Overcoming Challenges to Zero Waste in Massachusetts:

Analysis and Recommendations

A thesis

submitted by

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Abstract

The Massachusetts 2010-2020 Solid Waste Master Plan, *Pathway to Zero Waste* identified zero waste as a statewide goal with both environmental and economic development benefits. Zero waste is a newer vision formulated in the last two decades that proposes re-organizing linear waste management of extraction→production→consumption→disposal into circular economic cycles of resource→production→consumption→resource. In part, zero waste helps to reduce greenhouse gas emissions and toxic pollution from the current system. The purpose of this thesis was to identify barriers and challenges to zero waste in Massachusetts and gather legislative and economic strategies to overcome these barriers through evaluating successful zero waste initiatives throughout the United States.

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List of Abbreviations

ACE	Alternatives for Community and Environment
AD	Anaerobic digestion
ADC	Alternative daily cover
AIC	Alternative intermediate cover
C&D	Construction and Demolition
CalRecycle	California Dept. of Resources Recycling and Recovery
CH_4	Methane (a greenhouse gas)
CIWMB	California Integrated Waste Management Board
CO_2	Carbon dioxide (a greenhouse gas)
CWA	Clean Water Action
EPA	United States Environmental Protection Agency
EPP	Environmentally Preferable Product Procurement Program
EPR	Extended producer responsibility
GAIA	Global Alliance for Incinerator Alternatives
GHG	Greenhouse gas
GRRN	GrassRoots Recycling Network
ILSR	Institute for Local Self-Reliance
LOCOG	London Organizing Committee for the Olympic Games
MAC	Municipal assistance coordinators
MassDEP	Massachusetts Department of Environmental Protection
MRF	Material recovery facilities
MSW	Municipal solid waste
PAYT	Pay as you throw
REC	Renewable energy credits
RLF	Recycling loan fund
SF	San Francisco, California
SWMP	Massachusetts 2010-2020 Solid Waste Master Plan: Pathways to Zero Waste
UK	United Kingdom
VOCs	Volatile organic compounds
WBE	Waste ban enforcement
WTE	Waste-to-energy
ZWA	Zero Waste Alliance
ZWIA	Zero Waste International Alliance

Introduction

Traditional waste disposal methods of landfill and incineration are globally recognized as being harmful and unnecessary (Costa, Massard, & Agarwal, 2010; ZWA, Zero Waste Alliance, 2012). In response, governments at the federal, state and municipal level are advocating for "zero waste" strategies. Zero waste encompasses many different approaches that attempt to change the trajectory of waste from a linear extraction→production→consumption→disposal path to a circular path where waste is viewed as a resource. Products are designed without waste, meaning that when their original utility has ended, they become feedstock for a new product, thus avoiding the need for landfills or incineration techniques.

Massachusetts is one of two states leading the nation with the assertion of zero waste as a state goal. In the Massachusetts Department of Environmental Protection's most recent plan for solid waste, "Massachusetts 2010-2020 Solid Waste Master Plan: Pathways to Zero Waste" (SWMP) the Patrick Administration proclaims adherence to a "Zero Waste future" (MassDEP, 2013c, p. iii). The statewide waste bans, recycling and organics policies in the SWMP put together a framework for zero waste, which includes a combination of expanding old laws and implementing new ones. The success of the plan will hinge on compliance and enforcement of these laws, changes to the current infrastructure, political and community leadership, funding, and implementing economic strategies that leverage systematic changes to the current system. It remains to be seen if the state will effectively enact zero waste initiatives.

The projected outcome of this thesis is to assess potential barriers in achieving zero waste in Massachusetts. This evaluation will examine strategies as outlined in the Solid Waste Master Plan (SWMP) revised in April 2013, "Pathway to Zero Waste." Along with a review of the literature and selected case studies, and interviews with policy, industry, and community leaders, the project will include an analysis of economic and legislative tools to catapult Massachusetts into a zero waste future. As there is an absence of information regarding the impact and implementation of zero waste policies, this study is well-timed and relevant to the current issues of waste in Massachusetts.

Ch. 1 Background

Section One: The What and The Who of Zero Waste

Defining Zero Waste

Definitions of zero waste vary, with some defining it primarily as a philosophy and others as a goal to be achieved. Rather than drawing hard lines with strict definitions, advocacy and governmental groups describe zero waste as a visionary process (Chalfan, 2001). The UK's Department for Environment, Food & Rural Affairs (Defra) defines zero waste in England as "a simple way of encapsulating the aim to go as far as possible in reducing the environmental impact of waste. It is a visionary goal which seeks to prevent waste occurring, conserves resources and recovers all value from materials" (Phillips, Tudor, Bird, & Bates, 2011, p. 336).

The summer Olympic Games described their zero waste vision as part of "One Planet Living principles…a philosophy that encourages the redesign of resource life cycles so that all products are reused" (LOCOG, 2012, p. 7).

Similarly, the Zero Waste International Alliance (2004) describes zero waste as:

> A goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.
>
> Zero waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. (para. 2, 3)

In essence, zero waste is about altering the current cultural trajectory of waste. The philosophy driving zero waste initiatives challenges people in all production, consumption and waste systems to re-evaluate relationships to resources and to each other. Instead of individualistic competition for resources based on extracting precious materials and destroying intact biological communities, zero waste begs the human population to acknowledge our impact on the biosphere and to change that relationship. Instead of looking at the world from a "cowboy" perspective where the world seems limitless and there is infinite room for waste, zero waste aligns with a "spaceship" mentality where we survive in a closed-loop interdependent system (Greyson, 2007).

At the same time that zero waste challenges us to change, the goals clearly coincide with the economic concept of the efficient use of resources. Zero waste is a nexus where the environment and economy coincide and have mutually

reinforcing ideologies. The overall economic stability depends on both the materials supplied by nature and the ecological benefits nature provides. The generation of unnecessary waste of otherwise recyclable resources creates inefficiencies related to the existence of negative externalities in the market economy that are not often taken into account by either the consumer or producer of these resources. Negative externalities are unintended or uncontrolled consequences passed on to the society as a whole by producers and consumers participating in the specified market behavior. Adopting incentives and policies to promote zero waste agendas could help re-align the market for waste so that it is efficient and adequately protective of limited natural resources. Furthermore, recycling markets need further development in order to scale back pressure for natural resource extraction.

Examples of Zero Waste Places

Cities all over the world are setting zero waste goals. In the United States, most of the places that have adopted zero waste goals are at the municipal, county or regional level. According to the Zero Waste International Alliance (ZWIA) (Liss, 2013), California is the only state that has officially adopted a zero waste goal. Table 1 provides a list of locations throughout the country designated by ZWIA as zero waste places. According to ZWIA, the majority of zero waste places in the U.S. are found in California. Massachusetts has established a plan to forward a zero waste agenda. When asked via email to be included on the ZWIA list, the response from zero waste advocates was that the recent moratorium lift on incineration in the state's most recent Solid Waste Master Plan excluded them by

definition from zero waste (G. Liss and L. Pledger, personal communication, May 8, 2013).

Table 1: Cities, Regions, & States that have adopted zero waste goals in the USA
Source: Zero Waste International Alliance, Feb 16, 2013

As for the rest of the world, according to ZWIA, 25 international countries, regions, and cities as well a majority of New Zealand have indicated adherence to a zero waste goal. Australia and South Africa are two nations that have made zero waste commitments. In addition the Regional Districts Nelson, Kootenay Boundary, Central Kootenay, Cowichan Valley, Sunshine Coast, and British Columbia have all made commitments. The following is a list of locations outside of the U.S. that are listed as zero waste places by the ZWIA (2013).

Table 2: International Zero Waste Places | Source: ZWIA, Feb 16, 2013

• Smithers, British Columbia • Nanaimo, British Columbia • Halifax, Nova Scotia • Toronto, Ontario • Buenos Aires, Argentina • Eurobodalla Council, Australia • Willoughby, Australia • South Australian State Government • Canberra, Australia • The State of Western Australia • The State of Victoria • New Zealand	• more than 50% of New Zealand cities • 33 Italian cities • 2 regional/district Councils in England • Chew Magna, Wales • Blaenau Gwent County Borough Council, Wales • South Africa • 5 Pilipino Cities • Kamikatzu, Japan • Kovolam, India • Kanchrapara Municipality, West Bengal, India

Section Two: Why Zero Waste? Current Waste Management Issues

Economic Impacts

One concrete reason given for why zero waste is an important practice is that the cost to bury and burn is increasing. The average tipping fee (the amount charged to dump a load of materials) across the country is around $44/ton for landfilling compared to $67/ton for incineration (Bailey, Waste-Of-Energy, 2011). Keep in mind that comparing averages gives an overall view of what is happening in the country, but the average costs for both landfilling and incineration will vary from state to state.

Massachusetts is one of the most expensive states to landfill or incinerate trash. A report from *Waste & Recycling News* revealed that the averages across the country in 2012 for "tipping fees" to dump at landfills range from $18.43 to $105.40 per ton in Idaho and Massachusetts, respectively (News, 2012). In 2006 the average cost in Massachusetts to landfill waste was $79 per ton and $71 per ton to incinerate (Arsova, van Haaren, Goldstein, Kaufman, & Themelis, 2008).

According to the *Boston Recycling Report May 2000*, in 1999 the city alone produced 572 million pounds of trash and spent $22.5 million to dispose of it. Landfill capacity is expected to decline as a result of expensive tipping fees (Neale, 2013). On the other hand, combustion facilities that generate income via "waste to energy" (WTE) may make incineration a more economically feasible solution for waste disposal in this particular state.

In part the rising costs of landfilling may be attributed to the state regulated limits placed on building more landfills and that the existing landfills are reaching maximum capacity. In 2012 the landfill capacity was 2.17 million tons (Neale, 2013). By 2020 that capacity is expected to decline to 600,000 tons (MassDEP, 2013c). If incineration (also referred to as combustion) capacity remains at the current rate, it will be limited to 3.23 million tons from now going forward. However, the expansion of combustion facilities is expected to provide 3.8 to 5.4 million tons each year of extra incineration capacity over the course of eight years (Neale, 2013).

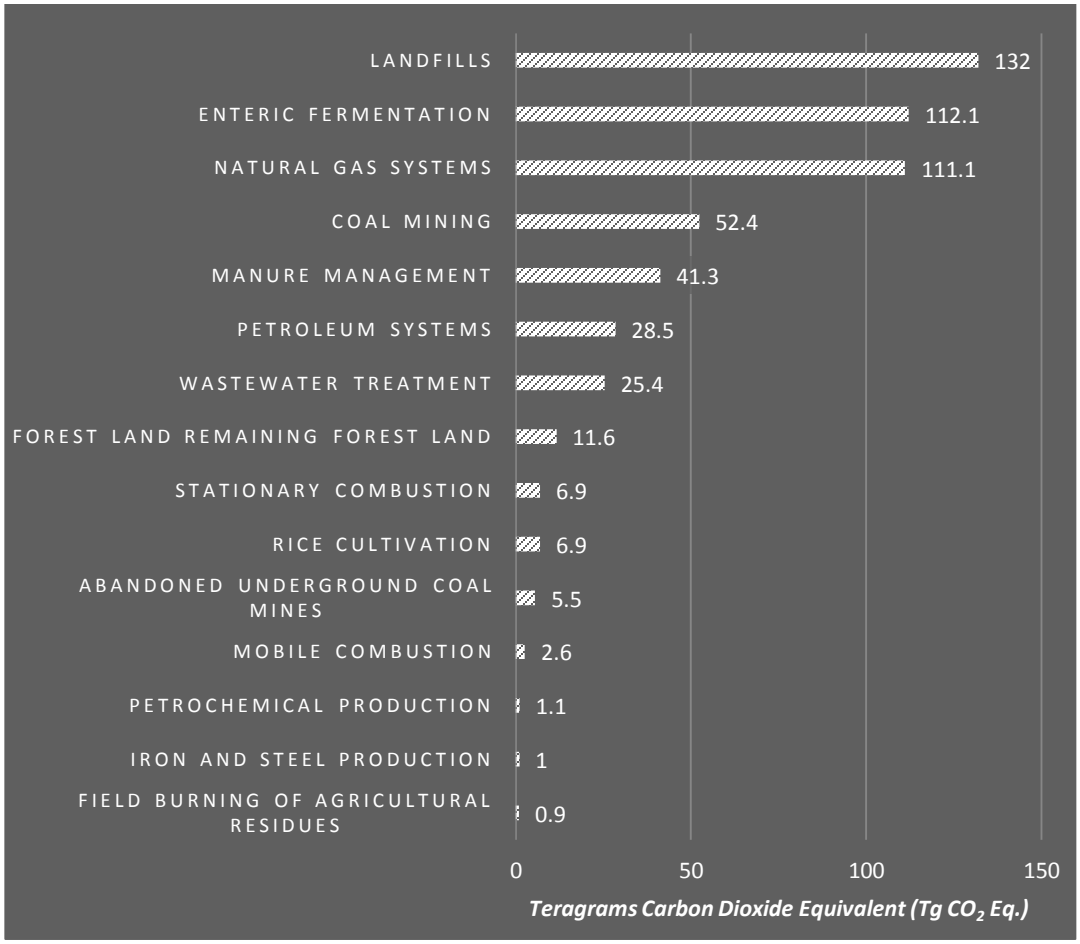
Environmental Impacts

Another reason that the costs of disposal at landfills and combustion facilities has been rising is the result of needing to continuously monitor their environmental impact (News, 2012). Even after a landfill closes it will continue to be monitored for impacts (EPA, United States Environmental Protection Agency, 2012), because historically leaching landfills have been known to contaminate groundwater sources (GRRN, 2007).

Other environmental impacts that need monitoring relate to climate change. According to the EPA, landfills have a significant impact on greenhouse

gas emissions "accounting for approximately 17.5 percent of the total U.S. anthropogenic methane (CH_4) emissions in 2011, the third largest contribution of any (CH_4) source in the United States" (EPA, United States Environmental Protection Agency, 2013b, p. 8.1). Adapted from the U.S. Environmental Protection Agency's report, *Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990-2006,* the figure below, compares methane produced at landfills to other industrial processes in 2005 (as cited in Platt, Ciplet, Bailey, & Lombardi, 2008).

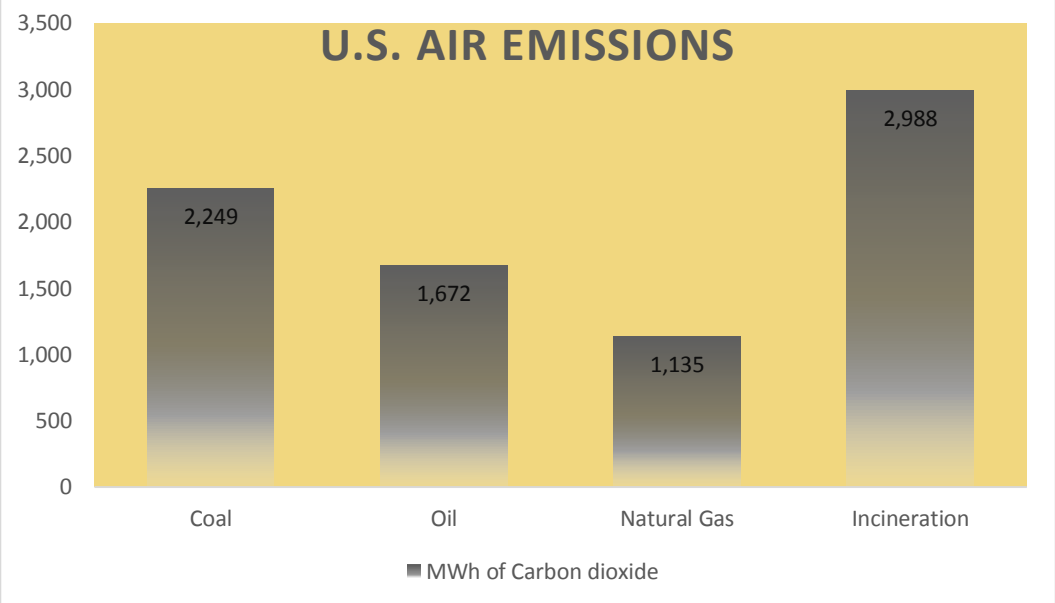
Figure 1: U.S. Methane Emissions by Source, 2005 in Teragrams Carbon Dioxide Equivalent (Tg CO_2 Eq.)



Incineration also comes with an environmental price tag. Almost all incineration occurs at waste-to-energy (WTE) facilities (EPA, United States Environmental Protection Agency, 2013b, p. 3.44). Incinerators release problematic "particulate matter, volatile organic compounds (VOCs), heavy metals, dioxins, sulfur dioxide, carbon monoxide, mercury, carbon dioxide, and furans" (Bailey, 2012, p. 8). Furthermore, Massachusetts' greatest source of dioxin and mercury is released into the air via incineration (City of Boston, 2000).

As a means of comparison, combustion facilities create more carbon dioxide (CO_2) than coal, oil, or natural gas fired plants (Platt, Ciplet, Bailey, & Lombardi, 2008). Furthermore, once the materials are treated with heat technologies, there is a residual ash that is toxic and has to be landfilled. This ash can equal up to 30 percent the weight of the materials processed by incineration (Bailey, 2012). Therefore, incineration does not eliminate the need for landfills.

Figure 2: U.S. CO_2 Emissions, Comparing Electricity Producing Technologies in pounds per megawatt hours. Source: (EPA, United States Environmental Protection Agency, 2013a)



Job Creation

Not only are landfilling and incineration expensive and produce harmful side effects in the environment, they also support minimal job creation in comparison to recycling. According to the Northeast Recycling Council (as cited in MassDEP, 2013c) the recycling and reuse industries provide thousands of jobs in Massachusetts, touting a payroll of nearly $500 million. Also, annual revenues fetch up to $3.2 billion for the couple thousand recycling related businesses in Massachusetts.

Backing these statistics the Institute for Local Self-Reliance (ILSR, 1997) compares jobs created through reuse and recycling versus jobs created in disposal industries. Compared to jobs created by disposal industries, plastic product manufacturers from recycled materials create 93 times more jobs. General recycling-based manufacturers create 25 times more jobs and materials recovery facilities create 10 times more jobs than disposal. (See Table 3). Reuse and repair industries, which vary widely, create anywhere from 30 to almost 300 times the number of jobs provided from incineration or disposal (ILSR, 1997). Advocating for and working towards zero waste in Massachusetts makes sense economically and for the safety of our environment and health.

Table 3: Job Creation Based on Reuse and Recycling Industry vs. Disposal
Source: ISLR, 1997

Industry	Jobs per 10,000 tons per year
1	Landfill/Incineration
4	Composting
10	Materials Recovery Facilities
18	Paper Mills
25	Recycling Based Manufacturers
26	Glass Product Manufacturers
28	Wooden Pallet Repair
93	Plastic Product Manufacturers
62	Miscellaneous Durables Reuse
85	Textile Reclamation
296	Computer Reuse

Section Three: Zero Waste Framework for Solutions

Sustainability Principles and Zero Waste Theory

In the biological world every organism has its role in passing energy from one form to another. All life encounters death which then feeds another form of life. Interactions between organisms create a closed-loop system where nothing is wasted and all processes are life-sustaining. A Senior Fellow at the National Academy of Engineering, Robert Frosch applied these ecological concepts to industrial material flows to develop what he termed "industrial ecology" (Frosch, 1996). In the quest for reaching a functioning and sustainable society, matching material product "life" to continuous re-cycling loops is a key consideration to attaining zero waste. The modeling of waste systems on biological processes is also referred to as biomimicry.

Frosch's ideas were further popularized in the book *Cradle to Cradle* (McDonough & Braungart, 2002). Both writings attempt to deal with the likelihood that people are going to continue to consume products and discard what they no longer need or find useful. For McDonough and Braungart (2002),

consumerism is not mutually exclusive to improving the longevity of resources and reducing pollution. On the contrary, for society to transform itself, sustainability needs to also be a joyful process.

Like Frosch (1996), McDonough and Braungart (2002) make connections between sustainability and zero waste as part of exploring interconnected relationships between production, consumption, and waste in a closed-loop system. Expanding on the ideas of recycling end products, the authors propose designing products with materials that have other planned uses when the product reaches its end-life. In other words, zero waste encompasses extended producer responsibility (EPR) for its products and practices (CWA, 2012). For example, under the concept of EPR, the fibers in carpets could be made non-toxic to begin with and when they reach the end of their usefulness as carpet, they could be recycled into paper or insulation. The successful reuse of a product requires smart design for recycling and market connections for further material use.

