

## Towards a Green Energy Revolution in Africa: Reflections on Waste-to-Energy Projects

Trynos Gumbo<sup>1</sup>

The twin processes of urbanisation and industrialisation are positively correlated with waste generation and energy consumption. Sadly, the global reliance on fossil fuels has contributed not only to new challenges of global warming, but also to price volatility and relentless depletion of finite reserves. With its very low oil reserves and heavy dependence on coal, Africa has not been spared, making the need for innovations in renewable energy more urgent than ever. Admittedly, the African continent is endowed with several renewable energy sources. This policy brief discusses experiences of converting waste to energy in Africa. The work demonstrates that currently there are very few waste-to-energy (WTE) projects on the continent. Nevertheless, there exist great opportunities to improve waste management, financial investments, technological take-up and skills sets to support the continent's green energy revolution.

### Introduction and background

The twin processes of urbanisation and industrialisation are positively correlated with not only the generation of large quantities of organic waste, but also an astronomical rise in energy consumption the world over. This is notable in African cities that continue to experience rapid population growth and incessant physical expansion in response to modernisation and globalisation processes.<sup>1</sup> The advances in production processes and improvements in consumption and standards of living also being recorded in the continent bring about new challenges, such as increased waste generation and a high demand for and consumption of energy resources.<sup>2,3</sup> Related to these formidable concerns

is the continuous depletion of non-renewable energy reserves such as coal, as well as the continuous rise and volatility of the price of oil, the currently dominant global energy resource. Such unfavourable developments specifically demand innovative strategies to generate sustainable, affordable, secure, reliable, clean and renewable electrical energy from alternative sources – such as waste.<sup>4,5</sup>

This policy brief focuses specifically on the experiences in WTE projects in a few African countries that have also adopted the appropriate technologies to generate the much-needed green energy, specifically from municipal solid waste (MSW). It goes on to discuss the prospects of establishing projects of the same nature in other African countries. Challenges that commonly

1. Dr Trynos Gumbo is a Research Specialist within the Sustainable Development and Knowledge Transfer Programme of the Africa Institute of South Africa (AISA).

**Volumes of waste rise directly with increases in population and standards of living**

confront WTE projects in African countries are also highlighted. The brief ends by proffering recommendations on the way forward as the continent steers towards a green revolution agenda.

### **Waste-generation streams**

MSW is a consequence of lifestyles in urban centres, where volumes of waste rise directly with increases in population and standards of living. With 4,3 billion people likely to be living in urban centres of the world by 2025, it is estimated that the volume of waste they generate will reach 2,2 billion tonnes.<sup>6</sup> Waste that is generated within these urban centres is basically rubbish or garbage made up mainly of food leftovers, paper, plastic, glass and metal that are thrown away, as they are commonly regarded as lacking in value. Such waste is generally categorised according to its source of generation, which ordinarily includes major streams such as households, commercial activities and markets, as well as minor contributors such as street sweepings. At source, MSW can also be separated into dry and combustible components (paper, plastics, metal and glass) and wet and non-combustible components (wood, yard and food-waste materials).

### **Waste management processes**

The maintenance of hygiene and cleanliness in urban communities involves several stages of MSW management, which range from the collection to transfer, treatment and disposal of garbage.<sup>7</sup> Traditionally, MSW has been collected and disposed of by municipal authorities as part of community sanitation responsibilities and services. The complex and integrated processes of managing MSW range from eco-design of production plants to reduce waste at source, to reusing, recycling and recovery of waste generated, as well as composting, incineration and landfilling of collected waste from various sources. Disposal at landfill sites can be done directly from sources or from temporary community collection points such as skips, bunkers, standby trailers and open lots.<sup>8</sup>

### **Waste as a source of green energy**

Energy from waste is green in the sense that the major components of MSW are plants and trees,

which are themselves renewable resources and form constituent parts of the natural ecosystem.<sup>9</sup> The energy is produced by incinerating the waste, or disposing of it in landfills and extracting gas, which is converted to electrical energy. The greenhouse gases (GHGs) that are emitted during the energy-generation process from the waste are considered to be part of the natural carbon cycle, since they would have been removed from the atmosphere during the lives of the trees and plants. Therefore there are no additional or new gases that are released into the air; instead the same gases are recycled. This is the opposite of burning fossil fuels such as coal when generating electricity, as they release carbon dioxide that would have ceased to be part of the atmosphere for several centuries.

