

# WASTE MANAGEMENT

Waste as a source of energy



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COVER PHOTO: Waste piles to be used as resource

ENVIRONMENT AGENCY - ABU DHABI

Call us: +971 2 4454777

E-mail us: [customerservice@ead.ae](mailto:customerservice@ead.ae)

Know more about us: <http://www.ead.ae>



*Mixed waste dumped in western region*

# CONTENTS

<b>THE CHALLENGES</b>	4
Waste generation has increased by 19.9% from 2009 to 2013	4
68.8% of total waste is disposed without proper utilisation	5
<b>THE OPPORTUNITIES</b>	6
Our target: to divert more than 85% of waste from landfills	6
Waste as a renewable energy source from global perspective	7
Different techniques in generating power from waste	7
What does it mean for Abu Dhabi?	8
Optimising material flow in the conversion of waste to energy	8
Economic and environmental benefits of using non-recyclable waste as an energy source	9
<b>THE ISSUES TO BE ADDRESSED IN USING NON-RECYCLABLE WASTE AS AN ENERGY SOURCE</b>	10
Cost and revenues of energy-from-waste	10
Strengthening the regulatory framework to support the use of non-recyclable waste as a source of energy	12
Factors to support energy-from-non-recyclable waste	12

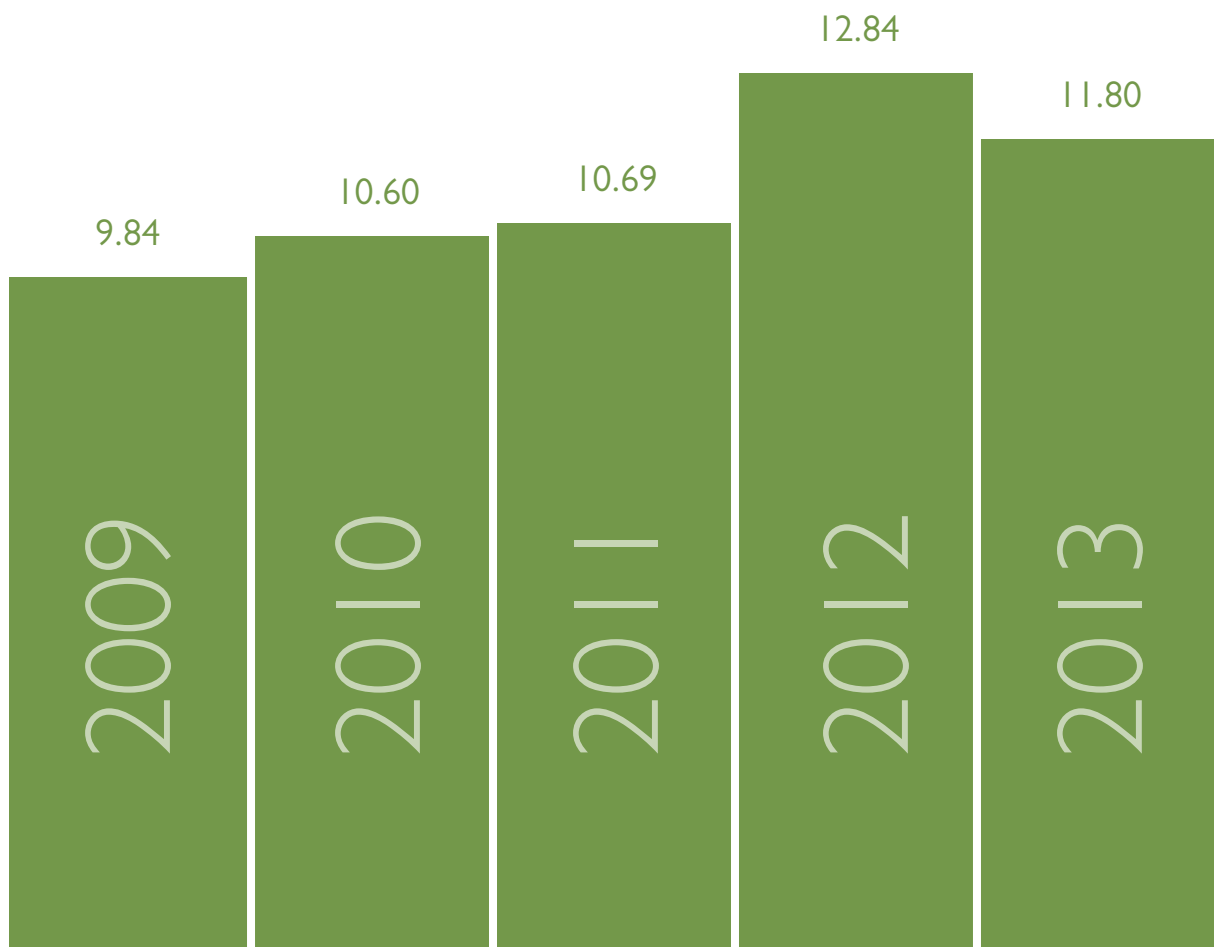
## Waste generation has increased by 19.9% from 2009 to 2013

