Decarbonisation of the Waste Sector: Global Experiences

IEA-Bioenergy Task 36 Roundtable 29 - 30 November 2022 - Durban, South Africa (Hybrid event)

Workshop Report

IEA Bioenergy: Task 36 – 29 November 2022

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Edited by: Mar Edo (RISE, Sweden)

Preface

This report summarises the deliberations of a hybrid workshop that IEA Bioenergy Task 36 organised in Durban, South Africa, on the topic of "Decarbonisation of the Waste Sector: Global Experiences" on 29th and 30th November 2022. This 2-day workshop is the second of a series of seminars that Task 36 organised, since 2021, on the topic of decarbonization of the waste sector in support to South Africa's Just Transition towards a Decarbonised and Circular Economy.

Since 2021, the South African National Energy Development Institute (SANEDI), an R&D state entity of the Department of Minerals, Resources and Energy has been collaborating with the South African Research Chair in Waste and Climate Change and the other members of Task 36 of the IEA Bioenergy for the development of a Waste to Energy Roadmap for South Africa. Phase 1 of the "WtE Roadmap for South Africa" was launched in March 2022. A WtE Policy Review Report, including a detailed comparison of barriers and drivers for the implementation of WtE systems in the Task 36 member-countries was published in the IEA Bioenergy website in February 2023. (To access the report click here, and to the new/highlight click here)

In South Africa 95% of the energy mix is dominated by energy from fossil fuels (primarily coal). In this context, any meaningful strategy to activate a pathway for decarbonization in line with the Paris Agreement needs to prioritize the optimization of existing and the development of new waste-to-resource infrastructure.

This report focusses on the first day of the workshop.

On Day 1, Task 36 members were invited to present their experiences and lessons learnt on the development, implementation and impacts of similar waste to energy roadmaps in their respective countries. The webinar explored the main issues that are preventing the widespread insertion of waste to energy and biogas to energy projects in the South African energy mix, despite the challenging times of continued loadshedding imposed by the electricity utility ESKOM.

On Day 2, Task 36 members from South Africa, Ireland and Germany invited experts from South Africa in a panel discussion on sustainability indicators and LCSA for the development of WtE technology assessment tools. The panel discussion was followed by a knowledge exchange on Waste to Energy between postgraduate students from the University of KwaZulu-Natal (South Africa) and the University College Dublin (Ireland).

Disclaimers

The workshop was organized by IEA Bioenergy Task 36 and held in the Howard College Campus (Unite Building) of the University of KwaZulu-Natal in Durban South Africa. Task 36 members were invited guest speakers, together with leadership members from SABIA and the World Bank Group. The views and opinions of the workshop attendees, as summarized in this document, do not necessarily reflect those of Task 36' members, SABIA, the World Bank or their respective employers, nor do their employees make any warranty, expressed or implied, or assume any liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its use would not infringe upon privately owned rights.

The IEA Bioenergy Technology Collaboration Programme (TCP) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings, and publications of the IEA Bioenergy TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

Abbreviations, Acronyms and Definitions

CSIRO: Centre for Scientific and Industrial Research Organisation

DFFE: Department of Forestry Fishery and the Environment

DMRE: Department of Minerals Resources and Energy

FGE: Fountain Green Energy

GHG: Greenhouse gas

IEA International Energy Agency

RISE: Research Institute of Sweden

RSE: Ricerca Sistema Energetico

SABIA: South African Biogas Industry Association

SANEDI: South African National Energy Development Institute

SARCHI: South African Research Chair Initiative

TCP: Technology Collaboration Programme

UKZN: University of KwaZulu-Natal

WBA: World Biogas Association

WROSE: Waste to Resource Optimisation and Scenario Evaluation Model

Introduction

The increased need to incorporate renewable energy resources in the energy mix has initiated a global discourse on the modalities for a just the transition towards a decarbonized circular economy among policy makers, governmental departments, and local authorities. However, not many countries worldwide have developed comprehensive roadmaps to navigate this transition.

This 2-day workshop is the second of a series of seminars that IEA Bionergy Task 36 organised, since 2021, on the topic of decarbonization of the waste sector in support to South Africa's Just Transition towards a Decarbonised and Circular Economy.

Since 2021, the South African National Energy Development Institute (SANEDI), a R&D state entity of the Department of Minerals, Resources and Energy has been collaborating with the South African Research Chair in Waste and Climate Change and the other members of Task 36 of the IEA Bioenergy for the development of a Waste to Energy Roadmap for South Africa. Phase 1 of the "WtE Roadmap for South Africa" was launched in March 2022. A WtE Policy Review Report, including a detailed comparison of barriers and drivers for the implementation of WtE systems in the Task 36 member-countries was published in the IEA Bioenergy website in February 2023. (To access the report click here, and to the news/highlights click here)

On Day 1, Task 36 members were invited to present their experiences and lessons learnt on the development, implementation and impacts of similar waste to energy roadmaps in their respective countries.

The workshop was opened by Inge Johansson (RISE, former Task 36 Leader - Sweden) who presented Sweden's experience in moving from disposal of waste into landfills to the progressive adoption of materials' recycling and energy recovery systems. Dieter Stapft (Karlsruhe Institute of Technology (KIT), Task 36 member - Germany) discussed innovations developed in Germany and Europe on carbon cycle-recycling and incineration of residual waste. The adoption of a new concept of waste to resource hierarchy towards the application of the circular economy in Italy was discussed in great details by Giovanni Ciceri (RSE, Task 36 member - Italy). Beau Hoffman (US Dept. of Energy, Task 36 member - USA) joined online from Seattle and discussed the lessons learnt in the deployment of advanced waste to energy projects in the USA. The international experiences presented by Task 36 members were echoed and amplified by SABIA' former Secretary General, Alberto Borello (FGE, South Africa), who detailed strategic interventions that the South African Biogas Industry Association is putting in place to promote biogas to energy as fulcrum of a sustainable decarbonized economy in Southern Africa. Cristina Trois (University of KwaZulu-Natal, Task 36 member - South Africa) presented the key elements of the Waste to Energy roadmap that she is developing for the South African Department of Minerals, Resources and Energy. The lack of reliable waste data has been identified as a critical barrier in the implementation of waste to energy projects in South Africa. Aiden Bowers (JG Afrika, South Africa) closed the workshop presenting the results of a recent project funded by the World Bank on the diagnostic of SWM businesses in South Africa's metropolitan municipalities.

