Organic Waste Management in the Hotel Sector

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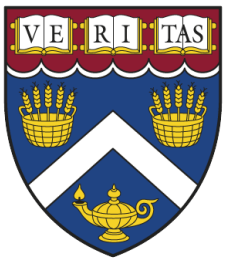

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Executive Summary

Food waste is a global problem with environmental, economic, and social consequences. This paper quantifies the impacts of food waste in the hotel sector first through the lens of the Massachusetts Organics Ban and then in the United States. Using the latest available research, each ton of food wasted in US hotels is calculated to have a lifecycle footprint of 2.75 tons of $CO2_e$ and to consume 156.3 m^3 of water. Financially, each ton is costing hotels between $3,000- $7,000 in purchasing, energy, labor, and other costs; and if just one percent of that ton was donated, 166 meals could feed hungry people.

Massachusetts, one of only five states to enact an organic waste ban, targets commercial establishments generating one ton or more of organic waste per week. This applies to an estimated 29 resort and conference centers generating 4,416 tons of waste annually. While this is significant, the author suggests that the ban is regulating only 40 percent of hotel food waste generated statewide. When all hotels are considered, it is found that more than 10,500 tons of organic waste contribute to a footprint of approximately 29,000 tons $CO2_e$ and 1.6 million m^3 of water. If one percent were donated, more than 175,000 meals could be distributed. Using a mid-range estimate, food waste adds up to $53.5 million in lost costs, while hotels stand to save $10.7 million by reducing waste at its source by just twenty percent.

In U.S. hotels, the footprint of the 1.3 million tons of food that is wasted each year exceeds 3.7 million tons $CO2_e$ and 211.9 million m^3 of water. Donating just one percent of this waste would result in 22.6 million meals to feed hungry people. Using a mid-range estimate, food waste costs hotels $6.7 billion, while a twenty percent source reduction would yield savings of $1.3 billion.

Most food waste management methods can be implemented at no or minimal costs to hotels. A change in mindset is needed above all else. Hotels may be limited, however, by the infrastructure available to handle their food waste. Governments can accelerate proper management through bans applicable to all waste generators, access to technical assistance, and financial incentives to spur adoption and the development of necessary infrastructure to process organic waste.

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1 Introduction

The lodging industry is, by its nature, a resource intensive industry. Large buildings need to be heated and cooled, customers enjoy longer than average showers, and many loads of linens need to be washed every day whether it be on-site or outsourced. The more luxurious a hotel is, the more resources it uses. Waste has also become a large problem, and for hotels that serve food or run a restaurant, organic waste, in particular, adds up.

This paper quantifies the economic, social, and environmental effects of food waste in the hotel sector, first through the lens of the Massachusetts Organics Waste Ban and then expanded to the United States. This information is intended for hotel managers to use as a business case and starting point for launching a food waste management program. For state governments, hopefully this information spurs action in leveraging organics waste management as a tool to address social and environmental issues, to help businesses save money, and to reduce the volume of material taking up limited landfill space.

1.1 Background: A Global Problem

Food waste is a global challenge with staggering environmental, social, and economic ramifications. One-third of the world's total agricultural production, or 1.3 billion tons of edible food, goes uneaten every year (FAO 2013, p.6).

Wasted food is also a waste of the resources that went into producing and distributing it: water, energy, labor, fuel, pesticides, fertilizers etc. Additional resources are used during disposal. Studies show that if food waste were a country it would be the third largest emitter of greenhouse gases (GHGs) after the USA and China (FAO, 2013, p. 17). Further, 805 million people are hungry worldwide while there is currently enough food available to end chronic undernourishment by eliminating food waste and loss (EPA, 2016b).

1.2 Food Waste in the United States

The United States is a major contributor to the issue, foregoing 40 percent of all food produced and $165 billion annually (Gunders, 2012, p.4). The latest estimates suggest that 63 million tons of food are wasted annually in the US, comprising 21 percent of the waste stream (Refed, 2016, p.6), (EPAb,2016). Although producing and distributing food accounts for ten percent of the energy, fifty percent of the land, and eighty percent of the freshwater used in the U.S. (Gunders, 2012, p.4), only 5.1 percent of food waste was diverted to composting in 2014 (EPAb, 2016). Not only does this mean that the nutrients never return to soil, but also that it is mostly added to the organic matter in landfills that is generating 16 percent of America's methane emissions, a GHG 25 times more heat trapping than CO2 (EPAb, 2016).

2 An Overview: Massachusetts Commercial Organics Waste Ban

The Commercial Organics Waste Ban (Organics Ban) is a part of Massachusetts' Solid Waste Master Plan to reduce waste disposal by 80 percent by 2050 (Fischer, 2015, p.10). In Massachusetts, organics, defined as any type of food or vegetative material, make up 25 percent of the waste stream or one million tons per year (Fischer, 2015, p.11). The goal of the ban is to divert 350,000 tons of organic material per year and generate 50MW of energy through anaerobic digestion by 2020 (Fischer, 2015, p.10).

The Organics Ban went into effect on October 1, 2014 and applies to businesses that dispose of one ton or more of organic material per week. Institutions are subject to this ban on a week to week basis, meaning that if a business disposes of organic waste in excess of one ton during only a few weeks a year, it is subject to the ban during those weeks. The ban is enforced by the Massachusetts Department of Environmental Protection (MassDEP), which estimated that 1,700 institutions were subject to the ban at the time of reporting in 2011 (Fischer, 2015, p.16).

