A Waste of Space: The Revolution of Waste Management!

by

Joshua Padilla
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Thesis Supervisor

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Abstract

By doing a comparative study of several countries who utilize a circular economy, have a superior waste management system, and are an industrialized country, this thesis will come to the conclusion as to whether or not better waste management equates to a better economy in the long run. Based on the findings of the comparative study, the thesis will make policy suggestions on how to improve the United States waste management system and economy. Lastly, the thesis will seek to provide solutions and alternatives to waste management in the United States through innovative technology and processes from other countries and from original concepts.

Thesis Intro

The purpose of this thesis is to answer the following question, "Does better waste management lead to a better economy?" A better economy will be defined as "a sustainable economic system in which waste and pollution is limited while also satisfying consumer wants and needs within society through sustainable products that creates as minimal waste as possible." By doing a comparative study of several countries who utilize a circular economy, have a superior waste management system, and are an industrialized country, this thesis will come to the conclusion as to whether or not better waste management equates to a better economy in the long run. A circular economy will be defined as "a country with strong legislation that supports that creation of sustainable products that limits the creation of waste through its products and services and encourages the recycling of raw, broken, and used material in order to be reintroduced into the market." An industrialized country will be defined as "a country that has amassed a large GDP, utilizes modern technology, and has grown economically over several years." Superior waste management will be defined as "a system that turns its waste into opportunity and reintroduces it back into the economy as: recycled raw material, a recycled product, raw material for waste to energy facilities, recycled goods, and compost, while landfilling, incinerating, and burying as little waste as possible."

This thesis will do a comparative study between the United States and several countries including: China, Sweden, and Japan. The reason as to why China, Sweden, and Japan were selected for this thesis is because they are industrialized countries with diverse social norms, legislation, economies, education, and morals; these values directly impact the treatment of waste and how it is managed from a micro scale, including an individual or small community, to

a macro scale, which could range from the entire city, state, and country. Each country introduces different waste management treatment technologies and initiatives along with different legislative policies and level of enforcement. The reason why China was selected for this case study was because of its immense population, large economy, movement towards a sustainable, circular, sharing economy. Sweden was selected because of its small population, astronomical recycling rate, and waste management legislation and policies. Japan was selected because of its strict, thorough sorting system, dedication to recycling, its strong economy, and strong collectivist culture.

By doing an in-depth comparative study between the United States' waste management system and the waste management system of other industrialized countries, one will be able to determine the strengths and weaknesses of other waste management systems. One of the questions that this thesis will seek to answer is is it important to lessen CO2 emissions from an economical perspective? Is a circular economy effective? What would be the impact of better waste management to national economies and the environment?

The thesis will hypothesize that countries with better management have better economic performance. The thesis will also seek to test and hypothesize that more legislation in waste management will lead to better waste management. Based on the findings of the comparative study, the thesis will make policy suggestions on how to improve the United States waste management system and economy. Lastly, the thesis will seek to provide solutions and alternatives to waste management in the United States through innovative technology and processes from other countries and from original concepts.

1. Circular economy

This section will go into an in-depth description of what a circular economy is, its positive impact on some of the countries that were selected as cases, how a circular economy is implemented, why a circular economy is important from both an environmental and economic perspective, and what are some of the many of the components that go into building and creating a circular economy.

The Waste and Resources Action Programme defines a circular economy when they write, "A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life," (Waste and Resources Action Programme, 2018). The significance of a circular economy, from an economic perspective, is how it capitalizes on the full utility of a product or service while also minimizing on the waste that is left over at the end of the products life cycle. Preston & Lehne also explain that the circular economy serves as a model for sustainable growth in developing countries by recycling, repairing, and using waste rather than throwing it away, turning waste into an input, or material to be used, towards processes (Preston & Lehne, 2017).

An example of a nation that effectively utilizes a circular economy is Japan. Ghosh & Agamuthu discuss the positive effects of an effective implementation of a circular economy when they explain, "Effective implementation of a CE can give multi-fold benefits if the government encourages and pushes. Seven percent of Japan's gross domestic product is generated by the recycling industries alone, which employs 0.65 million people," (Ghosh & Agamuthu, 2018). Through the previous quote one can see that if a government pushes a green and sustainable agenda on its people through strict legislation, a circular economy can be

implemented. Sustainability will be defined as 'the ability to produce a product, or serve a customer or client, that appeals to consumer needs, while also reducing costs and needless waste, and reducing the consumption of natural resources.' By reusing and recycling materials, the demand for raw materials will lessen while the demand for more recycling centers will go up.

Dr. Gregory J. Howard, an expert on social ecology and consumerism, writes about the detrimental effects that consumerism when he writes, "Of course, it has become painfully obvious that obsolescence and frenzied consumption have their price in the form of spiraling amounts of waste and refuse," (Howard, 1999). The creation of waste is often overlooked by both companies and consumers; the aftermath of what becomes of a product once its disposed is, more often than not, rarely an afterthought. The greatest problem that consumerism creates is the heavy emphasis on purchasing the "latest and greatest" model of a product, which distracts consumers from the discarding process of their previous "obsolete" model; the current process of consumerism, buying, replacing and discarding, has led to the creations of billions of pounds of waste. Dr. Howard continues to explain how unsustainable consumerism is when he explains, "The ever-mounting glut of waste material is a characteristic byproduct of modem consumer society. It might even be argued that capitalism's continual need to find or generate markets means that disposability and waste have become the spine of the system," (Howard, 1999). Although it can be argued that capitalism does emphasis on creating new markets, the fact that "disposability and waste lie at its core" does not necessarily mean that it is an unsalvageable system and that its core cannot be changed or replaced in order to create a better economic system. A newer, cleaner, and more sustainable form of consumerism could be considered an economic system that focuses on: satisfying consumer needs, the creation of newer and better sustainable products and services, creating miniscule amounts of waste and pollution as possible,

and incorporating recycled materials into new products and services. This economic system could be referred to as **Modern Consumerism**.

The circular economy model is heavily dependent on the creation of sustainable products and products that are made from recycled products. In the long run, the creation of waste over time will lessen more and more while the production of new products made from recycled products continues unabated. Ghosh & Agamuthu further explain how resources are effectively dispersed throughout a circular economy when they report, "The resources are being efficiently utilized within its lifetime by sharing bikes, sharing pool cars, residing in bigger housing complexes, which are popular in many cities. Many people even lease mobile phones, electronic appliances, toys and furniture instead of buying them, adding value in the CE value chain," (Ghosh & Agamuthu, 2018). By incorporating a sharing economy, a sharing economy shall be defined as 'an economy that encourages the sharing of products and services between individuals in order to receive the maximum utility while minimal waste and pollution in the process,' a circular economy heavily reduces the amount of waste that is produced by consumers by maximizing the utility of almost every product and service available while also limiting waste and encouraging the creation of sustainable products and services. If a product were to reach the end of its life cycle and were to either be considered waste or obsolete, the product would simply be broken down and turned into recycled materials that would go towards the creation of new products.

Dr. Howard defines what it means to consume, along with the consequences of consuming, when he writes, "To consume means, literally, to destroy or expend and in the garbage crisis we confront the underlying truth of a society in which ongoing market priorities and enormous productive capacities have engaged human needs and desires, without regard to

the long- or even short-term viability of life on the planet," (Howard, 1999). The circular economy accounts for both the maximization of profits by satisfying consumer needs and the well-being of the environment. The reasons as to why this matters is because businesses are still able to generate maximum profits within the margins of a circular economy, and **modern consumerism**, while also fighting against: climate change, hunger, pollution, landfilling, and many other harmful things within society.

The circular economy has many definitions and is often thought of as only a system of waste management rather than an economic model. Kirchher, Reike & Hekkert, researchers and analysts of sustainable development at Utrecht University, in the Netherlands, analyzed the various definitions of what a circular economy is when they wrote, "This is corroborated by our coding with recycling found to be the most common component in the definitions examined (79% of definitions), followed by reuse (74%–75% of definitions) and reduce (54%–55% of definitions)," (Kirchher, Reike & Hekkert, 2017). Through this quote, one can come to understand that the circular economy is being observed mainly as a part rather than a whole. Kirchher, Reike & Hekkert clearly explain and define what a circular economy is when they write, "We defined CE within our iteratively developed coding framework as an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes," (Kirchher, Reike & Hekkert, 2017). A circular economy focuses on capitalizing on extracting materials that can be recycled from waste rather than extracting virgin materials, which in most cases is a lot more expense to retrieve.

The circular economy operates on more than just a macro level, benefitting not only the overall economy but benefitting society and the environment by empowering everyone to do

their part through legislation, tax breaks, and other innovative incentives that promote a sustainable society. Kirchher, Reike &and Hekkert further explain this when they write, "It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations," (Kirchher, Reike & Hekkert, 2017). The circular economy seeks to improve the overall quality of both sustainable and unsustainable operations in both businesses and governments by setting clear parameters that lead to the long-term growth of society as a whole.

The results of promoting a closing-loop production in an economy leads to greater efficiency of resource management, focus on urban and industrial waste, and creating a sustainable balance between the economy, environment and society. (Ghisellini, Cialani, & Ulgiati, 2015).

Most, if not all, MNCs (Multi-National Corporations) face challenges between being sustainable and being an organization that focuses solely on the bottom line. Ghisellini, Cialani, & Ulgiati discuss one of the main focuses of a circular economy when they write, "The ultimate goal of promoting CE is the decoupling of environmental pressure from economic growth. The implementation of CE worldwide still seems in the early stages, mainly focused on recycle rather than reuse," (Ghisellini, Cialani, & Ulgiati, 2015). The circular economy seeks to free both, governments and organizations, from having to decide between being sustainable and being profitable by applying guidelines for both to follow that leads to long-term benefits for society, the environment, and the economy.

The circular economy's focus on the principles of reuse, reduce, and recycle, give it its strength because it creates opportunity for organizations to take advantage of by offering recycled materials, which are often times cheaper than newer, virgin materials that must be extracted, along with the costs of its extraction and cost of transportation as well. Ghisellini, Cialani, & Ulgiati further explain the potential of what the circular economy can provide when they write, "CE has the potential to understand and implement radically new patterns and help society reach increased sustainability and wellbeing at low or no material, energy and environmental costs," (Ghisellini, Cialani, & Ulgiati, 2015). By creating opportunity for organizations to create more sustainable products, from a sustainable economy that supports the 3 Rs (Reduce, Reuse, Recylce) of sustainability and waste management, the circular economy promotes rich, long-term growth.

Although the circular economy delivers many benefits, both short term and long term, it isn't perfect. Ghisellini, Cialani, & Ulgiati report the limits of the circular economy when they explain, "It is important to mention that the benefits from recycling of materials tend to decrease until a cut-off point is reached where recycling could be environmentally or economically too expensive to provide a net benefit," (Ghisellini, Cialani, & Ulgiati, 2015). Although there are some materials that have an infinite amount of recycling life, such as glass, and metal, many items do not have an unlimited recycling life span. This is one of the few short comings of the circular economy, however, it is also one of its greatest strengths. Ghisellini, Cialani, & Ulgiati explain the core strength the circular economy when they report, "In CE, products and processes are redesigned to maximize the value of resources through the economy with the ambition to decouple economic growth and resource use (UTS, 2015)," (Ghisellini, Cialani, & Ulgiati, 2015). By introducing products made from recycled materials into the market, it creates a

demand for not only a product's convenience but for more sustainable products that ensure economic, environmental, and social prosperity. Ghisellini, Cialani, & Ulgiati explain more benefits of the circular economy when they write, "Castellani et al. (2015) showed that reuse of products avoids the emission of noxious substances as well as many other environmental impacts in the case of different items (clothes, books, furniture, glass, sideboard), by means of an LCA approach,"(Ghisellini, Cialani, & Ulgiati, 2015). The circular economy maximizes and capitalizes on the full utility of products until the cut-off point of recycling is reached, allowing for dozens of products to be created through recycled materials which provide economic, social, and environmental benefits to society as a whole.

The benefits that are derived from a circular economy are great but are not always instant and require time; it is a long-term investment that appeals to society, the environment, and the economy. Kirchher, Reike & Hekkert, explain how the circular economy takes time and commitment when they write, "Consultants advising on CE may sell it not as a 'quick win', but a major long-term undertaking. Selling it as the latter (which includes framing it as an endeavour undertaken for future generations) can help ensure that those interested in it will not give up too soon and we thus find that this long-term perspective must be included in all CE definitions," (Kirchher, Reike & Hekkert, 2017). The reasons as to why the development of a circular economy takes time to both develop and see immediate benefits is because of the necessary conditions needed to create and develop a circular economy such as: the cooperation of citizens in society, the cooperation of private organizations, the passing of legislation that supports a circular economy, specific metrics that serve as measures and indicators of a successful circular economy, and most importantly time.

The circular economy is not something that can be applied swiftly. It requires years of commitment from corporations, governments, and individuals living within society in order to achieve the common goal of one day creating a prosperous sustainable economy for future generations. Ghisellini, Cialani, & Ulgiati discuss challenges that corporations face when dealing with a circular economy when they report, "The adoption of a circular economy program entails that a company carries out different strategies to improve the circularity of its production system and also cooperates with other companies over the supply chain for the achievement of a more effective circular pattern (Wrinkler, 2011)," (Ghisellini, Cialani, & Ulgiati, 2015).