The traditional method of waste management is a linear processes (Seadon, 2010). There is the extraction of virgin resources, production of goods from these resources, the transport of goods connecting them to consumers, the consumption of goods, and the disposal of goods to be burned or buried. Conventionally, waste is created and disposed at an environmental and social expense to the places where resources are extracted, transformed into goods for consumption, and then deposited. The places where products are consumed are also impacted, but not always to the same extent or with the same detrimental impacts (Fox, 2007).

With the globalized economy, the places where goods are consumed are often geographically distant from the places where goods are made. The market's failure to incorporate and adjust for the impacts of linear production, consumption, and waste of goods in a global market is exemplified in the following situation. The fiber for clothing can be grown and woven in Asia, assembled into clothing in the Caribbean, and then sold and worn by people in North America who have no idea what the conditions were like for the people who were part of the extraction and production process. Furthermore, they have no experiential idea at what cost the extraction of those resources came for the local watersheds and the subsequent deterioration to the health of the people in those places. When consumers become aware of the issues and if they decide they care, the impact of the negative feedback consumers give (boycotting an item or finding alternatives to purchase) is weakened by markets that are now established and difficult to influence.

The negative externalities, the cost of dealing with pollution effects in the present or future and the degraded working conditions, are not included in the price of the good. Those costs are passed on to the society through environmental health consequences or tax payer clean-up. Furthermore, the price consumers pay to dispose of the good at the end of its usefulness is negligible. The market signals that trashing this item is appropriate, when in terms of conserving resources the clothing could have other uses. In the clothing example, we rely on the public's "good will" to make sure that the clothing is reused rather than trashed.

The globalized economy and the physical separation of market communities has an impact on the ability to make changes quickly or at all. According to model of "Leverage Points" developed by Donella Meadows of the Sustainability Institute (1999), this type of globalized distancing creates an informational delay in the negative feedback loop. The longer the delay, the more stubborn the system is to receiving feedback (Meadows, 1999). In the case of markets, negative feedback would be represented in the higher cost of goods made for linear waste management.

This linear waste management process is what Meadows (1999) refers to as a "paradigm", which she proposes is one of the most difficult concepts to create or leverage change, because this requires a shift in the way that society as a whole deals with the issue of extraction→production→consumption→disposal of goods. The pathway to zero waste requires that we move as individuals, cities, states and countries from a linear to a circular economy of goods. In fact, our resiliency as a species, interconnected by a global economy and limited by our planet's carrying capacity may depend on it.

Changing the way our global society deals with waste means shifting a basic component of civilized organization. Altering patterns central to societal organization need political, industrial/commercial, and citizen leadership (Healey, 2010). Often all three may not come together at the same time in the same place, depending on the local constraints and the cultural climate. Yet all three play a part in the political will of a place to make change happen.

Community Leadership for Sustainability

A study in England revealed that successful campaigns for reaching zero waste had strong grass roots advocacy connections (Phillips, Tudor, Bird, & Bates, 2011). The impetus for behavior change came from the political will of the people, not from the initiative of regulators. According to authors from the GrassRoots Recycling Network (GRRN), zero waste is the result of decades of grassroots advocacy from concerned citizens promoting recycling and preventing incineration and landfilling of waste (Connett & Sheenan, 2001). The public is needed to push the waste agenda towards zero waste.

The involvement of grassroots advocacy in zero waste is related to a core principle in sustainability. Professor Andrew Ross posits that true sustainability cannot be reached until the most vulnerable members of a community have access to the same environmental resources and the same protection from harm as everyone else in the community (Ross, 2012). Historically, the communities that have the least control over their living situation are the ones where landfills and incinerators are placed. For this reason advocacy groups in Massachusetts, Alternatives for Community and Environment (ACE) and Clean Water Action (CWA) work together to promote zero waste strategies that protect environmental justice communities (ACE, 2008).

The prevention of bury and burn is intimately linked with creating momentum moving towards the kinds of eco-friendly places that many people desire to live in. Replacing the adversarial energy associated with opposing landfills and combustion facilities, zero waste provides an action that communities can work for together, thus creating a positive political will (Connett

& Sheenan, 2001). The impact of people working together for a common goal may increase community support, the dissemination of information, and the ultimate success in adopting a new ideological system. Actions taken against or without the will of the people will lead to further distrust of government and the potential failure of the zero waste agenda (Innes & Booher, 2010).

Political Leadership for Sustainability

It is important to realize that citizens are one piece of the puzzle. Although citizen action may provide the impetus needed to forward a zero waste agenda, the GrassRoots Recycling Network acknowledge that zero waste ultimately relies on community, industry, and political responsibility and leadership (Connett & Sheenan, 2001). That is to say that bottom up approaches can be powerful, but the right combinations of policy and economic incentives establish the environment for change.

Our current waste systems are managed by policies set forth at all levels of government; municipal, state and federal. Federal policy requires states to maximize recycling and minimize waste through the Solid Waste Disposal Act of 1976. The federal role of the EPA is to monitor pollution effects caused by landfills, incineration, and other waste issues. Also, the EPA provides some financial incentives to increase waste diversion. In the case of zero waste, the role that the federal government currently plays is largely informational.

Most policies for zero waste in the U.S. occur at the municipal level. This is certainly true for Massachusetts (D. Quinn, personal communication, April 24, 2013). There are benefits and challenges to waste systems organized based on local control. On the one hand, waste systems are tailored to the specific needs of

local communities. On the other hand, this has led to an inefficient system with increasing environmental and infrastructural impacts and costs.

The state occupies the middle ground between the federal and local level. The state sets forth guidance and regulation that applies to all the municipalities and businesses that operate within and between state boundaries. Sometimes the state acts as the federal and local intermediary, receiving funds from the federal government and dispersing them to the municipalities. Monitoring waste management and enforcement happen at the state level. Education is another state role.

Zero waste requires the support of the legal system at all levels. Where the market fails to incorporate negative externalities into the cost of a service, as in the case of waste handling and processing, the state government should implement regulations to help correct for these market failures. Furthermore, the state is the regulatory permitting and compliance enforcement institution. Therefore, compliance with regulation requires buy-in from the people enforcing the policy as well as those writing and passing policy (Innes & Booher, 2010). Whether they lead from behind or push the agenda forward, it is imperative that our policy makers and designers be willing to craft and pass new policy while committing to education and enforcement.

Industry Support for Sustainability

Another sector of support that is needed for the overall long-term success is the commercial sector. Businesses have a stake in the way that policy impacts their management and profitability. The support of for-profit entities reduces resistance to and allows for greater ease in passing policy. Also, commercial

support increases technological innovation and compliance with regulations. All of these are aspects of zero waste success.

As the Executive Director of Eco-Cycle and zero waste advocate, Eric Lombardi states, "it is a mistake for the environmental community and Zero Waste advocates to expect for-profit companies to act in a way that doesn't support their primary mission of making profits" (2002). In order to survive in the competitive market, for-profit entities need to make a profit. These businesses include the companies that design and sell goods, waste haulers, waste processors, and manufacturers of waste processing technologies.

The commercial sector will support zero waste if a viable market for turning wastes into resources is developed. There has to be the existence of a manufacturing sector that turns waste resources into products that people desire, whether that product is fiber material, energy or something else. Waste becomes a valuable feedstock for manufacturing if there are goods that can be made at costs comparable to goods made from virgin resources.

The market exists for recycled plastics in manufacturing centers all over Asia. According to Brooke Nash of Massachusetts Department of Environmental Protection (MassDEP), recycled plastic is the largest export item going out of the Boston Harbor (B. Nash, personal communication, Feb. 6, 2013). The growth of anaerobic digestion to turn waste into energy, as well as composting are other potential sectors for market growth (Bailey, 2011; Platt, Bell, & Harsh, 2013).

As is true for all commercial enterprises, new technologies that increase the efficient and environmentally safe conversion of waste materials into

feedstock for new goods need monetary backing. Also, innovative product design that creates products out of non-toxic materials that can be recycled into other non-toxic products takes time and investment. The seed money for start-up businesses and expansion need the support of banks, venture capital, grant opportunities, and prioritized government funding.

Economic Strategies to Leverage Change

According to Greyson (2007) there are four options currently available that can be employed to correct for market failures and internalize negative externalities associated with those market failures:

- "Taxes and government charges
- Regulations
- Tradable permits
- Recycling insurance" (2007, p. 1385).

Zero waste practices can be incentivized within all four categories. Taxes, fees, and surcharges are common practices to discourage certain behaviors, while encouraging preferred behaviors. Taxation can be politically difficult to achieve (Greyson, 2007). Yet, revenue gained through government charges can be allocated into funds for programs that encourage desired behaviors, such as recycling and outreach programs (Connett & Sheenan, 2001). Well known examples of waste management taxes and fees include refundable deposits for bottles and other materials or products, government fees for processing and handling recyclables, and either flat taxes or unit based fees for managing waste, recycling, and compost.

Regulations can be used to limit behavior, such as banning items from waste, requiring producers to self-manage waste, or requiring waste customers to source separate their trash. Enforcing regulations can be difficult, time consuming and expensive to administer (Greyson, 2007). These expenses can be offset by fines collected from individuals and businesses that fail to comply with regulations. If the fines are able to effectively offset implementation costs, excess revenue can be used to fund preferred environmentally friendly waste programs.

Tradable permits, offset permits, and energy credits are relatively newer methodologies that can be used to incentivize desired waste management behavior. The offset permits and tradable permits allow businesses to create a market for trading allowable levels of pollution. Energy credits are federally subsidized programs for creating renewable energy. Waste-to-energy, (WTE) includes any combustion or incineration, capture of gas from landfills, and anaerobic digestion that results in conversion to energy.

There is much controversy over the definition of WTE as "renewable energy" and the validity of WTE as a zero waste technology with the exception of anaerobic digestion (Bailey, 2011; GRRN, 2007). Since 2006, WTE plants have been able to claim these credits (Young, Ralph, Madland, Kinsella, & Pica, 1999). (See Appendix A for more details at the federal level). In Massachusetts combustion based WTE plants are required by the state's Renewable Portfolio Standard to share 50% of the revenue they receive from selling Waste Energy Certificates unless they use the energy as fuel for the plant (MassDEP, 2013e, p. 55).

Recycling insurance is a producer-responsibility tool that insures a producer's liability against future costs to recycle their products at prescribed current costs. Recycling insurance was first sold in Sweden in 2003 as a way to "limit a producer's liability for unknown future recycling costs to a known current premium" (Greyson, 2007, p. 1385). The cost to purchase insurance was subject to the recyclability of the product. In theory recycling insurance can cover any type of good. In practice it has been sold for a variety of products, including 30,000 cars form Suzuki and Mazda (Greyson, 2007). Cost-share for insurance premiums are passed on to the purchaser in the sale price of insured goods. Primary benefits include incentives to reduce hazardous materials as part of production and "guaranteed end-of-life recycling" (Greyson, 2007, p. 1386).

The concept of recycling insurance can be extended to pre-cycling insurance as well. Pre-cycling refers to "actions taken now to prepare for current resources to become future resources" (Greyson, 2007, p. 1384). When mandated, pre-cycling and recycling insurance help raise funding for recycling and source reduction programs through redesign (Greyson, 2007). Premiums are based on products risk of becoming waste and can be calculated based on recyclability or compostability, producer's provision of product specific recycling infrastructure, and existing concentrations of a products material makeup persisting in the current ecosystem (Greyson, 2007).

The basic idea behind taxes, permits, and insurance is to help level market inequities among industry, incentivize desired behavior, and use revenue gained to finance select programs. A drawback to permitting and insurance strategies is

that they tend to be not well understood, because they are newer practices and can be complicated (Greyson, 2007). People are more acquainted with taxes, but in today's political climate they are a hard sell with the public. With practical use over time, there is potential for permits and insurance to become more familiar and advantageously implemented tools.

Of utmost importance to a sustainable zero waste plan are viable economic incentives and "stable long-term funding" (Allaway, 2007). Current federal, state, and municipal budget constraints present challenges to zero waste viablility. Furthermore, it is just as important to achieving zero waste that waste inducing industries and behaviors be discouraged or made economically infeasible, which may happen naturally through privatized markets and/or through publicly funded incentive programs. The potential for market development of new materials and new technologies exists within a zero waste framework, which may provide new jobs (Krausz, 2012). It remains to be seen if the new industries will be able to compete with the old ways of linear trash management business.

Section Four: Setting the Stage for Zero Waste in Massachusetts

State Waste Characterization

Between 2003-2010[1] Massachusetts residents, institutions and businesses generated on average about 12.7 million tons of solid waste each year (MassDEP, 2011). On average each year, as is demonstrated in Figure 3, about 4.3 million tons was privately handled and 8.4 million tons was generated at the municipal level, meaning that municipalities contracted the waste to be hauled and disposed

[1] See Appendix B for detailed waste generation, disposal and diversion amounts.

of. The costs to do so was generally passed on to residents and businesses via fees and taxes.

Figure 4 highlights that on average 84% of the non-municipally handled material, about 3.6 million tons out of 4.3 million tons of waste was primarily produced in the construction and demolition (C&D) business sector. A partial list of other types of non-municipal waste included contaminated soils, marine and fresh water dredge spoils, paper mill and waste water treatment plant sludge, and coal combustion wastes.

Figure 3: Massachusetts Average Yearly Total Waste Generation 2003-2010 (in tons) | Source: *(MassDEP, 2011)*

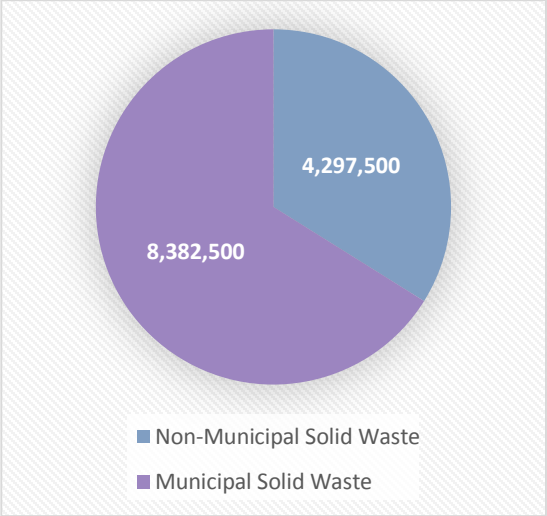
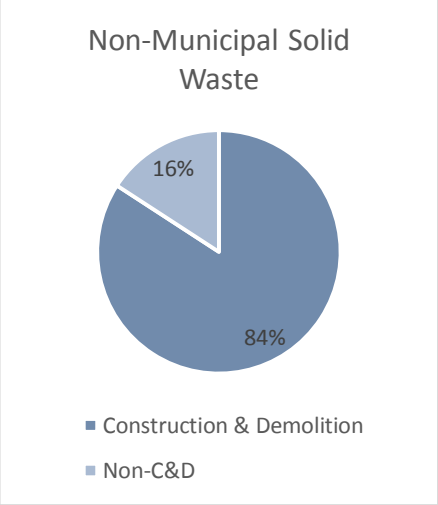


Figure 4: Massachusetts Non-Municipal Solid Waste Composition, Yearly Average 2003-2010 | Source: *(MassDEP, 2011)*

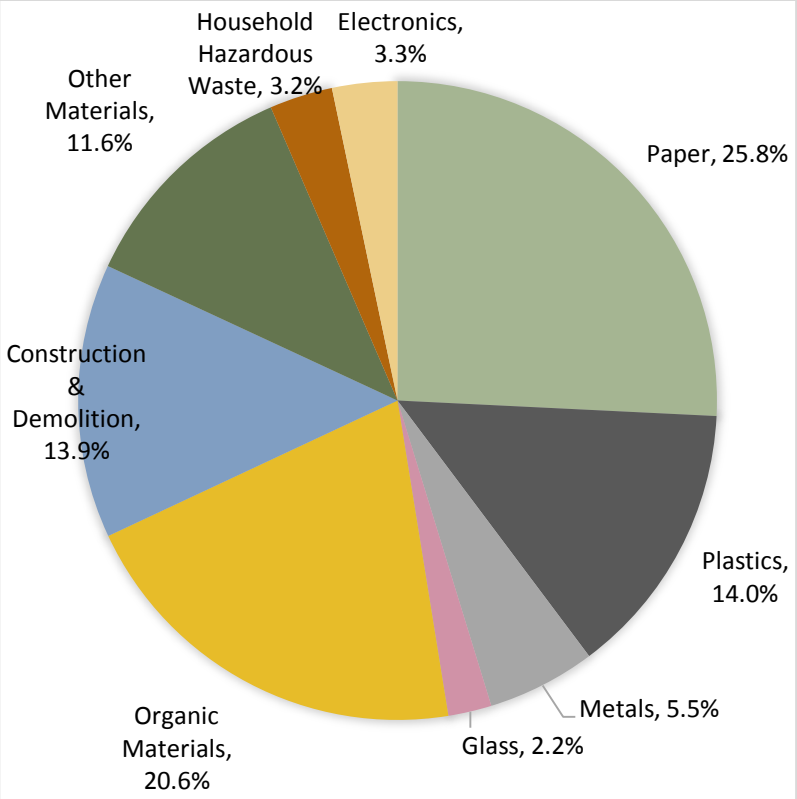


Describing the municipal waste stream, a MassDEP waste characterization study in 2010 revealed that paper[2], including food contaminated paper, constitutes

[2] These waste streams are grouped by their recyclable potential. Subsequently, even though wood, paper, yard and food waste are technically all organic based materials, each constitute a different recycle stream based in part on their marketability as a recycled good. Furthermore, each material category has been legally treated separately through individualized waste bans. For the purposes of the waste characterization study and this project, paper and organics will constitute separate waste streams and wood is treated as C&D material.

the largest percentage of materials[3] at 25.8 percent (see Figure 5 below). Organics, which refers to vegetative yard waste, food waste and manures follow at 20.6 percent. Plastics are next making up 14.0 percent of the waste-stream. C&D closely follow constituting 13.9 percent of the waste-stream. Of the C&D waste, wood composes the greatest percentage by weight.

Figure 5: Massachusetts Municipal Solid Waste Composition 2003-2010, about 8.4 million tons (66% of the total waste stream) | Source: *(MassDEP, 2013c)*



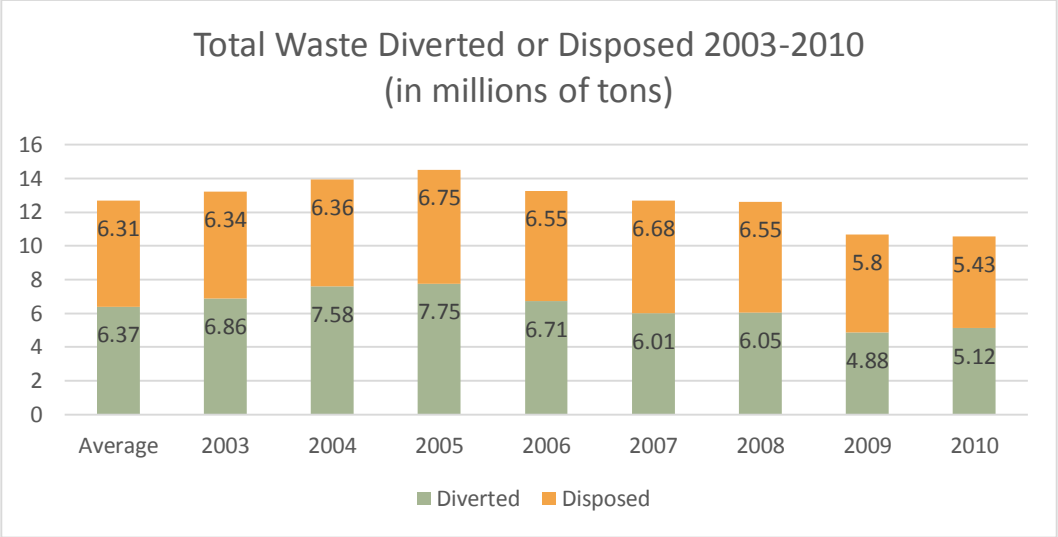
In addition, paper, organics, and wood are high-carbon materials, which are highly productive for generating energy via anaerobic digestion. Subsequently, the 2010-2020 Massachusetts Solid Waste Master Plan specifies

[3] To give an idea of how much food contaminated paper may represent the overall waste stream, a 2010 study found that about 4.4% of the paper stream was food contaminated paper (Mid Atlantic Solid Waste Consultants, 2011).

that paper, organics and wood are an immediate focus of state waste reduction efforts.