WORKSHOP OBJECTIVES

The main aim of the first day of the workshop on "Decarbonisation of the waste sector – Global Experiences" was to provide opportunities for discussion on lessons learnt on the implementation of waste to energy projects from the member-states of Task 36. A second aim was that to share experiences on the development of waste to energy roadmaps globally, to inform the South African's Just Energy Transition.

WORKSHOP AGENDA

IEA Bioenergy
Technology Collaboration Programme

TASK 36 WORKSHOP

Decarbonisation of the Waste Sector: Global Experiences
29 November 2022 – Durban, South Africa (Hybrid online)

PROGRAMME - DAY 1

DAY 1 – 29 November 2022 - **Decarbonisation of the Waste Sector: Global Experiences**
Venue: UNITE Bld. (and online on Zoom) - Time: 14 – 18 (SA time)

14:00 – 14:10
Welcome address and Introduction — Inge Johansson and Cristina Trois

14:10 – 14:30
Moving from landfills to recycling and energy recovery in Sweden — Inge Johansson

14:30 – 15:30
Waste as a Resource to close carbon cycle-recycling and residual waste incineration in Germany — Dieter Stapf

15:30 – 16:00
Waste as a Resource to close carbon cycle – an update on recycling in Italy — Giovanni Ciceri

16:00 – 16:15 Tea/coffee break

16:15 – 16:45
Advancing local deployment of advanced waste to energy in the USA — Beau Hoffman

16:45 – 17:10
Building a sustainable biogas to energy market in South Africa — Alberto Borello

16:50 – 17:10
Pathways for the decarbonisation of the waste sector in South Africa — Cristina Trois

17:10– 17:30
A diagnostic of SWM businesses in South Africa's metropolitan municipalities — Aiden Bowers

17:30 – 18:00 Discussion and closure
18:00 Cocktail event

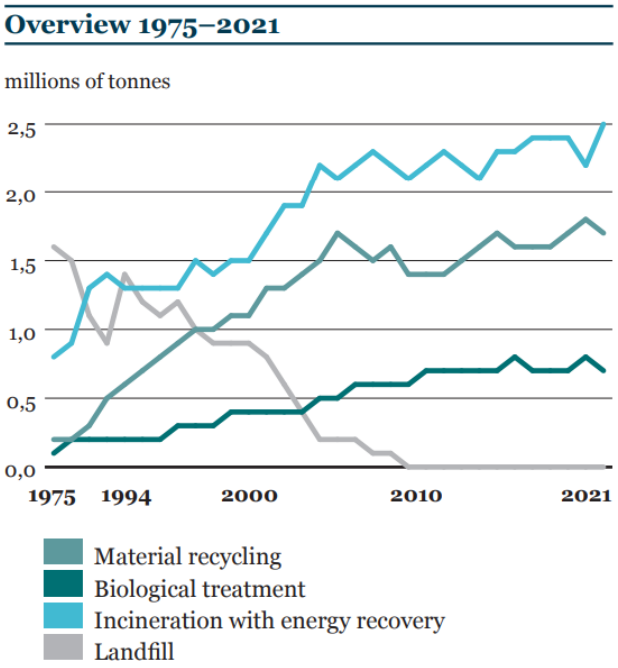
Workshop Structure

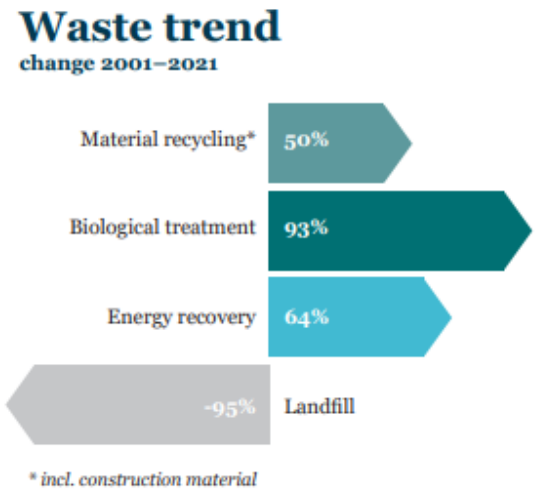
KEYNOTE SPEAKERS

Mr Inge Johansson, Tec. Lic. Researcher, RISE Research Institute of Sweden, Division Built Environment, Sweden

Title: Moving from landfills to recycling and energy recovery in Sweden

Mr Johansson's presentation details the pathways followed by Sweden since the introduction of the Landfill Tax in 2000 to 2020 when an Incineration Tax of 7.5-12.5 Euros/tonne of waste was reintroduced in the country. The development of a legal framework was supported and informed by a 70% reduction in GHG emissions as a result of the introduction of improved waste management and wastewater treatment technology during the period 1990 to 2019, through the systematic insertion of landfills, biological treatment of waste, incineration of hazardous material and sewage water treatment. 40% of MSW were landfilled 30 years ago, however material recycling, biological treatment, and incineration with energy recovery were progressively introduced since 2010.

