill or “improve”

lowlands.¹³¹ He condemned ocean dumping first for being unsanitary, then for the “pollution” (*Verunreinigung*) of the water and the “disfigurement” (*Verunzierung*) of the coast.¹³² In discussing the reasons he advocated the *Dreiteilungssystem* (hereafter DTS), he observed that one of its advantages was the ability to bury the ash and dust that has been pre-sorted from the organic matter or garbage in pits outside of the cities, without raising concerns about vapors (*Ausdünstungen*) or about “water contamination.”¹³³ Finally, he emphasized the “natural” credentials of the DTS: far from being novel and untried, it was in fact akin to the way all people had handled their waste before living in the artificial environment of the *modern* city, and was in line with what contemporary farmers continued to do. On the farm, the three waste categories were never mixed but always kept separate for their proper uses.¹³⁴ And even in the city a version of this system lasted as long as there were economic reasons for household-based separation of wastes: that is, so long as waste-users or carters such as farmers, rag-pickers, or even milkmen collected it from households for free, the traditional separation continued.¹³⁵ In the modern city, with no household animals, huge apartment complexes, and city waste removal fees, there were no longer reasons for the former separation practices, and “in a relatively short time people have gotten so accustomed to this thoroughly unnatural condition that today in many circles one hardly considers a return to the old, well-tried and tested separation system to be viable.”¹³⁶

Von der Linde’s major motivation was not pollution prevention or concern over urban lifestyles, however, but finding ways to prevent the waste of resources that were mistakenly regarded as useless, much like the chemist tasked with finding all possible uses for byproducts of existing processes—a heroic figure in the Germany of his day to whom von der Linde made an explicit appeal.¹³⁷ Germany in particular must learn to depend on an intensive use of its *own*

resources, he believed, rather than (for example) on colonies, and waste was one such resource, useful for fodder, various industrial employments, and fertilizer.¹³⁸ The DTS allowed for the return of all such resources to those who could best use them. After listing the destinations of major components of the waste stream (paper and rags were sold to papermakers, glass to glassmakers, metal containers to chemical companies like Goldschmidt where they were de-tinned and iron was melted down; whole bottles were collected and returned to consumers; old leather went to fertilizer producers), he concluded, “Thus each product finds its interested party, be it only for combustion for the production of energy.”¹³⁹ He did not at all ignore the public health and hygiene concern of the time, however. Indeed, he emphasized the benefits to health that arise from avoiding the mixing of wastes and the putrescence such mixing produces in otherwise unobjectionable items, and observed that the extra incentive given the private entrepreneur by the possibility of reselling the separated organic matter as fodder would induce him to move the waste faster and more effectively, preventing offense and health hazards.¹⁴⁰ In fact, balancing health or hygiene and the preservation of economically valuable materials was von der Linde’s stated goal, and he pointed to the project already underway in Charlottenburg to portray this balance as anything but utopian.¹⁴¹

Von der Linde’s business case for CAG and its source separation system depended at least as much on showing the inadequacies of the alternative systems of waste management, in the areas both of health and economic sustainability, as it did on providing positive indications that the DTS itself could function, however. Though generally positive toward the most traditional system, the collection for agricultural use of city wastes, he pointed out the high and increasing incidence of broken shards, paper, rags, boxes, etc. as an impediment to effective use and to farmers’ demand for waste.¹⁴² Although this approach—still around 1900 the preeminent

solution in France and most other European countries aside from Britain—had been subject to hygienic objections, von der Linde argued that these objections did not require abandoning agricultural use of waste so much as abandoning the unhygienic ways of treating it prior to its direct application as fertilizer and for improving swamp or marshland.¹⁴³

Some entrepreneurs, he recognized, had attempted to remedy the first problem with agricultural usage (that of sharp and bulky objects) at the same time that they tried to resell the other useful goods to be derived from the total waste stream, by operating sorting facilities on the Budapest-Munich model. Generally, however, he argued that the cost of sorting made the “purer” waste for agricultural use expensive enough that it could only be employed in the general vicinity of the plant because the subsequent additional transportation costs raised its price to unprofitable levels.¹⁴⁴ The sorting systems in general, though preferable to incineration so long as sanitary conditions were properly considered,¹⁴⁵ were altogether too uneconomical, however, even aside from the attempt to produce marketable fertilizers. Both because the rag-pickers generally removed the best wastes prior to collection, and especially because only some 12 percent of the total waste stream was constituted of recoverable materials after removal of ash and garbage while 100 percent of it had to pass through single-stream collection and processing, dirtying the recoverables and breaking some of them along the way, single-stream systems had never been able to operate without substantial subsidy.¹⁴⁶

Incineration, meanwhile, received von der Linde’s intense opposition. In 1902, while CAG was still very much in the experimental stage, he observed that a city’s selection of incineration was complicated by the substantial differences in composition among cities’ wastes, by having the highest costs of all the procedures, and by the concerns expressed by some “economists” that valuable material was irremediably destroyed in the process.¹⁴⁷ A few years

later, von der Linde had evolved into an active opponent of incineration, as he flatly stated, calling it the “barbarism of destruction.”¹⁴⁸ He insisted both that it was uneconomical and, rejecting the usual claim that incineration was the most hygienic procedure, that it *created* health problems. No private business, he observed, had by itself successfully carried out an incineration operation across a period of years; instead, they merely sold equipment and whole incineration facilities to municipal entities which were not compelled by the market to cover costs.¹⁴⁹

He was particularly intent on dismissing the claims made for energy recovery: if, he argued, the incinerator in the wealthy city of Wiesbaden, with its higher calorific trash content, was unable to produce the amount of electricity claimed by major incineration proponents, then surely other cities with less energy-rich wastes would fail to cover their costs through energy recovery.¹⁵⁰ Advocates of incineration had taken to calling it a form of recovery or recycling (*Verwertung*), he observed, prefiguring later twentieth-century debates, but for von der Linde such claims were illegitimate so long as incineration either required subsidies or preserved less “value” than what would be preserved by the same amount of waste used more efficiently for agricultural purposes.¹⁵¹ He attributed the success of the incineration method in Britain to the general prosperity of its cities, to the greater quantities of unburned coals left in British waste, to the relative backwardness of the methods of employing waste in the competing use of agriculture there, and finally to the marketing skills of the incinerator producers.¹⁵² Despite the common suggestion that incineration was the most hygienic practice, he argues that it was in fact dirtier and more hazardous to health than other methods, not just because of the air pollution it generated but because of the fact that the facilities were located *within* the cities and, when not in operation, garbage piled up around them closer to population centers than it did outside the city

in the countryside.¹⁵³ The fear that wastes used agriculturally would spread contagion outside the cities during an epidemic (which had been the reason behind Hamburg's adoption of incineration in the 1890s), could be put to rest according to von der Linde by the proper use of disinfection, removing a major health rationale for incineration proponents.¹⁵⁴