2005 marked the year of highest waste generation (about 14.5 million tons) in Massachusetts from 2003 through 2010. Although the total quantity of waste generated and therefore disposed of has decreased since 2003, the percent of waste disposed has increased over the time period from 48% (6.34 million tons) in 2003 to 51% (5.43 million tons) in 2010.[4] The year of the highest percentage of waste disposed was 2009 at 54% (5.8 million tons).

Figure 6: MassachusettsTotal Waste Generation Displayed as Diverted or Disposed 2003-2010 | Source: *(MassDEP, 2011)*

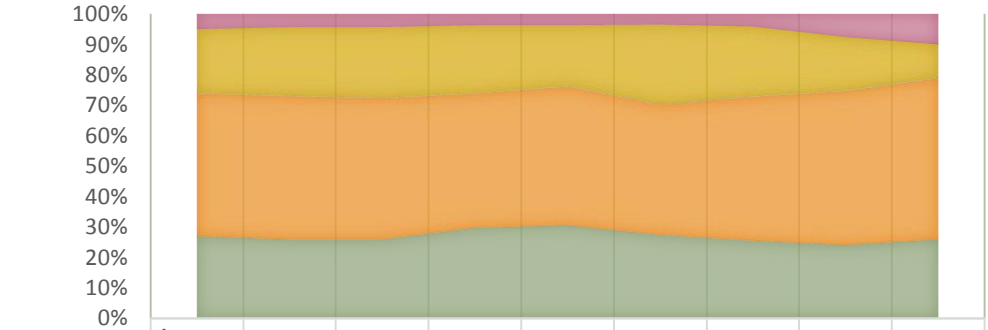


As depicted in Figure 7, waste exports steadily decreased after 2007. The quantity of waste exported decreased by more than 50% between 2003 (1.51 million tons) and 2010 (690,000 tons), yet imported waste more than doubled from 2003 (280,000 tons) to 2010 (580,000 tons). Furthermore, the state indicated

[4] It should be noted that these waste generation and disposal rates do not account for any waste (including food waste) that is processed at the wastewater treatment plant via the sewer system.

that exporting wastes has become an unsatisfactory method of eliminating waste (Andersen, 2013).

Figure 7: Massachusetts Method and Quantity of Total Waste Disposed 2003-2010 (in millions of tons) | Source: *(MassDEP, 2011)*



	Average yearly	2003	2004	2005	2006	2007	2008	2009	2010
Imported	0.33	0.28	0.28	0.25	0.25	0.24	0.27	0.47	0.58
Exported	1.4	1.51	1.56	1.58	1.37	1.82	1.58	1.12	0.69
Combusted	3.12	3.13	3.08	3.09	3.1	2.97	3.23	3.18	3.18
Landfilled	1.79	1.71	1.72	2.07	2.08	1.9	1.74	1.5	1.56

Clearly depicted in Figure 7, the majority of waste disposed was sent for incineration. On average Massachusetts incinerated 1.74 million tons of waste per 1 million ton of waste that was sent to an in-state landfill. As previously mentioned, the majority of waste was generated at the municipal level. Subsequently, the majority of waste disposed, either incinerated or landfilled, was generated at the municipal level. Figure 8 further details this trend. Of the 50.5 million tons of solid waste disposed of in and out of the state between 2003 and 2010, about 85% (43 million tons) was generated at the municipal level. (MassDEP, 2011).

Figure 8: Massachusetts Waste Disposal Method by Source Generation 2003-2010 (in millions of tons) | Source: *(MassDEP, 2011)*

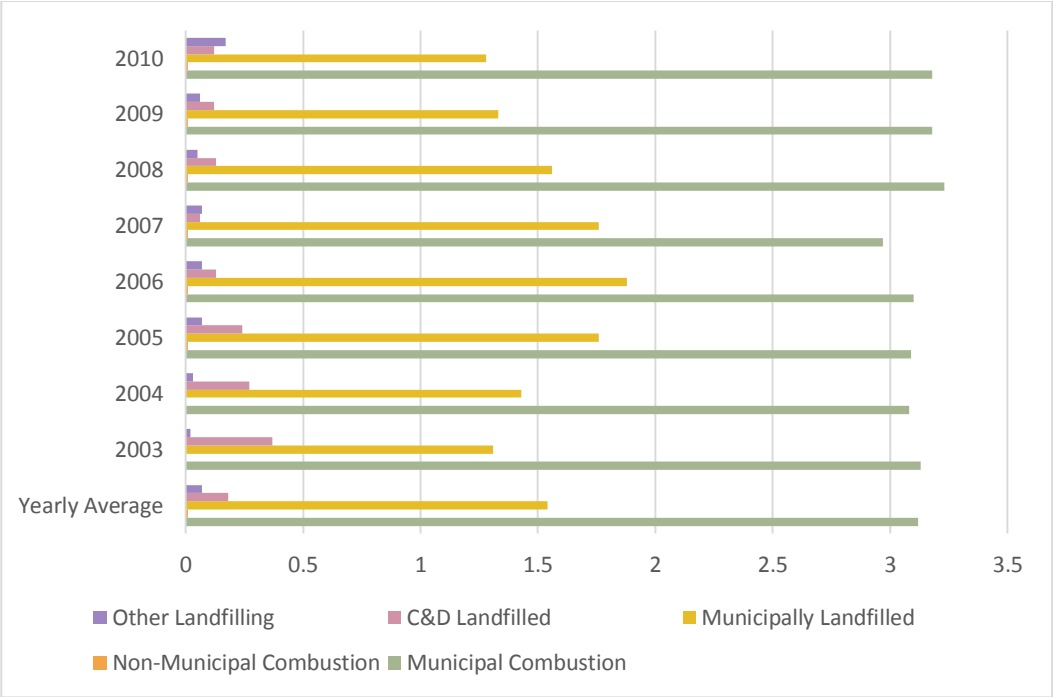
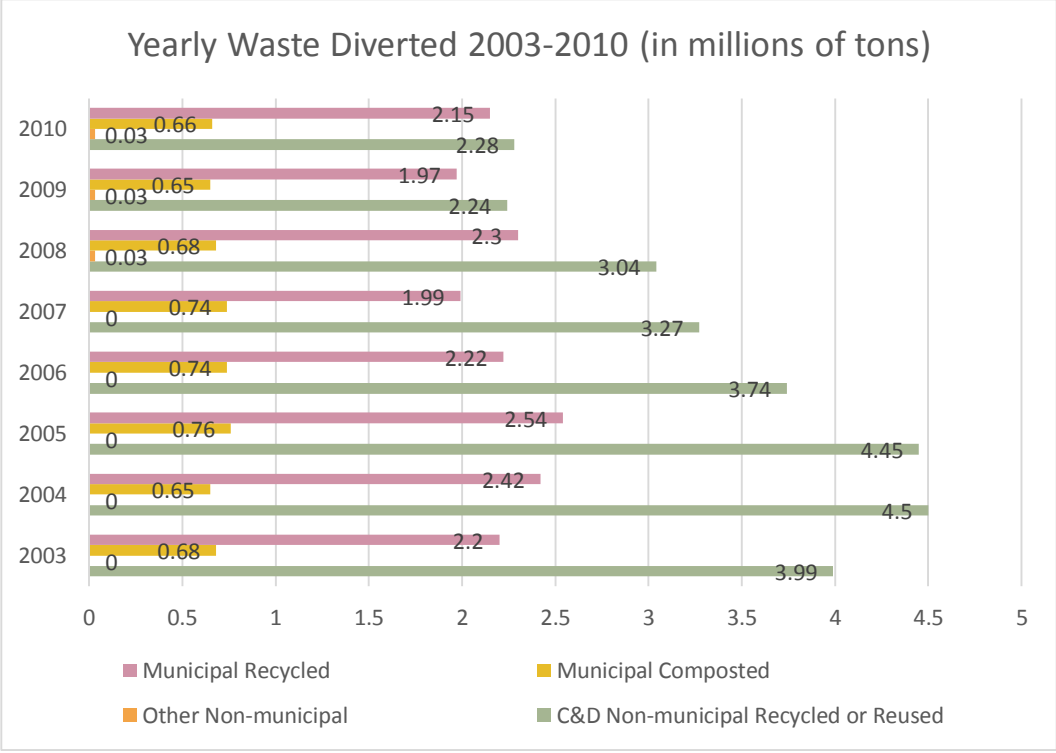


Figure 9: Yearly Waste Diverted Based on Generation Source 2003-2010 (in millions of tons) | Source: *(MassDEP, 2011)*



On the other hand, C&D material comprises about 22.6 % of the overall solid waste generated in MA, which is recycled or diverted from disposal at a rate between 66% and 75% depending on the year (MassDEP, 2013c, p. 69; MassDEP, 2011). (See Figure 9.)

State Waste Initiatives

Massachusetts employs a combination of regulation and providing supportive resources to stimulate higher diversion rates of useful materials. A primary tool used by the Massachusetts government is waste banning with the purpose of ensuring public and environmental health and safety. Currently there are bans on the following items:

- Asphalt pavement, brick & concrete
- Cathode ray tubes
- Clean gypsum wallboard
- Metals
- Aluminum containers
- Glass & metal containers
- Lead acid batteries
- Leaves & yard waste
- Recyclable paper, cardboard & paperboard
- Single resin narrow-necked plastics
- Treated & untreated wood & wood waste (banned from landfills only)
- White goods (large appliances)
- Whole tires (banned from landfills only; shredded tires acceptable)
- Any products containing mercury

(310 CMR 19.017, 2013)

In terms of strategies to encourage increased recycling rates, the state of Massachusetts requires a five cent deposit on soda and beer bottles. For the past 13 years the state has continually attempted to update the original 1983 Bottle Bill to include non-carbonated bottles with the exception of milk, infant formula, and liquid medicine bottles (Domenitz, News Release, 2013a). There is a 75 percent recycling rate for bottles that require the five cent deposit whereas only 25% of containers that do not require a deposit end up in the recycling stream (MassDEP, 2005). Commissioner Kimmell of MassDEP testified that 1.2 billion more

beverage containers would likely be recycled if the bill expanded to include other types of beverages consumed. Furthermore, and estimated $5 million out of $59 million of unclaimed bottle deposits in Governor Patrick's 2010 would help fund recycling programs budget if the bill was expanded (Dugan, 2010).

Other tools to support waste diversion, such as recycling, include technical and financial assistance programs. MassDEP will provide up to eighty hours of planning assistance for municipalities wanting pay as you throw (PAYT) programs, which require residents and businesses to pay for the quantity of trash they throw out rather than a flat waste disposal fee. Planning and implementation assistance is also provided by designated Municipal Assistance Coordinators (MAC). The MAC and members of MassDEP take calls from residents, businesses, and local officials to answer questions about PAYT and troubleshoot issues as they arise.

Also, MassDEP provides market development assistance for recycling businesses in the form of information, supplies, or loans. For example, the Recycling Loan Fund supplements funding to recycling businesses, which includes compost and anaerobic digestion (AD) facilities (BDC Capital, Financing Solution, 2013). Other types of assistance for AD projects include site assessment, feasibility studies, design assistance, and construction financing (MassDEP, 2013c). Some grants, loans and assistance programs for both private and public entities are distributed through MassDEP, while others come from available funding provided by the Massachusetts Department of Agricultural

Resources, Massachusetts Department of Energy Resources, Massachusetts Clean Energy Center as well as other federal and state agencies (MassDEP, 2013c).

Moreover, MassDEP works with schools on developing recycling and composting programs. Educating the public occurs through multiple online resources and community recycling coordinators. The state provides recycling bins for schools that are expanding or initiating recycling programs and does demonstration workshops on both recycling and composting. The intention is to decrease waste disposal and increase waste prevention and diversion, by passing pertinent knowledge on to the public. MassDEP also encourages education, donation and reuse through special programs like hosting textile collection competitions between municipalities.

Section Five: "Pathway to Zero Waste," The Massachusetts Plan

All of the previously listed policies and programs can be seen as creating a partial foundation for a zero waste future. Historically, the state has worked on an incremental basis, chipping away at disposal through diversion. Going forward, the plan will continue taking waste apart step by step. By 2020 the plan in Massachusetts is to reduce solid waste disposal by 30 percent based on actual 2008 disposal amounts, regardless of changes in consumption patterns or population. This would reduce disposal from 6,550,000 tons per year to 4,550,000 tons per year (MassDEP, 2013c). By 2050 the SWMP (2013) is to reduce disposal amounts by 80% based on actual 2008 disposal quantities, resulting in 1,310,000 tons waste disposed per year.

Entering the state dialogue are proposals that promote a shift from linear waste-management to a circular waste to resource trajectory, which requires rethinking product design. According to the SWMP, this includes the elimination of products containing toxic chemicals from disposal by 2050.

Pathway to Zero Waste outlines three main objectives; reduce waste and maximize recycling, improve the environmental performance of solid waste facilities, and develop integrated solid waste management systems. Within these objectives are focus points that can be summarized as the maximization of solid waste diversion, creating jobs and economic development, encouraging technological solutions to address disposal capacity limits, minimizing waste generation, growing regional waste and recycling networks, and encouraging more efficient and environmentally improved solid waste management systems that encompass more holistically all aspects of waste generation, diversion and disposal.

Strategies recognized in the SWMP are viewed as having both environmental benefits and providing economic opportunities. Several of the approaches are improvements or expansions of older strategies, whereas others are new methods. The 2010-2020 Solid Waste Master Plan, *Pathway to Zero Waste* (MassDEP, 2013c) outlines the following six new initiatives as a means of achieving the aforementioned objectives:

- Using recycling funding from municipal waste combustor renewable energy credits (REC) to fund recycling and composting initiatives through the Sustainable Materials Recovery Program;

- Establishing a framework for an extended producer responsibility (EPR) system. Work with Northeast states on a regional framework;
- Requiring haulers to provide full recycling services to their customers to ensure a level playing field for all waste haulers;
- Amending Massachusetts' siting regulations to streamline siting of recycling, anaerobic digestion and composting facilities while ensuring a high level of environmental performance (which was accomplished in November, 2012);
- Expanding MassDEP's authority over problem landfills to step in and conduct site cleanup work if needed;
- Establishing more rigorous waste ban standards and requiring waste composition studies by municipal waste combustors and landfills. (p. 16)

MassDEP's strategies range from securing and creating program funding, flexing regulatory muscle, establishing political regional networks, encouraging market based solutions through providing subsidies, education, and technical assistance. The following descriptions will outline these strategies in more detail. There are a total of 85 action items which are too numerous to cover individually. As such, this project will highlight some of the more the high profile initiatives.

Securing Funding

Budgetary constraints are probably one of the most significant impediments to implementing a plan that calls for significant change, making creative and secure sources of funding of utmost importance. The Waste to Energy Credit program, more formally referred to as Class II Renewable Energy Credits (REC) will be used to fund waste reduction and recycling programs. The

Green Communities Act (Chapter 169, 2008) allows permitted municipal combustion facilities to earn REC for turning waste into energy. Fifty percent of the revenue from sales of these credits must be dedicated to MassDEP approved recycling programs. It is estimated that about $6 million will be raised by these credits, which is the primary source of funding for most of the recycling initiatives outlined in the SWMP (MassDEP, 2013c); (Neale, 2013).

The 2010-2020 Massachusetts Solid Waste Master Plan lists increased enforcement resulting in fines as a strategy, and extending the Bottle Bill as possible avenues for revenue. The Bottle Bill has been previously discussed in this chapter and will continue to be debated in the upcoming legislative session. The unclaimed deposits and the suggested increase in charges to industry for the handling of returned bottles are both sources of needed revenue. In addition to the potential $5 million from unclaimed deposits if the Bottle Bill was updated (Dugan, 2010), MassDEP estimates that a one cent increase in handling charges would result in $16 million per year increased revenue (Domenitz, Update the Bottle Bill, 2013b).

In the case of a specific program, pay as you throw (PAYT), funding is generated directly from the program (MassDEP, 2013c); (G. Clark, personal communication, April 26, 2013); (D. Quinn, personal communication, April 23, 2013). PAYT may vary from one municipality to another, but the conceptual framework is to bring home to customers that waste management is not a free service. As previously stated, many municipalities have their residents pay a flat fee for waste hauling and disposal. In order to encourage more diversion of

recyclables and organics, a PAYT program makes customers pay for each bag of trash that they throw out. Recycling and compost programs are subsidized by the trash disposal fees.

According to the SWMP (MassDEP, 2013c), 24 percent of Massachusetts residents are covered by a PAYT program. Households in 2011 covered by PAYT that paid for all their garbage, generated 1,252 pounds per household. Those homes that were provided with one free barrel and had to pay for any bags beyond that generated 1,509 pounds per household. Households that had no PAYT program generated 1,927 pounds per household (D. Quinn, personal communication, April 23, 2013). The goal by 2020 is to raise the number of PAYT residents to 50 percent in order to divert an extra 500,000 tons of residential waste (MassDEP, 2013c). The SWMP posits these increases can be attained through technical assistance and grants provided to municipalities (MassDEP, 2013c).

Regulation

Lacking the financing to encourage market development, Massachusetts is utilizing regulatory muscle to support several initiatives that would inhibit waste from occurring, opening the market for waste-to-resource measures, and preventing disposal at landfills and incineration. In addition to increasing enforcement of current waste bans, MassDEP is poised to enact new legislation banning commercial/institutional food waste beginning the summer of 2014. Organics diversion constitutes a central focus for MassDEP in removing prioritized materials from the waste stream. The new regulations will initially

impact producers of one ton or more organic waste per week in the commercial sector, which is intended to drive the private sector to preclude waste and build the necessary infrastructure for organic waste management (MassDEP, 2013c). Included in the private sector are partnerships that MassDEP has been establishing with farmers and public water treatment facilities.

A majority of the SWMP revolves around building recycling and composting markets. There is a delicate balance between government interference and independent free market development. A new initiative MassDEP promotes in the SWMP is requiring all waste haulers to provide recycling services. Under the current system there are many haulers contracted independently in multiple overlapping service areas. Apart from having to comply with waste bans, the haulers operate without much regulatory oversight. MassDEP will "explore the development of legislation to establish new authority for MassDEP to regulate solid waste haulers and establish minimum statewide performance standards" (MassDEP, 2013c, p. 27). This would require haulers to register with the MassDEP, provide recycling services for every customer, participate in educating customers about recycling, and report to MassDEP the amounts of material they are diverting and disposing (MassDEP, 2013c).

Waste ban enforcement is a definitive aspect of building recycling and composting markets. Especially with the advent of WTE competing for feedstock streams, a steady supply of materials will be needed to support market demand and keep costs of recycled goods low. Waste ban compliance is required by haulers, generators, and facilities.

Legislating extended producer responsibility (EPR) is another method of reorganizing the materials market without directly dictating production markets. The intention of EPR is to reduce the burden on governments to manage material wastes and shift that responsibility to the producers. The national EPR program has become more prevalent in dealing with electronics, ceiling tiles, carpet and some beverage containers by encouraging the demand for recycled materials. Specifically the SWMP targets the aforementioned goods, plastic bags, and updating the Bottle Bill as part of EPR (MassDEP, 2013c). The SWMP proposes that action will occur through supporting legislation requiring EPR, working with existing business associations and take-back programs.

In terms of regulating material composition of products, the SWMP supports passing the "Safer Alternatives" bill, which promotes the removal of toxics from products when there are other less-toxic products available and economically feasible to substitute (MassDEP, 2013c).

Regional Cooperation

Also the SWMP calls for developing a regional framework including Maine, Vermont, Connecticut, New Hampshire, New York and New Jersey (J. Fischer, personal communication, July 26, 2013; (MassDEP, 2013c). This regional framework would reduce competition between states and increase the overall competitiveness of the Northeast region to supply industry with recycled and less toxic materials.

At the regional level, recycling market development is planned to occur through sharing equipment and information via internet resources. The SWMP suggests working with the Green Building Council to maximize recycled content material markets from C&D for new buildings and utilizing regionally appropriate materials. Material supplies could be located at regional reuse centers, which the SWMP prioritizes for funding. Also proposed are regional solid waste and recycling districts.

Directly Subsidizing Markets

Recycling jobs in materials management as well as manufacturing are promoted in the SWMP (2013) and by the state Commonwealth's Leading by Example Program. As recycling conserves energy and reduces emissions (Tellus Institute, December, 2008), the construction of clean and energy efficient buildings as recommended in Leading by Example should also incorporate more recycled materials into building plans. Leading by Example focuses on and Environmentally Preferable Product Procurement Program (EPP), where the state fosters market development through purchasing items with a minimum recycled content and working with contracts to take back product packaging when possible (MassDEP, 2013c, p. 43).