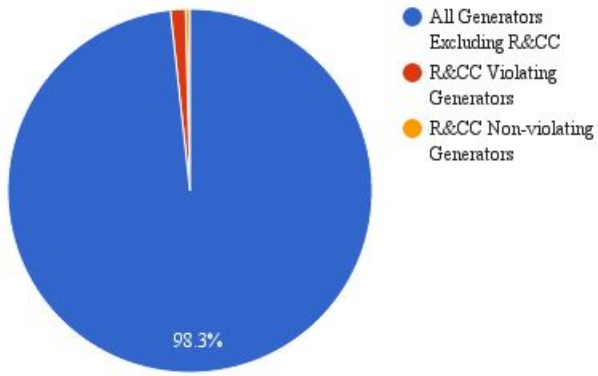
2.1 Scope of the Ban

MassDEP commissioned a study to identify commercial entities in violation of the Organics Ban. Specifically, it analyzed 181 resort and conference centers (R&CC) as potential violators. Based on size and number of meals served, the study identified 29 institutions in violation of the ban, generating an estimated 4,416 tons of organic waste annually. In addition, 61 other establishments were identified as waste generators not in violation of the ban, responsible for 1,316 tons of organic waste annually. The remaining establishments were not considered waste generators (MassDEP, 2011).

In comparison, the study identified a total of 1,702 violators out of a potential 6,862 institutions that generate a combined 224,530 tons of organic waste annually. An additional 3,697 organizations were found to be non-violating generators producing 103,258 tons annually (MassDEP, 2011).

To put this in perspective, this means that resort and conference centers account for less than two percent of organic waste generated at large commercial establishments in Massachusetts, as seen in Figure one below. Further, conference centers tended to generate larger amounts of waste, so this estimate is inflated when trying to understand solely the hotel sector. It is also important to note that the data does not include smaller hotels or other establishments that were not considered at-risk for violating the Organics Ban.

Figure 1: Identified organic waste generators in Massachusetts



3 Impacts of Organic Waste from Violators

Although hotels are a minor player when it comes to generating organic waste in Massachusetts, the importance of waste reduction should not be diminished. There are environmental, social, and economic impacts to consider.

3.1 Environmental Impacts

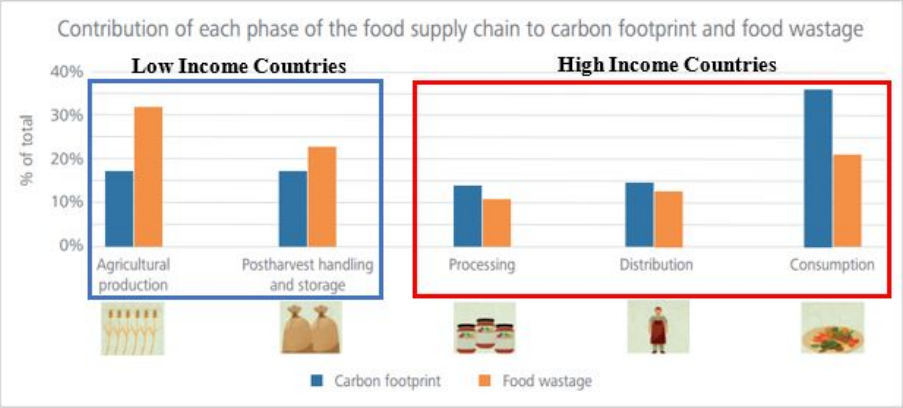
3.1.1 Calculating Life Cycle Environmental Impacts

The Food and Agriculture Organization of the United Nations (FAO) used a lifecycle approach to estimate that, globally, 1.6 billion tons of food is wasted each year and has a footprint of 4.4 billion tons of $CO2_e$ and a water footprint of 250 km^3 (FAO, 2013, p6), (FAO, 2015, p. 1).

Given these numbers, one ton of wasted food would emit 2.75 tons of $CO2_e$ and would represent the consumption of 156.3 m^3 of irrigation water taken from ground or surface water in the agricultural production phase (See Appendix A). These calculations are made accepting that converting a global estimate to a per ton measure for use in a specific state or country leaves much to be desired in terms of accuracy. The impacts of a ton of food waste vary vastly depending on many variables including but in no way limited to: composition of waste, farming techniques, production location, distances travelled, types of energy used, and technology.

Nonetheless, food waste in wealthier countries tends to have a larger footprint as the waste frequently occurs later in the life cycle in the processing, distribution, and consumption phases as seen in Figure 2 below. This suggests that the emissions from a ton of food waste may be greater than the average stated above. Additionally, this estimate halves an estimate out of UC Berkeley, which suggests a ton of food waste in America has a footprint of 5 tons of $Co2_e$ (UC Davis Dining Services, 2009, p.6). For these reasons, the author has decided to use the previously described calculations to estimate the footprint of food waste.

Figure 2: Where food waste occurs in high and low income countries
(Adapted from (FAO, 2015))



3.1.2 Calculating Potential Reduction in Emissions from Food Waste

In a perfect world, hotels would produce zero food waste. While this may not be possible, the Waste Resources Action Program (WRAP) estimates that approximately 65 percent of food waste in hotels is avoidable, meaning there is a large opportunity for reduction (WRAP, n.d., p. 1). Hotels can make the biggest impact through source reduction and then subsequently through how the remaining waste is managed, explored in greater detail in Section 5. To determine the potential reduction in GHGs that hotels can have by implementing a food waste management program, the EPA's Waste Reduction Model (WARM) tool was used to compare three scenarios to a business as usual approach (EPA, 2016c). The business as usual approach assumes hotels are not diverting any organic waste and that waste is being processed in line with state averages (See Appendix B).