Von der Linde's confident predictions that his own method would need no subsidies were not borne out in practice when his company passed from the experimental stage to full-scale operations. He had the support of the local community, and a citizen group called the Verein für Gemeinnützige Abfallverwertung, which was a 30% shareholder in CAG, conducted extensive public relations work through brochures and newspaper articles aimed at persuading residents to sort their trash, instruction in schools, and even by providing tours of the facility in Seefeld. But even so his vertically integrated firm's high hopes were met a raft of challenges which prevented it from ever reaching profitability.¹⁵⁵

In its early experimental days, the firm's operations seemed to bear out von der Linde's convictions. The company recognized from the outset the problem it would face in persuading those who handled urban households' trash (primarily servants and housewives) to separate their household wastes. In the absence of the municipal ordinances requiring separation which obtained in New York under Col. George Waring, therefore, von der Linde attempted to promote separation indirectly in his sample of about 500 Charlottenburg residences by offering small payments for separated wastes to the porters of large apartment buildings.¹⁵⁶ He lobbied the city government to pass ordinances or differential fees for removing un-separated and separated wastes, as these could level the playing field with other waste companies that did not recover value from the waste stream. But while waiting for success on this front, the payments to porters worked reasonably well, and the company also made efforts to ensure that its receptacles were

handy and aesthetically pleasing to maximize their use by residents.¹⁵⁷ Initially, the company aimed to recycle only the dry rubbish (the standard scrap goods), which was easier to put back into immediate industrial use, but success with these products induced CAG to collect and recycle the animal and vegetable matter as hog fodder.¹⁵⁸ Although the facility which organized the pre-sorted wastes was operating successfully and employing 60 people in 1902, according to von der Linde, it burned down in 1904.¹⁵⁹

During the experimental phase of the CAG's operations, von der Linde observed that there were households that made no objection to separating their wastes, but only as long as the proceeds from the collection and processing were directed not to the apartment building porters or to the company but to the "common good." Consequently the Verein für gemeinnützige Abfallverwertung (Association for Non-Profit Waste Recovery) was set up in 1903, possibly by von der Linde, and this organization contracted with the CAG to receive a set amount (on the order of 15-25 Pfennig (cents) per hundred pounds of wastes collected) in exchange for taking over supervision of the "agitation for separation and oversight over its proper execution," as mentioned above.¹⁶⁰ When the city of Charlottenburg selected the CAG to run its entire waste management operation beginning April 1, 1907, the wholly owned subsidiary which processed the separated wastes was known as the Allgemeine Müllverwertungs-Gesellschaft m.b.H.¹⁶¹ The contract was to run for fifteen years, while the city retained the right to supervise all operations, and the company was obliged to put aside a high deposit of 200,000 marks against the possibility that it did not fulfill its obligations. These obligations were, in general terms, the exact execution of the system as described, including the provision of the tripartite bins, regular pick-up service and objection-free disposal, and keeping the infrastructure sanitized and intact.¹⁶² In return, CAG

received its desired monopoly status as residents were required by police ordinance to use the DTS and therefore to separate their wastes in the home.¹⁶³

More trouble than a fire was in store, however.¹⁶⁴ Although the prospectus for 1908 expected a profit of six hundred thousand marks, in fact the firm was nearly five hundred thousand in the red, a situation which worsened by about fifty thousand marks the following year, forcing the city to raise its collection fees for residents and to offer the firm a guaranteed interest rate on its debt. Some of these early woes owed to unexpected circumstances: the rail line to the sorting facility was not completed on schedule, requiring expensive cart transportation for a year and a half; and the first year saw a very high rate of death among the company's pigs, which frequently ingested needles, glass, and pottery shards inadvertently left in the food matter used to feed them. Von der Linde had emphatically denied the existence of this problem,¹⁶⁵ but it persisted. The latter problem indicated one of several structural difficulties, namely the need to change the cultural norms that governed household waste disposal: residents sometimes resisted sorting in the home or did so in an ineffectual or haphazard manner. Even if this cultural problem could be solved, the costs of running three separate collection wagons made Charlottenburg service the most expensive in Germany. Ultimately, moreover, it seems that not enough waste was generated in the city confines to make the costs of the collection and sorting profitable, raising an intriguing problem about the relation of the recycling industry and the volume of consumer wastes. With the help of subsidies from the city, the firm survived well into World War I, during which it was feted as a model contributor to the cause of extending the usefulness of scarce resources. Nonetheless, the withdrawal of most of its man- and horsepower during the war caused the company to close its doors in 1917.¹⁶⁶

Recycling during Wartime and in Nazi Germany

CAG was the best known of the firms which introduced source separation of household wastes, though there were efforts to introduce a “*Zweiteilungssystem*” or dual sorting system in Potsdam and in Hamburg, and as we have seen, the WBG studied the possibility in Berlin.¹⁶⁷ During the First World War, a federal regulative ruling permitted state and municipal governments of a certain size to require separation of organic food matter and other kinds of refuse as a means of ensuring provision of animal fodder under the Allied blockade. Only the state of Hesse formally did so by 1916, but an effort in Hamburg was spearheaded by a private entrepreneur, the engineer Simon Gumpertz, who founded the firm *Hamburger Abfallverwertung* (HAV). Beginning in April, 1915, HAV contracted with the city to collect household wastes separated by the citizens into organic and other wastes. Despite difficulties due to the declining caloric value of household waste during the hard years after 1916, the firm survived until 1922. But it was ultimately felled by increasing costs during the hyperinflation period, by competition from other collection firms not as heavily regulated by the city, and by decreasing willingness of consumers to separate their wastes once the peacetime conditions no longer made such practices seem like a patriotic duty.¹⁶⁸