Eco-design, the term given to a product that is designed to be sustainable and recyclable, leads to the growth of a prosperous circular economy that guarantees that each product within a market, society, and economy is used to its full utility. As eco-design becomes more and more wildly accepted within society, the standards of an eco-designed product's design and performance rise to a higher standard, ensuring that quality is both ensured and encouraged within a competitive market.

When a circular economy is implemented into a society, a common foundation that arises as a result of new legislation, demand for sustainable products and services, and the need to lower costs, an EIP (Economic Industrial Park) park is born. Ghisellini, Cialani, & Ulgiati explain the economic benefits that derive from EIPs when they report, "The economic benefits arising from symbiotic exchanges in an EIP (Economic Industrial Park) can be summarized as direct (e.g. revenues from selling by-products, reduced costs from avoided discharge fees or disposal costs, reduced costs deriving from substituting virgin energy and materials with alternative feedstock obtained at lower prices) and indirect,"(Ghisellini, Cialani, & Ulgiati, 2015). EIPs provide businesses to not only maintain the quality of their products and services but

to cut costs, form agreements and contracts in order to work together and prosper under a circular economy to benefit everyone.

Sakai, Yoshida, Hirai, Asari, M., Takigami, H., Takahashi describe several reasons as to why China adopted the Circular Economy Promotion Law when they report, "Several factors are said to be behind the enactment of the Circular Economy Promotion Law, including a lack of resources, insufficient use of recycled materials, and a national strategy of tackling the problem of resource depletion, accompanied by the desire for sustainable economic growth," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi , 2011). China's lack of resources, along with subpar waste management system, is what led it towards adopting a circular economy in order to grow their economy and improve their environment and society. Must all countries wait until it reaches this point in order to implement and adopt a circular economy?

Sakai, Yoshida, Hirai, Asari, M., Takigami, H., Takahashi explain how an economy can improve its circular economy through lessons that were learned from various countries such as Sweden, China, Japan, when they report, "In order for the Circular Economy Promotion Law to have substantive effects, WEEE and MSW management systems needed to be enhanced through improving recycling and waste treatment techniques and strengthening the financial base of companies utilizing recycled resources," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi, 2011). By reducing the costs of recycling, and waste treatment, while still maintaining high quality, the circular economy becomes more sustainable and stable, encouraging a trickle-down effect that creates a higher demand for sustainable products within society.

Will McDowall, Yong Geng, Beijia Huang, Eva Bartekova, Raimund Bleischwitz, discuss how both economies measure and determine the success of their implemented circular economies when they write, "The Resource Efficiency Scoreboard establishes a hierarchy of

indicators, with resource productivity (measured as gross domestic product [GDP]/raw material consumption) the headline indicator (EC 2015b)," (McDowall, Geng, Huang, Bartekova, Bleischwitz, 2017). Having indicators for a successful implementation of a circular economy is pivotal in determining whether a country is on track towards reaping the benefits of having a sustainable economy. However, the European Commission (EC) has not yet identified specific indicators of success for a circular economy; McDowall, Geng, Huang, Bartekova, Bleischwitz further explain why when they report, "The CE Action Plan (EC 2015a) highlights the need for such a set, but addresses this need by referring to existing indicator sets (the Resource Efficiency Scoreboard and the Raw Materials Scoreboard) and by committing to develop indicators in the future," (McDowall, Geng, Huang, Bartekova, Bleischwitz, 2017). Although indicators of success vary from country to country, many indicators share several mutual characteristics such as: resource allocation, water consumption, raw material consumption, and various harmful emissions (McDowall, Geng, Huang, Bartekova, Bleischwitz, 2017).

Thomas Friedman, author of *Hot Flat and Crowded*, writes about an additional benefit that economic development can have on society when he writes, "Yes, as economic development spreads it is possible that overall global population growth will slow and the world total will not reach the nine billion plateau by 2050; as more women get better educated and join the work force, they generally have fewer children," (Friedman, 2008). In Friedman's book *Hot Flat and Crowded,* Friedman explains that the Earth's population is growing at an alarming rate, adding that the Earth's natural resources will not be able to keep up and sustain human life for long if the population continues to grow and harm the environment in the process. Many of Friedman's findings support the development and the need for an implementation of a circular economy in order to protect the environment, society, and the economy. Friedman briefly

explains the dangerous future that mankind is headed towards when he reports, “The IPCC (Intergovernmental Panel on Climate Change) further concluded that without a dramatic reduction in human-induced CO z emissions, climate change may bring "abrupt or irreversible" effects on air, oceans, glaciers, land, coastlines, and species,” (Friedman, 2008). Various countries have turned towards developing a circular economy in order to help protect and improve the environment and their economy.

Leepson, discusses Brazil’s initiative towards reducing their costly oil imports when he writes, “Brazil's goal is to increase the amount of alcohol added to gasoline until eventually its autos burn nothing else. The nation's automobile manufacturers have begun building cars with engines that can run on gasoline with a high-alcohol content; today the average content is about 20 percent,” (Leepson, 1979). The mix of gasoline and alcohol has been dubbed gasohol by many critics. Various tests, as well as extensive research, has been done in order to determine the effectiveness of gashol in terms of energy content in comparison to standard gasoline. Pryor discusses his findings on the comparison among gasohol, ethanol, and traditional gasoline when he reports, “A gallon of ethanol contains about 35% less energy than a gallon of regular gasoline, which means that E10 gasohol has an energy content 3.6% less than that of regular gasoline and E85 gasohol, about 30% less,” (Pryor, 2009). Pryor further explains his findings when he says that the study found that the per gallon average of a E68 gasohol, was 14.6% less effective than a gallon of regular gasoline; Pryor also added that gasohol with a E100 level would be 21.4% less effective than standard gasoline as well (Pryor, 2009). Although Brazil is trying to create a sustainable solution to their expensive oil imports, the effects have very high risks. Pryor also explains how gasohol can yield massive consequences for society when he explains the economic impact that a larger demand for gasohol can have when he explains, “For instance, the

spike in corn prices in Mexico in 2006 doubled the price of tortillas, which has been a main source of calories for the poor in that country. Given that low-income people spend a larger proportion of their income on food, these food price increases would have a severely regressive impact on the world's population and would exacerbate global hunger," (Pryor, 2009). The alcohol in gasohol is made primarily from corn, which is a major staple in countries such as Mexico. Although gasohol can save an economy by reducing its gasoline imports from oil rich countries, dependency on gasohol would prove to be fatal on society as a whole due to the likely increases in the price of corn that would perpetuate hunger throughout society. Pryor further explains that high blends of ethanol and gasohol are not cost competitive when compared to gasoline, adding that it is unlikely that it will ever be cost effective unless the prices of oil increase dramatically (Pryor, 2009).

Lastly, Leepson points out, "While keeping perspective and realizing that the use of alcohol fuels in and of themselves will not solve the energy crisis, we must acknowledge that they do present one of our most hopeful short-to-intermediate term solutions …." (Leepson, 1979). As technology improves, it is possible that better engines will be created in order to help sustain the demand for gasohol, which would directly impact the amount of corn needed to create the alcohol mix for gasohol itself. The significance of ethanol, gasohol, and other biogases, to a circular economy is imperative to countries with superior waste management like Sweden. By relying less on fossil fuels, and more on sustainable energy, countries are able to import less oil and export more of their own oil, or other sustainable energy substitutes for oil in order to grow their economy over time.

McDowall, Geng, Huang, Bartekova, Bleischwitz write about how trade between both China and the EU benefit bot countriesthrough mutual sustainable product standards in

international trade when they write, “The large trade flows between the two regions suggest a number of areas in which agreed indicators, standards, and mutual learning could facilitate the development of a CE within both regions and beyond,” (McDowall, Geng, Huang, Bartekova, Bleischwitz, 2017). Through constantly trading products that support the development of their circular economies, China and the EU can build upon both of their countries’ economies socially, economically, and environmentally. Preston & Lehne predict that since China’s circular economy developed, along with its laws, China’s proposal on the ban of 24 types of secondary materials, which was implemented January 1st, 2018, will have a significant impact on its trade partners to meet China’s recycling goals (Preston & Lehne, 2017). The EU, along with other countries, has also turned towards becoming a more sustainable union through the Paris Agreement that was enacted in 2016. Preston & Lehne explain the impact that circular economy policymaking has on developing countries when they write, “Developing countries are also closely watching CE-related policymaking in wealthier countries, as new policies could significantly affect trade,” (Preston & Lehne, 2017). Preston & Lehne explain that the EU Circular Economy Action Plan will likely cause the EU to reduce its exports of electronic and plastic waste and scrap metal to developing countries because the EU will be utilizing their plastic waste and metal scraps as materials and resources for their own economic development and for the sake of resource allocation, which will have an impact on the import demands within the EU for raw and processed materials from developing countries (Preston & Lehne, 2017). Preston & Lehne also add, “All this suggests that while there will be new dynamics in international trade and the location of production, the CE will often involve – and indeed depend on – international cooperation,” (Preston & Lehne, 2017). With China’s proposed ban on 24 types of waste, countries will need to meet its demands in order to continue doing business and

maintain a good relationship as trade partners; China's circular economy's influence is a prime example of how the circular economy's power and influence is slowly growing over time, as well as how the economic demands and laws of other countries can have a direct impact on the economy, business operations, and potentially the laws of its trading partners.

Although a circular economy has a lot of benefits, it currently faces opposition by challenging the status quo and by entering a hungry market that is perpetuated by consumerism. Preston & Lehne explain that the challenges that larger businesses face in regards to the circular economy are a lack of consumer knowledge of what a circular economy is, and implementing the use of a circular economy without it affecting its own existing streams of revenue (Preston & Lehne, 2017). Kirchher, Reike & Hekkert support this claim when they write, "This negligence of the consumer in CE definitions may be reflective of a research gap regarding the consumers' perspective on CE with Borrello et al. writing that "little is known about consumers' willingness to participate in [a CE]," (Kirchher, Reike & Hekkert, 2017). Preston & Lehne further add, "Careful approaches are also needed to avoid rapidly displacing employment in informal sectors without addressing the near-term social impacts," (Preston & Lehne, 2017). Economists, government officials, and large business executives, fear that the development of a circular economy can directly impact and hurt organizations such as organizations that operate within the energy sector due to the negative impact that it would have on fossil fuel generators and grid companies (Preston & Lehne, 2017). However, it can be argued that it would also create a lot of jobs in the renewable energy sector alongside other jobs that would be created in order to help the development of the circular economy.

2. The reason as to why China, Sweden, and Japan were selected for this thesis is because of their unique and diverse: culture, legislation, waste management technology, and innovative methods of waste management.

In China…

China has one of the largest economies in the world, as well as one of the most densely populated countries in the globe as well. China is a collectivist country which values face, social order, and honor. Ghisellini, Cialani, & Ulgiati, economic analysts and researchers of the circular economy in China describe some of China's economic and social values in Chinese society when they report, "This country seems strongly committed and attracted by CE because of the huge environmental, human health and social problems posed by its very rapid and continuous economic development pattern," (Ghisellini, Cialani, & Ulgiati, 2015). The Chinese have developed a strong commitment to the circular economy since its official implementation in 2002. Since its implementation, the Chinese have taken various steps towards sustainability and a circular economy through various implementations of legislation throughout the years. Ghisellini, Cialani, & Ulgiati explain how China began the development of their circular economy in 2002 when they write, "Cleaner Production was more extensively promoted and adopted in China compared to other methods for environmental management, in particular after the "Cleaner Production Promotion Law" in 2002 (Geng et al. 2010b, 2012 Su et al. 2013)," (Ghisellini, Cialani, & Ulgiati, 2015). The "Cleaner Production Promotion Law" was the beginning of what led up to the economy of China is today, leading up to many other legislative acts that would be written or amended such as "The Environmental Pollution Prevention and Control Law by Solid Waste" which acted as a breakthrough for Chinese Waste Management. Sakai, Yoshida, Hirai, Asari, Takigami, &Takahashi, Japanese analysts of the circular economy, doing a comparative analysis of various circular economies and legislative policies, explain the

significant impact of The Environmental Pollution Prevention and Control Law by Solid Waste when they write, "The Environmental Pollution Prevention and Control Law by Solid Waste was enacted in 1996 and amended in 2005. It introduced the application of 3R policies for solid municipal, industrial, and hazardous wastes and required not only a reduction in the amount of waste but also in its hazardousness," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi , 2011). By focusing on the strict implementation of 3R policies (reduction, reuse, and recycling) China was able to reduce their waste and reintroduce recycled material back into their economy, save on material costs and help protect the environment.