As seen in Table 1, the three alternative approaches achieve increasing levels of source reduction while not quite attaining the 65 percent that WRAP suggests is possible. Remaining waste is split between composting and anaerobic digestion, with digestion being favored for any extra waste that does not split evenly. This is in accordance with the EPA Food Recovery Hierarchy and results in a more conservative $CO2_e$ result.

Table 1: Potential GHG Reduction Model for Massachusetts Hotels

	Tons Source Reduced (%)	Tons Landfilled (%)	Tons Combusted (%)	Tons Composted (%)	Tons Anaerobically Digested (%)
Business as usual		45%	55%	0	0
Alternative 1	10%	0	0	40%	50%
Alternative 2	30%	0	0	30%	40%
Alternative 3	50%	0	0	20%	30%

It is important to note that WARM calculates emissions starting at the point when food is thrown away rather than from production (See Appendix A) (EPA & ORCR, 2016, p. 4). Also, it is using a slightly different 'typical food make up' and model than FAO did to calculate life cycle impacts. For this reason, the results should be considered representative rather than exact and more attention should be paid to the percent change possible from the business as usual approach.

3.1.3 Environmental Impacts Applied to Violators

From these calculations, it can be determined that hotels in violation of the Organics Ban have a footprint of 12,144 tons of $CO2_e$ and consume 690,221 m^3 of water. This is the equivalent of 2,567 cars driving for a year and filling 276 olympic sized pools. Implementing a food waste management program could have a very significant impact on reducing GHGs. Hotels could reduce their GHG footprint by 300 to 1,200 percent just through source reduction and changes in how they are managing food waste, as seen in Table 2 below.

Table 2: Potential GHG Reductions for Ban Violators

R&CC Violators							
	Tons Source Reduced	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2e	% Decrease
Business as usual		1,987	2,429	0	0	870	
Alternative 1	442	0	0	1,766	2,208	-1987	328%
Alternative 2	1,325	0	0	1,325	1,766	-5126	689%
Alternative 3	2,208	0	0	883	1,325	-9134	1150%

3.2 Social Impacts

In Massachusetts in 2013, 10.6% of households were food insecure, comprising close to 700,000 adults and children (Project Bread, n.d.). In this paper, social impacts are measured by and limited to potential donation to feed hungry people (See Appendix A). As explored in section 5, this is the most preferred option for food waste diversion after source reduction.

If hotels in violation of the Organics Ban donated just one percent of their food waste, 73,600 meals could feed hungry people. This is enough meals to feed 67 people three full meals a day for a year. If five percent were donated, 368,000 meals could feed 336 people three meals a day for one year. Not only do hotels have the ability to make a positive impact in the surrounding communities, they are also eligible for federal tax breaks, explored more in the following section.

3.3 Economic Impacts

3.3.1 Calculating Economic Impact of Food Waste in Hotels

WRAP conducted a study to determine the true cost of avoidable food waste to UK hotels. They discovered that the majority of lost costs are attributed to food purchase (62%), labor (26%), and energy (7.2%) as seen in Figure 3 below. The 2011 study found the true cost of total (avoidable and unavoidable) food waste to be £4,008 per ton or 52 pence per meal (WRAP, 2013, p.20). Using 2011 exchange rates and adjusting for inflation, the 2016 cost of total food waste would be $0.89 per meal or $6,907 per ton.

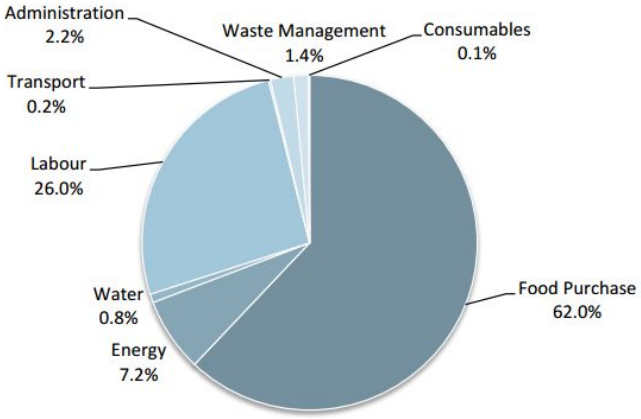
For comparison, ReFed's 2016 report, "A Roadmap to Reduce US Food Waste by 20%," which is considered to be the most comprehensive, up-to-date report on wasted food in America, calculates that the average purchase price of a pound of food at the retail level is $2.50, which can be extrapolated to $5,000 per ton. At wholesale prices, a ton of food is priced at $2,000 - $2,500 per ton. According to WRAP, purchase price is only 62% of the true cost of food waste. Extrapolated out, a ton of food waste at retail prices costs $8,065 and at wholesale prices costs $3,226 - $4,320.

To account for uncertainties, three 'Total Cost' tiers will be examined, as seen in Table 3 below:

Table 3: Tiers of the Total Cost of US Hotel Food Waste

Low	Medium	High
$3,000/ton	$5,000/ton	$7,000/ ton

Figure 3: Breakdown of the cost of avoidable food waste in the UK hotel sector (WRAP, 2013, p.20).