Furthermore, the SWMP "targets capacity development for new processing or manufacturing capacity for priority materials and provide direct start-up funding assistance to support these projects" (MassDEP, 2013c, p. 42). This may be supported through the low-interest state distributed Recycling Loan

Fund (RLF). Partnerships with research universities are encouraged for developing new material uses out of recycled materials (MassDEP, 2013c).

Education

Finally, the SWMP promotes engaging the larger community at hand through work with businesses and school programs. MassDEP collaborates with schools to develop "Green Team" strategies for recycling and composting that over 120,000 students have already participated in. MassDEP also works with businesses to establish or improve recycling programs (MassDEP, 2013c).

Evident by the many action items and objectives in the 2010-2020 SWMP, Massachusetts has a lot of work ahead of itself in order to secure its long-range goal of reducing disposal by 80% by 2050. The purpose of this study is *not* to determine if zero waste is a worthy goal, it is assumed to be so and supported by evidence thus far presented. Rather this project's aim is to evaluate key strategies outlined in the SWMP, assess challenges to achieving zero waste, and to make recommendations for achieving zero waste based on findings in the literature, interviews, and case studies.

Chapter 2: Research Methods

An assessment of the potential barriers for implementing zero waste strategies in Massachusetts is based on information gleaned from reviewing the academic literature on zero waste and sustainability as a framework for zero waste. Also instrumental to the assessment of zero waste barriers is the qualitative analysis of interviews and a single case study based on multiple data sources.

Evidence that includes documentation, archival records, and interviews offer a means of corroborating material provided by varying sources; also referred to as "triangulation" (Yin, 1984, p. 91). The information may contradict or support differing points of view, leading to a deeper understanding of the zero waste phenomenon and its context.

There are three main questions this research is focused on:

- *What are barriers and challenges to achieving zero waste?*

Potential barriers and challenges identified from the literature help to inform questions, asking the interviewees to think of multiple challenges to zero waste. Possible barriers may include physical infrastructural challenges, available technology, cultural customs or values, language barriers, lack of political will, public attitudes, revenue shortages, unstable or non-existent markets, business interests, or variances in defining zero waste.

- *What are the most effective strategies for achieving zero waste?*

Interviews are the primary basis for answering this question as there is a lack of data in the literature supporting a list of strategies for zero waste that have been successful. Additionally, there are no known cases of achieved "zero waste to landfill" (Krausz, 2012, p. 1), or what is known as eliminating 100% of the waste sent to landfills. Therefore, embedded in this line of query is logically the following.

- *What does zero waste progress or success look like?*

Instead of actually achieving 100% zero waste to landfills, the measurement of a strategy's success is likely about the process of getting closer to zero waste. In

other words, how do informants evaluate the process of narrowing in on zero waste? As definitions of zero waste range from aspirational to measurable waste decreases, it is expected that informants' views of a zero waste campaign's success will also vary.

Interview Purpose and Selecting Interviewees

The purpose of personal interviews is to more closely examine the relationship that stakeholders have with zero waste strategies. Themes to consider which facilitate the assessment of barriers to zero waste include the state of the economy, availability of technology, legislative process, political culture defined by stated goals, and infrastructure conditions.

Stakeholders in zero waste planning and policy are identified as those people who have participated in successful or attempted zero waste campaign initiatives. These stakeholders include advocates, policy makers, and waste managers. Advocates tend to work for non-profit entities that watchdog waste issues. Policy makers are people who write policy or influence the policy process. Waste managers work with the actual physical waste either as an organizer of waste, a hauler, or processor of waste.

These three classes of informants have been chosen, because they hold a primary affiliation to waste management and policy. Each role encompasses a different relationship to waste policies and is hoped provides comparable points of view across sectors. Interview questions are tailored to the specific role that each interviewee has in regards to zero waste. Many of the questions are open-ended in order that the informant can corroborate other sources of information

while espousing their own opinion (Yin, 1984). The specific list of questions can be found in Appendix C.

Within the three categories of zero waste stakeholders, interviews are sought in Massachusetts and in the area of the selected case study. No international interviews are conducted for this project. Interviews in Massachusetts assist in clarifying the momentum of zero waste in the state as well as the intention behind the 2010-2020 Massachusetts Solid Waste Master Plan, *Pathways to Zero Waste.* Is this really a plan leading to zero waste? What are perceived barriers to success of the plan? Is waste management policy in Massachusetts comparable to that of the case study?

The purpose of the case study interviews is to corroborate the multiple sources of evidence, illuminate the history leading to the current zero waste system, and to provide testimony that may be applicable to Massachusetts on its path to zero waste. Stakeholders interviewed for the case study are chosen based on association with the subject of zero waste, their potential knowledge base, scale of operation, as well as their willingness to participate.

In addition, interviewees for both Massachusetts and the case study are selected based on information obtained from other interviewees, creating a snow-ball effect. The following Table 4 lists the interviewees, their group and agency affiliation. However this list is not exhaustive of potential interviewees on zero waste. There are many more people who are involved in all three areas of waste management and policy that could make good informants. A more comprehensive list of potential interviewees from the United States is listed in Appendix D.

Table 4: List of Interviewees

Advocate/Community Leader	Policy Maker/ Governmental Leader	Waste Manager/ Processor/ Hauler
Ed Hsieh, MassRecycle Executive Director	Brooke Nash, MassDEP Recycling Subdivision Supervisor	Rob Gogan, Recycling and Waste Manager-Harvard
Gretel Clark, Hamilton Recycling Committee Chairperson	John Fischer, MassDEP Organics Subdivision Superviosr	*Bob Besso, SF Recology
Lynne Pledger, Clean Water Action	David Quinn, Barnstable Massachusetts Regional Waste Reduction Coordinator	
	*Alex Dimitriew, SF Dept. of Environment Zero Waste Commercial Coordinator	
	*Jack Macy, SF Dept. of Environment Senior Commercial Zero Waste Coordinator	

***Case study informant**

As previously mentioned, the purpose of this thesis is to assess barriers and strategies to achieving zero waste. This study was not about questioning the legitimacy of zero waste as a goal. Although the opinions of opponents to zero waste would be interesting, seeking their perspective was assumed to be outside the scope of this study.

Case Study Selection

Municipal and state government agency policies, plans, reports, maps and other online documentation are reviewed to determine the extent to which they are committing to the issue of waste as a resource. Are they supportive of zero waste strategies? What regulations have they instituted in regards to waste? How active are they currently pursuing zero waste issues?

The review of literature and online sources informed a comprehensive list of U.S. states and municipalities that promote zero waste goals. From the list,

potential case studies were selected based on whether zero waste was a goal, had achieved aspects of the goal, or was perceived as an accomplished zero waste location.

Initially the intention of case study selection was to identify locations with zero waste goals that had similarities to Massachusetts for a direct comparison, such as population size, regional location, or political organization. Quickly it was discovered that no such locations exist that exemplify all of these criteria. Since the basis of this thesis is to uncover the many varied aspects regarding zero waste and assess barriers that may pertain to Massachusetts as a state and as a collection of municipalities, selecting case studies was further modified according to the following criteria:

- *Location within the United States in order to more easily conduct interviews.*
- *Political scale.*
- *A marked perception of the case study as a leader in the field of zero waste.*
- *Availability of information regarding the place and waste programming.*
- *Willingness of informants to participate.*

Under the revised criteria, the only waste platform that matches Massachusetts' political scale at the state level is California. Furthermore, California is also seen as a leading state for zero waste programming. Based on

these two conditions, the state of California was selected for the case study research.

Chapter 3 Results: Characterization of Barriers and Zero Waste Strategies

The subsequent discussion will constitute a review of challenges and strategies for zero waste in Massachusetts based on information gained in the interviews and case study. The intention is to address the three main queries presented in Chapter 2; identify barriers and challenges to zero waste, discuss potential solutions, and ascertain what defines a successful zero waste campaign. Insights gained from the interviews with stakeholders will be initially presented, followed by the California case study. The final section of this chapter takes a closer look at California and Massachusetts to compare goals, strategies, and measurement of progress. The chapter wraps ups up with a discussion of the validity of incineration as a short-run solution.

In combination with reviewing the literature, the interviews with stakeholders and the case-study informed a list of primary barriers and challenges confronting zero waste programs. This list includes issues relating to all three components of sustainability planning framework; community leadership and public will, governance, and industry support. There exist struggles to continuously grow public support for programs, find initial and long-term financial stability, write new policy and enforce regulations, and deal with the internal differences between all factions in defining zero waste and the purpose behind it.

Revelations from Interviews

The intention of interviewing stakeholders in advocacy, policy and planning, and waste management was to provide testimony helping to flesh out the context to zero waste in Massachusetts. The goal of interviews from stakeholders in California was to give a background to compare and contrast Massachusetts issues against. As only U.S. interviews were conducted, the theme of precycling insurance could not be further developed from these interviews. Expectations were that interviewee responses would vary based on their particular locations and cultures while some overlapping themes would be found. Explanations for variance may have to do with cultural norms, the built environment, the economy, or mixture of reasons not previously identified.

All interviewees gave permission to use their names and the project thesis was exempted by Tufts Institutional Review Board. In the end, ten interviewees participated in the study. Four interviewees work in state or city government, and one works at the regional Massachusetts level. Three interview participants work for Massachusetts-based non-profit waste advocacy at either the municipal, state or regional level. The final two work in waste disposal management, one in San Francisco and the other for Harvard University.

Most interviews were conducted via the phone. All of the interviews gave insight as to the types of initiatives and programs that are utilized in California or Massachusetts at the municipal and state level, as well as some primary challenges they have faced. When applicable, the interviews are compared to each other, the literature, and online documentation as a means of validating or

providing alternative points of view to the assertions made by interviewees. Some interviews presented in this section also provided insights applicable to the California case study and will be discussed further in that section.

In general, a list of barriers that any campaign for change might encounter includes lack of political will or cohesion, corruption, the spread of misinformation, lack of technological options, infrastructure deficiencies, unstable markets, and unsustainable revenue sources. On the path to zero waste, altering a fundamental aspect of social organization, Massachusetts is confronted by all of these challenges to some degree. According to the interviewees and the literature, the most prominently identified barriers are listed below.

- *Goal framing and definitions of zero waste:* Differences were found between and among policy makers, advocates, and waste managers in framing of goals as a process or with a specific end amount of waste leftover. For some the target is to get as close to zero as possible and for others the goal is about getting to absolute zero waste for disposal, also sometimes referred to as "zero waste to landfill."
- *Measuring progress on the path to zero waste:* Embedded in the question of framing goals and definitions of zero waste are issues with long and short term goal setting. How progression of these goals should be measured varied widely, creating challenges to managing and identifying strengths and weaknesses to a program, as well as communicating waste issues to a broader public audience.
- *Powerful business interests influencing legislative policy:* Politicians paying more attention to commercial rather than public interests demonstrated a lack of political will to forward a zero waste agenda. The oil lobby and bottling manufacturers stood out as adversaries to zero waste, backed by an anti-environmental preference of the legislature.

- *Misinformation and lack of accurate public understanding* of both the issues and programs that address zero waste are aspects that foster a lack of public support. This included the belief trash disposal is cheap, PAYT programs are taxes, PAYT dictates to people how they have to behave, and that people are already recycling everything that they can.
- *Sustaining the momentum of a campaign:* During the initial phases there are many challenges faced by zero waste program implementation. These challenges have to have consistent persistent guidance to reach final implementation. Once begun, there are continued challenges facing a program's successful progression, including garnering full public compliance.
- *Economic instabilities caused by fluctuating global recycling markets:* Volatile recycling markets, changes in international policy, differences in recyclable material value all present challenges to zero waste programs.
- *Unsustainable long-term zero waste program funding:* Many programs aimed at reducing waste disposal charge more for waste and less for recycling. As the incentives work to change behavior, less people waste and less money comes in to support recycling services. Also, cash flow from specific funding accounts have been shifted away from recycling programs.
- *Conflicting relationships and lack of regulatory enforcement:* A conflict of interest develops in a multiple hauler scenario where the hauler is expected to also enforce the law against their own client. This leads to a lack of enforcement unless there is strong enforcement against all haulers. The more haulers, the harder it is to enforce the rules.
- *Infrastructure challenges and incorporating new technologies:* Both the built environment and access to technology are current barriers to zero waste goals. In the older Massachusetts cities and towns, the streetscape was not built to support massive hauling trucks to take waste away. Some places do not haul waste for residents and rely instead on inefficient systems of self-haul waste removal. Also there exist technologies that

could help remove segments of the waste stream, but have difficulty becoming integrated as a major part of the current infrastructure.

- *Needing flexibility to create new systems:* For new systems to take hold there needs to be some room for experimentation. This includes being able to find wiggle room in service fees and time to work out issues as they arise.

The following discussion will review each of the barriers in more detail through the eyes of the interviewees from three sectors of stakeholders: advocates, policy makers, and waste managers. Insights from the literature and interviewees to employ strategies to address these barriers will also be discussed.

Goal framing and definitions of zero waste

Advocates for zero waste and agents at MassDEP agree that goals and the framing of goals for achieving zero waste are an important component of enacting a successful zero waste campaign. Brooke Nash, Branch Chief for the Municipal Waste Reduction Program at MassDEP posits that goal setting has significance. In her opinion, the 2010-2020 SWMP could be more aggressive, which would push the state to make changes more quickly (B. Nash, personal communication, February 6, 2013). Her counterpart at MassDEP, John Fischer, Branch Chief for the Commercial Waste Reduction Program, proposed that making major changes in how materials are managed will take a longer time than some expect based on the existing infrastructure, people's habits regarding waste, and the current methods of material production and consumption (J. Fischer, personal communication, August 1, 2013).

> *While MassDEP can play an important role in advancing waste reduction through regulations, policies, compliance and enforcement, and grants and assistance, major changes in how materials are managed will require involvement and changes from all stakeholders, including municipalities, individual citizens, business owners, and the solid waste and recycling industry. (J. Fischer, personal communication, July 23, 2013)*

One of the most prominent differences between interviewees regarding zero waste in the SWMP is the loosening of the moratorium on incineration. Lynne Pledger, the Solid Waste Director for Clean Water Action's New England Division, indicated that planning for more incinerators renders the plan unworthy of the title "Pathway to Zero Waste" (L. Pledger, personal communication, May 8, 2013). Pledger's comments were echoed by Alex Dimitriew, the Zero Waste Coordinator for San Francisco's Department of the Environment who specified that there is no place for incinerators or landfills in defining zero waste (A. Dimitriew, personal communication, May 9, 2013).

From a purists perspective zero waste goals require that any item which "cannot be reused, repaired, rebuilt, refurbished, refinished, resold, recycled or composted…should be restricted, redesigned or removed from production" (Anonymous, 2013). There is fear that once the door is reopened and more incinerators are built, then the impetus for waste diversion will also be relaxed (S. Broude, personal communication, May 21, 2013; L. Pledger, personal communication, May 8, 2013).

Measuring progress on the path to zero waste

Although diversion and recycling rates can be an indicator of progress towards reducing waste, it is important to recognize that utilizing diversion or recycling rates as a benchmark of achievement can be misleading. Recycling and diversion rates can become inflated simply by consuming more recyclable goods. In other words, the recycling rate could be high, but the actual quantity of waste disposed may stay the same or increase if nothing is done to reduce the consumption and waste at the source.

Furthermore, diversion and recycling rates are sometimes based on an estimate of waste generation and source reduction. Source reduction is difficult to measure as it includes any type of waste that is reduced at the production and consumption level, such as home composting or using less packaging in retailing a product. According to CalRecycle, the California government agency in charge of waste management, which uses source reduction in quantifying recycling and diversion rates:

> *"Source reduction" means any action which causes a net reduction in the generation of solid waste. Source reduction includes, but is not limited to, reducing the use of nonrecyclable materials, replacing disposable materials and products with reusable materials and products, reducing packaging, reducing the amount of yard wastes generated, establishing garbage rate structures with incentives to reduce waste tonnage generated, and increasing the efficiency of the use of paper, cardboard, glass, metal, plastic, and other materials."* (CalRecycle, 2012b)

Recycling rates are often used as a measure of a program's success. In Massachusetts many of the study participants referred to recycling rates. For the purpose of zero waste in Massachusetts, the Solid Waste Master Plan (SWMP) focuses on an absolute number of quantities disposed of (landfilled or incinerated), rather than recycling rate percentage as a way to avoid misleading figures (MassDEP, 2013c).

When asked what constitutes a successful zero waste campaign, the responses varied from more ambiguous units of increased waste diversion and decreased waste generation, to "if we can get something big, like removing the 25% of organics from the waste stream, we are happy" (E. Hsieh, personal communication, May 9, 2013).

Powerful business interests influencing legislative policy

Another barrier identified by several interviewees and framed by Rob Gogan, the Recycling and Waste Manager for Harvard Campus Services is the "weak-kneed" (R. Gogan, personal communication, February 28, 2013) tendency of the legislature to adhere to private business interests over the needs and desires of the public. Nash, of MassDEP points to the "powerful oil lobby" as a reason why the government subsidizes the extraction of virgin resources over recycling and recovery markets, creating an "unlevelled playing field" (B. Nash, personal communication, February 6, 2013).

More than half of the interviewees indicated that business interests have played a part in preventing zero waste strategies and programs from being implemented. Probably the instance most clearly demonstrating business interest

overshadowing our democracy in the minds of the study participants can be seen in the failure of the state legislature to update the Bottle Bill and opposition to extended producer responsibility (EPR) programs. As MassDEP's John Fischer asserts, "The beverage industry has strongly opposed an expanded bottle bill in Massachusetts" (J. Fischer, personal communication, July 23, 2013).

Several interviewees pointed out the weakness of the Massachusetts legislature to give environmental issues fair and serious consideration. In particular, Massachusetts Speaker of the House, Robert DeLeo is singled out as someone who is anti-environment (R. Gogan, personal communication, February 28, 2013) and too "focused on casinos to address important environmental issues" (L. Pledger, personal communication, May 8, 2013).

For many people working in the world of recycling, the failure for the state legislature to pass the updated Bottle Bill over the past 13 years has been disappointing. During the summer of 2012 when the Bottle Bill was most recently rejected, a total of 208 Massachusetts cities and towns and 77% of people supported updating the Bottle Bill to include collecting a five cent deposit on more types of beverage containers (Domenitz, Update the Bottle Bill, 2013b). Furthermore, recycling is a known job creator (ILSR, 1997), which is a pertinent current theme of political focus. Reasons given as to why industry objects to the bill is that the bottlers are required to pay deposit handlers a fee of 2.5 cents per

bottle for collecting, storing and transporting returned bottles (Domenitz, News Release, 2013a).[5]

Misinformation and lack of accurate public understanding

Misinformation among citizens was cited as another key barrier to creating positive political will and cohesion. Gretel Clark heralded as Hamilton's Recycling Committee's "Superhero," and David Quinn, Barnstable County's Massachusetts Regional Waste Reduction Coordinator agree that people sometimes oppose zero waste initiatives, such as pay as you throw (PAYT), because they do not understand what the program will do for them, or they think they are already doing their part for recycling.

Whereas traditional trash collection systems are based on a single stable fee, PAYT incentivizes recycling and compost by charging customers higher rates for anything not recycled or composted. Another way to think about flat-fees is that they allow people who create the most trash to rely on people who create less trash to supplement the cost of waste collection. Instead of making everyone pay a flat-rate for waste removal services, the PAYT system treats waste as a "unit-based" fee, similar to the rate systems for utilities or water. Awareness campaigns have focused on the unfairness of a flat-rate fee for trash removal as a way to raise awareness about waste generation and encourage customers to 'reduce, reuse, and recycle.'

[5] The proposed fee is expected to increase by one penny in this years' Bottle Bill battle on the House floor in order to help keep redemption centers in business.

Opposition to changes in waste management and promoting zero waste cuts to the core of how people in this country tend to feel about their personal liberties without taking into account who is funding those liberties now and into the future. As Nash points out "people are emotional about their trash and about being told what to do with their trash" (B. Nash, personal communication, February 6, 2013). Clark frames the problem as "a royal battle with people who think we are taking away their rights" when in reality "they are costing everyone else in town for not recycling" (G. Clark, personal communication, April 26, 2013).

To allay resistance to the PAYT program Gretel Clark advocated for in Hamilton, MA, she and her Wenham counterpart went to countless meetings and presented findings and research at public forums, ballgames, and elections. Confronting the expansion of the program were misinformed and sometimes hostile residents. Also, she womanned a town hotline to answer simple questions and responded to occassionally irate townspeople about the program until the questions and complaints stopped (G. Clark, personal communication, April 26, 2013).

