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# IMPLEMENTATION OF THE WASTE RESOURCE OPTIMISATION AND SCENARIO EVALUATION (WROSE) MODEL: A WASTE MANAGEMENT DECISION MAKING TOOL FOR SOUTH AFRICAN MUNICIPALITIES


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EDGEWOOD CAMPUS | HOWARD COLLEGE CAMPUS | NELSON R MANDELA SCHOOL OF MEDICINE | PIETERMARITZBURG CAMPUS | WESTVILLE CAMPUS

INSPIRING GREATNESS

# Acknowledgements

- NRF
- SARCHI Waste and Climate Change
- eThekwini Municipality
- DSW

iwwg
international waste working group
SOUTHERN AFRICAN REGIONAL BRANCH

IPLA
International Partnership for Expanding Waste Management Services of Local Authorities

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# Outline

**WASTE AS A PROBLEM**

- The Waste Management problem in South Africa
- Rationale for the study

**INTEGRATED WASTE MANAGEMENT**

- National waste management strategy in South Africa and implementation of the waste hierarchy
- Introducing ZERO WASTE in South Africa

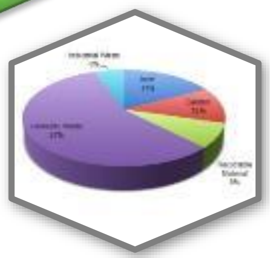
**THE W.R.O.S.E MODEL**

- Waste Resource Optimisation & Scenario Evaluation Model W.R.O.S.E
- Decision-making tool