Recycling did not disappear from the scene during the 1920s; as we saw above, there were continued efforts such as Gerson’s *Müllverwertung AG*. Nonetheless, there appears to have been a certain parallel with the later postwar period of the 1950s: increased consumption and increased dumping of the refuse it generated. In the German case, the story of European recycling received a unique twist in the 1930s owing to the Nazi regime’s commitment to intensifying domestic reuse of waste materials in the course of its efforts to promote national autarky and preparation for war. Although the regime advocated a certain vision of

environmental protection,¹⁶⁹ the principal study of its impact on the secondary materials and waste management sector concludes that the “driving motive [for intensified recycling] was the improvement of the raw material situation in the German Reich, not environmental protection.”¹⁷⁰ The Nazi state did not nationalize the scrap industry or other recycling businesses, but after 1936 it controlled them to such a degree that business conditions radically changed even before the start of World War II. Although it appears that there is no evidence for the contention that scrap firms owned by Jewish Germans were confiscated especially early compared to the “aryanization” of other sectors,¹⁷¹ when Jewish ownership of businesses was banned, major gaps opened up in the personnel and especially leadership of a sector the Nazis considered essential.¹⁷² Because of the importance of the scrap business to the rearmament program, the party deferred slightly more than usual to industry expertise: it employed its customary expansion of bureaucratic controls, but without putting state officials or Nazi party members in charge of confiscated businesses, and the state in fact extended some economic protection measures intended to secure the sector’s survival. Be that as it may, the industry was largely reorganized by administrative command. Aside from the expulsion of Jewish and other “undesirable” workers, the largest changes occurred under the “Four Year Plan” of 1936, and involved the official designation of a local monopoly collection area (*Pflichtsammelbezirk*) for each small firm or individual scrap dealer substantial enough to secure a living for the firm’s employees, who were required to ensure the “complete” return of old material to new uses within their territory. Those operating within the monopoly area had to visit its households during the first ten days of each month and pay for scrap there at state-set prices, after which they were allowed to expand beyond their local territory to the surrounding 50-square-kilometer area during the remainder of the month. Larger firms were required to buy from these local or

smaller dealers, though they were also allowed to have their own employees collect under the same regulatory conditions. The bureaucratic nightmare of this intensive regulation led to many disputes about the borders of firms' areas of operation, and to disconnects between supply and demand. By 1939, the head of the waste management regulatory agency confessed that only the scrap metals and rags were being used adequately, while much collected paper and bone was lying unused and spreading disease instead.

During the war itself, there was at first a relaxation of efforts to collect scrap as Nazi victories abroad generated a steady stream of plundered material.¹⁷³ However, as the army's advance was checked and Allied air attacks began to take effect, a renewed urgency for intensified recycling led to further attempts to increase control over the scrap industry and to maximize its efficiency. The Nazi leadership attempted to generate efficiencies through organizing the larger companies into a close alliance with a common policy, forcing them to share patented technologies and processes and trade secrets with their former rivals, and promoting a sole focus on materials useful to war production. Because of the lack of adequate labor, the Nazis tried imposing forced labor obligations on Jews and on convicts, and also famously initiated a successful campaign of child labor by organizing schoolchildren to take over visiting residences for scrap sales and all manner of scavenging, including in dumps. Moreover, beginning in 1937, all households in cities of more than 35,000 people were required to sort their wastes according to a *Zweiteilungssystem* intended for the use of state-run piggeries to ensure the meat supply; compliance was ensured by police surveillance more intrusive than in pre-World War I Charlottenburg. Since this was a state program, firms already engaged in organic waste recycling were put out of business and their employees had either to join the program or find

other work. With veterinarian monitors employed as well, the project appears to have been a success; the Nazis were good at feeding pigs with garbage.¹⁷⁴

Conclusions

This working paper has shown that German and other European entrepreneurs built substantial businesses which aimed to achieve “shared value” by making positive social and environmental contributions to their societies. Some of these entrepreneurs had strikingly modern views of environmental challenges and they prefigured many later twentieth-century recycling processes. These businessmen were neither conservation activists nor could they have benefitted from re-branding or greenwashing their businesses as environmentally-friendly in the century before mass public engagement with environmentalist ideas. Instead, they were driven by a desire to keep city and countryside healthy and unpolluted, and to avoid the gratuitous waste of resources. At the same time, the profit motive encouraged technological innovation, a major ideal of capitalist enterprise, and left a legacy of scientific and engineering knowledge of waste materials and their processing and utilization which benefited later recyclers.

The entrepreneurs’ goals were thus both economically- and socially-minded in an era when Central European chemists became folk heroes for finding better uses for wasted byproducts of industrial processes and thereby creating both health and wealth. Neither the small-scale independent waste carters, scrap dealers, and peddlers of the nineteenth century, nor the integrated multinational waste management companies of the late twentieth century, these firms represent a neglected stage in the evolution of business responses to the waste problem—in terms of scale, diversification, the involvement of scientists and engineers, and the social and environmental motives of their founders.

In an era of municipalization, these entrepreneurs demonstrated the potential for fruitful interactions between business and city government. For public authorities and citizens looking to reuse their wastes and to recover some of the cost of providing municipal waste services, they offered a variety of alternatives appropriate to cities' differing waste streams and preferences. At the same time, they benefitted from municipal legal ordinances which created the conditions for new entrepreneurial endeavors which would not otherwise have been profitable. For instance, although businesses might have been able to provide "dust-free" collection service in a technically successful way prior to 1895, and many contemporary city-dwellers no doubt wanted a cleaner and healthier urban environment, the public-good character of the latter would have made it difficult for any firm to have profitably supplied it instead of low-cost individual service that left dust and ash for neighbors and passersby. Such mutually beneficial relationships between firms and city governments did, however, sometimes lead to the reduction or elimination of competition, an outcome which raised few eyebrows in pre-1945 continental Europe.

These companies also drew attention to the challenges of achieving profitability in large-scale recycling. Entrepreneurs faced a difficult terrain when building their businesses. Despite their frequently collaborative relationships with municipal governments, they often struggled to survive longer than two decades in an environment of continuous economic and political upheaval. Although they paid low wages, these labor-intensive businesses were sometimes unable even to cover their variable costs. They encountered exogenous turbulence and shocks. Prices for recycled commodities were volatile, and these recovered resources often faced competition from virgin materials. There was a tension between the cyclicity of demand for recycled materials and the continuousness of waste production. While collection services had to

function at all times and for all waste products, the profitability of processing and reselling any given recovered resource depended on many factors, including the season, the point in the business cycle, the volume of salvaged material collected by competitors and scrap drives, and the availability of substitutes. This made the business difficult or uncertain without subsidies or guaranteed minimum prices, at least insofar as it was geared to fix the waste collection problem, and was one reason why some governmental actor often became involved. Governments, too, could be not only allies but competitors or threats. Entrepreneurs needed to negotiate contracts with local authorities, who sometimes replaced them entirely with government-owned entities. Although the state rarely involved itself directly in the waste problem before the last third of the twentieth century, wars depleted companies' personnel and assets and introduced new non-profit competitors even as they raised the prices of recovered resources. The Nazi dictatorship in Germany after 1933 removed waste businesses' independence and expropriated many of their owners while distorting scrap markets and reorienting the industry solely around war production.