In the first nine months with the new system, Hamilton waste disposal decreased 30% (539 tons), recycling increased 24% (198 tons), organics collected equaled 229 tons which alone saved Hamilton over $25,000 in disposal costs (MassDEP, 2013d). By removing the organics from the disposal stream, the town was able to cut in half tipping fees (the costs to the town for disposal) (G. Clark, personal communication, April 26, 2013).

In addition, there is the misconception that people hold that they are already doing plenty of recycling or all the recycling that they can. Quinn spoke about how he works with people to support PAYT programs who say that they are already recycling everything. Then it sometimes turns out that they are unaware of programs like the textile recycling program that allows recycling of every fiber product used for clothing, bedding, bathing, curtains, stuffed animals, and etc. that is free from hazardous waste contamination at Goodwill, Salvation Army and many other places. Furthermore, incentives are lacking for people to do more than what they already do (D. Quinn, personal communication, April 23, 2013). Pledger of Clean Water Action agreed that many people lack motivation to improve their recycling habits. Also she expressed that there may be less motivation to create new waste reform policy, because Massachusetts has historically had higher rates of recycling than many other states (L. Pledger, personal communication, July 31, 2013).

Because there is not much consistency between states and even towns in how waste is managed, there is often misinformation among people who are living in one place and working in another. This is true all over the country where municipalities all vary in their dealings with waste. Further complicating matters in Massachusetts are areas of the state where some residents are "seasonal" who are mostly vacationing and who cause massive influxes into the waste stream on a temporary, albeit predictable time frame. In Quinn's opinion, these seasonal residents do not tend to have a long term commitment to the local community or

think much about what to do with their waste (D. Quinn, personal communication, April 23, 2013).

Education and outreach to overcome these issues cannot be overstated. One outstanding urban success for SF Department of Environment and Recology has been the branding of their "three cart system", synchronicity of their message and the extensive outreach communicated by both entities. If there is an issue with a customer, Recology will communicate to SF Department of Environment and they will send a letter explaining what the customer needs to do to reach compliance. They do education in multiple languages customized to the neighborhood or the individual (B. Besso, personal communication, February 21, 2013). Also, they will do onsite educational visits for residents that are having difficulty separating into the three carts. Although cultural norms may differ between urban areas and more suburban or rural places, the important lesson is to cater the message to the people intended to receive it.

Sustaining the momentum of a campaign

As the Chairperson of the Recycle Committee in Hamilton, Gretel Clark's position is volunteer-based and appointed by Hamilton's Board of Selectmen. The town of Hamilton is a mostly rural-suburban town located in northeastern Essex County of Massachusetts. Clark has been involved in the initial stages, as well as the continued development of the town's current three-bin curbside waste/recycling/compost collection.

In 2006, Hamilton instituted a Waste Ban Enforcement (WBE) program mandating that the town's hauler refuse the collection of any visible recyclables

(plastic, paper, metal, glass) mixed in with trash. In 2009 Clark initiated a pilot program to quantify the amount of food waste being thrown out with the trash. Then in April 2010 the pilot program expanded to food waste collection for 600 households funded by an individual household per year fee of $75 in Wenham and Hamilton.

In 2012, a "three-sort" program was put into effect requiring residents to source separate compostables, recyclables, and residuals into three separate bins. The residuals bin was limited to 33 gallons per household and pick-up for that specific bin occurs every other week. Recycling and compost are collected weekly. If residents have an overflow of trash belonging in the residuals bin, they are required to purchase overflow bags (PAYT) that can only be picked-up on the alternate weeks (MassDEP, 2013d).

What led to successful crafting and implementation of a zero waste initiative is a story of consistent perseverance on the part of Gretel Clark who championed the program away from a waste-favoring system, to a waste reducing pay as you throw (PAYT) system. An initial challenge was gathering support for the program by the Board of Selectman whose votes were needed to approve the change from waste paid through flat tax rate to unit based pricing. She earned the support of her town's elected officials by taking advantage of opportunities, like carpooling to events, to forward the agenda about waste issues (G. Clark, personal communication, April 26, 2013).

Clark has persisted through delays in funding and combating misinformation. Getting all residents to change their habits has been a continuous battle. Clark and her volunteer committee are in the process of tracking and procuring feedback from residents whom are not complying and setting up "in-house coaching" for those that need the extra push (G. Clark, personal communication, April 26, 2013). In the end, Hamilton's three-sort program and bi-weekly trash collection system is paralleled in design only by Portland, Oregon (G. Clark, personal communication, April 26, 2013).

Not every place can count on a volunteer to act as their local champion they way that Clark has. In all likelihood, most places will not, which is why it is important for the expansion of zero waste programs to be heralded by people who can be employed as Zero Waste Coordinators, as they have in places like San Francisco. In Massachusetts there are Municipal Assistance Coordinators (MAC) that are contracted by MassDEP and have the potential to become those coordinators.

It should be noted that even in places that have longer standing waste reduction programs, like San Francisco, sustaining good behavior in the long-run poses a continual challenge (A. Dimitriew, personal communication, May 9, 2013). San Francisco experiences challenges in garnering full compliance. Bob Besso, the Recycling Program and Waste Reduction Manager for Recology's SF company, pointed out that in addition to what they receive in the green and blue carts, the black cart's composition remains at about 1/3 compostable and 1/3 recyclable, while only 1/3 contains the refuse that actually belongs in the black

cart. To reach their absolute zero waste goal by 2020, they need to strategize on how to deal with the remaining portions of waste, the final 1/3 that currently belongs in the black cart. They are looking at technological solutions, developing smaller scale localized sorting facilities for the waste and AD development for much of the organic waste, like pet waste that is remaining in the black cart (B. Besso, personal communication, February 21, 2013).

Economic instabilities caused by fluctuating global recycling markets

Volatile recycling markets are another barrier to successful recycling campaigns. During the beginning of the Recession in 2008, the recycling market came to a standstill (MassDEP, 2013c). Bales of plastic piled up and some haulers refused to collect recyclables, because there was no place to sell the materials. Many of the waste haulers and processors are forced to weather the fluctuations in market value for recyclables, which poses a threat to the viability of their businesses.

The volatility of the recycling market continues to be an issue for recyclers. Initially, recyclers baled all their plastics without separating them and sent them overseas to be manufactured into something else. Recently, China began rejecting plastics with the resin code of 3, 6, or 7 (Profita, 2013). These codes represent plastics such as coffee cup lids, clamshell containers, and PVC pipes. Reasons for the recent rejections can be sourced to China's "Operation Green Fence," where customs officials are becoming more rigorous in their import inspections for hazardous waste contamination or loads of plastic that are contaminated with too much non-plastic material (Jansen, 2013).

There has been some speculation that the customs inspections represent a tactic to manipulate the market prices of recyclable material feedstocks[6] (Jansen, 2013). Whether intentional or unintentional, the result is that recyclers are forced to look for alternative markets or cheap ways of disposal for their rejected plastic loads. There is already an extraordinary amount of plastics in the oceans from "accidental" spills from cargo ships.[7]

The impact this has on recycling markets, as well as the global economy should not be underestimated. Not only is scrap material the number one export from Boston's piers (B. Nash, personal communication, Feb. 6, 2013), in 2011, recycling of scrap metals, paper, and plastic became the number one U.S. export to China valued at $11.3 billion (Jacobs, 2013). Combined scrap materials were worth more than soybeans ($10.45 billion) and nearly double the value of aircraft and aircraft parts ($6.32 billion) (Jacobs, 2013).

When suddenly a primary consumer of the number one U.S. export begins to change the rules and restrict supplies, the impact is far reaching for the U.S. economy. Some places, like San Francisco, are already beginning to see the value of creating more markets for manufacturing from recycled plastics locally as a way to have more agency in controlling material feedstocks (A. Dimitriew,

[6] "Feedstock" is a general industry term for any material that has the capacity to be turned into another material or product. Petrol is a feedstock for many plastics. Corn is feedstock for high-fructose corn syrup. Scrap materials are feedstock for many goods made from recycled goods.
[7] For more information on plastic pollution in the ocean, especially in regards to the Great Pacific Garbage Patch and the Atlantic Ocean plastic patch, visit http://ocean.nationalgeographic.com/ocean/critical-issues-marine-pollution/ or follow Plastiki http://ocean.nationalgeographic.com/ocean/explore/plastiki/

personal communication, May 9, 2013). Massachusetts also plans to continue supporting local recycling markets with procurement policies within state government agencies under the Lead by Example initiative, which requires state government agencies to purchase products made from recycled content when it is feasible (MassDEP, 2013c).

Further impacting the recycling markets is the relationship between different recyclable materials and the value of each recyclable material put in a recycling bin. There are vast differences between what is technically recyclable and what is economically feasible to recycle. Styrofoam and glass are cases in point. Although it is technically recyclable, Styrofoam is not easily collected and transported because it is so light. Glass is not as highly valued as most other recycled materials, but is included in most recycling programs. The resale of metals, paper and plastic collected from recycling bins helps to pay for the collection of glass and other less valuable materials.

Unsustainable long-term zero waste program funding

Many times the rates for refuse collection are set by local municipalities and taken out of property taxes or collected as a set fee. Changes to these fees and taxes are voted on and need public support. Even though the costs associated with waste collection may rise with inflation, the rates for collection are essentially capped and do not reflect the rising costs. When rates are capped, there is little to no funding available to cover new programs for recycling and organics diversion. Instead, those programs have to rely on revenue from the sale of recyclable or compostable materials for industrial and commercial inputs.

Pay as you throw (PAYT) has been used to pay for the recycling programs. The more garbage a customer throws out, the more they pay. Recycling and composting in this programs is usually "free" or less expensive. The unit based rate for garbage pick-up subsidizes the collection of recyclables and compostables. There are a couple types of PAYT programs in Massachusetts. As of 2011 five Massachusetts communities are allowed one free trash barrel and pay for waste beyond that and 130 communities pay for all the trash they do not recycle (D. Quinn, personal communication, April 23, 2013). Each program structure is tailored by municipalities as they see fit.

In some programs, such as the three-cart system in San Francisco, customers are charged a fee for garbage (the black cart) and then their recycling (blue cart) and compost (green cart) volumes count as a discount towards their garbage rates. These programs are cited as the reason that SF has achieved an 80% diversion rate (A. Dimitriew, personal communication, May 9, 2013) and towns like Hamilton have seen their recycling rates skyrocket from 20% to 40% within months of implementation (G. Clark, personal communication, April 26, 2013).

The difficulty comes when the program succeeds at diverting significant amounts of recyclable materials and the whole program loses revenue, jeopardizing its sustainability. The city and Recology have tried out several fee collection schemes. Both San Francisco and Recology identified the most recent system highlighted in the previous paragraph as unsustainable in the long run. Eventually there will be a charge for both recycling and compost collection, but

the plan is to gradually phase out the discount system and keep the black cart rates higher than the green and blue cart (B. Besso, personal communication, February 21, 2013). The issue of sustainable funding is a long-range issue.

MassDEP is at a different stage in the process as Massachusetts is confronted with the short-range goal of increasing recycling rates in a time of impending disposal capacity shortfalls and stagnant recycling rates. However, places that have successful recycling programs, such as San Francisco and Hamilton are faced with inverting the model so people now pay for the recycling and compost services that they have become accustomed to utilizing. If the state of Massachusetts reaches its goals via PAYT programs, they will also face the issue of long-term funding.

Program funding is further undermined by misappropriating revenues raised by zero waste initiatives and directing the cash flow elsewhere in the budget. Initially, unclaimed deposits from beverage containers in Massachusetts went into the Clean Environment Fund to support recycling efforts. In 2003 the mandate requiring unclaimed deposits to be deposited into the Clean Environment Fund was repealed and the revenue is now directed to the General Fund, while recycling programs scramble for viability.

Also related to the deficits in program funding has been the lack of enforcement for waste banned materials. Waste bans can be a driving force to recyclables collections in states where cash-strapped departments are looking for

results. To be effective, there has to be follow-through to make waste processors, haulers, and customers adhere to regulations.

Conflicting relationships and lack of regulatory enforcement

San Francisco cites their unique relationship with their hauler as part of reason they have gotten higher than average compliance. In many cases, as is true in Massachusetts, enforcement depends on the hauler. This relationship of the hauler as a service provider and enforcement professional contradicts itself when there are multiple haulers. When a customer does not want to comply with waste bans, they can fire their hauler/enforcer and find another one. In San Francisco the city can rely on the hauler to inform them of customers who refused to comply with the law because the city, not the individual being serviced is the hauler's client (B. Besso, personal communication, February 21, 2013). In a system with many haulers contracted by individuals, there is a negative incentive to make customers comply as they can just find someone else to do their dirty work for them.

They system of compliance in Massachusetts depends on effective enforcement on the haulers and waste processors. Previously in Massachusetts, budgetary constraints were cited as the reason that enforcement had been difficult (B. Nash, personal communication, February 6, 2013; J. Fischer, pers. comm., February 28, 2013; E. Hsieh, personal communication, May 9, 2013). Yet enforcement should lead to fines, which should lead to the ability to fund enforcement. With the recession, many State Departments were not allowed to hire new personnel. Recently, Massachusetts hired three new waste ban

enforcement members in preparation for the new organics diversion policy set for the summer of 2014.

Infrastructure challenges and incorporating new technologies

The built environment and access to technology are cornerstone pieces to smooth and well-functioning waste to resource systems such as zero waste. John Fischer of MassDEP, Gretel Clark of the Hamilton Recycle Committee, David Quinn of Barnstable's Regional Waste Reduction program, and Edward Hsieh of MassRecycle cited infrastructure issues as barriers to furthering zero waste goals. The structure of narrow streets and overall lack of space in the North End of Boston pose challenges to waste collection trucks and adding separate bins for compost and recycle collection (E. Hsieh, personal communication, May 9, 2013). Hamilton, Massachusetts was challenged by infrastructure shortcomings. Clark succeeded in getting the utility company to raise their wires so a hauler with a specialized truck could make the collection rounds (G. Clark, personal communication, April 26, 2013).

Although Massachusetts has an overall recycling rate of about 48% in 2010, there are places where the recycling infrastructure is highly inefficient. This can be seen on the Cape where most residents are responsible for their own waste hauling to the transfer station just to drop off their recyclables (D. Quinn, personal communication, April 23, 2013). There are waste haulers contracted by residents and by the municipalities, but not all of them provide services for recycling or compost, forcing residents to either self-haul or to take the easy route and dump it all in the trash (D. Quinn, personal communication, April 23, 2013).

One of the most promising markets for organics is anaerobic digestion (AD), turning food and yard waste into energy (Bailey, Waste-Of-Energy, 2011). There are about fourteen AD facilities in MA (MassDEP, 2013b). Two of these facilities are farms and twelve are wastewater-treatment plants. Through partnerships with several state departments, six of the wastewater treatment plants are conducting feasibility studies to include food waste as part of AD energy production (MassDEP, 2013a). Jordan Dairy is one of the farms and is heralded as an AD success story, creating electricity out of manure and food waste from four food companies. The farm produces 1.7 million kWh of energy each year, which is equivalent to removing four cars from the road every year (MCEC, 2011).

Restructuring the built environment takes a large financial investment, political support, and time. These are changes that are unlikely to happen quickly.

> We see all the things that have to happen and we see it (zero waste) taking more time. If you think it needs to happen by 2020, then there are serious barriers. By 2050, there will be time for those systemic changes to develop and be implemented. (J. Fischer, personal communication, July 31, 2013)

Another challenge related to technology arises from the continual development of new products that claim they are biodegradable or compostable, but lack any oversight in production or verification. There are international compostable standards certified by The Biodegradable Products Institute (BPI), a not-for-profit association comprised of individuals from government, academia, and industry. Often retailers, customers, and even some producers do not have the

necessary information to discern between "biodegradable" and "compostable" (B. Besso, personal communication, Feb. 21, 2013). As a result, there is risk of contaminating the recycling stream with unstable plastic components that are meant to break down, which destroys the potential of these contaminated plastics from being reutilized as the recycling feedstock they were intended to be. Furthermore, biodegradables do not break down in landfills, as many people believe, but instead are mummified by the landfill process (BPI, 2013).

Needing flexibility to create new systems

Any new or improved system of operations or technology needs a flexible time schedule, financial and technical support in order to work out the kinks of the system and give it a chance to become established. In Hamilton, Clark had support from the Selectmen, she worked closely with MassDEP, the hauler, and a farm to process the organic waste. The practice of hauling and processing residential organic waste was new to the whole Massachusetts state. When the program was first being tested and then implemented, she said she spoke with MassDEP and the hauler every day. This close relationship created a support network and allowed for necessary quick access to sharing important information and making needed adjustments.

According to Edward Hsieh, the Executive Director of MassRecycle a non-profit recycling education advocacy group in Massachusetts, the market for waste haulers is tight and competition is steep (E. Hsieh, personal communication, May 9, 2013). There is not much cushion in the market allowing service providers to weather market fluctuations or test out new types of services, because they

could get undercut at any moment by the competing providers. In the case of Hamilton, the hauler saw an opportunity and shaped their business around what most would have perceived as a gamble. The hauler bought a new truck that would make their collection operations of the three types of waste more efficient and cost-effective (G. Clark, personal communication, Apr. 26, 2013), but only if the pilot program succeeded and they continued to provide services past the trial period.

On a much larger and more urban scale, San Francisco has a similar program to Hamilton in that they require customers to source separate recycling (blue cart), organics (green cart), and refuse (black cart). A nationally unique feature of the program is their single-permitted waste hauler and processor, the worker-owned cooperative, Recology-SF. In the early 20th century, San Francisco suffered major issues of corruption, derelict waste haulers, illegal dumping, and other problems with their trash removal system (B. Besso, personal communication, Feb. 21, 2013; A. Dimitriew, personal communication, May 9, 2013). As a result, in 1932 the city restricted permitting to different waste districts in which each could be contracted by a single waste hauler.

By the late 1980's, Recology had collected all the permits and became the city's sole hauler permitted to charge for waste removal activities (B. Besso, personal communication, Feb. 21, 2013). Other haulers may be contracted by residents or commercial enterprises for a fee to collect recycling and compost, but not the black cart (A. Dimitriew, personal communication, May 9, 2013). The result has been a unique and reliable relationship appreciated by both sides (B.

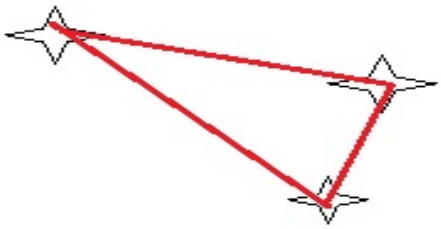
Besso, personal communication, Feb. 21, 2013; A. Dimitriew, personal communication, May 9, 2013).

Also put in place was a system that requires the waste hauler had to get permission from the city in order to modify their service fees, giving the city more control over the market (B. Besso, personal communication, February 21, 2013). Although in theory, a monopoly would lead to increased consumer costs, in practice it has not. In large part the prices are kept at comparable levels to other cities because the municipality controls the price and type of services offered. In return, the city does not collect a franchise fee from Recology, which helps to keep Recology's cost of operations down.

Other potential benefits are lower environmental costs and overhead costs to the hauler on a *per customer basis* as a result of fewer trucks with inefficient overlapping routes in neighborhoods that would otherwise have multiple trucks traveling to different customers in the same neighborhood. Using Figure 10, imagine the two scenarios are the routes traveled by haulers in two different situations (the stars represent neighborhoods). In one situation there is one hauler collecting three different neighborhoods' waste. In another scenario there are three haulers collecting the waste in three different neighborhoods with overlapping routes. Assume the trucks are all the same type and use the same type of fuel. Which scenario seems more efficient? Which scenario uses less fuel, produces less greenhouse gas emissions, causes less wear and tear on the road, and costs the hauler less on a per customer basis to fuel and maintain the trucks?

Figure 10: Three Truck Routes in Three Neighborhoods

Vs. One Truck Route in Three Neighborhoods



In addition to savings on a per customer basis for the hauler, logically it follows that CO_2 emissions, noise disturbances, and wear and tear of the roads is reduced in a single hauler scenario saving the residents in health costs and the city in infrastructure improvements.

Not everyone is a fan of the regulated monopoly that has evolved. Former California state Senator and Judge Quentin Kopp states that the city is losing "hundreds of millions of dollars in franchise fees" (Phelan, 2011) that the city could be collecting from competitive bidders. Tony Kelly, a local activist, said that the ratepayers of San Francisco were paying too much, based on comparisons to neighboring San Jose (Local CBS SF, 2012). Yet when comparing prices of waste services in the two municipalities, it appears that San Francisco services have been provided at comparable pricing.

