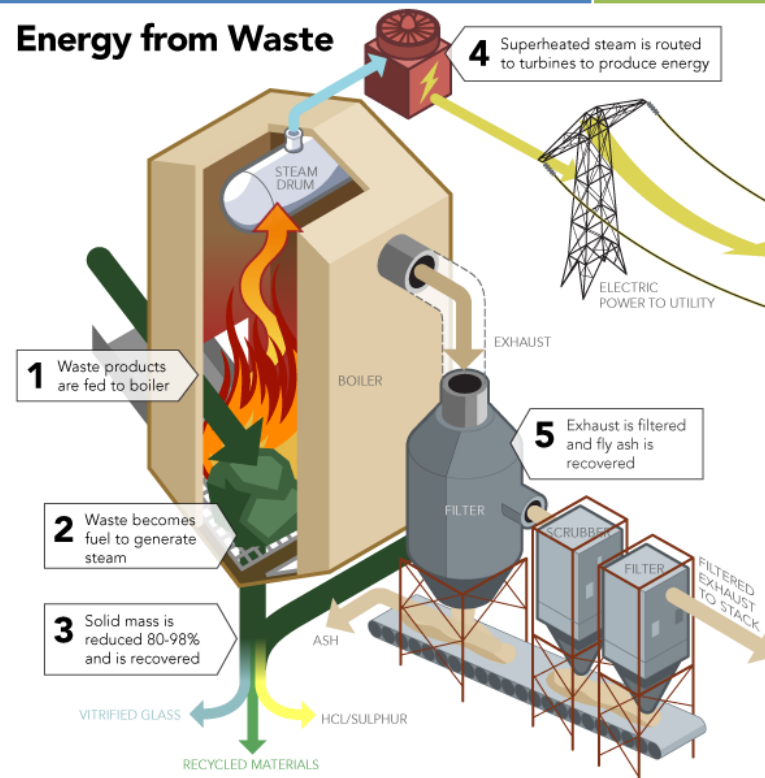


# National Energy-from-Waste Policy 2010-2030

## Energy from Waste



**National Energy-from-Waste Policy**

**Ministry of Energy and Mining**

**October 2010**

# Table of Contents

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<b>List of Acronyms</b>	i
<b>Acknowledgements</b>	ii
<b>Message from the Minister of Energy and Mining</b>	iii
<b>Executive Summary</b>	iv
<b>Section 1 – Overview and Context</b>	1
Introduction	2
Background	5
Rationale for Energy-from-Waste Policy	11
The Energy Sector in Jamaica	13
The Waste Sector in Jamaica	16
Defining the Scope for the Use of Waste in the Energy Sector in Jamaica	22
Linkages between Energy-from-Waste Policy and National Energy Framework	28
Linkages between Energy-from-Waste Policy and National Solid Waste Management Policy	30
SWOT Analysis of the Energy-from-Waste Sector	32
Key Issues in the Energy-from-Waste Sector	34
<b>Section 2 – Defining the Policy Framework</b>	41
Strategic Framework	41
Goals of the Energy-from-Waste Policy	41
Goal 1	42
Goal 2	45
Goal 3	48
Goal 4	50
<b>Section 3 – Implementation, Monitoring and Evaluation Framework</b>	53
Policy Implementation	53
Institutional Framework	53
Implementation Framework	55
Monitoring and Evaluation Framework	57
Proposed Indicators	57
<b>Appendices</b>	58
<b>I Glossary</b>	59
<b>II Economic Viability Analysis of Waste-to-Energy at Riverton City</b>	62
<b>III Examples of International EFW Initiatives</b>	66
<b>IV Members of Energy-from-Waste Policy Working Group</b>	65

## List of Acronyms

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3Rs	Reduce, Reuse, Recycle
CDM	Clean Development Mechanism
CO <sub>2</sub>	Carbon dioxide
EFW	Energy-from-Waste
EIA	Environmental Impact Assessment
EMD	Environmental Management Division (OPM)
GHG	Greenhouse Gas
HAZMAT	Hazardous material
IPP	Independent Power Producer
LGD	Local Government Department (OPM)
MJ	Megajoule
MOA	Ministry of Agriculture
MOH	Ministry of Health
MSW	Municipal Solid Waste
MTW	Ministry of Transport and Works
MW	Megawatt
NEPA	National Environment and Planning Agency
NLA	National Land Agency
NGO	Non-governmental Organization
NIMBY	Not In My Back Yard
NO <sub>x</sub>	Nitrogen Oxide
NSWMA	National Solid Waste Management Authority
NWC	National Water Commission
OPM	Office of the Prime Minister
OUR	Office of Utilities Regulation
PCJ	Petroleum Corporation of Jamaica
PWG	Policy Working Group
REP	Rural Electrification Programme
SRC	Scientific Research Council
SWOT	Strengths, Weaknesses, Opportunities, Threats
UNFCCC	UN Framework Convention on Climate Change
WTE	Waste-to-Energy

## *Acknowledgements*

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The Ministry of Energy and Mining wishes to thank the members of the Energy-from-Waste Policy Working Group for providing technical support and guidance to the development of this policy. Unlike the other sub-policies, the nature of this policy required significant input from those agencies with responsibility for waste management, who are outside of the Ministry of Energy and Mining, and to this end, we thank all those agencies for their inputs.

The National Energy Policy 2009 – 2030 provided the overarching framework for the development of the Energy-from-Waste policy. Of note, we also wish to thank the members of the Energy and Minerals Development Thematic Working Group of the Vision 2030 Jamaica – National Development Plan Monitoring and Evaluation Process as well as the various Ministries and Agencies that assisted the process by providing pertinent data and engaging in the consultative process that is so important in national policy development.

We also wish to thank other International Development Partners who are currently providing extensive support in the development of Jamaica's energy sector and in particular our efforts at achieving energy security, diversification of the country's energy mix and reducing the cost of energy to Jamaicans. We especially thank the United Nations Development Programme (UNDP) for the support they have provided the Ministry to facilitate the development of five sub-policies under the National Energy Policy 2009 – 2030.

## *Message from the Minister of Energy and Mining*

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When the National Energy Policy was promulgated in 2009, I indicated that the very next step was the development of six sub-policies to guide the further development of Jamaica's energy sector in which the emphasis will be placed on the development of renewable energy, generation of energy from waste, use of biofuels, the ability of Jamaica to trade carbon credits in international carbon markets, increasing energy conservation and efficiency, and improving the delivery of electricity. This National Energy-from-Waste Policy, as one of the six sub-policies, provides the framework for the generation of electricity and fuel from wastes that come from our cities and towns, rural areas, farms and industries.

Jamaica is joining many countries in developing an energy-from-waste sector that produces clean energy from indigenous materials. We will take advantage of the best practices used worldwide and ensure that all the necessary safeguards are put in place to protect our environment, our citizens' health and our communities. This is an exciting endeavour that will facilitate the development of new economic opportunities, help Jamaicans to use less petroleum, ease the oil bill burden on the country, result in lower greenhouse gas emissions, reduce the amount of land used for disposal sites and lead to improved waste management.

This policy creates the opportunity for the Ministry of Energy and Mining to work in close partnership with the Department of Local Government in the Office of the Prime Minister and the National Solid Waste Management Authority and other ministries and agencies to mutually achieve our goals of reducing the country's dependence on imported oil and minimizing the amount of waste that is now sent to landfills.

With this policy we are, in effect, treating waste as a resource and turning our waste management problems into an energy generation solution. Creating something valuable from what is considered useless is a positive lesson that can go beyond the spheres of energy and waste and one that Jamaicans can learn and apply to many other aspects of our lives.

***James Robertson, M.P.***

# Executive Summary

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This document presents Jamaica's National Energy-from-Waste Policy which is designed to ensure that:

***Jamaica is the regional leader in providing affordable and clean energy from waste contributing to a sustainable future***

The creation of this policy was a specific response to the National Energy Policy 2009 – 2030 which calls for the development of specific aspects of the energy sector as it relates to the energy sector especially in areas related to renewables, diversification of fuels, development of biofuels and energy-from-waste. This policy, as a sub-policy of the National Energy Policy, supports the implementation of the National Energy Policy 2009-2030 and will contribute to the achievement of:

**“A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework”**

(Vision of the National Energy Policy 2009 -2030)

This policy also will directly support the implementation of two other energy sub-policies: the National Renewable Energy Policy 2010 – 2030 and the National Biofuels Policy 2010-2030.

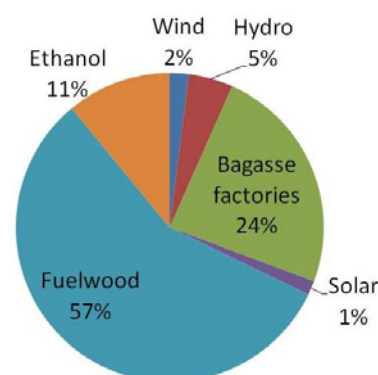
## Overview and Context

Jamaica is highly dependent on imported petroleum to meet its energy needs. The country imports approximately 91% of its energy, with the remainder derived from renewable sources. The spiralling cost of world oil prices, coupled with an increasing demand for fuel locally and the paucity of financial resources to cover an ever increasing oil bill, necessitate that Jamaica urgently explores various options in the energy sector.

Jamaica, through its National Energy Policy 2009 - 2030 and Vision 2030 Jamaica – National Development Plan, has set targets for renewable energy (20% by 2030) and the percentage

diversification of energy supply (70% by 2030). The National Energy-from-Waste Policy will contribute to the achievement of these targets.

Jamaica is relatively advanced in the development of renewable energy, surpassing a number of Caribbean countries. Currently, 9% of the country's energy supply mix comes from renewable sources such as wind, mini-hydro, solar and biomass (mainly fuelwood, ethanol from sugar cane used in E10, and bagasse used in co-generation facilities). The figure above shows the contribution of different sources to the renewable energy total. Bagasse – waste from the sugar cane industry – already constitutes over 30% of the country's renewable energy sources. Jamaica has the potential to expand this contribution and to further develop energy-from-waste initiatives based on other types of waste using a variety of technologies, including incineration of municipal solid waste; capture of landfill gas, production of bio-diesel, production of biogas using animal wastes, and using wastewater sludge. This policy provides the framework for the further exploration, development and expansion of these options.



Key institutions in both the energy and waste management sectors will take leading roles in the implementation of this policy. Collaboration with other sectors such as environmental management, agriculture, health, and finance also will be necessary.

## Policy Framework

The policy framework is underpinned by a **Strategic Framework** which sets out the goals, strategies and actions necessary to facilitate the implementation of the policy; and the **Institutional Framework** describes the roles and responsibilities of the various stakeholders in the energy-from-waste sector.

The Strategic Framework underpinning this policy presents four (4) goals which will contribute to achieving the vision: *Jamaica is the regional leader in providing affordable and clean energy from waste contributing to a sustainable future.*



The four goals are:

- Goal 1:** Jamaica creates economic infrastructure and planning conductions conducting to the development of the energy-from-waste sector
- Goal 2:** Jamaica builds its energy-from-waste sector on the most appropriate technologies that are environmentally-friendly, producing a clean reliable renewable source of energy
- Goal 3:** Jamaica creates partnerships between the energy sector and the waste management and agriculture sectors to facilitate the continuous streams of waste into the energy from waste
- Goal 4:** Jamaica has a well-defined governance, institutional, legal and regulatory framework for the generation of energy from waste

The Strategic Framework presents the desired outcomes related to achieving those goals, discusses key issues and includes the short- to medium-term as well as long-term strategic directions for the government, private sector and industry. The Framework has been designed to be flexible and adaptable to meet new challenges and opportunities as they arise.

## **Monitoring and Evaluation**

A continuous programme of monitoring and evaluation, involving relevant stakeholders from public and private sectors, will be implemented and this will be aligned to the Monitoring and Evaluation Framework that is part of Vision 2030 Jamaica as well as the Whole of Government Business Planning Process. The ministry responsible for energy in collaboration with the ministries responsible for environment and waste management will use several indicators to assess the effectiveness of the National Energy-from-Waste Policy in achieving the outcomes, which will form the basis for reviewing the policy and recommending any changes to the policy framework.

# Section 1

## Overview and Context

# Introduction

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This document presents Jamaica's National Energy-from-Waste Policy 2010-2030. This policy is one of six (6) sub-policies under the National Energy Policy 2009 – 2030 which are intended to support the achievement of the goals of the National Energy Policy. The National Energy Policy seeks to provide **“A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework”** by 2030. The National Energy Policy calls for the development of the energy sector, with specific emphasis on renewables, new and alternative fuels, biofuels and energy-from-waste.

## Sub-Policies under Jamaica's National Energy Policy 2009 – 2030

- Renewable Energy Policy
- Energy-from-Waste Policy
- Biofuels Policy
- Carbon Emissions and Trading Policy
- Energy Conservation and Efficiency Policy
- Electricity Policy

The National Energy-from-Waste Policy is being developed to ensure that **“Jamaica is the regional leader in providing affordable and clean energy from waste contributing to a sustainable future.”**

Energy-from-waste is an effective method of waste management and waste volume reduction with the added benefit of generating clean energy. Waste processing is already a significant source of renewable energy in many countries around the world. Potential exists for the development of renewable energy sources which can be exploited from municipal solid waste (MSW) as well as from wastes generated from agri-business and wastewater treatment. Energy-from-waste can make a significant contribution to achieving renewable energy targets, ensuring security of energy supply as well as treating waste that cannot otherwise enter a waste minimization or recycling/composting programme. Certain energy-from-waste opportunities are already being pursued in Jamaica; this Policy will bring coherence to the existing situation and will address other opportunities for application of EFW technologies.

This Energy-from-Waste Policy will guide the operations and processes associated with generating energy from waste in Jamaica. The Policy establishes a strategic framework – goals,

desired outcomes and a mix of short- to medium-term as well as long-term strategies to support the development of an energy-from-waste sector. Implementation of the strategies within the framework will result in the following outcomes:

- Economic viability
- Security of energy supply
- Production of clean energy
- Diversification of the energy supply mix
- Development of renewable energy sources
- Best-practices in waste management
- Environmental sustainability
- Protection of human health
- Promotion of new and emerging waste management technologies that are clean, less polluting and contribute to eco-efficiency in industry

The development of this policy was guided by a Policy Working Group comprising representatives of key government ministries and agencies (see Appendix IV for the members of the working group). The Policy also benefitted from the input of key stakeholders in the waste management and environmental management sectors. This policy working group is part of the Energy and Minerals Development Thematic Working Group under the monitoring and evaluation framework of Vision 2030 Jamaica. The development process included the inputs of various stakeholders in the public and private sectors as well as from non-governmental and civil society organizations.

## Structure of the Policy

The Energy-from-Waste Policy consists of the **Executive Summary**, followed by the sections described below.

**Section 1 – Overview and Context** provides the introduction to, and rationale for, the policy and identifies the linkages between this policy and the National Energy Policy 2009 – 2030, Vision 2030 Jamaica – National Development Plan and other components of the national energy framework as well as the National Solid Waste Management Policy. This section also presents the current legislative framework for energy-from-waste in Jamaica and global issues and trends in energy-from-waste.