Quite apart from the lack of sustained profitability, these enterprises were never a panacea for the waste problem from an environmental perspective. As critics have noted, there was a system-wide contradiction in the less conspicuously wasteful or polluting forms of the waste industry, such as incineration with energy recovery or even recycling. The entire waste industry depended for its profits on the capitalist system generating ever-increasing consumption and amounts of waste. But this was as true of incineration plants that required waste as fuel and recycling facilities that sought to reach profitability through economies of scale as it was of landfills. This fact has led environmentalists such as Barry Commoner to argue that truly effective solutions to the environmental challenges of capitalism rest on abolishing capitalism entirely.¹⁷⁵ Still, in the absence of such an unlikely outcome, entrepreneurs committed to

improving recycling processes and technologies have done much to reduce the sheer volume of postconsumer waste that is routed into landfills where it cannot be reused and where it will eventually leach into groundwater. And although the post-1970 non-profit community recycling centers, municipal collection programs, and recycling divisions of waste management companies provided the terminology and the ideology behind modern recycling, they owed their technological and organizational foundations to an earlier generation of profit-seeking engineers, scientists and entrepreneurs.

¹ Raymond G. Stokes, Roman Köster and Stephen C. Sambrook, *The Business of Waste. Great Britain and Germany, 1945 to the Present* (Cambridge: Cambridge University Press, 2014).

² The major works include Martin Melosi, *Garbage in the Cities: Refuse, Reform, and the Environment*, rev. ed. (Pittsburgh: University of Pittsburgh Press, 2005); Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000); Susan Strasser, *Waste and Want: A Social History of Trash* (New York: Metropolitan Books, 1999); and to a lesser extent (since it deals almost entirely with other areas of urban infrastructure), Joel Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron: University of Akron Press, 1996). On salvage and early recycling of waste, see especially Carl A. Zimring, *Cash For Your Trash: Scrap Recycling in America* (New Brunswick, NJ: Rutgers University Press, 2005); Daniel J. Zarin, "Searching for Pennies in Piles of Trash: Municipal Refuse Utilization in the United States, 1870-1930," *Environmental Review* 11:3 (1987), 207-222; and on agricultural use of cities' organic wastes, Richard A. Wines, *Fertilizer in America: From Waste Recycling to Resource Exploitation* (Philadelphia: Temple University Press, 1985).

³ Geoffrey Jones, “Debating the Responsibility of Capitalism in Historical and Global Perspective,” *Harvard Business School Working Paper*, No. 14-004, July 2013; Michael Porter and Mark Kramer, “Creating Shared Value,” *Harvard Business Review*, February-January (2011).

⁴ Municipality- and technology-focused histories of waste management include: Melosi, *Garbage in the Cities*, and H. Lanier Hickman, *American Alchemy: The History of Solid Waste Management in the United States* (Santa Barbara: Forester Press, 2003); on Europe, see Sabine Barles, *L'invention des déchets urbains: France, 1790-1970* (Seyssel: Champ Vallon, 2005), which despite its title does not venture much beyond 1920; Jeanne-Hélène Jugie, *Poubelle-Paris, 1883-1896: la collecte des ordures ménagères à la fin du XIXe siècle* (Paris: Larousse, 1993); Caterina Isabella, Giuseppe Rubrichi, and Franco Sensi, *Per una storia della nettezza urbana a Roma dal 1870 al 1960* (Gorle, Bergamo: CEL, 1997); Andrea Giuntini, *Cinquant'anni puliti puliti: i rifiuti a Firenze dall'Ottocento alla Società Quadrifoglio* (Milan: FrancoAngeli, 2006); Siv Sæveraas, *Fra boss til bruk: BIR 1881-2006* (Bergen: BIR, 2006); Hermann Josef Bausch et al., “Es herrscht Reinlichkeit und Ordnung hier auf den Straßen,” in *Aus 400 Jahren Geschichte der Stadtreinigung und Abfallentsorgung in Dortmund* (Dortmund: Entsorgung Dortmund GmbH, 2001); Alexander Schmidt, *Die Nürnberger Abfallwirtschaft und Stadtreinigung, 1899-1999* (Nürnberg: ASN, 1999); Ralf Breer, Stephan Mlodoch, Hanskarl Willms, *Asche, Kehricht, Saubermänner: Stadtentwicklung, Stadthygiene und Städtereinigung in Deutschland bis 1945* (Iserlohn: SASE, 2010).

⁵ Suellen M. Hoy and Michael C. Robinson, *Recovering the Past: A Handbook of Community Recycling Programs, 1890-1945* (Chicago: Public Works Historical Society, 1979); Melosi,

Garbage in the Cities, 221-222; Strasser, *Waste and Want*, Ch.3 and Ch.6, which also notes the salvage activities of large scrap-using firms; exceptions include Zimring, *Cash For Your Trash*, and now Stokes, et al., *Business of Waste*.

⁶ For this and the following criticisms, focusing mostly on the United States, see: Strasser, *Waste and Want*, 283-286, 292; Laurie Davidson Cummings, "Voluntary Strategies in the Recycling Movement: Recycling as Cooptation," *Journal of Voluntary Action Research* 6:3-4 (1977), 153-160; Harold Crooks, *Giants of Garbage: The Rise of the Global Waste Industry and the Politics of Pollution Control* (Toronto: James Lorimer, 1993); Adam S. Weinberg, David N. Pellow, and Allan Schnaiberg, *Urban Recycling and the Search for Sustainable Community Development* (Princeton: Princeton University Press, 2000); Heather Rogers, *Gone Tomorrow: The Hidden Life of Garbage* (New York: The New Press, 2005), esp. 157-158, 176-181; Samantha MacBride, *Recycling Reconsidered: The Present Failure and Future Promise of Environmental Action in the United States* (Cambridge: MIT Press, 2012).

⁷ In addition to the critics cited in the previous note, see Bartow J. Elmore, "The American Beverage Industry and the Development of Curbside Recycling Programs, 1950-2000," *Business History Review* 86:3 (Autumn 2012), 477-501.

⁸ Strasser, *Waste and Want*, Ch.1.

⁹ On city sanitation in Central Europe, see Peter Münch, *Stadthygiene im 19. und 20. Jahrhundert* (Göttingen: Vandenhoeck & Ruprecht, 1993), Part I; and the classic social-historical study of public health and sanitation in nineteenth-century Germany, Richard Evans, *Death in Hamburg: Society and Politics in the Cholera Years, 1830-1910* (New York: Penguin, 2005 [1987]), esp. Ch.2.

¹⁰ For Berlin, see Maria Curter, *Berliner Gold: Die Geschichte der Müllbeseitigung in Berlin* (Berlin: Haude & Spener, 1996), 19; for Hamburg, see Hildegard Frilling and Olaf Mischer, *Pütt und Pann'n: Geschichte der Hamburger Hausmüllbeseitigung* (Hamburg: Ergebnisse Verlag, 1994), 25; Evans, *Death in Hamburg*, 129.

