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The JBEP in Brief

Volume XLVII Number 2 Fall/Winter

The textiles, apparel & luxury Goods sub-industry comes under the Consumer Durables & Apparel industry and comprises 5.3% revenues of the entire consumer discretionary sector. The two largest revenue contributors within the textiles, apparel & luxury Goods sub-industry are Apparel, Accessories & Luxury Goods and Footwear. In this study, we benchmarked the operating performance of 35 textile, apparel, and accessories companies. We used data envelopment analysis (DEA) as a decision-making tool to analyze the operating performance of cosmetics firms that are classified as competitors. This methodology benchmarks best-performing companies against worst-performing companies using financial ratios. We found that overall only one company consistently outperformed others over the sample period of 2015 to 2019. Further, using an overall efficiency score, data envelopment analysis eliminated the need to interpret conflicting ratios, because it clearly identified the factors contributing to the performance of a company.

In the context of a circular economy, green businesses thrive to mitigate environmental problems and create environmentally friendly products. One of the most prominent and fast paced sectors in a green economy is Waste to Energy (WtE). This paper aims at scrutinizing waste-to-energy technologies as a green business model and their dual purpose of enhancing the solid waste management sector while providing valuable renewable energy (heat and electricity). The paper utilizes a comparative analytical approach to review the case of Germany and Sweden in employing WtE technologies and their impact in the economy with the aim of drawing valuable lessons learned for developing countries that suffer from energy deficiency and struggle with municipal solid waste as well. The paper assessment of WtE reveals that WtE projects represent successful green business models that accomplish the triple bottom line (planet, people, and profit) fulfilling the three pillars of sustainability. Furthermore, they offer a practical solution of the dilemma of energy shortage and pollution from municipal solid waste.

The analysis of the European experience with WtE shows the importance of extensive regulations in exploiting the full benefits of WtE while avoiding any negative outcome. The German and Swedish case studies show the necessity of a comprehensive energy policy linked with a well organized solid waste management policy to ensure the integration of WtE as a tool to achieve both energy requirements and waste management goals. Each country employed different types of WtE technologies to serve their needs which reveal that there is no optimum WtE technology for all. Accordingly, the choice of a country to employ a certain type of WtE depends on multiple factors (economic, social, environmental..etc).

Keywords:
Waste to Energy, Solid Waste Management, Sustainable Development, Green Businesses, European Union, Renewable Energy
Jel Classification: O52, O57, Q01, Q2, Q42, Q53, Q55, Q56, N54, N74

Purpose - This paper analyzes the possible long-run bi-directional causal nexus between Australia's nominal effective exchange rate and stock market return with their short-run interactive feedback effects. Monthly data from May, 1992 through December, 2017 are employed.

Design/Methodology/Approach – Linear ARDL Bounds Testing Approach is implemented and VECM's are estimated for co-integration and causality, respectively.

Results/Findings - The evidence shows relatively stronger long-run effect of stock market return on nominal effective exchange rate than its converse. However, net interactive feedback effects in both cases are positive. Additionally, parametric stability is evidenced in both cases, based on the CUSUM and the CUSUM-squares tests.

Implications - Stock market returns have relatively stronger influence on Australia's nominal effective exchange rates. So, Australia's policymakers should closely monitor the unfolding developments in the national stock market to understand potential changes in foreign currency market for decision purposes on the external front.

Keywords: Stock Market Return, Nominal Effective Exchange Rate, Autoregressive Distributed Lag, Error-Correction Model, Feedback Effects. JEL Classifications: F31, G10, G15

This paper explores the impact of a few macroeconomic factors namely industry value addition, trade liberalization, exchange rate, urbanization, and external debt on tax revenue in Bangladesh through a complete set of time series analysis from 1979 to 2015. This paper reveals that unlike depreciation of Bangladeshi currency, increase in industry value addition, level of external debt, and urbanization significantly increases the tax revenue in the long-run. Even if deprecation in Bangladeshi currency insignificantly increases tax revenue in short-run due to excessive dependency on import, it decreases the tax revenue in the long-run due to switching from import oriented country to export oriented country. Unfortunately, this study does not find significance of trade liberalization to increase the tax revenue of Bangladesh. Since the elasticity of tax revenue with respect to industry value addition is relatively higher in the long-run than that of short-run, to ensure adequate tax revenue, Bangladesh Government should give importance on the increase of industry value addition. One of the possible ways to increase industry value addition is the reduction of corporate taxation.

Kew Words: Industry Value Addition, Trade Liberalization, External Debt, Exchange Rate, Urbanization, Tax Revenue

The purpose of this study is to examine the influence of parental saving behavior on college student employment. A total of 219 traditional, undergraduate students participated in the study. Ordinal logistic regression analysis revealed that parental saving tendencies exert a significant influence on the employment status of college students. When parents plan and prepare financially for higher education, students are less likely to work and less likely to work long hours. Parental saving thus appears to offset student employment, possibly improving prospects for academic achievement and success.

This study seeks to investigate the gender differences in blue-collar work environments as it relates to job satisfaction, where blue-collar work environments are those environments once dominated by male workers. The relationship between perceived organizational support and job satisfaction is evaluated with perceived supervisory support and perceived organizational family support used as moderators. Hierarchal multiple regression is used in the data analyses. The data is obtained from 227 correctional officers employed at a state prison in the southeastern part of the United States. Results of the analyses indicates that there is a significant difference among gender in blue-collar work environments as it relates to job satisfaction. Comparison of the coefficient of determination show that the above constructs accounts for nearly 63.6% of the variation in job satisfaction for males; however, for females, the same model accounts for only 37.4% of the variation in job satisfaction. Further, it shows that perceived supervisory support moderates the relationship between perceived organizational support and job satisfaction for male but not for females. Conversely, it shows that perceived organizational family support moderates the relationship between perceived organizational support and job satisfaction for female but not for males.