Ghisellini, Cialani, & Ulgiati, discuss how China has taken steps towards evolving their circular economy in some of their biggest cities when they report:

> "Beijing, Shanghai, Tianjin and Dalian in the last years implemented eco-city pilot projects with the aim of investigating the evolution of CE in terms of resource efficient use (e.g., indicators of energy intensity per GDP and water intensity per capita), municipal waste production, waste treatment and reclamation (rate of waste water treatment, rate of industrial solid waste reuse) (Geng et al., 2009; Su et al., 2013). From 2005 to 2010 in the four mentioned eco-cities the highest reductions have been observed in energy and water consumption indicators." (Ghisellini, Cialani, & Ulgiati, 2015)

China is seriously committed to developing a circular economy through the various laws and legislative acts that they have put into action over the last 20 years. By writing legislation

that forces people on both a micro and macro scale to comply with the laws that enforce and support the development of a circular economy, China has led both their society and ways of commerce towards a cleaner, greener, and more sustainable path for the future. Ghisellini, Cialani, & Ulgiati report how China's legislative acts have led many businesses towards pursuing more sustainable operations that support the fruition of a circular economy when they report, "Li et al. (2010) report in their study that 5000 industries have introduced cleaner production in China and that important improvements in energy conservation have been achieved at national level in Chinese process industries," (Ghisellini, Cialani, & Ulgiati, 2015). It is through both leading their people through legislative acts, that force them into complying and supporting the development of a circular economy, and through creating social awareness that supports the development a circular economy.

Ghisellini, Cialani, & Ulgiati explain how China encourages the development of Economic Industrial Parks in their economy when they report, "China is trying to develop its own model of EIPs (within the theoretical framework of industrial ecology) in order to properly account for the different political, socio-economic and environmental context compared to the rest of the World (Chiu and Geng, 2004; Fang et al., 2007)," (Ghisellini, Cialani, & Ulgiati, 2015). Economic Industrial Parks within an economy encourage commerce throughout a community by allowing resources to be available to businesses in order to create mutually beneficial relationships among all businesses that operate within the Economic Industrial Parks within the economy.

Ghisellini, Cialani, & Ulgiati talk about how China was able to successfully promote the development of their circular economy when they wrote, "In China CE is promoted as a top-down national political objective while in other areas and countries as European Union, Japan

and USA it is a tool to design bottom-up environmental and waste management policies," (Ghisellini, Cialani, & Ulgiati, 2015). Leading by example and enforcing rules that supported their agenda, China was able to achieve the necessary steps towards developing a circular economy. The impact that leading by example has on both a country and an organization is revolutionary, especially in times of dire crises.

Sakai, Yoshida, Hirai, Asari, Takigami, and Takahashi comment on how although China has made great progress in developing their circular economy they are far from a model example of a circular economy when they write, "Although legislation in China has been developed soundly so far, China may need to develop greater abilities to manage and implement the legislation to achieve better outcomes on 3R and hazardous waste management," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi , 2011). Developing an ideal circular economy takes decades of commitment and cooperation from governments, multi-national corporations, local businesses, and people living within society.

Over the last 20 years, China has passed over thirty pieces of legislation in regards to waste management alone. The reason as to why China is able to pass so many laws regarding waste management so frequently, much more frequently than the United States, is because of China's governmental structure. China's legislative body —whose entire legislative body is mainly controlled by the Communist party— is a unicameral system that is able to process and produce laws faster with far less restraint than a bicameral system like the United States or Japan. The Standing Committee of The National People's Congress had passed thirty laws regarding environmental protection, and resource conservation (Mu, Bu, Xue, 2014). One can closely observe the thirty laws below in Figure 1. and see that many of the laws that were passed

were amended and had revisions in order to remain relevant and remain up to date with current policies.

Figure 1.

Table 1. *Cont.*

Note	Name	Adopted	Went into Effect	Revised	Went into Effect
9	Law on Prevention and Control of Atmospheric Pollution	1987-09-05	1988-06-01	1995-08-29 2000-04-29	1995-08-29 2000-09-01
10	Water Law	1988-01-21	1988-07-01	2002-08-29	2002-10-01
11	Law on the Protection of Wildlife	1988-11-08	1989-03-01	-	-
12	Law on Urban and Rural Planning	1989-12-26	1990-04-01	2007-10-28	2008-01-01
13	Law on Water and Soil Conservation	1991-06-29	1991-06-29	2010-12-25	2011-03-01
14	Surveying and Mapping Law	1992-12-28	1993-07-01	2002-08-29	2002-12-01
15	Law on Prevention and Control of Environmental Pollution by Solid Waste	1995-10-30	1996-04-01	2004-12-29	2005-04-01
16	Electric Power Law	1995-12-28	1996-04-01	-	-
17	Law on the Coal Industry	1996-08-29	1996-12-01	2011-04-22	2011-07-01
18	Law on Prevention and Control of Environmental Noise Pollution	1996-10-29	1997-03-01	-	-
19	Flood Control Law	1997-08-29	1998-01-01	-	-
20	Law on Energy Conservation	1997-11-01	1998-01-01	2007-10-28	2008-04-01
21	Law on Protecting Against and Mitigating Earthquake Disasters	1997-12-29	1998-03-01	2008-12-27	2009-05-01
22	Meteorology Law	1999-10-31	2000-01-01	-	-
23	Law on Prevention and Control of Desertification	2001-08-31	2002-01-01	-	-
24	Law on the Administration of the Use of Sea Areas	2001-10-27	2002-01-01	-	-
25	Law on Promotion of Cleaner Production	2002-06-29	2003-01-01	2012-02-29	2012-07-01
26	Law on Evaluation of Environmental Effects	2002-10-28	2003-09-01	-	-
27	Law on Prevention and Control of Radioactive Pollution	2003-06-28	2003-10-01	-	-
28	Renewable Energy Law	2005-02-28	2006-01-01	2009-12-26	2010-04-01
29	Law on Promotion of Circular Economy	2008-08-29	2009-01-01	-	-
30	Law on the Protection of Offshore Islands	2009-12-26	2010-03-01	-	-

Note: In order of adopted date; data current to 31 August 2014.

In Sweden…

Sweden is famous for its effective waste management program and cutting-edge waste management technology that turns what appears to be garbage into opportunity. Swedish culture values egalitarianism, innovation, conservation of their resource; Sweden is a left leaning, socialist – welfare state with a great democracy, and a green party that has allowed them to push

for renewable energy and develop sustainable technology from early on. Shepard further explains that Sweden's government was a parliamentary system since 1809, which then implemented parliamentary rule in 1917 and then ultimately reduced the powers of the king in 1975 (Shepard, 1995).

As the current leader of recycling and zero waste, Sweden has passed various pieces of legislation over several decades that led to the development of their circular economy, recycling heavy society, and zero waste landfills. Peter Shepard, an expert on Swedish waste management, explains the history of environmental regulation in Sweden when he writes, "Environmental regulation in Sweden has a long history, beginning in the 1960s. The first major piece of legislation wits the Nature Conservancy Act, passed in 1964. In 1967, the Environmental Protection Agency was set up. In 1968, the Environmental Advisory Committee was established to act as a government consultant in environmental affairs," (Shepard, 1995). Since the 1960s, Sweden began to slowly cultivate and create the framework necessary to develop their circular economy and work towards the EU's desired goal of zero waste. By 1993, more than 50% of Sweden's municipal solid waste was processed in one of the twenty-one waste to energy plants that were currently operating at the time (Shepard, 1995). Shepard explains that Sweden's environmental policies include and require various licenses and permitting processes, meticulous planning and measures, and sanctions (Shepard, 1995).

As a member of the European Union, Sweden takes the initiative when it comes to waste management laws. Every member country in the EU mutually follows an accepted set of policies that are created by a committee. Ghisellini, Cialani, & Ulgiati explain the significance of one of the most important pieces of legislation passed by the EU when they write, "The zero waste goal is also included within the European Union policy, as indicated by the 7th Environment Action

Program, with the aim to: “virtually eliminate landfilling by 2020 while the Landfill Directive, only required the EU Member States to reduce the landfilling of “biodegradable municipal waste” to less than 35% of the amount produced in 1995,” (Ghisellini, Cialani, & Ulgiati, 2015). As a member state of the EU, Sweden has not only complied with the law but has worked the hardest towards achieving the goal of zero waste through various advancements in their technology, waste management laws, and their implementation of a circular economy.

Weine Wiqvist, Managing Director of Avfall Sverige, one of Sweden’s most notable recycling organizations, and the President of The Board of Municipal Waste Europe, discusses the various steps taken in treating waste throughout the waste hierarchy when he explains, “Preventing the creation of waste is the first step in the waste hierarchy. It is the priority of both Swedish and European waste legislation. The waste hierarchy priority is: » waste prevention » reuse » material recycling and biological treatment » other recycling, e.g. energy recovery » disposal,” (Wiqvist, 2017). By strictly following the waste hierarchy, Sweden has been able to develop a circular economy, turn waste into opportunity, and greatly reduce the amount of waste that it landfills to nearly 0 percent.

Wiqvist talks about the significant reduction of waste created in Sweden in 2016 when he writes, “In 2016, the quantity of household waste treated was 4,666,260 tonnes. This is a reduction of 0.8 percent compared to 2015. For the population as a whole, every Swede produced 467 kg of household waste in 2016, compared to 478 kg per person in 2015,” (Wiqvist, 2017). Although the percentage may seem small, on a macro level the reduction itself is a great improvement of waste reduction. Sweden was able to achieve positive results through various factors such as: the application and strict enforcement of waste management legislation on both a micro and macro level, through the cooperation of the Swedish government and organizations

that work towards achieving the common goal of a sustainable Swedish socio-economy, and through the advancements of their technology.

The innovative waste management technology that Sweden possesses allows Sweden to not only effectively collect waste, but to also do it safely and reduce work related accidents and fatalities. Wiqvist explains the various types of automated vacuum systems that helps deliver waste from homes to facilities when he reports, "Vacuum waste collection is a fully automated system which reduces the need for transports, particularly in residential areas. There are two kinds of vacuum waste collection systems, stationary and mobile," (Wiqvist, 2017). By reducing the need for constant transportation between homes and facilities, Sweden has been able to dramatically reduce creating CO2 levels from garbage trucks. Wiqvist explains how the automated stationary vacuum system transports garbage when he reports, "The stationary vacuum waste collection system collects waste pneumatically in an automated vacuum system. This is then transported through underground tubes from the refuse chutes to large containers located in a terminal," (Wiqvist, 2017). By greatly reducing the need for garbage trucks, Sweden was able to create an innovative method to transport its waste, potentially creating thousands of jobs in the process, as well as opening a new market for businesses to explore and enter in order to achieve their goal of zero waste. In Sweden, it is becoming common practice for both municipalities and organizations to work together in order to create recycling parks and reuse centers (Wiqvist, 2017)

Wiqvist further explains how they reduced work related injuries in the waste collection phase when he writes, "Waste collection previously meant heavy lifting and many work-related injuries, but today bags have been replaced by bins or other types of containers, providing a better working environment," (Wiqvist, 2017). Through the elimination of plastic bags, waste

management facilities have eliminated one of the biggest threats to their sorting machines. Plastic bags often jam and damage sorting machines, which could cause a waste management plant to lag behind in work and leave factories with loads of waste that compound over time.

What's led Sweden to achieving its goal of virtually zero waste are its recycling, and recovery, centers; by extracting materials from waste and reintroducing them into the market as raw materials, or materials to be used into other products, Sweden has been able to effectively create a circular economy. Wiqvist explains the potential that recycling and recovering waste has when he reports, "Much can be recovered once the hazardous substances have been removed. Plastic cases are incinerated in energy recovery plants, and metals are sent to smelting plants for recovery. Recovered copper, aluminium and iron are used as raw materials in new products," (Wiqvist, 2017). By recognizing that waste has better potential as either energy, recycled material, or recycled products, Sweden was able to sort its waste into sections where it would be used appropriately and effectively. In Sweden's district heating systems waste is used as a fuel to keep homes warm (Wiqvist, 2017). Wiqvist further explains how much energy was generated through waste to energy facilities when he explains, "In 2016, a total of 18.1 TWh of energy was produced, of which 15.9 TWh was used for heating and 2.2 TWh for electricity," Rather than burning coal as a source of energy to create electricity, Sweden burns the natural methane gas that decomposing garbage releases, which releases a much cleaner and less hazardous CO2 levels than coal, in order to spin a turbine which in turn creates electricity.

The waste management procedure, as well as its legislation, in Sweden is both very strict and specific; it ensures that virtually all waste is harnessed to its full potential appropriately. Wiqvist explains the process of how Sweden recycles even its smallest, most insignificant, pieces of waste when he elaborates, "Once larger objects and metal residues have been sorted out

for material recycling, the material is sifted and stabilised to form granulated slag," (Wiqvist, 2017). By turning even the most insignificant waste into recycled material, with purpose and use, Sweden strengthens and supports their circular economy. Wiqvist even states that the granulated slag is used as construction material. The granulated slag replaces the use of sand and gravel, both being finite resources that could be better used for other matters, in order to protect the overall environment and give construction workers a far more sustainable solution and resource to utilize (Wiqvist, 2017).