### **A synopsis of WTE projects within the African continent**

Faced with the daunting challenges of dwindling reserves of coal, which is the common source of energy, and low oil reserves fetching high and volatile prices, some African countries have started shifting towards adopting and using renewable energy sources, thus asserting the so-called green energy revolution agenda in the continent.<sup>10</sup> Indeed, waste has lately come to be regarded as a resource in the African continent, with many countries adopting integrated management practices that emphasise recycling, reusing and recovery strategies.

### **Experiences**

A few African cities have established WTE projects, although on varying scales. A classic example is the eThekweni municipality in South Africa, which has embraced innovative technologies to convert MSW into energy since 2006, although the projects were initiated in 2002. Three projects at La Mercy, Mariannhill and Bisasar landfill sites were initiated under the Clean Development Mechanism (CDM), a brainchild of the United Nations Framework Convention for Climate Change (UNFCCC) of the Kyoto Protocol. The projects generate about 7,5 MW of electricity, which provides power to about 3 500 residents of the municipality,<sup>11</sup> generating R48 million through the selling of certified carbon credits; it is estimated to be able to generate a total of R400 million during its life.

In the municipality of Abidjan, Côte d'Ivoire, about 30 MW of electricity is generated from landfilled waste. The project was started in 2009

**Energy from waste is green in the sense that the major components of MSW are plants and trees**

in Bingerville, North of Abidjan. About 200 000 tonnes of waste are treated anaerobically, and gas is extracted from the landfills and later converted into electrical energy.

In Ghana, WTE projects have already been set up to generate about 6 MW of electricity, starting from 2014. The landfill site receives 270 000 tonnes of waste every year and it is expected to be closed by 2044. Investments by private companies will see a further 10 MW WTE project in Accra, also starting in 2014. About 1 000 tonnes of waste will be processed per day and the projects should generate US\$ 100 million in revenue per year for a period of 30 years.

Other African countries have also been generating electrical energy through incineration and cogeneration of organic waste, without landfilling. Mauritius produces about 87 MW, while Kenya generates 35 MW, Uganda produces 12 MW from waste and South Africa generates about 6 MW from either bagasse or biomass. The WTE initiatives in these African cities have gone a long way towards improving energy security, at the same time expanding and widening available choices.

### Prospects

A large corpus of literature sources has highlighted the huge potential of untapped and under-utilised renewable energy sources in the African continent.<sup>12</sup> There is great potential for increasing the generation and supply of renewable energy from waste in the African continent. First, prospects of converting waste to energy lie squarely on the positive correlation between high population concentrations in urban centres, generating huge quantities of waste, and advancements in technology and production processes that are realised as economies grow. Excitingly, millions of tonnes of waste, rich in organic content and value, are generated every year in African cities; hence they need to be properly managed and used innovatively to contribute to renewable energy production.<sup>13</sup> Moreover, climatic conditions in Africa, such as high rainfall and high temperatures, are conducive to rapid decomposition of landfilled waste.

Secondly, a number of African countries are flaring gas from landfills, biomass and bagasse, but not yet converting it into heat or electrical energy. In Dar es Salaam, Tanzania, about 202,27 kt CO<sub>2</sub>e (carbon dioxide equivalent) of landfill gas is flared every year, while in Dakar, Senegal, about 131,32 kt CO<sub>2</sub>e is also burnt every year. In South Africa a total of 237,67 kt CO<sub>2</sub>e is flared every year in Ekurhuleni municipality within the

Gauteng province, while about 188,39 kt CO<sub>2</sub>e is burnt every year in various urban centres by the EnviroServ landfill gas recovery project in the country. All these developments represent great potential for energy generation from waste; all that is needed is the acquisition of engines that convert the gas that is being flared currently into energy.