¹¹ Evans, *Death in Hamburg*, 130-31.

¹² Schmidt, *Nürnberger Abfallwirtschaft*, 17.

¹³ Renate Rüb, "Müll und Städtehygiene um 1900," in Susanne Köstering and Renate Rüb, eds., *Müll von gestern? Eine umweltgeschichtliche Erkundung in Berlin und Brandenburg* (Münster: Waxmann, 2003 [orig. 1992]), 19-29, here p. 22; Frilling and Mischer, *Pütt und Pann'n*, 125. See also Camillo Popp, *Die festen städtischen Abfallstoffe* (Munich: Oldenbourg, 1930), 3.

¹⁴ Stokes, et al., *The Business of Waste*, Ch.1, suggests that most German cities municipalized waste collection, if not disposal, during the late nineteenth century. Many did so, including the cities they studied such as Frankfurt, Mannheim, and Dortmund. But the authors' intentional focus on large cities (see p. 14) creates a bias in favor of cities with municipal waste management, as small cities could not afford to provide services themselves. And even among large German cities, many, such as Berlin, Hamburg, Munich, Leipzig and Dresden, continued to contract with or simply allow private waste service providers during much of this period, while the private sector always provided service outside the central city even in those jurisdictions with municipal control.

¹⁵ Curter, *Berliner Gold*, 27; Ingrid Schmid, "Der lange Weg zur Kommunalisierung der Berliner Müllabfuhr," in Köstering and Rüb, eds., *Müll von gestern*, 31-38, here 31.

¹⁶ Frilling and Mischer, *Pütt und Pann'n*, 26; Evans, *Death in Hamburg*, 135; Bruno Röhrecke, *Müllabfuhr und Müllbeseitigung* (Berlin: Kommissionsverlag von R. Skrzeczek, 1901), 4-5.

¹⁷ Gottfried Hösel, *Unser Abfall aller Zeiten: Eine Kulturgeschichte der Städtereinigung* (Munich: Jehle, 1987), 201. In Nuremberg, two private firms were given the concession in the 1870s before the city municipalized the service in 1899: Schmidt, *Nürnberger Abfallwirtschaft*, 17.

¹⁸ Münch, *Stadthygiene*, 111. This is not altogether different from the American situation in 1880, when of 199 cities surveyed, 48 had a municipal system, 38 contracted with private firms, and 59 “left the responsibility to private parties,” as pointed out by Martin Melosi, *Garbage in the Cities*, 25.

¹⁹ This paragraph draws on Schmid, “Der lange Weg zur Kommunalisierung,” and especially Curter, *Berliner Gold*, 25-27.

²⁰ Stokes et al., *Business of Waste*, Ch.2.

²¹ Bibliothek des Umweltbundesamtes (Dessau, Germany), Sammlung Erhard, Sign. A 715. “*Staubschutz*” *Gesellschaft mit beschränkter Haftung: Förderung der staubfreien Verladung und Beseitigung bezw. Verwerthung von hauswirtschaftlichen Abfällen, Kehricht (Müll) und dergleichen* (Berlin, March 1900), 3.

²² *Ibid.*, 6.

²³ *Ibid.*, 4-6.

²⁴ Sammlung Erhard, Sign. A 747. IX. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1903*, 3.

²⁵ Sammlung Erhard, Sign. A 748. X. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1904*, 4-5.

²⁶ Sammlung Erhard, Sign. A 749. XVI. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1910*, 4.

²⁷ Sammlung Erhard, Sign. C V 13. XX. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1914*, 4.

²⁸ Sammlung Erhard, Sign. C V 14. XXI. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1915*, 1.

²⁹ Sammlung Erhard, Sign. C V 15. XXII. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1916*, 1.

³⁰ Sammlung Erhard, Sign. C V 17. XXIV. *Geschäftsbericht der Wirtschafts-Genossenschaft Berliner Grundbesitzer, e.G.m.b.H., für das Geschäftsjahr 1918*, 1-2, 6.

³¹ Sammlung Erhard, Sign. A 279. "Berliner Müllabfuhr, A.-G.," n.d. (ca. 1923), 4, attributes the WBG's failure directly to the inflationary spiral.

³² Stokes et al., *Business of Waste*, 7.

³³ Sammlung Erhard, Sign. A 279. "Berliner Müllabfuhr, A.-G.," 2-3.

³⁴ *Ibid.*, 3, 5.

³⁵ *Ibid.*, 5.

³⁶ *Ibid.*, 4, 6-7.

³⁷ Evelyn Hauser, "Berliner Stadtreinigungsbetriebe," in Tina Grant, ed., *International Directory of Company Histories*, vol. 58 (Detroit: St. James Press, 2004), 26.

³⁸ Hösel, *Unser Abfall*, 169.

³⁹ Frilling and Mischer, *Pütt und Pann'n*, 53; Stokes, et al., *Business of Waste*, 31-32, 61; see also <http://www.schmidtfamilie.de/linie-schmidt/schmidt-a-melmer>

⁴⁰ See the advertising materials available in the Sammlung Erhard, D II.

⁴¹ Frilling and Mischer, *Pütt und Pann'n*, 45ff.

⁴² For a visual depiction of the difference in urban-environmental impact between the messy, dust-generating old approach and the new dust-free systems, see the comparisons in W. Silberschmidt, “Müll: Mit Hauskehricht,” in A Gärtner, ed., *Weyls Handbuch der Hygiene*, 2d ed., Vol. 2 (Leipzig: Barth, 1919), 600.

⁴³ Rüb, “Müll und Städtehygiene um 1900,” 26.

⁴⁴ Carmelita Lindemann, “Verbrennung oder Verwertung: Müll als Problem um die Wende vom 19. zum 20. Jahrhundert,” *Technikgeschichte* 59:2 (1992), 91-107, here 96, 99ff. Among the most prominent engineering firms of the period to produce incineration facilities were Nottingham’s Goddart, Massey & Warner, and Horsfall Refuse Co. of Leeds, both used in Berlin at various stages before World War I.

⁴⁵ Aside from Lindemann, this discussion draws on Münch, *Stadthygiene*, esp. 54-55, and Sonja Windmüller, *Die Kehrseite der Dinge: Müll, Abfall, Wegwerfen als kulturwissenschaftliches Problem* (Münster: LIT, 2004), Ch. 4. For American experiments with incineration, see Melosi, *Garbage in the Cities*, esp. 154-59, 164-67.

⁴⁶ Lindemann, “Verbrennung oder Verwertung,” 97.

⁴⁷ Frilling and Mischer, *Pütt und Pann’n*, 73-75, 126.