**CASE STUDIES**

- The case study of Dube Trade Port Agribusiness

**WAY FORWARD**

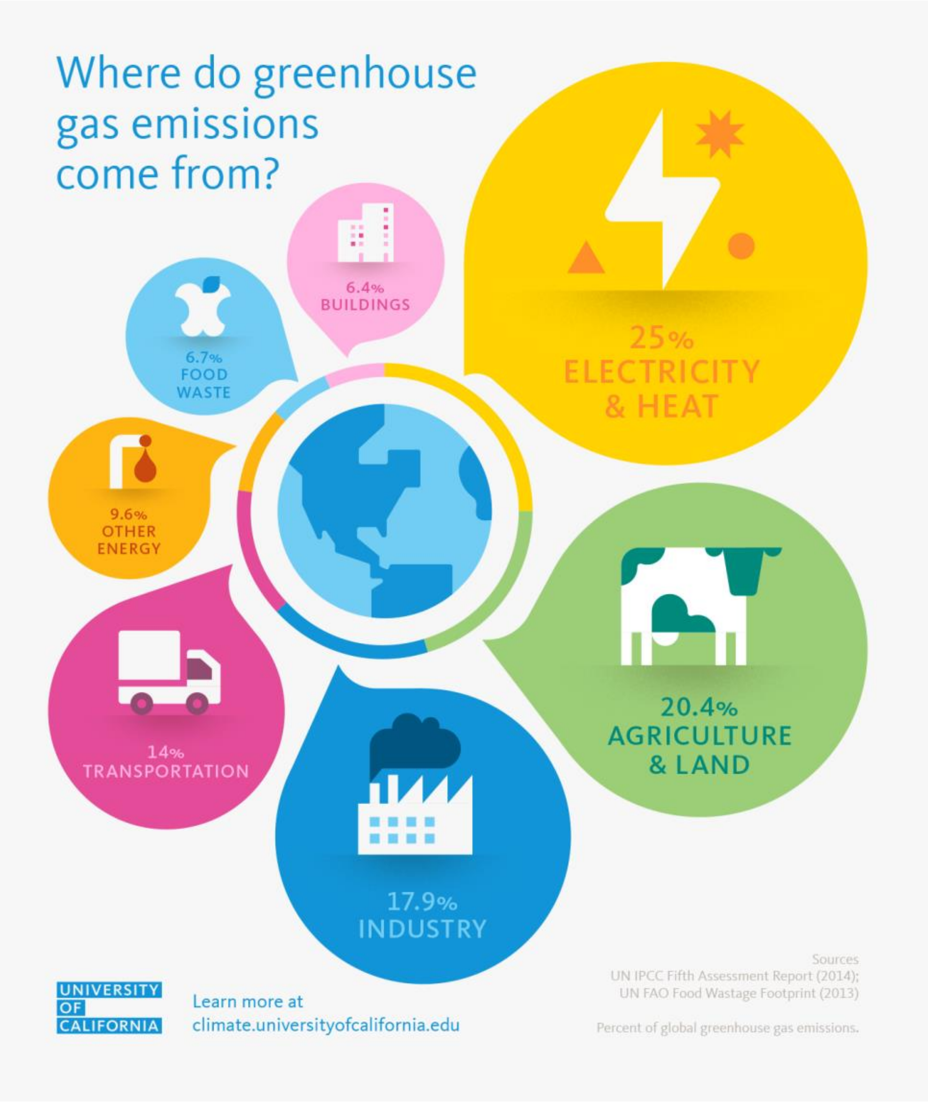


- Results and Recommendations
- Future scenarios of the research

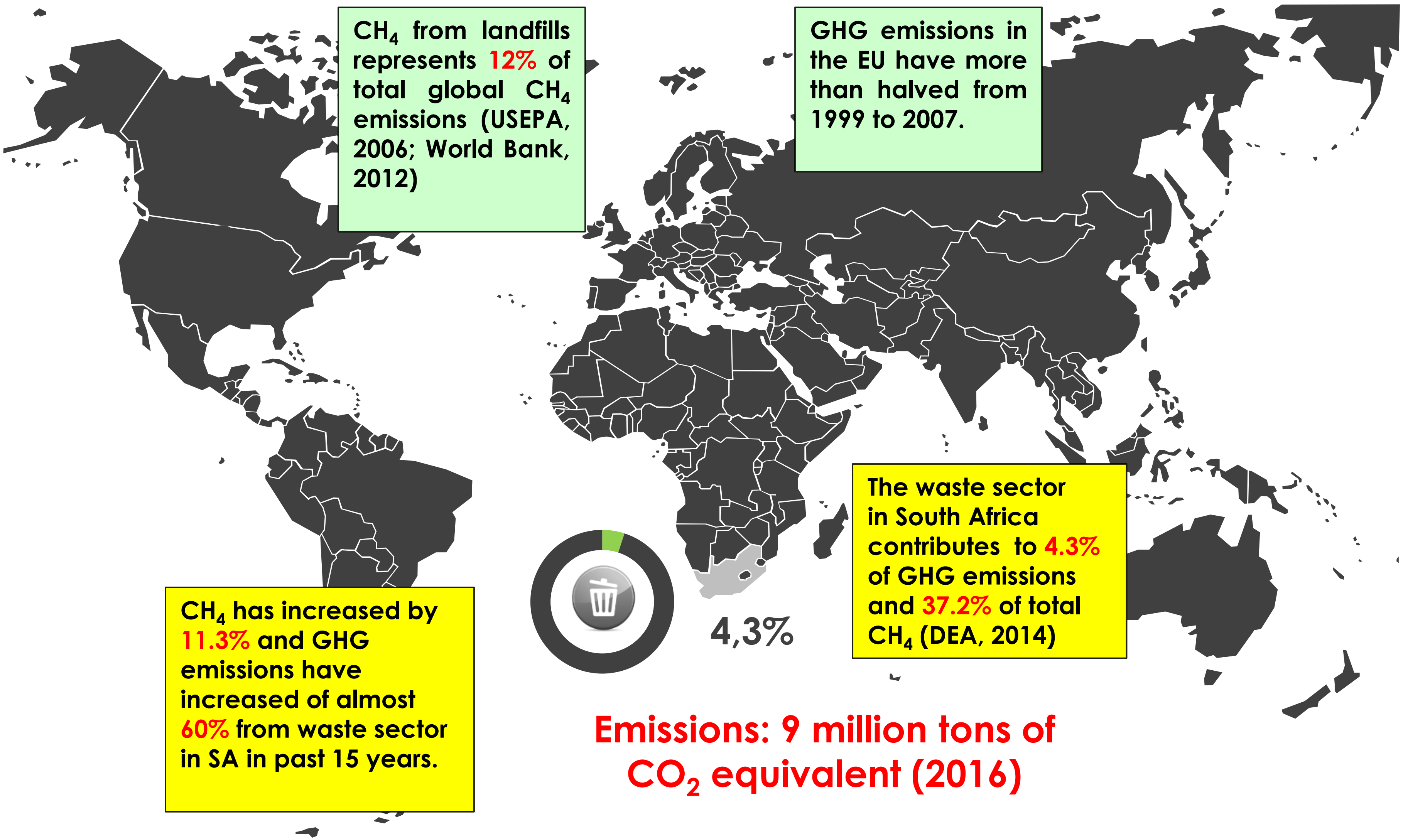

Waste management in an emerging economy is a complex socio-technical challenge…
Namaste SA

# Our Grand Challenge






# Waste and Climate Change in SA - GHG




$CH_4$ from landfills represents 12% of total global $CH_4$ emissions (USEPA, 2006; World Bank, 2012)

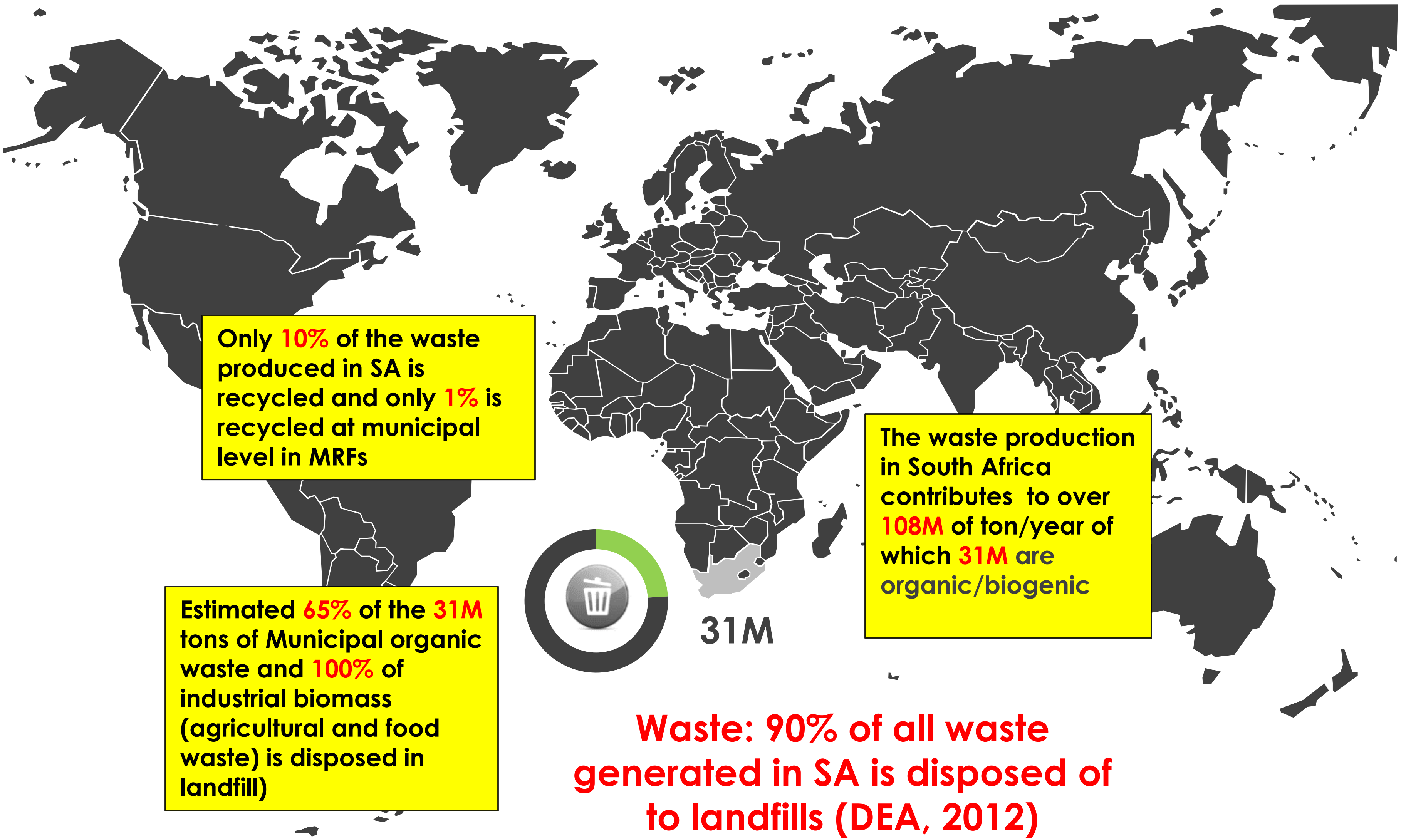
GHG emissions in the EU have more than halved from 1999 to 2007.