Thirdly, there have also been recent shifts in the policies and legislative instruments of various African governments towards increased generation and use of renewable energy and reduction in the use of the fossil fuels that cause global warming and consequently climate change. It is also hoped that efforts will be made to enforce them and regulate productive activities.

Fourthly, in some countries interest has been shown in investing in evaluating the potential of diversifying energy sources through the conversion of waste into energy. This is the case in Nairobi, Kenya, where Kenya Power may investigate possibilities of generating energy from waste at Dandora dumpsite; it is hoped that such plans will be converted into tangible actions.

### Challenges

In most African countries, modern technology that is efficient and effective in converting waste to energy, particularly the equipment used to suck gas from landfills, as well as the engines that are used to cool and convert the gas to electricity, is still lacking due to prohibitive costs.<sup>14,15</sup> The few projects that have been implemented in the continent suffer critical shortages of experienced and well-trained personnel.<sup>16</sup> Appropriate policies that support investments in renewable energy production are also lacking in most African countries, and where they exist, there are serious inconsistencies in their application.

### Conclusions and recommendations

Interestingly, the majority of the African population is not connected to modern energy services, a situation that makes the adoption of technological innovations in generating renewable energy from sources such as waste imperative in the continent. Admittedly, this is a predicament that demands not only immediate and concerted efforts from a multiplicity of stakeholders, but also a complete shift in approaches and techniques of problem solving.

In response to the demands, a few African countries have recently embraced modern technologies and innovations to effect the

**Waste has lately come to be regarded as a resource in the African continent**

**There is great potential for increasing the generation and supply of renewable energy from waste in the African continent**

All that is needed is the acquisition of engines that convert the gas that is being flared currently into energy

A few African countries have recently embraced modern technologies and innovations to effect the generation and supply of renewable energy

generation and supply of renewable energy sources to their populations, and more are in the process of doing so. To this end, this work proffers the following recommendations:

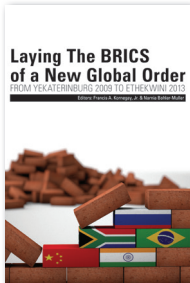
- Against the backdrop of dwindling fossil fuels such as coal and the volatility of oil prices, renewable resources are critical to securing future energy supplies and socioeconomic development within the continent.
- The immediate and long-term energy demands of the ever-exploding populations in African cities need to be met, at the same time as ensuring progressive reduction of GHGs, such as methane and carbon dioxide, that directly cause global warming and climate change.
- There is need for a change in behaviour and attitudes so that waste will be regarded and treated as a valuable resource, which can only be possible through awareness raising and sensitisation of the general populace to its usefulness.
- The pursuit of sustainable and clean cities or societies calls for not only a shift in attitudes and views about waste, but also a better and clearer understanding of modern methods of waste management; hence there is a need for WTE technological uptake and training of personnel to improve the skills set in the continent.
- Lessons from practices taking place in the few African countries such as South Africa and some other countries mentioned in this article should provide motivation for the programmes and endeavours that are being established in other urban centres of the continent.
- Besides realising direct benefits of increasing and securing energy sources, scaling up the green revolution in the African continent will also help African countries to achieve the Agenda 2063 of achieving sustainable socioeconomic and environmental development.

## Notes and references

- 1 Mutanga, S.S., Pophiwa, N. & Simelane, T., 2013. Cities as green economy drivers: Making a case for green cities in South Africa, in Mutanga, S.S., Simelane, T. & Pophiwa, N. (Eds), 2013. *Africa in a changing global environment: Perspectives of climate change adaptation and mitigation strategies in Africa*. Pretoria: Africa Institute of South Africa.
- 2 Simelane, T. & Mohee, R., 2012. *Future directions of municipal solid waste management in Africa* (Policy Brief no 81). Pretoria: Africa Institute of South Africa.
- 3 Mazhindu, E., Gumbo, T. & Gondo, T., 2012. Waste management threats to human health and urban aquatic habitats: A case study of Addis Ababa, Ethiopia, in Rebellon,

L.F.M. (Ed.), 2012. *Waste management: An integrated vision*, pp.21–54. INTECH Open Access Publishers, ISBN 978-953-51-0795-8. Available at: <http://www.intechopen.com/books/waste-management-an-integrated-vision> [Accessed 4 June 2013].