In 2013, 11.8 million tonnes of non-hazardous solid waste was generated in Abu Dhabi, not including waste that was generated and discarded illegally. Out of the 2013 total, 27% was recycled, 3.9% was composted and 68.8% was sent to landfills or dump-sites.

Waste generation is an inevitable result of any society's urbanisation, development, industrialisation and population growth – and Abu Dhabi is no exception. But these increasing quantities, and the inappropriate disposal of waste, obviously have an adverse impact on the environment. The 2013 figure actually represents a slight reduction on the preceding year, but is still

unacceptably high. And there is enormous potential, as yet unexplored, for reusing, recycling and recovering resources – especially energy – from waste.

Waste Generation in Abu Dhabi (in millions of tonnes)



## 68.8% of total waste is disposed without proper utilisation

The most environmentally and economically efficient way to manage waste is to eliminate as much of it as possible at source. To make this a reality, there is a need for a paradigm shift in our approach to waste management. Most importantly, a culture of sustainable consumption needs to be developed.

Waste will, of course, continue to be generated; in any urban society, it is inevitable. But in Abu Dhabi we need to start thinking of waste as an utilisable resource. We can achieve this by adopting a 'life cycle' approach, which promotes circular economy over the 'waste hierarchy' principle.

With the life cycle approach, we see that waste which cannot be reused or recycled may still have the potential for resource recovery. For instance, we can extract organic fertiliser from animal waste, compost from green and organic waste, as well as biogas and biofuel from other forms of waste.

Using non-recyclable waste – also known as residual waste - as a source of energy will entail a revision of priorities and a working partnership between the energy, waste management and environment sectors. But it would prove to be a highly worthwhile exercise, bringing direct benefits and extra revenues to all those sectors and helping to meet the Abu Dhabi government's targets.

It will help to increase the share of renewables in the energy mix, which is a high priority for Abu Dhabi. It can also contribute to the achievement of Abu Dhabi's ambitious targets in optimising material flow and diverting waste from landfills.

In line with international practices, energy generation from non-recyclable waste is now considered a key component in any integrated waste management system. However, the need for collaboration between all related stakeholders on waste generation, management and regulation cannot be overemphasised.



*Al Ain Sanitary Landfill*

## Our target: to divert more than 85% of waste from landfills

The Abu Dhabi Environment Policy Agenda (ADEPA) and the Waste Management Strategy for the Emirate of Abu Dhabi both aim to reduce domestic waste generation and divert more than 85% of waste streams from dump-sites to more appropriate, environmentally sound treatment or disposal alternatives.

