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Zero waste in Los Angeles: Is the emperor wearing any clothes?

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ABSTRACT

This article asks how effectively and to what extent contemporary urban solid waste management systems can effect sustainable materials use. To assess this we first trace the origins of waste management in the U.S., identify the existing federal regulatory framework, and examine trends in waste generation and composition. We then describe waste management in Los Angeles, California, including identifying the city's waste management objectives and current programs, a long-range "zero waste" planning process, and an overhaul of waste collection and processing infrastructure currently underway. We find that, although aggressive, Los Angeles' efforts to achieve zero waste are insufficient for addressing resource conservation challenges. The main reasons for this are continued reliance on waste management approaches that have proven inadequate to address the increasing complexity of solid waste and limited data quantifying and characterizing waste generation patterns. The paper concludes by suggesting that addressing resource conservation in the U.S. will require renewed federal leadership as well as redoubled local efforts to improve waste flow accounting.

1. Introduction

Much has been made of the need for societies to reduce resource consumption. Recent estimates of human appropriation of the net primary productivity of nature range from 20% to 34% (Rojstaczer et al., 2001; Imhoff et al., 2004; Haberl et al., 2007); there is continued extraction of virgin minerals and ores due to linear material use patterns; energy inputs are predominantly supplied by non-renewable fossil resources (U.S. EIA, 2012); and both population and the resource intensity of lifestyles continue to increase rapidly (UNEP, 2011). Increasing resource consumption has brought with it the global rise of a middle class, but also increasing waste generation. These have continued in lockstep with economic growth since the dawn of the industrial age (Smil, 2008, p. 336).

Contemporary waste management practices emerge from a historical and institutional context. In the U.S., local governments have had primary responsibility for managing solid wastes generated by residents and businesses since the first creation of formalized waste management practices in the late 19th century. Universal waste collection and disposal were sufficient to address human health and sanitation issues, but subsequent decades have seen the rise of new challenges that these systems were never designed to tackle.

One such challenge is the conservation of natural resources, defined as the minimization of consumption of renewable or nonrenewable resources. Resource conservation may be achieved through waste prevention or waste recovery. Waste prevention (source reduction) is any action that results in a net decrease in the generation of waste, such as reducing the quantity of materials needed to produce or package a product, replacing disposable products with reusable products, using products more intensively, or delaying the end of life of a product (California Public Resources Code; Allwood, 2013). Waste recovery refers to the utilization of waste as either a substitute for virgin resources in goods production (i.e. recycling) or for energy recovery (New Zealand Ministry for the Environment, 2007). Recycling is commonly referred to as waste diversion because it diverts materials from landfill. Waste prevention is generally environmentally superior to waste recovery, however the precise outcome depends on the materials in question, boundaries of analysis, and assumptions on waste management technologies and practices (e.g., U.S. EPA, 2006; Schmidt et al., 2007; Merrild et al., 2008). The potential for source reduction and materials recovery to achieve resource conservation objectives is an active area of research. See for example work on waste reduction strategies for achieving industrial greenhouse gas reductions in the UK (Allwood et al., 2010; Allwood, 2013); the potential for closed-loop utilization of rare metals in response to supply constraints (Ayers and Peiro, 2013); policies to prevent waste in product packaging as a strategy for reducing solid waste generation in the Netherlands (Worrell and van Sluisveld, 2013); and the analytical challenges associated with attempts to reduce environmental impacts through source reduction recognizing interactions across materials (Lifset and Eckelman, 2013).

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Despite federal government intervention beginning in the 1960s, systems and policies to address issues such as resource conservation and climate change remain lacking. Following MacBride (2012), we find that existing management systems have proven grossly insufficient for addressing current challenges and simultaneously bound the scope of possibility for consideration of more effective alternatives. North (1990) explains such patterns as path dependencies, and points out the difficulties in shifting course as there is an accumulated set of rules, subsidies, expectations and institutions that get built up around particular ways of doing things.

Solid waste is again coming to the fore of public consciousness in the U.S., particularly in socially and environmentally progressive cities (e.g., Ferry, 2011). These cities recognize the complex set of local impacts related to waste management, including limited landfill capacity, worker health and safety, environmental justice, and costs, in addition to issues of resource sustainability and climate change which transcend any one level of governance. In response, these cities are setting aggressive diversion targets, and some even seek to eliminate disposal entirely under a rubric of “zero waste,” despite a lack of state or federal requirements to do so. While reducing disposal is laudable, the measures taken to achieve such reductions tend simply to redouble previously established municipal approaches to managing solid waste—in particular, increasing the range of materials accepted for recycling without considering the downstream fate of such wastes.

Several recent studies of efforts to achieve zero waste have been conducted. Curran and Williams (2012) describe ZeroWIN, a multi-year project funded by the European Commission’s Seventh Framework Program to facilitate closed-loop management of electronics and construction and demolition waste through innovative research methods, technology, design, and policies. Phillips et al. (2011) describe the U.K.’s Zero Waste Places initiative which funded six case studies to identify barriers and solutions to improved waste management practice as part of a national-level strategy to decouple solid waste generation from economic growth. Recognizing the limitations inherent in using diversion rates to measure waste management performance, Zaman and Lehmann (2013) develop a zero waste index to calculate the potential reduction in virgin material consumption made possible by a jurisdiction’s waste management practices. They pilot the index in three cities and find that similar diversion rates can mask very different zero waste index scores.

The contribution of this paper is to assess the effectiveness of contemporary solid waste management systems in the U.S.—including federal, state and local policies—for conserving resources. Drawing upon data demonstrating the limited efficacy of curbside recycling to reduce waste generation and disposal, we argue that the hurdles to be overcome are more than technical in nature. In particular, these limitations suggest that continued municipal responsibility for difficult-to-recycle fractions of solid waste may be incompatible with resource conservation objectives and that alternative policy approaches should be implemented. To explore the potential and limitations of city-led efforts to improve resource conservation, we examine waste management in Los Angeles, California, which is currently crafting a long-range zero waste plan and overhauling its waste collection system. This research comes out of a pilot sustainability assessment of Los Angeles County funded by the California Energy Commission which uses an urban metabolism framework to analyze and quantify flows of inputs (energy, materials, water) and outputs (wastes) entering and exiting the county. After a brief overview of historical issues that motivated the creation of modern solid waste institutions and practices, we present a detailed review and critique of efforts underway to reform waste management in Los Angeles. Following this case study, we conclude with a discussion of the ability of Los Angeles to address the resource sustainability issues embodied in solid waste.