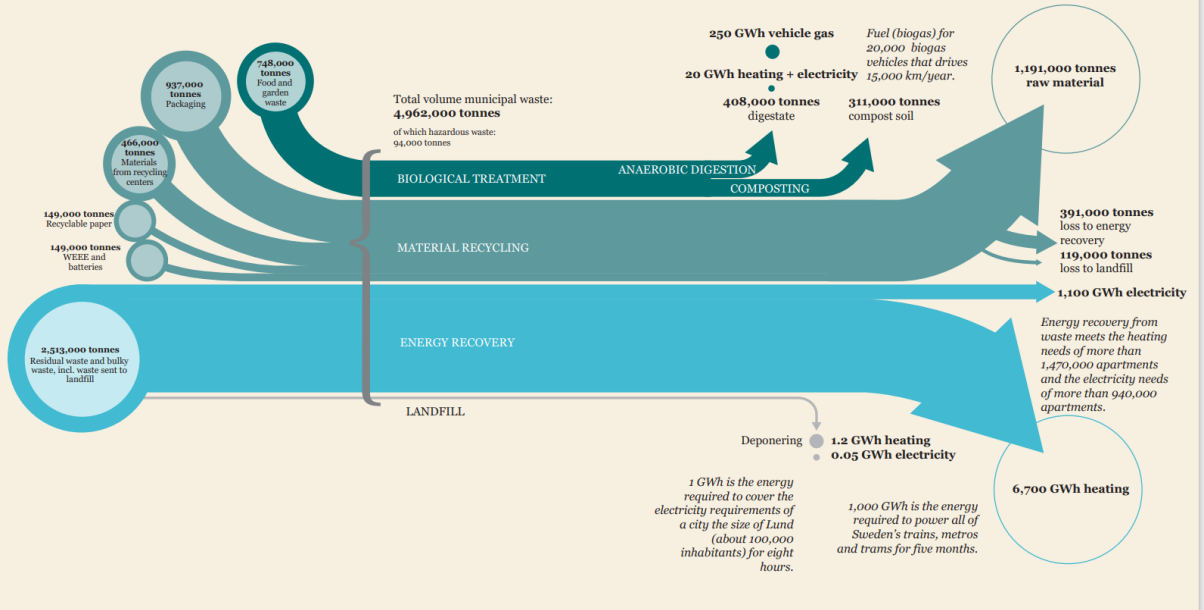




The main drivers and barriers for the decarbonisation in Sweden were introduction of clear responsibilities for municipalities that are responsible for the management, recycling, and disposal of solid waste. Producers are responsible for the safe disposal of packaging, waste electrical and electronic equipment (WEEE), tires, cars, batteries, pharmaceuticals, and textiles.

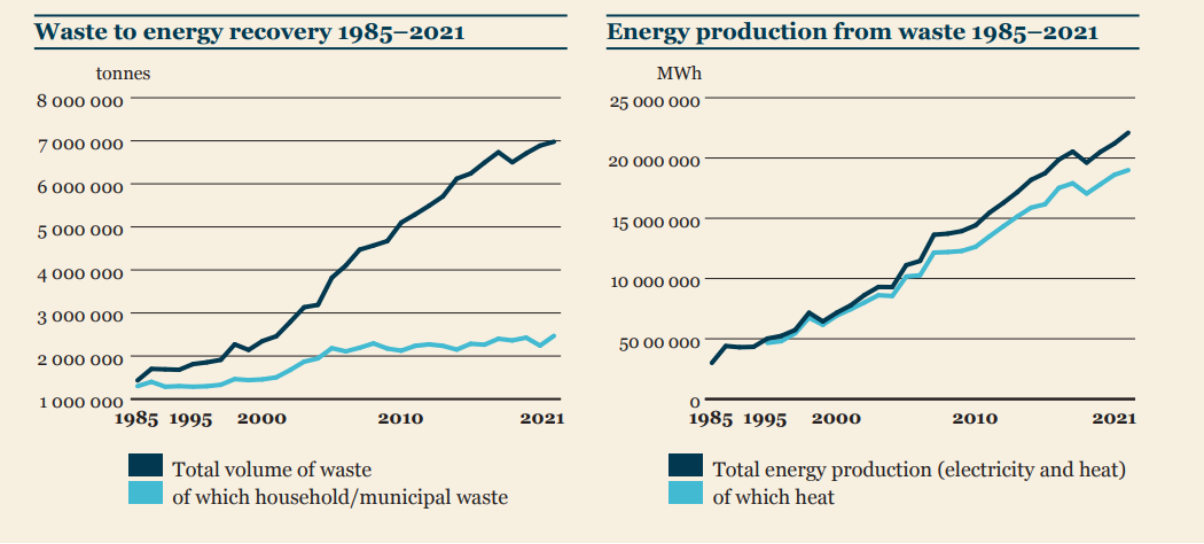
The legislative framework introduced in Sweden in the past 30 years includes: 1. The EPR policy, 2. The Landfill tax was introduced in the year 2000 (currently ranging around 53€/ton), 3. A ban on landfilling of combustible waste in 2002, 4. The landfill directive went into full force in 2009 resulting in the closure of many landfills.

Municipalities have been an important driver in the decarbonisation transition, prioritising AD and biogas production. The current waste to resource flow implemented in Sweden is below.



The main decarbonisation steps were 1. Policy driven resulting in the introduction of policy targets on the collection and treatment of organic waste and not only compost; 2. Climate change driven resulting in more emphasis in reaching net carbon neutrality towards a progressive decarbonisation of the transport sector; as well as 3. Circular economy driven resulting in more emphasis given to the circular use of nutrients as by-products of the treatment of waste and/or wastewater.

Waste to energy was progressively introduced in Sweden since 1985, resulting in substantial diversion of waste to landfill and increased energy production as in the figure below.



In conclusion, the introduction of new policy and different incentives had a major effect on the development of decarbonisation pathways for the waste sector in Sweden. Therefore, incentives or policies need to be predictable and not ever changing in the short term to give the industry the courage to develop. The presentation highlights that recycling alone will not be enough to activate a circular economy, as the demand for materials and products is larger than the materials available for recycling. Therefore, consumption needs to become more sustainable. Re-use and recycling need to increase since they are generally the most efficient ways to decrease GHG emissions and to save energy.