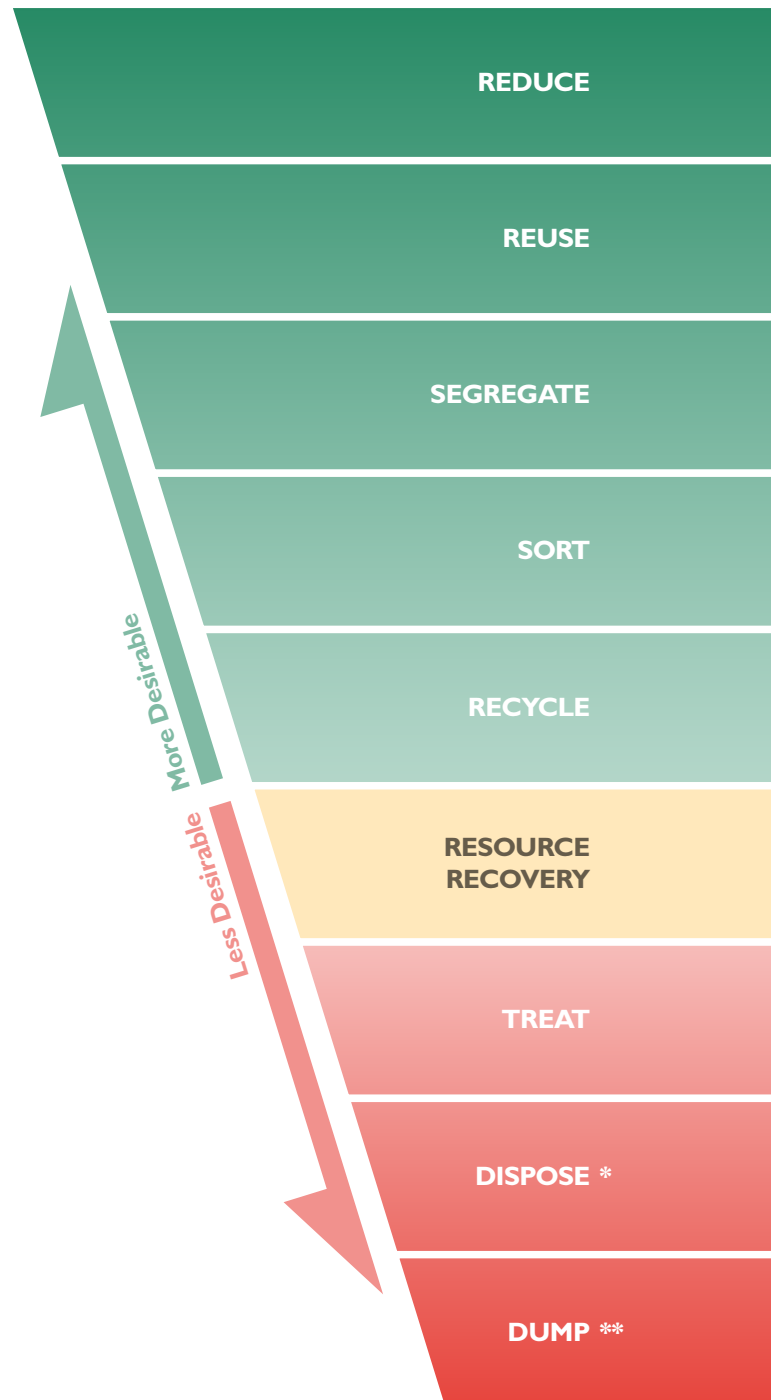
We also aim to increase the volume of energy and heat generated from residual waste by 0.5% of Abu Dhabi's total energy output and to dispose 100% of landfilled waste in sanitary engineered landfills. A number of initiatives have been introduced to achieve these goals.

Here are the guiding principles behind our waste management policy:

- Avoid waste generation and reduce it as much as possible
- Maximise the reuse of material
- Recycle valuable waste components
- Recover high value components and materials that cannot be recycled. This includes the utilisation of non-recyclable waste as a source of energy
- Improve treatment of materials and waste that cannot be utilised
- Provide sanitary engineered landfill sites for residues that cannot be recycled or recovered.

Resource recovery, including energy generation, is an important stage in this hierarchy. It must take place before disposal and landfilling are considered as options. Without it, achieving the target of diverting 85% of Abu Dhabi's waste from landfills will be difficult.

### WASTE HIERARCHY



\* Sanitary landfill  
\*\* Controlled dump

## Waste as a renewable energy source from global perspective

### Different techniques in generating power from waste

The concept of using waste as a source of energy involves taking valuable material from waste streams and turning it into usable forms of energy, such as electricity and heat. This concept also includes the production of materials that can be used as sources of energy, such as diesel, coal and natural gas.