2. The origins of modern approaches to waste management

By the end of the 19th century, as a result of a growing linkage of epidemics and disease to poor sanitation in crowded urban environments, formalized collection and disposal of solid waste was becoming routinized in American cities. Until this time, solid waste was primarily handled by scavengers and individuals and large quantities of refuse were dumped at will in city streets (Melosi, 2005, p. 23). Formalization of waste management was part of widespread social, economic, and governmental reforms implemented during the Progressive Era, motivated not only by public health problems but also by political corruption and poor quality of life for working-class Americans. These reforms included the creation of a professionalized administrative structure for local government organized into specialized competences to increase efficiency and accountability, and the application of scientific knowledge to address serious sanitation issues (Pincetl, 2010, p. 45). While only 43% of cities had implemented formalized collection of solid waste in 1880, 78% had by 1899, and 88% had by 1924. Solid waste historian Martin Melosi notes, “the practices established by the early twentieth century have been remarkably influential. . .the administrative and organizational functions of modern public works departments are largely refinements of past practices” (2005, p. 232).

Universal collection and disposal proved largely sufficient to address sanitation and public health by the 1920s and the management of solid waste fell from public consciousness. Attention would not return until after World War II, when solid waste would be linked to issues of pollution and environmental protection. Postwar economic prosperity created a nation of affluent suburbanites who valued the natural environment as an amenity and recreation opportunity. In conjunction with involuntary exposure to radiation and pesticides and growing awareness of other unintended ecological consequences of economic growth and development, this coalesced into the modern environmental movement (Andrews, 2006, pp. 202, 210–211; Rome, 2001).

A broad-based political constituency for stronger environmental policy led to an unprecedented expansion of federal lawmaking for environmental protection in the 1960s and 1970s. Whereas the federal role had previously been limited to providing research and planning grants, Congress now established stringent regulatory frameworks across environmental policy domains during this time. This was enabled by an ideological shift from President Eisenhower, who sought to devolve federal authority to the states and to prevent new federal spending on environmental issues, to Presidents Kennedy and Johnson, who had urban constituencies supportive of federal leadership on environmental issues. Such an expansion was further supported by Congressional redistricting in the 1960s, which increased the clout of urban constituencies versus extractive industrial interests opposed to such intervention (Andrews, 2006, pp. 221–222).

Despite these shifts, federal policy on solid waste would not look beyond waste disposal, nor would it alter existing local responsibility for waste management. Federal involvement in the management of solid waste began in 1965 with the Solid Waste Disposal Act (SWDA), passed in response to President Johnson’s call for better solutions to the disposal of solid waste (Johnson, 1966). Implicit in this call was the understanding of solid waste as a source of environmental pollution when disposed of improperly. However, continued and rapidly increasing generation of waste itself was not challenged. Federal solid waste policy did not immediately require any changes to existing practice; SWDA simply provided technical and financial assistance to state and local governments for the creation and implementation of solid waste management programs and for demonstration projects to develop improved management methods. Its successor, the Resource Recovery Act of 1970, continued this approach (Louis, 2004). As a result, disposal practices remained "cheap and casual," with wastes commonly hauled to open-burning municipal dumps or disposed of in oceans (Andrews, 2006, p. 247).

A regulatory framework for solid waste would not come until 1976 under President Ford, with the passage of the Resource Conservation and Recovery Act (RCRA). Through RCRA, Congress directed EPA to develop minimum national performance standards applying to all solid waste landfills (RCRA Subtitle D) and to establish a rigid manifest system for the cradle-to-grave tracking of hazardous wastes (RCRA Subtitle C). While RCRA and its subsequent reauthorization, the HWSA of 1984, dramatically reduced *pollution* from waste disposal, these policies set no mandatory waste reduction, waste diversion, or maximum disposal targets, despite rapid increases in waste generation. Nor did they call into question the consequences of dramatic shifts in waste composition.

The limitations of federal policy for addressing issues beyond safer disposal of solid waste were not for want of awareness of need. Safe substitutes for toxic chemicals used in products, curbing increases in product and packaging wastes, and recovering wastes were important discourses in the scientific and environmental spheres (e.g., Commoner, 1971). By 1970, these concerns helped catalyze widespread public support for recycling of cans, bottles, and paper through voluntary or municipally sponsored collection programs (MacBride, 2012, p. 38). This model of responsibility sought to extend universal municipal waste services to disposal alternatives. Environmental groups also put forth numerous proposals for producer-based product taxes and deposits at this time, arguing that these were necessary to provide economic incentives to minimize waste at the source. Essentially these were based on the principle of polluter pays, and sought to internalize costs into the purchase price of goods. Industry fiercely resisted such "product stewardship" or "extended producer responsibility," as did the Nixon administration which argued their effectiveness in reducing the generation of waste was not sufficiently demonstrated (New York Times, 1970, p. 27).

Congress unsuccessfully attempted to expand the federal regulatory purview through deliberations around RCRA and subsequent bills, with more than 100 proposals between 1988 and 1994. For example, multiple bills proposed in the Senate and House of Representatives in 1989 included provisions to gather comprehensive data on industrial waste generation and to regulate industrial nonhazardous waste disposal with equal stringency as municipal waste disposal (MacBride, 2012, p. 93). However, they were unsuccessful and industrial wastes remain a glaring weakness in both data collection and regulation. During this period, environmental groups lobbied for national packaging standards and a national bottle bill, but were similarly unsuccessful. These efforts were marginalized by an emerging conservative backlash against regulation and federal leadership on environmental protection (Mazmanian and Kraft, 2009, p. 14). For example, the George H.W. Bush administration stymied the Senate's RCRA reauthorization plans in 1991 on the grounds that they unnecessarily increased federal responsibility for waste management (Davis, 1991, p. 2685).

After the 1984 Hazardous and Solid Waste Amendments set more stringent standards for solid waste disposal facilities and prohibited land disposal of untreated hazardous waste, no further modification of the federal waste management framework would occur (McCarthy and Tiemann, 1999). As a result, subsequent decades would see no correction of RCRA's limited regulatory purview. Thus solid waste management at the federal level has not advanced beyond safer disposal nor does it address industrial nonhazardous waste, despite the latter's significantly greater quantity. To date the U.S. has no national packaging waste standard, national e-waste regulation, and no national materials conservation policy or diversion objective, in contrast to the European Union and elsewhere (Deutz, 2009). Characteristic of the "first epoch" of federal environmental policy, RCRA and its amendments simply represent an incremental, end-of-pipe improvement to waste disposal that sought to address environmental pollution without altering the behavior of businesses or individuals (Mazmanian and Kraft, 2009, p. 20).

3. Beyond the federal framework

3.1. State and local actions

Despite a lack of federal leadership, waste management in many U.S. states and localities has moved well beyond a sole emphasis on safer disposal. A range of policy instruments has been adopted, including recycling targets, disposal bans, and extended producer responsibility (EPR) policies. More than 40 states have recycling goals (New York City, 2004, Appendix I). For example, in 1989 California adopted AB 939 which sets statewide diversion targets for local jurisdictions of 25% by 1995 and 50% by 2000. In 2011, the California legislature approved AB 341, which increases the state's diversion objective to 75% by 2020 and requires recycling service be provided to large multi-family residential properties and to commercial properties generating more than 4 cubic yards of waste per week. Nearly every state has adopted a disposal ban on at least one type of waste. These bans most often cover lead-acid batteries, waste oil, tires, untreated infectious waste, consumer electronics like CRTs and computers, mercury-containing products, and green wastes (Northeast Recycling Council, 2011).