$CH_4$ has increased by 11.3% and GHG emissions have increased of almost 60% from waste sector in SA in past 15 years.

The waste sector in South Africa contributes to 4.3% of GHG emissions and 37.2% of total $CH_4$ (DEA, 2014)

**Emissions: 9 million tons of $CO_2$ equivalent (2016)**

# Waste and Climate Change in SA - WASTE




**Only 10% of the waste produced in SA is recycled and only 1% is recycled at municipal level in MRFs**

**The waste production in South Africa contributes to over 108M of ton/year of which 31M are organic/biogenic**

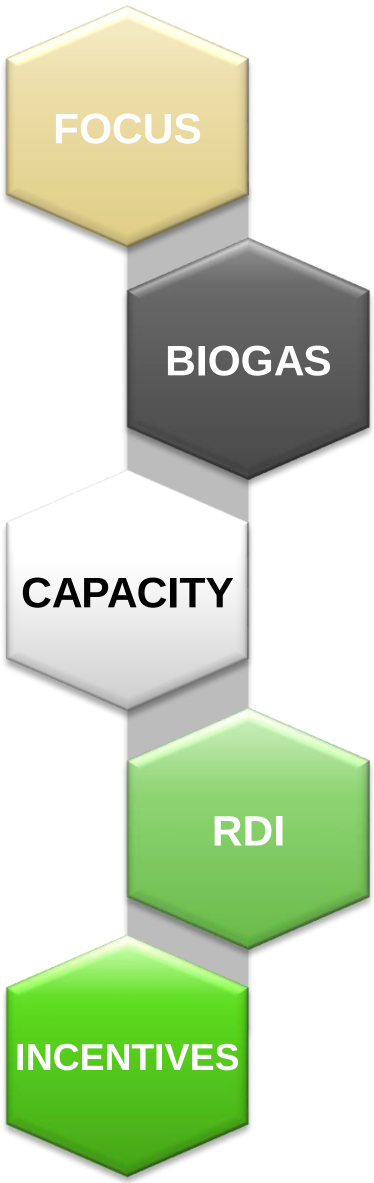
**Estimated 65% of the 31M tons of Municipal organic waste and 100% of industrial biomass (agricultural and food waste) is disposed in landfill)**

**Waste: 90% of all waste generated in SA is disposed of to landfills (DEA, 2012)**

# Waste Management in South Africa

- **Challenge of meeting high standards in service delivery with limited resources**
- Lack of environmental control systems and appropriate legislation
- **Limited know-how**, indiscriminate dumping
- **Lack of reliable data on waste streams and GHG emissions indicators**
- Poor environmental and waste awareness of the general public

# Golden rules to build the sector

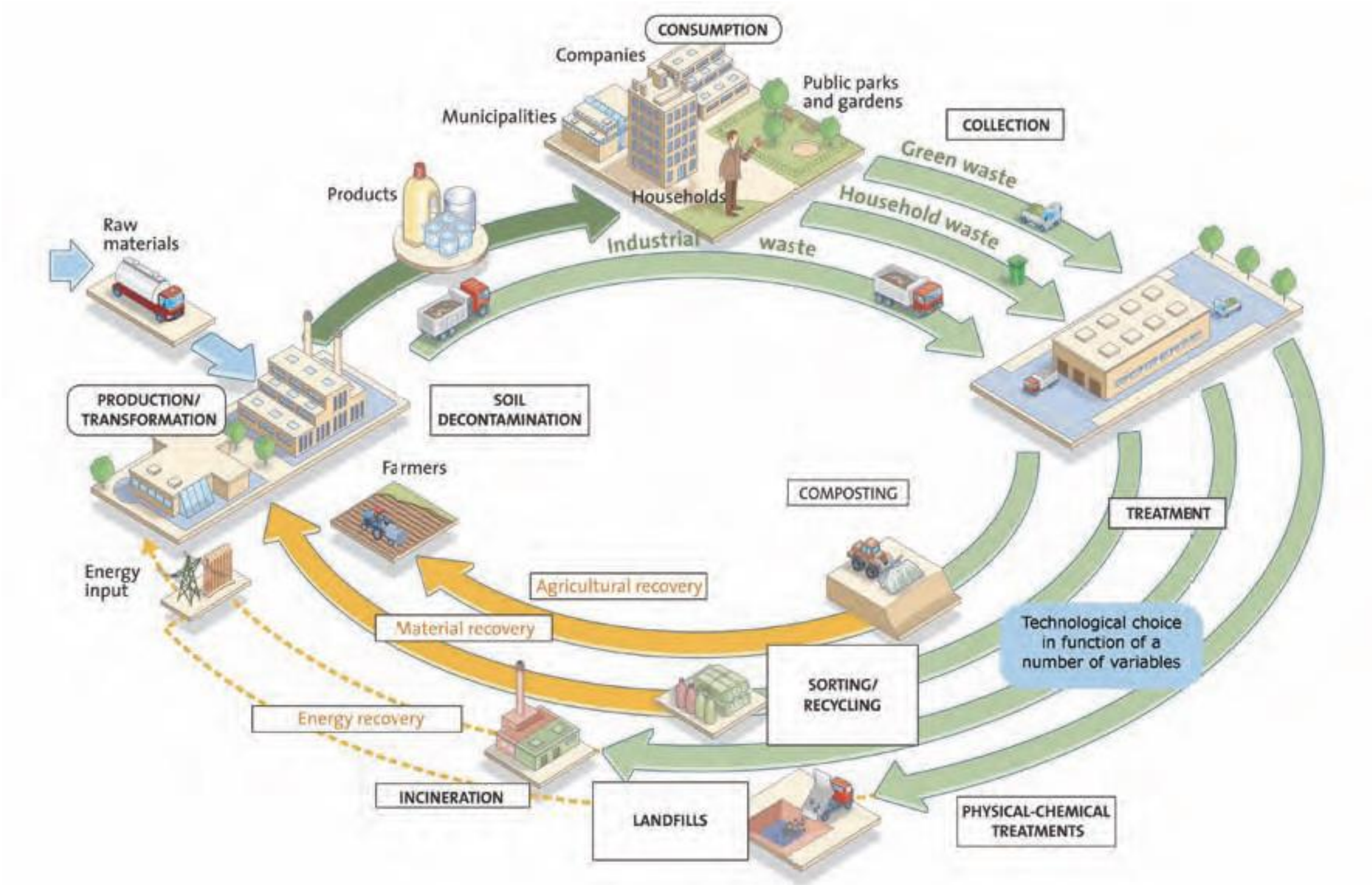



- Don’t mix apples with pears
- “Programmable Energy” is better
- Build capacity to build the sector
- Build projects through RDI
- Incentivise in the right direction