Table 5: San Francisco and San Jose Single Family Waste Removal Costs, 2013

San Francisco Single Family Residential Per month $$$	San Jose Single Family Residential Per Month $$$
32 gal. recycle bin **32 gal. compost bin** **(including food and yard waste)** **Total ==========$9** **Plus 20 gal trash bin==========$25**	**32 gal. recycle bin** **20 gal. trash bin** **Total==========$28** **Plus 32 gal yard waste bin=== $33** **(no food waste)**

For a 20 gallon trash bin, one 32 gallon compost bin and one 32 gallon recycling bin, Recology charges about $25 per month (Recology, 2013). If a resident can manage without the monthly trash bin, then their total price for recycling and compost services is only $9 per month. For a similar service (yard trimmings, but not food waste) San Jose was charging residents $33 per month, or $28 without the 32 gallon bucket for yard trimmings (Jose, 2013). Beginning in July, 2013, San Jose discontinued charging all but the yard trimming fees. See Appendix F for more details. Yet, San Jose cannot claim to have separated curbside collection of waste, food waste and recycling and an 80% diversion rate of waste. In other words, the two cities are not paying for the same service.

Three separate times the voters of San Francisco have been asked to repudiate the monopoly that Recology has been granted and each time the voters have supported to retain the status quo (Krausz, 2012). Outreach Director for Recology stated that the collection fees for San Francisco are on par with the Bay Area and different proposals than the one the city currently has with Recology do not “guarantee for lower rates but does guarantee an increased bureaucracy at City

Hall" (Local CBS SF, 2012). As for the franchise fees that the city is not collecting from Recology and potential competing bidders, those costs would have to be passed on to ratepayers in the long-run, anyway. The city has opted for arguable the best waste removal service in the country in place of raising revenues through fees that would make residents cost of living a little bit higher.

Finally, the waste removal system is funded directly from the fees people pay for their waste. Since SF has the ability to control the service fees and the public has to comply with waste removal, they are able to create sustainable funding for their programs and the flexibility to implement new programs as needed. The salaries and other operation costs for SF Department of Environment all come out of an "impound account" collected by Recology from waste removal fees and then distributed to the Department (A. Dimitriew, personal communication, May 9, 2013).

Case Study: California's 75% Recycling Goal

California, the state that leads the nation

Comparisons centered on the scale of implementation proved a challenge to this research project, because so few (if any) states have adopted a state-wide zero waste plan. Based on the criteria outlined in the methods for the selection of case studies, a unique case study emerged: the state of California. In particular, California fit the description of a state that is seen as a leader for zero waste (Liss, 2013); (O'Connell, 2002).

Overall the case study highlights that California is in the process of defining a waste reduction plan for 75% recycling by 2020. This short term goal

is difficult to compare to that of Massachusetts' goal to decrease waste disposal to 30% by 2020, but there are a number of similarities in the two plans. One of the main findings is that there are different ways to measure progress towards zero waste. Looking at it from many angles, including information about population, the state of the economy, waste generation, disposal, and diversion provides a more holistic picture of what is happening with waste today.

The California case brings up an interesting question; why is California considered a leader in zero waste? On the one hand a report contracted by the California Integrated Waste Management Board (CIWMB), the state entity producing and managing waste policy for California now known as CalRecycle, indicated that California has committed to a zero waste goal (Cascadia Consulting Group, 2009). On the other hand, CalRecycle avoids the phrasing "zero waste" in any documentation declaring goals, purpose or the state's vision. However, the language of their vision statement is similar to definitions of zero waste. According to their website, the CalRecycle vision is:

"To inspire and challenge Californians to achieve the highest waste reduction, recycling, and reuse goals in the nation through innovation and creativity, sound advancements in science and technology, and efficient programs that improve economic vitality and environmental sustainability" (CalRecycle, 2012d).

Although the state does not claim that they are zero waste or on a path to zero waste, California's 75% state-wide recycling goal is ambitious. As a sub-proclamation, zero waste is a goal (CalRecycle, 2012a). Primarily California

provided a backdrop to evaluate Massachusetts progress, answering questions of how to define zero waste and detailing intricacies involved in measuring waste reduction progress. Accordingly, California proved a worthwhile study for this project especially in looking at the question how we define a successful zero waste campaign.

Contributing to the perception that California is the country's leader in zero waste (Liss, 2013) is the quantity of municipalities and communities in California that have adopted zero waste goals or plans. Overall there are 11 California communities listed by the Zero Waste International Alliance as having zero waste goals. Embedded in the success of California overall is the success of these communities. As such, interviews for the California study were sought from its leading zero waste city, San Francisco. Informants included two members of the San Francisco Department of Environment and one person from the San Francisco branch of the regional waste hauling and processing industry, Recology. Data representing the California case study relies on the literature, online documents, and these interviews at the municipal level.

Further supporting California's image as a leader of the pack for zero waste is the state's overall diversion rates for waste. In 1989 the state passed AB 939, the Integrated Waste Management Act which spurred California to a 65% diversion rate. Also, California passed the Beverage Container Recycling Act and the Litter Reduction Act, which provided the platform for their current bottle recycling rate of 82% and overall 2010 recycling rate of 49% (CalRecycle, 2012a).

The California Plan

At this point the California plan for enacting AB 341 to achieve a 75% recycling goal by 2020 is still in draft phase, considering stakeholder input through "workshops, webinars, and working groups" (CalRecycle, 2012a, p. 4). The final presentation is slated for completion by January 2014. By the time this thesis project is finished, there may be many changes that could not have been taken into account before completion. Regardless of the stage of their process, since California has been listed as a leader for the nation on the issue of zero waste, it is considered worthwhile to provide a general overview of their latest draft plan in order to establish context for comparison with the Massachusetts SWMP. Particular attention will be paid to the proposed strategies that make the plan stand out as a zero waste leader.

The California plan to reach 75% recycling employs a number of commendable strategies, many of which are similar to the Massachusetts 2010-2020 SWMP. The plan lists the following ten focus areas: increase recycling infrastructure, organics, commercial recycling, establish extended producer responsibility, reform the beverage container program, increase procurement and demand, other materials management, governance and funding, source reduction, and the other 25% (CalRecycle, California's New Goal, 2012a).

Although the Zero Waste International Alliance lists California as a "zero waste state," the focus of the California plan is on recycling 75%. According to the plan if California is able to recycle 75% of the material waste stream, there might still be 25% that is not yet recyclable (CalRecycle, 2012a, p. 63). The

discussion of the "Other 25%" includes the need for gathering more information about what materials make up this final 25%, education to promote local and private sector zero waste, the potential for more staff to address this final 25%, and defining a "Beneficial Use Policy". The new policy would consider guidance on "waste-to-energy, combustion ash in road base, or land application of green materials" (CalRecycle, 2012a, p. 63).

Even though zero waste may be a guiding principal, California has not fully adopted the concept of zero waste as a brand or that zero waste means no incineration or landfills. One could argue that their focus strategies support zero waste progress in the short-term by 2020, but the state appears focused on marketing efforts promoting recycling and building recycling markets rather than achieving zero waste at this time (CalRecycle, 2012a).

The new goal of achieving a 75% recycling rate takes into account population growth and economic fluctuations. The base from which the state wishes to reduce is approximated using the average per capita generation rate of total solid waste between 1990 and 2010, which is 10.7 pounds/person/ day (CalRecycle, 2012a). This rate represents an average of the total solid waste generated, including waste from commercial enterprises and industry, divided by the total state population. That is to say that California wishes to recycle 75% of the average per capita waste generated per day and limit disposal to a per capita rate of 2.7 pounds/day of disposal (CalRecycle, 2012f).

Measuring California Progress

In the previous 20 years, California has focused on diversion rates to measure the progression of their waste reduction goals. Diversion rates according to the AB 939 resolution (which required that all California municipalities reach 50% diversion by 2000) consist of recycling, composting, and the use of landfill cover, alternative daily cover (ADC) and alternative intermediate cover (AIC). ADC and AIC may comprise of incineration ash residuals used to cap landfills or hazardous soils, and materials for beneficial reuse or transformation, such as tires or roads turned into fuel (CalRecycle, 2012a).

Shifting from diversion rates, California's most recent framework of measurement is the promotion of a "recycling rate" of 75% through resolution AB 341 that includes everything from source reduction, recycling, composting, and anaerobic digestion (AD) (CalRecycle, 2012e). AB 341 removes from the equation materials used for "alternative daily cover (ADC) used at California landfills; alternative intermediate cover at California landfills; beneficial reuse at California landfills; material transformed at California transformation facilities; and used-tire derived fuel at California facilities" (CalRecycle, 2012a, p. 7).

The difference between the two measurements is intended to reflect a more pure recycling measure. "Source reduction" is a vague term that lacks concrete defined measurement in the CalRecycle documents. The data is collected by households and businesses (CalRecycle, 2012e), which could vary widely depending on the sample reporting.

Not only is the term "source reduction" confusing, but in order to compare goals across states or among municipalities, one has to pay close attention to the definitions of "disposal rates", "diversion rates", "recycling rates", and "waste generation" and how those definitions are changing. Based on these nuances, one can conclude that the complexity of defining their waste measurement rates could be a barrier to most people understanding exactly what California aims to achieve and how they plan on achieving it.

According to Jack Macy, the Senior Commercial Zero Waste Coordinator for the San Francisco Department of the Environment, using the state's measurement for diversion, the city complies with and already surpasses the state's goal of 75% recycling rate with their own 80% diversion rate (J. Macy, personal communication, May 16, 2013). Although San Francisco followed the overall methodology for California when reporting diversion rates to the state, the city's individual method of measurement is changing as they get closer to zero waste. Moving forward, San Francisco is focusing on the actual quantities of disposal rather than recycling or diversion rates. Disposal quantities at landfills tend to be more straightforward and easier to quantify than calculating rates.

Macy took issue with per capita measures of waste disposal, indicating that it is difficult to compare in places where commercial activity is high, like San Francisco (J. Macy, personal communication, May 16, 2013). Actually, the per capita measure may punish places where the economic sector is strong. Generally speaking, greater commercial activity that results from higher levels of product consumption tends to create more discards. If the economic boom leads to higher

rates of waste generation, but the population stays at about the same level, then the per capita rate of waste disposed will also tend to rise. In this situation imagine the following equations represent the two opposite outcomes:

rate of diversion > rate of waste generation = per capita rate of disposal decreases.

rate of diversion < rate of waste generation = per capita rate of disposal increases.

To clarify, even if the rate of diversion is increasing, the rate of per capita disposal will still increase if waste generation as the result of economic activity increases at a faster rate than waste diversion. The only way for a levelled off population with a high level of commercial activity to decrease the per capita disposal rate is to increase the diversion rate surpassing the rate of waste generation.

To clarify further, California as a state is moving away from measuring diversion as a percentage of generation to a recycling rate based on how much waste is generated per person and how much is disposed per person. Source generation continues to play a role in their reported recycling rates. Furhermore, when a population grows or the economy is doing well, it is expected the amount of waste generated will naturally increase. Unless people improve reducing and reusing materials, the disposal rate will continue to grow as well.

Each method of measurement paints a slightly different picture and puts emphasis on different aspects of the waste cycle. Waste diversion is only one piece of the zero waste puzzle. As places improve their education about waste, it would behoove these places to be able to measure the impact education has had

on behavior change. Program funding often depends on the ability to show results. Possibly, "source reduction" may prove a way to include behavior change as a result of education. Other places may focus on disposal rates or even quantities. The variety of methods presented together may provide the most accurate depiction of a program's success.

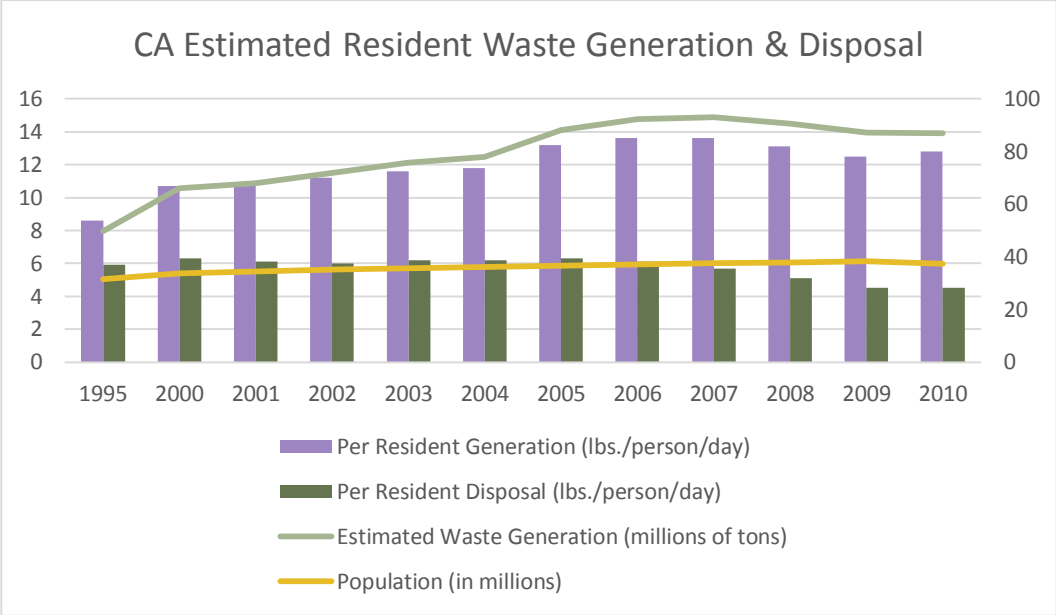
In the overall representation of zero waste these varying methods of measurement may seem like trivial differences. Yet, if we are to analyze the progression towards a successful zero waste program, then there has to be a way to compare what methods different locations are implementing to demonstrate their success. Which is why undefined methods of "source reduction" are problematic and can create doubt in the validity of a zero waste program's progress. Are the diversion rates touted by California communities and therefore, the state as a whole more about saving political face than attaining zero waste?

In looking at San Francisco's numbers between 2000 and 2010, it is obvious that there have been significant gains in waste diversion and reductions in disposal. In 2000, the rate of diversion was 46%. Source reduction, calculated according to the generally accepted California model, counted for less than 1%. In 2010, the rate of diversion was 77.8% and source reduction counted for about 2% (J. Macy, personal communication, May 16, 2013).

California overall saw a rise in per capita waste generation between 1995 (8.6 pounds/person/day) and 2010 (12.8 pounds/person/day). Yet during the same

time period the state per capita waste disposal went from 5.9 to 4.5 pounds/person/day (See Table 6).

Table 6: California Estimated Resident Generation and Disposal Per Capita Rates, 1995-2010 (lbs./person/day) | Sources: (CalRecycle, 2012c; CalRecycle, 2012f)



In response to the question regarding diversion rates as a means of saving political face, the answer is probably not. Even so the question begs for public transparency. How is source generation calculated? Without the ability to track over time how this number is consistently generated, how does the public verify that the information they are given by the state is accurate and not manipulated by the need for political validation?

Comparing California and Massachusetts "Paths to Zero Waste"

Massachusetts and California are very different states. One thing they have in common is both state agencies in charge of waste planning, CalRecycle for California and the Department of Environmental Protection for Massachusetts, proclaim a commitment to zero waste in their statewide waste plans. As presented

in Chapter 1, the list of states in the U.S. includes only California. Since Massachusetts had developed their SWMP to include a zero waste proclamation, it was curious why they were not acknowledged on the ZWIA web listing of zero waste places last updated in February, 2013.

When requested via email if ZWIA would include Massachusetts on the list, the founder, Gary Liss and his eastern zero waste advocacy counterpart, Lynne Pledger responded that by relaxing the moratorium on incineration and allowing for the expansion of waste combustion facilities in the latest version of the SWMP, the state negated its own efforts to make the SWMP a real zero waste plan (L. Pledger and G. Liss, personal communication, March 15, 2013). This peaked further interest in comparing the states' plans in regards to their zero waste aspirations, the clarity and definition of their goals, and the states' plans for disposal of materials that have no other place to go at this time. What is it about California's plan that makes it stand out as a leader for zero waste?

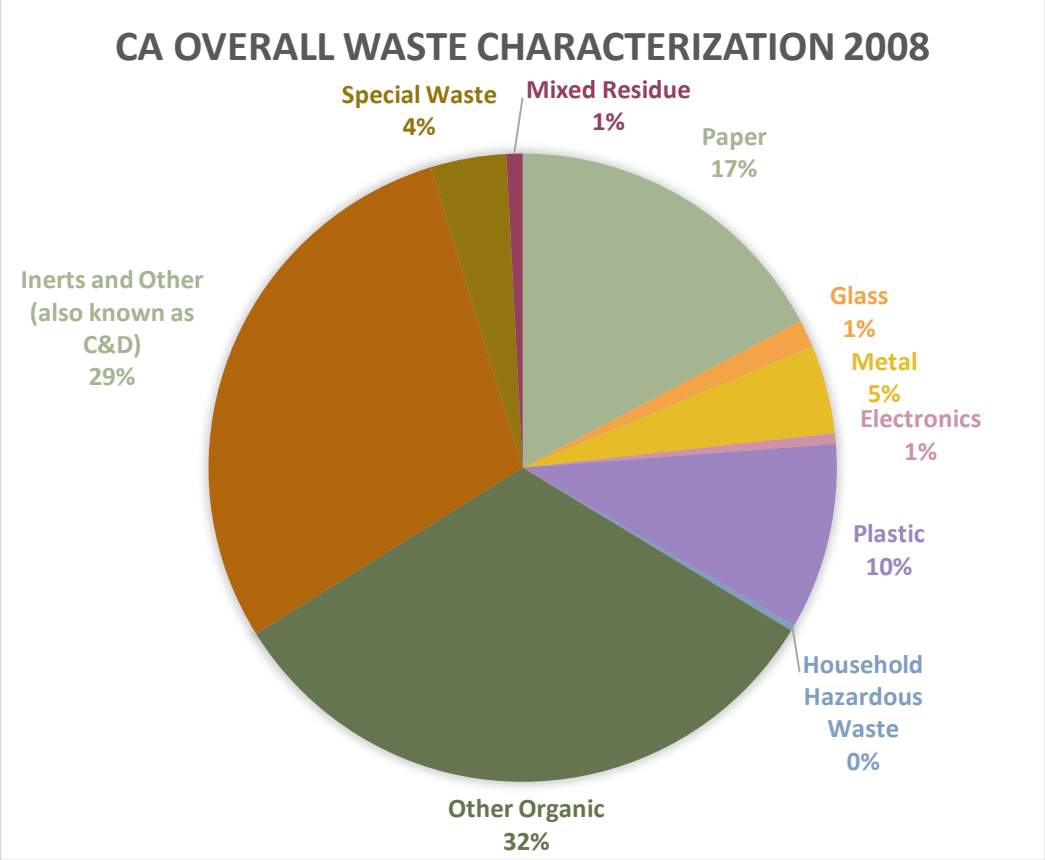
This led to the question; can we compare California's goal to increase a recycling rate to 75% by 2020 to the Massachusetts goal of 30% waste disposal reduction by 2020 as part of an overall zero waste plan? Several factors hinder direct quantitative comparisons between the two states and their goals. The two states are very different in geographic and population size. The baseline years that each state founded their goals represent different years. More importantly, what they are each measuring differs. The Massachusetts disposal reduction is a static quantity based on 2008, whereas the California goal is a per capita reduction that is allowed to fluctuate with population and economic changes over time. These

are nuanced ways of defining goals and evaluating metrics that potentially mean different things. We may not be able to directly compare the future recycling and disposal goals of these two programs, but hopefully we are able to compare the data.

Although the amount of waste that is generated on a yearly basis in California greatly outweighs what is produced in Massachusetts, there are other similarities. What is called Municipal Solid Waste (MSW) in Massachusetts is called "Residential and Commercial Waste" in California. Similar to Massachusetts, this portion of the waste stream takes up about 80% of the waste sent to disposal facilities. Self-hauled Commercial Waste takes up about 84% of the self-hauled materials, analogous to the 84% of C&D non-municipal solid waste in Massachusetts. Which is to say there are some resemblances in sector based waste between the two states as understood from the Massachusetts SWMP and the Cascadia Consulting Study in 2008.

Like materials in comparable quantities make up the disposal stream. In both Massachusetts and California, paper and organics are two primary components of the total waste stream. C&D materials are present in higher quantities in California, although C&D materials were in the top four categories in Massachusetts. In both states, wood is a key component of the C&D waste stream (Cascadia Consulting Group, 2009; MassDEP, 2013c).

Figure 11: California Overall Waste Characterization 2008 (estimated at 39.7 million tons). See Appendix E for material details.