Keywords: job satisfaction, gender difference, organizational support, supervisory support, organizational family support

Waste to Energy in the Context of a Circular Economy: The Case of Germany and Sweden

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INTRODUCTION

Countries all over the world thrive to achieve economic growth in their pursuit to become developed. The past fifty years witnessed a shift in countries agenda towards achieving sustainable development rather than mere economic growth. This exposed the environmental impact of economic activities, a side that was often neglected in the pursuit of maximizing economic growth. Firms and households are profoundly responsible of increasing the threat of climate change through their decisions. The current consumption and production patterns are unsustainable as they rely heavily on fossil fuel. Accordingly, the world is suffering from an ecological deficit which is unsustainable and poses further growth constraints. If environmental preservation is to be put as a priority, these patterns should change to a more eco-friendly growth pattern. Thus, there must be a switch towards a green culture that puts the limits of the planet's natural resources into consideration.

Economies beliefs and attitudes toward natural resources as inexhaustible and their unrestrained discharge of waste led to catastrophic outcomes. Reversing this necessitates that businesses place sustainability as a strategic concern by altering their operations, organizational processes, and strategies. The pursuit of being greener is a continuing process. Accordingly, new business models that are focused on achieving sustainability and help in the shift towards an inclusive green circular economy are gaining momentum. One of these businesses is Waste-to Energy (WtE). This paper aims to analyze waste-to-energy firms and shed the light on the European Union (EU) experience in employing WtE especially in Germany and Sweden to draw important lessons for developing countries.

The paper is organized into seven sections; the first section is the introduction, followed by an overview of waste-to-energy (WtE) as a type of green businesses and its relevance to municipal solid waste, explaining what is meant by WtE, its different types; main drivers, advantages and disadvantages. The third section examines the European Union rules and regulations for the waste sector especially those pertaining to WtE technologies and their context within a circular economy. The fourth and fifth sections demonstrate the German and Swedish experience with utilizing WtE technologies respectively, the sixth section draws lessons learned from the European experience in general and the German and Swedish experiences in particular to guide developing countries in employing WtE in their transition to a green economy, and the final section is the conclusion.

1 SCRUTINIZING WASTE-TO-ENERGY (WTE)

Businesses are at the centre stage of the sustainability debate (Bisgaard, Henriksen, and Bjerre, 2012). Businesses realization that they can be successful while preserving the environment and society encouraged many firms to restructure their processes and become more environmental friendly. This realization helped in the creation of a new type of businesses (green) businesses especially in the context of a green economy.

A green business is basically one that focuses on sustainability in resources and environmental impact. These businesses make efforts aiming at creating low-carbon, resource efficient and/or remanufactured products, services, processes and business models (Gkasialis, 2013). Green businesses take different forms and are present in multiple sectors. One model of these green businesses is Waste-to-Energy (WtE) firms that utilize Municipal Solid Waste (MSW) as a feedstock and convert it into heat or energy, thus reducing pollution from MSW while supplying sustainable renewable energy.

Municipal Solid Waste (MSW) is considered a major source of pollution, the growing waste generation rates result in multiple environmental problems such as greenhouse gas emissions (GHG), air pollution, land pollution, and water pollution. MSW is considered the third largest source of anthropogenic methane gas which accounts for 3-4% of global anthropogenic GHG emissions (Kumar and Samadder, 2017; Taherzadeh, 2010). Multiple factors including political, economic, environmental, social, educational, demographic, climatic as well as technological are attributing to the escalation of waste generation worldwide and affect the composition and characteristics of MSW resulting in multiple socio-economic and environmental issues (Kumar and Samadder, 2017; Malinauskaite et al., 2017; Moya et al., 2017).

While there is a global call for recycling, reuse and repurpose of waste to save valuable raw materials and the environment, most of the waste ends up in landfills. The dominance of the throw-away philosophy and waste accumulation caused numerous environmental problems, health issues, safety hazards as well as hindering sustainable development in terms of the forgone resource recovery of recyclable materials in waste.
Waste-to-energy (WtE) technologies use MSW as a feedstock and convert it into heat or energy. According to the World Energy Council (2013) WtE consists of any waste treatment process that leads to the creation of energy in the form of electricity, heat or a waste derived fuel. Hence, it is a key component of any circular economy which fosters sustainable consumption and production (Malinauskaite et al., 2017). WtE is considered an ecological and economical practice which is rising rapidly in association with the heightened demand for energy, waste disposal, and environmental monitoring (Beyene, et al., 2018).

1.1 Types of Waste-to-Energy Technologies

WtE technologies were established to decrease the amount of waste land-filled. They comprise thermal processes like mass-burn incineration and gasification, in addition to non-thermal technologies like anaerobic digestion and landfill-gas recovery (Seltenrich, 2016). The most common type is the processing of MSW through incineration in a combined heat and power plant. However, there are multiple types of WtE technologies.

WtE technologies can be classified according to the type of conversion process. Thermal treatment technologies (Thermo-chemical processes) include combustion/incineration, pyrolysis, conventional gasification, plasma gasification and refuse derived oil (RDF), while biological treatment technologies (Biochemical processes) include fermentation, anaerobic digestion and landfill gas recovery. Finally bio-electrochemical processes include Microbial fuel cell (MFC) and microbial electrolysis cell (MEC) (Beyene, 2018; Malinauskaite et al., 2017; Moya, Aldas, Lopez, Kaparaju, 2017; Boonpa and Sharp, 2015; Tan, 2013: World Energy Council, 2013; Stehlik, 2009). Each technology type is most suited to a different MSW content. For instance, anaerobic digestion is more suited for food and yard wastes, while, gasification is better for plastic wastes and incineration is suited for mixed MSW (Kumar and Samadder, 2017).

Environmental regulations as well as economic requirements play a major role in choosing the optimal WtE technology (Stehlik, 2009).

1.2 Waste to Energy Drivers and the Global Market

WtE projects have been implemented in many countries all over the world. They gained special attention under the green economy initiative as one of the green sectors that offers numerous benefits especially in developing countries. Technological advancement, government regulations and incentives as well as better pollution control systems have helped the rise of WtE as alternative energy source. Kumar and Samadder (2017) argue that WtE technologies are untapped potential for sustainable solid waste management that must be regarded as an important renewable energy source which is both environmental friendly and economically feasible.

Globally around 84% of electricity generation is still dependent on fossil fuels which are depleting at an accelerating rate. Hence, there is a need for alternative energy sources to lessen the upcoming energy crisis. Approximately, 13 Giga Watt of energy can be generated from WtE projects alone. WtE technologies that transform waste into a useable form of energy offer a great opportunity especially for developing countries. Developed countries incorporated WtE technologies as part of their Integrated Solid Waste Management Systems (ISWM-S) to help produce by-products as well as addressing global warming and climate change (Moya, Aldas, Lopez, Kaparaju, 2017).