The use of landfills are very limited in Sweden, and are often used as a last resort for materials that cannot be recycled, reused, or be broken down in order to extract its materials. The landfills that are utilized, however, are designed for the purpose of collecting leachate. Wiqvist explains the unique design of Swedish landfills, and defines what leachate is when he writes, "Landfills are built with a bottom barrier layer to make it possible to collect and purify leachate. Leachate is defined as the liquid – usually rainwater – which has been in contact with the landfill material and flows out of or is retained in a landfill," (Wiqvist, 2017). The Swede's innovative method of collecting unpurified rain water, and then purifying it, is brilliant because water is a finite resource that is often used in a lot of business and government related activities and operations. Wiqvist further explains how much leachate was purified in 2016, along with how its treated when he reports, "In 2016, approximately 7.3 million cubic metres of leachate was handled at 96 waste treatment plants. This includes contaminated surface water from operational areas. All of the water is handled in the same treatment process," (Wiqvist, 2017). When converted into gallons, 7.3 million cubic meters of leachate is 1,928,455,982 gallons of water. By sending all unpurified water to the same treatment plant, Sweden also guarantees that all unclean water is purified to the same standard. The purification of contaminated water also creates a lot

of jobs, as well as demand for individuals well-versed in engineering and science. The purification of contaminated water also helps protect the environment by reducing the demand and constant need for a finite resource.

Landfills, a common practice and method of waste disposal in the United States, are often prone to sudden explosions and combustion(s) due to the buildup and release of methane gases that are released from the organic waste stored in landfills. Wiqvist explains the single most i benefit to banning organic waste in landfills when he reports, "Since the ban on organic waste going to landfill was introduced, the formation of gas at landfill sites has progressively decreased," (Wiqvist, 2017). The decrease of methane gas in landfills is not only beneficial to the safety and health of employees and workers, that tend to the landfill, but is also beneficial for the environment. The Scottish Environmental Protection Agency explains the detrimental effects of methane gas on the environment when they report, "The main impact of methane is on a global scale, as a greenhouse gas. Although levels of methane in the environment are relatively low, its high 'global warming potential' (21 times that of carbon dioxide) ranks it amongst the worst of the greenhouse gases," (Scottish Environmental Protection Agency, 2018). Landfills are not a sustainable solution to the unabated generation of waste; modern problems require modern solutions, and thus require innovative and sustainable solutions that aid in mending a constant problem, both in the short and long term. Sweden has been able to create innovative solutions that tends to the creation of their waste, while also contributing to its economy, society, and the overall environment in the process.

Wiqvist explains that local municipalities often dictate what fuels are acceptable in the transportation of their waste to their local waste facilities, adding that many municipalities prefer to use biogas as their primary source of fuel (Wiqvist, 2017). By switching from fossil fuels to a

cleaner, synthetic fuel source Sweden was able to dramatically reduce the amount of CO2 emissions that their waste trucks produced through daily operations.

Swedish legislation has aided in the development of Sweden's circular economy, as well as help Sweden reach their goal of zero waste. Wiqvist explains how legislation affecting producer responsibility has pushed for a circular economy when he writes, "Since producer responsibility for WEEE was introduced in Sweden, municipalities and producers have cooperated on the collection of WEEE (Waste Electrical and Electronic Equipment)," (Wiqvist, 2017). Common WEEE (Waste Electrical and Electronic Equipment) contains various materials that could be reused and recycled and reintroduced into the economy for use as either a raw recycled material, recycled material to complete a product, or it could be broken down to create another raw material. Wiqvist explains that large electronic shops collect various types of consumer electronics, regardless of whether or not their customers purchase any products at the time (Wiqvist, 2017).

Although legislation lays out the framework for the development of an orderly society, people must also be incentivized, as well as educated, to follow legislation through both sanctions and rewards. Wiqvist explains how the Swedish government incentivizes its citizens to separate its food waste from other waste when he writes, "Many municipalities that introduced the voluntary collection of food waste use the charge as an incentive. Then, for example, households, that separate food waste pay a lower charge than those that choose to leave mixed waste for collection," (Wiqvist, 2017). By giving its citizens a choice to separate their food waste, Sweden perpetuates the development of its circular economy as well encourages and empowers its citizens to do the right thing or pay a price.

Over a four-year period, one can observe the growth of Sweden's material recycling, biological treatment, and energy recovery; the growth of Sweden's total volume of waste treatment procedures proves that Sweden was able to effectively allocate and sort its waste better over the years, as well as heavily reduce the amount of waste that it sends to be landfilled.

Figure 2.

Treated volumes of household waste 2013–2017 (tonnes)

	2013	2014	2015	2016	2017
Material recycling	1,467,200	1,617,930	1,652,710	1,615,170	1,617,640
Biological treatment	711,450	713,110	728,570	757,480	741,280
Energy recovery	2,235,930	2,148,640	2,284,210	2,262,610	2,400,440
Landfill	33,300	32,900	38,300	31,000	23,650
Total volume treated	**4,447,880**	**4,512,580**	**4,703,790**	**4,666,260**	**4,783,010**

Treated volumes of household waste 2013–2017 (kg/person)

	2013	2014	2015	2016	2017
Material recycling	152	166	168	162	160
Biological treatment	74	73	74	76	73
Energy recovery	232	221	232	226	237
Landfill	3	3	4	3	2
Total volume treated	**461**	**463**	**478**	**467**	**473**

Treated volumes of household waste 2013-2017 (%)

	2013	2014	2015	2016	2017
Material recycling	33.0	35.9	35.1	34.6	33.8
Biological treatment	16.0	15.8	15.5	16.2	15.5
Energy recovery	50.3	47.6	48.6	48.5	50.2
Landfill	0.7	0.7	0.8	0.7	0.5

Collected volumes of food waste, residual waste, and bulky waste, 2013–2017 (tonnes)

	2013	2014	2015	2016	2017
Food and residual waste	2,208,000	2,221,720	2,221,280	2,240,690	2,213,540
of which food waste		318,850	336,940	358,790	373,100
Bulky waste	1,780,000	1,719,180	1,773,930	1,725,670	1,760,140

Collected volumes of food waste, residual waste, and bulky waste, 2013–2017 (kg/person)

	2013	2014	2015	2016	2017
Food and residual waste	229	228	225	224	219
of which food waste		33	34	36	37
Bulky waste	185	176	180	173	174

One of the most notable increase that one should take notice of is Sweden's increase of energy recovery, as well as its reduction on utilizing landfills. In Figure 2., one can see that energy recovery makes up 50% of Sweden's waste treatment methods. The reason as to why Sweden's waste disposal methods revolve heavily around energy recovery is because it utilizes waste to generate electricity and to provide heat for homes.

In Japan…

Japan's government is a constitutional monarchy, and a representative democracy that has its officials elected directly by the people. Japan's legislative branch utilizes a bicameral system, much like the United States, in which bills must pass through two houses before it can be signed by the Ministers of States, the Prime Minister, and the Emperor. Japan is a collectivist society in which social harmony, teamwork, and face is valued.

Japan's waste management system, much like Sweden's, revolves around the development and strength of its circular economy and the laws that support its growth. Ghisellini, Cialani, & Ulgiati explain when Japan began its development for its circular economy when they write, "Japan implemented CE since 1991 with the Law for Effective Utilization of Recyclables (IES, 2015) and, later on, the Japanese CE initiative (He et al., 2013; UNEP, 2013a)," (Ghisellini, Cialani, & Ulgiati, 2015). Ghisellini, Cialani, & Ulgiati further add that it was due to close collaboration from its citizens, the Japanese government, and private organizations, that Japan was able to slowly transition and develop into having a circular economy.

Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi explain the desired goal of the Law for Effective Utilization of Recyclables when they explain, "The law has the goal of a society wherein the consumption of natural resources is restrained and the environmental load is reduced as far as possible, through promotion of the 3R as well as the environmentally sound waste management," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi, 2011). By effectively reducing, reusing, and recycling waste, Japan is able to significantly reduce the impact that their economy has on the environment, the cost of extracting virgin material, and the amount of waste that their society produces. Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi further add,

"The law set quantitative targets for three indicators: resource productivity, cyclical use rate, and final disposal amount," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi, 2011). By effectively laying out specific and measurable goals, Japan is able to effectively track their progress towards developing a circular economy. Various countries have different metrics in order to measure and track their progress, however, resource productivity appears to be the most common value shared by countries that aspire towards transitioning towards a circular economy.

Japan is well known for their eco-towns; eco-towns in Japan were funded by the Japanese government in 1997 as a means to create small economic industrial parks throughout the Japanese economy (Ghisellini, Cialani, & Ulgiati, 2015). Ghisellini, Cialani, & Ulgiati explain how Japan developed and empowered its Eco-Towns when they write, "From the adoption of the Eco-town program in 1997 a number of 26 eco-towns were created in Japan, by approving their eco-town plans. Eco-towns also received subsidies to invest in innovative recycling projects," (Ghisellini, Cialani, & Ulgiati, 2015). Japan's Eco-town program benefited both government and private organizations through the development of small economic industrial parks within communities, which helped progress the state of each city's respective economy and reduce the overall creation of waste over nearly two decades.

In Figure 3. Below, one can see how resource productivity has dramatically increased in the span in six years. From the fiscal year of 2000 -2006, one can see a 90,000 yen increase in performance productivity, which signifies substantial growth in performance. One can also take note of the increase of the circulation use ratio and how it grew by 2.5% in six years, proving that Japan's circular economy is on its way towards developing into a sustainable economy through the use of more recycled products and goods. The Municipal Solid Waste per person per day in Japan has also reduced from 1,185 grams, which converts into roughly 2.6 pounds, to

1,116 grams, which converts into 2.4 pounds, in six years. The two most notable changes one can observe from Figure 3. are the recycling amount and final disposal numbers. Japan's overall recycling amount nearly doubled in six years, processing and recycling 10 metric tons of recyclable materials in 2006. Japan's recycling increase proves that environmental and waste management legislation, along with the cooperation and support of both private organizations and the Japanese government, perpetuate the development of a circular economy. The final disposal numbers also show a significant reduction from 56 metric tons, to almost half, 29 metric tons.

Figure 3.

Table 4 Waste management targets in Japan [10, 37]

	Fiscal year 2000 (base year)	Fiscal year 2006 (performance)	Fiscal year 2015 (target)
Resource productivity	260,000 yen/t	350,000 yen/t	420,000 yen/t
Circulation use ratio	10%	12.5%	14–15%
MSW, per person per day (decrease)	1,185 g	1,116 g (−5.8%)	1,070 g (−10%)
Household waste, per person per day (decrease)	654 g	601 g (−8.1%)	520 g (−20%)
MSW from business sectors	17.99 Mt	15.82 Mt (−8.1%)	14.40 Mt (−20%)
Recycling amount (increase)	5.9 Mt (~11%)	10 Mt (~20%)	12 Mt (~24%)
Final disposal	56 Mt	29 Mt	23 Mt

In Japan, there has been a large social issue regarding the amount of dioxin emissions released by advanced incineration plants. Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi explain how the Japanese government replied to the concerns of its people when they explain, "As a result, dioxin emissions have been greatly reduced through the use of technology and the reduction of the amount of organic waste incinerated," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi, 2011). When the people of a nation unite in order to address an issue, although it may take time, a good governing body will hear the cries of its people and will answer.

Conclusion:

Although a country's culture and core values can help a country identify social, economic, and environmental needs, it isn't the only method to determine what a country needs in terms of legislation. Governmental structures are imperative in the legislation making process; unicameral systems tend to pass legislation faster than bicameral forms of legislative government. However, bicameral legislation making tends to pass laws that are accepted by those from diverse backgrounds, reaching a fair consensus that often reflects the will of the people within society. In some cases, the will of the people can influence the will of their government by spreading awareness from the bottom up, letting the government know of their wants and needs in society. In many cases however, it is often the government that tells its people of the nation's needs by enacting laws that force citizens to either change the ways that they behave or restrict them from completing certain actions. It is undeniable though that cooperation and understanding is needed from both the government and the citizens that it governs in order to not only develop a circular economy but to achieve anything productive that perpetuates the growth of their nation's society as a whole.

3. Good waste management is defined as…

There are three levels of waste management: poor, average, and superior. Poor waste management will be defined as 'waste that is handled and managed poorly by both society and the government; the government, nor society emphasizes on the necessity of sustainability, a circular economy, or responsible disposal of waste.' Average waste management will be defined as 'social or governmental emphasis and acknowledgement of sustainability, a circular economy, or responsible disposal of waste' Superior waste management will be defined as 'social and governmental emphasis and acknowledgement of sustainability, a circular economy, and responsible disposal of waste. Very few countries fall within the category of superior waste management and often times end up in the average category. Many of the countries that fall within the average category of waste management are also industrialized countries.

Ghisellini, Cialani, & Ulgiati give a traditional explanation of waste management and explain the problem with the definition when they report, "Waste management has been considered in the past simply a way to get rid of the waste materials by landfilling or incinerating. This is still the dominant disposal pattern worldwide, in so generating a huge loss of valuable resources and very heavy environmental impacts," (Ghisellini, Cialani, & Ulgiati, 2015). Ghisellini, Cialani, & Ulgiati realize the potential that is literally thrown away when "waste" reaches landfills or incinerators. Landfills and incinerators are unsustainable and outdated methods of waste management that, although are cheap, are potentially harmful to society and the overall environment. Landfills are breeding grounds for waste to naturally decompose and release methane into the atmosphere, hurting our atmosphere in the process. Meanwhile incinerators burn and release harmful CO2 emissions into the atmosphere, as well as other harmful chemicals that can have an overall impact on people's health. Saffron, Giusti &

Pheby, researchers of the effects of landfills, incinerators, and other unsustainable waste management practices, explain their analyses and findings of the correlation between landfills and its health effects on people when they report, "The literature search revealed more than 220 papers published about the hazards to health from landfill sites…Six review papers were found which covered the epidemiological evidence linking health effects with landfill sites," (Saffron, Giusti & Pheby, 2003). Although there were many studies conducted in order to test whether or not landfills have a direct impact on human health, there is still no evidence available to prove that landfills are directly having a negative impact on human health.