Source: Cascadia Consulting Group, 2009, Table 7: Composition of California's Overall Disposed Waste Stream by Material Type

The 65% "diversion rate equivalent" from 2010, touted by California as the historical measure of success, is much higher than Massachusetts' 48.5% diversion rate from that same year (a difference of 16.5%). But when California takes that same year and limits the measure to recycling, compost and source reduction, the rate drops to 49% in 2010 (CalRecycle, 2012f). Whereas in Massachusetts, when you calculate the recycling rate using MSW recycling, compost, and C&D recycling while excluding all "other diversion," the Massachusetts rate only drops to 44%, lagging California by a narrower margin of 5 percentage points. Massachusetts may not be as far behind California as many

would believe. Since we have no way of measuring California's source reduction, the difference between the states can only shrink.

Table 7: Comparing California and Massachusetts Benchmarks

	State Reported Diversion Rate 2010	Estimated Recycling Rate 2010	State Goals by 2020
California	65%	49%	Limit disposal to 2.7 lbs./person/day by 2020 (also known as 25% per capita waste disposal or 75% recycling rate)
Massachusetts	48.5%	44%	Limit disposal to 4.55 million tons of disposal by 2020 (also known as 30% 2008 disposal reduction) and 1.31 million tons by 2050 (also known as 80% 2008 disposal reduction)
Rate difference between states	16.5%	5%	N/A

Within the California plan, the organics focus mimics the Massachusetts Organics Waste Ban poised for action starting in 2014. Establishing extended producer responsibility (EPR) and reforming the beverage container program are similar to the Massachusetts stated goals. Also the focus on creating local manufacturing in recycled plastic goods and state departments local purchasing preference for products with post-consumer recycled content as part of growing locally produced goods is similar within both plans.

Aspects that differ in the California plan when compared to the Massachusetts SWMP are numerous. In the California plan, there is more discussion of increasing tipping fees, which are the costs of dumping a load of material. Also the California plan speaks to Cap & Trade funds, which are a

category of tradable permits. Other California goals are to utilize methane produced from AD for vehicle transportation fuels, increasing the materials separation at Material Recovery Facilities (MRF), and create minimum recycled content laws for glass beverage containers and other paper or plastic products. Lastly, the California plan lists as a goal the recovery of wasted tires and other materials to be recycled into products made and sold in California.

Both California and Massachusetts focused their plans on recycling markets. Indeed, recycling is an important end of the pipe solution. Yet, in terms of source reduction, neither plan offers anything more concrete than they will continue work on EPR and Environmentally Preferable Product Procurement Program (EPP) with the private sector.

When it comes down to what to do with the residual waste that is not composted or recycled, California discusses creating capacity limits for landfills, potentially continuing to burn residuals for energy (i.e. incineration) and turning residual combustion ash into materials for roads (CalRecycle, 2012a). Massachusetts has decided that waste to energy incineration is the best option for what to do with the majority of their residual waste. What seems to differentiate the two plans more than their dedication to zero waste or their zero waste strategies is that Massachusetts has already made the decision to loosen their moratorium on incineration and California is in the process of discussing that same option for themselves.

Does Incineration fit into a Zero Waste Plan?

In Massachusetts, landfilling is the most expensive in-state option for disposal and the capacity for landfills in-state is declining. Currently, there is not the capacity to compost, recycle, and digest all of the waste that is created in the state (MassDEP, 2013c). For these reasons and the federally subsidized incentives for renewable energy credits (REC), MassDEP argues that incineration technologies such as gasification or pyrolysis, with environmental performance improvements and assessment, can be a viable option for reducing landfill waste.

On the one hand, MassDEP sounds committed to making sure that these types of combustion technologies will not harm public health. Yet, the following statement underlines public concern: "An assessment of the environmental and public health impacts of burning C&D materials for energy generation will be conducted *when funding allows…*and other materials will be assessed over time *as needed*" (MassDEP, 2013c, p. 48). There is something unsettling about safeguards for protecting environmental health depending on the stability of funding in a time of stagnant recession.

Although the SWMP refers to gasification and pyrolysis as "alternative technologies" (MassDEP, 2013c, p. 47) that are part of advancements in combustion practices that have developed since the incineration moratorium was initially put in place, community advocates, scientists and non-profit organizations fiercely debate this assertion. According to the Global Alliance for Incinerator Alternatives (GAIA, 2012), even the most technologically advanced incineration techniques may not adequately prevent hazardous air pollution. Also, scientists have noted that although air pollution emission levels may be slightly

less in gasification or pyrolysis, the char (solid remainder) would show high concentrations of pollutants negating air emission gains (Fitchner Consulting Engineers Limited, March, 2004).

In 2008, MassDEP commissioned a report assessment of materials management by the Tellus Institute in partnership with Cascadia Consulting Group and Sound Resource Management. According to this report, evidence has shown that pyrolysis and gasification are thermal technologies that result in the same levels of air pollutants and potentially higher levels of CO2 emissions than older incineration technologies, even though some plants in Europe were able to meet emissions standards (Tellus Institute, December, 2008). Furthermore, multiple instances of pyrolysis and gasification plants were closed due to economic infeasibility, operational failures or environmental hazards (Tellus Institute, December, 2008; Ciplet, 2009).

What zero waste advocates fear is seemingly coming true. If the infrastructure was already in place and the cost of sustainable zero waste solutions was less than landfilling and incineration, then it logically follows the traditional linear waste management would die out. This is not yet the case. At the moment when the tide of linear waste management was set to turn and make the market open up to anaerobic digestion (AD) and maximize recycling, the state is going to allow the expansion of resource competing waste-to-energy facilities that utilize gasification or pyrolysis. Long-time (30 years) waste advocate and resident of Cambridge, Amy Perlmutter, points out that a fraction of the money spent on

these technologies could be invested in creating "a world class (recycling) program" (Perlmutter, 2013).

Although the moratorium would remain in place for traditional waste to energy technologies, and MassDEP would only allow for gasification or pyrolysis to be permitted on a limited basis, up to 350,000 tons of annual capacity (J. Fischer, personal communication, May 17, 2013), in the eyes of many zero waste advocates the attempts to dissuade the public's fear by describing gasification and pyrolysis as new and improved technologies undermines the legitimacy of the plan as a commitment to zero waste (L. Pledger, personal communication, May 8, 2013; S. Broude, personal communication, May 21, 2013).

A different point of view was presented by Edward Hsieh, the Director of MassRecycle non-profit organization. He states that people "forget what a realistic approach is" and that there "has to be incremental changes to get us there (to zero waste)" (E. Hsieh, personal communication, May 9, 2013). Also, it can be difficult to know which parts to focus on since many pieces of the waste management puzzle in Massachusetts are moving all at once. Within the incinerator debate, the state has to take into consideration the maximization of landfill capacity, stagnant recycling rates, costs and reliability to shipping waste outside of the state, and the impact of new regulations. Considering all these factors, there remains an estimated shortfall of 2 million tons per year of waste disposal capacity by the year 2020 (Neale, 2013).

Commissioner of MassDEP, Kenneth Kimmell points out that there is a certain portion of the waste stream that cannot be recycled or composted at this

time and it would be inappropriate to continue sending this waste to another state (Andersen, 2013). Given the current available technology, there is only one method of disposing residuals; landfilling. Incineration and anaerobic digestion (AD) reduce residuals which then have to be disposed or transformed into something else. Taking into account the tipping fees at landfills in Massachusetts and the cost and absence of AD facilities, incineration appears to be the least expensive option the state has to eliminate residual waste. Moreover, incineration will generate income from energy and earn REC.

Could the state be setting itself up for failure by permitting this cheaper technology? When pressed for an immediate solution for disposal that does not include incineration, staunch opposition to lifting the moratorium on incinerators cannot come up with a current technology that is available and will seal off the waste disposal gap (L. Pledger, personal communication, May 8, 2013). The closest anyone can get is to establish facilities to pre-treat residuals, recover the maximum amount of organics and recyclables, and landfill the remainder as a means of storing materials for future use rather than burning them (Pledger, 2013). Granted, there are many steps that could be taken to mitigate the need for incineration, but the stark reality is that waste generated today has to have a place to go until the state has built enough non-incineration capacity. If it does not have a place, it will end up somewhere we do not want.

An in depth analysis of the long-term environmental and subsequent financial impacts of AD for eliminating residuals versus specific types of incineration, such as gasification or pyrolysis, was outside the scope of this study.

Yet, even without comparing the long-term costs associated with each technology, it logically follows that expanded incineration would create competition for AD materials. Meaning that if AD is a better WTE option for the environment in the long-run, but is more expensive in the short-run than different incineration techniques, the market will favor incineration and further hinder the development of AD. This may become a barrier to AD, a technology regarded by zero waste practitioners as a viable zero waste technology (B. Besso, personal communication, February 21, 2010).

Chapter 4: Policy Recommendations and Conclusions

In the Massachusetts 2010-2020 Solid Waste Master Plan: *Pathway to Zero Waste*, the state identified the need to incorporate zero waste as a strategy to reduce greenhouse gases and overall pollution impacts. The purpose of this thesis is to identify barriers or challenges that the state of Massachusetts faces in becoming a zero waste state as identified in the literature, from interviews and through case study research. From these sources, a list of challenges was identified and discussed in the preceding chapter.

The following section outlines several strategies that are recommended for Massachusetts to employ in order to achieve a zero waste future. These recommendations are offered as best management practices based on information gleaned from the literature, California case study, as well as interviews with policy makers, waste managers, and waste advocates. Recommendations may encourage development of plans already in action or they may be strategies unfamiliar, but applicable to Massachusetts. The strategy of implementing

precycling insurance could not be explored in the interviews and is based solely on the literature thus far reviewed.

Table 8: Summary of Recommendations

Focus on the management of material content produced for goods and packaging	• *Legislate bans and the phasing out of toxic and non-recyclable materials* • *Incentivize manufacturers in the development stage of non-toxic and recyclable products providing grants and loans*
Support the stabilization of recycling markets for local and regionally manufactured goods and anaerobic digestion	• *Encourage recycling infrastructure through recycling market expansion within MA and New England* • *Develop AD potential among farmers, food processors, public waste-water treatment facilities, and energy companies*
Legislate the phase out of landfill and incineration technologies	• *Support recycling and clean energy technologies by eliminating the competition for resources at waste-to-energy plants* • *Provide a time-table and plan to end incineration*
Identify, expand, and direct sustainable funding sources	• *Expand PAYT* • *Engage legislature in discussion about updating Bottle Bill and reclaim revenue for recycling* • *Collect fee from producers for products that are difficult to recycle and use to fund recycling programs*
Investigate and legislate circular economic policies	• *Conduct research comparing taxes, fees, and precycling and recycling insurance for product manufacturing*
Continuing Education	• *Focus on job creation and economic vitality of recycling markets* • *Utilize innovative information sharing, such as strategic green gamification* • *Support, develop, and fund local champions*
Research potential for streamlining processes and infrastructure	• *Explore the potential for supporting regional organization of haulers and waste facilities, similar to utilities and water systems*
Engage federal agencies	• *Collaborate with federal agencies in developing EPR, recycling infrastructure, monitoring pollution, and developing grants*

As previously acknowledged, there are many players that fulfill roles in many aspects of waste management at this scale. These recommendations are targeted for the Massachusetts state government and agencies as this was an analysis of state policy. Therefore, in the following discussion of recommendations it will be assumed that the state has a role to play.

Focus on the management of material content produced for goods and packaging

The framing of zero waste should be founded on waste reduction through the redesigning products to remove materials that are toxic or do not fall into categories appropriate for recycling or remanufacturing markets. The list of materials, products, and processes that have toxic and detrimental environmental impact needs to expand. These products should continue to be banned or phased out of the economic system.

The current SWMP is vague on how it plans to implement the phase out of problematic materials. Although this type of legislation is difficult to achieve, it is probably some of the most essential work that the state can do. Collaborating directly with manufacturers and providing grants and loans to businesses that are developing non-toxic and recyclable products has the potential for economic development. The private sector will not be able to accomplish this alone and needs the governmental sector to intervene. As such, materials management needs to be a top governmental priority for zero waste to ever become a reality.

Support the stabilization of recycling markets for local and regionally manufactured goods and anaerobic digestion

The expansion of recycling markets for all materials, especially organics is one of the most important initiatives of *Pathway to Zero Waste*. Listed in the plan is an excellent array of ideas including performance-based start-up grants for municipalities, seed money for regional reuse facilities and new equipment, education and web-based information tools, funding Municipal Assistance Coordinators (MAC), and expanding PAYT programs to 50 percent of the state's residents (MassDEP, 2013c).

Key to settling the instability of recycling markets is for the state to encourage recycling materials and manufacturing recycled materials in Massachusetts and the larger New England region. Just as we need to reduce our dependency on foreign oil, it makes sense to reduce our dependency on other countries for material goods made from recyclables. These are resources that the state should try to retain and utilize locally to create more jobs.

The development of infrastructure to support locally sourced energy from AD is critical for making sustainable markets in organics waste management. The regulations will help to drive organics diversion. Furthermore, if organics become and are marketed as a valuable energy resource, the diversion from waste will be much easier to achieve. Partnerships with farmers, fishermen, food processors and public wastewater-treatment facilities for AD development shows promise. Partnerships with energy companies for AD development would also have benefits for locally-produced energy. Although the feedstock for AD does

seasonally vary with food production, AD has the advantage that it is not an intermittent source of renewable energy.

Legislate the phase out of landfill and incineration technologies

In order to truly support zero waste there should be an exit strategy and time frame established for diminishing reliance on competing incineration technologies. Phasing out landfills and incinerators should be clearly defined with an end-date for their use. Right now the state is capping the amount of incineration capacity expansion, but there is still room to address the public's concerns about expanding incineration by outlining an exit plan. As there is a predicted capacity shortfall by 2020, then set a goal of addressing that gap with a combination of methods that galvanize political support for zero waste, create impetus for behavior and product changes, develop and maximize clean AD technology for organics, and investigate methods of greater source separation of materials in order to reduce reliance on incineration. Some of these strategies will be further developed in this chapter.

Maybe our government has become afraid to state a goal as strong as 100% zero waste, because of fear that they will not achieve exactly what they set out to do? In the current state of linear waste management and economic systems that still use resources inefficiently, no one yet knows how to 100% eliminate the need for disposal. Yet, zero waste cannot come to fruition if there is not a real vision for it and dedication to an actual zero waste goal. For zero waste to happen, there needs to be a plan to attack the problem through rigorous enforcement, market development, and laws that encourage or require changes in the materials

used in consumables. As someone wise once said, "The scale of our ambitions must match the scale of the problems as a whole" (The Social Network for Sustainability, 2013).

Identify, expand, and direct sustainable funding sources

Consumers have to take responsibility for the results of their actions. According to several interviewees, PAYT is probably the most effective tool for raising consumer awareness and impacting waste customer's behavior, while reducing disposal and increasing diversion (B. Nash, personal communication, February 6,2013; D. Quinn, personal communication, April 23, 2013). PAYT also marks the transition to unit-based pricing, which forces people to pay for their habits rather than relying on the community to pick up the tab. This step is vital in transforming people's relationship to their waste and establishing a system that begins to reflect the real costs of waste management programs, which leads to overall waste management sustainability.

Consumers are one piece of the puzzle. The other side of sustainable funding should come from producers. Producers of goods that are difficult to recycle should be charged a fee for waste processing. The fee may be an appropriate avenue to raise revenue in support of developing more recycling markets or changes in product design and must be directed to a fund for that purpose. The fee should be reflective of the costs to innovate new technologies, renovate waste processing facilities, cleanup of litter and pollution from waste treatment, and establish recycling markets.

As admirable as MassDEP and advocates have been in staying with the fight for updating the Bottle Bill, the strategies of the past 13 years have not yet demonstrated success. Somehow the legislature and bottle manufacturers need to be held accountable and drawn out into public discussion about their resistance to updating the Bottle Bill. Besides inviting more stakeholders for collaborative problem solving sessions that includes the bottling manufacturers and other private sector resistors to the table to figure this out, there is not much more that the state can do. If they can bring all the stakeholders to the table, they might be able to work out a solution that is agreeable to all sides.

Investigate and legislate circular economic policies

The downside of EPR as it is currently promoted is that it is implemented on a case by case basis, limiting impacts to the business sector that is under review, such as paint producers, carpet and electronics manufacturers. Financial responsibility for product redesign is acutely directed to a few industries and relies heavily on the ability of lawmakers to legislate each product individually. Also, EPR does nothing to prevent new toxic and difficult to manage products from entering the market and causing havoc for waste managers.

More research needs to be done on the feasibility and implementation of legalizing circular economic policies such as pre-cycling and recycling insurance, which mandate producers to pay into a fund for improving product design with reuse and end-of-use in mind. Further investigation would be needed in order to understand if a fee, tax, or insurance would be more politically appropriate and produce the desired consequences in the long-run.

Instead of implementing incremental changes, which get more difficult to achieve as we get closer to zero waste, policies need to be created that incentivize product stewardship (Greyson, 2007). Pre-cycling and recycling are the bookends of extended producer responsibility. The benefits of the insurance policy is that it provides shared costs to society, stabilizing markets for recyclability, while correcting for market failures in production and consumption. This sounds similar to a tax, but differs in that the rates directly reflect the product's recyclability.

In order to level the playing field for producers and encourage widespread market development, the national implementation of an insurance policy or tax would have the most expansive impact. National implementation would reduce regional imbalances created by taxing or charging precycling fees that eventually get passed on to consumers. Politically speaking, a national policy seems very unlikely.

Although many hurdles would be expected at the state level, precycling/recycling insurance has a better chance of passing than at the national level. One negative impact that a state precycling/recycling policy like this may have at the local level could include reduced consumption of luxury goods within the state as people might be motivated to travel to another state to purchase their more expensive non-recyclable items in neighboring states, avoiding the subsequently higher local consumer prices.

In order to remedy such behavior, regional alliances should be sought after among Northeast states. If multi-state regional implementation is possible, this

would give states a consumption buffer to reduce out of state travels to purchase goods impacted by taxes or increased costs from purchasing insurance. The more producers insured or impacted by taxes, the stronger recycling markets will become and the more funding for non-toxic and recyclable goods development there will be.

Obligation to purchase pre-cycling and recycling insurance and guidelines for regulations would fall on law-makers, but could be implemented by non-profits dedicated to circular economic principles or insurance companies. An important benefit of an insurance program is creating an established system that evaluates all products based on a circular economy. Daily operations managed by a non-governmental entity, may ease tensions between industry, consumers, and the government over environmental regulations.

Continuing Education

A functioning democracy depends on an enlightened citizenry. Knowledge sharing of updated technologies and scientific thought and the transparency of decision-making are essential for public buy-in and the long-term success of any program. Humans are social creatures by nature, an obvious but often overlooked point. Social cohesion depends on the dissemination of information and people understanding themselves to be participants in the discourse narrative (Polletta, Ching, Chen, Gharrity-Gradner, & Motes, 2011) (Cody, 2011). As such, the framing of waste management has always been an issue of public health and is the basis of a healthy ecologic and economic system.

A focus for public education should be on the economic vitality and job creation stimulated by recycling businesses. The result will be increased public support and reduced industry resistance to programs such as PAYT and EPR.

Utilizing new information sharing technologies, such as strategic gaming in planning and green gamification could be an excellent way to inform and motivate citizens into action.[8] The games become a way for people to gain rewards that are "measurable, engaging, and shared" (Kamal, 2013).

Furthermore, the example of Gretel Clark in Hamilton is a case in point of what can happen on the local level. Every project needs a champion. In the case of Massachusetts, every town will need a champion. Massachusetts needs to continue to use its education campaigns to identify and support individuals like Gretel Clark and expand the role of the Municipal Assistance Coordinators. Since not every town will have a volunteer like Clark, it will be important to continue to employ people who can work with each town and persevere while zero waste programs are implemented.

Research potential for streamlining processes and infrastructure

While some people object to the waste system structure that San Francisco employs, there is something to be said for the smoothness of systematic transition that has occurred in the city allowing for synchronized programming such as their three-cart system and messaging within their education programs.

[8] Ideas for engaging citizens in the planning process using technology and gaming strategies to get people to cooperate are being tested by teams at Emerson College's Boston based Engagement Game Labs and Adobe's Globalization Strategies found at http://innovationgames.com/2011/09/serious-games-for-strategic-planning/

The relationship between SF Department of Environment and Recology is unique. More importantly it is functional. Waste collection and processing require intensive infrastructure use, potentially similar to utilities and water supply. Further research is needed before making a recommendation to adopt the San Francisco model for waste hauling and processing. But the research for this project suggests that waste services can be provided at comparable costs regardless of a sole service provider or multiple haulers in the market. This indicates there exists a distinct possible argument that limiting the number of haulers driving in the same neighborhoods with overlapping routes may come with both service and environmental perks.