3.3.2 Economic Impacts Applied to Violators

Hotels in violation of the Ban may be losing between $13 and $31 million in lost costs due to food waste. Of course, hotels can't eliminate all food waste, but savings from just a 20 percent source reduction range from $2.5 to $6 million.

Table 4: Economic Impacts of Food Waste for Violating Generators

	Low	Medium	High
Total Cost of Food Waste	$13,248,000	$22,080,000	$30,912,000
Potential Savings with 20% Source Reduction	$2,649,600	$4,416,000	$6,182,400

Hotels would realize additional savings from tax breaks for donation. Although Massachusetts does not provide any state level tax incentives for food donation, hotels are eligible for federal tax incentives. Hotels may receive a non-enhanced or enhanced tax deduction depending on how and to what

type of organization it is donated. The less strict, non-enhanced deduction allows hotels to deduct the amount of the property's basis. The enhanced deduction allows businesses "to deduct the lesser of (a) twice the basis value of the donated food or (b) the basis value of the donated food plus one-half of the food's expected profit margin" (Harvard Food Law and Policy Clinic, 2016, p. 2). This may account for up to 15% of the businesses taxable income for food donation.

3.4 Evaluation of the Massachusetts Organics Ban

Although there is no data as to how hotels have changed their food waste management practices since the Ban went into effect, RecyclingWorks estimates that in October 2015, one year after the ban went into effect, 54 businesses had been helped by RecyclingWorks to divert 5,020 tons of food scraps from landfills. The state's emphasis on compliance over enforcement has been seen as a strong point of the program. The Ban relies on the benefits to the business to encourage compliance, and provides the tools and technical expertise needed for organizations to implement a program. Additionally, MassDEP provides access to financial incentives such as grants and low interest loans to incentivize infrastructure development necessary to process large quantities of food waste (CET, 2015).

As one of only five states to implement an organics ban, Massachusetts is a leader in food waste management; however, the ban could be strengthened by widening the scope to include all generators. The ban regulates only 40 percent of food waste generated at hotels statewide, as examined in Section 4.2.

4 Potential Beyond the Organics Ban

The impacts of organic waste generated at hotels extends beyond just those businesses in violation of the Organics Ban. There are other hotels in Massachusetts and across the United States that are dealing with the same problems.

4.1 All Generators Identified by MassDEP

If the scope is extended to all hotels that MassDEP identified as waste generators, rather than just those in violation of the ban, impacts would increase by 30 percent. The footprint of hotel food waste would increase to 15,763 $CO2_e$ or the equivalent of 3,333 cars driving for a year. The water footprint would increase to 895,912 m^3 or the equivalent of filling 358 olympic swimming pools. If just one percent of food were donated, 95,533 meals could feed 87 people three meals a day for a year. If five percent were donated, then 477,667 meals could feed 436 people three meals a day for a year. As seen in Table 5, the food wasted by all identified generators costs hotels between $17 and $40 million, while savings range from $3 to $8 million.

Table 5: Economic Impacts of Food Waste for All Identified Generators

	Low	Medium	High
Total Cost of Food Waste	$17,196,000	$28,660,000	$40,124,000
Potential Savings with 20% Source Reduction	$3,439,200	$5,732,000	$8,024,800

By implementing a food waste management plan, identified generators could reduce their GHG footprint by 300 to 1,000 percent, as shown in Table 6 below:

Table 6: Potential GHG Reductions for All Identified Generators

All R&CC							
	Tons Source Reduced	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2e	% Decrease
Business as usual		2,579	3,153	0	0	1129	
Alternative 1	573.20	0.00	0.00	2,292.80	2,866.00	-2578	328%
Alternative 2	1,720	0	0	1,720	2,293	-6654	689%
Alternative 3	2,866	0	0	1,146	1,720	-10728	1050%

4.2 Massachusetts Hotels

Thus far, the calculations stated in this paper have been solely based off of properties identified in MassDEP's study of waste generators. Only large properties that potentially had a chance of being in violation of the ban were considered, excluding any small and medium sized hotels. While smaller hotels generate less waste, their presence should not be underestimated. According to a lecture given by Megan Epler Wood, 75 to 80 percent of all hotels are small and independently run (2016, p.5). Further, these businesses often lack the resources and expertise of larger chain operations and are less likely to implement sustainable practices. The impacts of each individual location may be small, but can add up quickly.

On its website, RecyclingWorks, a program funded by MassDEP to offer recycling assistance to businesses, has a calculator that hotels can use to estimate their food waste by comparing industry averages to number of rooms, number of guests, or volume of waste produced (See Appendix A).

The total number of rooms available in Massachusetts was unable to be obtained for this calculation; however, Cvent, a global meeting, event, and travel technology leader, provides a robust, though not complete, listing of hotel and meeting spaces in Massachusetts. It lists 447 hotels and 62,015 rooms in the state (Cvent, n.d.). In comparison, Booking.com lists a total of 815 lodging properties that are broken down as follows: 549 hotels, 121 motels, 108 bed and breakfasts, 32 resorts, 4 lodges, 1 resort village (Booking.com, n.d.). Although Booking.com lists significantly more properties, it can be argued that the Cvent list contains properties that generate more waste as they offer meeting and event services. Future researchers should attempt to identify the total number of rooms for a more accurate calculation. Resources such as STR Hotel Census data would be a good starting point.