**Section 2 – Defining the Policy Framework** presents the vision for an energy-from-waste sector in Jamaica and the strategic framework (goals, outcomes and strategies) for this policy.

**Section 3 – Implementation, Monitoring and Evaluation Framework** describes the implementation, monitoring and evaluation framework for this policy. Section 3 also includes the institutional framework for energy-from-waste in Jamaica.

**Appendix I** is a glossary of terms used in this policy document.

**Appendix II** presents an Economic Viability Analysis of Waste-to-Energy at Riverton City from a study conducted in 1995-6.

**Appendix III** describes some international EFW initiatives from which Jamaica can learn.

**Appendix IV** lists the members of the Policy Working Group who developed this policy.



*Energy-from-waste can make a significant contribution to achieving renewable energy targets, ensuring security of energy supply as well as treating waste that cannot otherwise enter a waste minimization and recycling programme.*

# Background

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Jamaica currently has no known local petroleum-based energy resources and therefore relies heavily on imported petroleum. The country imports 91% of its energy, with the remainder derived from renewable sources. The spiralling cost of world oil prices, coupled with an increased demand for fuel locally and the paucity of financial resources to cover an ever increasing oil bill, necessitate that Jamaica urgently explores various options in the energy sector.

Consequently, to address these issues, in 2009, Jamaica promulgated its first long-term national energy policy “National Energy Policy 2009 – 2030”. This Policy is aligned to the country’s National Development Plan – Vision 2030 Jamaica and calls for the reduction of energy costs to the citizens of Jamaica, to be achieved primarily through the diversification of energy supplies, increasing renewable in the energy mix, energy conservation and efficiency, modernization of the energy infrastructure and an updated regulatory framework and the overall development of the energy sector.

Jamaica, through its national energy policy and Vision 2030 Jamaica has set targets for renewable energy and the percentage diversification of energy supply. These targets are presented in the table below.

Indicator	2009	2012	2015	2030
Percentage of renewables in energy mix	9%	11%	12.5%	20%
Percentage diversification of energy supply	9%	11%	33%	70%

These targets, therefore call for Jamaica to investigate various options for advancing the development of the energy sector. Energy from waste, expansion of renewables, and increased use of biofuels become important considerations for the achievement of these targets and goals as set out in the National Energy Policy. Energy-from-waste policies are being developed by countries worldwide as a means of balancing their energy policies, increasing renewables while at the same time managing the growing volumes of waste that are being generated as a result of current consumption and production patterns.

Energy-from-waste presents an affordable way of managing municipal solid waste that cannot be recycled or used in a composting programme but can be used to generate energy, thereby contributing to energy security and a reduction in the country's energy bill.

The sharp increase in the volume and diversity of waste materials generated by human activity and their potentially deleterious effects on public health and the environment, have led to heightened awareness about the urgent need to adopt scientific methods for safe disposal of wastes and for the conversion of wastes to productive uses such as energy generation. This national Energy-from-Waste policy does not advocate for the generation of more wastes but places emphasis on the utilization of waste that cannot be absorbed through the institution of waste minimization, recycling or composting programmes. In other words, this Policy will focus on disposal of residual waste in a safe and environmentally-friendly manner through its conversion into energy. In so doing, the Policy will be consistent with efforts by the National Solid Waste Management Authority (NSWMA) and local government authorities to establish and manage an appropriate and integrated waste management framework.

### **Residual Waste**

**Residual waste is solid waste that remains after the institution of programmes for waste minimization, recycling and composting**

Within this context, the development of an energy-from-waste policy becomes a viable consideration for the development of the energy sector and the management of wastes.

With respect to waste, currently the country generates an estimated 1.5kg/per person/per day of solid waste<sup>1</sup>, a per capita amount equivalent to that which is generated in some developed counties, such as the United Kingdom. Most waste generated in Jamaica is disposed of in managed dumpsites and the availability of land to deal with increasing volumes of waste will become an increasingly important issue to address. For example, it is estimated by the NSWMA that the country's largest disposal site (Riverton) will reach its maximum capacity by 2014<sup>2</sup>. Also, the country's disposal sites are becoming increasingly more difficult and expensive to manage. A Characterization of Waste Study undertaken by NSWMA in 2006 reported that 69 per cent of the solid waste generated in Jamaica is organic, representing a good source of input into an energy-from-waste sector. However, while most of the focus within waste management is on municipal solid waste, Jamaica's agriculture sector is the largest source of wastes – such as bagasse and animal wastes – outside of the mining sector.

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<sup>1</sup> Estimated from "Waste Characterisation Study at the Riverton Landfill," National Solid Waste Management Authority, 2006, as reported in "Management of Hazardous & Solid Wastes In Jamaica," Sustainable Development and Regional Planning Division, Planning Institute of Jamaica, November 2007

<sup>2</sup> "Management of Hazardous & Solid Wastes In Jamaica," Sustainable Development and Regional Planning Division, Planning Institute of Jamaica, November 2007



At present, Jamaica's power system has an electricity generating capacity of 818 MW. Based on the country's projection of economic growth, it is estimated that approximately 400 MW of new generating capacity will be required over the next ten (10) years in the electricity sector.

The growing amount of municipal solid waste – and other wastes – coupled with the increasing demand for electricity present win-win opportunities to engage in energy-from-waste initiatives – even after recycling options have been utilized.

Based on the relationship between energy and waste, this Policy will present a change in the way that waste is managed and energy is produced in Jamaica. It will present a Strategic Framework that will provide a platform for the energy and waste management sectors to work together to reduce the amount of waste generated while creating an enabling environment for significant investment in energy recovery from residual waste.

## Understanding Generation of Energy- from- Waste

Wastes which can be used to produce energy are classified by the International Energy Agency as follows:

- **Municipal solid waste (MSW)** – consists of biodegradable and combustible products collected from households, industry and the service sector.
- **Biomass** – consists of plant matter used directly as fuel, including agricultural waste (e.g. bagasse), animal wastes, human waste and wastewater.

The combustion of municipal solid waste to generate electricity is the most common method of converting “waste to energy.” The MSW is incinerated in specially designed chambers at high temperatures, thereby reducing it to one tenth of its original volume. At the same time, the heat generated by combustion is transferred to steam that can flow through a turbine to generate electricity.

## Energy-from-Waste vs. Waste-to-Energy

The term Energy-from-Waste is used to encompass all methods of generating energy and fuels from any kind of waste materials instead of the narrower concept of Waste-to-Energy. These two terms are defined below.

### Waste-to-Energy (WTE)

The two proven means for disposal of municipal solid waste (MSW) are burying it in landfills or combusting it at high temperatures. This “incineration with energy recovery” process is called waste-to-energy (WTE). It converts the energy from combustion of MSW to electricity.

### Energy-from-Waste (EFW)

Energy-from-waste encompasses all technologies and systems that produce energy from waste products and includes waste-to-energy. Other waste processing methods are:

- energy from landfill gas extraction
- co-incineration of solid recovered fuel as a fuel in both cement kilns and power plants
- dedicated biomass energy plants incinerating waste wood



Landfills and dumpsites used for the disposal of municipal solid waste produce gas which consists of approximately 50% methane. This can be captured as a source of energy.

Biomass can be used to create fuel directly or combusted to generate electricity. For example, bagasse has high co-generation potential. Manure and other animal bio-solids can be used to create diesel fuels. Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils, recycled cooking greases or oils, or animal fats.

Sludge – the waste produced by plants that treat wastewater – can be considered as a fuel. When operating, a wastewater treatment plant generates waste that has been separated from the water during the sedimentation process as well as other waste produced during the biological treatment process. When combined, both kinds of waste form sludge that has to be treated and removed. Rather than simply disposing of this sludge, it can be used to generate energy. In other words, there is the potential to transform the sewage treatment process from a simple clean-up to one that recovers significant quantities of energy.

## **Benefits of Implementing an Energy-from-Waste Policy**

### **Generation of clean electric power**

In the past there were many concerns of the environmental impact of waste-to-energy incineration plants. Today, modern technologies have proven to be safe. Today's energy-from-waste facilities produce clean renewable energy through the combustion of municipal solid waste in specially designed power plants that differ significantly from the old-fashioned municipal incinerators. Modern pollution control systems ensure a cleaner-burning power plant.

### **Environmentally safe solid waste management and disposal**

Modern waste-to-energy technology has proven to be safe, environmentally friendly, and economical. Burning trash effectively destroys waste stream bacteria, pathogens, and other harmful elements. The waste-to-energy process also reduces the incoming volume of waste by about 90 per cent, thereby reducing the need for land space to create new dumpsites. Also, waste-to-energy allows for easy disposal of sewage sludge, as WTE facilities can burn sewage sludge from wastewater treatment plants as fuel, thus providing a practical means of sludge disposal.

### Reduced greenhouse gas (GHG) emissions

Combusting municipal solid waste (MSW) rather than depositing it in a dumpsite results in a reduction in greenhouse gas emissions. Landfill gas contains about 50 per cent methane, which is 21 times more potent as a greenhouse gas than carbon dioxide.<sup>3</sup> Comparative studies of WTE and landfilling have shown that for each tonne of MSW combusted rather than landfilled, the overall carbon dioxide reduction can be as high as 1.3 tonnes of CO<sub>2</sub> per tonne of MSW when both the avoided landfill emissions and the avoided use of fossil fuel are taken into account.

- WTE plants conserve fossil fuels by generating electricity. One ton of MSW combusted reduces oil use by one barrel
- It has been estimated that one ton of MSW combusted rather than landfilled reduces greenhouse gas emissions by 1.2 tons of carbon dioxide.
- WTE plants do not have the aqueous emissions that may be experienced in landfills.
- WTE plants reduce the space required for landfilling by about 90%.

### Reduction in the overall waste quantities requiring final disposal

By diverting waste from landfills, existing landfills will last longer, thereby reducing the rate at which new land is needed for this purpose. As a small island with high coastal densities of people, settlements and industries, Jamaica cannot afford to use precious land to “store” solid waste.

### Increased independence and less reliance on imported petroleum

Municipal solid waste (MSW) is an indigenous, renewable source of energy and, depending upon the moisture and energy content of the waste materials, is a good fuel source. The thermal treatment of MSW results in the generation of 500-600 kWh of electricity per tonne of MSW combusted. By using WTE initiatives to meet a percentage of Jamaica’s energy needs, the demand for imported petroleum is reduced.

### Improved balance of payments

For every one million tonnes of refuse processed, the need to use about 1.67 million barrels of oil to generate the same amount of electricity is offset. This leads to savings on countries’ fuel bills, resulting in an improved balance of payments.

### Sustainable economic growth and development

EFW facilities and the EFW system will include the creation of jobs for Jamaicans.

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<sup>3</sup> H. Taylor, Jan. 1990: “Municipal Waste to Energy Facilities Reduce Greenhouse Gas Emissions”, Proceeds of the 4th Annual Symposium on Municipal Solid Waste Disposal and Energy Production.

## Global Trends in Energy-from-Waste

With the rapid increase in energy and resource consumption stemming from the advancement of free trade, globalization and economic activities from emerging economies like Brazil, India and China, the world is facing a double crisis – over-dependence on fossil fuels with the inherent vulnerabilities to price shocks, and environmental concerns such as air pollution and climate change. Most countries realize that it is essential to reduce their energy dependency by producing and widely distributing new and renewable energy sources that can replace fossil fuels such as oil and coal. This also serves to reduce the emissions of climate change-inducing greenhouse gases and other pollutants.



Worldwide, about 130 million tonnes of municipal solid waste are combusted annually in over 600 waste-to-energy (WTE/EFW) facilities that produce electricity and steam for district heating and recovered metals for recycling. Since 1995, the volume of MSW handled by the global WTE industry increased by more than 16 million tonnes. Currently, there are WTE/EFW facilities in 35 nations, including large countries such as China and small ones such as Bermuda.

Countries or regions which have successful energy-from-waste sectors have ensured that energy-from-waste goals are incorporated into both their energy policies and their waste management policies. For example, in 2000, the European Union announced a “Green Paper” designed to secure energy resources, and established a road map with to achieve renewable energy targets. Moreover, it defined wood and organic wastes such as food waste, livestock manure and sewage sludge as “biomass,” and has actively pursued biomass energy technology development. At the same time it has banned the direct landfilling of wastes that can be converted to energy, in line with the Landfill Directive published in 1999.

Appendix III describes some innovative international energy-from-waste initiatives that indicate directions in which Jamaica could move.

# Rationale for Energy-from-Waste Policy

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Jamaica's interest in creating an energy-from-waste (EFW) sector stems from the increase in growth in municipal solid waste (MSW) coupled with the increasing demand for energy. Energy-from-waste is known to be an effective method of waste management and waste volume reduction with the added benefit of generating clean energy.

This Energy-from-Waste Policy responds to the directive within the National Energy Policy to increase the percentage of renewables in the country's energy mix to enable the reduction in the dependence on imported petroleum. Developing this sector will not only respond to the National Energy Policy but also will effectively support the country's waste reduction goals, including addressing the problem of scarce landfill space.

*Energy-from-waste is a win-win case for Jamaica and this policy will enable us to generate clean energy using appropriate technologies within a good regulatory framework, expand renewable energy sources and create a more sustainable environment through better management of waste.*

Energy generated from waste is considered to be renewable since much of the waste is biomass<sup>4</sup>. Therefore increasing the portion of energy obtained from waste will contribute to the achievement of Jamaica's targets of renewables in the total energy mix of 11% by 2012, 12.5% by 2015 and 20% by 2030.

The promotion of the energy-from-waste sector through this policy will **not** result in the creation of more waste but will support Jamaica's goals of minimization of waste requiring final disposal - a major thrust being considered as part of the revised integrated waste management framework to be promulgated by the National Solid Waste Management Authority (NSWMA). Waste reduction and recycling will remain at the top of the waste management hierarchy, with energy-from-waste initiatives being used only for those unavoidable residual municipal wastes that cannot be reused or recycled.

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<sup>4</sup> According to the European Directive on Renewable Energy Sources the biodegradable fraction of municipal and industrial waste is considered biomass, thus a renewable energy source. Also, EFW is designated as renewable by the US 2005 Energy Policy Act and by the US Department of Energy.

Internationally, it has been proven that recycling and energy generated from waste materials which cannot be recycled go hand in hand in order to improve national environmental outcomes with respect to waste management while at the same time supporting viable energy-from-waste operations. Thus, this policy will help to facilitate better management of waste by local authorities and will therefore complement the country's national waste management strategies. With the development of a modernized and revised national spatial plan that is currently taking place, the promulgation of this policy also will promote the proper siting of EFW plants.

This energy-from-waste policy will promote energy diversification which will help to enhance Jamaica's energy security. Also, the policy will provide income-generating options for handling agricultural wastes and wastewater sludge. In addition, converting waste at disposal sites to usable forms of energy reduces the volume of solid waste by 90% and therefore will alleviate the problem of inappropriately managed disposal sites that contribute to poor health and environmental standards, emission of greenhouse gases and the occurrence of fires from combustion or arson. Also, this will reduce the costs associated with creating and managing disposal sites.