The global market for WtE has witnessed a significant increase in the past few years and is expected to grow further. The main drivers for this growth are increasing waste generation, high energy costs, growing concerns of environmental issues as well as restricting capacities of landfills (Kumar and Samadder, 2017). Thermal WtE is expected to keep the largest share of the market with the Asia Pacific being the fastest growing market for WtE with major expansions in China and India. The European market is also expected to expand as well. In addition, there is a trend for the private sector to replace the public sector monopoly over WtE (World Energy Council, 2013).

1.3 Advantages and Disadvantages of Waste to Energy

Waste is considered a negative output associated with any production/consumption processes. The aim of any country should be to reduce the volume of waste produced. Accordingly, there are multiple ways to handle waste including recycling, reusing and repurposing which work on decreasing the amount of waste and saving valuable raw materials. These practices must be encouraged and given the highest priority in waste management. Nonetheless, in case of unavoidable waste there remain two options, energy recovery from waste through WtE projects and disposal in landfills. Hence, WtE is a better option than disposal for multiple reasons.

Being a renewable and reliable source of energy, WtE has various advantages along with reducing GHG emissions and waste sent to landfills (Crawford, 2012). WtE is a dependable and effectual energy alternative to decrease CO_2 emissions and keep limited fossil fuel resources required by traditional coal-fired power plants which are expensive and pose adverse environmental impact. 1 tonne of MSW incinerated reduces approximately the equivalence of 1.3 tons of CO_2 eq emissions in comparison with fossil fuels based power plants, in addition, redirecting 1 ton of biodegradable waste from a landfill towards anaerobic digestion averts up to 2 tons of CO_2 eq emissions. In 2015, the United Nations Environment Programme (UNEP) and the International Solid Waste Association (ISWA) argued that improvement of waste management could lead to an estimated 10–15% reduction of current global emissions. WtE is a major contributor to realize that potential. In addition, WtE facilities operate 24 hours a day, 7 days a week, 365 days per year providing a reliable supply of energy to the electricity grid (UN, 2018; Kumar and Samadder, 2017; Kleppmann and Stengler, 2015; Kleppmann, 2014). WtE benefits include energy empowerment, improving health conditions, enhancing economic growth, as well as the opportunity of benefiting from the by-products and the recovery of metal and other material from WtE ash (Jamasb and Nepal, 2010; the INVENT book, 2009).

Furthermore, WtE technologies provide a number of economic development benefits for communities such as long term savings in waste disposal tipping fee, reduction of long term costs of landfills, retention of the money used as waste management expenditure in the community, as well as creating jobs during construction and operation phases in the local economy that cannot be outsourced. Additionally, the amount of land required for WtE plants are less than those required for landfills. For example a WtE incineration plant that can process 1 million tonne per year of MSW with an average of 30 year time span requires 100,000 m^2 of land while a landfill for 30 million tonnes requires 300,000 m^2 of land (Kumar and Samadder, 2017; The Solid Waste Association of North America [SWANA], 2011).

On the other hand, WtE projects have some disadvantages. First, in some countries WtE might substitute or discourage recycling and reuse practices which are superior options in waste treatment. Second, the success of WtE projects depends on the quality of the waste separation process (to produce suitable feedstock), which might not be available especially in developing countries. Third, WtE is an expensive option in comparison to the other waste treatment options like recycling, repurpose and reuse. Fourth, in the absence of proper health and safety measures, workers in WtE plants might be imposed to some health risks. Fifth, WtE plants might impose some environmental risks. Residual emissions discharged from WtE plants into the atmosphere are dangerous, with no adequate environmental laws this might lead to environmental pollution reversing the aim of the WtE projects in the first place. Moreover, improper handling of byproducts of waste conversion processes including bottom ash and sludge leads to environmental pollution.

However, these disadvantages can be lessened to fully utilize the benefits of WtE. First, raising societies' awareness of the importance of recycling, reuse and repurposing will allow for better waste management coupled with the use of WtE projects to treat unavoidable waste and turning it into a much needed energy. Second, establishing sorting centers and imposing fines to ensure waste separation from the source would guarantee the availability of a suitable feedstock for different WtE technologies. Third, governments can offer incentives or partnerships with the private sector to encourage the implementation of WtE technologies. Fourth, Imposing stringent environmental laws as well as health and safety measures would ensure that WtE projects impose no risk on the society and the environment. Fifth, with better filtration systems the amount of gases emitted by WtE can decline, and the problem of undesirable byproducts can be solved through recycling and reuse of byproducts in other products.

2 OVERVIEW OF WASTE-TO-ENERGY IN THE EUROPEAN UNION

Historically, waste volumes have been rising in Europe as waste is a byproduct of economic activity, with approximately 3 billion tonnes of waste generated in the European Union every year. Nevertheless, WtE is one of the emergent green energy sectors in Europe who has been a leader in developing WtE technologies. Due to changes in waste management regulation, escalating commodity prices, development in prevention, reuse, recycling and recovery technologies, waste is being gradually treated as a valuable resource for companies and the rest of society; since 2008 WtE capacities in Europe has grown substantially and starting from

2010, European countries substituted their focus from disposal to preventing and recycling MSW (Research and Markets, 2018; Cleancluster, 2017). It is suggested that diverting waste from landfills significantly mitigate GHG. Enhancing the waste management sector is estimated to save 92 million tonnes of CO_2 emissions by 2030 in the EU-28 if all municipal waste are diverted from being land-filled (Kleppmann and Stengler, 2015; Kleppmann, 2014).

Additionally, the heat and electricity from WtE facilities substitute fossil fuels used by conventional power plants which helps in decreasing CO_2 emissions. Thus, 8-42 million tons of fossil fuels (gas, oil, hard coal and lignite) which emit 8-42 million tonnes of CO_2 can be substituted annually. Henceforth, diverting waste from landfills to recycling and WtE projects accompanied by enhancing grid access and WtE facilities infrastructure to supply energy would permit European WtE facilities to produce around 196 billion kWh of sustainable energy by 2020, which is corresponding to the energy generated by 6-9 nuclear stations or 25 coal power plants (Kleppmann, 2014).