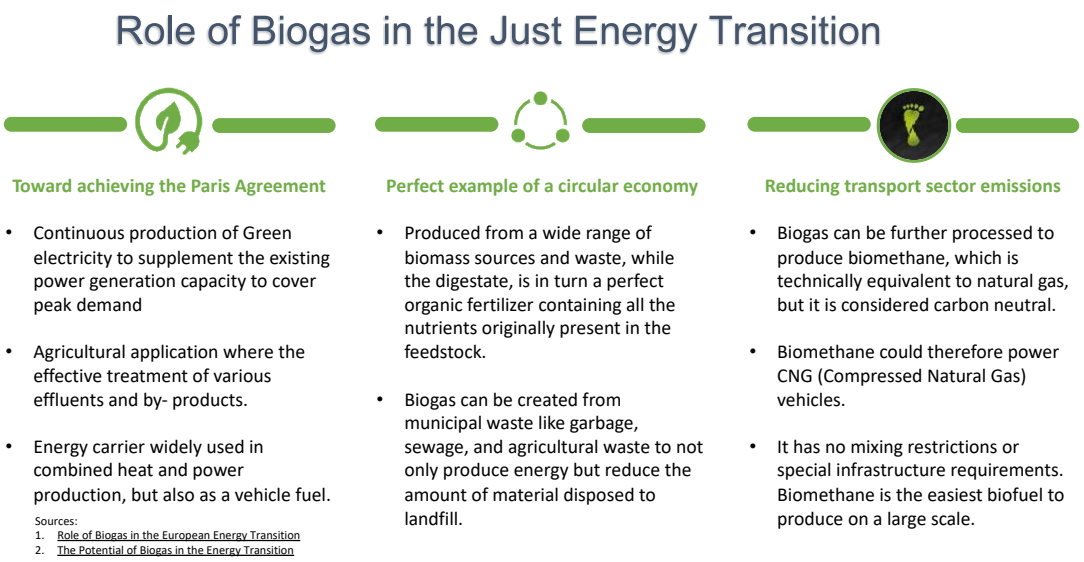
Mr Alberto Borello, Former Secretary General of SABIA and Technical Director at FGE, South Africa

Title: Strategy towards pivoting biogas in a decarbonised economy

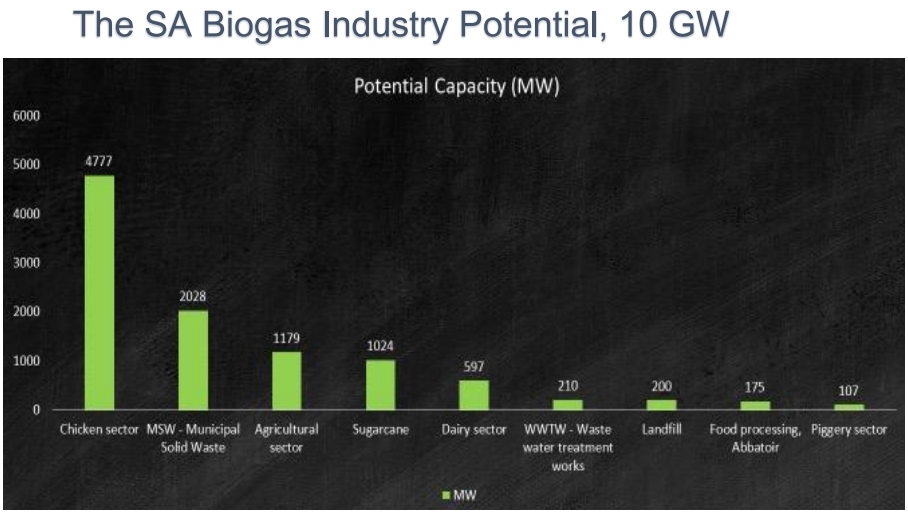
Former SABIA' Secretary General, Alberto Borello (FGE, South Africa) detailed strategic interventions that SABIA is putting in place to promote biogas to energy as fulcrum of a sustainable decarbonized economy in Southern Africa. Alberto Borello discussed the role of biogas in the Just Energy Transition and the role of SABIA in representing and promoting the biogas sector in Southern Africa.

SABIA aims to drive the industry growth for the biogas sector, which has a theoretical potential of 10 GW (SABIA White Paper, 2020), towards the delivery of a roadmap for Southern Africa to produce over 1.25 GW in 5 years. The implementation of this roadmap in the first 5 years would create over 30,000 permanent and 140,000 temporary jobs, while preventing CO2 emissions for almost 10 million tons per year (2% of the South African carbon footprint). However, challenges to the growth of the biogas industry have been identified in institutional (lack of clarity on Government policy and direction relating to Biogas), financial (access to funding, project development costs, regulations and feed-in tariffs, developing the market), technical (need for more research and development into new technologies, focus on skills and capacity development across the industry value chain) and institutional (lack of clarity on Government policy and direction relating to Biogas) factors that need to be addressed.

The role of biogas in contributing towards the Just Energy Transition is detailed in the Figure below.



The potential for the biogas industry sector in South Africa was estimated to be around 10GW.



The Figure below details the predicted impact on the South African economy of the biogas sector if developed accordingly.

Job creation	Theoretical	Feasible within 5 years
Direct permeant job creation	247 122	30 177
Development/Construction jobs in the sector	1 153 234	141 455

Carbon reduction to be separated	Theoretical	Feasible within 5 years
CO2e avoided [t/y]	81 189 768	9 889 650
% on total country emission in 2019	15%	2%

Comparison to other renewable technologies	Theoretical	Feasible within 5 years
Energy delivered to or displaced from the national grid [MWh/y]	85 462 913	10 410 158
Equivalent Wind installed capacity [MW]	35 610	4 338
Equivalent PV installed capacity [MW]	58 536	7 130
Installed peaking capacity in SA 2019 [MW]	3 570	

The presentation concluded with the role of SABIA in South Africa and the key elements of the VISION 2030 – Biogas Strategy being developed by SABIA in 2021 (Launched in November 2022).

SABIA has adopted a global strategy for the development of a local biogas industry and is working with the South African Government to:

1. Include the production of biogas as a climate change mitigator in all levels of government including national, provincial, municipal and individual cities' energy plans

2. Include targets for the recycling of biodegradable wastes and feedstocks to produce biogas in Nationally Determined Contributions to the UNFCCC by 2020

3. Build a Circular Economy in which organic wastes, residues and feedstocks are recycled into renewable biogas and valuable organic nutrients for use in the agricultural sector

4. Adapt the flow of financial support to the biogas sector, which is not only an enabler of a low- carbon based economy, but is also the quickest and most cost-efficient CO_2 reduction pathway.

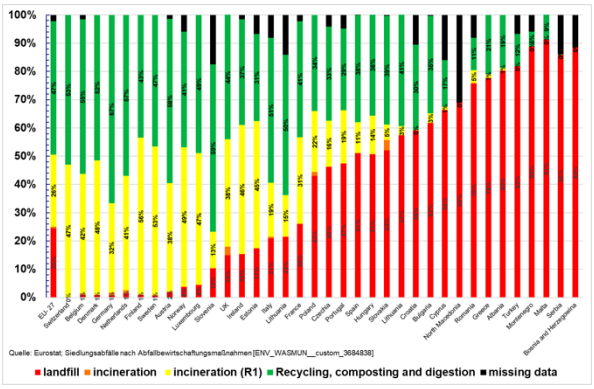
5. Use the fuel produced by biogas production facilities for power generation, publicly owned transport and waste collection trucks. Carbon neutral fuel for electricity generation and for transport, contribute to improved air quality in cities worldwide using biogas as a clean fuel.