While waste incineration to produce energy is a common and well known technique, other techniques are available and have been tested internationally. Different types of waste can be utilised within these techniques, such as municipal waste, industrial and commercial waste, some forms of construction and demolition waste, sewage sludge, agriculture and animal waste.

#### **Generating power through waste incineration**

In this technology, municipal waste can be directly combusted in incinerators at 850-1200 °C. The heat from this process is used to turn water into steam, which in turn runs a steam-turbine generator to produce electricity. Waste incinerators need to incorporate air pollution control systems, and the correct treatment of ash or other pollutants captured in the process must be carefully considered.

#### **Generating power through pyrolysis and thermal gasification**

Pyrolysis is a process that uses heat to decompose or break down organic materials in the absence of oxygen or with limited amounts of it. It produces a mixture of combustible gases, mainly methane, complex hydrocarbons, hydrogen, and carbon monoxide, along with liquids and solid residues. Low temperature pyrolysis can also be used to produce a synthetic diesel fuel from plastic waste. A beneficial by-product of pyrolysis is biochar, a kind of charcoal which can be used as a fertiliser.

#### **Generating power through anaerobic digestion**

Anaerobic digestion is a process that produces biogas by placing organic waste and various types of bacteria in an airtight container called a digester. The bacteria feed on the waste to produce a mix of methane and carbon dioxide. The process is appropriate for wet organic waste such as food waste, sewage sludge and agricultural residues.

#### **Generating power through refuse derived fuel**

Refuse derived fuel (RDF) is produced by either shredding solid waste or sterilising it with steam pressure in a process known as autoclaving. The materials to be treated, such as plastics and biodegradable waste, are taken from solid waste streams. Municipal waste needs to be first sifted to remove glass, metals and other materials that are not combustible, many of which can then be recycled. Autoclaving causes plastics to soften and flatten, paper and other fibrous material to disintegrate. These processes reduce the volume of the waste by up to 60%. The residual material can then be compressed into pellets or bricks and sold as solid fuel.

## What does it mean for Abu Dhabi?

Internationally, the current best practice for recycling rates is between 50% to 60% of total waste produced. This leaves 40% to 50% that is not recycled but still needs to be managed in a way to protect human health and the environment, and where possible used to promote a benefit such as energy recovery. The Abu Dhabi Environment Policy Agenda and the Waste Management Strategy have both emphasised the need to develop energy-recovery-from-waste schemes. They represent a practical means to achieve Abu Dhabi's targets to divert the maximum amount of waste from landfills,

reduce the environmental impact of landfills, optimise material flow and create real value from waste.

Abu Dhabi has the opportunity to implement policies that stimulate and intensify the use of waste as an energy source, to promote efforts to study available alternatives and techniques based on global best practices, and to define the options that can be applied. Tadweer - the Center of Waste Management, is developing a waste master plan for the Emirate of Abu Dhabi, which aims to investigate all the options and their management.

## Optimising material flow in the conversion of waste to energy

The waste dumped in landfills contains a mixture of organic and inorganic materials. Over time, the organic materials degrade to generate harmful emissions and leachate. According to the Greenhouse Gas Emission Inventory Report for Abu Dhabi, issued by EAD in 2012, an estimated 6.9% of total greenhouse gas emissions come from the waste sector. Moreover, organic waste such as non-recyclable plastic, non-recyclable and non-reusable wood, non-recyclable rubber and textiles contain valuable calorific value that can be used as an energy source. Merely dumping these materials truly represents a missed opportunity.

When comparing the landfilling option with energy production from non-recyclable waste, it is recognised that both options produce significant quantities of greenhouse gases. But emissions from landfills consist of carbon dioxide and methane, and the effect of methane on global warming is as much as 25 times higher than the same amount of carbon dioxide. In the old and non-sanitary landfills which occupy large areas throughout the Emirate, these emissions are extremely difficult to control. On the other hand, energy production from

non-recyclable waste especially when the incineration technique is used, mainly produces carbon dioxide emissions which are easier to control and manage.