Waste policies in Europe have advanced over the last 30 years. The 7th Environment Action Programme (2012-2020) entitled “Living well, within the limits of our planet” advocates improving waste management in the EU due to its potential benefits of efficient use of resources, decreasing raw materials dependency, reducing environmental impacts to move towards a circular economy, abolishing land-filling and restraining energy recovery to non recyclable materials. In addition, the EU legislation regards the biodegradable fraction of municipal and industrial waste as biomass, thus, a source of renewable energy. Accordingly, around 50% of the energy generated by WtE facilities is renewable (Cleancluster, 2017; Kleppmann, 2014).

A number of European countries landfill less than 10% of their MSW, including Germany, Sweden, Netherlands, Belgium, Denmark, Norway and Austria. These countries utilize their waste as a resource either for recycling, composting or energy recovery. Energy recovery is considered a North European phenomenon where Norway, Denmark and Sweden incinerate more than 50% of their MSW to recover energy (Cleancluster, 2017).

2.1 European Waste Regulations

The EU has issued multiple directives concerning waste management, setting binding laws and targets for its member states. The paper will focus on the most relevant directives to waste. First, the Waste Framework Directive (WFD) adopted by the European Commission (EC) in 2008, it is the main legislative document on waste at the EU level. According to the WFD, the determination of whether a substance or an object is waste and its classification as non-hazardous or hazardous waste is an important decision (European Commission, 2018a).

The European waste policy is planned according to the Waste Framework Directive (WFD), which lays down the general framework for the EU legislations on waste. The importance of the WFD is in creating a five-step obligatory waste hierarchy to be executed by member states in their own legislation to shift waste management up the waste hierarchy. This waste hierarchy is considered the foundation of waste legislation in the EU. The WFD has set a 50% recycling rate of municipal waste as a target for EU Member to be achieved by 2020. The waste hierarchy can be depicted as an upside down pyramid with prevention (zero waste) as a top goal followed by preparing waste for reuse, recycling, recovery, and disposal (Cleancluster, 2017). It is considered the keystone of EU policy and legislation on waste and a key to the transition to the circular economy. The waste hierarchy priority is: waste prevention, reuse, material recycling and biological treatment, other recycling, e.g. energy recovery, and finally disposal (European Commission, 2017).

The second pertaining directive is the Landfill Directive which includes rules on the management, sanction conditions, closure, and landfills after-care (European Commission, 2018a). The directive is set to avoid or diminish the negative effects of land-filling of waste on the environment, particularly on surface water, groundwater, soil, air, and human health. According to the WfD, land-filling is the least favorable option and is restricted to the minimum; wastes that must be land-filled are sent to landfills that comply with the requirements of the landfill directive 1999/31/EC on the landfill of waste (European Commission, 2016).

The third directive is the Waste Incineration Directive (WID), in which the EU set up actions to avert or diminish air, water and soil pollution in addition to any anticipated human health risk that might happen due to incineration and co-incineration of waste. It necessitated that incineration and co-incineration plants have to acquire a permit to operate and laid down emission boundaries for certain pollutants to be released in the air and water (such as dust, nitrogen oxides, sulphur dioxide, hydrogen chloride, heavy metals, dioxins and furans, etc.) (Cleancluster, 2017). According to the WID energy from waste incineration is an extremely low risk environmentally friendly technique of post recycling/composting remaining MSW. It reduces the environmental impacts of land-filling waste and assists in global warming mitigation both through its green energy measure and the reduction in landfill gas releases (Chaliki, Psomopoulos, and Themelis, 2016).

The fourth directive is the Renewable Energy Directive (RED) which is concerned with promoting renewable energy sources. The 2030 Climate and Energy Policy Framework anticipated that renewable energy contribution will increase to at least 27% by 2030. Accordingly, the exploitation of MSW adds to enlarging the renewable energy share in the final energy production. In that sense, WtE processes- as a source of renewable energy- are predicted to have an important role in the sustainable management of MSW. The fifth directive is the Industrial Emissions Directive (IED) which aims to reduce emissions into air, soil, water and land and to prevent the generation of waste from industrial sector to achieve a high level of protection of the environment. The IED is important in the context of WtE facilities as it set the key requirements for the operation of an incineration plant with a minimum combustion temperature of 850 °C and residence time of 2s for MSW combustion, it also laid down specific emission limits for all resulting gases and substances (Scarlat, Fahl, and Dallemand, 2019).

In addition to the abovementioned directives, the EC established its energy union strategy in 2015, with the aim of constructing a unique European energy market that supply citizens and businesses with a secure, affordable, and climate-friendly energy. In 2016, the Commission announced a new sustainable energy security package within the framework of the energy union. This package aims at increasing the flexibility of the EU to gas supply disruptions. In the same year, the European Parliament ITRE committee approved a draft report that targets a 40% binding energy efficiency goal by 2030 (Kleppmann and Stengler, 2015). The European energy policy has three key goals: sustainability, competitiveness and security of supply. Consequently, a transition from a fossil fuel base to a renewable fuel base is required which is a major driver for developing and investing in WtE technologies. A 15% energy generation rate from renewable sources is an officially required target put by the European renewable energy directive to be achieved by members, which led to promoting WtE technologies in Europe (UN, 2018).

2.2 Waste to Energy in the Context of a Circular Economy

The abovementioned waste regulations are tools created by the EU to reach its goal of achieving an inclusive green circular economy as a substitute of the traditional linear economy (make, use and dispose). In a circular economy resources are reserved for the longest time through exploiting the maximum value from them while in use and recovering and redeveloping materials and products at the end of their lifetime to minimize waste and resource use. Transforming to a circular economy is essential due to escalating pressure on resources as well as pollution from waste generation. In light of that, WtE is of a paramount importance to the circular economy as it is a type of energy recovery process through waste treatment processes that produce energy in the form of heat or electricity from a waste source which falls under waste management aspects of the circular economy (UN, 2018).