WASTE → RESOURCE

| Component | Biodegradable? | Combustible? | Recyclable? |
| --- | --- | --- | --- |
| Paper & Card | ✓ | ✓ | ✓ |
| Yard / Green | ✓ | ✓ | ✓ |
| Kitchen | ✓ | ✓ | ✓ |
| Wood | ✓ | ✓ | ✓ |
| Textiles | (✓) | ✓ | ✓ |
| Metals | ✗ | ✗ | ✓ |
| Glass | ✗ | ✗ | ✓ |
| Plastic | ✗ | ✓ | ✓ |
| Stones / fines | (✗) | ✗ | (✓) |

# Integrated Waste Management System

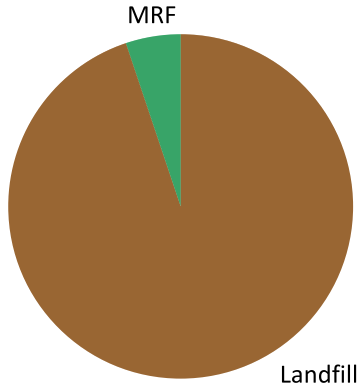



*From ISWA White Paper – Waste and Climate Change, 2009*

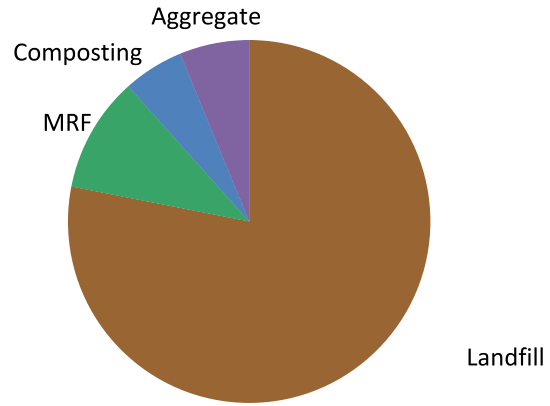
# Developing a Landfill Waste Volume Reduction Strategy

## The eThekwini Municipality

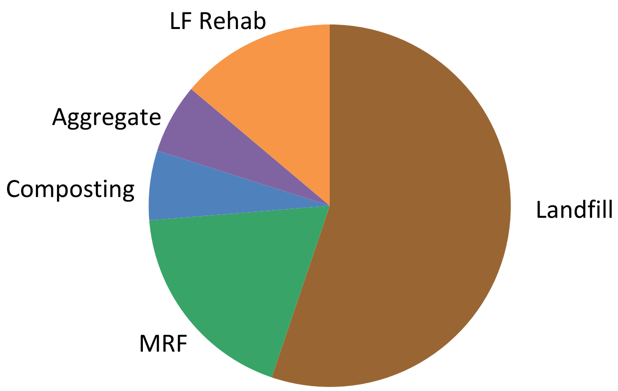
### Phase 1A Volume Distribution



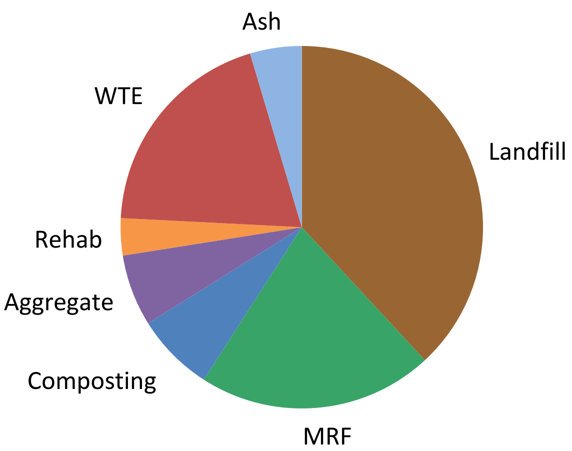

### Phase 1B Volume Distribution




### Phase 1C Volume Distribution




### Phase 2A Volume Distribution



# What is the W.R.O.S.E model?

- **W.R.O.S.E. = Waste & Resource Optimisation Scenario Evaluation model**
- Is a Zero Waste decision support tool
- WM Strategies: landfill, landfill gas recovery, recycling, AD and aerobic composting, Waste to Energy, biogas upgrading
- Evaluates GHG emissions reductions from applying waste diversion strategies
- Microsoft Excel Spreadsheet Interface