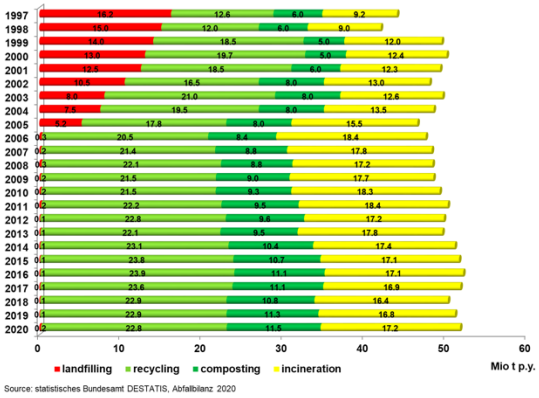
Prof. Dieter Stapf, Karlsruhe Institute of Technology, Germany

Title: Waste as a Resource to close carbon cycle-recycling and residual waste incineration in Germany

Prof. Stapf presented a comprehensive account of recycling technologies adopted in Germany, where industry (Chemical, steel, cement, other) is responsible for 40% of the GHG emissions, which in 2021 equated to 750 Mton. The Carbon Feedstock demand of the chemical industry is 20 Mt/year.

The figures a and b below present in a. The contribution of recycling, incineration and landfilling of municipal solid waste (MSW) in Europe and in b. Percentage of MSW that is landfilled, recycled and composted in Germany in 2020.





The road towards carbon neutrality in the waste sector in Germany must take into consideration the following barriers:

1. Scarcity of renewable energy / electrical power and sustainable carbon feedstocks to achieve climate neutrality;
2. Remaining non-fossil carbon demand in industry and transportation sectors;
3. Carbon neutrality can be achieved through a combination of waste recycling, sustainable biomass and CCU / CCS, only waste recycling is the most efficient way.

In conclusion, current efforts are still insufficient, waste collection systems, waste treatment and different recycling technologies are needed, and these must be adapted to the different types of waste.

Dr Giovanni Ciceri, Deputy Head, Health & safety, environment, quality, technical and general services, Research on energy systems – RSE s.p.a, Italy

Title: Waste as a resource to close carbon cycle – an update on recycling in italy

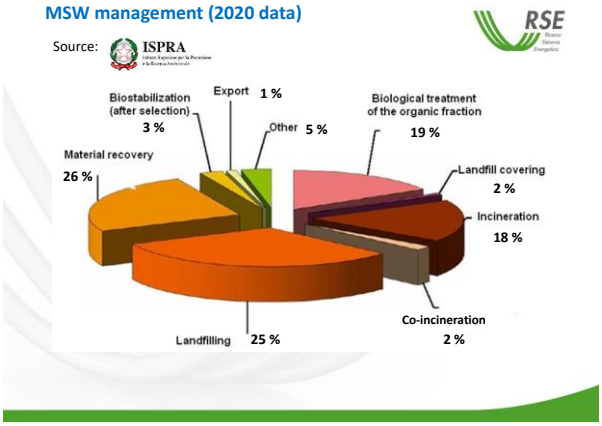
The presentation explores the Italian experience and recycling strategies of various MSW fractions.

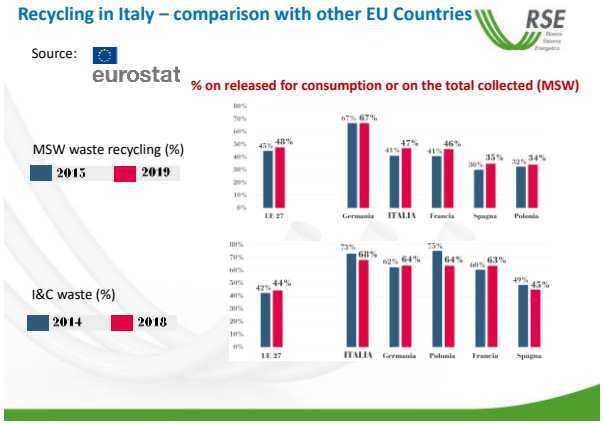
As separated collection at the source is widely spread in Italian cities, the national waste management strategies have redefined a new waste management hierarchy, that prioritises

Prevention, followed by reduction, reuse, recycling, recovering and final disposal of residues.

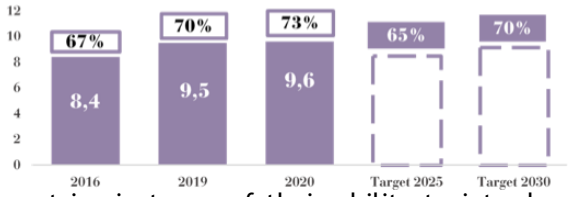
Landfilling of residues and material recovery constitute the most common waste management systems in Italy, followed by incineration and biological treatment of organic waste with 18% and 19%, respectively.

The Figure below presents also a comparison between the recycling rate of MSW and Industrial and Chemical waste in Italy and Europe in the quinquennium 2014/15 – 2018/19.

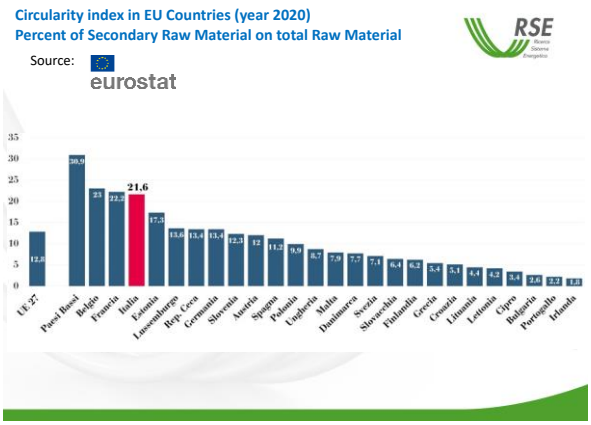




In 2020, there was a decrease of 4.6% in the quantities released for consumption compared to 2019 (13.1 mt). Despite the pandemic period, packaging recycling remained at a stable level, compared to 2019, while the recycling rate grew to 73% compared to that released for consumption, with an increase of 3 % compared to the previous year, mainly due to the less quantity of packaging placed on the market.