Based on the number of rooms identified by Cvent, Massachusetts hotels generate an estimated 10,717 tons of organic waste per year. This waste has a GHG footprint of 29,472 tons $CO2_e$ and if avoided would have had the same effect as removing 6,231 cars off the road for a year. Similarly, it has a

water footprint of 1,675,067 m^3 or 670 olympic swimming pools. Donating one or five percent of this waste would result in 178,617 or 893,083 meals distributed respectively. The waste could be responsible for as much as $32 to $75 million in lost costs. Savings from reducing waste by 20% at its source range from $6.4 to $15 million.

Table 7: Economic Impacts of Food Waste for Massachusetts Hotels

	Low	Medium	High
Total Cost of Food Waste	$32,151,000	$53,585,000	$75,019,000
Potential Savings with 20% Source Reduction	$6,430,200	$10,717,000	$15,003,800

Including hotels that aren't classified as at risk for violating the Organics Ban increases the amount of organic waste and subsequent impacts by 143% as seen in Figures 4 and 5 below. This highlights the importance of organic waste management for all hotels, large and small, for not only environmental and social reasons but economic ones as well. In comparison, this means that the Ban only regulates about forty percent of the waste generated at hotels statewide.

By implementing a food waste management plan, Massachusetts hotels could reduce their GHG footprint by 300 to 1,000 percent as seen in Table 8 below.

Figure 4: Tons of organic waste generated annually

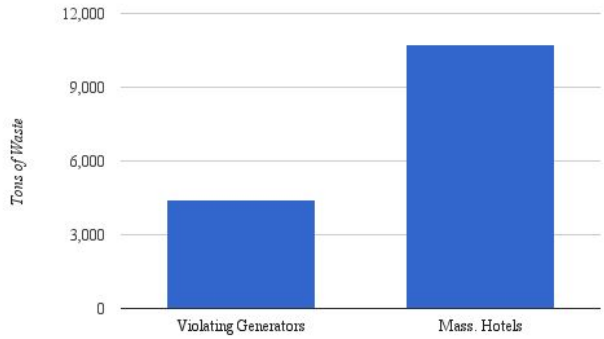


Figure 5: Cost of food waste annually

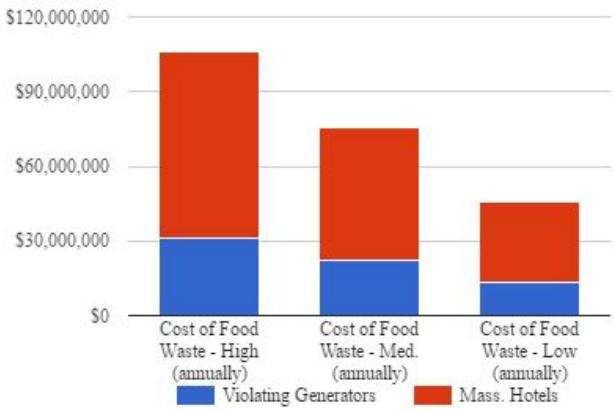


Table 8: Potential GHG Reductions for All Massachusetts Hotels

Mass Hotels							
	Tons Source Reduced	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	**Total MTCO2e**	**% Decrease**
Business as usual		4,823	5,894	0	0	2,111	
Alternative 1	1,071.70	0.00	0.00	4,286.80	5,358.50	-4,819	328%
Alternative 2	3,215	0	0	3,215	4,287	-12,438	689%
Alternative 3	5,358.50	0.00	0.00	2,143.40	3,215.10	-20,057	1050%

4.3 United States Hotels

ReFed estimates that the United States produces 62.5 million tons of food waste each year (p. 6). Large hotels contribute 1.36 million tons to this result, or just above two percent of the total (p.11). What constitutes a large hotel is not defined in the ReFed report.

As stated by Business Travel News, which cites STR's June 2015 Hotel Census, there were 5,001,163 rooms in 53,554 properties in the United States at the time, encompassing chain and independent locations of all sizes (Sickle, 2015). To gauge the impacts from small hotels in addition to just large hotels, the Recycling Works Calculator was once again used to attempt to derive a rough estimate. The Calculator suggests that all hotel rooms across the U.S. generate approximately 864,301

tons of organic waste per year. Although it may have been assumed that the Calculator should overestimate the amount of food waste in this scenario since not every hotel in America serves food, it undercuts ReFed's calculation, which only includes large hotels, by close to 500,000 tons. This brings to light questions of if the waste generated from Massachusetts hotels calculated in Section 4.2 is also underestimated. Future researchers should further investigate this point, as well as the impacts from small hotels.

Using ReFed's widely accepted estimate, US hotel food waste is calculated to have a footprint of 3,729,371 tons of $CO2_e$ and a water footprint of 211,963,901 m^3 annually. This is equivalent to 788,451 cars driving for a year and filling 84,786 olympic swimming pools. Further, if just one percent of this waste were able to be diverted by donation to feed hungry people, 22,602,250 meals would be distributed. If five percent were donated, 113,011,250 meals would be distributed.

In total, wasted food could be costing U.S. hotels $4 to $9.5 billion in lost costs each year. Savings from reducing waste by 20% at its source range from $8.1 million to $1.9 billion dollars annually. Implementing other management methods would result in additional savings.

Table 9: Economic Impacts of Food Waste for U.S. Hotels

	Low	**Medium**	**High**
Total Cost of Food Waste	$4,068,405,000	$6,780,675,000	$4,068,405,000
Potential Savings with 20% Source Reduction	$813,681,000	$1,356,135,000	$1,898,589,000

By implementing a food waste management program, hotels could reduce their footprint by 200 to 550 percent. It is important to note that the business as usual scenario for the United States differs from that of Massachusetts in that it more heavily favors landfills (See Appendix B).