States have been an important level of governance implementing EPR as well. Currently, 32 states have at least one EPR policy, covering products such as automobile switches, batteries, beverage bottles, carpet, cellular phones, fluorescent lighting, mercury-containing devices, paint and pesticide containers, and electronics. California and Vermont lead the nation with EPR laws covering six categories each (Product Stewardship Institute, 2013). The first EPR policies to be adopted were bottle bills, currently in place in 10 states. These require beverage companies to take back and recycle empty beverage containers, funded through a deposit incorporated into the product purchase price (Product Policy Institute, 2013a). Numerous states are members of product stewardship councils which promote source reduction through EPR, as well as other objectives such as toxics reduction, recycling, and environmentally preferable purchasing by public-sector agencies (Northwest Product Stewardship Council, 2013).

Municipalities are also leading the push for better waste management. Cities like Seattle, Washington, and San Francisco, California, have mandatory recycling, including food waste diversion, and can issue citations for noncompliance (Navarro, 2013). More than 130 California municipalities and associations of governments have adopted a resolution in support of EPR, representing two-thirds of the state's population, as have numerous municipalities across the U.S. (California Product Stewardship Council, 2013). Municipal associations, including the U.S. Conference of Mayors, the National League of Cities, and the National Association of Counties, have been active in promoting EPR, much as they have been for climate change initiatives. In 2009 both the National League of Cities and the National Association of Counties adopted resolutions in support of EPR, as did the U.S. Conference of Mayors in 2010 (Product Policy Institute, 2013b). Municipalities are active participants in product stewardship councils as well. For example, the Northwest Product Stewardship Council is a regional council of local governments in Washington State that in 2006 succeeded in requiring producers to create recycling programs for electronic products (Sheehan and Spiegelman, 2010, p. 11).

3.2. Assessing the success of recycling for conserving resources

Time series data from the U.S. Environmental Protection Agency (EPA) on waste generation, waste recovery, and waste disposal provide a means of assessing the effectiveness of existing waste management policies and approaches for conserving resources. These data show dramatic increases in solid waste generation: from 79.9 million metric tons in 1960 to 227.2 million metric tons in 2010. Seventy percent of this total represents product wastes, which includes durable goods, nondurable goods, and packaging and containers (U.S. EPA, 2013, p. 63). The remaining 30% is comprised of food waste, green waste, and miscellaneous inorganic wastes. Product wastes represent the vast majority of increases in absolute waste generation over this period. Even on a per capita basis, product waste generation has grown significantly over time, while other wastes remain roughly constant. These data are shown graphically in Figs. 1 and 2.

EPA data also show notable changes in solid waste composition since 1960, particularly reflecting the rise of plastics and other modern wastes. These fractions of the materials economy pose significant challenges to current recycling practices due to their physical properties, including high complexity and heterogeneity compared to more historical materials. Plastics, for instance, comprise hundreds of resin formulations and exhibit a variety of material properties ranging from foams to films to rigid containers. Each is distinct in terms of recyclability, and even rigid plastics of the same resin type cannot be recycled together if created from different molding methods (Andrady, 2003). As a result, plastics recycling is minimal. The EPA estimates that 28.4 million metric tons of plastics were generated in 2010 but that only 2.3 million metric tons (8%) were recovered, compared to recovery rates of 63% for paper and paperboard, 27% for glass, and 35% for metals (U.S. EPA, 2013, p. 34). The majority of what is recycled is PETE and HDPE bottles and jugs as these are highly prevalent, readily cleaned of contaminants, and optically sortable. The remaining portion of the plastic waste stream typically cannot be economically recycled, with few exceptions. When plastics recycling does occur, it often is to produce “secondary use” products, such as composite lumber from recycled LDPE film plastic, rather than true loop closure (MacBride, 2012, pp. 200–201). Electronic wastes engender equally complex recycling challenges that include some highly toxic materials in addition. Further, limited domestic infrastructure for recycling means that most of these wastes are exported from the U.S. to be processed elsewhere, with little transparency (Zhang et al., 2007; Puckett et al., 2002). Lyons et al. (2009, p. 292) document shifting spatial patterns of U.S. waste export over a study period of 1995–2005, with China emerging as the most important importer of six of seven material categories. Data showing generation and recovery of solid waste by material is presented below, graphically demonstrating the rise in plastics and the challenges to its recovery (Figs. 3–5).

Data on recovery rates for products covered by EPR suggest that this policy mechanism can contribute to greater resource sustainability. For example, lead-acid batteries, subject to disposal bans in nearly every state, have extremely high recovery rates: more than 96% in 2010 (U.S. EPA, 2013, p. 68). In addition, EPA estimated that states with bottle bills were responsible for more than half of all beverage bottle recovery in the U.S. in 2007, despite representing less than 30% of the U.S. population (U.S. EPA, 2008, p. 144).

The failure of municipally sponsored recycling to effect sustainable resource use in the U.S. is leading some cities to adopt zero waste targets. As described by the Product Policy Institute (PPI), “Zero waste is an approach directed at preventing waste rather than managing it. Its scope is the entire production and consumption system, not just the backend activities of our economy that have traditionally been carried out by local governments and the waste industry. It is a holistic focus on global resource flows, rather than a myopic focus on local waste management” (Sheehan and Spiegelman, 2010, p. 9). An incomplete list suggests that at least two dozen cities and counties in the U.S. have adopted zero waste ordinances (Zero Waste International Alliance, 2013). Los Angeles is one such city. It has established a long-range zero waste goal of 93% diversion by 2030 and is concurrently implementing a franchise system to streamline waste collection. Below, we examine how Los Angeles is implementing zero waste by reviewing published documents and conducting personal interviews. As will be shown, the efforts underway retain the dominant approach to waste management in the U.S. today, reflecting path dependency and institutional inertia. We follow the case study with a discussion of implications for resource conservation.

4. Solid waste management in Los Angeles

4.1. Solid waste policy and planning in Los Angeles

Los Angeles is home to nearly four million residents, making it the second largest city in the U.S. The city has a history of proactive management of solid waste, including being the first U.S. city to institute a curbside co-mingled recycling program (Villaraigosa, 2007, p. 23). The city’s 1993 Solid Waste Management Policy Plan, the long-range planning document currently guiding solid waste management, launched residential curbside recycling, green waste composting, and construction and demolition waste recycling programs, as well as recycled-content procurement policies and education and outreach efforts to achieve state diversion requirements (Smith, 2005, pp. 1–5). The Solid Waste Management Policy Plan also set a goal of achieving 70% diversion by 2020—subsequently advanced to 75% by 2013 by mayoral directive (City of Los Angeles, 2009b). In June 2013, Los Angeles became the largest city in the country to implement a ban of single-use plastic bags, set to go into effect January 1, 2014 (Zahniser et al., 2013).