Table 1 summarizes the social, economic and environmental benefits to Jamaica of implementing this Energy-from-Waste Policy.

**Table 1: Summary of Benefits of an Energy-from-Waste Policy**

Social	Economic	Environmental
<ul style="list-style-type: none"> <li>• Generation of clean electric power</li> <li>• Reduced land space used for landfills</li> <li>• Sustainable economic growth and development</li> <li>• Job creation</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced costs for users of electricity and bio-diesel</li> <li>• Increased supply of bio-diesel</li> <li>• Increased independence and less reliance on imported petroleum</li> <li>• Improved balance of payments</li> <li>• Sustainable economic growth and development</li> <li>• Job creation</li> <li>• Stimulated industrial development</li> <li>• Reduced costs for solid waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Environmentally safe waste management and disposal</li> <li>• Reduction in disease vectors such as vermin and insects</li> <li>• Reduced greenhouse gas (GHG) emissions</li> <li>• Reduction in the overall waste quantities requiring final disposal</li> </ul>

# The Energy Sector in Jamaica

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The development of Jamaica's energy sector shows much promise in reducing dependence on imported petroleum, lowering the cost of energy to consumers and creating a framework for better use of energy through energy conservation and efficiency by all Jamaicans, because of the promulgation of the country's first long-term National Energy Policy 2009-2030. The national policy was promulgated in 2009 to address the situation facing the energy sector of being "characterized by an almost complete dependence on imported petroleum; high rates of energy use; ... and an inadequate policy and regulatory framework."

The following provides a synopsis of the energy sector, identifying some key strengths and weaknesses. The National Energy Policy will build on the strengths and reduce many of these weaknesses.

## Strengths:

- Existence of a regulatory framework
- Jamaica has a well developed power supply and distribution system with more than 90% of the population having access to electricity
- Jamaica is endowed with a very high potential for the use of renewables in the form of solar, wind, hydro and biomass production
- There are diverse opportunities for co-generation

## Weaknesses:

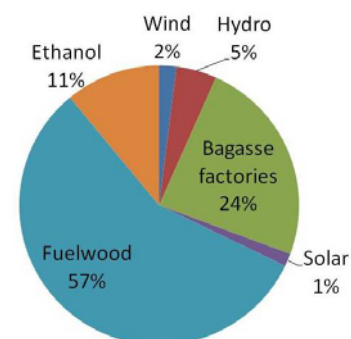
- High dependence on imported petroleum
- High energy import bill
- High cost of electricity
- Old/aging electricity generation plant - Over 40% of the power generation system is old and in need of replacement/retirement
- Aged technology of the local petroleum refinery
- Lack of detailed and up-to-date data for determining renewable energy projects
- Low level of adaptation of new energy technologies
- Use of charcoal and firewood as energy sources
- Slow development of renewable energy resources
- Low levels of public action on energy conservation
- Weak enforcement by regulatory agencies

## Energy Use in Jamaica

The energy sector in Jamaica is dominated by imported petroleum, which meets approx 91% of the nation's energy needs.

Approximately 9% of the energy supply mix comes from renewable sources such as wind, hydro, biomass and solar (see Figure 1).

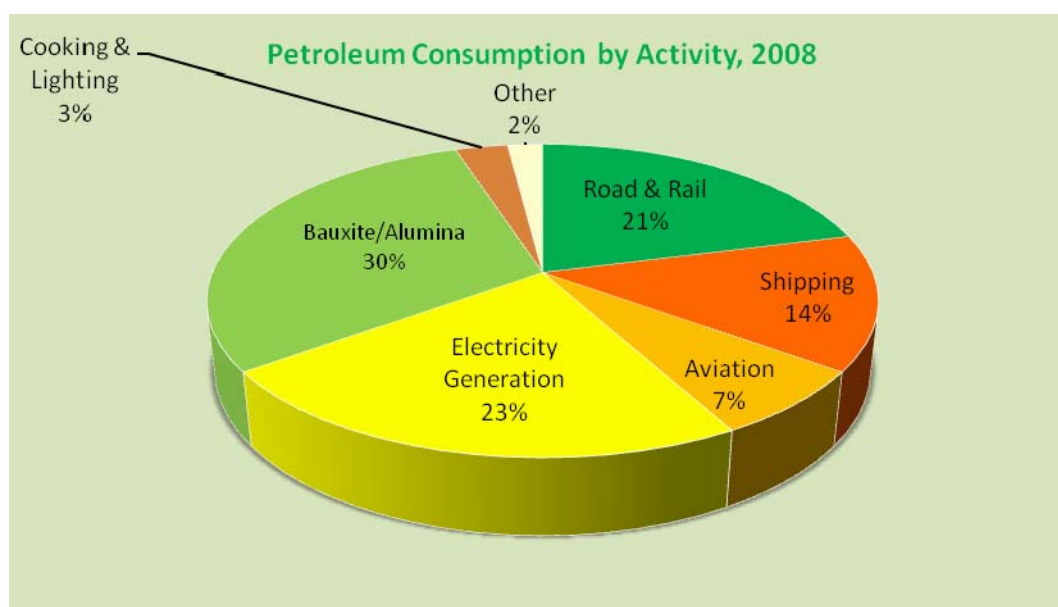
Biomass sources include fuelwood, bagasse (used in co-generation facilities) and ethanol processed from sugar cane used as a component of E10 (a liquid fuel composed of 10% ethanol and 90% gasoline which is now widely used in the transportation sector).



**Figure 1. Composition of renewable energy sources in Jamaica - 2009**

A small percentage of renewable energy comes from biogas plants located across the island. They generate fuel from animal wastes from the agricultural, small manufacturing, educational and residential sectors.

As shown in Figure 2, transport is the largest consumer of petroleum in our economy, accounting for 37 per cent of total petroleum consumption in 2008 and the demand for automotive fuels (gasoline and diesel oil) is growing at a rate of 4.3% per annum. The bauxite and alumina industry accounts for 34 per cent, while electricity generation accounts for 23 per cent.



*Figure 2: Petroleum Consumption by Activity, 2008*

## Management of the Energy Sector

The Ministry of Energy and Mining has overarching responsibility for the development of the energy sector in Jamaica. The Ministry's Energy Division facilitates the development of strategies, programmes and projects to ensure the successful implementation of the National Energy Policy with a focus on the identification of new, renewable and alternative energy sources and the promotion of energy conservation and efficiency.

The Petroleum Corporation of Jamaica (PCJ) is the main implementing agency of the Ministry and focuses on implementing the energy security and fuel diversification strategies and the cost-effective availability of petroleum products.

The Jamaica Public Service Company Limited (JPSCo) is the National Electric Grid Operator and, along with several Independent Power Producers (IPPs), satisfies the electricity generation needs of the country.

The Rural Electrification Programme (REP) has responsibility for providing electricity to non-urban areas. Under the REP, 7,000 km of low voltage distribution lines were constructed and approximately 70,000 rural homes electrified. In excess of 90% of households island-wide now have access to electricity.

Currently, the Government of Jamaica owns 20% of the Jamaica Public Service Company (JPSCo) Limited. The Government has taken the decision to privatize and liberalize the electricity sector, and as a first step, all new generating capacity is being undertaken by the private sector through independent power producers (IPPs) which generate electricity for their own use (self producers) and/or for sale to the national grid. While JPSCo retains a monopoly on the transmission and distribution of electricity, independent power providers now account for over 25% of electricity generation capacity. In 2008, total generating capacity in Jamaica was approximately 818 megawatts (MW), which included 217 MW capacity provided by IPPs.



# Waste Management in Jamaica

Jamaica generates all types of waste including gaseous emissions, solid waste, hazardous waste, medical waste and sewage. Within the energy-from-waste framework, the focus is on the types of waste that can be used to safely generate energy. These are municipal solid waste, agricultural wastes (including bagasse and animal wastes) and sewage sludge. Types of waste that Jamaica generates that would not be included in the energy-from-waste sector because of their potential impact on human health and the environment include hazardous waste and medical waste.

*Types of waste that can be considered within an energy-from-waste framework include:*

- municipal solid waste
- agricultural wastes (including bagasse and animal wastes)
- sewage sludge

## Management of Municipal Solid Waste

Solid waste is broadly defined as non-hazardous solid material emanating from households and institutional, industrial and commercial facilities. By definition, solid waste does not include solid component of hazardous and medical wastes since those wastes are subject to special handling and treatment regimes. In 2006, approximately 1,463,905.5 tonnes<sup>5</sup> of solid waste were produced from residential, commercial and institutional sources. There was a 150 per cent increase in per capita generation of solid waste from 0.6 kg/person/day in 1996 to an estimated 1.5 kg/person/day in 2006 (Treasure, 2002).

## Characterisation of the Solid Waste Stream

A Characterization of Waste study carried out by the National Solid Waste Management Authority (NSWMA) in 2006 reported that 69 per cent of the solid waste produced in Jamaica is organic and represents approximately 1.01 million tonnes by volume (see Table 2 and Figure 3).

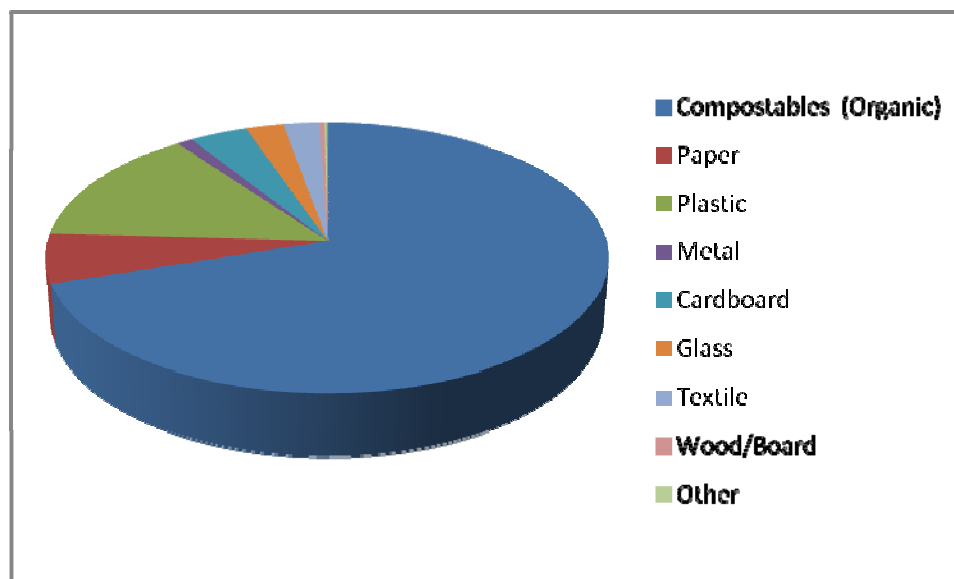
**Table 2. Waste Generation by Type 2006**

Type of Waste	Percentage	Volume (tonnes)
Compostables (Organic)	69	1 010 094.8
Paper	5.9	86 370.5
Plastic	13.9	203 482.9
Metal	1	33 669.8
Cardboard	3.7	54 164.5
Glass	2.4	35 133.7
Textile	2.3	33 669.8

<sup>5</sup> This is a crude estimate based on 1.5 kg per capita per day and a population size of 2,673,800 in 2006.

Wood/Board	0.3	4 391.7
Other	0.2	2 927.8
<b>Total</b>		<b>1 463 905.5</b>

Source: Waste Characterisation Study, NSWMA, 2006



**Figure 3: Components of Jamaica's Waste Stream**

Approximately 70 per cent of the estimated total solid waste comes from households while commercial and industrial solid waste represent about 20 per cent and 10 per cent respectively of the total waste generated.

### Solid Waste Management

The National Solid Waste Management Authority (NSWMA) has the sole jurisdiction for solid waste management in the country. The NSWMA was given its legal mandate with the enactment of the National Solid Waste Management Policy and the National Solid Waste Management Act (2002). The Authority currently collects and disposes of domestic solid waste (including hazardous waste) while simultaneously regulating the sector.

Collection by garbage trucks and burning are the predominant methods of garbage disposal and treatment. Garbage collection in the Kingston Metropolitan Area (KMA) and other towns has been more efficient than in other areas of the country. Collection is particularly low in rural areas

#### Sanitary landfill

A sanitary landfill is a solid waste disposal site with:

- designated cells for tipping different types of waste
- leachate controls (e.g. cell linings)
- gas controls (e.g. a network of pipes to collect the landfill gas – methane – that is generated from the decomposing waste within the landfill)
- daily covering of waste

where the main method of treatment and disposal is burning. Other disposal methods include burying and dumping on open lots and in gullies.

Jamaica has no sanitary landfills but has eight (8) authorized disposal sites which are managed by the NSWMA. According to the NSWMA, the country's disposal sites received about 940,000 tonnes of garbage during the year 2006 and this figure is projected to increase to 1.2 million tonnes by 2010. According to the NSWMA, it takes about US\$100 per tonne to collect and dispose of solid waste in Jamaica. Over the past ten years, municipal solid waste dumped at disposal sites across the island has grown by an annual average rate of 6% per year. The National Solid Waste Management Authority projects that 70 to 75% of the country's solid waste is collected, while the remainder is uncollected due to inaccessibility, competing disposal practices such as burning and improper waste management practices such as dumping into open spaces. The 25 to 30% of uncollected waste represents inputs that could be used as input into energy-from-waste facilities.

Private waste management firms establish long-term contracts with businesses, hotels and residential complexes for garbage removal. Jamaica's disposal sites are divided into cells, and tractors are used to compact the garbage on a daily basis. Hazardous wastes, such as motor vehicle batteries, are separated from the general waste stream. Additionally, work has been initiated to separate and bale used tires. The disposal sites across Jamaica are listed in Table 3 below:

**Table 3. Disposal Sites in Jamaica**

<b>Name of Disposal Site</b>	<b>Location</b>	<b>Parishes Served</b>
<b>Riverton</b>	St. Catherine	<b>Kingston and St. Andrew, St. Catherine and sections of Clarendon</b>
<b>Church Corner</b>	St. Thomas	<b>St. Thomas</b>
<b>Doctor's Wood</b>	Portland	<b>Portland</b>
<b>Tobalski</b>	St. Ann	<b>St. Ann</b>
<b>Haddon</b>	St. Ann	<b>St. Ann and St. Mary</b>
<b>Martin's Hill</b>	Manchester	<b>Manchester and sections of Clarendon</b>
<b>Myersville</b>	St. Elizabeth	<b>St. Elizabeth</b>
<b>Retirement</b>	St. James	<b>Trelawny, St. James, Hanover and Westmoreland</b>

The larger sites are Riverton, Retirement, Martin's Hill and Haddon. These sites are considered primary sites for development based on the four (4) regions which the NSWMA regulates.

Generally, these dumps have not had the benefit of appropriate equipment or sufficient funding for adequate management to be sustained. In addition, the small size of the disposal sites has affected the economies of scale for proper management to be instituted.

The Government plans to close the smaller dump sites in order to funnel resources into proper development and management of the larger sites. To facilitate the disposal of the waste at the main sites, transfer stations are to be established in or near these smaller sites.