The figure below attempts to compare European countries in terms of their ability to introduce circular economy, with the Netherlands displaying the highest Circularity Index (30.9) and Ireland the lowest (1.8).



The extension of separate waste collection following the implementation of the EU circular economy package will result in an estimated increase of 2 Mt/year of organic waste from separated collection

This must be accompanied by a corresponding adaptation of the treatment plants present in the area. Currently, a lower separate collection rate is observed in some regions, especially in Southern Italy together with a lower availability of treatment plants

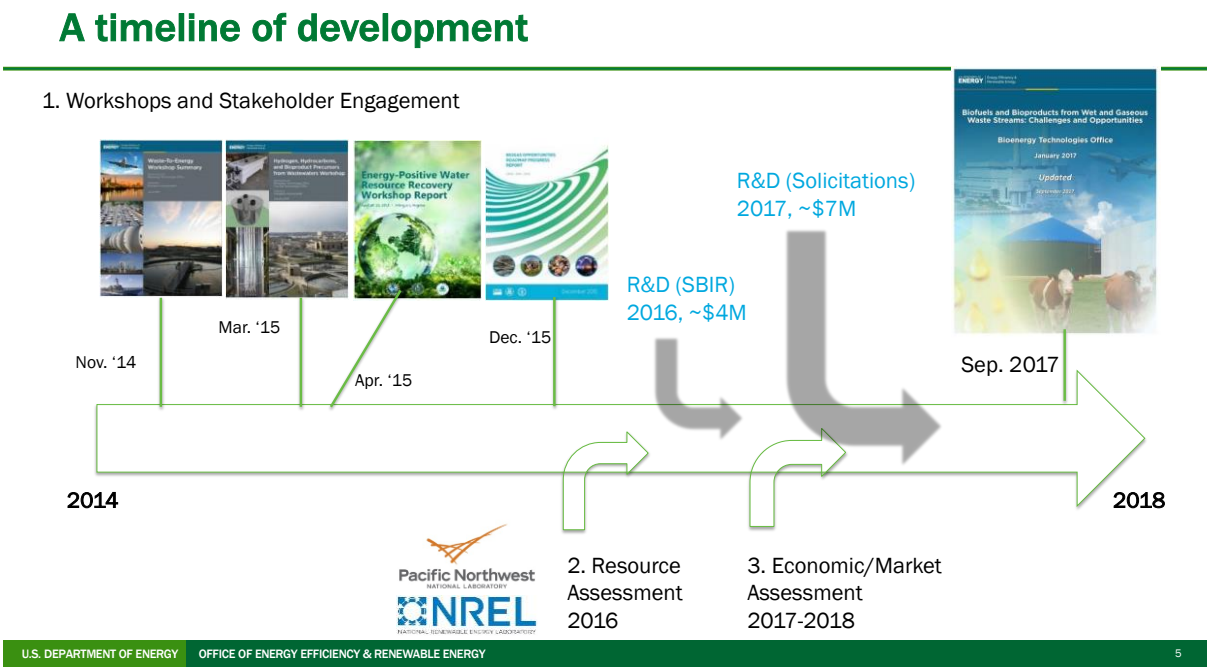
Dr Beau Hoffman, Technology Manager, Conversion R&D. Bioenergy Technologies Office, U.S. Dept. of Energy, USA

Title: Lessons learnt in developing Waste to Energy roadmaps for USA

Dr Hoffman, of the bioenergy technologies Office of the US Department of Energy has overseen several projects in the development of the waste to energy roadmap across the US. The presentation detailed the role of the Bioenergy Technologies Office, the explored the definition of organic waste in the context of waste management and waste to energy in the US. The key elements of the waste to energy Roadmap adopted by the US Dept. of Energy were:

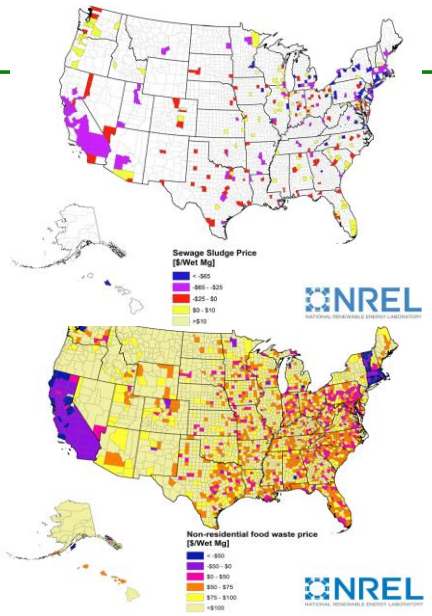
1. Stakeholder Engagement that aimed to answer the question: What are the problems to be solved (by the community)?
2. Assemble Experts & Analysts
3. Resource Assessment, that aimed to answer the key questions: How much waste is there? How much is being beneficially used? And where is it?
4. Economic/Market/Logistics Assessment, that aimed to answer the following questions: What does it cost to manage? What are the costs of current practices? How to regulations play into this?

The figures below present a snapshot of the typical timeline for the development of the stakeholder engagement, which for the US resulted in over 4 years.



Economic Assessment

- Price maps developed for each feedstock, except FOG
- If a resource has been commoditized (e.g., FOG), its price is determined by market demand
- If a resource is regarded as waste, its price is driven by the cost of its disposal
- Negative prices occur in areas with:
  - Organic waste disposal bans
  - High disposal costs (e.g., landfill tipping fees)
- Formal or informal local markets can drive prices in a given area



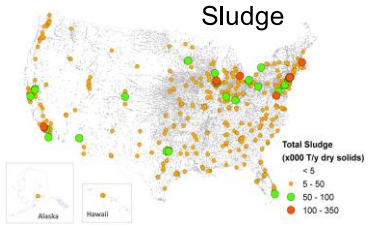
Badgett, A., Newes, E., Milbrandt, A. "Economic Analysis of Wet Waste-to-Energy Resources in the United States". *Energy*. Vol. 176, June 2019.