Los Angeles also has the highest diversion rate among the 10 largest cities in the U.S., achieving 72% in 2012 (City of Los Angeles, 2012a,b), although this may be in part an artifact of California’s waste management framework which classifies alternative daily cover, alterative intermediate cover, beneficial reuse, tire-derived fuel, and transformed waste as diverted (CalRecycle, 2012, p. 7). City data are not sufficiently disaggregated to calculate a diversion rate in the absence of these allowances, but for comparison this reduces California’s statewide 2010 diversion rate from 65% to 49% (CalRecycle, 2012, p. 8). The city has also reduced waste disposal by a full third between 2000 and 2012 despite an increase in population over that period (County of Los Angeles, 2013). Waste disposal trends are shown in Fig. 6. The city is now attempting to implement a new paradigm of zero waste through a 20-year blueprint vision, multi-year community stakeholder process, and an overhaul of its waste collection system. The zero waste vision and community stakeholder process for achieving that vision are now introduced, followed by a summary of the waste collection system overhaul.

As stated in the blueprint vision, called Recovering Energy, Natural Resources and Economic Benefit from Waste for Los Angeles (RENEW LA), this new paradigm will require “a bold shift from a system concept of ‘waste disposal’ to one of ‘resource recovery”’ (Smith, 2005, pp. 1–2). Adopted by city council in February 2006, RENEW LA sets a goal of achieving at least 90% overall diversion through waste reduction, reuse, recycling, or non-combustion conversion by 2025, with continued disposal of only inert residual

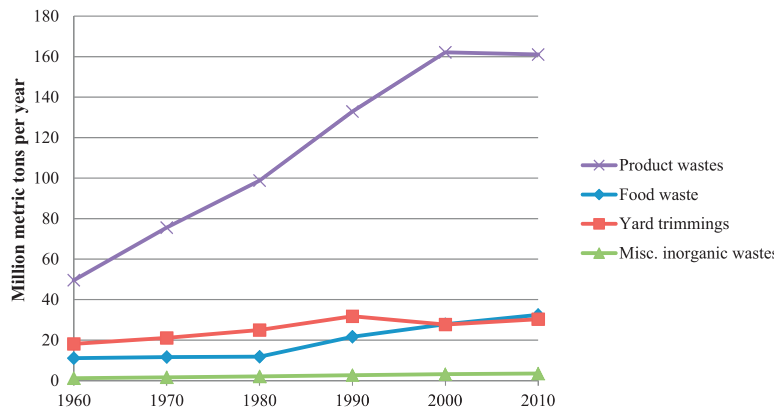

Fig. 1. Annual U.S. solid waste generation.

Source: U.S. EPA (2013).

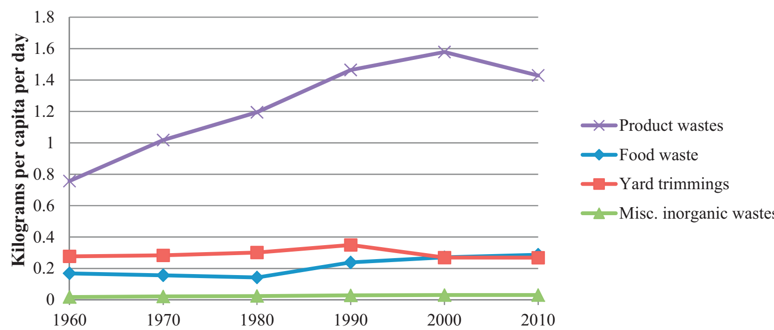

Fig. 2. Daily U.S. solid waste generation per capita.

Source: U.S. EPA (2013).

such as soil and concrete (Smith, 2005, pp. 1–2). To achieve this target, RENEW LA calls for an expansion of existing diversion programs, increased waste processing via materials recovery facilities, and the establishment of several non-combustion conversion technology facilities (such as gasification, anaerobic digestion, and composting) to ultimately replace disposal facilities. These measures can yield significant benefits for Los Angeles. For instance, mandatory segregation of green waste and food waste from trash, as the city is considering, can reduce tonnages sent to landfill while generating valuable compost. Yet important questions remain, including the extent to which expanded diversion programs can meaningfully recover and cycle the vast array of product wastes generated as well as what conversion technologies will be selected and what their implications for resource conservation will be on a life cycle basis.

The objectives set forth in RENEW LA are undergirded by the city's Solid Waste Integrated Resources Plan (SWIRP). SWIRP is a six-year, community-driven planning process begun in 2007 built upon stakeholder input through multiple series of workshops and citywide conferences. SWIRP also extends RENEW LA's 2025 diversion target to at least 93% by 2030. When finalized, SWIRP will replace the existing Solid Waste Management Policy Plan as the

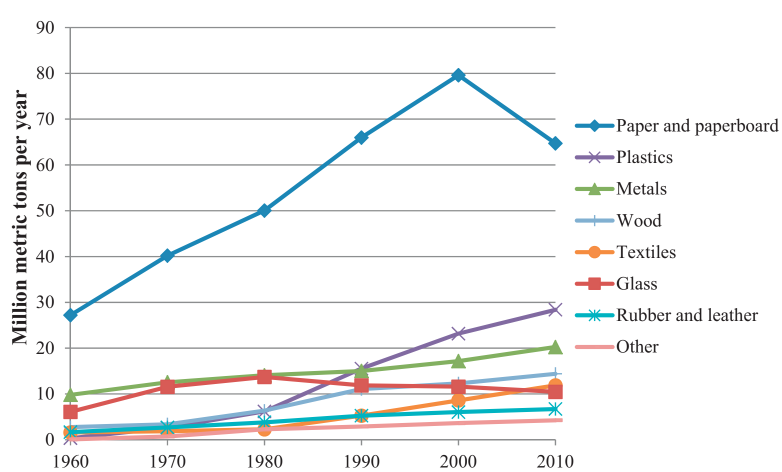

Fig. 3. Annual U.S. solid waste generation by material.

Source: U.S. EPA (2013).

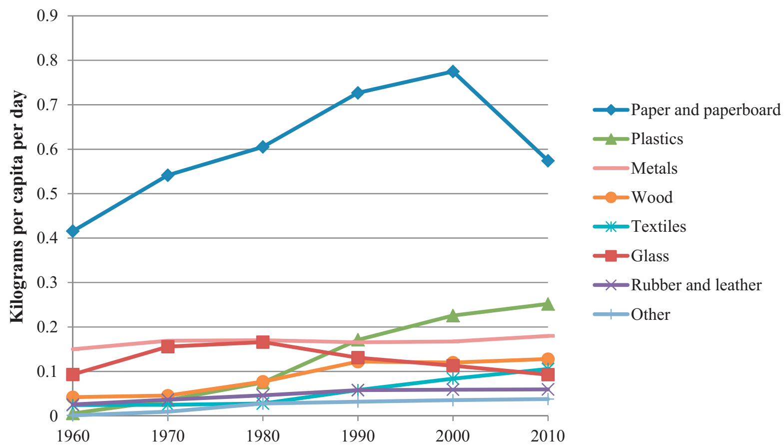

Fig. 4. Daily U.S. solid waste generation per capita by material.

Source: U.S. EPA (2013).