### **Processing/Recycling of Solid Waste**

Waste processing only takes place on a formal scale on a limited basis in Jamaica. There are a few companies that are collecting waste paper, PET (polyethylene terephthalate) plastic bottles and scrap metal, reducing the volume by shredding or crushing and then baling the recyclables for export. These companies operate independently and are not within the jurisdiction of the NSWMA. With the exception of glass bottle recycling there is no major recycling industry.

There have been a number of investors that have made proposals to recycle the hundreds of thousands of tyres that have been baled by the NSWMA and are currently being stored at Riverton. The NSWMA continues to have dialogue with potential investors in relation to this issue.

The scrap metal industry has been vibrant in recent years. Nearly all disposal sites have scrap metal stockpiles, with Riverton and Retirement having the largest. Scrap metal exports were valued at US\$100 million in 2009. While this industry provides income generation for communities and provides an incentive for recycling waste materials, it has a negative side. Trade in scrap metals is posing a threat to some of the country's important infrastructure due to theft of telephone and traffic light cables; removal of drain and manhole covers; and removal of bridge rails and road sidings. Recognizing this problem, in April 2010, the Government of Jamaica placed a ban on trade in scrap metal<sup>6</sup>. However, the GOJ realizes the importance of this industry to local communities and the country in general and is in the process of formulating strategies aimed at formalizing, regulating and improving this industry.

### **Management of Agricultural Wastes**

In Jamaica, the agriculture sector is the largest source of waste outside of the mining sector. Bagasse constitutes 30% by volume of Jamaica's sugar crop and is the largest component of

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<sup>6</sup> This ban exempts manufacturers who generate their own material, and do not buy from other sources.

agricultural waste. Bagasse is already being used in cogeneration facilities to produce electricity and contributes about 47% to the current renewable energy mix, representing 5% of national energy use. Based on recent research, cogeneration potential from bagasse for the period 2008 to 2030 is estimated to range between 20 and 63 MW.

The Ministry of Agriculture has overall responsibility for the sugar industry, but it deals with general policy issues while delegating to the Sugar Industry Authority (SIA) the specifics of regulation and control of the industry.

Wastes from animal farms also fall within the responsibility of the Ministry of Agriculture. However, the Scientific Research Council (SRC) works with the Ministry and other government agencies as well as the private sector to provide solutions for handling animal wastes using biogas technologies.

## **Management of Wastewater**

Sanitation services exist in most major urban areas, and are being improved. In the Kingston Metropolitan Area (KMA), 92% of households have flush toilets, while in other towns 60% of households have this facility. The great majority of households without flush toilets use pit latrines. In order for a national system to be developed to process wastewater sludge for energy generation, centralized wastewater treatment plants are necessary. However, while coverage of sewerage services has increased significantly in recent years, only 20 per cent of the population island-wide is connected to sewage treatment facilities. In the KMA the percentage is considerably higher with 60% of households linked to sewer systems, while in other towns only 11% of households are connected most of which are in housing developments. The NWC is currently implementing a programme to expand the sewer connections in the KMA and recently completed the construction of a new sewerage system in the Montego Bay area.

The National Water Commission (NWC) is a statutory organization charged with the responsibility of providing wastewater services for the people of Jamaica. However, there are a number of entities that own and operate wastewater treatment facilities in Jamaica. The NWC operates the largest number of plants and has a fairly large network of sewerage systems in major cities and towns. In addition to the NWC, sewage treatment plants are owned by hotels, strata corporations and public housing development agencies. Major urban centres such as Kingston and St. Andrew, St. James and St. Catherine account for approximately 90 per cent of the waste handled by the NWC.

Jamaica's wastewater sector generally has a low level of performance, and sewage effluent quality from most treatment plants has generally not been able to meet the NRCA's sewage

effluent standards. This is mainly due to issues such as improper plant designs, old technology, overloading, lack of maintenance, and improper operations. This problem has been alleviated somewhat by the 2008 commissioning of the first phase of the Soapberry Treatment Ponds that provide tertiary treatment of sewage from Kingston and St. Andrew and South East St. Catherine (Portmore).

Wastewater is also generated from agri-businesses. However, industrial wastewater treatment facilities in the agro-industrial sector are also plagued with poor trade effluent discharge quality. This is of particular concern in the sugar industry, coffee industry, distilleries, and abattoirs. Codes of Practice have been developed for the coffee and sugar industries which aim to improve the quality of effluents.

Sludge is left behind from the process of treatment of wastewater and is suitable to generate energy through processes such as gasification to produce syngas, incineration to generate electricity, or anaerobic digestion.

# Defining the Scope for the Use of Waste in the Energy Sector in Jamaica

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While there are diverse methodologies used to obtain energy from waste materials implemented in countries throughout the world, this policy will focus on those technologies that are feasible within the context of Jamaica's physical size, population, economic activities and natural environment.

## Prospects for Development of the Energy-from-Waste Sector in Jamaica

As described above, wastes suitable for generation of energy consist of municipal solid waste and biomass. The most promising technologies for energy-from-waste in Jamaica are:

- Incineration of Municipal Solid Waste
- Capture of Landfill Gas
- Production of Bio-diesel
- Co-generation using Bagasse
- Production of Biogas using Animal Wastes
- Use of Wastewater Sludge

These technologies are described below with respect to the current and anticipated development environment in Jamaica.

### Incineration of Municipal Solid Waste

Burning non-toxic waste is considered an efficient method of waste disposal as it is rapid and has the potential for creating thermal energy that can be utilized. Disposal of municipal solid waste (MSW) by incinerating is environmentally preferred to uncontrolled dumping as it reduces the volume of garbage by over 85%.



*A modern energy-from-waste facility*

The technology used consists of a reception bunker for storing the delivered waste, an incineration furnace with grate and air supply, a steam generator for energy conversion and cooling flue gases, slag and ash removal systems, equipment for cleaning the flue gases to acceptable environmental standards, and a stack for discharging the cleaned flue gases to atmosphere.

In 1995-6, a feasibility analysis was conducted by Dr. Mohini Kiswani for the use of waste at Riverton City to generate energy by incineration in a waste-to-energy facility. The study reported that the average calorific value of residential waste disposed at the site was 8.87 MJ per kg per day. Table 4 shows the heating values of the components of the waste at Riverton. The requirements for combustion is that the waste have a minimum calorific value of 5 MJ per kg per day; the moisture content of waste should be less than 50%; and the combustible portion of the waste should not be less than 50%. Based on the analysis, heat recovery through incineration of municipal waste at Riverton City seems feasible. The annual energy generation for 109,500 tonnes is estimated to be 269,698 MWh, with a thermal efficiency of about 25%. The energy output would be 67,500 MWh with about 9 MW available for export to the national grid.



**Table 4. Heating values of Residential Waste Disposed – Riverton City**

Items	Lower End (MJ/kg)	Quantity Disposed per day (kg)	Total Heating Values (MJ per day)
Plastic	22.7	44,020	999,254
Wood/Board	15.0	36,684	550,260
Garden Waste, Trees	4.8	110,051	528,245
Paper/Cardboard	12.2	40,352	492,294
Textiles	16.1	29,347	472,487
Food	4.12	51,357	211,591
<b>Total</b>		<b>311,811</b>	<b>3,254,131</b>

*Source: Presentation by M. Kiswani, PhD to the EFW PWG on May 26, 2010*

Potential NSWMA plans for diverting garden and food waste into composting initiatives will reduce the volume of waste being deposited at the disposal site. However, Table 4 shows that these components, although constituting a large volume, have the lowest calorific content and therefore contribute comparatively less than the other waste stream components such as plastic. Also, given the volume of garden and food waste generated in Jamaica, composting initiatives would not likely be able to use all this organic waste, some of which would still end



up at disposal sites such as Riverton. Therefore, the energy-generating potential of Riverton, after a composting initiative has been established, would be less but still viable.

A description of an economic viability analysis of waste-to-energy at Riverton City based on this study is presented in Appendix II.

In 2009, the Petroleum Corporation of Jamaica (PCJ) entered into an agreement with a private sector company and partners for the establishment of two waste-to-energy plants using new technologies. When the plants are established, they will generate up to 65 MW of electricity from garbage at the country's two largest waste disposal sites. The project as proposed will see the construction of one 45 MW facility at Riverton that will generate 358 gigawatt-hours (GWh) of electricity a year and one 20 MW facility at Retirement producing 141 GWh. Annual savings in fossil fuel are projected to be some 700,000 barrels or US\$60 million.

### Capture of Landfill Gas

Landfills produce gas – mainly methane and carbon dioxide – directly in proportion to the total quantity of organic material contained in them. Therefore, Jamaican dumpsites generate large volumes of gas since 69% of the municipal waste stream consists of organic matter.

The volume of methane available for recovery from the Riverton dump site is estimated at 200L/kg of refuse over a period of 30 years. The estimated quantity of municipal solid waste for 3 years is 520,125 tonnes. The methane recovery rate during the first 5 years is 1,040,250 m<sup>3</sup> per year. The energy content of the methane fuel is equal to 222,424,440 x 105kJ per year. According to JPSCo, the average requirement per household is 1,869 kWh per year. Therefore, based on the estimated conversion of  $3.6 \times 10^6 \text{ J} = 1 \text{ kWh}$ , the energy produced can serve over 3,300 homes (Model: Emcon Associates-Henry 1989 study, Model: Zsuzsa- Hungarian – biogas). Both models demonstrate that garbage dumped at Riverton City has potential for generating energy. However, a detailed viability study needs to be done.

### Production of Bio-diesel

Existing initiatives to explore the production of bio-diesel focus on growing crops as feedstock. The Petroleum Corporation of Jamaica's Centre of Excellence for Renewable Energy (CERE) and the Ministry of Agriculture and Fisheries Research and Development Division are partnering on a J\$13.59 million biodiesel project that, if successful, should open up new crops to farming. The joint venture agreement will test whether Jamaica can viably grow the feedstock. The project will establish 10 acres of inter-cropped



jatropha and castor plants at the Bodles Research Station in Old Harbour, St Catherine. The research will consider the harvest potential under prevailing climatic condition and will seek to determine the productivity of feedstock varieties on marginal lands.

However, the potential exists to incorporate waste cooking oils in the system to generate bio-diesel. The unsafe practices of cooking oil disposal pose an environmental hazard. Currently, while there are some small operations in existence, there is no national system in place for collecting used cooking oil which is usually thrown away, or poured down the drain. According to the US Environmental Protection Agency, a gallon of diesel produces 22 pounds of carbon dioxide (CO<sub>2</sub>) emissions. But vegetable oil is a carbon-neutral fuel: it emits only as much CO<sub>2</sub> as it absorbed while growing in the field as plants.

### Co-generation using Bagasse

Approximately 600,000 tonnes of bagasse - equivalent to about 940,000 barrels of oil at a value of US\$37.5 million - are used per annum (as of 2003) in cogeneration in Jamaica's sugar factories. It is estimated that excess electricity of approximately 300GWh per year would be available with bagasse combustion alone, resulting in about 68MW of available capacity.



### Production of Biogas using Animal Wastes

The Scientific Research Council has been involved in the development of biogas plants using animal wastes in the agricultural, small manufacturing, educational and residential sectors. A total of 250 of these plants are in operation across the island, though cultural barriers are still to be broken in order to gain full acceptance of biogas as a fuel for cooking. However, no overall estimate exists which determines how much biogas contributes to the energy mix.

A recent example is at St. John Bosco Boys Home in Manchester. The property includes a farm that produces pork, beef and chicken that is sold from a well established butchery. Vegetables and other crops are also grown. SRC constructed a 100 m<sup>3</sup> biodigester along with a drying bed and a polishing pond. The system now produces over 50 m<sup>3</sup> of gas per day equivalent to 300 kWh per day and 25 litre of diesel oil per day. The school presently utilizes the gas generated to operate industrial cookers, stoves, water heaters, chicken and pig brooders.

The Jamaica Pig Farmers Association, the Ebony Park Academy and other partners have been working to manage wastes from pig farms across the country. Pig farms produce an estimated 195,000 kg of manure per day and without proper disposal, this waste can pose a potential threat to Jamaica's fresh water supply. Currently, four farms employ biodigesters to help manage manure, and several others are currently under construction. These biodigesters have

the potential to refine the raw manure into useful fertilizer and some will capture methane gas, which can augment or completely replace a farmer's need for cooking fuels such as propane.

### Use of Wastewater Sludge

Sludge is left behind from the process of treatment of wastewater. Due to the physical-chemical processes involved in the treatment, the sludge can concentrate heavy metals and poorly biodegradable trace organic compounds as well as potentially pathogenic organisms (viruses, bacteria etc) present in wastewaters. Sludge is, however, rich in nutrients such as nitrogen and phosphorous and contains valuable



organic matter. Sludge generated as a result of the treatment of agricultural wastewater is often used as a soil conditioner or fertiliser on crops. Some National Water Commission facilities give away the dried sludge to farmers for use on their crops. The high organic content also makes this waste suitable to generate energy.

The Natural Resources Conservation Authority Wastewater and Sludge Regulations have been developed to address the safe management, treatment and disposal of wastewater from residential, business or industrial sources as well as sewage and industrial sludge. The regulations include standards for the disposal of sludge by means of landfilling or application for agricultural purposes. The regulations also provide for the disposal of sludge other than in a landfill to be done in accordance with the management practices set out in the guideline document to be issued by the Natural Resources Conservation Authority. The conversion of sludge to energy, for example, would be addressed in the guideline document.

The Scientific Research Council (SRC) provides biodigester systems which operate on the principles of anaerobic technology, and are used to treat organic farm waste. Another variant, the Biodigester Septic Tank (BST) is an on-site sanitation unit that utilizes anaerobic technology for the disposal of toilet (black) wastewater as well as of kitchen and bathroom (grey) water, in a closed system. The SRC currently applies this technology instead of septic tanks and absorption pits on several farms, housing complexes and single households to treat animal waste and domestic sewage. One example is a biodigester system in Western Kingston which treats solid waste - banana skin – and sewage to generate biogas and organic fertilizer at a local chip factory in the community.

## **Incentives/Disincentives for Development and Utilization of Energy-from-Waste**

JAMPRO is supportive of green energy investments and recently launched the World Investment Report 2010 titled “Investing in a Low-Carbon Economy.”

Specific incentives that may apply to energy-from-waste projects on a case by case basis include:

- Full duty and GCT exemption for importation of machinery and equipment used on the project (excluding motor vehicles)
- Tax credits for a number of years (to be negotiated)
- Accelerated Depreciation benefits allowing full write-off of capital costs associated with the acquisition of new machinery and equipment items for renewable energy projects
- Land at concessionary rates (where possible)

## **The Current Legislative Framework for Energy and Waste Management in Jamaica**

All energy-from-waste projects must comply with the laws, standards, and regulations listed below:

- National Solid Waste Management Act and regulations
- Natural Resources Conservation Authority Act and regulations
- Electricity Lighting Act
- Factories Act
- Public Health Act
- Occupational Health and Safety Act (draft)
- Companies Act
- Office of Utilities Regulation Act

The Natural Resources Conservation Authority (Permits and Licences) Regulations, 1996 are applicable to EFW projects. It provides for the permits and licensing system to control the undertaking of any new construction or development of a prescribed nature. Certain activities may require an environmental impact assessment (EIA) before a permit can be issued.