Weine Wiqvist, explains the definition of waste according to Swedish legislation when he writes, "According to the definition in the Swedish Environmental Code 1, waste is any matter or object that the bearer disposes of, intends to dispose of, or is obligated to dispose of," (Wiqvist, 2017). Superior waste management is necessary for the future and will eventually become the standard for waste management on a global scale. Superior waste management's strengths come from the support of a country's citizens, government, and private organizations that come together in order to improve their circular economy and protect the environment. The World Bank, a global organization dedicated towards eliminating poverty, discusses the costs and necessities of effective waste management when they report, "Effective waste management is expensive, often comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported," (The World Bank, 2018).

The dividing line between countries that have a good waste management system, and countries that have a superior waste management system, lies at the center of their society's and government's core values. The people of a country with superior waste management value the

idea of protecting the environment, even if it requires some effort to do so, as well as the idea of protecting themselves and others within their society from unsustainable waste management practices such as the uses of incinerators, landfilling, and dumping.

A country with average waste management systems tends to have a sense of apathy towards improving its waste management capabilities due to the process being a long-term investment that requires effort. Whether the apathy is rooted from either the government or its people the end result is the same; the bare minimum is achieved in order to remain above the margin of danger, following current legislation and rules established for waste management with reluctance and a lack for a need of improvement.

A country with poor waste management systems has overall apathy from its government and potentially from its people unless they protest against their government and demand for better waste management systems and waste treatment. The countries that fall into the category of poor waste management are often third world countries such as India, The Philippines, Haiti, and various African countries like Zimbabwe, and Ghana. The World Bank explains some of the waste management problems that these developing nations utilize in order to dispose of their waste when they write, "In low and middle-income countries, waste is often disposed in unregulated dumps or openly burned. These practices create serious health, safety, and environmental consequences," (The World Bank, 2018). The mistakes that developing nations and large unsustainable organizations tend to make are prioritizing their bottom line and neglecting their citizens or employees. It is economically cheaper to landfill waste; however, nations do this at the risk of the environment, potentially at the risk of their own citizen's health, and at the long-term cost of sustainability. Landfills are limited in size and space and have the potential to become a part of a sustainable and circular economy by being enhanced and

upgraded into a multi-recycling center that sorts and recycles waste effectively as a multi-purpose recycling plant that could also serve as a waste to energy facility.

Wiqvist further elaborates on landfill gas and the dangers that it poses to the environment when he writes, "Landfill gas is the term used for the gas produced at a landfill where organic waste was deposited in the past. The gas is approximately 50 percent methane. The rest is carbon dioxide, nitrogen, and small amounts of other gases. Since it contains methane, it must be collected to reduce its environmental impact," (Wiqvist, 2017). Superior waste management harnesses waste and turns it into opportunity; superior management in of itself turns crises into opportunities and sees them as the harbinger of change. Sweden's waste facilities operate by burning methane gas created by landfills, which release a much lower and safer amount of CO2 emissions (Wiqvist, 2017). However, before the burned methane is released, it is processed and filtered before it leaves the waste to energy facility, reducing the overall harm to the environment dramatically (Wiqvist, 2017). Innovation, dedication, and cooperation are what fundamentally define a country with superior waste management and its willingness to protect its environment, its people, and develop its economy.

The 3Rs of waste management play an important role in both superior waste management systems and some average waste management systems. The 3Rs (Reduce, Reuse, & Recycle) are the basics of any average waste management system; it is the execution and utilization of the three that determines whether or a country has a superior waste management system or an average one. Wiqvist explains the definitions of reuse, and recycle, when he reports, "Recycling means that the waste will be used as replacement for another material. Preparation for reuse is also a recovery operation. According to the definition, it means inspecting, cleaning or repairing any item that is waste so it can be reused without further treatment," (Wiqvist, 2017). Countries

with superior waste management tend to favor reduction out of the three R s because it has a bigger impact on the waste problem out of the three. By reducing waste creation through legislative and social initiatives, a government is able to dramatically reduce the amount of waste that is produced. Eriksson, Carlsson, Frostell,Björklund,Assefa, Sundqvist, Thyselius, waste management experts and analysts, explain the benefits of reduction and reduced landfilling when they report, "The study shows that reduced landfilling in favour of increased recycling of energy and materials lead to lower environmental impact, lower consumption of energy resources, and lower economic costs," (Eriksson, Carlsson, Frostell,Björklund,Assefa, Sundqvist, Thyselius, 2005). Reduction has a domino effect of benefits such as: the reduction of materials needed, leading to the preservation of the environment, leading to the growth and recovery of the ozone layer, as well as air quality, better resource allocation, which leads to the development and growth of the overall economy.

Recycling can be expensive after the cut-off point for product that have limited recycling life time. Wiqvist explains the limits of corrugated board when he writes, "Corrugated board is a large fraction and is sent for recycling into new corrugated board. One paper fibre can be recycled 7-8 times," (Wiqvist, 2017). After 7-8 times, when a product's limit is reached, it is cheaper to harvest and mine virgin material than it is to recycle the material itself. A superior waste management system, and circular economy, is limited by the fact that it is not limitless and needs a constant supply of virgin materials in order to stay economically sound. Wiqvist explains the recycling potential of two materials when he reports, "Glass and metal are two materials that could theoretically be recycled an infinite number of times as long as they are not contaminated," (Wiqvist, 2017). When the 3Rs are successfully implemented into a waste management system, the 3Rs effectiveness begin to depend solely on the success of the other; in short, the three 3Rs

are heavily interdependent and succeed only when the other elements of the 3Rs of waste management do as well. Knowing this, countries with superior waste management constantly work to improve the quality of their waste treatment, as well as create and implement innovative technology to help sort, treat, and recycle waste effectively.

Recently, the uses of biogas and ethanol has started trending in countries such as Brazil and Sweden. Eriksson, Reich, Frostell, Björklund, Assefa, Sundqvist, & Thyselius explain the various uses for waste in terms of energy recycling as well as how biogas is created when they write, "However, it is not only by incineration that waste can be used for energy recovery. Recycling of nutrients and materials reduces the need for energy intensive extraction and production of these resources, and the biogas obtained from anaerobic digestion can be used as vehicle fuel," (Eriksson, Reich, Frostell, Björklund, Assefa, Sundqvist, & Thyselius, 2018) Wiqvisit further comments on the process and development of biogas through anaerobic digestion when he writes, "Anaerobic digestion is the most common method of treating food waste. Anaerobic digestion produces biogas, which consists mainly of methane and carbon dioxide. Biogas is a renewable source of energy. Following refinement, it can be used as a vehicle fuel. It can also be used for heating or electricity generation," (Wiqvist, 2017). As a fuel source to power both vehicles, and turbines, biogas proves to be a much cleaner, safer source of sustainable energy than common fossil fuels, and coal.

Conclusion: Various countries are beginning to slowly turn away from fossil fuels, and are beginning to rely more on sustainable energy. As sustainable energy and waste to energy technology improves over time, countries will begin to make 'green' the standard of operations within their legislation.

4. Legislation and Policy Suggestions

In terms of waste management, The United States falls into the average category. However, it appears that it is beginning to progress slowly towards building the foundation of a circular economy. In order for the US's progress to be noticeable, it must face some of its biggest challenges head on in order to demonstrate that it is serious about establishing a circular economy and going green. For American society to change and progress towards developing a greener America, the American government must lead by example and pass legislation that penalizes unsustainable waste management practices and technology.

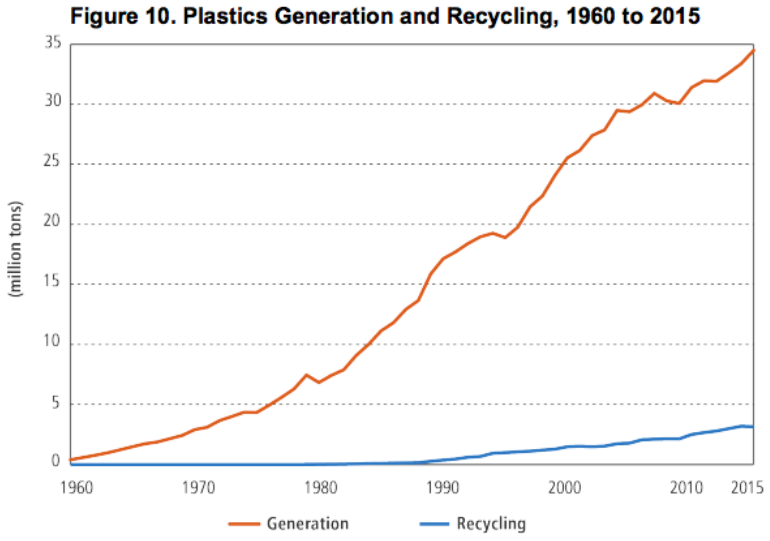
One of the biggest challenges that the United States faces in waste management is its use and dependency on landfills. According to Eriksson, Carlsson, Frostell, Björklund, Assefa, Sundqvist, Thyselius, experts on waste management and writers for *Journal of Cleaner Production*, write about the dangers that unsustainable methods of waste disposal such as incinerators and landfills pose to the environment when they write, "In all scenarios, except for landfilling, incineration is the main contributor of CO2 emissions emanating from combustion of plastic of different forms. Methane emissions from the landfill have the same effect in the landfill scenario," (Eriksson, Carlsson, Frostell, Björklund, Assefa, Sundqvist, Thyselius, 2005). An important legislative policy that could jump start the United States' economy and future towards pursuing a circular economy would be through legislation that supports selective waste collection. Selective waste collection is the act of sorting out waste with the intentions of allocating specific types of waste to their respective recycling facilities in order to properly allocate and utilize the waste to its fullest potential. Mrówczyńska, an expert on the economy and flow of waste management, explains the benefits of selective waste collection when he reports, "The result of selective waste collection is reduction of weight and volume of waste in landfills

up to 60% [4]. It is very important because the costs of building new landfills that meet EU standards are very high. Due to the impact on the environment, it is also difficult to find a suitable location, especially in heavily urbanised areas," (Mrówczyńska, 2011). Selective waste collection, would have a staggering impact on American waste management due to the colossal amounts of waste that the United States alone generates. Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi explain how much waste the average person in the United States generates when they report, "The USA has the highest rate of waste generation (800 kg person−1 year−1), followed by Japan and Korea (both around 400 kg person−1 year−1)," (Sakai, Yoshida, Hirai, Asari, M., Takigami, H., Takahashi, 2011). According to the United States Energy Information Administration, "In 2014, about 258 million tons of MSW were generated in the United States, of which: 53% was landfilled, 35% was recycled and composted and 13% was burned for energy," (US Energy Information Administration). By relying less on landfills, and relying more on recycling centers, The United States can develop a strong, stable circular economy over time. Modern landfills — which shall be defined as, "landfills that are equipped with waste to energy technology, or sorting systems in order to ensure maximum extraction of potential recyclable materials,"— are an important staple in the development of a circular economy, and having the necessary innovative technology in order to maximize the utility of all recyclable materials is the dividing line between countries with superior waste management and countries with average waste management. Wiqvist explains the potential that can be found in waste recycling when he explains, "Much can be recovered once the hazardous substances have been removed. Plastic cases are incinerated in energy recovery plants, and metals are sent to smelting plants for recovery. Recovered copper, aluminium and iron are used as raw materials in new products," (Wiqvist, 2017). Wiqvist further explains that the recycling of "waste" material plays an

essential role in sustainable societies, and that it is imperative that waste be perceived as a resource rather than garbage and that it be handled correctly in order to utilize it to its full utility (Wiqvist, 2017).

Below in Figure 4. one can see the ratio between the creation of plastic material to its rate of recycle along with the increase of the generation of plastic and its recycling throughout the United States from 1960 - 2015. With a ratio of 35: 3, one can see the great disparity between the creation of plastic materials and its rate of recycle. The unsustainable and rampant production of plastics, in combination with an underwhelming rate of recycling is a major factor that contributes tremendously to the waste issue in the United States. The amount of plastic that can be reused and recycled could greatly reduce the amount of waste that is landfilled in the United States.

Figure. 4:



Much of the waste that is disposed of in landfills can be recycled. Sakai, Yoshida, Hirai, Asari, Takigami & Takahashi explain an average of what makes up a landfill when they report, "In terms of MSW composition in the USA, the most dominant component is packaging, which accounts for 30%, followed by waste containing organic materials (27%), paper (24%), and steel and plastics (18%; percentage by weight in 2008),"(Sakai, Yoshida, Hirai, Asari, M., Takigami, H., Takahashi, 2011). Slowly, after about a decade or two, once the amount of waste is reduced to less than 50 million tons being landfilled, a ban on landfilling can slowly be enacted over time. R.K. Ham, an expert on the trends of American waste management, explains the potential ways that a landfill ban can be executed and implemented when he explains, "For example, landfill bans may be written to say that the amount of MSW to be landfilled must be reduced by a certain percentage, commonly 25 to 50 percent, or specific wastes cannot be landfilled… Landfill bans in essence leave it up to local officials to decide what to do with banned materials," (Ham, 1993). By adopting principles of waste management from countries that have superior waste management systems, The United States could revolutionize its outdated system and have a positive impact on the environment through sustainable waste management practices. The most common, and essential, waste management practice is explained by Wiqvist when he writes, "At a modern waste treatment plant, material separation – for processing, for reuse and material recycling, and for energy recovery – is a major part of operations," (Wiqvist, 2017).