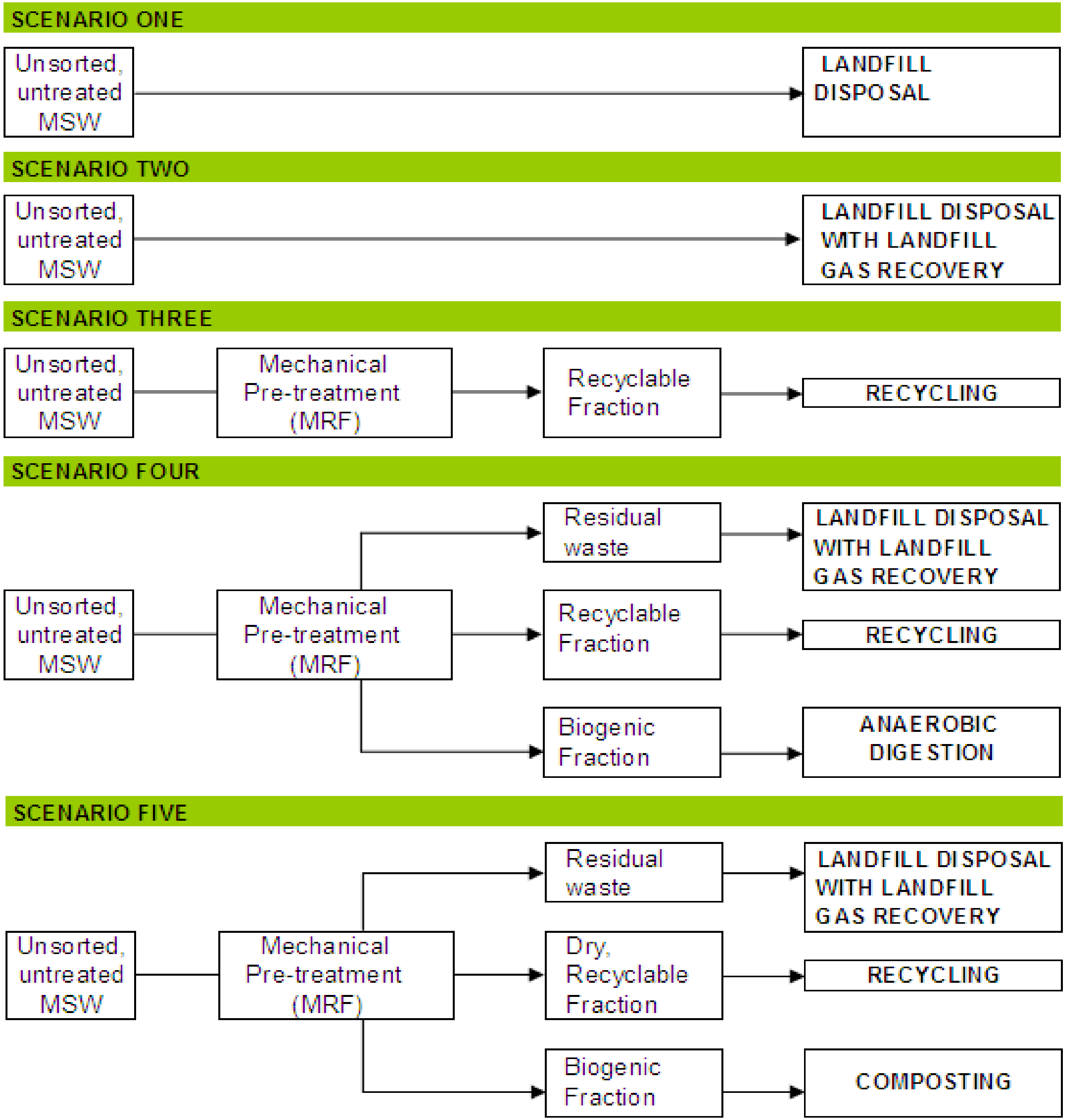
# The Waste Resource Optimization and Scenario Evaluation Model (WROSE)

- Developed by UKZN to assist South African municipalities and the private sector in achieving the zero waste targets and apply appropriate waste strategies

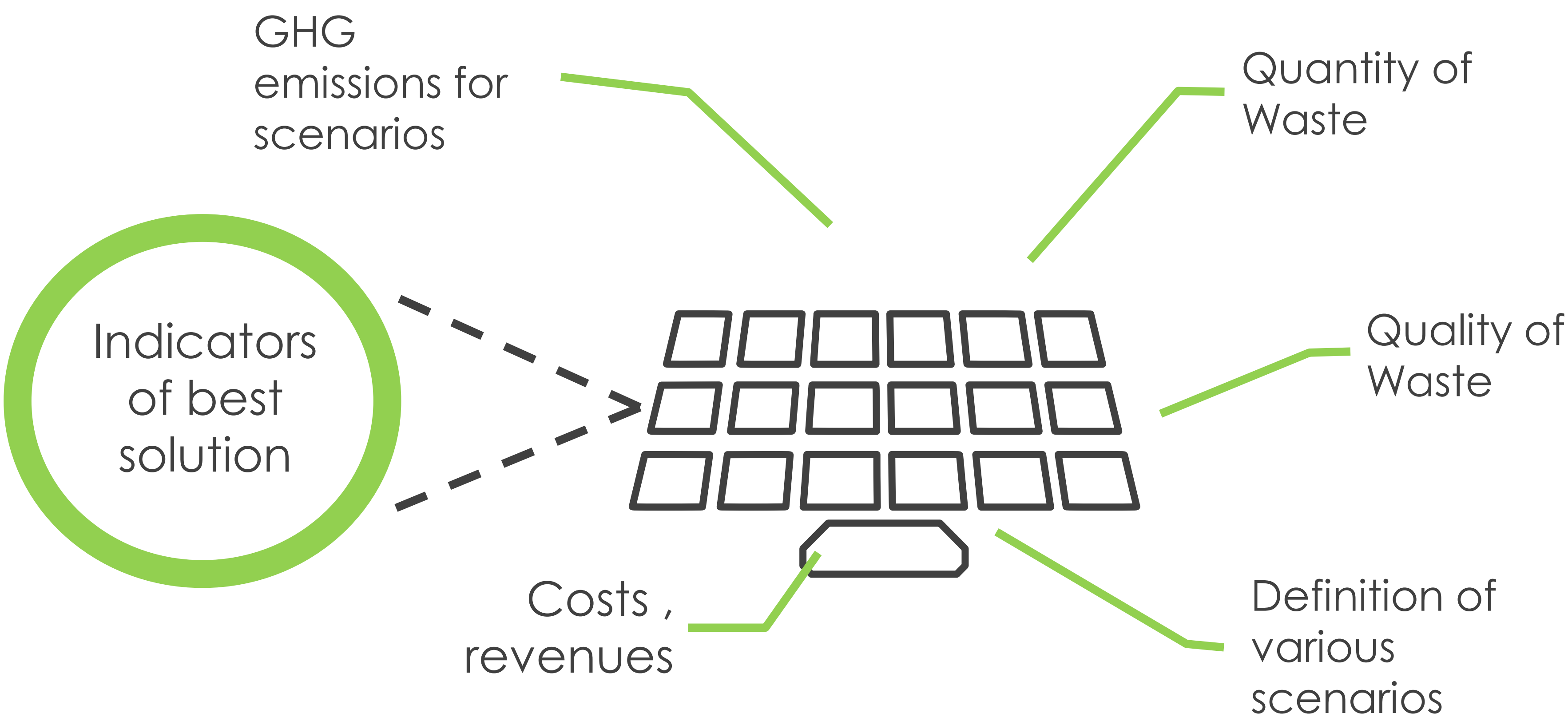
- WROSE was initially developed with 5 scenarios selected as most relevant/appropriate to waste management for SA Municipalities.