Other applicable regulations under the NRCA Act will include:

- Air Quality Regulations and its amendment
- Wastewater and Sludge Regulations

# Linkages between Energy-from-Waste Policy and National Energy Framework

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The Energy-from-Waste Policy has been developed to support the National Energy Policy 2009-2030 and has strong linkages with other sub-policies of the National Energy Policy that govern renewable energy, biofuels, electricity, energy conservation and efficiency, and carbon emissions and trading.

## Linkages between Energy-from-Waste Policy and National Energy Policy

The National Energy Policy 2009-2030 is designed to ensure that by 2030 Jamaica achieves: **“A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework.”**

The Policy places priority on seven key areas, including:

- Security of Energy Supply through diversification of fuels as well as development of renewable energy sources
- Development of renewable energy sources such as solar and hydro

The Energy-from-Waste Policy specifically addresses these priority areas which are encapsulated in two goals of the National Energy Policy:

- **Goal 3:** Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness and energy security whilst reducing its carbon footprint

This goal focuses on the development of indigenous renewable energy resources with the goal of increasing the percentage of renewables in the energy mix to 20% by 2030. Waste is considered a renewable source of energy since it is indigenous and sustainable. By adding waste to the list of solar, hydro, wind and biofuels, the target of renewables in the nation’s energy mix will be facilitated.

- **Goal 4:** Jamaica’s energy supply is secure and sufficient to support long-term economic and social development and environmental sustainability

Under this goal, Jamaica will reduce the percentage of petroleum in the country's energy supply mix from the current 91% in order to protect the country from disruptions in oil supply and price volatility. The Energy-from-Waste Policy will contribute to fuel diversification to achieve this goal.

### **Linkages between Energy-from-Waste Policy and *Vision 2030 Jamaica: National Development Plan***

Like the National Energy Policy itself, the Energy-to-Waste Policy is consistent with *Vision 2030 Jamaica: National Development Plan*. The Energy-to-Waste Policy supports the implementation of strategies that contribute to three national outcomes:

- National Outcome No. 10: **“Energy Security and Efficiency”** – Strategy: Diversify the energy supply
- National Outcome No. 13: **“Sustainable Management and Use of Environmental and Natural Resources”** – Strategy: Manage all forms of waste effectively
- National Outcome No. 14: **“Hazard Risk Reduction and Adaptation to Climate Change”** – Strategies: Develop measures to adapt to climate change; and contribute to the effort to reduce the global rate of climate change

The strategies identified in this policy are consistent with those presented in the Sector Plans for Energy and for Environmental Management under Vision 2030 Jamaica.

### **Linkages with other energy sub-sector policies**

The Energy-from-Waste Policy has close linkages with other energy sector policies as described in Table 5.

**Table 5. Linkages between the Energy-from-Waste Policy and other energy sector policies**

Energy Conservation and Efficiency	Biofuels	Renewable Energy	Carbon Emissions and Trading	Electricity
Energy generated from waste can improve energy efficiencies on the supply side	Agricultural wastes e.g. bagasse are biofuels used as a source of energy Bio-diesel can be made using waste vegetable oils	Energy-from-waste is considered a renewable source of energy and will contribute to the renewable energy targets	Some EFW initiatives can be considered for CDM projects which generate carbon credits	Electricity generated from waste should feed into the national grid and should also be allowed to be distributed separate from the national grid

# Linkages between Energy-from-Waste Policy and National Solid Waste Management Policy

The National Solid Waste Management Policy has two objectives that are linked to the Energy-from-Waste Policy: waste minimization and waste processing. The policy states that “the Government will be encouraging projects and programmes that are geared towards reducing the quantity of waste generated” and that “Investors interested in establishing waste processing and waste-to-energy enterprises” will be facilitated. Pursuance of energy-from-waste initiatives requires adequate feedstock (i.e. waste) for conversion to energy.

In the existing National Solid Waste Management Policy, the hierarchy of integrated solid waste management is stated as: Reduce, Reuse, Recycle, Landfill as indicated in Figure 4 below. This Energy-from-Waste Policy amends this hierarchy to introduce Energy Recovery as a stage before Landfill, as indicated in Figure 5. All waste that remains after reducing, reusing and recycling should be processed to generate energy, with landfilling being used to handle only those wastes that cannot be used in other processes or programmes. The waste processing described in the National Solid Waste Management Policy should be explicitly integrated into the waste management hierarchy.

## Hierarchy of Integrated Solid Waste Management

**Figure 4**  
**National Solid Waste Management Policy**

<b>REDUCE</b>	First order of business is not to generate the waste in the first place
<b>REUSE</b>	If you generate the waste see if you can find another use for it
<b>RECYCLE</b>	If it cannot be reused, join the recycling programme in your community
<b>LANDFILL</b>	The last resort should be to dispose of it in a landfill

**Figure 5**  
**National Energy-from-Waste Policy**

<b>REDUCE</b>	First order of business is not to generate the waste in the first place
<b>REUSE</b>	If you generate the waste see if you can find another use for it
<b>RECYCLE</b>	If it cannot be reused, join the recycling programme in your community
<b>ENERGY RECOVERY</b>	If the waste cannot be reused or recycled, utilize it to generate energy
<b>LANDFILL</b>	The last resort should be to dispose of it in a landfill

Giving efficient EFW plants priority over landfilling by providing waste to EFW facilities before sending to dumpsites is not expected to hamper recycling. Recycling is clearly higher up the waste hierarchy than energy recovery from waste. Recycling and generating energy from waste which cannot be recycled properly both contribute to diverting waste from landfills. Taking into account the fact that not all municipal waste is suitable for recycling, waste that can be separated at source should be recycled if possible. The remaining residual waste should be transformed into energy in clean and safe EFW plants, instead of being buried in landfills.

Acknowledging that both recycling and EFW are essential pillars to steer waste from the lowest step in the hierarchy, the National Solid Waste Management Policy should incorporate the 3Rs (reduce, reuse, recycle) and develop a recycling sector, bearing in mind that recycling initiatives can contribute to economic benefits and job creation and generally conserve more energy than energy recovery efforts can generate<sup>7</sup>. The solid waste policy should recognize EFW's place in the waste hierarchy below recycling, but above landfilling.

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<sup>7</sup> According to a study by Jeffrey Morris published in the *Journal of Hazardous Materials*, recycling conserves energy that would otherwise be expended extracting virgin raw materials from the natural environment and transforming them to produce goods that can also be manufactured from recycled waste materials. Furthermore, energy conserved by recycling exceeds electricity generated by energy-from-waste incineration by much more than the additional energy necessary to collect recycled materials separately from mixed solid waste, process recycled materials into manufacturing feedstocks, and ship them to manufacturers.



# SWOT Analysis of Energy-from-Waste Sector

For the energy-from-waste sector in Jamaica, the identification of strengths and weaknesses represents the internal assessment of the sector while the consideration of opportunities and threats represents the analysis of the impact of the external environment on the sector. The SWOT analysis, along with the issues and challenges and the profile of the waste and energy sectors presented above, form the basis for identifying goals and strategies that will be employed to apply the strengths and address the weaknesses of the sector, and capitalize on the opportunities and mitigate the threats for the long-term development and sustainability of the sector.

Strengths	Weaknesses
<p>Existence of long-term national energy policy that establishes the framework for the development of the energy-from-waste sector: National Energy Policy and Vision 2030 Jamaica</p> <p>National policies for renewable energy and biofuels</p> <p>Existence of an institutional framework for renewable energy in government (for example CERE) to promote research and facilitate the development of the RE sector</p> <p>Available energy sources/waste stream – 55% of municipal waste stream can go into the energy-from-waste sector</p> <p>Existence of high energy crop residues (bagasse) and high levels of experience in sugar cane production</p> <p>Existing technical capacity for appropriate biodigester technologies</p>	<p>Poor coordination amongst entities</p> <p>No sanitary landfills; inappropriate techniques being used at disposal sites</p> <p>NSWMA in dual role as regulator and operator in the waste management sector</p> <p>No framework for separation of waste</p> <p>Difficulty to do business in Jamaica (doing business rating)</p> <p>Lack of a comprehensive waste management framework</p> <p>Limited capacity of regulating agencies to monitor and enforce laws</p> <p>Low levels of technical and R&amp;D capacity in EFW</p> <p>Limited regulatory framework for promoting the generation of energy from waste</p> <p>Lack of infrastructure and inadequate financing</p>
Opportunities	Threats
<p>Private sector interest</p> <p>Improved balance of payments through import substitution</p> <p>New and innovative technologies existing worldwide</p> <p>Limited life span of disposal sites and land space for landfills present an incentive for developing EFW initiatives</p> <p>Carbon trading and CDM projects</p> <p>Regional leader in the development of energy from waste</p> <p>Creation of new jobs and new industries</p> <p>Availability of new technologies and developments –</p>	<p>Negative public perception by environmentalists and communities</p> <p>Demand for waste by unregulated entities</p> <p>Conflict between waste minimization and adequate feedstocks for EFW initiatives</p> <p>Fluctuating oil prices relative to EFW (if oil prices fall low there could be loss of interest in EFW)</p>

improved technology and capacity for increased productivity assisted by regional expertise High population densities due to urbanization offer opportunity for efficient collection of waste	
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# Key Issues in the Energy-from-Waste Sector

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The National Energy-from-Waste Policy addresses a number of key global and local issues that must be considered in the development of a successful energy-from-waste sector. These issues focus primarily on protecting the health of Jamaicans, preventing environmental degradation, and are related to the viability of sector. The issues are described below and are addressed by strategies associated with each goal of this policy.

## Certainty of waste

EFW facilities will require a guaranteed volume of waste materials as feedstock. While Jamaica produces over 1.5 million tonnes of solid waste per year, only 70-75% of it is collected and thus available to EFW facilities. Reduced illegal dumping and increased collection, especially in rural areas, would provide additional waste materials for EFW plants. The goal should be to transfer all waste materials that are not suitable for recycling to EFW facilities.

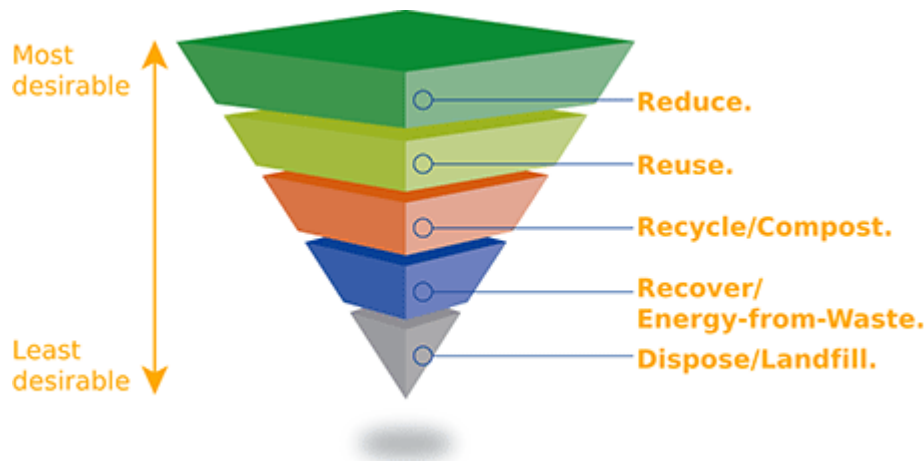
Collection of municipal solid waste can be facilitated by the creation of transfer stations located throughout the country. These transfer stations would receive waste from rural areas, thereby reducing the amount of waste that is informally disposed of. This waste would then be transported to central waste management facilities, including EFW plants, thus helping to increase the amount of waste that is available for the generation of energy.

## Importation of waste

This policy will not support the importation of waste. However, whilst not a favoured option, the country may be required to import feedstock materials (e.g. wood chips) for EFW facilities. Any importation of feedstock must be based on considered study of the volumes and types of waste required for different EFW initiatives using different technologies. Clear rules for the importation of materials for input into EFW initiatives will have to be developed consistent with the country's international obligations and the protection of the health of Jamaicans. The rules should specify the characteristics of the materials (for example, high caloric value) that will be allowed into the country and must ensure that there are no negative health or environmental impacts from the materials imported. A comparative analysis of other countries with well-developed energy-from-waste sectors would provide examples of international best practice in implementing successful EFW facilities.

### Conflict between energy-from-waste and solid waste minimization

Even though the energy-from-waste sector depends on waste as its “raw material”, it is critical that energy-from-waste initiatives support a country’s solid waste management goals of waste minimization and not result in the creation of more waste. Waste reduction and recycling (which includes composting) are at the top of the waste management hierarchy and must remain so, with energy-from-waste being the final stage before waste is sent to a landfill or disposal site. Taking into account the fact that not all municipal waste is suitable for recycling, waste that can be separated easily at source should be recycled. The remaining residual waste should be transformed into energy in clean and safe EFW/WTE plants, instead of being buried in landfills. Therefore, waste-to-energy initiatives should be considered as energy recovery options and not disposal (at the same level as landfill).



Countries that have most successfully reduced dependence on landfill (<5%) have the highest recycling rates in Europe, and have achieved this in combination with EFW/WTE (Germany, Netherlands, Belgium, Denmark, Sweden), proving that recycling and generating energy from waste which cannot be recycled properly go hand in hand in order to divert waste from landfills.

A 2008 briefing released by the European Environment Agency states:

“Increased recovery of waste and diverting waste away from landfill play a key role in tackling the environmental impacts of increasing waste volumes. As recycling and incineration with energy recovery are increasingly used, net greenhouse gas emissions from municipal waste management are expected to drop considerably by 2020.”

Other studies have found that improved waste management could contribute to climate reduction targets if clear legislation is applied and if high calorific and biodegradable waste is diverted from landfill and more support is given to both recycling and energy-from-waste initiatives. These studies have concluded that energy-from-waste does not hamper recycling.

The optimum combination of recycling and energy-from-waste saves primary energy sources, combats climate change and helps to secure a country's energy supply.

### **Rethinking the concept of waste – waste as a resource**

Waste is usually defined by most people as “anything unused, unproductive, or not properly utilized.” In the typical scenario, new products are purchased and when they are “used up” they are thrown away and carted off to a landfill. The new way of thinking is the concept of “industrial ecology” which seeks to eliminate all waste by capturing and utilizing the output from every operation as an input to another operation – with the necessary environmental and health safeguards. In other words, one person's trash is another person's “cash.” Both recycling and energy-from-waste initiatives can produce value from waste items. For example, EFW projects can turn municipal solid waste into electricity or bagasse into liquid fuel. If waste is managed properly, environmental and health concerns will be addressed, which will result in persons feeling more confident that the waste can be converted safely into a useful product and will be more amenable to using that product.

### **Security of waste**

Treating waste as a resource actually creates a market for waste. Energy-from-waste facilities require a guaranteed volume of waste in order to operate. Typically, waste is not protected or “locked up” and there is potential for creating a “black market” for waste. The energy-from-waste sector must include a system to safeguard the incoming feedstock and to ensure that entities such as the National Solid Waste Management Authority control the waste materials and provide them to the generation facilities under specific agreements.