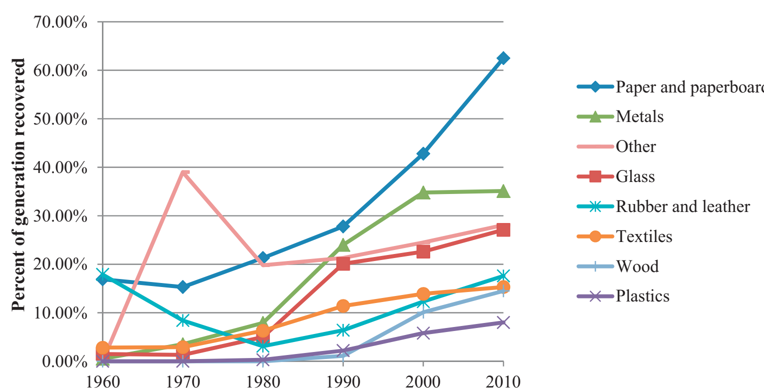

Fig. 5. U.S. solid waste recovery by material.

Source: U.S. EPA (2013).

master plan guiding solid waste management through 2030. To date, the SWIRP process has included a detailed assessment of the city's solid waste stream, development of a zero waste vision, and evaluation of policy and technology options for achieving that vision. Goals explicitly identified by SWIRP include source reduction and conserving limited virgin resources (City of Los Angeles, 2009d).

The diversion targets set forth by RENEW LA and SWIRP are aggressive beyond dispute, significantly exceeding targets established by California—itself a leader among U.S. states in proactive

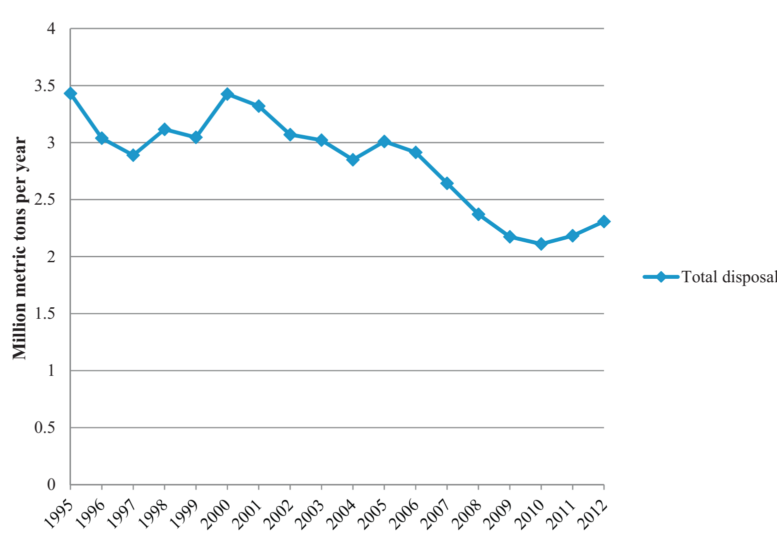

Fig. 6. Annual solid waste disposal, City of Los Angeles 1995–2012.

Source: County of Los Angeles (2013).

Table 1
Timeline of SWIRP programs, policies, and facilities.

	2013	2020	2025	2030
Programs and policies	Initial voluntary programs; upstream advocacy	Additional voluntary programs; mandatory programs; continue advocacy	Continue programs and advocacy	Continue programs and advocacy
Facilities	Residential compost facilities; one black-bin processing facility	Commercial compost facilities; two black-bin processing facilities; resource recovery center	Two black-bin processing facilities	Two black-bin processing facilities
Estimated diversion	70%	87%	90%	93%

Source: City of Los Angeles (2009d).

Table 2
Policy and program details by SWIRP scenario.[a]

	2013	2020	2025	2030
Scenario 1	–	–	–	–
Scenario 2 2.3 $MMTCO_2e$ reductions; 2500 jobs created	Pay as you throw pricing; increased outreach; bulky item reuse; textiles collection; food waste collection; more recycling in public areas; require all C&D waste to be processed; environmentally preferable purchasing policy; LAUSD zero waste curriculum; community beautification grants for zero waste projects	Add multi-family recycling; multi-family green waste collection; commercial haulers provide recycling to all customers; all businesses provide recycling within their business.	Continue programs	Continue programs
Scenario 3 1.7 $MMTCO_2e$ reductions; 2000 jobs created	–	Add mandatory recycling separation; mandatory organics separation; resource recovery centers at transfer stations; diversion requirements at C&D facilities; increased code enforcement	Continue programs	Continue programs
Scenarios 4 and 5 0.4 $MMTCO_2e$ reductions; 500 jobs created	Advocate for EPR for toxics; advocate for EPR for difficult to recycle materials; advocate for State packaging legislation; single use bag ban	Continue upstream advocacy	Continue upstream advocacy	Continue upstream advocacy

Source: City of Los Angeles (2009d).

[a] Scenario 1 represents business as usual; Scenario 3 adds mandatory programs to Scenario 2; Scenarios 4 and 5 add upstream policies to Scenarios 2 and 3, respectively; greenhouse benefits and jobs creation estimates are similarly additive across scenarios (such that the total for Scenario 4 would be 2.7 $MTCO_2e$ and 4.4 $MTCO_2e$ for Scenario 5); years shown represent implementation dates.

solid waste management. However, the process to date has displayed a clear emphasis on continued municipal responsibility for all fractions of solid waste, which externalizes the cost of waste management from producers and consumers to taxpayers. Regarding the possibility of shifting responsibility for particular product waste streams to manufacturers or imposing product bans, stakeholder recommendations included that the city pursue a "careful, phased approach" to "maximize voluntary programs and education before implementing mandatory requirements" (City of Los Angeles, 2009d). A range of scenarios developed by stakeholders to guide policy, program, and facility implementation efforts significantly expands the set of materials accepted for curbside collection (e.g., potentially to include food waste and textiles), but puts no additional responsibility on producers. SWIRP calls for new composting, conversion, and materials recovery facilities to process the expanded waste stream that will be diverted from landfill. The city estimates significant benefits: depending on scenario chosen, greenhouse gas reductions will range from 4.5% to 8.6% of the city's total and between 2500 and 5000 jobs will be created (City of Los Angeles, 2009d; Villaraigosa, 2007, p. 3). The following two tables summarize the policies, programs, and facilities proposed through SWIRP. Table 1 provides an overview of the implementation timeline along with estimated diversion rates while Table 2 provides further detail on policies and programs proposed for each of the scenarios as well as estimated greenhouse gas mitigation benefits and jobs created by scenario.

Despite these benefits, even the most aggressive scenarios limit consideration of "upstream programs" to *advocating for* EPR for toxics and for materials that are difficult to recycle through mixed curbside recycling models (City of Los Angeles, 2009d). This perpetuates a model of waste management that subsidizes over-packaging of products and minimal design of products for recovery, while also limiting the potential beneficial use of such waste streams. Considering the increasing prominence of plastic and electronic product wastes, such an approach will likely not achieve significant resource conservation benefits, even if such wastes are successfully diverted from local landfills. Further, SWIRP's emphasis on waste management rather than waste prevention is incompatible with the definition of zero waste proposed by PPI in Section 3.