- Each technology and scenario in WROSE aims to aid the waste managers in determining a final decision

- WROSE outcomes are case specific – strategies and scenarios can be tailored to suite individual municipal needs


SCENARIO ONE
Unsorted, untreated MSW
LANDFILL DISPOSAL
SCENARIO TWO
Unsorted, untreated MSW
LANDFILL DISPOSAL WITH LANDFILL GAS RECOVERY
SCENARIO THREE
Unsorted, untreated MSW
Mechanical Pre-treatment (MRF)
Recyclable Fraction
RECYCLING
SCENARIO FOUR
Unsorted, untreated MSW
Mechanical Pre-treatment (MRF)
Residual waste
LANDFILL DISPOSAL WITH LANDFILL GAS RECOVERY
Recyclable Fraction
RECYCLING
Biogenic Fraction
ANAEROBIC DIGESTION
SCENARIO FIVE
Unsorted, untreated MSW
Mechanical Pre-treatment (MRF)
Residual waste
LANDFILL DISPOSAL WITH LANDFILL GAS RECOVERY
Dry, Recyclable Fraction
RECYCLING
Biogenic Fraction
COMPOSTING

# WROSE Model Framework



# WROSE Model Input Screen

Microsoft Excel - wrose

File Edit View Insert Format Tools Data Window Help Adobe PDF

H14

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | WASTE & RESOURCE OPTIMISATION STRATEGY EVALUATION MODEL | | | | | |
| 2 | W.R.O.S.E | | | | | |
| 3 | WASTE MATERIAL OR | Quantity of Waste Disposed/treated/diverted by (tons): | | | | |
| 4 | WASTE FRACTION | LANDFILL | LANDFILL | RECYCLING | ANAEROBIC | AEROBIC |
| 5 | | DISPOSAL | GAS REC | | DIGESTION | COMPOSTING |
| 6 | Newspaper | 5453 | | | | |
| 7 | General mixed paper (CMW) | 7234 | | | | |
| 8 | Scrap Boxes & Cardboard (K4) | 11402 | | | | |
| 9 | Low density polyethylene (LDPE) | 2450 | | | | |
| 10 | High density polyethylene (HDPE) | 1401 | | | | |
| 11 | Polyethylene-terephthalate (PET) | 2037 | | | | |
| 12 | Polypropylene (PP) | 1613 | | | | |
| 13 | Polyvinyl Chloride (PVC) | 8 | | | | |
| 14 | Polystyrene (PS) | 1101 | | | | |
| 15 | Glass | 6861 | | | | |
| 16 | Steel Cans/Tins | 4245 | | | | |
| 17 | Aluminium Cans | 547 | | | | |
| 18 | Biogenic Food Waste | 36608 | | | | |
| 19 | Garden Refuse: Green | 637 | | | | |
| 20 | Garden Refuse: Wood | 46 | | | | |
| 21 | Other | 32287 | | | | |
| 22 | Total Waste Diverted/Disposed | 113930 | 0 | 0 | 0 | 0 |

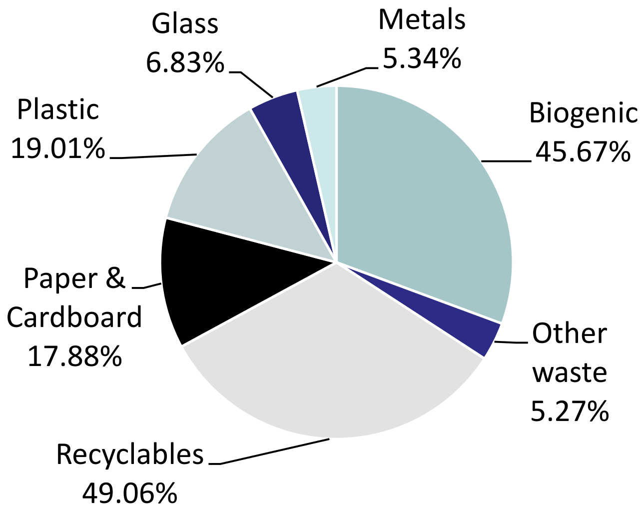
User enters waste fraction quantities to be diverted or disposed of by each strategy.

**Outputs :**

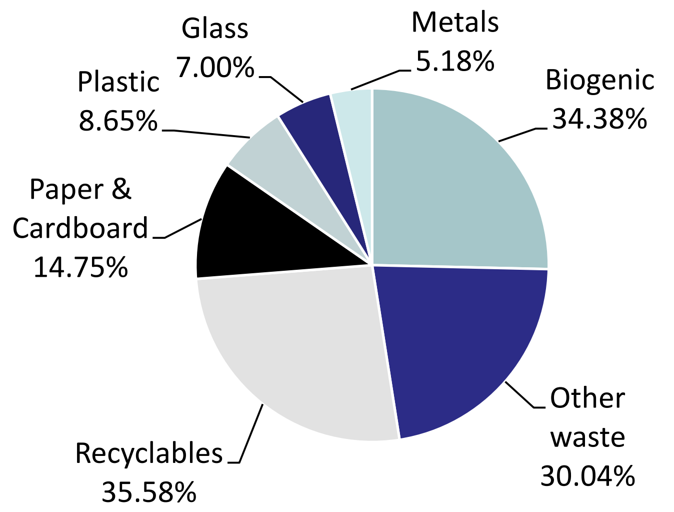
- GHG Emission Reduction Potential
- Landfill Space saving potential
- Economic Feasibility