In line with the EU 2030 Agenda for Sustainable Development, the EC embraced an action plan for a circular economy on December 2, 2015. The plan aimed at boosting the transition to a circular economy that preserves the value of products, materials and resources for the longest period, and minimizes waste generation. This action plan clarified that the conversion to a more circular economy necessitates taking action throughout a product’s life-cycle: from production to the formation of markets for secondary (waste-derived) raw materials with waste management as a chief area. The EC identified high quality waste materials as valuable secondary raw materials that should be treated according to the open market rules for products which could lead to substantial economic opportunities. Economic benefits include the development of the supply of raw materials to industry, generating local jobs and endorsing European leadership in the green technologies sector. In this context, WtE plays a major role with its various waste treatment processes, each of which has different environmental impacts and circular economy potential (European Commission, 2018b; European Commission, 2017).

In 2017, the EC issued the communication on WtE that was centered on the situation of WtE in the circular economy (European Commission, 2018b). WtE is considered by the EC as a hygienic method of treating waste through destruction of viruses and bacteria and prevention of polluted, degraded, dirty or contaminated waste materials from entering the recycling process and harmfully lowering its quality. Hence, WtE facilities are agents for quality recycling through treatment of complex polluted waste and diverting dangerous substances out of the circular economy (Kleppmann, 2014). According to the EC, WtE is a wide term that encompasses a variety of waste treatment methods to generate energy; each treatment method has special environmental impact and different potential within the circular economy. Ultimately, WtE role in the transition to a circular economy is substantial. Given the EU waste hierarchy as the guiding principle, each type of WtE technique is classified according to the hierarchy ranging from disposal, recovery to recycling i.e. anaerobic digestion which results in the production of a biogas and of a digestate is regarded by EU waste legislation as a recycling operation, while waste incineration with limited energy recovery is classified as disposal (European Commission, 2017).

3 WASTE TO ENERGY IN GERMANY

The previous section demonstrated that the EU has set an extensive framework for waste and energy policies to be adhered by all its member states. Germany a leader country in the field of renewable energy has followed EU regulations and stipulations and surpassed them by setting its own targets. The development of renewable energy market (including the WtE sector) within the framework of a circular economy in Germany can be attributed to two key factors: the Renewable energy policy "Energiewende" and the waste management sector.

The renewable energy policy in Germany dates back to the 1970s and is subject to frequent revisions and updates. Hence, Germany issued a number of laws to transform the energy mix to include more renewable resources. A significant law is the Renewable Energy Heat Act in 2009 which required new buildings to obtain a share of their total heating/cooling demand from renewable resources. A complementary Market Incentive Program was issued alongside the Renewable Energy Heat Act to use renewables in existing buildings. In 2015, the Climate Protection Quota stipulated a minimum contribution of bio-fuels to reduce greenhouse gas emissions by 3.5%. In addition, Germany set a target of a 30% renewable energy share in total final energy consumption by 2030 (up from 10% in 2010) (The International Renewable Energy Agency {IRENA}, 2015).

3.1 Germany's Transition to Renewable Energy: Energiewende

The country's transition to renewable energy is known as the Energiewende (The Energy Concept/ The Energy Revolution) officially adopted in 2010. It intends to transform the country's energy system based on two pillars: renewable energy and energy efficiency. The Energy Concept led to substantial success of renewable energy exploitation in Germany particularly in the power sector. A mix of economic and environmental motives is the main drivers for the Energiewende including: climate protection, employment, energy security, industrial development, and the phase-out of nuclear power. Moreover, in the wake of the Landmark Paris Climate Accord in 2015, Germany along with 200 nations around the world agreed to keep global warming below 2 degrees Celsius and endeavored to limit the rise to 1.5 degrees. Accordingly, Germany-one of the world's largest consumers of coal- is in the process of shutting down all of its 84 coal-fired power plants over 19 years to fulfill its international commitments in the battle against climate change. By 2030, Germany will have around eight coal-burning plants remaining, producing 17 gigawatts of electricity. In addition, the German government settled on shutting down all nuclear plants by 2022, which means that Germany will be depending on renewable energy to provide 65%-80% of the country's power by 2040 (My Waste, 2019; IRENA, 2015).

3.2 Waste to Energy and Waste Management in Germany

The waste management market in Germany transformed after the implementation of the EU Directive on Landfills, whereas extensive restructuring has been undertaken. In addition, the waste hierarchy was reflected into German law. Germany issued the new Waste Management Act/Circular Economy Act (Kreislaufwirtschaftsgesetz, KrWG) which transformed waste management into resource management and extended producer responsibility on waste. As a result, the Federal Ministry of the Environment formulated a waste prevention programme in 2013. Since 2016, around 14 % of the raw materials used by the German industry are recovered waste, which led to major reduction of extraction levels along with related environmental impacts. The act resulted in waste management industry becoming a far reaching and powerful economic sector in Germany with more than 200,000 people employed in 3,000 companies generating an annual turnover of 40 billion euro. In addition, increased resource efficiency rates has been reached, with 60% of municipal waste, 60% of commercial waste, and 90% of construction and demolition waste being processed through recycling and recovery procedures. As a result, Germany's waste recovery rates are one of the highest in the world and demonstrate the contribution of waste industry to sustainable economic production and management in Germany through saving raw materials and primary energy (Nelles, Grunesa, Morscheck, 2016; IRENA, 2015). Moreover, the WtE sector has undergone major changes over the years. Germany is considered a top country in utilizing the finest WtE technologies and was the top in the European WtE market in 2018 (Research and Markets, 2018).