⁴⁸ Curter, *Berliner Gold*, 28-30; Etienne de Fodor, *Elektrizität aus Kehricht* (Budapest: Julius Benko, 1911), 53-54. Fodor, director of the Budapest Allgemeine Elektrizitätsgesellschaft, is a principal source for all subsequent accounts of pre-war waste disposal methods. His book also contains countless images from the time.

⁴⁹ Lindemann, 97, notes the existence of these different systems, and gives three names: Herberth, Dörr, and Caspersohn. Some six cities besides Hamburg built and operated incinerators before 1914: Beuthen, Kiel, Barmen, Frankfurt, Fürth, and Aachen. For Berlin’s first facility, run

by BEMAG in the 1920s, see Susanne Köstering, ““Der Müll muss doch heraus aus Berlin!””, *WerkstattGeschichte* 3 (1992), 16-26, here 18-21.

⁵⁰ Olaf Stellberger, “Müllstandort Rote Insel in Schöneberg: Experimentierfeld der Müll-Moderne,” in Köstering and Rüb, eds., *Müll von gestern*, 125-138, provides the names of a number of engineers and the dates of the patents they received for their processes.

⁵¹ Letter of 8 April 1927 from BAMAG-Meguïn to Heinrich Erhard, Sammlung Erhard, Sign. C IV 111.

⁵² Sammlung Erhard, Sign. D II, BAMAG-Meguïn company pamphlet.

⁵³ Bamag-Meguïn Aktiengesellschaft, “Die Verwertung von Hausmüll als die Zukünftige Müllbeseitigung für Mittlere und Grosse Städte,” (Berlin, 1927). Sammlung Erhard, Sign. A 271.

⁵⁴ *Ibid.*, 5-6.

⁵⁵ *Ibid.*, 7. As Stokes, Köster, and Sambrook also observe, the “rationalization” movement affected the waste business already in Weimar Germany, even if it was to have a more pronounced effect after World War II: *Business of Waste*, 49.

⁵⁶ *Ibid.*, 11.

⁵⁷ *Ibid.*, 8.

⁵⁸ *Ibid.*, 10.

⁵⁹ *Ibid.*, 13.

⁶⁰ *Ibid.*, 14-16.

⁶¹ *Ibid.*, 18-26.

⁶² *Ibid.*, 27.

⁶³ For the following discussion of Gerson, see Stellberger, “Müllstandort Rote Insel,” Windmüller, *Kehrseite der Dinge*, 178-84, and the company prospectus cited in the following note.

⁶⁴ Sammlung Erhard, Sign. C IV 113. “Müllverwertung Aktiengesellschaft: Die Gersonschen Verfahren der Müllverwertung,” (n.d., ca. 1925), 1.

⁶⁵ *Ibid.*, 2.

⁶⁶ *Ibid.*, 3.

⁶⁷ Sammlung Erhard, Sign. C IV 113. “Gutachten: Das Gerson’sche Verfahren und seine praktische Ausnutzung in der Müllvernichtungsanstalt zu Schöneberg”; for employment numbers and cost and revenue estimates, see the un-paginated model income statement in “Müllverwertung Aktiengesellschaft: Die Gersonschen Verfahren der Müllverwertung.”

⁶⁸ This product appears to have been a dry, matt-like board made of organic materials which could be laid in small gardens to decompose, thereby fertilizing the soil.

⁶⁹ On Aretz, see Stellberger, “Müllstandort Rote Insel,” and Windmüller, *Kehrseite der Dinge*, as cited above.

⁷⁰ See Silberschmidt, “Müll: Mit Hauskehricht,” 627-30 on this topic.

⁷¹ Frilling and Mischer, *Pütt und Pann’n*, 75; Camillo Popp, *Die festen städtischen Abfallstoffe: Ihre Beseitigung und industrielle Verwertung* (Munich: Oldenbourg, 1930), 26.

⁷² See Fodor, *Elektrizität aus Kehricht*, 4-6, for this account.

⁷³ Hösel, *Unser Abfall*, 186.

⁷⁴ Lindemann, “Verbrennung oder Verwertung,” 104 n.18.

⁷⁵ *Ibid.*, 95.

⁷⁶ Hösel, *Unser Abfall*, 186.

⁷⁷ This account of Schurig is drawn from Renate Rüb, “Grenzen eines tradierten Systems: Vier Jahrzehnte Mülldüngung bei Nauen,” in Köstering and Rüb, eds., *Müll von gestern*, 87-100, esp. 93-98, and Köstering, ““Der Müll muss doch heraus aus Berlin!””, 23-24.

⁷⁸ Undated letter from Franz Boerner, ca. 1925, in Sammlung Erhard, Sign. D II b.

⁷⁹ Ibid.

⁸⁰ Franz Boerner, Chemische Produkte, “Kulturin,” in Sammlung Erhard, Sign. D II b.

⁸¹ Undated letter from Franz Boerner, ca. 1925, in Sammlung Erhard, Sign. D II b.

⁸² Sammlung Erhard, Sign. C V 8. “Edaphon Dünger.” Typescript, February 1930, 1.

⁸³ Ibid., 3, for all of the above claims.

⁸⁴ Ibid., 6.

⁸⁵ Ibid., 7.

⁸⁶ Ibid., separately paginated 1-4.

⁸⁷ See the photographs of facilities in these cities dating to the 1930s in Sammlung Erhard, Sign. D II, “Über Müllverwertung und Edaphon-Humus-Düngung” (1947).

⁸⁸ Ibid., 10.

⁸⁹ Ibid., 8-9.

⁹⁰ Ibid., 7.

⁹¹ Ibid., un-paginated advertisement.

⁹² DANO, “Das Müll-Problem und seine Lösung. System DANO,” 30 December 1943, 2. Sammlung Erhard, Sign. D II d.

⁹³ Ibid., 3-8. On the company’s patented, mechanized process, which allowed for much greater speed in composting than natural aerobic or anaerobic composting in a garden, see also

“DANO’s Nye Mekaniske og Biologiske Metoder til Behandling af Affald,” (n.d., ca. 1937-1943), 4-13. Sammlung Erhard, Sign. D II d.

⁹⁴ DANO, untitled Danish-language brochure, ca. 1937-1943, 2; 5. Sammlung Erhard, Sign. D II d.

⁹⁵ See the ecologically-aware images accompanying “DANO’s Nye Mekaniske og Biologiske Metoder til Behandling af Affald.”

⁹⁶ Carl A. Zimring, *Cash For Your Trash: Scrap Recycling in America* (New Brunswick, NJ: Rutgers University Press, 2005), 22-23 and Ch.1 generally.