Sorting and recycling waste is essential for the development of a circular economy, which creates the very foundation that perpetuates said economy into motion. The United States' Environmental Protection Agency's *Recycling Economic Information* report explains some of the benefits that sustainable business practices when they report, "By converting waste materials into

valuable raw materials, recycling creates jobs, builds more competitive manufacturing industries and significantly contributes to the U.S. economy," (Environmental Protection Agency). The banning of unsustainable and obsolete landfills would also reduce the amounts of methane gas that is created by organic waste that makes its way into landfills, which would significantly reduce the amounts of greenhouse trapping gases that are released from outdated and poorly managed landfills.

There are various challenges that go into building a landfill in the United States. Ham writes about some of the challenges that come with building a landfill when he writes, "Designing and operating a sanitary landfill is emerging as administratively and technically challenging. No longer can uninformed people handle the many decisions to be made on a daily basis at a large, well-run landfill," (Ham, 1993). What makes building a landfill administratively challenging is the pressure and opposition from various interest groups, along with elected officials and the general public (Ham, 1993). Ham further adds, "Other driving forces are the lack of landfill space and the inability or political difficulty of siting new landfills, and the cost and public acceptance of improving or constructing incinerators," (Ham, 1993). The challenges and costs of constructing a landfill —an outdated method of waste disposal — outweigh the benefits that it could ever provide when compared to building a modern landfill. Landfills are also limited by their space and capacity, which is a problem because, although garbage decomposes in landfills, it takes a long time; the decomposing garbage also releases methane which is a potent greenhouse gas that does significant harm to the environment. Preston & Lehne further added that it is estimated that dumpsites and landfills will account for about 8-10 percent of the global greenhouse gas emissions by 2025 (Preston & Lehne, 2017). Ham explains what happened in the United States in the 1990s during a landfill shortage when he explains,

“Recently, prodded by a shortage of landfill space, revived interest has developed in composting yard or "green" waste in many states, and composting of mixed residential waste is being done in a few instances,” (Ham, 1993). Composting is an excellent, and sustainable, substitute for landfills because it’s good for the environment. Vochozka, Maroušková, & Šuleř, a group of organic scientists and economists, explain what compost is when they explain, “Compost is understood to be a more or less decomposed organic material, mostly from biodegradable waste, which contains a certain small amount of mineral nutrients and water,” (Vochozka, Maroušková, & Šuleř, 2017). Although composting is beneficial for the environment Vochozka, Maroušková, & Šuleř explain why it currently is not financially feasible based off of their hypothesis and various tests results when they report, “Based on the above, the current standards for compost quality are found to be obsolete and counter—productive. The case study shows that obsolete legislation has significant implications, which are not only environmental, but also economic,” (Vochozka, Maroušková, & Šuleř, 2017). In order for composting to become a sustainable solution and substitute for landfilling it needs the support of both society and the government in order to improve awareness of the need for better quality compost that is created and for the government to take action towards improving compost so that it may become more profitable and reduce landfilling.

Various states within the United States send their garbage to other states in order for it to be landfilled. Ham explains some of the longest distances that garbage is exported when he reports, “The longest haul distances discussed or observed were from New York and New Jersey to Ohio and Kentucky, which would be in the range of 400 to 600 miles, one-way, and waste is now being hauled approximately 1,300 miles one-way from the New York region to Nebraska,” (Ham, 1993). The problem with exporting garbage from one state to another is that it does not

solve the overall issue; the act of exporting garbage is a short-term solution to a long-term issue. Rather than export garbage for it to be landfilled, legislation should be passed for states to export their garbage to states that specialize in recycling or recovering waste while weaker states develop their circular economy and begin implementing more sustainable technology and waste management practices.

After selective waste management laws are passed, along with laws that restrict states from exporting their waste for the purpose of it being landfilled in other states, the government can invest in opening various waste to energy facilities that can be both publicly and privately owned. The US Energy Information explains some of the benefits of utilizing waste to energy plants when they explain, "Producing electricity is only one reason to burn MSW. Burning waste also reduces the amount of material that would probably be buried in landfills. Burning MSW also reduces the volume of waste by about 87%," (US Energy Information Administration). The US Energy Information Administration explains that different fuels, when burned, emit different CO2 emissions (US Energy Information Administration). Below in Figure 5., one can see the different amounts of CO2 emissions that are released by each respective fuel source. Coal anthracite appears to be the fuel source with the highest CO2 emissions, meanwhile, natural gas appears to be the fuel source with the lowest rate.

Figure 6.

Coal (anthracite)	228.6
Coal (bituminous)	205.7
Coal (lignite)	215.4
Coal (subbituminous)	214.3

Diesel fuel and heating oil	161.3
Gasoline (without ethanol)	157.2
Propane	139.0
Natural gas	117.0

Legislation that could be passed, shortly after the strict adherence of following selective waste management, could be a coal ban. Although it would potentially take years, if not decades to pass, it would have an astounding impact on the environment by switching to less harmful and more sustainable energies such as diesel fuel, gasoline, propane, and other natural gases. A coal ban may have an impact on the overall coal industry; however, it would also lead to the growth of the sustainable energy industry, which would lead to the expansion of the solar, hydro, wind, and waste to energy, industry on a national level.

More than 85 pounds, out of 100 pounds of MSW (Municipal Solid Waste) in the United States can be used as fuel in waste to energy facilities to generate electricity (US Energy Information Administration, 2018). One ton of MSW, when converted into energy at a waste to energy facility in 2016, generated 474 kilowatt-hours of electricity, which is enough to power 16. U.S. households in one day (US Energy Information Administration, 2018). According to the US Energy Information Administration, "In 2015, 71 waste-to-energy power plants and four other power plants burned MSW in the United States. These plants burned about 29 million tons of MSW in 2015 and generated nearly 14 billion kilowatthours of electricity," (US Energy Information Administration). The U.S. already shows promise in terms of its latent potential in waste to energy facilities, as time passes and society and technology progresses, the number of houses that a ton of MSW will be able to power will grow.

Along with heavily limiting coal, The United States must also keep in mind of the impact that gasoline and diesel fuels have on an environmental and macroeconomic level. Eriksson, Carlsson, Frostell, Björklund, Assefa, Sundqvist, Thyselius, explain the main contributor to CO2 emissions when they write, "In the compensatory system, the main contributor in almost all scenarios is external vehicle fuel, i.e. petrol and diesel oil," (Eriksson, Carlsson, Frostell, Björklund, Assefa, Sundqvist, Thyselius, 2005). The US population is over 320 million, and within that population, a substantial number of people drive; by passing legislation that effects the types of fuel that motorists use, the government can effectively reduce and control the amount of pollution that they create by supporting the uses of biofuels, electric cars, and even ethanol, rather than oils. Victor S. Rezende explains a problem that The United States has when he writes, "In the Energy Security Act of 1980, Congress found that United States dependence on imported oil should be reduced," (Rezende, 1992). Thomas Friedman further adds, "We have to do better, because ending our oil addiction is not simply an environmental necessity anymore. It's a strategic imperative. We will only breathe freely—in every sense of that phrase—if we can reduce global demand for oil and gas," (Friedman, 2008). There's a myriad of reasons for slowly transitioning to more sustainable vehicles that run on electricity, biogas, gasohol, or ethanol; these reasons can vary from environmental, political, economic, to even social. Friedman explains some of these issues when he writes, "The increase in fuel prices around the world also raises the costs of farming around the world, and therefore the cost of food. It also encourages more and more countries to allocate land for biofuels such as ethanol, so they won't be so dependent on oil, which adds to grocery prices by reducing the acreage devoted to food crops," (Friedman, 2008). By reducing oil imports, countries can focus on improving sustainability technology in order to progress their society and ultimately reduce their

dependency on oil by getting society to focus on creating and developing engines that run effectively on biofuels, electricity, and other fuels. Friedman also explains the reason as to why the United States should limit its purchases of petro-oil when he writes about the contradictory nature of how it affects the United States' war on terror when he explains, "We are financing the U.S. Army, Navy, Air Force, and Marine Corps with our tax dollars, and we are indirectly financing, with our energy purchases, al-Qaeda, Hamas, Hezbollah, and Islamic Jihad," (Friedman, 2008). By reducing its dependency on oil imports, the United States can impact the finances of terrorist organizations whose funds stem from their country's exports of oils, and cripple them economically. Hill, Nelson, Tilman, Polasky, Tiffanywrite about how an increase of petroleum prices could have a positive effect on biofuels when they report, "Further increases in petroleum prices above 2005 average prices improve the cost competitiveness for biofuels. Even when not cost competitive, however, biofuel production may be profitable because of large subsidies," (Hill, Nelson, Tilman, Polasky, Tiffany, 2006). There is a lot of opportunity in the sustainable technology industry, economically, politically, environmentally, as well as socially, for not only the United States but for the entire world.

A short-mid-term suggestion that the US should consider is slowly transitioning away from utilizing crude oil and transition into utilizing ethanol. The U.S. Department of Energy reports that ethanol often contains less energy than gasoline per gallon depending on the percentage of ethanol in the blend, and that 98% ethanol contains roughly 30% less energy per gallon than traditional gasoline (U.S. Department of Energy, 2018). By switching to ethanol, the U.S. could greatly reduce the amount of CO2 emissions that it generates per year, while also creating a market need for sustainable cars and engines to be created. The U.S. Department of energy further adds, "Ethanol's impact on fuel economy is dependent on the ethanol content in

the fuel and whether an engine is optimized to run on gasoline or ethanol," (U.S. Department of Energy, 2018). Through market-based need, social support, and legislative support, innovative engines that run effectively on ethanol would be created in order to help match the market demand for ethanol, and the development of sustainable technology. 95% of the United States ethanol consists of starch from corn grain, and the energy required to produce ethanol yields a positive energy balance, which means that the process of creating ethanol does need more energy than the energy that the ethanol will produce itself (U.S. Department of Energy, 2018). After roughly a decade of utilizing ethanol as a fuel source, the United States could begin to slowly innovate and create engines that utilize more sustainable energy such as solar power, or electric cars that can be charged at charging stations that generate its electricity from either solar panels, windmills, hydro power, and etc. Thomas Friedman supports this when he writes, "He asserted that appropriately planned environmental regulations will stimulate technological innovation, leading to reductions in expenses and improvements in quality," (Friedman, 2008). The creation of power charging stations that generate electricity solely from sustainable energy would create millions of jobs across the country and would also force companies in the automotive industry to adapt to change in order to remain in business. Meticulously planned environmental regulations offer the benefit improving both the environment, and the competitiveness of an organization and country (Friedman, 2008).

Another issue that various countries face is the issue of creating enough biofuels without having an impact on food demand. The inverse relationship that the biofuel demand and food demand have is vicious for countries that have already moved towards, or have already established, a society that's dependent on biofuels. Hill, Nelson, Tilman, Polasky, Tiffany further explain the issue when they report, "Global demand for food is expected to double within the

coming 50 years, and global demand for transportation fuels is expected to increase even more rapidly). There is a great need for renewable energy supplies that do not cause significant environmental harm and do not compete with food supply," (Hill, Nelson, Tilman, Polasky, Tiffany, 2006). By opening up subsidiaries, the American government can fund projects for engineers, scientists, and various people from S.T.E.M. backgrounds who have innovative ideas ranging from the creation of more powerful electric car engines to making solar powered cars to even the creation of a sustainable hybrid car that's made of light- recycled metal and runs on electricity and solar power. The Food and Agriculture Organization of The United Nations, a department of The United Nations dedicated towards providing solutions towards the food epidemic, explains the necessity for education of the food waste crisis in schools when they report, "Education on these matters in schools and political initiatives are possible starting points to change people's attitudes towards the current massive food waste," (Food and Agriculture Organization of The United Nations, 2011). The people of the world deserve to be educated on matters that directly impact them economically in order to adopt a socio-political agenda and focus on addressing the problem under a united front in collaboration with their national government. The United States Environmental Protection Agency estimates that food is the most landfilled, as well as the most incinerated, material out of every other waste item, and that it makes up 22% of disposed municipal solid waste (Environmental Protection Agency, 2018). The Environmental Protection Agency further adds, "Additionally, the U.S. Department of Agriculture (USDA) estimates that in 2010, 31 percent or 133 billion pounds of the 430 billion pounds of food produced was not available for human consumption at the retail and consumer levels (i.e., one-third of the food available was not eaten)," (Environmental Protection Agency, 2018).