Table 10: Potential GHG Reductions for U.S. Hotels

U.S. Hotels							
	Tons Source Reduced	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2e	% Decrease
Business as usual		1,084,908	271,227	0	0	565,943	
Alternative 1	135,613.50	0	0	542,454.00	678,067.50	-609,834	208%
Alternative 2	406,840.50	0	0	406,840.50	542,454.00	-1,573,952	378%
Alternative 3	678,067.50	0	0	271,227.00	406,840.50	-2,538,071	548%

6 Food Waste Management Methods

There are many reasons hotels do not participate in food recovery programs, despite potential cost savings. These include lack of guidance, real or perceived costs, lack of space, no legal requirement, or the institution does not feel it generates enough material to warrant a program. The economic, environmental, and social case for food waste management has already been stated in this paper. This section will examine various methods for food waste management and the feasibility of implementing each.

6.1 Methods for Food Waste Reduction

The EPA created a Food Recovery Hierarchy demonstrating the ideal management methods, ranked from most to least preferred, to be taken to prevent and divert food waste (See Appendix C). The hierarchy suggests source reduction, donating meals to hungry people, donation for animal feed, industrial uses, and composting in that order. Incineration and landfilling should be a last resort.

Many guides have been created detailing exactly how to implement a food waste reduction program; therefore, this section simply provides a cursory overview of the available options.

***Source Reduction*:** Reduce waste by not generating any in the first place

Regardless of regulation or infrastructure, every hotel can reduce waste at its source. As previously stated, WRAP estimates that about 65 percent of all food wasted in hotels is avoidable

(WRAP, n.d., p. 1). Further, it identified the typical breakdown of food waste at hotels: spoilage (21%), food preparation (45%), and plate waste (34%) (WRAP, n.d., p. 2).

Conducting a waste audit will help hotels understand the types of waste they are generating and inform decisions for improvement. Several methods of source reduction are: tailoring food purchasing to meet needs, offering flexible portion sizes, ensuring proper storage, repurposing ingredients and food scraps, adjusting menu to remove low selling or high waste items, and practicing just in time cooking (EPA, 2016a). Benjamin Lephilibert, Managing Director of LightBlue Consulting and expert in hotel food waste prevention, suggests that twenty percent of food waste can be avoided "by implementing a monitoring system, reviewing… storage practices and empowering...employees" (2016).

The cost of source reduction to hotels is minimal. It takes resources to track, plan, and monitor. Once a routine is established, less time will be needed to maintain the program. Establishments that generate a large amount of waste can invest in software for monitoring, though these systems usually have a relatively short payback period.

Feed Hungry People: Donate wholesome food for human consumption

In the hotel and restaurant industry there is a stigma that businesses are at risk when donating food; however, the Bill Emerson Good Samaritan Food Donation Act protects businesses from any liability. Additionally, businesses are eligible for federal tax benefits and potentially state tax benefits. Hotels should locate a food distribution organization to partner with. Most organizations pick food up free of charge. Again, the cost to hotels is none to minimal. Setting up and managing the partnership will take time, but as the program matures, less resources will be needed. Hotels may be limited by the number of organizations operating in their area (EPA, 2016a).

***Feed Animals*:** Donate to farms, zoos, etc.

State regulations about donating food to animal feed vary and it may be banned in some states. Hotels should research the viability of this option. If it is feasible, costs are none to minimal, decreasing

as the program becomes more established (EPA, 2016a).

Industrial Uses: Anaerobic digestion, biofuel, bio-products

Using food waste for energy alleviates some of the associated environmental and economic issues. Waste can be processed in anaerobic digesters to produce biogas and a soil amendment. Fats, oils, and grease can be converted into biodiesel. Liquid fats and solid meats can be converted to raw materials for use in a variety of products through rendering. Some rendering organizations provide free pickup. Access to industrial processing may be limited based on available infrastructure. Costs range from none to minimal. Resources will be needed to research organizations and set up a management plan but will decrease as the program becomes established. Reduced hauling costs may offset costs to send organic waste for industrial processing. (EPA, 2016a).

Composting: Turn food scraps into a soil amendment

After all other sources of reduction have been exhausted, remaining scraps should be composted. Hotels can contract with an off-site composter to remove waste. For hotels generating a small amount of waste and who can spare the resources, on-site composting could be an option. This would require initial setup and ongoing maintenance costs. Overall costs to hotels are none to moderate, depending on the amount of food waste and if it is handled on or off site. Composting may offset hauling costs and save the hotel money (EPA, 2016a).

7 Conclusion

Targeting large generators through the Massachusetts Organics Ban is an excellent start, but as seen in this paper, is only regulating forty percent of the waste generated at hotels throughout the state. While the ban could be more effective if expanded to all establishments generating organic waste, it also falls to hotels to recognize the savings and benefits of a management program. RecyclingWorks offers technical assistance to all businesses, not just those in violation of the ban. Massachusetts hotels stand to

save $6 to $15 million simply by reducing waste at its source by twenty percent, and would have the added benefits of a reduced environmental footprint and positive social benefits through food donation.

Across the United States, there is less regulation and support for organic waste management, and therefore a larger opportunity for improvement. U.S. hotel food waste has a footprint of 3.7 million tons $CO2_e$ and a water footprint of 212 million m^3. Savings range from $8.1 million to $1.9 billion dollars for a 20 percent source reduction, and if just one percent of total food waste were donated could produce 22.6 million meals.