⁹⁷ Silberschmidt, “Müll,” 620-21. The account in Hösel, *Unser Abfall*, 207-208, is taken virtually word for word from this now-obscure handbook article.

⁹⁸ As, e.g., in Hamburg-Fuhlsbüttel: see Frilling and Mischer, 107; or in Cologne, where the entrepreneur paid the city some 6,000 marks annually for sorting rights: Lindemann, “Verbrennung oder Verwertung,” 104, n.22 (derived from Silberschmidt, “Müll,” 630).

⁹⁹ Fodor, *Elektrizität aus Kehricht*, 19-20.

¹⁰⁰ Zimring, *Cash For Your Trash*, 47-51.

¹⁰¹ Timothy C. Jacobson, *Waste Management: An American Corporate Success Story* (Washington, DC: Gateway Business Books, 1993), Ch.2.

¹⁰² Friedrich Huchting, “Abfallwirtschaft im Dritten Reich,” *Technikgeschichte* 48:3 (1981), 252-73, here 260.

¹⁰³ Zimring, *Cash For Your Trash*, chs. 1 and 2, provide an excellent background in the sector-wide impact of the changes owing to the growth of markets, new technologies, and mass production in steel, paper, and rubber products; the details in this paragraph are drawn from Zimring.

¹⁰⁴ Friedrich Grabner, “Gummirecycling: Altgummi: Abfallproblem oder Wertstoff?,” in Ulrich Giersch, ed., *Gummi: Die elastische Faszination* (Nicolai, 1995), 346-47. These included the German subsidiary of Dunlop, and one E. Walter Fischer of Leipzig, which boasted in an advertisement reproduced in Grabner’s article of being the largest operation in the industry.

¹⁰⁵ Although precise numbers are not available, according to the firm’s historians, the scrap trade very likely generated less than half of the firm’s business until the 1890s: Jeppe Nevers and Jens Åge Petersen, *Købmænd i 175 år: H.J. Hansen, 1829-2004* (Odense: H.J. Hansen Holding A/S, 2004), 27.

¹⁰⁶ *Ibid.*, 37-41 for discussion of the early rag and bone business; 42-47 for the scrap iron business. The book contains data on the firm’s gross receipts and profits both in its dry goods business and in the scrap business beginning in 1888. The numbers suggest the scrap business generated the bulk of both.

¹⁰⁷ *Ibid.*, 54-55.

¹⁰⁸ *Ibid.*, Ch. 3.

¹⁰⁹ There is brief mention of the Thyssen Konzern’s Duisburg scrap metal subsidiary, for instance, in Jeffrey Fear, *Organizing Control: August Thyssen and the Construction of German Corporate Management* (Cambridge, MA: Harvard University Press, 2005), 471.

¹¹⁰ On Goldschmidt, there is a thorough discussion in Köstering, “Hundert Jahre Entzinnung von Konservendosen: Ein Wettlauf zwischen Altstoffrückgewinnung und Rohstoffeinsparung,” in Köstering and Rüb, eds., *Müll von gestern*, 151-164, and an account derived largely from Köstering in Reinhold Reith, “Recycling: Stoffströme in der Geschichte,” in Sylvia Hahn and Reinhold Reith, eds., *Umwelt-Geschichte: Arbeitsfelder, Forschungsansätze, Perspektiven* (Munich: Oldenbourg, 2001), 99-120.

¹¹¹ While several European sources, including Fodor, speak generally of American precedents, the major contemporary American study of waste management efforts states that the first American sorting plant was that run on an experimental basis in New York City from 1898-1900 on the initiative of the innovative street-cleaning commissioner, Col. George E. Waring, Jr: Rudolf Hering and Samuel A. Greeley, *Collection and Disposal of Municipal Refuse* (New York: McGraw-Hill, 1921), 299. On the so-called “reduction plants” (the first was set up by a company in Buffalo in 1896) which may have done some sorting prior to compressing garbage to extract oils and fats, see Melosi, *Garbage in the Cities*, 40-41, and note 65, p. 246-47. These plants put into practice the so-called “Merz System” originating in Vienna but apparently first tried on a large scale in Buffalo.

¹¹² On the Budapest facility, see Fodor, *Elektrizität*, 24-44, esp. 33-44; Silberschmidt, “Müll,” 631-33; Windmüller, *Kehrseite der Dinge*, 164-65.

¹¹³ Fodor (who lived in Budapest) suggested that the enterprise’s contract with the city would probably not be renewed in 1912 owing at least in part to the rapid expansion of residential building around the facility, which had initially been far from dense settlement.

¹¹⁴ On the Puchheim plant, see Fodor, *Elektrizität*, 7-10, 44-48; Silberschmidt, “Müll,” 633-37; Windmüller, *Kehrseite der Dinge*, 165; and Röhrecke, *Müllabfuhr und Müllbeseitigung*, 28ff.

¹¹⁵ Fodor, *Elektrizität*, 47, contains a useful table of the total annual subsidy payments between 1898 and 1909. Over that period, they amounted to 1,594,950 marks. An incinerator replaced these uses of remainders in 1910.

¹¹⁶ Apparently, a comparable facility in Amsterdam was more profitable, in part owing to lower transportation costs and the higher value of Amsterdam refuse. See Silberschmidt, “Müll,” 637.

¹¹⁷ Sammlung Erhard, Sign. A 268. “Muk-Aktien-Gesellschaft zur Verwertung von Müll und Kehricht (in Vorbereitung).” (Berlin, 1910).

¹¹⁸ Ibid., 1.

¹¹⁹ Ibid., 2.

¹²⁰ Ibid., 8.

¹²¹ Ibid., 7-8.

¹²² According to Fodor, *Elektrizität*, 12, and Silberschmidt, “Müll,” 638, this was true not only in a small number of German cities but in Sweden.

¹²³ Sammlung Erhard, Sign. A 715. “*Staubschutz*” *Gesellschaft mit beschränkter Haftung: Förderung der staubfreien Verladung und Beseitigung bezw. Verwerthung von hauswirtschaftlichen Abfällen, Kehricht (Müll) und dergleichen* (Berlin, March 1900), 18-19.

¹²⁴ Ibid., 20.

¹²⁵ Sammlung Erhard, Sign. C V 21. Wirtschaftsgenossenschaft Berliner Grundbesitzer eGmbH, “Betrifft Zweiteilung des Mülls. Anlagen zu unseren Schreiben an den Herrn Oberbürgermeister der Stadt Berlin vom 13. November und 14. Dezember 1914.”

¹²⁶ Sammlung Erhard, Sign. A 279. “Berliner Müllabfuhr, A.-G.,” 7.

¹²⁷ Ibid., 8.

¹²⁸ Ibid.