- 4 Strachan, L.J., Wright, M., Pass, J., Couth, B. & Pearson, G., 2008. *Landfill gas generation: theory and practice*. Proceedings of the Conference on Waste and Resources Management: A Shared Responsibility, 16–17 September, Warwickshire, England.
- 5 Zeng, X., Sun, Q., Huo, B., Wan, H. & Jing, C., 2010. Integrated solid waste management under global warming. *Open Waste Management Journal*, 3, pp.13–17.
- 6 Hoorweg, D. & Bhada-Tata, P., 2012. *What a waste: A global review of solid waste management*. (Urban Development Series Knowledge Paper). Washington: The World Bank.
- 7 World Bank/SDC, n.d. Collaborative programme on municipal solid waste management in low income countries. (Working Paper No 9). Nairobi, Kenya: World Bank.
- 8 Okot-Okumu, J., 2012. Solid Waste Management in African cities – East Africa. Chapters 1, 3–20. In Rebellon, L.F.M., (ed.), 2012. *Waste Management: An Integrated Vision*, 1st ed., INTECH open access publishers. Available at: <http://www.intechopen.com/books/waste-management-an-integrated-vision> [Accessed 6 June 2013].
- 9 Togo, M. & Kaggwa, M., 2013. The implications of a transition to a green economy in the African context, in Mutanga, S.S., Simelane, T. & Pophiwa, N. (Eds), 2013. *Africa in a changing global environment: Perspectives of climate change adaptation and mitigation strategies in Africa*. Pretoria: Africa Institute of South Africa.
- 10 Kaggwa, M. & Togo, M., 2013. Embracing the green economy: Concepts and concerns, in Mutanga, S.S., Simelane, T. & Pophiwa, N. (Eds), 2013. *Africa in a changing global environment: Perspectives of climate change adaptation and mitigation strategies in Africa*. Pretoria: Africa Institute of South Africa.
- 11 Strachan, L.J. & Pass, J., n.d. *Credits Where they are Due: Clean Development Mechanism (CDM) – Energy from waste: An overview of Africa's first landfill gas to energy CDM projects*. Durban: Durban Solid Waste Management, eThekweni Municipality.
- 12 Hussein, S., El-Khattam, W. & Abdel-Rahman, M., 2011. Investment requirements for Africa to lead in renewable energy production and distribution, in Simelane, T. & Abdel-Rahman, M. (Eds), 2011. *Energy transition in Africa*. Pretoria: Africa Institute of South Africa.
- 13 Abdel-Rahman, M. & Simelane, T., 2011. Introduction, in Simelane, T. & Abdel-Rahman, M. (Eds), 2011. *Energy transition in Africa*. Pretoria: Africa Institute of South Africa.
- 14 Mudombi, S., 2013. Exploring the challenges and opportunities for low carbon climate resilient development in Africa, in Mutanga, S.S., Simelane, T. & Pophiwa, N. (Eds), 2013. *Africa in a changing global environment: Perspectives of climate change adaptation and mitigation strategies in Africa*. Pretoria: Africa Institute of South Africa.
- 15 Simalenga, T., 2011. Human capital requirements for sustainable renewable energy production, in Simelane, T. & Abdel-Rahman, M. (Eds), 2011. *Energy transition in Africa*. Pretoria: Africa Institute of South Africa.
- 16 El-Khattam, W., Hussein, S. & Abdel-Rahman, M., 2011. State of energy infrastructure in Africa: How much investment is needed to migrate to renewable energy? in Simelane, T. & Abdel-Rahman, M. (Eds), 2011. *Energy transition in Africa*. Pretoria: Africa Institute of South Africa.