Massachusetts would also benefit from a vetting process to identify exemplary waste contractors, provide those contractors with needed funding, and encourage working relations with zero waste motivated municipalities.

Engage federal agencies

Waste management has become a global issue. There is much work that needs to be done in order to transpose our current linear waste management into a circular economy. Whenever possible, Massachusetts should cooperate with federal agencies to develop EPR, promote recycling markets on US soil, police the ocean for illegal dumping, develop grants and infrastructure for waste to energy, and monitor/prevent pollution. All of these strategies are important components for establishing a zero waste future in Massachusetts and beyond.

Conclusions

Using 2008 as a baseline for waste disposal, Massachusetts aims by 2050 for an 80 percent reduction in the amount of waste disposed, capping the amount for potential disposal at 1.31 million tons per year. 2050 may seem like a long time from now, but there are many steps between now and then that are needed to build the requisite infrastructure, compel community and industry support, and devise stable markets for zero waste programs. Of course, Massachusetts needs to keep pushing the limits and implementing the strategies that it has recognized for waste reduction. However, the reality is that the 2010-2020 Massachusetts Solid Waste Master Plan, *Pathway to Zero Waste* outlines many initiatives that keep the state an active player in the waste reduction climate change mitigation game.

That being said, there is room within the SWMP to develop more concrete plans and policies to become a zero waste state in the long-run. Although interviewees had varying ideas about whether zero waste is an end goal or a process or whether a plan for zero waste should include incineration or landfilling in the short run, not one interviewee offered a critique of the SWMP as a zero waste plan for not addressing what to do beyond 80% waste diversion?

The SWMP has many promising short-run initiatives that have the potential for great long-term impacts. Yet, the SWMP longest-term goal at 80% waste diversion by 2050 does not ever address how to eliminate materials that are not recyclable and get rid of the 1.31 mil tons of waste that is planned for creation each year. In the end, this is a very ambitious waste disposal reduction plan. The

SWMP addresses building recycling markets, but does not provide clear guidance on how to manage materials at the source during the production phase.

Partly, this requires changes in consumer understanding of materials management and changes in consumption patterns. When there are alternatives to demand, consumers have the power to influence product development. Consumers also have the ability to contact companies directly to make requests for changes.

Equally important to consumer power is the need for changes in production patterns. Legislation is the most comprehensive strategy available that can impact what materials are acceptable for waste processing in Massachusetts, while leveling the playing field to establish circular economies of resource→production→consumption→resource.

The state of Massachusetts has the potential for the SWMP to be more if the people of Massachusetts really want it to be, industry gets on board, and the government believes that it is possible. California has a history of being a leader, advancing technologies and social agendas. At this point the country expects California to lead. Massachusetts can also lead by setting its sights and designing a plan for a future without waste, a real zero waste future.

Appendix A. Federal Taxpayer Subsidies

FEDERAL TAXPAYER SUBSIDIES THAT UNDERMINE RECYCLING AND REUSE			
	Average over 1 year ($ Millions)	Total over 5 years ($ Millions)	Tax or Spending Subsidy[a]
DIRECT SUBSIDIES			
Timber			
1. Capital Gains Status For Timber Sales	$ 635	$ 3,175	tax
2. Below-Cost Forest Service Sales	111	555	spending
3. Forest Roads Construction	31	157	spending
4. Forest Service Salvage Fund	34	171	spending
Timber Subsidies Subtotal	**$ 811**	**$ 4,058**	
Hard Rock Mining			
5. 1872 Mining Law	$ 200	$ 1,000	resource
6. Mining Percentage Depletion Allowance	269	1,345	tax
7. Expensing Exploration And Development Costs	27	135	tax
8. Inadequate Bond Requirements	NA	NA	tax
Mining Subsidies Subtotal	**$ 496**	**$ 2,480**	
Energy			
9. Percentage Depletion Allowance	$ 276	$ 1,380	tax
10. Intangible Drilling Costs (IDCs)	9	45	tax
11. Passive Loss Tax Shelter	38	190	tax
12. Alternative Fuel Production Credit	543	2,715	tax
13. Enhanced Oil Recovery	245	1,225	tax
14. BPA: Electric Power Subsidies For Aluminum	200	1,000	spending
Energy Subsidies Subtotal	**$ 1,311**	**$ 6,555**	
Waste Facilities			
15. Private Activity Bonds	NA	NA	tax
TOTAL DIRECT SUBSIDIES	**$ 2,618**	**$13,093**	
INDIRECT SUBSIDIES			
Energy (e.g. unnaturally low prices, cheap feedstocks)	**Substantial**	**Substantial**	
Water (e.g. replacement for higher-priced energy)	**Substantial**	**Substantial**	
Transportation (e.g. remote highways, inland waterways)	**Substantial**	**Substantial**	
Tax (e.g. bias towards capital investments)	**Substantial**	**Substantial**	
International (e.g. Multilateral promotion of extractive industries, trade and aid favoritism, transfer pricing)	**Substantial**	**Substantial**	
Unfunded External Costs (e.g. avoidance of pollution clean-ups, environmental damage, failure to incorporate cost of disposal)	**Substantial**	**Substantial**	

[a] Tax subsidies are taken from line items in Table 5-1. "Total Revenue Loss Estimates For Tax Expenditures In The Income Tax," in the *Budget of the United States Government, Fiscal Year 2000, Analytical Perspectives* (Washington, DC: Office of Management and Budget, 1999). Calculations of spending subsidies (which in this report include related subsidies for resource giveaways) were carefully developed, in consultation with experts from diverse perspectives, from amounts allocated in appropriations bills. Some of the spending subsidies were first published in *Green Scissors*, Friends of the Earth (Washington, DC: Friends of the Earth, 1999).

Source: Young, Ralph, Madland, Kinsella, & Pica, Welfare for Waste, 1999

Appendix B. Massachusetts Yearly Waste Generation, Diversion and Disposal Amounts in tons, 2003-2010

Table 2 Integrated Solid Waste Management System 2003-2010

			2003	2004	2005	2006	2007	2008	2009	2010
Total Generation			**13,210,000**	**13,930,000**	**14,490,000**	**13,260,000**	**12,690,000**	**12,600,000**	**10,680,000**	**10,550,000**
MSW			8,460,000	8,720,000	9,310,000	8,710,000	8,370,000	8,360,000	7,610,000	7,520,000
Non-MSW			4,750,000	5,210,000	5,190,000	4,550,000	4,320,000	4,240,000	3,080,000	3,040,000
		C&D	4,720,000	5,160,000	5,100,000	4,460,000	3,940,000	3,800,000	2,870,000	2,700,000
		Other	30,000	50,000	90,000	90,000	380,000	440,000	210,000	340,000
Diversion			**6,860,000**	**7,580,000**	**7,750,000**	**6,710,000**	**6,010,000**	**6,050,000**	**4,880,000**	**5,120,000**
MSW			2,870,000	3,070,000	3,300,000	2,970,000	2,740,000	2,980,000	2,620,000	2,810,000
		Recycling	2,200,000	2,420,000	2,540,000	2,220,000	1,990,000	2,300,000	1,970,000	2,150,000
		Composting	680,000	650,000	760,000	740,000	740,000	680,000	650,000	660,000
Non-MSW			3,990,000	4,500,000	4,450,000	3,740,000	3,270,000	3,070,000	2,270,000	2,310,000
		C&D Recycling	3,360,000	3,650,000	3,530,000	3,070,000	2,750,000	2,520,000	1,850,000	1,830,000
		Other C&D Diversion	630,000	860,000	930,000	670,000	510,000	520,000	380,000	440,000
		Other Non-MSW Diversion						30,000	30,000	30,000
Disposal			**6,340,000**	**6,360,000**	**6,750,000**	**6,550,000**	**6,680,000**	**6,550,000**	**5,800,000**	**5,430,000**
	Landfill		1,710,000	1,720,000	2,070,000	2,080,000	1,900,000	1,740,000	1,500,000	1,560,000
		MSW	1,310,000	1,430,000	1,760,000	1,880,000	1,760,000	1,560,000	1,330,000	1,280,000
		C&D	370,000	270,000	240,000	130,000	60,000	130,000	120,000	120,000
		Other	20,000	30,000	70,000	70,000	70,000	50,000	60,000	170,000
	Combustion		3,130,000	3,080,000	3,090,000	3,100,000	2,970,000	3,230,000	3,180,000	3,180,000
		MSW	3,120,000	3,070,000	3,080,000	3,090,000	2,960,000	3,210,000	3,180,000	3,170,000
		Non-MSW	*0	*0	10,000	10,000	10,000	10,000	10,000	10,000
	Net Exports		1,510,000	1,560,000	1,580,000	1,370,000	1,820,000	1,580,000	1,120,000	690,000
		Exports	1,790,000	1,840,000	1,820,000	1,620,000	2,060,000	1,850,000	1,590,000	1,270,000
		MSW	1,370,000	1,370,000	1,360,000	1,000,000	1,090,000	840,000	900,000	690,000
		Non-MSW	420,000	460,000	460,000	620,000	970,000	1,010,000	680,000	580,000
		Imports	280,000	280,000	250,000	250,000	240,000	270,000	470,000	580,000
		MSW	200,000	220,000	200,000	230,000	180,000	240,000	420,000	440,000
		Non-MSW	70,000	60,000	50,000	30,000	60,000	30,000	50,000	140,000

Amounts may not add exactly due to rounding.

Source: MassDEP, 2010 Solid Waste Update, 2011

Appendix C. Interview Questions

General Questions Asked of Policy Makers/Advocates/Waste Managers:

1) What does "zero waste" mean to you?
2) What are some of the sustainability goals of your state and how could zero waste fit in with or support these goals?
3) Why would MA/CA government want to establish zero waste goals? Why not? Is there any desire on the part of the state/city to establish zero waste goals? Why or why not?
4) What makes for a successful zero waste campaign?
5) How close to no waste do we have to get in order to make a zero waste campaign successful?
6) What are the main challenges/roadblocks/barriers your city or state faces in reaching zero waste?
7) Are these challenges related to the physical design/infrastructure of region?
8) Are there barriers to creating more recycling markets (including organics)?
9) How important is the design of materials/products to achieving zero waste?
10) What have been challenges/roadblocks to implementing Extended Producer Responsibility? PAYT?
11) Easier to implement legislation at the state level or create education campaigns?
12) Are there cultural challenges; language barriers or ingrained customs?
13) What are other ways that your city or state is working towards zero waste?
14) Has your city/state instated taxes or fees to support zero waste? How effective is this system?

15) What do you think is the most effective approach your town or state has taken to increase the rate of waste diversion from landfills or incinerators?
16) What other approaches would you suggest for achieving a zero waste strategy?
17) In what ways have you reached out to or supported zero waste for businesses in your region?
18) What were some successes in approaching zero waste?
19) Is there difference between “biodegradable” and “compostable”? What is that difference?
20) Can you think of anyone else that I should be talking with about zero waste?
21) How much waste does your city/state currently divert from landfills (as a percent and whole)? How is this measured?
22) How does the state/city rank itself in comparison to other states/cities on the issue of zero waste?
23) What are some of the differences between those states/cities and

Massachusetts/Boston? (For places outside of MA: What are some of the differences between those states/cities and your own?)

24) Who were the key players for pushing for zero waste?
25) Do you think waste prevention is more or less important than waste diversion? Why or why not?
26) What items are most challenging to deal with from a zero waste perspective? Why?

Only asked of policy makers

1) Challenges to creating cooperative regional framework?
2) How important is the concept of "buy-in" to a successful zero waste campaign?
3) What types of businesses have received assistance/support for zero waste programs?
4) Which municipalities have received support?

Only asked of waste managers

5) How did your state begin to build the infrastructure needed to make zero waste happen?
6) What were some of the roadblocks and how did you get past them?
7) Do you operate at the state, regional, or municipal level? What areas do you serve?
8) Do you recommend any economic strategies?
9) Do you recommend any political strategies?
10) What role has your business played in supporting zero waste initiatives in your region?
11) What types of assistance/support has your business received to forward greater diversion of waste?

Only asked of advocates:

12) Why do you care about zero waste or sustainability? How does waste impact your community?
13) How effective do you think Reduce Reuse Recycle campaigns have been?
14) Do you support legislation of product materials? Are there specific materials that should be banned from products, in order to promote materials that are more easily reutilized or recycled?
15) Do you support laws that mandate recycling or diverting organic waste from the trash stream?
16) Are you concerned that bans might lead to illegal dumping?
17) Has the legislature and state agencies been receptive to your point of view?
18) Do you support laws that require companies to list the composition of a product or define whether a product is recyclable or compostable?
19) Right now, given the available infrastructure that we have in place and the state budget (think of trade-offs) what would you recommend the state does w/ waste that is not compostable or recyclable?

Appendix D. Comprehensive List of Potential Interviewees

Advocate/Community Leader	Policy Maker/ Governmental Leader	Waste Manager/ Processor/ Hauler
*Ed Hsieh, MassRecycle Executive Director	*Brooke Nash, MassDEP Recycling Subdivision Supervisor	Massachusetts Water Resource Authority
Gary Liss, Zero Waste International Alliance	*John Fischer, MassDEP Organics Subdivision Supervisor	*Bob Besso, SF Recology
*Lynne Pledger, Clean Water Action	Greg Cooper, MassDEP Bureau of Waste Prevention Division Supervisor	Lor Holmes, CERO Waste Services
Janet Domenitz, MASSPIRG	*Alex Dimitriew, SF Dept. of Environment Zero Waste Commercial Coordinator	Allied Waste Management
*Gretel Clark, Hamilton Recycling Committee Chairperson	*Jack Macy, SF Dept. of Environment Zero Waste Director	Save That Stuff
Amy Perlmutter (former DEP) Zero Waste	*David Quinn, Barnstable Massachusetts Regional Waste Reduction Coordinator	Farmers that accept food waste for processing
Bill Sheenan, GRRN (Grass Roots Recyclers Network)	Kenneth Kimmell, MassDEP Commissioner	EOMS Recycling
ACE	Richard Sullivan, Jr. EEoEA Secretary	Cape Cod Waste Management
Sylvia Broude, Toxics Action Center	Michael Lombardo, Hamilton Town Manager	King County Solid Waste Division
Phil Siego, Sierra Club	Concord Town Manager	*Rob Gogan, Recycling and Waste Manager- Harvard
Sean Pontani, CET	MAPC-environmental director	

Appendix E: California Overall Disposed Waste Stream by Material Type | Source: Cascadia Consulting Group, 2009

Table ES-3: Composition of California's Overall Disposed Waste Stream by Material Type

Material	Est. Percent	+ / -	Est. Tons	Material	Est. Percent	+ / -	Est. Tons
Paper	**17.3%**		**6,859,121**	**Other Organic**	**32.4%**		**12,888,039**
Uncoated Corrugated Cardboard	4.8%	0.9%	1,905,897	Food	15.5%	1.9%	6,158,120
Paper Bags	0.4%	0.1%	155,848	Leaves and Grass	3.8%	0.7%	1,512,832
Newspaper	1.3%	0.3%	499,960	Prunings and Trimmings	2.7%	1.5%	1,058,854
White Ledger Paper	0.7%	0.3%	259,151	Branches and Stumps	0.6%	0.4%	245,830
Other Office Paper	1.2%	0.6%	472,147	Manures	0.1%	0.1%	20,373
Magazines and Catalogs	0.7%	0.2%	283,069	Textiles	2.2%	0.3%	886,814
Phone Books and Directories	0.1%	0.0%	24,149	Carpet	3.2%	2.0%	1,285,473
Other Miscellaneous Paper	3.0%	0.4%	1,202,354	Remainder/Composite Organic	4.3%	0.5%	1,719,743
Remainder/Composite Paper	5.2%	0.7%	2,056,546				
				Inerts and Other	**29.1%**		**11,577,768**
Glass	**1.4%**		**565,844**	Concrete	1.2%	0.4%	483,367
Clear Glass Bottles and Containers	0.5%	0.1%	196,093	Asphalt Paving	0.3%	0.4%	129,834
Green Glass Bottles and Containers	0.2%	0.1%	79,491	Asphalt Roofing	2.8%	1.5%	1,121,945
Brown Glass Bottles and Containers	0.3%	0.1%	108,953	Lumber	14.5%	2.2%	5,765,482
Other Colored Glass Bottles and Containers	0.1%	0.0%	40,570	Gypsum Board	1.6%	0.7%	642,511
Flat Glass	0.1%	0.1%	33,899	Rock, Soil and Fines	3.2%	1.1%	1,259,308
Remainder/Composite Glass	0.3%	0.1%	106,838	Remainder/Composite Inerts and Other	5.5%	1.3%	2,175,322
Metal	**4.6%**		**1,809,684**	**Household Hazardous Waste (HHW)**	**0.3%**		**120,752**
Tin/Steel Cans	0.6%	0.1%	236,405	Paint	0.1%	0.1%	48,025
Major Appliances	0.0%	0.1%	17,120	Vehicle and Equipment Fluids	0.0%	0.0%	6,424
Used Oil Filters	0.0%	0.0%	3,610	Used Oil	0.0%	0.0%	3,348
Other Ferrous	2.0%	0.4%	801,704	Batteries	0.0%	0.0%	19,082
Aluminum Cans	0.1%	0.0%	47,829	Remainder/Composite Household Hazardous	0.1%	0.1%	43,873
Other Non-Ferrous	0.2%	0.1%	84,268				
Remainder/Composite Metal	1.6%	0.5%	618,747	**Special Waste**	**3.9%**		**1,546,470**
				Ash	0.1%	0.1%	40,736
Electronics	**0.5%**		**216,297**	Treated Medical Waste	0.0%	0.0%	0
Brown Goods	0.2%	0.1%	76,725	Bulky Items	3.5%	1.2%	1,393,091
Computer-related Electronics	0.1%	0.1%	32,932	Tires	0.2%	0.1%	60,180
Other Small Consumer Electronics	0.1%	0.0%	34,588	Remainder/Composite Special Waste	0.1%	0.1%	52,463
Video Display Devices	0.2%	0.1%	72,053				
				Mixed Residue	**0.8%**		**330,891**
Plastic	**9.6%**		**3,807,952**	Mixed Residue	0.8%	0.2%	330,891
PETE Containers	0.5%	0.1%	199,644				
HDPE Containers	0.4%	0.1%	157,779				
Miscellaneous Plastic Containers	0.4%	0.1%	163,008				
Plastic Trash Bags	0.9%	0.1%	361,997				
Plastic Grocery and Other Merchandise Bags	0.3%	0.0%	123,405				
Non-Bag Commercial and Industrial Packaging Film	0.5%	0.2%	194,863				
Film Products	0.3%	0.2%	113,566				
Other Film	1.4%	0.3%	554,002				
Durable Plastic Items	2.1%	0.4%	834,970	**Totals**	**100.0%**		**39,722,818**
Remainder/Composite Plastic	2.8%	0.7%	1,104,719	**Sample Count**	**751**		

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

More detailed composition tables can be found in Appendix D: Expanded Statewide Waste Characterization Tables

Appendix F. San Jose Residential Waste Service Fees

Collection Service (Single-family dwellings)	Monthly Rate (Effective July 1, 2012)	Monthly Rate (Effective July 1, 2013)
Garbage		
20-gallon cart	$28.23	No Change
32-gallon cart	$29.95	No Change
64-gallon cart	$59.90	No Change
96-gallon cart	$89.85	No Change
Extra Garbage Sticker	$6.25 each	No Change
Recycling		
Any size cart (32, 64, 96 gallon)	Included with garbage fee*	Included with garbage fee*
Yard Trimmings		
Subscription cart (optional) Any size cart (32, 64, 96 gallon)	$4.35/month	$4.69/month
Loose in the street	Included with garbage fee	Included with garbage fee
Large Items (e.g., tires, furniture)		
Call your recycling hauler to prepay and set up a collection appointment	$25.86 for up to 3 large items	$26.30 for up to 3 large items
On-Premise Collection**		
20-gallon cart	$89.23	No Change
32-gallon cart	$90.95	No Change
64-gallon cart	$120.90	No Change
96-gallon cart	$150.85	No Change
Household Hazardous Waste		
Call the County at 299-7300 or schedule a free drop-off appointment.	Free	Free

Key

* The rate you pay for collection service is based on the size of your garbage cart. Recycling is unlimited at no additional charge. By recycling as much as you can, you will be able to use the smaller garbage cart sizes, which costs less.

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