The city has initiated a process to improve the physical infrastructure of waste collection and processing through an overhaul of the city's commercial-sector solid waste collection system. This entails transitioning from a loosely regulated permit system to an exclusive franchise which will limit the number of haulers providing city service while increasing service quality and providing incentives for further investment in waste processing infrastructure. We now describe the existing waste collection system and explore the details of the proposed overhaul to assess its likely ability to contribute to materials recovery and resource conservation objectives.

4.2. Solid waste collection in Los Angeles

The Los Angeles Department of Public Works' Bureau of Sanitation has provided solid waste collection service to the residential sector—defined as single-family homes and multi-family housing complexes of four or fewer units—since 1943 (Smith, 2005, pp. 1–4). Today the Bureau separately collects trash, co-mingled recyclables, and green waste from the city's 540,000 single-family homes and 220,000 small multi-family complexes (Zaldivar, 2012, p. 5). Private waste haulers provide collection services to the city's commercial sector—defined as multi-family housing complexes of five or more units and commercial, industrial, and institutional properties. There are approximately 45 permitted haulers providing commercial collection service, although the four largest firms control 85% of the market (Zaldivar, 2012, pp. 3, 6). According to city estimates, commercial properties are responsible for generating 69% of the city's waste sent to disposal facilities: 20% from large multi-family residential properties and 49% from non-residential properties (City of Los Angeles, 2009c, 2013, pp. 1–2). However, due to a lack of detailed reporting requirements for private haulers, these percentages are estimated based upon a 2002 waste characterization study (City of Los Angeles, 2002, 2009a).

Since September 2002, Los Angeles has had a non-exclusive permit arrangement with private haulers. The permit system allows an unlimited number of haulers to provide waste collection service and imposes few requirements. Until 2012, haulers were simply required to report total source-separated and mixed tonnages of waste and recyclable materials delivered to each transfer and disposal facility and to pay a state AB 939 compliance fee of 10% of gross receipts if they collect more than 1000 tons (907 metric tons) of waste per year (Zaldivar, 2012, p. 3). The Bureau has identified that limited reporting requirements under the existing permit system impede its ability to track recycling in the commercial sector (City of Los Angeles, 2013, pp. 1–3). It notes that haulers closely guard their customer lists, citing confidentiality concerns in response to requests for such information. The Bureau further notes that there is no standardization for collection or organization of customer and service information across haulers, and that even basic reporting terms are not defined consistently (City of Los Angeles, 2013, pp. 1–4). Service requirements are similarly limited under the existing system. Until the implementation of California Assembly Bill 341 (2011) mandated recycling for many multi-family residential and non-residential properties, Los Angeles only required that haulers collecting more than 1000 tons (907 metric tons) of material per year make recycling service available to customers as an option (Smith, 2005, pp. 1–6).

Despite achieving significant diversion of commercial-sector waste from landfill in recent years through programs funded by AB 939 compliance fees, the city has had little direct control over commercial waste management under the existing system. Adequate monitoring of private haulers to ensure correct fees are paid or that materials are managed as claimed is difficult, as much of the processing infrastructure is owned and operated by the private sector. Additionally, social and environmental justice groups such as the Los Angeles Alliance for a New Economy (LAANE) have drawn significant attention to the negligence of the waste management industry in providing adequate safeguards and pay for workers; unequal environmental burdens from collection and processing of solid waste faced by residents in less affluent areas of Los Angeles; and potential "green jobs" benefits of increasing waste diversion (Bornstein, 2011). LAANE has been an important player in a number of local policy campaigns in Los Angeles, including the adoption of the city's Living Wage Ordinance.

In response to these challenges and pressures, the city initiated a process to consider converting its commercial-sector permit system to a franchise. In 2010, the city council directed the Bureau to study implementation of a combined commercial-sector franchise (Zaldivar, 2011, pp. 5, 9; Zaldivar, 2012, p. 6). The Bureau contracted with HF&H Consultants to prepare an analysis of franchise system options to supplement the city's own study and initiated a stakeholder process to gain community input. The key decision would be whether the franchise should be exclusive or non-exclusive. Both systems would allow the city to charge a franchise fee to private haulers and impose numerous requirements, including more robust data reporting, specified diversion rates, and the use of clean-fuel collection vehicles. However, an exclusive franchise would divide the city into geographic boundaries each served by a single hauler, whereas a non-exclusive system would continue to allow an unlimited number of haulers to provide collection service. An exclusive franchise would also allow the city to set rates.

In January 2011, LAANE released a white paper that argued the need for an exclusive franchise system to address numerous issues related to solid waste management, including increasing waste diversion and reducing GHG emissions, setting consistent rates to protect small businesses and apartment complexes, increasing workplace safeguards and pay for laborers, and creating additional green jobs in the recycling industry (Bornstein, 2011). The report noted a significant lack of transparency and accountability in the current system, which not only hampered city efforts to ensure materials were appropriately processed after collection but also to ensure the safety of waste collection and waste processing workers. It also noted that Los Angeles County was beginning to run out of landfill capacity: based on current disposal rates, the county has less than fifteen years of capacity remaining (County of Los Angeles, 2012, pp. 4, 25, 47–66). LAANE would subsequently help to lead a broad coalition of environmental, environmental justice, and labor groups called Don't Waste L.A. (DWLA) to advocate for an exclusive franchise in the city's public input process, including organizing testimony from waste industry workers at public hearings.

In January 2012, HF&H Consultants released its final report comparing exclusive and non-exclusive franchise systems. HF&H found that an exclusive franchise system could maximize routing efficiency, thereby minimizing health and environmental impacts from collection, and offered the greatest possibility of achieving a high diversion rate, arguing that under a non-exclusive franchise haulers may not have sufficient customer density or access to materials processing facilities to achieve aggressive diversion targets. A non-exclusive franchise, however, would likely result in better service, protect customer choice, and leave other service providers available to the city during a work stoppage (HF&H Consultants, 2012, pp. 23–24, 28). Following this assessment, the Bureau released its proposal for an 11-area combined exclusive franchise in February 2012. Franchise service contracts would be for 10 years, with two five-year renewal options, beginning as early as December 2016 (Zaldivar, 2012, p. 20).

At the direction of the mayor and city council, the Office of the City Administrative Officer (CAO) also conducted an assessment of exclusive and non-exclusive franchise systems, released in August 2012. The CAO argued that a non-exclusive system could achieve the same diversion, environmental, social, and revenue objectives as an exclusive franchise system without several key drawbacks. Most notably, these included a loss of city leverage due to the reduced number of haulers, higher costs of program administration and enforcement resulting from more complex franchise agreements, increased risk of litigation, elimination of customer choice, and near-term job losses resulting from forcing existing haulers out of the market (Santana, 2012, pp. 1, 10–11, Appendix C, p. 5). In its assessment, the only advantage of an exclusive franchise would be the potential for greater routing efficiencies. Despite the CAO's findings, the city council approved the Bureau's concept of an 11-zone exclusive franchise system by a vote of 11 to 3 in November 2012 and subsequently adopted the Bureau's implementation plan in April 2013. As of this writing, the next step is for the mayor and city council to approve a policy directing the Bureau to execute an RFP process, create necessary municipal ordinance changes, and conduct a concurrent environmental review (Garrison and Mai-Duc, 2012). A map of the proposed franchise areas included with the Bureau's implementation plan is shown in Fig. 7.