Adopting the life cycle approach, plastic that is produced from crude oil is recycled to conserve the original resource. But after a certain degree of recycling, plastic is rendered non-recyclable and landfilling this type of waste means discarding organic materials that contain high calorific value and could be converted to energy sources through a number of available techniques.

So the life cycle approach could make a significant contribution to Abu Dhabi's target of providing 7% of its total energy from renewable sources, as well as preserving the world's finite reserves of fossil fuel.





Al Ain Plastic Recycling Plant

## Economic and environmental benefits of using non-recyclable waste as an energy source

Benefits that can be achieved from producing energy from waste include:

- Production of renewable energy, with electricity and thermal energy generated from waste, providing an environmental friendly alternative
- Reduction in carbon emissions as a result of burning fossil fuels for power generation
- Reduction in landfilling by diverting waste to power generation or fuel generation plants, which contributes to saving the environment from pollution
- Reduction in dependence on fossil fuels as an energy source
- Significant reduction in the costs associated with disposal of waste in landfills. This prompts a prioritised need to review current landfill tariffs and gate fees to promote waste reduction and deter the landfilling option
- Creation of social and economic benefits by providing new job opportunities and optimising use of materials.
- Production of by-products for applications such as fertilisation and soil enhancement, using techniques such as anaerobic digestion
- Reduction in dangerous methane emissions caused by the decomposition of organic waste in landfills

## Cost and revenues of energy-from-waste

Energy from waste is a by-product. The use of waste as a source of energy is an added benefit of this type of waste disposal method. It is not a standalone energy generation alternative.

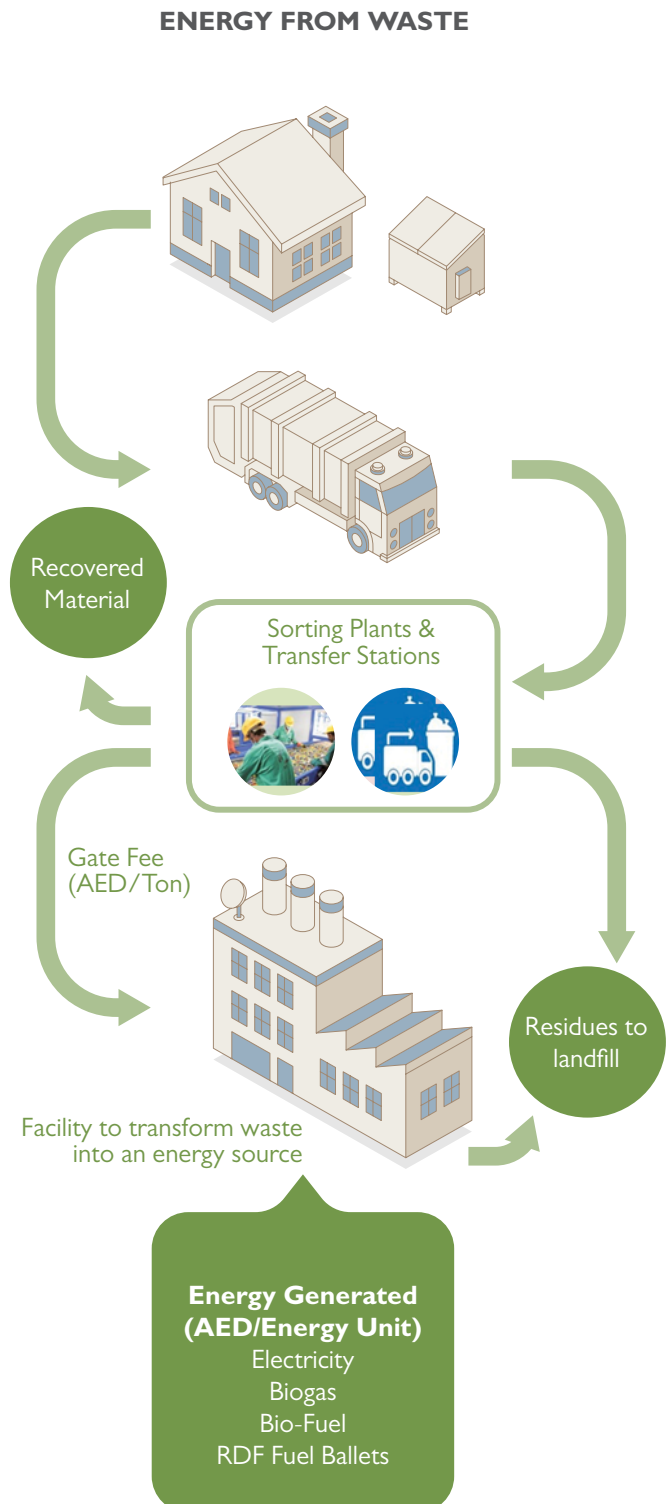
When comparing disposal alternatives, energy-from-waste, waste landfilling, or any other option, the following aspects should be considered:

- Capital and operational costs.
- Cost of environmental controls.
- Environmental mitigation costs.
- Revenues from gate fees.
- Environmental credits (in case of CO<sub>2</sub> reduction).
- Revenue from selling by-products (e.g. energy generated).

A key challenge of this principle is related to cost and funding. After collection from various sites, waste is transferred to a sorting facility and a material recovery facility to recover as much of the recyclables as possible. The remaining mixed residue is then transferred to landfills, or could be sent to an energy-from-waste facility. In determining the cost/benefit aspects of such a facility, the following financial components need to be considered:

- Construction and operating costs of the facility
- Costs of managing and handling the remaining residues
- Revenue from selling the energy or solid fuel produced
- Revenue from gate fees.

To be successful, the costs of establishing and operating the facility should at least be covered by the resulting revenues.



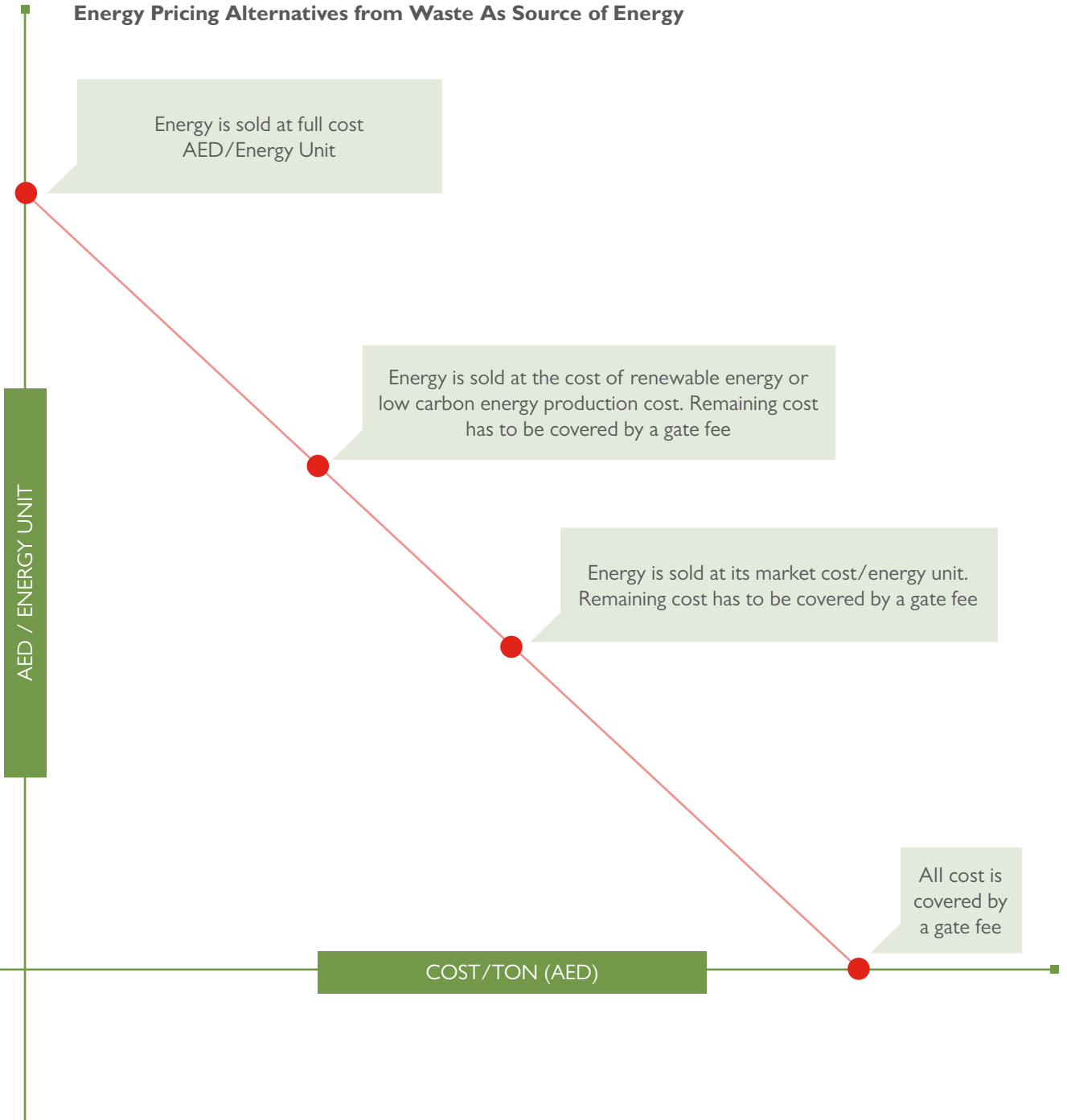
Abu Dhabi can introduce energy-from-waste to its current waste management practices without adding a financial burden to the government. This would require the introduction of a comprehensive waste tariff system to cover the costs of waste management and gate fees for related facilities.