### **Land use and siting**

Decisions regarding the siting of EFW facilities will be made in accordance with the National Spatial Plan being developed and under the direction of NEPA/NRCA and local planning authorities. Where possible, such facilities should be sited on marginal lands which are not suitable for agriculture or housing. In order to promote the EFW sector, the Jamaican Government may provide state-owned lands at concessionary rates to the operators of energy-from-waste facilities.

### **Dispatchability**

One concern about power generated from waste is its possible intermittent generation, which could limit its contribution to the grid. A “dispatchable” power plant is one that can be directly called upon by grid operators to produce power, and whose output can be increased or decreased in response to real-time fluctuations in demand for electricity. There must be coordination of all waste-to-energy plant operations in the country in order to meet the required load on the national grid.

### **NIMBY concerns**

It is natural for persons and communities to say “Not In My Back Yard” (NIMBY) to any proposed EFW facilities to be constructed in their vicinity. National Land Use Spatial and Development Plans should dictate where such facilities should be sited taking into account the concerns of stakeholders, including communities. It is paramount that environmental regulators coordinate with local officials to hold public hearings where new facilities and technologies, operating standards and the “do-nothing” consequences can be discussed.

### **Air quality standards and waste/effluent enforcement**

The protection of the environment is a primary objective of this Energy-from-Waste Policy, and as such, the environmental guidelines of the National Environment and Planning Agency (NEPA) will be enforced. EFW facilities must meet or exceed the environmental standards for effluent discharge, air emissions and all other applicable standards.

### **Hazmat standards and integration/non integration**

There are no hazardous waste disposal sites in Jamaica. However, disposal of hazardous ash generated from the operations of a MSW incinerator will have to be handled. Also it is inevitable that some hazardous wastes end up at municipal disposal sites, especially those near major industrial, residential and business centres. However, the amount of hazardous materials present in the country’s dumpsites is unknown. If municipal solid waste is to be incinerated to generate energy, standards for hazardous materials (“hazmat”) must be established and these wastes separated from the general solid waste. This will require that the necessary infrastructure and ongoing public education and awareness campaigns are in place.

### **Types of technology to be used and technology transfer**

Development of the energy-from-waste sector will not occur without research. The selected technology and processing capacity of a energy-from-waste facility is a function of a number of technical considerations (i.e., the amount of waste remaining after recycling to be processed, the capital and operating cost of the facility and the price paid for the renewable energy produced) and the country’s long-term solid waste planning goals (i.e., reduction in carbon footprint, benefits of a stable domestic source or renewable energy, stability of disposal costs). It has been shown in the USA, Europe and Asia that there is no single threshold size that makes energy-from-waste projects feasible. Research and feasibility studies will be conducted to determine the most appropriate technologies for Jamaica, taking into account the volume and types of waste generated.

While much of the expertise currently exists outside the region, it will be critical to ensure that the knowledge and skills are transferred to local institutions and individuals so that capacity within the country is built.

## Waste separation

Currently, within municipal solid waste, there is little to no separation of the different types of waste at source. All MSW is deposited at the disposal sites distributed throughout the country which provide residents of nearby areas a significant source of income. For social reasons, it may be in the country's best interest to continue allowing access by these persons to the disposal sites. A regulated system, which safeguards public health, will need to be developed which would allow for the sorting and collection of waste by such persons at the sites, thereby facilitating the pursuance of income-generating activities. However, there should be clearly defined and identified areas where access will be allowed/not allowed.

A national system will need to be established to channel all useful *residual* waste to energy-from-waste facilities. Agricultural residues, including garden cuttings, and bio-solids will be directed to biodigesters.

## Financing and tipping fees

Legislation drafted after the enactment of the National Solid Waste Management Act, 2001 includes provisions for tipping fees. Due to the high cost of waste collection, sorting and management, some of these costs may be recovered through tipping fees. A review of tip fee trends and charges in a number of countries indicates that the average tip fee is about US\$75 per tonne. Some countries charge higher commercial fees, which relate to the quantity and character of their commercial waste streams. Jamaica currently has property and environmental tax legislation which generates funds that are used for a number of purposes including solid waste collection. In 2008, Jamaica's annual tax revenues for property tax was J\$1,299 Million (*US\$20 Million*), while the environmental levy recovered J\$2,217 Million (*US\$34 Million*). While these taxes could be a source of financing, they are not likely to be able to adequately support energy-from-waste initiatives. In order to finance EFW initiatives, tipping fees must be established and their collection enforced.

## Legislative and policy inconsistencies

Goals and objectives of national policies and legislation that govern various aspects of the energy-from-waste sector must be aligned so that there are no conflicting priorities. Also, the relative roles of the relevant entities with management responsibilities must be clarified to ensure the smooth development of the sector and implementation of initiatives.

## Climate change and greenhouse gas emissions

Climate change is caused by the emission of greenhouse gases (GHGs) such as water vapour, carbon dioxide and methane into the atmosphere and the removal of carbon-sequestering trees and other plants. The combustion of fossil fuels and production of methane from landfills and agricultural activities cause the highest levels of greenhouse gas emissions. Methane has a heat-trapping effect in the atmosphere that is 21 times stronger than that of carbon dioxide

emitted from fossil fuel combustion. Some energy-from-waste (EFW) initiatives capture and burn methane from landfills, thereby replacing emissions of methane with CO<sub>2</sub>. EFW initiatives also lessen the demand for fossil fuels and therefore reduce the volume of CO<sub>2</sub> generated from combustion of these fuel sources.

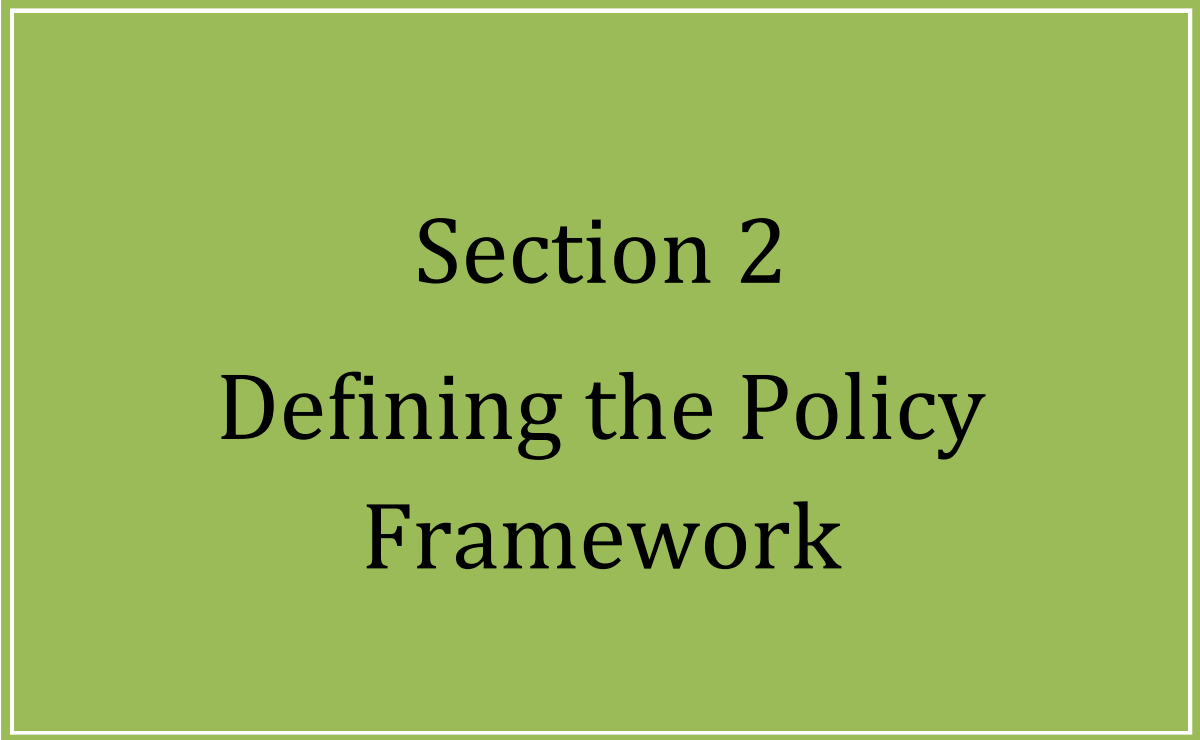
Jamaica is a Party to the United Nations Framework Convention on Climate Change and its Kyoto Protocol that set the overall framework for intergovernmental efforts to stabilize the concentrations of greenhouse gases (carbon dioxide and methane in particular) in the atmosphere. As a non-Annex 1 (developing country) party to the Protocol, Jamaica is not bound by specific targets for reductions in greenhouse gas emissions. However, the specification of emissions targets for developing countries is being reviewed at the global level in the development of a new carbon trading regime after 2012 when the Kyoto Protocol comes to an end.

### **Carbon emissions credit trading**

Under the Kyoto Protocol, countries with commitments to limit or reduce greenhouse gas emissions must meet their targets primarily through national measures. As a supplemental means of meeting these targets, the Kyoto Protocol introduced the Clean Development Mechanism (CDM) as a trading regime that would allow Annex 1 Parties to implement project activities to reduce GHG emission (or removal by sinks) in developing countries (non-Annex 1 Parties).

Eligible projects under the CDM fall under several categories including renewable energy, diversification of fuel sources in areas such as transportation, alternative fuels, and energy-from-waste (e.g. biogas, methane). There are specific energy-from-waste CDM project opportunities for Jamaica in the areas of bagasse co-generation, landfill gas recovery and biofuels. Jamaica's Carbon Emissions and Trading Policy addresses this issue in detail.





## Section 2

# Defining the Policy Framework

# Strategic Framework for Energy-from-Waste in Jamaica

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This Strategic Framework underpinning the Energy-from-Waste Policy is designed to accomplish the following vision:

***Jamaica is the regional leader in providing affordable and clean energy from waste contributing to a sustainable future***

This vision guides the creation of an energy-from-waste sector that will create a market for waste, opening up opportunities for investment in both the energy and waste sectors while achieving both energy and waste management goals.

The Strategic Framework supports the goals of the National Energy Policy and will be sustained to 2030 and beyond yet be flexible and adaptable to meet new challenges and opportunities as they arise. The framework specifies short- to medium-term as well as long-term strategic directions for the government, private sector and industry as well as civil society.

The vision and strategic framework of the Energy-from-Waste policy reflect the input of a policy working group charged with the responsibility of developing this policy using as a starting point, a Concept Paper prepared by the Office of the Prime Minister's Department of Local Government in August 2009. Appendix IV lists the members of this working group.

## Goals of the National Energy-from-Waste Policy

There are four (4) goals in this policy which, when achieved together, will realize the vision of Jamaica becoming the regional leader in providing affordable and clean energy from waste contributing to a sustainable future

The goals are:

**Goal 1:** Jamaica creates economic infrastructure and planning conductions conducing to the development of the energy-from-waste sector

**Goal 2:** Jamaica builds its energy-from-waste sector on most appropriate technologies that are environmentally-friendly, producing a clean reliable renewable source of energy

**Goal 3:** Jamaica creates partnerships between the energy sector and the waste management and agriculture sectors to facilitate the continuous streams of waste into the energy from waste

**Goal 4:** Jamaica has a well-defined governance, institutional, legal and regulatory framework for the generation of energy from waste legal framework

## The Strategic Framework

The strategic framework that will lead to the development of the energy-from-waste sector is presented below. The framework includes:

- ❖ Policy goals
- ❖ Outcomes
- ❖ Strategies

For each goal, the outcomes and strategies are listed as well as the key issues addressed by the strategies and the key agencies and partners who will be responsible for ensuring the successful implementation of the strategies. A description of the specific roles and responsibilities of these implementing agencies and partners is provided in the Institutional Framework sub-section of Section 3, the Implementation, Monitoring and Evaluation Framework.

## Goal 1

### **Jamaica creates economic infrastructure and planning conductions conducting to the development of the energy-from-waste sector**

This goal involves the establishment of a national enabling environment for the development of the energy-from-waste sector. The focus will be on establishing the national and local systems within which the energy-from-waste practitioners will function. This will include creating opportunities for private sector investment as well as public-private sector partnerships. This goal is also concerned with increasing awareness and acceptance among the Jamaican public for energy generated from waste materials.

## Outcomes

**Outcome 1:** Percentage of renewable sources of energy in Jamaica's energy mix increased

**Outcome 2:** An enabling financial and investment environment for the incubation and development of an energy-from-waste sector

**Outcome 3:** A national energy infrastructure that enables electricity generated from waste to be integrated into the national electricity grid as well as allowing flexibility in the use and sale of electricity and fuels generated from waste

## Key Issues Addressed

- Certainty of waste volumes / Importation of waste
- Rethinking the concept of waste – waste as a resource
- Security of waste
- Land use and siting
- Dispatchability
- NIMBY concerns

## Strategies and Actions for Goal 1

- Create an enabling environment for private sector investment for the energy-from-waste sector
- Undertake periodic reviews of the economics of energy recovery in Jamaica that incorporate up-to-date technologies as well as global and local realities
- Apply concessionary rates (where possible and appropriate) for land to be used to site energy-from-waste facilities
- Infuse energy issues into national spatial plan to address issues related to the siting of EFW facilities
- Conduct economic assessments of energy-from-waste facilities to determine the costs and benefits of investment in the sector
- Through a system of incentives, create a platform for improving investor confidence for investing in the energy-from-waste sector
- Implement tax policies designed to encourage the development of the energy-from-waste energy sector
- Identify potential useable residues and market opportunities
- Implement a national public education programme geared towards overcoming the population's bias against using energy generated from waste materials and sensitizing them on the benefits of energy-from-waste and their responsibilities to ensure a successful EFW sector
- Create a system of accounting that incorporates energy-from-waste into energy statistics
- Continuously assess resources available for energy recovery based on current waste planning drivers and analysis of the country's waste stream

- Allocate a portion of the environmental levy for energy-from-waste initiatives
- Create public-private partnerships to develop EFW initiatives
- Conduct assessments of non-price-sensitive barriers to the take up of energy recovery including planning approval and supply chain limitations
- Create a framework of national targets for recycling municipal solid waste and the amount of waste that goes into EFW facilities
- Align EFW initiatives with the Clean Development Mechanism (CDM) to facilitate the sale of carbon credits
- Create system for the measurement, verification and marketing of greenhouse gas (carbon dioxide) credits that will result from reducing methane generation potential
- Create a framework for net metering that allows electricity produced from EFW facilities to be sold to the national grid
- Establish dedicated substations and the protection systems required for interconnection with the electricity grid
- Establish national and local systems to facilitate the sale of liquid fuel generated from waste
- Examine a system to import quality-controlled refined materials with high caloric value to supplement local supplies for energy-from-waste facilities. This will include conducting a feasibility study and establishing rules for the importation of feedstock materials as an input into EFW initiatives

### Key Implementing Agencies and Partners

- Ministry of Energy and Mining
- Petroleum Corporation of Jamaica
- Office of Utilities Regulation
- Office of the Prime Minister
- Ministry of Finance and the Public Service
- Jamaica Public Service Company Ltd.
- National Solid Waste Management Authority
- JAMPRO (Jamaica Trade & Invest)
- National Environment and Planning Agency
- Local authorities
- National Land Agency

## Goal 2

### **Jamaica builds its energy-from-waste sector on most appropriate technologies that are environmentally-friendly, producing a clean reliable renewable source of energy**

Jamaica has the opportunity to generate energy from a variety of waste materials, including but not limited to, municipal solid waste, agricultural waste – including bagasse and animal wastes, and wastewater sludge. The focus of this goal will be to develop energy-from-waste initiatives by determining the most appropriate types of waste materials in the country that can be used to generate energy and the best technologies to be used. This goal would focus on the employment of continuous research and development to facilitate the development and operations of a viable industry – that is the identification of those energy-from-waste initiatives that can be viable within the context of Jamaica's size and economy, while ensuring that the maximum amount of energy is obtained from the different types of waste.