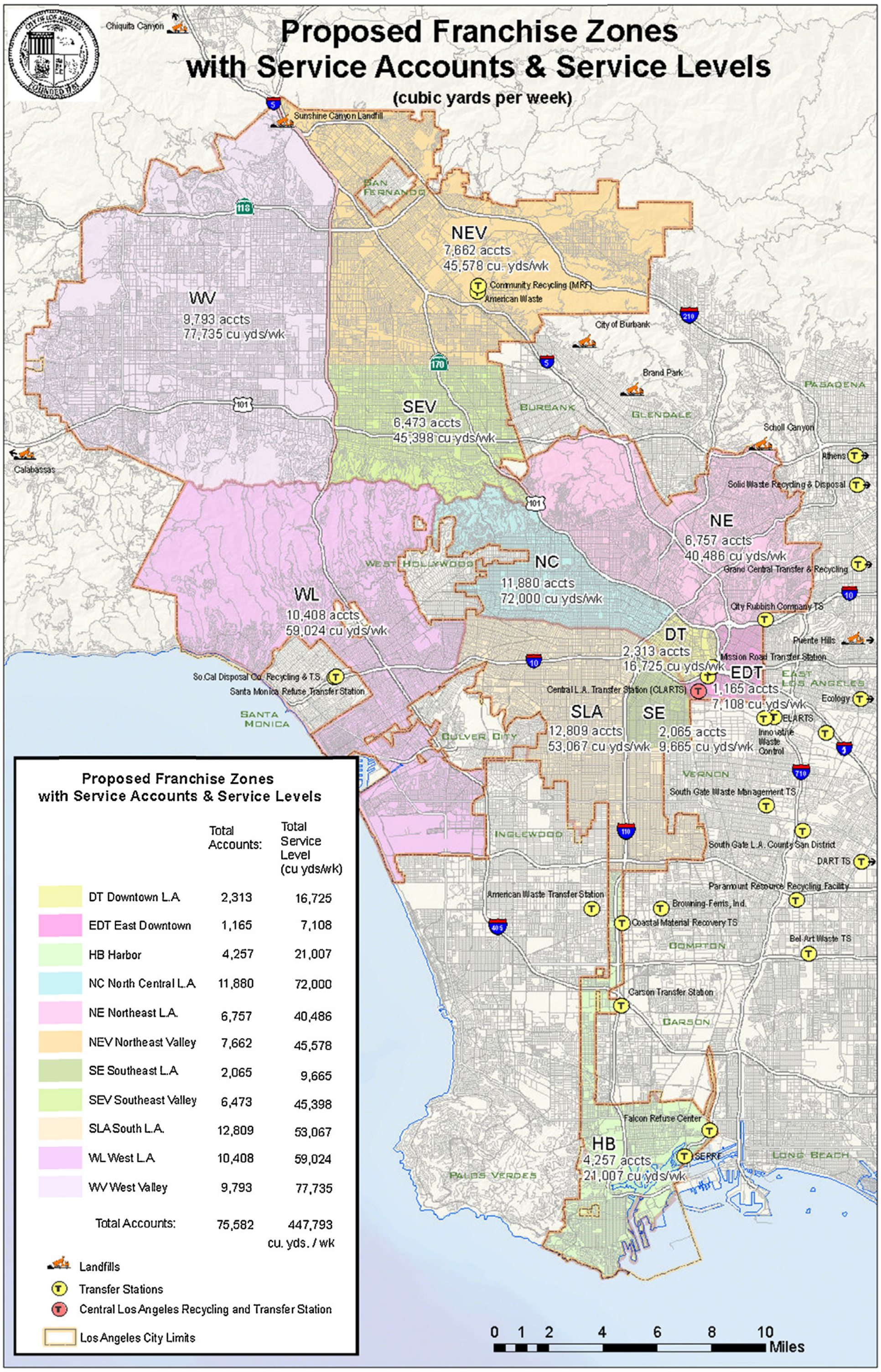

Fig. 7. Proposed commercial franchise areas, City of Los Angeles.

Source: City of Los Angeles (2013).

While both types of franchise system represent a significant improvement over the existing permit system, what are their implications for increased resource conservation? In our assessment, an exclusive franchise has three key advantages in this regard: greater accountability, higher diversion rate, and improved waste generation data. First, a limited number of haulers serving Los Angeles will improve city oversight. This will better ensure wastes are being processed in accordance with city goals, such as keeping recyclable materials out of landfills. All haulers and facilities will be required to maintain records on the handling of collected and received material, respectively, as well as inspection records from other compliance agencies, which the city will have the right to examine. Violation of these requirements could result in termination of a franchise agreement (City of Los Angeles, 2013, pp.

3–5, 3–21), which LAANE argues will serve as a strong compliance incentive that would not exist under a non-exclusive franchise.

Second, while a minimum diversion rate can be specified under either an exclusive or non-exclusive franchise, an exclusive system likely promotes higher diversion in practice. This is through two mechanisms. First, the city can use the request for proposals process to encourage competition on diversion rate as well as on price when selecting bids. These diversion rates can then be formalized in the franchise agreement. In contrast, a non-exclusive system does not provide incentives to compete on service quality. An exclusive franchise also creates long-term stability for waste haulers that will be important for helping promote investment in facilities and programs to achieve high diversion rates. Finally, an exclusive franchise improves analysis of waste generation patterns because it divides the city into 11 franchise areas. Stable routing over time also provides the possibility of much finer-grained spatial resolution, which could better unmask variation across the landscape of Los Angeles. Under a non-exclusive franchise with overlapping routes and accounts shifting among haulers, only generation and composition values for the entire city can be calculated. Our analysis thus finds that an exclusive franchise system is the superior choice. Yet significant limitations persist, as discussed below.