A problem that is affecting not only the United States is the rapid growth of waste generation rates. The World Bank explains that in 2012 the major cities of the world generated 1.3 billion tons of solid waste per year, further adding that the number of waste is predicted to increase to 2.2 billion tons by the year 2025 (The World Bank, 2018). It is imperative that the United States also adopts legislation that heavily reduces the amount of food waste that its consumers and businesses create; in order to do this, the United States must pass legislation that penalizes organizations that generate an excessive amount of food waste. In addition to this, the government can give incentives, such as tax breaks, to organizations that operate within the food industry to reduce the amount of food that they waste; by extension, the government could incentivize organizations to donate their food to local homeless shelters, community shelters, orphanages, hospitals, and other organizations in order to help fight against hunger. Shepard discusses Swedish legislation called "producer responsibility" and discusses its purpose when he reports, "Recent legislation in Sweden has emphasized the concept of 'producer responsibility.' The eco-cycle bill, which passed in February 1993, and introduced into law in January 1994, seeks more efficient use of materials and resources of the country by requiring greater participation by producers in the production, recovery, and reuse of waste," (Shepard, 1995). By adopting similar legislation for all organizations, especially those that operate within the food industry, The United States can lead its society towards a more sustainable future that stands against poverty, pollution, and outdated waste management practices.

A product that the United States should consider banning paper cups, as well as manage its restrictions on Styrofoam. Styrofoam cannot be recycled, nor does it biodegrade overtime (Lake, 2015). Packing peanuts, Styrofoam coffee cups, and various products are made of styrofoam, and are used widely across the United States. Although styrofoam is not recyclable,

and is not a sustainable product, it prevents the unsustainable process of creating paper cups through competition. Hocking explains, "Because 6 times as much wood pulp as polystyrene is required to produce a cup, the paper cup consumes about 12 times as much steam, 36 times as much electricity, and twice as much cooling water as a polystyrene foam cup," (Hocking, 1991). Although styrofoam cups are made from unrecyclable materials, from an utilitarian perspective, the benefits that it provides outweigh the bad that it provides; until the paper cup making process can be lowered to match the same process of creating styrofoam cups, in terms of materials, resources, waste created and generated, and even electricity, styrofoam cups serve as a short-midterm solution until a better alternative can be created or reached. A styrofoam cup is made mainly from hydrocarbons, which are oil and gas, a fossil fuel (Hocking, 1991). A paper cup requires roughly 580 times the amount of waste water that is needed to produce a styrofoam cup (Hocking, 1991). Although paper cups are made from sustainable and renewable materials, the process to create it, and possibly recycle it are far too unsustainable and prove to have a negative energy balance, which proves that it is not an ideal alternative for styrofoam cups.

Another item that the United States should consider heavily regulating is plastics bags. Plastics bags contribute to the harming of hundreds of marine life in ecosystems worldwide. Jambeck explains how plastic harms marine life when she writes, "Animals often ingest the tiny pieces of plastic and it can build up in their stomachs. Tiny pieces of plastic have been detected in sea creatures that humans like to eat such as fish, shrimp, mussels, and oysters," (Jambeck, 2018). Plastic bags are also made from petro-oil and are often not biodegradable. Khoo & Tan explain that there are bio-based polymers (pseudo plastic bags) that are better for the environment due to the fact that the bags are made from renewable resources, which reduces the need for fossil fuels needed in order to create the bags themselves (Khoo & Tan, 2009). Khoo &

Tan further add that the incineration of plastic bags can create up to double the amount of greenhouse gases that bio bags produce when incinerated (Khoo & Tan, 2009). Lake explains the common misconception of plastic bags when he reports, "Many people think that if something is made out of plastic, it can be recycled but this does not apply to plastic bags, since they have a tendency to get caught in recycling machinery and potentially damage the equipment," (Lake, 2015). The United States must reduce its dependency on traditional plastic bags, that are not biodegradable, and switch to bio-bags in order to reduce its impact on the world's oceans and marine life.

After amending several outdated and obsolete waste management, business, and environmental laws, and improving education, and raising awareness of the waste issue domestically and internationally, the United States' circular economy should be in full effect. The full implementation of a circular economy could take at least two decades, if not three, due to the bicameral system that makes up the United States' congress. The legislative body of the United States is systematically built in order to make the legislative making process as meticulous as possible, as well as to quell the passions that the people, and congress, may feel in order to prevent passing legislation in the "heat of the moment" and later have it repealed. Ghisellini, Cialani, & Ulgiati explain how countries such as Sweden, Japan, and China were successful in the implementation of their respective circular economy when they write:

> The success of such programs is due to legal, social, economic and technological factors, such as the evolving legislative framework towards the adoption of a recycling-oriented society, the shared responsibility of society over the need for environmental protection, the reduction of enterprise's risks and capital

> expenditure by means of subsidies, the diversification of enterprise's activities, and the improvement of technological capacity within particular industrial sectors. (Ghisellini, Cialani, & Ulgiati, 2015)

Various economists who are experts on the development of the circular economy all agree that a circular economy is a long-term investment, as well as a grueling undertaking that a society must face throughout the process. Ghisellini, Cialani, & Ulgiati agree that it is a combined effort from everyone in society when they write, "The lesson learned from successful experiences is that the transition towards CE comes from the involvement of all actors of the society and their capacity to link and create suitable collaboration and exchange patterns," (Ghisellini, Cialani, & Ulgiati, 2015). In order for society to become more aware for a need to address the waste problem, it must be led by their government and become educated on the issue. Education must be reformed in the United States in order to raise and develop future engineers, scientists, and more people from STEM backgrounds; a better education on the state of the world's climate would also help concentrate and shift society's focus on developing a more environmentally friendly, green, circular economy.

Conclusion: A country's circular economy is often formed under one of two circumstances; Preston & Lehne explain this when they write, "More 'circular' behaviour is often born out of economic necessity, while higher value opportunities for reuse and remanufacturing are relatively rare," (Preston & Lehne, 2017). In China's case it falls under the first circumstance, forming its circular economy in response to a material shortage crisis during the late 1900s. Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi confirm this when they write, "Driven by global environmental problems and the depletion of natural resources, the

major focus of waste management policies changed during the late twentieth and early twenty-first centuries," (Sakai, Yoshida, Hirai, Asari, Takigami, & Takahashi , 2011). In Sweden's case, it had adopted its circular economy earlier on in order to capitalize on extracting raw materials from waste, and to limit its carbon footprint and impact on the environment. One could also argue that a core value of Swedish culture is resourcefulness and using everything to its full utility. Preston & Lehne explain how the US can benefit from a circular economy when they write, "A recent study focused on the US finds that $2 trillion in annual US revenues could be generated by shifting to circular manufacturing," (Preston & Lehne, 2017). By implementing a circular economy, the United States would be able to have a much more environmentally friendly, sustainable, and low-waste producing society.

5. Innovative Methods to Revolutionize Waste Management In The United States

The expansion of the sustainable energy industry will naturally demand for far more professionals in the S.T.E.M. field such as engineers, scientists, programmers, in order to help develop, grow, and improve future sustainability technology; equivalently, a major expansion of waste to energy facilities across the United States would create hundreds of thousands of job opportunities for citizens, strengthening the economy, and the need for more education in order to further innovate sustainable energy and technology. However, the United States should create an incubation area for the concentration and development of sustainable energy. The incubation area could be named Area 99. The incubation area would be a government funded program that would bring together engineers, scientists, mathematicians, and computer scientists, from around the nation, and possibly foreign engineers, influences and guidance from other countries. Within the incubation area, engineers and scientists would work collaboratively alongside each other in order to develop next generation engines, motors, and technology for future sustainable technology.

After years of development, the program would begin its next step and go into phase II, which would be the implementation of the next generation sustainable technology into eco-towns that would serve as the testing grounds for the economic development of a potential, futuristic, zero waste economic industrial park. By implementing next generation sustainable technology into eco-towns, economists can observe the economic behavior of the eco-towns' economy over a period of five years and determine whether or not eco-towns outperform non-eco-towns with similar populations.

Depending on the results of phase II, if the expected results of the project are met —or even surpassed— then the project could be taken into its final phase. Phase III of the project

would be the implementation of next generation sustainable energy across the nation with laws dictating that a minimum threshold of electricity must be generated from sustainable energy.

In order for the United States to not only demonstrate that it is serious about developing a circular economy, but also serious about assuming leadership in the international community in terms of sustainability and sustainable energy, the United States must use historical symbolism. Historical symbolism will be defined as any act, piece of literature or art, or moment in history that changed dramatically changed society either domestically or internationally. Howard writes about how countries must think outside of the box in order to combat the climate change when he explains, "Indeed, innovative and effective solutions to the environmental threats arising from industrial production and mass consumption require that we transcend the system of thought that produced these threats in the first place," (Howard, 1999). Through historical symbolism, the United States can unite people domestically and internationally by creating a symbol to serve as the harbinger of the United States' ambition to become the world leader in sustainability and sustainable technology. The best example of historical symbolism is the Space Race between the US and the USSR because it was a literal race to the moon between two of the world's strongest powers at the time, and because both countries were trying to prove something to the world.

What if the United States took action and did something tremendously symbolic in order to demonstrate its commitment to developing a circular economy and ambition to make green the world standard? The action that the thesis suggests is that the United States puts together thousands of pounds of unrecyclable garbage, put it on a rocket ship, and shoot it into the sun as a one-time event. The action is meaningless and would have no effect unless the United States follows through with it and begins passing legislation to build and support the development of its circular economy. Thomas Friedman supports this when he writes, "There is a third trend,

though, and this is the one that gives me hope. This is the trend toward what I call 'nation-building at home.' While Washington may be gridlocked and drifting sideways, and our economic management has been anything but responsible, our country is still exploding with innovators and idealists," (Friedman, 2008). Through the innovation of sending garbage to the sun, along with its symbolic significance, countries will follow and even try to rival the United States' commitment to developing a circular economy and making the world greener.

The costs of the rocket itself would range from 750 million dollars to a billion dollars. The rocket itself would be able to lift around 100,000 pounds and would be able to reach its destination in several years through the use of S.E.P. NASA explains what S.E.P. is when they write, "Solar electric propulsion provides such high fuel economy that it reduces the amount of propellant required onboard vehicles for deep-space missions by as much as 90 percent," (National Aeronautics and Space Administration, 2016). As time passes, and technology advances, the costs of space travel will begin to decrease, making the launch the much cheaper over time. If the launch, for some reason, isn't possible now then it can be put off until later in the future.

Conclusion: In order for there to be change in the world, the United States must become the change and assume leadership in order to make green the world standard in order to protect society, the environment, and the economy. Through heavy investing and historic symbolism, the United States could reign in a new, green era in which all countries aspire to lower their carbon footprint and emphasize on selective waste management, recycling, and the use of clean, sustainable energy.

6. Chart Analysis

Figure 7. :

			
Countries	**Sweden**	**Japan**	**United States**
Waste Management Legislation	47 (17)	13	12
GDP Per Capita (2017)	$53,442.01	$38,428	$59,531.66
GDP Per Capita Increase (1987 & 2017)	161.665%	88.783%	206.963%
Bicameral or Unicameral	Unicameral	Bicameral	Bicameral
Total Waste to Energy Facilities	33	358	75
Waste to Energy Facilities Per Population (Per Millions)	3.32	2.82	0.23
Total Recylcing Facilities	25	177	588
Recycling Facilities Per Population (Per Millions)	2.51	1.40	1.84
Total National Incinerators	33	1156	2523
National Incinerators Per Population (Per Millions)	3.32	9.12	7.88
Total Landfill Sites	157	1661	1738
Landfills Per Population (Per Millions)	15.78	13.10	5.43
Tons Recycled Overall	1,615,170	221,000,000	91,600,000
Tons Converted Into Energy Overall	18,129,040	25,000,000	33,500,000
Tons Landfilled Overall	1,983,400	15,000,000	137,700,000
Landfilled Tons Per Population (Per Millions)	200,343.43	118,296.53	430,312.5

Sweden currently has seventeen pieces of waste management legislation; however, those seventeen pieces of legislation does not include the environmental and waste management laws passed by the European Union. If one were to include the additional 30 laws on waste management and environmental protection, Sweden would have a total of 47 laws. Sweden was one of the first countries to create its own Environmental Protection Agency in the late 60s. Japan currently has thirteen pieces of waste management legislation, and being geographically located adjacent to China, one could understand how Japan is motivated to pass more legislations in order to protect their environment and citizens from smog that China produces. The United States has the least amount of waste management laws out of all the countries, which

demonstrates that the United States does not currently acknowledge its waste issue as much as it should. While the former countries began implementing waste management laws to lay down the foundation for the development of their circular economies, the United States started implementing both environmental and waste management laws much later than other countries. Due to other countries such as Sweden, and Japan, having a head start in the development of their circular economies, the United States reasonably lagged behind. By having more waste management legislation, Sweden was able to meticulously form the foundation of its country's circular economy. Sweden's 47 laws on waste management are effective due to the emphasis of selective waste management and using waste to its full utility in order to benefit Sweden's economy, society, and environment. What makes Sweden far more successful than the United States, in terms of recycling, is the legislative support and foundation that was made to develop Sweden's circular economy. According to the data, with almost four times the amount of waste management and recycling laws, Sweden outclasses the US in almost every category on the comparative chart. The data supports the first hypothesis and demonstrates that more laws on waste management undoubtedly leads to more recycling and to better waste management. Although Japan has a lot less waste management laws than Sweden, one of its most important laws, the "Basic Law for Establishing a Recycling-based Society" which was passed in May 2000, specifically addressed the waste problem that Japan had and provided solutions for reducing waste, recycling, and creating a circular economy for Japan. Due to the passing of Japan's "Basic Law for Establishing a Recycling-based Society", followed by other recycling and waste laws, Japan's recycling rate has been able to increase to a rate of 45%. What makes Japan more successful than the United States, in terms of recycling, is the government's acknowledgement of its society's waste problem and the need for the government to take action

and create laws in order to reduce waste and create a circular economy. Although Japan has only one more law than the United States, the impact and the details that Japan's legislation has are what led the country to outclass the US in recycling. Due to technological advancements and the creation of sustainable technology, both Sweden and Japan have been able to turn their waste into sources of energy, and into materials for their products.