# Comparison of Waste Streams

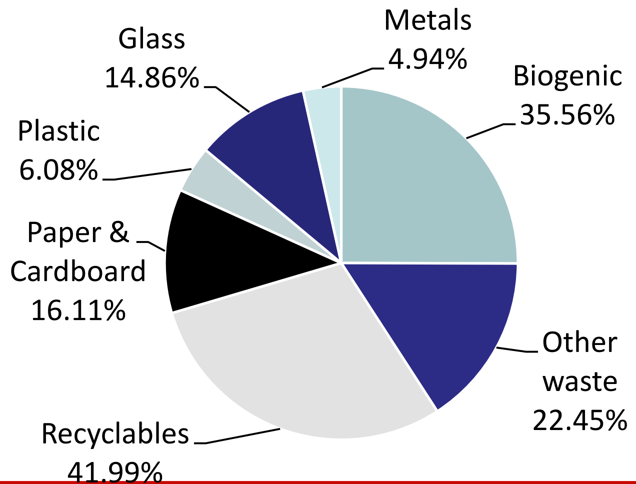
## eThekwini Household



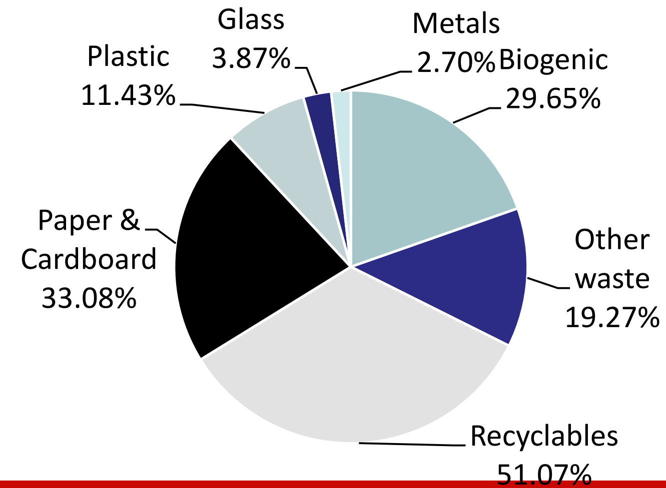

## UMDM Household



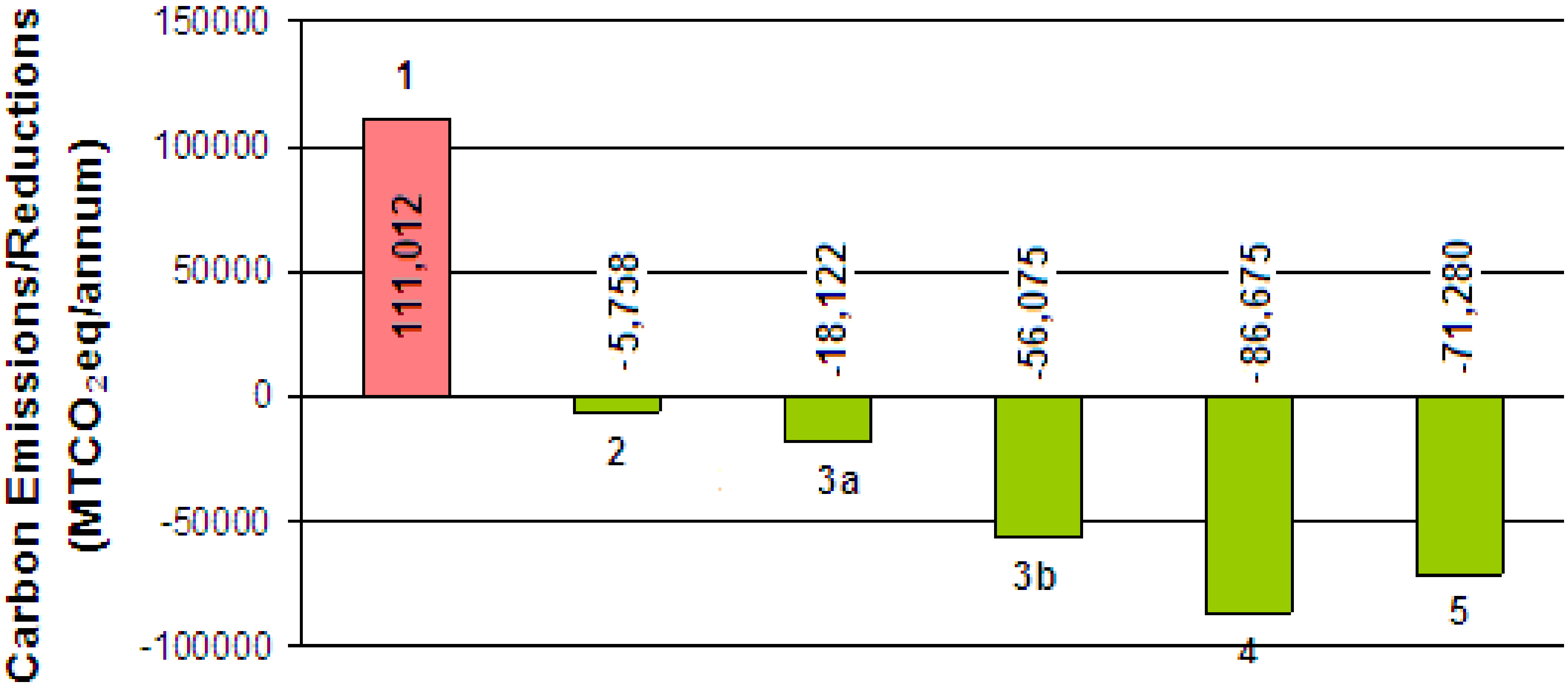

## eThekwini Commercial




## UMDM Commercial

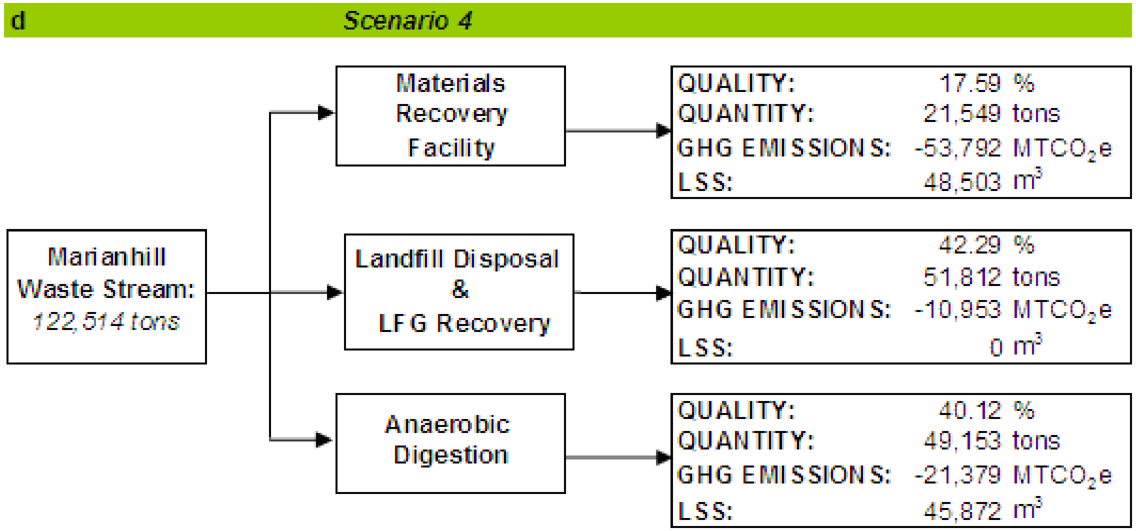


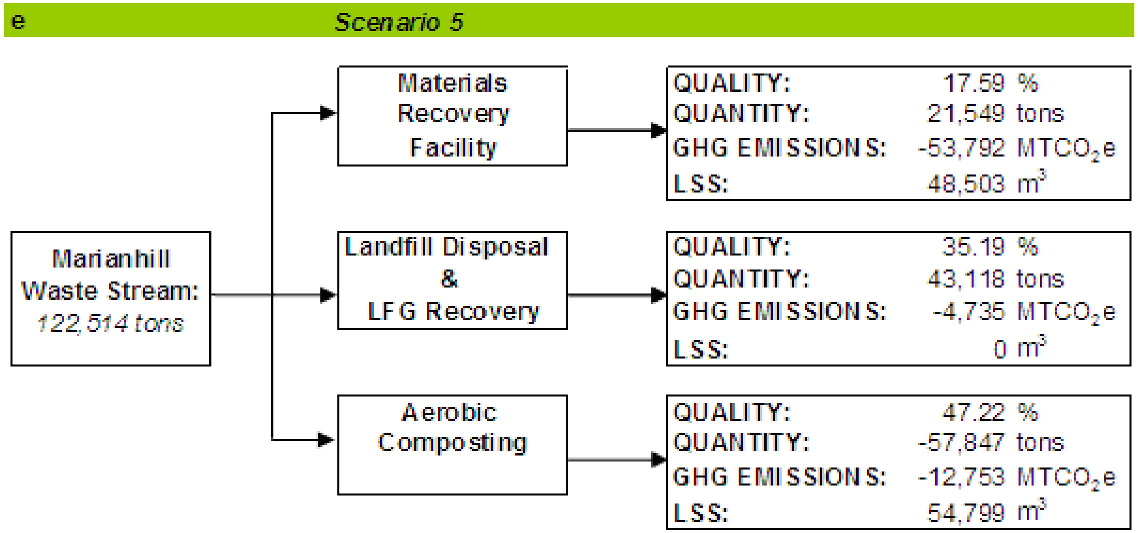
# Assessment of Marianhill Landfill




1. Landfill Disposal
2. LFG
3. LFG - MRF - 40% RR
4. MRF - 40%RR - AD
5. MRF - 40% RR - AC

# Marianhill Waste Stream – Landfill airspace savings



# Marianhill Economic Analysis

| Strategy | Quantity Managed/ Produced | Rate | Capital Cost (R) | Operating Cost (R/annum) | Income/Savings (R/annum) |
|---|---|---|---|---|---|
| **1. LANDFILL DISPOSAL & LFG RECOVERY** | | | | | |
| Landfill Gas Recovery System | 0.50 MW | | 1,100,000 | | |
| Landfill Disposal operations | 122,514 tons | 138 R/ton | | 16,906,932 | |
| Landfill Gas Recovery operating costs | 7,051,800 kWh | 0.018$/kWh | | 866,758 | |
| Sale of Electricty | 7,051,800 kWh | 0.047$/kWh | | | 2,263,201 |
| Certified Emission Reductions | 5,758 $MTCO_2e$ | 14 $/$MTCO_2e$ | | | 550,458 |
| Total | | | 1,100,000 | 17,773,690 | 2,813,659 |
| **2. MRF & RECYCLING** | | | | | |
| Materials Recycling Facility Capital Cost | 385 tpd | 30,668 $/tpd | 33,848,875 | | |
| Materials Recycling Facility Operating Cost | 385 tpd | 2,815 $/tpd | | 9,899,276 | |
| Sale of Recyclables | 21,549 tons | R/kg | | | 19,598,660 |
| Landfill airspace savings | 47,122 $m^3$ | 62.5 $R/m^3$ | | | 2,945,125 |
| Total | | | 33,848,875 | 9,899,276 | 22,543,785 |
| **3. ANAEROBIC DIGESTION** | | | | | |
| Anaerobic Digestion Plant Capital Cost | 49,153 tons | 15.24$ million | 104,066,340 | | |