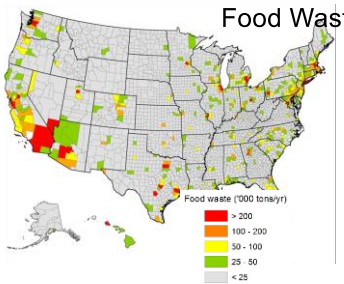
The figures below portray an economic assessment conducted during the development of the WtoE Roadmap by the US dept. of Energy.

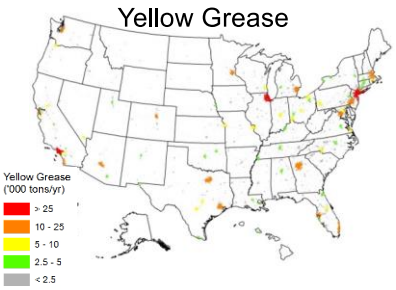
Resource Assessment

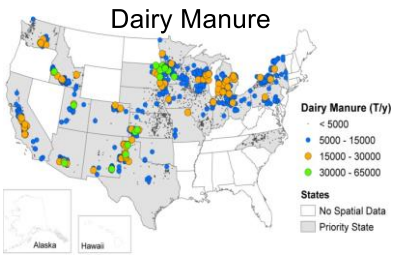
Wet Resources	Annual Beneficial Utilization (Current) Estimated Resource Availability (MM Dry Tons)	Inherent Energy Content (Trillion Btu)	Fuel Equivalent (MM GGE)[2]	Annual Potential Excess[1] Estimated Resource Availability (MM Dry Tons)	Inherent Energy Content (Trillion Btu)	Fuel Equivalent (MM GGE)[2]
Wastewater Residuals	7.12	107.6	927.0	7.70	130.0	1,119.6
Animal Waste	15.00	200.2	1,724.3	26.00	346.9	2,988.7
Food Waste	1.30	6.8	58.2	14.00	72.8	627.1
Fats, Oils, and Greases	4.10	147.4	1,269.3	1.95	66.9	576.6
Total	27.52	462.0	3,978.8	49.65	616.6	5,312.0

[1] Unused excess in this definition includes landfilled biosolids and other wet resources.
[2] 116,090 Btu/gal. This does not account for conversion efficiency.









Milbrandt, A., Seiple, T., Heimiller, D., Skaggs, R., Coleman, A. "Wet waste-to-energy resources in the United States". *Resources, Conservation and Recycling*. Volume 137, October 2018, Pages 32-47.
Seiple, T. et al. "Municipal wastewater sludge as a sustainable bioresource in the United States". *Journal of Environmental Management*. Volume 197, July 2017, Pages 673-680.

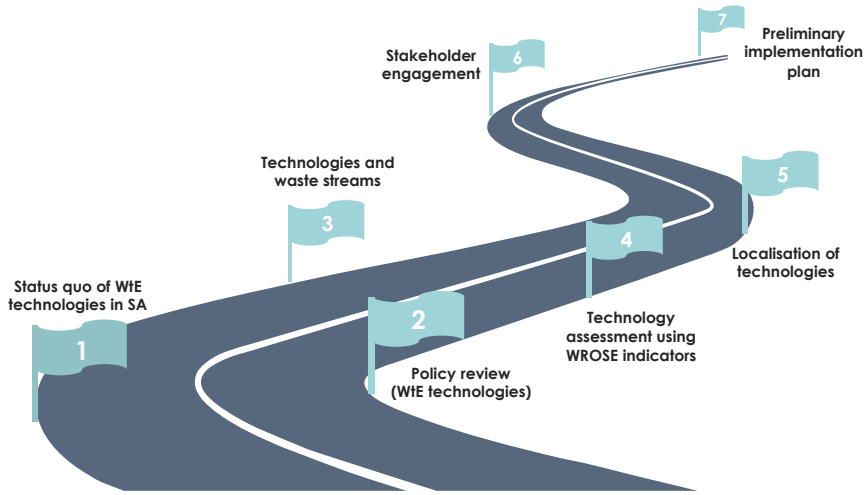
In conclusion, the presentation highlights the importance to consider which effects the legislation framework, policy and incentives have in the long period, not only in the national context but also in relation to surrounding markets.

Prof. Cristina Trois, SARCHI Chair Waste and Climate Change, University of KwaZulu-Natal, South Africa

Title: Developing a Waste to Energy Roadmap for South Africa

The waste sector in South Africa contributes to over 4.3% of GHG emissions in atmosphere of which 37.2% are methane emissions (NIR, 2017). Over 100 million tonnes of municipal solid waste are produced in South Africa every year, with 30% being organic. However, despite the many opportunities for recycling and recovery of these organic fractions, over 80% of the waste streams are landfilled. In the past 20 years, methane emissions from the waste sector have increased by 11.3% and GHG emissions of almost 60%. In the same time frame, the GHG emissions from waste management in the European Union have halved, because of the progressive insertion of mitigation strategies. Effective barriers to the implementation of mitigation strategies in South African municipalities have been identified in the lack of resources, knowhow, reliable waste data and absence of GHG emission indicators, as well as poor social acceptance of waste to energy technology. In this backdrop, the SARCHI Chair Waste and Climate Change has been mandated by SANEDI to develop a waste-to-energy roadmap for South Africa.

The WROSE model (Trois and Jagath, 2010) was used to conduct the technology assessment as well as the forecasting of GHG emissions for the next 50 years. The roadmap is due to be completed in March 2022. An implementation plan will follow afterwards. The main elements of the roadmap are presented in the Figure below and in the WROSE Application in www.wrose.co.za.



Mr Aiden Bowers, World Bank, Short Term Consultant, South Africa

Title: A diagnostic of SWM businesses in South Africa's metropolitan municipalities

This presentation reports on a diagnostic commissioned by the National Treasury's Cities Support Programme (https://csp.treasury.gov.za/csp/Pages/default.aspx) under the Climate and Sustainability component in 2021/22.

The CSP imperative is to improve the prospects for inclusive economic growth in cities, and to help them respond to the development challenges they face. The CSP supports metros directly and works across divisions in NT, with other national departments and broader stakeholders.