facility is recovered by selling the energy generated to the main grid. The remaining 70% is covered by gate fees, with the company charging 70 Euros (about 350 AED) per tonne of waste. Also, the company earns additional income from selling metals that remain after combusting the waste.

In 2013, a delegation from the Emirate of Abu Dhabi visited an energy-from-waste plant in Holland, managed by a company named AEB, where incineration technology is adopted. 30% of the annual cost of this

The costs of construction and operation of the plant can be covered in a number of different ways, as shown in the illustration.

**Energy Pricing Alternatives from Waste As Source of Energy**



## Strengthening the regulatory framework to support the use of non-recyclable waste as a source of energy

A strengthening of the regulatory framework on waste management will be an essential requirement, to promote the use of waste as a source of energy. This means also an increase of waste diversion from landfills and a reduction of greenhouse gas emissions. Enforcement mechanisms also need to be developed, to control and reduce the environmental impacts of new facilities, controlling their emissions and ensuring the safe disposal of residues.

Tadweer - the Center of Waste Management is developing a plan for the Emirate of Abu Dhabi, which will review the current tariff mechanism and propose a new tariff structure.

Waste generators or 'polluters' should bear a significant degree of responsibility for the environmental impacts of their activities or products throughout their life cycle. This includes upstream impacts inherent in the selection of materials used, impacts from the production process itself, and downstream impacts from the use and disposal of products and residues. They need to be encouraged to reduce material consumption and waste generation in order to reduce cost, bearing in mind that this will ultimately bring environmental and economic benefits. The main agent of change in this respect would be a form of Extended Producer Responsibility.

## Factors to support energy-from-non-recyclable waste

A number of elements are required in order to establish viable energy-from-non-recyclable waste projects. These include:

- A practical waste classification system that helps to sort wastes by types and identifies the types that can be sent to energy production
- Selection of appropriate techniques – which may be a combination of technologies – in line with international best practices and specific local needs
- A practical waste tariff system and gate fees that can incentivise the use of non-recyclable waste as a source of energy and discourage use of landfills and dump sites
- A practical and strict waste tracking system, featuring a credible waste database that lists quantities and types of waste generated in Abu Dhabi from various sectors
- Legislation and enforcement mechanisms to control emissions and environmental impacts from energy-from-residual waste plants, helping to assure the environmental and economic sustainability of these operations.



*Waste tires dumped in western region desert*

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