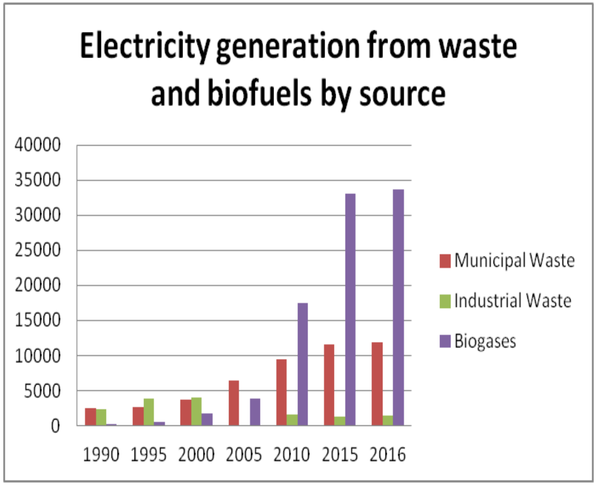
Table (1): Electricity and Heat Production from Waste and Biofuels in Germany 1990-2016

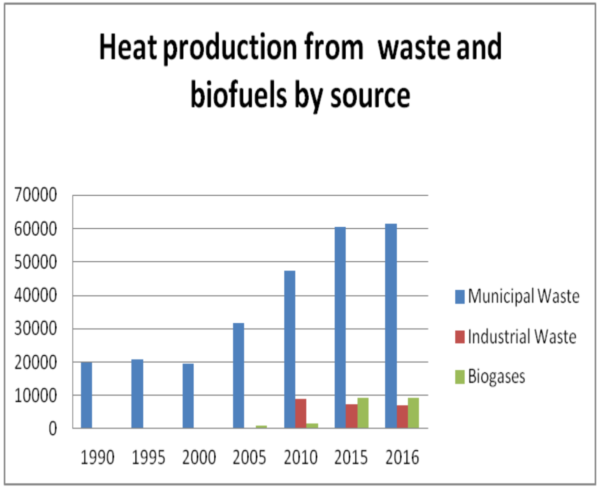
Electricity generation from waste and biofuels by source				Heat production from waste and biofuels by source			
Units: GWh				Units: TJ			
Year	Municipal Waste	Industrial Waste	Biogases	Year	Municipal Waste	Industrial Waste	Biogases
1990	2437	2373	247	1990	19771	0	0
1995	2696	3915	589	1995	20836	0	0
2000	3688	3946	1683	2000	19368	0	0
2005	6504	0	3862	2005	31526	0	823
2010	9494	1605	17430	2010	47252	9009	1508
2015	11536	1288	33073	2015	60568	7481	9285
2016	11860	1401	33703	2016	61332	6987	9317

Source: Done by the authors based on data from the International Energy Agency (IEA, 2018).

Figure (1): Electricity and Heat Production from Waste and Biofuels in Germany 1990-2016

Source: Done by the authors based on data from the International Energy Agency (IEA, 2018).





As shown in table and figure (1) electricity generation and heat production from waste and bio-fuels has been increasing over the years with major increase from 2010 after the adoption of the Energiewende and the extensive renewable energy targets set by both the EU and Germany. It is evident that most energy recovery from waste in Germany is targeted for the production of heat rather than electricity due to the country's geographical location and climate conditions which requires a constant supply of heat in the winter/Fall seasons.

4 WASTE TO ENERGY IN SWEDEN

Another pioneer European country in the utilization of WtE technologies is Sweden. Sweden offers a great model of a country that utilized WtE to accomplish its goal of a zero waste society. Sweden has a long extensive history of setting waste related environmental laws. The Environment Protection Act established in 1969 set complicated environmental obligations on new waste treatment facilities. Furthermore, waste was recognized as a resource in the 1970s with the establishment of sorting, composting and incineration facilities. In 1998, the Environmental Code was enacted to codify a number of existing laws and replace the Environment Protection Act, the code laid down principles applying to everyone impacting the environment (Folk, 2019; the Swedish Environmental Protection Agency, 2005). Moreover, the Swedish Environmental Quality objectives were endorsed by the parliament since 1999. Accordingly, Swedish authorities and companies work under extensive legislation covering products, waste, and chemicals. Sweden follows the environmental and chemical regulatory framework of the EU in addition to the Swedish Environmental Code which contains general rules to be applied to all operations necessitating that all enterprises must economize resources, use best obtainable technology and choose products based on their environmental and health impact. Permits to operate are given to companies after demonstration of how they fulfill these general rules (The Swedish Environmental Protection Agency, 2013).

4.1 Swedish Waste Management, Recycling and the Circular Economy

Waste Management in Sweden is represented by the Swedish Waste Management and Recycling Association (Avfall Sverige) (Avfallsverige, 2019a). In accordance with the waste hierarchy, waste prevention is a priority of both Swedish and European waste legislation. According to the Swedish environmental code, waste is any matter or object that the holder disposes of, intends to dispose, or is compelled to dispose. To achieve a circular economy in Sweden products are completely reused in a cradle-to-cradle approach. In view of that, in 2017 the Swedish government renewed the tax system to enable people to get cheaper repairs on used items and in 2018 the Swedish government established an advisory group to make the circular economy a key part of its policy. Furthermore, Sweden employs diverse methods for waste treatment including energy recovery, biological treatment, material recycling, and land-filling (Hinde, 2019; Avfallsverige, 2019b).

Sweden set the superior aim of being a zero waste society which led to a recycling revolution to divert land-filling to recycling and reusing (Hinde, 2019). Accordingly, recycling became required by law. In addition, citizens are encouraged to reuse or re-purpose materials before recycling or disposing them, leading to the reduction of the volume of new products consumed from fresh raw material and the preservation of resources (Folk, 2019; Kiger, 2018).

4.2 Solid Waste Management and Waste to Energy in Sweden

Sweden is considered a global leader in sustainable waste management with a diminishing per capita carbon footprint to reach its goal of a zero waste society. Since 2009, Sweden has been constantly developing methods of repurposing waste leading to less than 1% of total waste generated being land-filled (Folk, 2019).

Following Sweden's accession to the EU in 1995, Swedish waste management followed the EC directives and regulatory frameworks mentioned before especially the Waste Framework Directive, the Landfill Directive and the Waste Incineration Directive, which transformed the waste management in Sweden substantially. Sweden embraced the waste hierarchy which prioritizes the reduction, reusing or recycling and as a last resort land-filling of waste. In addition in 2005 a national waste plan was formulated by the Swedish Environmental Protection Agency (EPA). Furthermore, in compliance with the Waste Framework Directive, a Swedish Waste Prevention Program was established by EPA in 2013 to set waste prevention objectives, measures, and targets to fulfill Swedish national environmental objectives. These measures were taken to guarantee lower waste generation and promote products design without hazardous substances (Swedish Environmental Protection Agency, 2013; Swedish Environmental Protection Agency, 2005). Moreover, Sweden established producer responsibility a policy which indicates the necessity for a suitable collection and treatment methods for recycling for certain products: recyclable paper, packaging, waste of electrical and electronic equipment (WEEE), tires, car batteries, and pharmaceuticals. Hence, producers became responsible for the collection and disposal of end-of-life products (Hinde, 2019).