The **viability and sustainability** of Metro SWM business models are **under threat**

South Africa's metropolitan municipalities

https://commons.wikimedia.org/wiki/File:Map_of_the_metropolitan_municipalities_of_South_Africa_%282016%29.svg

- There are 8 metropolitan municipalities (also called category A) in South Africa
- 45% of the country's population
- 49% of municipal budgets
- R10bn in operating budgets (2021/22)
- Sufficient scale (population and economies) to transition up the waste hierarchy?

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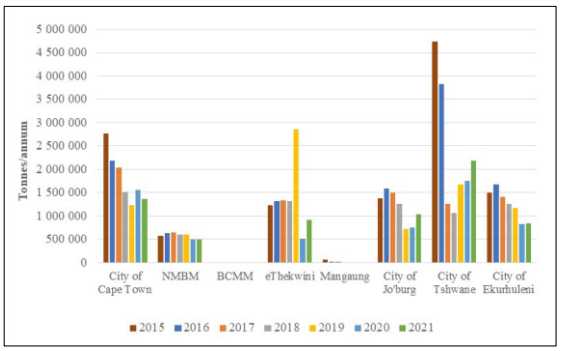
due to 1. cost inefficiencies; 2. diminishing landfill airspace; 3. **policy** and **regulatory reform** that is placing **increasing pressure** on metros to **move** towards a more **circular** SWM **approach**; 4. Metros have **largely satisfied the basics** by achieving high waste collection coverage and sanitary landfilling, but there is clear evidence that **all metros are showing signs of strain**, with some even struggling to provide a regular basic service to its citizens.

The purpose of this study was that to conduct a rapid assessment of the waste management businesses in South Africa's Metros with specific focus on **financial, operational** and **institutional performance**. The final product is a **concise report** that **articulates** the **main issues** and provide clear **evidence-based recommendations** and mitigating actions.

Evaluating performance is constrained by poor data and lack of institutional planning

- Waste **information** is **unreliable**, especially when extracted from the SA waste information system. Several metros report **issues with keeping weighbridges serviceable**
- **Financial data** is **improving** but is prone to **inaccurate categorisation** making it **difficult** to **evaluate** business **performance** or efficiency
- **Mandatory Integrated SWM plans** are **outdated** in 5 of 8 metros



Waste disposal data for Metros (from SAWIS)

After exploring all the possible barriers to the implementation and success of business models, the study concludes that there remains a **significant gap** between waste **policy objectives** and what is currently being **achieved.** Moreover, SWM businesses are **organised** to deliver on a mainly **linear system.** Metros wanting a meaningful **transition** towards a secondary materials economy will need to **invest** significantly in **new infrastructure** and **change** the way the **business is structured**. Given the fiscal constraints, it is likely that the **transition** can only be achieved through **partnerships** with the **private sector** coupled with **innovative financing** mechanisms.

A **gradual approach** and prioritising **basic service delivery** are two core principles underpinning SWM improvements, to effect change the **prominence of waste management** must be raised to **attract** adequate **resources** and place it on the **agenda** of **senior** metro and government **officials**.

To improve data quality, **functioning weighbridges** should be **mandatory** for all metros, as well as an improved **guidance** needed on **categorizing accounting data** in the municipal standard charter of accounts (mSCOA).

In conclusion, changing **spatial dynamics** of waste infrastructure in metros should be a **driver** for **investment in alternative** waste management infrastructure. Arrangements for **waste diversion and recycling** should be implemented at a scale and pace that is **affordable**. **Evidenced-based research** which will support metros when evaluating waste treatment technology options. **Innovative financing models** have been conceptualised for organic waste diversion and show that blended finance options using grants and concessional loans for capital investments make potentially bankable projects.

Concluding remarks of the workshop

This workshop successfully brought together a wide diversity of experiences and useful lessons learnt on barriers and drivers influencing the development of waste to energy roadmaps in South Africa, Sweden, United States, Italy and Germany.

Political will (or the lack thereof) to implement mitigation strategies seem to be the key barrier and/or driver in the accomplishment of set targets, which are often replicated in developing countries without taking in consideration the context in which municipalities operate, the presence of obsolete or inefficient waste management systems, the lack of know-how and the scarce availability of reliable waste data. Social acceptance of waste to energy projects remains one of the major barriers in the insertion of WtoE technology, coupled complex regulatory and legislative frameworks that dominate especially in Africa and developing, despite the lack of control and indiscriminate illegal dumping.

SABIA, in their shared Vision 2030 strategy have set very clear targets for the development of the biogas sector and the abatement of global GHG emissions to 10% by 2030, through the promotion of AD technology. Finally, the importance that R&D and international collaboration platforms, such as that with Task 36 and the IEA, are playing in informing and guiding the Waste to Energy Roadmap process was stressed. The workshop ended with SANEDI and the DMRE pledging their support towards the implementation plan of the waste to energy roadmap for South Africa in the future.

Appendix A: Related Links

All presentations are available at this link:
https://www.dropbox.com/scl/fo/hqfq1jmfgrpn47295k0hd/h?rlkey=04s3ljpkga9nculij48q8h6su&dl=0

Appendix B: Presenters' Short Biography

The biographies of all the task 36 presenters are available at this link:
https://task36.ieabioenergy.com

Non-Task 36 presenters

Alberto Borello

Working for 19 years in the renewable energy market, climate change and waste industry for global engineering companies, currently leading an engineering firm in South Africa for the development of renewable energy projects and the reduction of greenhouse gases. As secretary general of the Southern African Biogas Industry Association (SABIA) NPO, Alberto is responsible for the development and promotion of the association, the coordination of the activities and the relationship with the institutions to support the biogas industry in South Africa. From May 2020 Alberto serves in the Council of the World Biogas Association.

Aiden Bowers

Aiden is a Professional civil engineer with 20 years' experience in solid waste and municipal services sectors. He works with the specialist waste management consultancy JG Afrika as a Senior Engineer while also undertaking project work as an independent waste management consultant for various advisory firms. He recently led a Professional Team on the development of a first-generation Integrated Waste Management Strategy for Rwanda. Aiden has also undertaken various waste management assignments as a short-term consultant for the World Bank in Rwanda, Uganda, Sudan and South Africa.