## Outcomes

**Outcome 1:** Appropriate and innovative energy-from-waste technologies based on sound research

**Outcome 2:** Energy-from-waste facilities that meet or exceed national environmental standards and operational practices that contributes to the achievement of environmental protection

## Key Issues addressed

- Enforcement of air quality and wastewater and sludge standards
- Hazmat standards
- Types of technology to be used and technology transfer

## Strategies and Actions for Goal 2

- Develop a research agenda that would facilitate conducting research to analyze different EFW options – in terms of waste type and technologies – within the Jamaican context
- Undertake research to determine options available at small scale for EFW initiatives in rural parishes and other areas
- Require environmental impact assessments as well health impact assessments and other relevant impact assessments (social impact assessments, trade impact assessments etc.) for any energy-from-waste facility prior to development approval. The

assessments should include a life-cycle analysis of all associated environmental and energy impacts that will result from each option.

- Establish training, lab testing and plant control facilities, which will be used to ensure the air quality, process quality, fuel and power quality specifications are met. The air pollution control equipment should include but not be limited to dry scrubbers for acid gas control, filter fabric baghouses for particulates, nitrogen oxide (NO<sub>x</sub>) controls, a continuous emission monitoring and an activated carbon injection system for mercury and dioxin control
- Enforce treatment of residues (e.g. ash) to meet national discharge standards
- Continuously assess EFW plants in operation with a view to safeguarding human health and the environment
- Create a system to transfer knowledge and skills regarding EFW technologies to Jamaican professionals and institutions
- Develop certification and training programmes for operators of EFW facilities
- Explore and develop systems for the capture of landfill gas
- Incorporate waste cooking oils in the national system to generate bio-diesel
- Maximize the amount of bagasse used in co-generation facilities
- Expand the system of generating biogas from wastes
- Stimulate industrial development by encouraging synergies from co-generation
- Conduct a feasibility study for producing fuel from wastewater sludge
- Undertake research to determine the potential of the long-term use of commercial and industrial solid waste within EFW initiatives
- Establish a system for sale and distribution of liquid fuels generated from waste
- Include accommodations at EFW sites for Visitor Centres or viewing areas to accommodate field trips by schools, institutions or community groups

### **Key Implementing Agencies and Partners**

- Ministry of Energy and Mining
- Petroleum Corporation of Jamaica
- Office of the Prime Minister

- National Environment and Planning Agency
- National Solid Waste Management Authority
- Ministry of Health
- Ministry of Transport and Works
- Ministry of Agriculture
- Training institutions (MIND, HEART, etc.)
- Universities and research institutions



### Goal 3

#### **Jamaica creates partnerships between the energy sector and the waste management and agriculture sectors to facilitate the continuous streams of waste into the energy from waste**

Achievement of this goal will generate the maximum amount of energy from agricultural and municipal solid wastes. Strategies will be implemented to maximize the use of solid waste that cannot be reused or recycled which also will reduce the volume of solid waste that is disposed of in landfills or dumps. This goal addresses the linkages between the energy and solid waste management and agriculture sectors, to facilitate the accomplishment of important goals in all three sectors: diversification of energy sources and better management of the country's waste.

#### **Outcomes**

**Outcome 1:** Volume of solid waste being transported to and disposed of in landfills minimized, thereby resulting in less air, ground and surface water pollution as well as reduced greenhouse gas emissions

**Outcome 2:** All unavoidable municipal solid waste residues used to generate energy, thereby reducing the demand for imported petroleum

**Outcome 3:** Maximization of agricultural wastes used to generate energy, thereby reducing the demand for imported petroleum

#### **Key Issues Addressed**

- Conflict between energy-from-waste and solid waste minimization
- Waste separation at source

#### **Strategies and Actions for Goal 3**

- Develop memoranda of understanding and other collaborative agreements between key stakeholders in the energy sector and other sectors such as agriculture, solid waste management, wastewater treatment, local government and transport in order to maximize the use of waste products to generate energy and to utilize the energy produced from waste.
- Create systems to collect wastes to be used in energy-from-waste facilities. These wastes will include usable municipal solid waste (MSW), bagasse, animal wastes, used oils, and sewage sludge.

- Work with NSWMA in the design waste intake and sorting processes that will allow for reusable and recyclable materials to be transferred to the NSWMA and non-recyclable materials to be transferred to EFW facilities
- Create collection systems to facilitate transport of solid wastes to waste-to-energy facilities
- In collaboration with NSWMA, establish a system that includes licensing and zoning for residents to sort and collect waste from disposal sites
- Within the national integrated waste management framework, implement incentives to encourage the employment of the 3Rs as an alternative to reduce the use of landfilling
- Encourage energy recovery as an alternative to landfilling but not at the expense of recycling and composting
- Create teams of representatives of the energy and waste management sectors, involving both the public and private sectors, to develop an understanding of the appropriate application of energy recovery including integration of recovery with recycling facilities
- Create a strategy under the integrated waste management framework to use waste as a resource for energy generation

### Key Implementing Agencies and Partners

- Ministry of Energy and Mining
- National Solid Waste Management Authority
- Petroleum Corporation of Jamaica (Centre of Excellence for Renewable Energy)
- Office of the Prime Minister
- National Environment and Planning Agency
- Local planning authorities
- Scientific Research Council

## Goal 4

### **Jamaica has a well-defined governance, institutional, legal and regulatory framework for the generation of energy from waste**

Achievement of this goal will result in a coherent policy and regulatory framework that will enable the development of diverse energy-from-waste technologies and the incorporation of EFW initiatives within the relevant components of the national energy system such as the electricity grid and transportation fuel distribution. This goal will focus also on ensuring that the institutions with responsibility for guiding this sector have the requisite capacity and protocols.

## Outcomes

**Outcome 1:** National policies that support the smooth development and sustainability of the Energy-from-Waste sector

**Outcome 2:** Linkages between all energy policies clarified and the benefits to be derived from aligning the policies realized

**Outcome 3:** National and local institutions operating in collaboration to govern issues related to energy, solid waste management and finance

**Outcome 4:** Clear rules guiding the public and private sectors in implementing energy-from-waste initiatives

## Key Issue Addressed

- Legislative and policy inconsistencies
- Legal
- Coherent legal framework for energy management
- Financing and tipping fees

## Strategies and Actions for Goal 4

- Assist with the revision of the National Solid Waste Management Policy to minimize the volume of solid waste that is disposed of in landfills by committing to energy-from-waste and including energy-from-waste in the waste management hierarchy – below the 3Rs (Reduce, Reuse, Recycle) and above Disposal in Landfills
- Assist with the revision of the National Transport Policy to include provisions for waste-derived fuels

- Assist with the revision of the National Agriculture Policy to ensure the maximum use of bagasse to generate energy and to expand the use of animal wastes as a source of energy
- Establish protocols for government agencies and the private sector to implement energy-from-waste initiatives
- Implement tax policies designed to encourage the development of energy-from-waste initiatives and the involvement of the private sector
- Develop standards and regulations that govern specific aspects of the energy-from-waste sector, including the importation of feedstock materials and sale of EFW electricity to the national grid
- Build monitoring and enforcement capacity in key agencies (for example, NEPA and the Bureau of Standards) to be able to assess effective performance of EFW facilities
- Establish tipping fee structures and rates at authorized disposal sites, for the disposal of waste that will be included in the energy-from-waste sector
- Establish partnerships with NEPA and the Ministry of Health to determine arrangements to ensure protection of human health and the environment

### **Key Implementing Agencies and Partners**

- Ministry of Energy and Mining
- National Solid Waste Management Authority
- Ministry of Transport and Works
- Ministry of Agriculture
- Office of Utilities Regulation
- Jamaica Public Service Company Ltd
- Office of the Prime Minister
- Ministry of Finance and the Public Service
- Ministry of Justice/Chief Parliamentary Council
- Bureau of Standards, Jamaica
- National Environment and Planning Agency
- Scientific Research Council
- National Environment and Planning Agency
- Ministry of Health

# Section 3

## Implementation, Monitoring and Evaluation Framework

# Policy Implementation

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The Ministry of Energy and Mining will lead and facilitate the implementation of the Energy-from-Waste Policy, in collaboration with other Government Departments and Agencies, the private sector and NGOs. The successful implementation of this policy will require that linkages be made between the energy and waste management sectors as well as other aspects of the economy and society including, but not limited to, agriculture, transport, environment, finance and education.

## Institutional Framework

The key players in the implementation of the National Energy-from-Waste Policy and their roles and responsibilities are described below.

The **Ministry of Energy and Mining** will be responsible for the overall implementation of the Energy-from-Waste Policy and will provide expert advice and guidance with respect to all energy-from-waste initiatives. The **Petroleum Corporation of Jamaica (PCJ)**, which is an agency of the Ministry, and its **Centre of Excellence for Renewable Energy (CERE)** will be involved in facilitating the implementation of energy-from-waste initiatives.

The **Office of the Prime Minister (Department of Local Government)** has portfolio responsibility for solid waste management, and will have responsibility for the development and implementation of waste-to-energy initiatives, including economic performance. The **National Solid Waste Management Authority (NSWMA)**, within the Department of Local Government, has management responsibility for solid waste island-wide. The Authority has responsibility for establishing sector standards and performance criteria and licensing solid waste companies, solid waste collection vehicles and disposal site operators. The focus of the Authority is to provide management while the private sector will be encouraged to carry out the operations that include collection, transportation and disposal. With regard to generation of energy from solid waste, the NSWMA will be responsible for providing the required supply of wastes to the processing facilities and for monitoring operational activities at these plants.

The **Office of the Prime Minister (Environmental Management Division)** will provide expert advice and guidance on the environmental impacts of all energy-from-waste programmes. Also, the Division will facilitate proposals for consideration of projects to benefit from the Clean Development Mechanism.

The **National Environment and Planning Agency (NEPA)**, an Executive Agency under the Office of the Prime Minister, will have the responsibility of ensuring that energy-from-waste facilities operate in such a way that human health and the environment are protected from harmful emissions. Also, NEPA will be responsible for the issuance of the relevant permits for the establishment of EFW facilities. In carrying out its role, the Agency will continuously assess plant operations and their environmental performance for example by routinely checking emissions of EFW plants. NEPA will be responsible for taking appropriate monitoring and enforcement actions or prosecuting an operator if there is a breach.

**Local planning authorities** will have a fundamental role in ensuring that the goals of this policy are met. They will be part of the permitting process for EFW plants and will play a role in deciding on the characteristics of these facilities, for example, where the facilities will be built and their size and capacity. Also, local authorities will have a voice in decisions related to the utilization of property taxes to support energy-from-waste facilities.

**JAMPRO (Jamaica Trade & Invest)** will be responsible for implementing incentives and facilitating the growth of investment in the energy-from-waste sector.

The **Office of Utilities Regulation (OUR)** will have oversight responsibility for the regulatory framework guiding energy-from-waste initiatives. That office will protect the interest of both the consumer and investor in the provision and utilization of public utility services. The OUR will work with the **Jamaica Public Service Company (JPSCo)** to create power purchase agreements (PPA) arrangements with EFW facilities to sell electricity to the national grid.

The **Ministry of Agriculture** is responsible for the management of agricultural wastes such as bagasse and will ensure the generation of energy from these wastes.

The **National Water Commission** is responsible for management of sewage sludge and will assume a lead role in the analysis of options to utilize sludge to generate energy.

The **Ministry of Finance and the Public Service** will be responsible for establishing any financial or tax incentives or disincentives for the development of the EFW sector, and for any consideration of the utilization of the environmental levy in support of energy-from-waste facilities.

**The Ministry of Health** will work closely with the National Environment and Planning Agency (NEPA) to determine potential health impacts of EFW plants based on emissions standards and guidelines set by NEPA.

**The Ministry of Investment and JAMPRO** will be responsible for promoting the development of the energy-from-waste sector, particularly within the private sector.

**Local universities** will play a key role in keeping abreast of research in energy-from-waste technologies and the linkages between EFW facilities and impact on human health and the environment, and thus ensuring environmental sustainability.

## **Implementation Framework/ Action Plan for Energy-from-Waste 2010 - 2012**

For each goal outlined in the Energy-from-Waste Policy 2010 - 2030, priority projects/initiatives will be developed and implemented towards contributing to the achievement of the goals. The priority actions for 2010-2012 are presented below.

The strategies identified in the Strategic Framework will be operationalized by the associated implementing agencies and partners through the incorporation of specific actions in the Strategic and Operational Plans of these entities. These plans will provide detailed information on specific actions to be undertaken, the implementing agencies and partners, timelines and costs.

### **Priority Actions for the Energy-from-Waste Sector 2010-2012**

<b>Priority Action</b>	<b>Responsible Entities</b>
Infuse energy issues into national spatial plan to address issues related to the siting of EFW facilities	MEM, NLA
Develop memoranda of understanding and other collaborative agreements between key stakeholders in the energy sector and other sectors such as agriculture, solid waste management, wastewater treatment, local government and transport in order to maximize the use of waste products to generate energy and to utilize the energy produced from waste	MEM, MOA, SRC, NSWMA, OPM, NWC, MTW
Align EFW initiatives with the Clean Development Mechanism (CDM) to facilitate the sale of carbon credits	MEM, OPM (EMD)
Develop a research agenda that would facilitate conducting research to analyze different EFW options – in terms of waste type and technologies – within the Jamaican context	MEM, PCJ, CERE, SRC, UTech, UWI
Undertake research to determine options available at small scale for EFW initiatives in rural parishes and other areas	MEM, SRC
Conduct a feasibility study for producing fuel from wastewater sludge on a national level	MEM, NWC, SRC
Assist with the revision of the National Solid Waste Management Policy to minimize the volume of solid waste that is disposed of in landfills by committing to energy-from-waste and including energy-from-waste in the waste management hierarchy – below the 3Rs (Reduce, Reuse, Recycle) and above Disposal in Landfills	MEM, NSWMA, OPM (LGD)



Assist with the revision of the National Transport Policy to include provisions for waste-derived fuels	MEM, MTW, PCJ
Assist with the revision of the National Agriculture Policy to ensure the maximum use of bagasse to generate energy and to expand the use of animal wastes as a source of energy	MEM, MOA, SIRI
Establish partnerships with NEPA and the Ministry of Health to determine arrangements to ensure protection of human health and the environment	MEM, NEPA, MOH

# Monitoring and Evaluation Framework

The Ministry of Energy and Mining will be accountable for monitoring and evaluating the implementation of this Policy. The proposed indicators outlined in this policy represent the foundation of a results-based monitoring and evaluation system to ensure that the four goals of this policy are achieved which will, in turn, contribute to the achievement of the related goals as set out in the National Energy Policy 2009-2030 and Vision 2030 Jamaica, National Development Plan.