Sweden relies heavily on renewable energy (54.5%) mainly from water and Biomass (Swedish Institute, 2019). Material recycling and energy recovery constitute the majority of waste treatment methods prevailing in Sweden. Sweden recovers more energy from waste than any other country in Europe, approximately 3 MWh per tonne. The amplified threat of climate change has led Sweden to power everything from buses to apartment heating systems through energy generated from waste incineration in low-carbon incinerators and use food waste to make climate friendly biogas fuel. Energy recovery in Swedish WtE plants is considered a hygienic and environmentally sound treatment method for waste. In view of that, waste incineration with efficient energy recovery is viewed as recycling according to the EU Framework Directive on Waste and the Swedish Waste Ordinance (Hinde, 2019; Avfall Sverige, 2018).

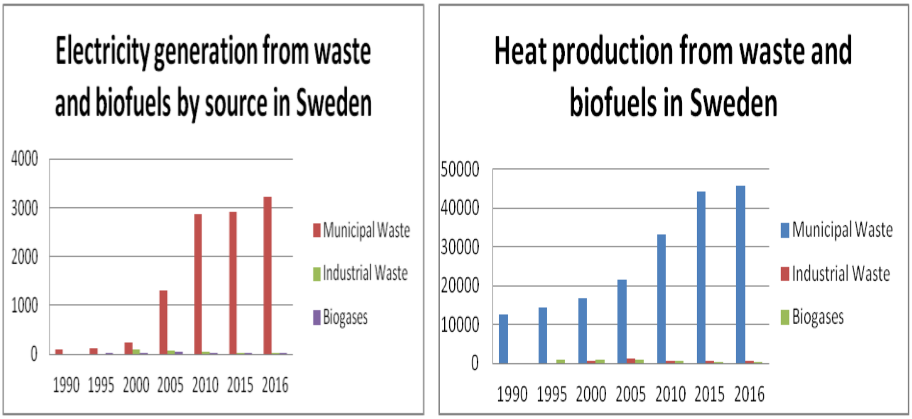
Sweden doesn’t generate enough waste to fuel its WtE plants, thus, waste is imported from neighboring countries. Moreover, the government provides tax incentives to WtE companies to make it more economically viable (Folk, 2019). The nation's WTE plants incinerate around 50% of MSW to provide heat to 1.2 million Swedish households and electricity for another 800,000 household. WtE plants abide by strict environmental regulation set by the EU and are relatively clean with harmful byproducts being filtered out before entering the environment. Hence, ash and other byproducts from WtE facilities are used for road construction materials. The heat from waste is effectively utilized in Sweden as half of the nation's buildings rely on district heating warmed by a common heating plant instead of running their own boilers or furnaces (Kiger, 2018). It is estimated that the energy produced by WTE is 0.46 MWh of electricity and 2.68 MWh of district heating per tonne (Chaliki, Psomopoulos, and Themelis, 2016).

Table (2): Electricity and Heat Generation from Waste and Bio-Fuels in Sweden (1990-2016)

Electricity generation from waste and biofuels by source				Heat production from waste and biofuels by source			
Units: GWh				Units: TJ			
Year	Municipal Waste	Industrial Waste	Biogases	Year	Municipal Waste	Industrial Waste	Biogases
1990	103	0	0	1990	12548	0	0
1995	116	0	30	1995	14338	0	770
2000	239	101	32	2000	16659	508	1042
2005	1309	81	54	2005	21443	1144	866
2010	2860	61	36	2010	33191	527	731
2015	2915	37	11	2015	44166	510	274
2016	3233	39	11	2016	45578	496	274

Source: Done by the authors based on data from the International Energy Agency (IEA, 2018).

Figure (2): Electricity and Heat Generation from Waste and Bio-Fuels in Sweden (1990-2016)



Source: Done by the authors based on data from the International Energy Agency (IEA, 2018).

The above table and graph show that producing energy from MSW was employed since the 1990s to produce heat and electricity in Sweden, it has continued to be an important source of energy over the years especially for heat purposes as in the German case due to the country's geographical location and climatic conditions which requires a constant supply of heat in the winter/Fall seasons. In addition, bio-fuels continue to be an important source of heat generation in Sweden.

Table (3): Volumes of Household Waste Treated in Sweden (2013–2017) (tonnes)

	2013	%	2014	%	2105	%	2016	%	2017	%
Material recycling	1,467,200	33.0	1,617,930	35.9	1,652,710	35.1	1,615,170	34.6	1,617,640	33.8
Biological treatment	711,450	16.0	713,110	15.8	728,570	15.5	757,480	16.2	741,280	15.5
Energy recovery	2,235,930	50.3	2,148,640	47.6	2,284,210	48.6	2,262,610	48.5	2,400,440	50.2
Landfill	33,300	0.7	32,900	0.7	38,300	0.8	31,000	0.7	23,650	0.5
Total volume treated	4,447,880	100	4,512,580	100	4,703,790	100	4,666,260	100	4,783,010	100.0

Source: Done by the authors based on data from Avfall Sverige, 2018.

It is apparent from the above statistics in table (3) that energy recovery from waste is still the main treatment method employed in Sweden followed by recycling as energy recovery accounts for around half of the total amount of treated household waste.

5 LESSONS LEARNED FOR DEVELOPING COUNTRIES

The scrutiny of the EU experience with Waste-to-Energy in general and the German and Swedish experiences in particular reveal many lessons for developing countries that aim to transform into a circular economy while mitigating the dual hazards of energy shortage and pollution from municipal solid waste.

Many developing countries suffer from inadequate solid waste sector leading to the accumulation of waste in open dumpsters and landfills. Waste left untreated cause serious health and environmental risks as well as being a forgone economic product. WtE projects can help developing countries in their sustainability pursuit through transforming a pressing environmental problem (MSW accumulation) into a valuable renewable energy source. The correct utilization of WtE presents multiple economic, social and environmental benefits for developing countries including lessening the accumulating waste problem, lowering the risk of health hazards for citizens and waste workers from the exposure to unsanitary waste dumped in open spaces (a common practice in developing countries), saving expensive fossil fuels needed for energy production, freeing and decreasing the demand on valuable land used as landfills, supplying a renewable and much needed source of energy especially in rural areas which usually suffer from energy shortage, as well as providing sustainable jobs for locals in WtE projects.