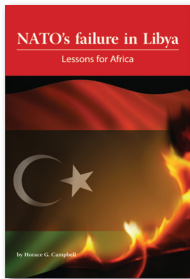
**Laying the BRICS of a New Global Order From Yekaterinburg 2009 to eThekweni 2013**

Edited by Francis A. Kornegay and Narnia Bohler-Muller  
ISBN 987-0-7983-0403-0



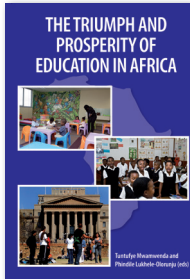
**Africa Union Ten Years After: Solving African problems with Pan-Africanism and the African Renaissance**

Edited by: Mammo Muchie, Phindile Lukhele-Olorunju and Oghenerobor Akpor  
ISBN 978-0-7983-0387-3



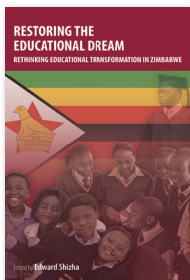
**NATO's failure in Libya: Lessons for Africa**

Horace Campbell  
ISBN 978-0-7983-0343-9



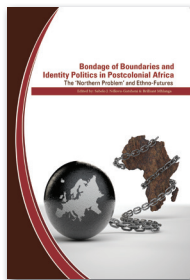
**The Triumph and Prosperity of Education in Africa**

Edited by Tuntufye Mvamwenda and Phindile Lukhele-Olorunju  
ISBN 978-0-7983-0371-2



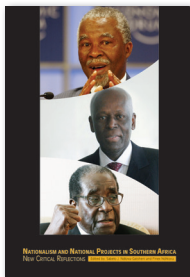
**Restoring the Educational Dream: Rethinking Educational Transformation In Zimbabwe**

Edited by Edward Shizha  
ISBN 978-0-7983-0407-8



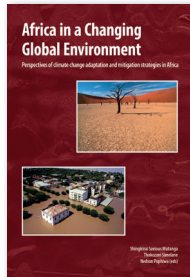
**Bondage of Boundaries and Identity Politics in Postcolonial Africa: The 'Northern Problem' and Ethno-Futures**

Edited by Sabelo J. Ndlovu-Gatsheni and Brilliant Mhlanga  
ISBN 978-0-7983-0391-0



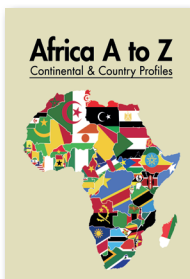
**Nationalism and National Projects in Southern Africa: New critical reflections**

Edited by Sabelo J. Ndlovu-Gatsheni and Finex Ndhlovu  
ISBN 978-0-7983-0395-8



**Africa in a Changing Global Environment: Perspectives of climate change and mitigation strategies in Africa**

Edited by Shingirirai Savious Mutanga, Thokozani Simelane, Nedson Pophiwa  
ISBN 978-0-7983-0375-0



**Africa A to Z: Continental & Country Profiles**

Cartographer: Elize Van As



**Forum on China-Africa Cooperation Knowledge, Skills and Development Cooperation**

Edited by Li Anshan and Funeka Yazini April  
ISBN 978-0-7983-0367-5



PO Box 630  
Pretoria  
0001  
South Africa  
Embassy House  
No 1 Bailey Lane  
Arcadia  
Pretoria

Tel: +27 (0)12 304 9700  
Fax: +27 (0)12 323 8153

E-mail: [publish@ai.org.za](mailto:publish@ai.org.za),  
Website: [www.ai.org.za](http://www.ai.org.za)

**AISA** is a statutory research body focusing on contemporary African affairs in its research, publications, library and documentation. **AISA** is dedicated to knowledge production, education, training and the promotion of awareness on Africa, for Africans and the international community. This is achieved through independent policy analysis, and the collection, processing and interpretation, and dissemination of information.

ISSN 1998-7994



9 771 998 799009