All told, the costs of managing food waste are minimal and require a change in mindset above all else. Hotels may even save money. Source reduction achieves the biggest economic and environmental results, while donating food has positive social impacts and can drastically reduce the amount of food that is disposed of in less valuable ways. It seems that the limiting factors on proper food waste management are education and infrastructure.

Governments can accelerate proper food disposal through bans, as Massachusetts has, and also through programs that offer technical and financial support. Offering technical assistance setting up management programs or waste processing facilities will spur adoption. Offering financial assistance through grants or low interest loans will catalyze the infrastructure development necessary to process large amounts of organic waste.

8 Recommendations

Hotels have much to gain from focusing on reducing organic waste. All hotels, regardless of size, can save on purchasing, labor, energy, and other costs through proper planning and source reduction. All hotels are eligible for federal tax breaks by donating food. Some hotels can save money or break even on landfill costs by reducing waste in accordance to the EPA's food recovery hierarchy. Depending on location, access to large scale services such as composting, anaerobic digestion, and incineration may be

limited, which could hinder progress. The following are suggestions that, if implemented, will help hotels realize savings while reducing their environmental and social impacts:

I. **Conduct a waste audit and make no or low-cost adjustments to reduce waste at its source.**

Identify the types, amounts, and causes of food waste in the hotel. This will inform better management strategies that will result in cost savings. Adjust menus and purchasing habits accordingly. Influence consumer habits through education, plate size, flexible portions, and signage. Look for efficiencies in the kitchen and find ways to repurpose scraps that would otherwise be discarded. Continue to track progress and make adjustments.

II. **Follow EPA or similar guidelines for starting a food waste management plan.**

Feed hungry people and receive federal, and potentially state, tax benefits for donating food. Contact local and state organizations to determine the feasibility of diverting organic waste to animal feed, industrial uses and composting, in that order.

III. **Governments should take a more active role in requiring and supporting proper organic waste management.**

While all hotels can take steps to reduce and divert organic waste through certain channels, some locations will be limited in what kind of diversion rates they can achieve. If infrastructure doesn't exist or isn't easily accessible, hotels will still be inclined to send material to landfills. Governments can accelerate the process by imposing bans, like the Massachusetts Organic Waste Ban, and also by providing financial and technical support to businesses trying to reduce waste as well as businesses seeking to expand infrastructure. Emphasizing compliance before enforcement will enable businesses to take action. Applying the ban to all organic waste generators will have the largest impact.

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Appendix A

Standard Conversions and Calculations

1 olympic swimming pool = 2,500 m^3 (NSWIC, n.d.).

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1 Car Driving for 1 Year = 4.73 tons of $CO2_e$ (EPA, 2016d).

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1 Meal = 1.2 pounds of food (GenerationOn, 2013).

How much food waste is generated based on number of hotel rooms

(RecyclingWorks Massachusetts, n.d.).

345.64 lbs/room/year * X rooms = Y lbs/year

$CO2e$ per ton of food waste (FAO, 2013, p6), (FAO, 2015, p. 1)

FAO estimates that there is 1.6 billion tons of food waste with a footprint of 4.4 billion tons of $CO2_e$

4.4 B tons $CO2_e$ / 1.6B tons food waste = 2.75 tons $CO2_e$ per ton of wasted food

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Water footprint of a ton of food waste (FAO, 2013, p6)

FAO estimates that there is 1.6 billion tons of food waste with a footprint of 250 km^3.

250 km^3 / 1,600,000,000 tons of food = .00000015625 km^3 of water per ton of wasted food

.00000015625 km^3 * 1000000000 m^3 =156.25 m^3

Potential reduction in GHG from implementing a management plan (EPA, 2016c).

The WARM tool used the following measurements to calculate potential reductions

Action	GHG emissions per ton of material processed
Source Reduce	-3.66
Landfill	.54
Combustion	.09
Compost	-.18
Anaerobic Digestion	-.03

% Increase of Impacts: Violators vs. All R&CC

(new value - old value)/old value
((5,732 - 4,416) / 4,416)*100= 29.8%

% Increase of Impacts: Violators vs. Mass. Hotels
(new value - old value)/old value
((10,717 - 4,416) / 4,416))*100 = 142.69%

Violators as a % of Mass. Hotels
(Violators / Mass. Hotels) * 100
(4,416 / 10,717)*100 = 41.2%

Appendix B

Business as Usual GHG Calculations

Business as Usual in Massachusetts:

MA Disposal	
Type	**Percentage**
Incineration	55%
Landfill	45%
Total	100%

According to MassDEP, seven municipal waste combustors burn 38 percent of municipal solid waste generated in state and 28 percent is landfilled or sent out of state. The other 34 percent is recycled. Because these calculations are being applied to hotels without any sort of composting program, this amount was split in half and equally distributed between incineration and landfill. In other words, the percent diverted to landfill and incineration both increased 17 percent (MassDEP, n.d.).