Most of developing countries lack the extensive vision of the hazards of the MSW problem and hence gives it little attention or even ignore it. However, one thing to learn from the EU is the impact of recognizing the gravity of the MSW problem. It is this acknowledgement that led to extensive measures to create uniform regulations to be administrated by all member countries to ensure conformity in the SWM sector in all member states. Similarly, developing countries need to formulate an inclusive vision for the future of the economy and the value of waste as a resource. Therefore, they can use the EU regulations as a reference in setting their own waste related regulations and directives with specific aims, targets, and defined timeframes. They should set extensive waste regulations accompanied by continuous revision and development of the solid waste policy. It is also imperative for those countries to consider renewable resources utilization in energy generation and link this goal with the aims and targets in the SWM sector.

Even though the EU recognized WtE as one of the tools in its shift to the circular economy, it stressed in its waste hierarchy on prevention (zero waste) as a top goal followed by reuse, recycling, recovery, and at the end disposal. Sweden for example had a clear defined zero waste vision. This was reflected in its solid waste policy that aims not only at the management of waste but rather on its reduction. This policy led to changing people's perception of waste to believe it is a valuable resource; this resulted in more reusing and repurposing of material. In addition, having an extensive MSW collection and transportation system helped facilitate the utilization of waste in different waste treatment techniques. Accordingly, developing countries should view WtE as one of the available options to solve the waste problem but not the only option or an aim in itself. They should try to aim at reducing waste volumes and encourage the culture of recycling before resorting to WtE. In addition, they should be aware to choose the most suitable type of WtE according to the type of waste, the country's needs, and conditions.

The analysis of the German experience in utilizing WtE demonstrate a country's success in employing WtE to help in transforming to an inclusive circular economy. Accordingly, Germany did not follow but surpassed the EU regulations by setting its own targets and issuing a number of laws to help realize this aim. Germany succeeded in transforming its waste management market and ensured the integration of the evolving German SWM needs. This was carried out through the implementation of the EU directive on landfills, reflecting the waste hierarchy in German laws, and the frequent update of the extensive waste management policy. Developing countries need to learn from the German experience that the aim is not having a lot of laws and regulations; more importantly is focusing on the quality and suitability of those regulations with the country's goals and needs. In addition, developing countries can learn from the German case the significant need for frequent updates of regulations according to the changing reality and goals coupled with extensive monitoring to ensure the correct execution of those regulations.

Developing countries must have clear goals for their SWM and renewable energy sectors, which entails recognizing the significance of formulating strong consistent policies to develop both sectors simultaneously. Hence, waste management should be transformed into resource management with multiple economic and environmental benefits. Additionally, disposal responsibilities should be imposed on manufacturers and distributors of products to increase people's awareness of the need to separate waste, new disposal technologies, and enhancing recycling capacities. In view of that, the role WtE technologies can play in this market must be determined and integrated in those policies to help reach the country's goals.

Most of developing countries suffer from energy shortage. Following the Swedish experience in utilizing WtE, developing countries can learn how to fully exploit the benefits of WtE to fulfill their own energy needs while ensuring the highest level of environmental protection. Consequently, each country must determine its energy needs whether to supply households/businesses with heat, electricity or for transportation purposes in order to correctly employ WtE projects to fulfill those needs. In addition, countries should consider the benefits of using the ash and byproducts of WtE processes through further recycling in road construction.

Most importantly developing countries need to consider the main obstacles that might hinder the success of WtE projects. First, there must be a governmental entity responsible for WtE projects. This entity role is to set the vision, policy, regulations, needs, as well as offer consultation related to WtE projects. It is imperative that this entity works in accordance with the country's solid waste management policy and objectives and the energy policy. Second, different types of incentives should be offered for the private sector to encourage the establishment of WtE projects. Third, Stringent monitoring for any WtE project must be carried out to ensure that these projects do not lead to adverse environmental impact. Fourth, Countries must realize that WtE projects are tools to treat unavoidable waste; however; the country's main target should be decreasing the waste volume in itself through promoting recycling and reusing options.

6 CONCLUSION

Green businesses are the key to achieve an inclusive circular economy. Waste-to-Energy (WtE) is an embodiment of a green business model that has vast potential to serve both the environment and the economy. Multiple types of WtE exist each of which is suited for a different type of waste. Countries all over the world are starting to realize the environmental, social and economic benefits of WtE. The experiences of the European Union especially Germany and Sweden demonstrate that WtE technologies when incorporated in both energy and solid waste management policies, and employed within a clear regulatory framework can lead to positive results and is a vital tool in the transformation into a circular economy.

Germany and Sweden are two of the top countries in the EU to employ WtE technologies to solve environmental problems caused by waste as well as providing reliable renewable source of energy for their countries. The analysis of both countries showed that they both followed EU regulations and exceeded them by tailoring their own regulations to attain desired results. Both countries demonstrated that a clear vision coupled with strong regulations can transform an environmental problem (waste) into a valuable and reliable energy source through the utilization of the right WtE technology.

The analysis of the German case showed that Germany's energy concept coupled with the waste management act/circular economy act that transformed waste management into resource management led to substantial success of renewable energy exploitation in Germany and endorsed the use of WtE to produce energy mainly for heating purposes. The study of Sweden showed that it recovers more energy from waste than any other country in Europe, which is attributed to the Swedish solid waste policy that aims not only at the management of waste but rather on its reduction. Accordingly, less than 1% of total waste generated is being land-filled. This was achieved through embracing the waste hierarchy with the aim of a zero waste society with recycling being required by law which led to a Swedish recycling revolution. Additionally, energy recovery through WtE technologies is incorporated in the Swedish environmental code among other methods for waste treatment.

Waste is one of the most critical and severe problems in many developing countries that necessitates immediate attention. Thus, there is a dire need for clearly defined energy and solid waste management policies with a comprehensive regulatory framework that aim at proper management and ultimately reduction of waste. Incorporating WtE technologies in these policies as a supporting tool can help developing countries by transforming waste into a valuable renewable energy source that is needed in their transformation to inclusive circular economies.

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