A continuous programme for monitoring and evaluation, conducted by relevant stakeholders from public and private sectors, will be implemented. The Ministry of Energy and Mining will conduct broad stakeholder consultations periodically to review and assess the effectiveness of the Policy using the indicators identified below as a guide. The results of the assessment including recommendations will be published in an annual report for submission to the Cabinet.

## Proposed Indicators

The proposed indicators for the National Energy-from-Waste Policy over the period 2010-2030 are presented in Table 6. These indicators are the building blocks of the Monitoring and Evaluation programme. Targets will be set in collaboration with the key implementation partners.

**Table 6. Energy-from-Waste Indicators and Targets**

Indicator	Baseline	Targets		
	2010	2012	2015	2030
Percentage of energy from renewable energy sources generated from EFW initiatives				
GWh of electricity generated from EFW facilities				
Percentage of workforce employed in EFW sector				
Number of new EFW projects				
Volume of solid waste disposed of in dumpsites				
Area of land used by dumpsites				
Volume of feedstock material imported for EFW sector				

# Appendices

# Appendix I

## Glossary

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### *3Rs*

Reduce, Reuse, Recycle – the top three goals in the solid waste management hierarchy.

### *Biofuels*

Biofuels are renewable fuels made from biomass (plants or animal wastes). They can be used to supplement or replace the fossil fuels petroleum and diesel used for transport. The two main biofuels created from plants are ethanol and biodiesel. Ethanol is produced from the fermentation of sugar or starch in crops such as corn and sugar cane. Biodiesel is made from vegetable oils in crops such as soybean, or from animal fats. Depending on the processes used to make biofuels, greenhouse emissions from cars and fuel-powered machinery can be substantially reduced by their use.

### *Calorific value*

The heat per unit mass produced by complete combustion of a given substance. Calorific values are used to express the energy values of fuels; usually these are expressed in megajoules per kilogram (MJ/kg).

### *Carbon footprint*

The global warming impact of human activities in terms of the amount of greenhouse gases they produce. The emissions associated with the use of power, transport, food and other consumption for an individual, family or organisation are added up to give one comparable measure in units of carbon dioxide equivalent.

### *Carbon neutral*

An individual, household or organisation that is responsible for no net emissions of greenhouse gases from all its activities is considered "carbon neutral". Emissions must be cut to a minimum and any necessary emissions then offset by emission reducing activities elsewhere. Buying accredited clean electricity helps cut household or office greenhouse emissions, while investing in sustainable energy projects or afforestation schemes are examples of offsets.

### *Clean Development Mechanism (CDM)*

A Kyoto Protocol initiative under which projects set up in developing countries to reduce greenhouse gas emissions generate tradable credits called CERs, the first step towards a global carbon market. These credits can be used by industrialized nations to offset carbon emissions at home and meet their Kyoto reduction targets. The projects include renewable energy generation, reforestation and clean fuels switching.

*Disposal site*

Solid waste disposal site that has little or no management, unregulated tipping and no environmental controls, infrequent or no covering of waste

*Energy-from-waste (EFW)*

Energy-from-waste encompasses all technologies and systems that produce energy from waste products and includes waste-to-energy (see below).

*Greenhouse Gas (GHG)*

Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapour, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), ozone (O<sub>3</sub>), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>).

*Kyoto Protocol*

The agreement reached in Kyoto in 1997 committing developed countries and countries making the transition to a market economy to achieve quantified targets for decreasing their emissions of greenhouse gases.

*Landfill*

Solid waste disposal site that is managed, it has designated cells for tipping and regular covering of waste.

*Landfill gas*

All gases generated from the landfilled waste

*Municipal solid waste*

Household waste and commercial waste that can be collected at curbside.

*Residual waste*

See unavoidable residual waste.

*Sanitary landfill*

Solid waste disposal site with leachate controls, gas controls, designated cells for tipping and daily covering of waste.

*Tipping fees*

Sum of money paid to the operator of a disposal facility that goes towards operating and maintaining the facility.

*Unavoidable residual waste*

All solid waste that remains after efforts to reduce, reuse and recycle; this waste would normally be disposed of in a landfill

*UNFCCC*

United Nations Framework Convention on Climate Change. Also referred to informally as the UN climate change convention. It is the international agreement for action on climate change and was drawn up in 1992. A framework was agreed for action aimed at stabilizing atmospheric concentrations of greenhouse gases. The UNFCCC entered into force on March 1994 and currently has 192 signatory parties. The UNFCCC in turn agreed the Kyoto Protocol in 1997 to implement emission reductions in industrialized countries up to 2012 and is currently seeking the negotiation of a new treaty to extend commitments beyond 2012.

*Waste-to-energy (WTE)*

Combustion of municipal solid waste at high temperatures in facilities to recover energy for the generation of electricity

## Appendix II

# Economic Viability Analysis of Waste-to-Energy at Riverton City

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In 1995-6, a feasibility analysis was conducted by Dr. Mohini Kiswani for the use of waste at Riverton City to generate energy using an estimated amount of waste of 300 tonnes (300 truck loads) per day or 109,500 tonnes per year. The combustible waste stream deposited at Riverton includes: plastics, wood, garden waste, trees, paper, textiles, and food. Table A-1 shows the heating values of the components of the waste deposited at Riverton based on a sample of 312 tonnes (approximately 85% of the total waste deposited).

**Table A-1. Heating values of Residential Waste Disposed – Riverton City**

Items	Lower End (MJ/kg)	Quantity Disposed per day (kg)	Total Heating Values (MJ per day)
Plastic	22.7	44,020	999,254
Wood/Board	15.0	36,684	550,260
Garden Waste, Trees	4.8	110,051	528,245
Paper/Cardboard	12.2	40,352	492,294
Textiles	16.1	29,347	472,487
Food	4.12	51,357	211,591
<b>Total</b>		<b>311,811</b>	<b>3,254,131</b>

*Source: Presentation by M. Kiswani, PhD to the EFW PWG on May 26, 2010*

The study reported that the heating value of residential waste disposed at the site was 3,254,131 MJ per day. The total residential waste disposed was 366,837kg per day; therefore, the average calorific value was 8.87 MJ per kg per day. The requirements for combustion is that the waste have a minimum calorific value of 5 MJ per kg; the moisture content of waste should be less than 50%; and the combustible portion of the waste should not be less than 50%. Based on the analysis, heat for recovery through incineration of municipal waste at Riverton City seems feasible. The annual energy generation for 109,500 tonnes is estimated to



be 269,698 MWh, with a thermal efficiency of about 25%. The energy output is 67,500 MWh with about 9 MW available for export to the national grid.

Potential NSWMA plans for diverting garden and food waste into composting initiatives will reduce the volume of waste being deposited at the disposal site. However, Table 4 shows that these components, although constituting a large volume, have the lowest calorific content and therefore contribute comparatively less than the other waste stream components such as plastic. Also, given the volume of garden and food waste generated in Jamaica, composting initiatives would not likely be able to use all this organic waste, some of which would still end up at disposal sites such as Riverton. Therefore, the energy-generating potential of Riverton, after a composting initiative has been established, would be less but still viable.

### ***Capital Investment***

The estimated total capital investment cost per tonne of a waste-to-energy treatment plant to is approximately US\$15 per tonne, excluding the cost of land and associated office, waste storage, visitor's centre and road/parking network. PCI's CERE's assessment of the total capital investment cost per tonne for thermal treatment is estimated to be between US\$25 – US\$30 per tonne, including costs for land, office, storage, visitor's centre and road/parking network.

### ***Operating Costs***

Waste-to-energy plants incur annual costs for energy consumed on site, labour, water, maintenance and spares and depreciation. About eighty percent (80%) of these costs relate to loan repayment costs for the direct capital investment and utilities. Hence projects are financed based on bankable long-term power purchase agreements and waste supply agreements with cost-effective and sustainable tipping fees. The estimated annual operating cost for thermal treatment is between US\$80 – US\$100 per tonne.

Capital expenditure and annual operating and maintenance costs for waste to energy treatment and disposal may be financed through revenues from long-term agreements for electrical energy sales, environmental levies, a portion of tipping fees and property taxes as well as direct foreign investment incentives.

### ***Electrical Energy Sales***

The Jamaica Public Service Company Limited (JPS) has the exclusive rights to transmit, distribute and supply electricity throughout Jamaica, for a twenty (20) year period, based on the All Island Electricity License (2001). Renewable electricity generation has the potential to reduce the current retail cost of electricity.



The annualized value of electrical energy sales for a 300 tonne-per-day process drive delivering 67,500 MWh and 9 MW of base load electricity to the grid at varied avoided costs is shown below:

**Table A-2. Potential Future Electricity Sales Using a Range of Avoided Costs**

Energy, Capacity & Premium (US¢/kWh)	12.05	13.05	14.05	15.05
Sales by Waste-to-Energy Plant (300 tonnes per day)	US\$8.13 M	US\$8.80 M	US\$9.48 M	US\$10.15 M
Revenue in US\$/tonne	US\$74	US\$80	US\$87	US\$93

Source: PCJ's CERE (2010)

The economic viability for a 300 tonne per day waste-to-energy plant is summarized in Table 6 below to indicate the potential for improving environmental conditions, while supporting energy diversification and security. The traditional financing options may be used to support such foreign direct investments; however the underlying issues of affordability and collectability of revenues must be worked out by the relevant local government authorities.

The Riverton City disposal site has the potential for several 300 tonne per day process drives, or larger equipment that may derive greater economies of scale. The conversion of the disposal site into a world class waste-to-energy facility will require extensive design and development works, which are focused on population growth trends, land use policy, transportation logistics and the increasing diversity of wastes.

**Table A-3. Economic Viability for a 300 tonne per day Process**

Category	Waste Quantity, Estimated Revenues & Costs
Annual waste to be incinerated (tonnes per year)	109,500
Annual Operating Cost	US\$ 11.63 Million
- Annual Energy Sales to the Grid (@US12.05 ¢/kWh)	US\$ 8.13 Million
- Annual Tipping Fee (@ US\$75 per tonne)	US\$ 8.21 Million
Net Profit/Loss	US\$ 4.71 Million
<b>Indirect Benefits</b>	
Value of Oil Import Reductions	US\$ 6.40 Million
Value of CO <sub>2</sub> Emission Trade	US\$ 1.91 Million
Overall Direct & Indirect Benefits (Annual)	US\$ 8.31 Million

Source: PCJ's CERE July 2010

## Appendix III

# Members of the Energy-from-Waste Policy Working Group

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<b>Mr. Oral Rainford (Chair)</b>	Ministry of Energy and Mining
<b>Mr. Wayne Robertson</b>	Office of the Prime Minister (Department of Local Government)
<b>Mr. Adrian-Charles Stewart</b>	Ministry of Agriculture
<b>Mr. Bradshaw Issacs</b>	Ministry of Health
<b>Mr. William Broughton</b>	Ministry of Health
<b>Mr. Charles Lewis</b>	Ministry of Health
<b>Ms Shernette Sampson</b>	Ministry of Transport & Works
<b>Ms Monifa Blake</b>	Ministry of Transport & Works
<b>Mr. Gary Campbell</b>	National Environment & Planning Agency
<b>Mr. Vivian Blake</b>	National Environment & Planning Agency
<b>Mrs. Paulette Kolbusch</b>	National Environment & Planning Agency
<b>Dr. Andrina Standhope</b>	National Solid Waste Management Authority
<b>Mr. Garfield Murray</b>	National Solid Waste Management Authority
<b>Ms Gillian Guthrie</b>	Office of the Prime Minister (Environmental Management Division)
<b>Miss Leonie Barnaby</b>	Office of the Prime Minister (Environmental Management Division)
<b>Mr. Rollin Alveranga</b>	Office of the Prime Minister (Environmental Management Division)
<b>Dr. Mohini Kiswani</b>	Office of the Prime Minister (Land Administration and Management Division)
<b>Mrs. Paula Robinson-Russell</b>	Office of the Prime Minister (Department of Local Government)
<b>Ms. Simone Walker</b>	Office of the Prime Minister (Department of Local Government)
<b>Mr. Hopeton Heron</b>	Office of Utilities Regulation
<b>Mr. Richard Brown</b>	Office of Utilities Regulation
<b>Mr. Courtney Francis</b>	Office of Utilities Regulation
<b>Mr. Andrew Wilson</b>	Petroleum Corporation of Jamaica
<b>Mrs. Denise Tulloch</b>	Petroleum Corporation of Jamaica – Centre of Excellence for Renewable Energy
<b>Mrs. Allison Richards</b>	Planning Institute of Jamaica
<b>Mr. Conroy Watson</b>	Ministry of Energy and Mining
<b>Ms. Julia Brown</b>	Scientific Research Council

## Appendix III

# Examples of International Energy-from-Waste Initiatives

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**Japan and China** built several plants that were based on direct smelting or on fluid bed combustion of solid waste. In China, there are about fifty (50) waste-to-energy plants. Japan is the largest user in thermal treatment of municipal solid waste in the world with forty (40) million tonnes. Some of the newest plants use stoker technology and others use the advanced oxygen enrichment technology. There are also over one hundred (100) thermal treatment plants using relatively novel processes such as direct smelting, the Ebara fluidization process and the Thermo-select-JFE gasification and melting technology process.

The East Bay Municipal Water District, which provides water to a portion of the **San Francisco Bay Area**, has launched a food-waste-to-energy-and-compost programme at its wastewater treatment plant. Food collected from restaurants and grocery stores is digested by bacteria that emit methane as a by-product. The emitted methane is collected and used to generate electricity that helps run the treatment plant. The material that remains is then sent to a green-waste composting facility to be turned into fertilizer.

Countries such as **Germany** and **Japan** have created independent bio-energy towns utilizing sewage sludge, food waste, livestock manure and forest, agricultural by-products. In **Spain**, a group of Spanish developers developed a biochemical process to convert solid waste into biodiesel. The **USA** utilizes the “Mass Burning” method. In this process, burning waste converts water to steam to drive a turbine connected to an electricity generator.

From 1 January 1997, **Denmark** stopped landfilling waste suitable for incineration. This led to an extensive increase in the incineration capacity at the end of the 1990s and in early 2000. Since 2001 all waste suitable for incineration is being incinerated at waste incineration plants where energy production is exploited. Since waste generation varies, limited waste volumes may however be temporarily landfilled for later incineration. In 2007 about 3.7 million tonnes of waste was incinerated at a total of 29 waste incineration plants in Denmark. The incineration capacity of the plants varies between 12,000 tonnes and 520,000 tonnes of waste each year.