¹²⁹ Melosi, *Garbage in the Cities*, 57-60, details Col. Waring’s New York City household separation program of 1896, supported by a police ordinance and the threat of fines or imprisonment; while a municipal program, this was influential as an example. Perhaps more interesting for our purposes, Fodor, *Elektrizität*, 10-11, also suggests that as US cities grew, but prior to any official municipal policy, small entrepreneurs replaced local farmers in picking up

and re-selling kitchen garbage, ashes, and assorted rubbish sorted in the home. Von der Linde later claimed that CAG's first experiments with the *Dreiteilungssystem* were independent of the New York operations, despite using the same three categories of waste: see Carl von der Linde, *Müllvernichtung oder Müllverwertung, insbesondere das Dreiteilungssystem: Ein Beitrag zur Hygiene des Mülls mit Rücksicht auf ihre volkswirtschaftliche Bedeutung* (Charlottenburg: Adolf Gertz, 1906), 19. Sammlung Erhard, Sign. A 106.

¹³⁰ This account of the Charlottenburg system is based on: Fodor, *Elektrizität*, 10-17; Silberschmidt, "Müll," 591, 638-39; Windmüller, *Kehrseite der Dinge*, 167-171, 174; Curter, *Berliner Gold*, 30-31; Köstering, "Der Müll muss doch heraus aus Berlin!," 16-18; Carsten Jasner, "Frühe Alternative: Das Charlottenburger Dreiteilungsmodell," in Köstering and Rüb, eds., *Müll von gestern*, 115-120, and Frilling and Mischer, *Pütt und Pann'n*, 126-28, as well as Von der Linde, *Müllvernichtung oder Müllverwertung*, 23-29 on the technical details of the system's operations.

¹³¹ Carl von der Linde, *Die Müllfrage und ihre Lösung nach dem neuen Separations-System der Charlottenburger Abfuhrsgesellschaft m.b.H.* (Charlottenburg: Adolf Gertz, 1902), 1. Sammlung Erhard, Sign. A 716.

¹³² Von der Linde, *Müllvernichtung oder Müllverwertung*, 3.

¹³³ Von der Linde, *Müllfrage und ihre Lösung*, 6.

¹³⁴ *Ibid.*, 4; Von der Linde, *Müllvernichtung oder Müllverwertung*, 20.

¹³⁵ Von der Linde, *Müllvernichtung oder Müllverwertung*, 22.

¹³⁶ *Ibid.*

¹³⁷ *Ibid.*, 2.

¹³⁸ *Ibid.*, 1.

¹³⁹ Von der Linde, *Müllfrage und ihre Lösung*, 7.

¹⁴⁰ Von der Linde, *Müllvernichtung oder Müllverwertung*, 33.

¹⁴¹ *Ibid.*, 11.

¹⁴² *Ibid.*, 5; Von der Linde, *Müllfrage und ihre Lösung*, 1.

¹⁴³ *Ibid.*, 11.

¹⁴⁴ *Ibid.*, 6.

¹⁴⁵ Like others, von der Linde concluded that sorting was the *least* hygienic process: *ibid.*, 17.

¹⁴⁶ *Ibid.*, 6-8; Von der Linde, *Müllfrage und ihre Lösung*, 3.

¹⁴⁷ Von der Linde, *Müllfrage und ihre Lösung*, 2. *Nationalökonomie* was the standard German term for economics in this period; however, it clearly conveys a special focus on the needs of the nation, hence the idea that economists are particularly concerned with the burning up of resources needed by German agriculture and industry.

¹⁴⁸ Von der Linde, *Müllvernichtung oder Müllverwertung*, 2.

¹⁴⁹ *Ibid.*, 12.

¹⁵⁰ *Ibid.*, 13-14.

¹⁵¹ *Ibid.*, 12.

¹⁵² *Ibid.*, 10.

¹⁵³ *Ibid.*, 9, 16.

¹⁵⁴ *Ibid.*, 17.

¹⁵⁵ See the sources in Note 130 above for details in this paragraph.

¹⁵⁶ Von der Linde, *Müllvernichtung oder Müllverwertung*, 22-23.

¹⁵⁷ *Ibid.*, 29.

¹⁵⁸ Ibid., 32, and Von der Linde, *Müllfrage und ihre Lösung*, 7, for greater detail and quantity estimates. Von der Linde argued that ideally, the company could supply the full Berlin demand for pork simply by using the fodder-ready wastes it threw away.

¹⁵⁹ Ibid., 30; Von der Linde, *Müllfrage und ihre Lösung*, 7.

¹⁶⁰ Ibid., 29-30.

¹⁶¹ Ibid., 37.

¹⁶² Ibid., 36.

¹⁶³ Ibid., 34.

¹⁶⁴ For the following paragraph, see again the sources in Note 130 above.

¹⁶⁵ Von der Linde, *Müllvernichtung oder Müllverwertung*, 30.

¹⁶⁶ A few of the modern sources mistakenly state that CAG went out of business in 1912. The same causes also forced the wartime closure of a Berlin sorting facility owned by the firm Gesellschaft für Müllverwertung in 1916: Curter, *Berliner Gold*, 32.

¹⁶⁷ The material on Hamburg is drawn from Frilling and Mischer, *Pütt und Pann'n*, 129-134, who have excavated it from city records.

¹⁶⁸ Only in Hesse, presumably, was this requirement legally enforced; however, there were clearly social pressures to participate in household waste sorting during the war.

¹⁶⁹ Major recent contributions in English are: Franz-Josef Brüggemeier, Mark Cioc, and Thomas Zeller, eds., *How Green Were the Nazis? Nature, Environment and Nation in the Third Reich* (Athens, OH: Ohio State University Press, 2005); Frank Uekötter, *The Green and the Brown: A History of Conservation in Nazi Germany* (Cambridge: Cambridge University Press, 2006).

¹⁷⁰ Huchting, "Abfallwirtschaft im Dritten Reich," 254.

¹⁷¹ Köstering, “ ‘Millionen im Müll?’ Altmaterialsammlung nach dem Vierjahresplan,” in Köstering and Rüb, eds., *Müll von gestern*, 139-149, here 140.

¹⁷² For the following, see Huchting, “Abfallwirtschaft im Dritten Reich,” 260-263.

¹⁷³ For the following, see *ibid.*, 254-57; 264-69.

¹⁷⁴ On the background to Nazi agrarian policy and the question of its “greenness,” see also Gesine Gerhard, “Breeding Pigs and People for the Third Reich: Richard Walther Darré’s Agrarian Ideology,” in Brüggemeier, Cioc, and Zeller, *How Green Were the Nazis?*

¹⁷⁵ Barry Commoner, *The Poverty of Power* (New York: Knopf, 1976). See also the sources cited above in Note 6.