5. Discussion

The actions considered by Los Angeles through SWIRP and the proposed exclusive franchise will generate a number of important local benefits, including decreased reliance on landfills, increased protections and pay for waste industry workers, local jobs, and reduced impacts from waste collection. Better handling of materials such as separating food waste from trash and expanded material types accepted for diversion, supplemented by new infrastructure and conversion technologies are important steps forward in waste management practice. However, these advances do not meet the definition of zero waste introduced before the case study. Neither SWIRP nor the exclusive franchise provides the city with leverage to reduce waste generation or effect increased loop closure for complex product wastes. Product design and consumption decisions are external from end-of-life management under a system of municipal responsibility for waste management, and neither SWIRP nor a franchise system does anything to address this weakness. Suggestive of this disconnect, Los Angeles projects continuing increases in waste generation through 2030 (City of Los Angeles, 2009c). Further, the SWIRP process has demonstrated little attention to assessing the resource conservation benefits that will be realized through the measures it will take to improve waste management. While both SWIRP and an exclusive franchise support increased diversion, it is unlikely that this will translate into significant resource conservation benefits because of the broad array of product wastes current mixed-materials recycling infrastructure must contend with. In this way, Los Angeles' implementation of zero waste exhibits a disconnect with one of its ultimate ecological motivations for zero waste. As the city appears poised to implement black-bin waste processing facilities as a strategy to increase its diversion rate (City of Los Angeles, 2009d), issues of contamination will also need to be considered carefully. This is a significant barrier to reuse of waste flows in subsequent manufacturing processes and has not received sufficient attention to date in either the SWIRP or franchise study processes. These limitations make clear that alternate models of responsibility are necessary for managing the end-of-life phase of many product wastes.

The limited coverage of product wastes by EPR in the U.S. to date is suggestive of the political difficulties in shifting end-of-life responsibility from an engrained municipal model to product manufacturers. Recognizing these challenges, cities should pursue two objectives. First, they must better track flows of materials to enable understanding of how much waste is being generated by neighborhood and generator type and what the composition of that waste is. Currently there is not enough accountability to document supply chains from neighborhood to processing facility to recycling facility to manufacturing facility. In California, only quantities of solid wastes sent to disposal facilities are attributed to city or jurisdiction of origin, and only aggregate data are reported. For example, the total quantity of solid waste disposed by Los Angeles, a city of four million, is reported as a monthly data point in the aggregate. This provides little information or leverage for addressing waste generation. Better accounting of waste flows across this chain will improve accountability. It will also help to shed light on the limitations of the current model of recycling for meaningfully cycling varied and increasingly heterogeneous product wastes, which in turn can provide additional public and political support for alternative approaches. Second, cities must continue to advocate for state- and federal-level action to expand EPR through participation in product stewardship councils, the National League of Cities, the U.S. Conference of Mayors, the National Association of Counties and other mechanisms. Action at the state and federal level is necessary to bring EPR into the mainstream of solid waste management, particularly given limited staff resources at the local level, to say nothing of the potential economic efficiencies.

Los Angeles will improve accounting and oversight through implementation of an exclusive franchise, but does not go far enough. Data improvements suggested by the Bureau to date focus on information needed to allow the city to more effectively audit and monitor haulers, such as lists of services provided to each customer account, customer call response times, and data on missed collections (City of Los Angeles, 2013, pp. 3–19). Tracking flows of wastes along the chain described above has received less attention, but precedent exists in the management of hazardous waste. While an exclusive franchise will enable reporting of commercial-sector waste generation by franchise area, further disaggregation of data will be needed to help understand patterns and drivers of solid waste by neighborhood and by class of generator. Tonnage data must also be complemented by waste characterization studies to identify waste composition. Compared to data available for other flows important for urban sustainability assessment such as electricity, natural gas, and water consumption, data proposed to be made available under the exclusive franchise are still highly aggregated. Because an exclusive franchise has consistent routing, it could support reporting by smaller zone, such as by neighborhood or collection vehicle. All waste generation, not just the fraction destined for disposal facilities, should be tracked by origin. Without information such as this, the ability of haulers, researchers, and local governments to identify and target appropriate policies and programs is limited.

Other significant data limitations remain as well. For example, large multi-family residential properties are classified as part of the commercial sector. As such, these tonnages are not reported separately from true non-residential properties. This is a significant limitation to effective policy, program, and outreach for reducing waste as households and businesses create waste for different reasons. Moreover, disentanglement of multi-family and true non-residential waste streams will also allow the city to refine its approach to commercial and industrial waste. Finally, we recommend that all collected data be compiled in a publicly accessible database updated on an ongoing basis to enable analysis.

6. Conclusion

Existing systems to manage solid waste in the U.S. are best characterized as end-of-pipe approaches. They take unlimited quantities of waste as a given and try to manage them to minimize pollution and other impacts. This is a legacy of the Progressive Era, which institutionalized solid waste management at the local level. While the composition of waste and the issues surrounding its management have changed dramatically, limited federal regulations have not kept pace. To date, there is no national regulatory framework to reduce waste generation or conserve resources. Nor has there been a shift in end-of-life management responsibility for product wastes from municipalities to producers which would provide economic incentives to reduce waste at the source. Scholars have noted that the reaction to the Clean Air Act, Clean Water Act and other transformative national legislation has been a deep anti-regulatory trend in federal environmental policymaking since the late 1970s (Mazmanian and Kraft, 2009; Andrews, 2006). The result is a linear model of resource management predicated on waste disposal, where solid waste is treated as a nuisance to be managed rather than as energy and materials to be utilized. In recognition of the gaps of federal waste management policy, many states have enacted recycling goals to divert waste from landfill, and even EPR policies to shift responsibility to producers for particularly noxious fractions of the solid waste stream. However, these policies have been too limited in scope to stem the tide of increases in waste generation. As a result cities and counties are left managing a problem that continues to grow. Addressing such growth in waste generation has not been brought to the forefront of current federal policy debates.

Los Angeles offers an excellent window into how cities are trying to address solid waste. The city is pursuing a number of environmental and social benefits through improved management of existing waste flows under the rubric of zero waste. To achieve these, it is expanding diversion programs, developing additional waste processing and conversion infrastructure, increasing oversight over private waste haulers, and setting aggressive diversion targets. While these advances are necessary, the city's focus on improved waste management to the exclusion of mechanisms that can prevent waste at the source is an oversight: the translation of better waste management into resource conservation benefits is stymied by the complexity and heterogeneity of product wastes under a model of municipally sponsored co-mingled diversion. Further, there has been insufficient attention to the challenge of improving the quality of diverted materials so that they may be used in subsequent manufacturing processes.

In light of these challenges, local governments must continue to advocate for the adoption of EPR policies at the state and federal level through product stewardship councils, the National League of Cities, the National Association of Counties, and the U.S. Conference of Mayors. EPR can provide economic incentives to reduce packaging, design products for recovery, and translate products into services. In this way it can reduce waste generation and material throughput. An expansion of EPR should be complemented by industrial policies that promote use of recovered resources and strong resource conservation targets imposed at state and national levels. The European example demonstrates that only with well-designed regulatory requirements mandating waste recovery will societies make progress toward resource conservation (Deutz and Frostick, 2009, p. 248).

Cities must also pursue better data tracking of solid waste flows. Our study of Los Angeles has identified substantial weaknesses in data reporting, including insufficient spatial, material, and sectoral disaggregation and tracking of data. The city's proactive and aggressive pursuit of waste management reform and its location within a proactive state suggests that these data challenges likely exist across the U.S. Better understanding of the tonnage and composition of waste flows can improve accountability, transparency, and the targeting of programs and policies. Without this, progressive cities across the U.S. can continue to improve the management of solid waste, but they will be unsuccessful in reducing it.

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