Sweden's GDP per capita is currently $53,442.01. From 1987 to 2017, the GDP per capita increased by 161.665%. Between 1987 and 2017, Sweden's population also grew from 8.4 million to 9.9 million. From as early as 1967, Sweden has invested heavily in sustainable energy and technology in order to help preserve its environment. Sweden is one of the world leaders in recycling and is the apotheosis of a circular economy. Japan's GDP per capita is currently $38,428.00. From 1987 to 2017, the GDP per capita increased by 88.783%. Japan's population also increased from 122 million to 126 million from 1987 - 2017. From the early 2000s, Japan passed several specific laws, which supported very specific sorting and disposal of different kinds of waste in order to further support Japan's flourishing waste to energy industry. However, once Japanese citizens began protesting against unregulated incinerators emitting sulfur and phosphorus into the air, the government took action and placed specific laws against incinerators that did not have a filter. The United States' GDP per capita is currently $59,531.66. From 1987 to 2017, the GDP per capita increased by 206.963%. The United States' population also grew from 242 million to 325 million from 1987 - 2017. However, the United States EPA (Environmental Protection Agency) has not accomplished much since the Clean Water Act in 1990 when compared to what Sweden, and Japan's government did. The reason as to why the United States wins is due to its massive growth in population within a short amount of time, along with the other variables; one could attribute the US' growth to oil being one of the reason

for its growth and how it tries to control the global production of oil in order to benefit its economy. The reason as to why GDP per capita and its increase matters is to see if the findings support the second thesis which asks whether or not countries with better waste management have better economies than countries that do not have as high-quality waste management laws. The results are mixed in a sense that there are various other factors to analyze and consider when comparing the GDP per capita of countries such as population, exports, imports, technology, and laws. However, from looking solely at the population growth over time alongside the per capita growth, the answer points to no due to various other factors that boost the economy of countries with fewer waste laws such as the United States.In short, the answer is inconclusive. This data also gives inconclusive answers to both the second and third hypotheses which claim that more legislation in waste management has a positive impact on a country's economy, and that countries with better waste management legislation have better economies due to the United States having fewer waste management laws and having a better economy, along with a higher GDP per capita.

Sweden also has a unicameral system, whose congress is known as the Riksdag. However, before the law can be passed, the law must go through one of the 15 Riksdag committees and be analyzed, then put up for debate, and processed before becoming a law. Japan has a bicameral system, which is made up out of the House of Representatives and the House of Councillors. The legislative making process is difficult for parties wishing to pass to their own legislation because passing laws requires both chambers to agree. The United States also has a similar bicameral system, which is made up of the House of Representatives, and the Senate. The structure of the United States' congress is built meticulously to prevent congress from passing laws rapidly by giving both chambers the ability to both pigeonhole a bill and send it back to the

other chamber for revisions and markups. Sweden's unicameral system encourages collaboration among parties to pass laws that will benefit Sweden's society rather than individual parties. By analyzing the legislative process of each respective country, the thesis was trying to determine which system is superior in passing both the most laws and the most effective laws. Sweden's unicameral system allows it to pass various laws by only having it processed through a single chamber, speeding up the legislative by a lot. Japan's bicameral system is effective in passing quality waste management laws by allowing both parties to add their own demands and amendments, which perpetuates both parties to work collaboratively. The United States is also bicameral, however, both parties tend to oppose one another and have difficulties passing legislation that supports the agenda of the other party, making it a difficult system to pass waste management legislation through. The reason why Sweden won is not only because it is a unicameral system but also because it is a member of the EU, which also passes legislation that Sweden is obligated to follow; due to this, Sweden benefitted and optimized its waste to energy facilities, allowing its waste management to become one of the best in the world.

Sweden has 33 waste to energy facilities, which is really good for a country of their small size. Being geographically placed all around Sweden, its waste to energy facilities provide both electricity and heat for its citizens. Rather than burning coal and various gases for energy that can pollute the air and harm its citizens. Sweden's extensive use of waste to energy facilities have led to the country's healthy air quality. Sweden's waste to energy facilities per population (per millions) is 3.32 which means that there are 3.32 facilities for every million people. Japan has 358 waste to energy facilities, demonstrating that Japan specializes heavily in the waste to energy segment of sustainability. Japan has a 2.82 waste to energy facilities per population (per millions). Although Japan's number of waste to energy facilities is ten times the number of

Sweden's waste to energy facilities, Japan's facilities per million is lower due to it having a much denser population than Sweden; although it has a lower number than Sweden's it does not fall far behind. The United States currently has 75 waste to energy facilities, with a majority, of them being located in the North East of the country. The United States has a score of 0.23 waste to energy facilities per population (per millions), which means that the United States has lagged behind in the waste to energy industry. The main sources of energy in the United States are oil and coal, which do tremendous harm to the ozone layer, and the environment. Naturally, it is expected for the United States to have a low score due to its dense population. However, the geographic disparity in placement of waste to energy facilities throughout the United States demonstrates how some states are more passionate about sustainable energy than others. By comparing the waste to energy facilities per million available one is able to see a fair comparative analysis and ratio of a country's waste to energy facilities against its population. Sweden has the highest ratio in per millions of waste to energy facilities, which demonstrates its country's dedication to reducing waste, turning waste into energy, and the strides towards sustainable energy that the country has over the years. Although Japan isn't too far away from Sweden's ratio, Japan demonstrates that waste to energy facilities are important to the reduction of its country's waste and the production of some of its energy. The United States' low score demonstrates that it is slowly becoming more and more involved in utilizing sustainable energy and technology. The US' low score also demonstrates how it prefers other, more harmful, forms of energy production such as coal and oil.

Sweden currently has 25 recycling facilities, along with a score of 2.51 per populations (per million) meaning that there are 2.51 facilities per millions of people. Japan has 177 recycling facilities around the nation and a score of 1.40, meaning that there are 1.40 recycling

facilities per million people. The United States has 588 recycling facilities with a score of 1.84 facilities per population per million. The United States surpasses Japan in terms of sheer numbers of recycling facilities available per million. However, the United States recycling rate is far lower than that of both Japan and Sweden. Sweden's score is nearly double that of the United States due its small population, stable population growth, and meticulous legislation. By examining the recycling facilities and their per population available in millions, one is able to understand who prioritizes more on recycling. The reasons as to why Sweden beats the United States in recycling, even by having less recycling facilities, are because of its supportive legislation, cultural and societal norms, and technological advancements in sustainable energy. Surprisingly the United States has a higher score than Japan, however, the United States overall recycling rate is only 25.8% while Japan's recycling rate is 45%, demonstrating that its possible that Japan's recycling centers may process more than that of the average US recycling facility. One could also argue that due to the special limit that Japan has on being able to build new buildings together, that Japanese recycling facilities are optimized and are built to process far more tons of recyclable material than the US. The reason as to why this matters is because it demonstrates that countries with fewer recycling centers still have the potential to recycle more than countries that have more recycling facilities.

Sweden has a total of 33 national incinerators, and a score of 3.32 total national incinerators per population. The number is identical to its waste to energy facilities due to waste to energy facilities being counted as incinerators. Japan has 1156 total national incinerators, with a score of 9.12 total national incinerators per population. Japan's high score of incinerators per population is due to incineration being one of Japan's favorite waste disposal methods, next to recycling, for reducing its waste. Japan's waste to energy facilities are also included as

incinerator facilities. The U.S has 2523 total national incinerators, giving it a score 7.88 total national incinerators per population. Due to its population, and the amount of waste that it generates on a daily basis, the need for national incinerators and landfills are perceived as a must for the purpose of sanitation and waste disposal. However, incinerators produce harmful chemicals and air pollutants that can harm citizens and are naturally outdated methods of waste disposal. Sweden wins due to its meticulous waste management laws and their dedication to preserving the environment by using sustainable energy; especially by vastly improving upon their waste management technology as well. The reason why the US beats Japan is because of its dense population. Out of the 2523 incinerators that the United States only 75 of them are waste to energy facilities. The reason why it matters is because it demonstrates how far behind the United States is in comparison to both Sweden and Japan in terms of both sustainable energy technology, and in development of a circular economy. This is important because it proves that countries with less waste management laws are more likely to use outdated waste management technology that is more harmful to the environment.

Sweden recycled 1,615,170 tons recycled overall and converted 18,129,040 tons into energy via its waste to energy facilities in 2017. The large disparity between the recycling rate and its waste to energy rate stems from the significance of Sweden's focus on waste to energy industry which focuses on providing both heat and electricity to homes throughout the country. In 2015, Japan recycled an estimate of 221,000,000 tons and also converted about 25,000,000 tons into energy overall. Japan's recycling rate is one of the highest in the world; due to its circular economy, which focuses on recycling waste rather than turning it into energy or landfilling it, Japan's circular economy has been able to make recycled plastics and metals into one of Japan's greatest exports. In 2015, The US has recycled 91,600,000 tons, and has also

converted 33,500,000 tons into energy. Due to a lack of a circular economy, and laws that perpetuate the foundation of a circular economy, the United States greatly falls behind both Sweden and Japan in terms of both progress and productivity. The reason as to why this is important is because it demonstrates how Sweden specializes more in its waste to energy facilities in order to provide both heat and electricity to homes throughout the country, along with how Japan specializes in recycling, having a rate that topples that of even a massive country like the United States. The United States loses through its underwhelming tons in waste to energy and recycling due to not only the higher ratios of the other countries, but also due to its heavy dependence on landfilling and incinerating. This further proves that countries with less management laws are likely to use old waste management technology, as well demonstrates that countries use different sectors of recycling to support their economic needs.

Sweden has a total 157 landfill sites, earning a score of 15.78 total landfill per population. Due to Sweden's low score, one can see that landfilling is not a viable option due to its scarcity, and its high costs. Sweden landfilled 1,983,400 tons overall in 2017, giving it a low score of 15.78 landfill ton per population. Due to Sweden's low population and proportionate landfilled tons, Sweden's score is relatively low in its ratio. Since Sweden landfills are used to landfill and average of 0.005% of its garbage, the size of Sweden's landfills are small. Japan has 1661 total landfill sites and has a score of 13.10 total landfill per population. The population to total landfills ratio is also relatively proportionate to the population. Japan also landfilled 15,000,000 total tons overall. Japan has a score 11,8296.53 landfill ton per population, which is a very low score relative to its population of 126 million people. Although the number of landfills in Japan are quite high, the size of a Japanese landfill is quite small due to the limited space that Japan has on the island itself. A Japanese landfill is most certainly a lot smaller than both a Swedish and an

American landfill which usually, according to NASA, covers an average of 600 acres. In 2017, the US landfilled 137,700,000 tons overall, leading it to have an overwhelming score of 430,312.50 landfill ton per population. In 2017 alone, the United States landfilled 52.5% of its waste, recycled 25.8%, used 12.8% for waste to energy, and 8.9% for composting. In total, the U.S has 1738 total landfills, giving it a score of 5.43 total landfill per population. Due to the dense population of the United States, the US earns its relatively low score.

Conclusion: Sweden is the best at converting waste to energy. Japan is the best at recycling, and the United States is best at landfilling. US landfills are much bigger than the landfills of Sweden and Japan. Although the US has much more recycling facilities, Japan's recycling facilities are of higher quality and are able to process more than that of US recycling facilities. The main reasons as to why the US does not recycle as much is because it is much cheaper to landfill waste than it is to currently recycle it. However, if the US were to adopt a circular economy, and if the global market were to demand more recycled products, the world would become a much greener place.

7. Conclusion

In conclusion the comparative study of several countries who utilize a circular economy and have a superior waste management system has come to the conclusion that it is not certain whether countries with better waste management have a better economy in the long run due to oversight of various factors such as recessions, population, and imports and exports. However, the results raise the question "What if a need for materials, or recycled materials, acts as a potential economic indicator?" The thesis was, however, able to conclude and prove that more laws do equate to better waste management due to the disparity in the amount of legislation in Sweden and the United States. Although Japan only has one more law than the United States, the laws that were passed were able to lay out a plan and a vision for the future of Japan's society. Culture does also, to some extent, play an important role in the development of a circular economy in terms of leaders and society being able to identify and set certain agendas for society to focus on.

Ultimately, the United States has proven to fall behind both Sweden and Japan in terms of green initiatives, but it has also demonstrated the massive potential that it has to assume leadership and become the world leader in sustainability. The circular economy will prove to be the future tool and foundation for the international community and the future of the global economy. The study can be further built upon by inspecting other economic indicators, as well as by running similar comparative analyses on other countries against the United States in order to see if further research can provide more knowledge on the potential correlation between waste management and economic performance.

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