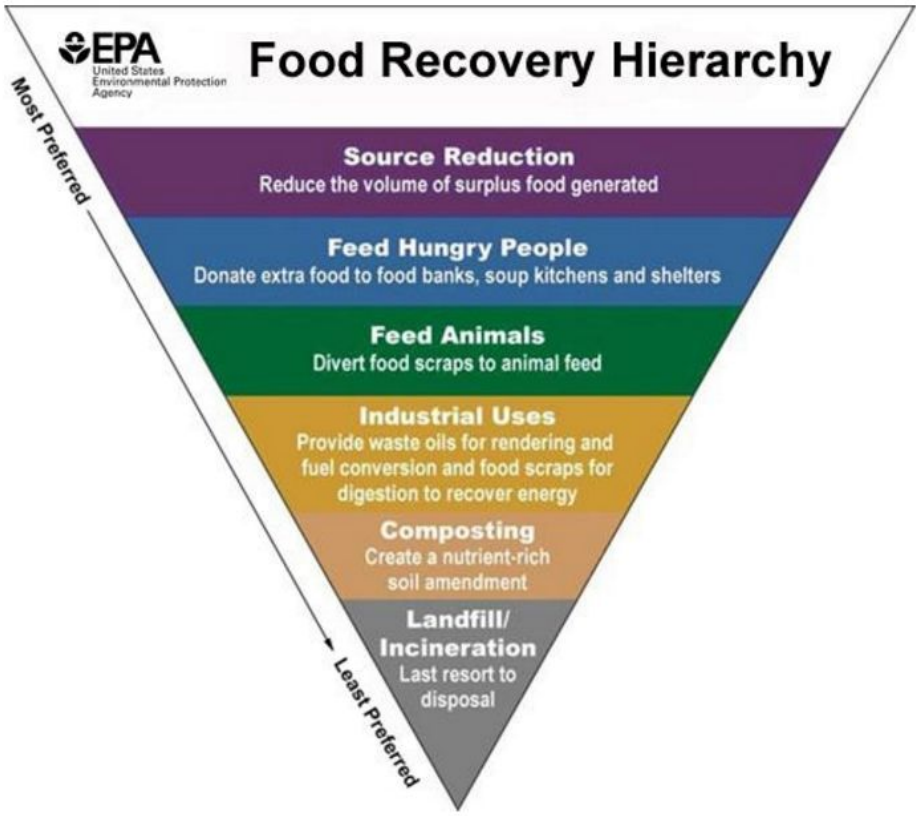
Business as Usual in the United States:

United States Disposal		
	Amount	**Percentage**
Incineration	33M	20%
Landfill	136M	80%
Total	169M	100%

According to the EPA, over 33 million tons of MSW were incinerated and 136 million tons were landfilled in 2014. Percentages were derived from these numbers and used as country averages (EPA, 2016e).

Appendix C

EPA Food Recovery Hierarchy (EPA, 2016a).



Appendix D

All calculations applied to each category

	All Generators	Violating Generators	Non-violating generators	R&CC Violating Generators	R&CC Non-violating Generators	All R&CC Generators	Mass. Hotels	US Hotels
Amount of Food Waste (tons/year)	327,709	224,531	103,259	4,416	1,316	5,732	10,717	1,356,135
GHG Footprint (tons CO2e)	901,200	617,460	283,962	12,144	3,619	15,763	29,472	3,729,371
How many cars off the road annually?	190,528	130,541	60,034	2,567	765	3,333	6,231	788,451
Water Footprint (m3/year)	51,220,917	35,094,195	16,139,382	690,221	205,691	895,912	1,675,067	211,963,901
How Many olympic pools filled annually?	20,488	14,038	6,456	276	82	358	670	84,786
Cost of Food Waste - High (annually)	$2,293,963,000	$1,571,717,000	$722,813,000	$30,912,000	$9,212,000	$40,124,000	$75,019,000	$9,492,945,000
Potential Savings w. 20% source reduction (high)	$458,792,600	$314,343,400	$144,562,600	$6,182,400	$1,842,400	$8,024,800	$15,003,800	$1,898,589,000
Cost of Food Waste - Medium (annually)	$1,638,545,000	$1,122,655,000	$516,295,000	$22,080,000	$6,580,000	$28,660,000	$53,585,000	$6,780,675,000
Potential Savings w. 20% source reduction (medium)	$327,709,000	$224,531,000	$103,259,000	$4,416,000	$1,316,000	$5,732,000	$10,717,000	$1,356,135,000
Cost of Food Waste - Low (annually)	$983,127,000	$673,593,000	$309,777,000	$13,248,000	$3,948,000	$17,196,000	$32,151,000	$4,068,405,000
Potential Savings w. 20% source reduction (low)	$196,625,400	$134,718,600	$61,955,400	$2,649,600	$789,600	$3,439,200	$6,430,200	$813,681,000
If 1 % were donated (tons/year)	3,277	2,245	1,033	44	13	57	107	13,561
If 1% were donated (pounds/year)	6,554,180	4,490,620	2,065,180	88,320	26,320	114,640	214,340	27,122,700
If 1% were donated, how many meals? (1.2 lbs/meals)	5,461,817	3,742,183	1,720,983	73,600	21,933	95,533	178,617	22,602,250
If 1% were donated, how many people could be fed 3 meals a day for a year? ((meals/3)/365)	4,988	3,418	1,572	67	20	87	163	20,641
If 5% were donated (tons/year)	16,385	11,227	5,163	221	66	287	536	67,807
If 5% were donated (pounds/year)	32,770,900	22,453,100	10,325,900	441,600	131,600	573,200	1,071,700	135,613,500
If 5% were donated, how many meals? (1.2 lbs/meal)	27,309,083	18,710,917	8,604,917	368,000	109,667	477,667	893,083	113,011,250
If 5% were donated, how many people could be fed 3 meals a day/year? ((meals/3)/365)	24,940	17,088	7,858	336	100	436	816	103,207