| Anaerobic Digestion Plant Operating Cost | 49,153 tons | 28.2$/ton | | 9,465,084 | |
| Sale of electricity | 18,128,413 kWh | 0.047$/kWh | | | 5,818,124 |
| Sale of Compost | 29,492 tons | 250R/ton | | | 7,372,950 |
| Certified Emissions Reductions | 21,379 $MTCO_2e$ | 14 $/$MTCO_2e$ | | | 2,043,797 |
| Landfill airspace savings | 45,872 $m^3$ | 62.5 $R/m^3$ | | | 2,867,000 |
| Total | | | 104,066,340 | 9,465,084 | 18,101,871 |
| **4. AEROBIC COMPOSTING** | | | | | |
| Composting Facility Capital Cost | 57,847 tons | 2E+06R/180tpd | 3,066,667 | | |
| Composting Facility Operating Cost | 57,847 tons | 152.05R/ton | | 9,123,000 | |
| Sale of compost | 43,385 tons | 250R/ton | | | 10,846,313 |
| Certified Emissions Reductions | 12,753 $MTCO_2e$ | 14 $/$MTCO_2$ | | | 1,219,182 |
| Landfill airspace savings | 54,799 $m^3$ | 62.5 $R/m^3$ | | | 3,424,938 |
| Total | | | 3,066,667 | 9,123,000 | 15,490,433 |



# Dube Tradeport





# Dube Trade Port - AgriZone

# Dube Trade Port - Aerotropolis

# Dube Trade Port – Agri-Zone

- **Approx. 40 tons of fresh produce weekly**
- **Large quantities of waste**
- **Large organic fraction**
- **Phase 1:**
  - 16Ha of greenhouses
  - Post-harvest pack-house
  - Central packing and distribution centre
  - Nursery
  - Dube AgriLab – plant culture laboratory
- **Phase 2: 90Ha Expansion**
  - Greenhouses and tunnels
  - Packing and distribution facilities
  - Waste-to-energy operation

# Aims and Objectives

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- To investigate the feasibility of establishing an electricity biodigester at the AgriZone of Dube Trade Port.

Objectives:

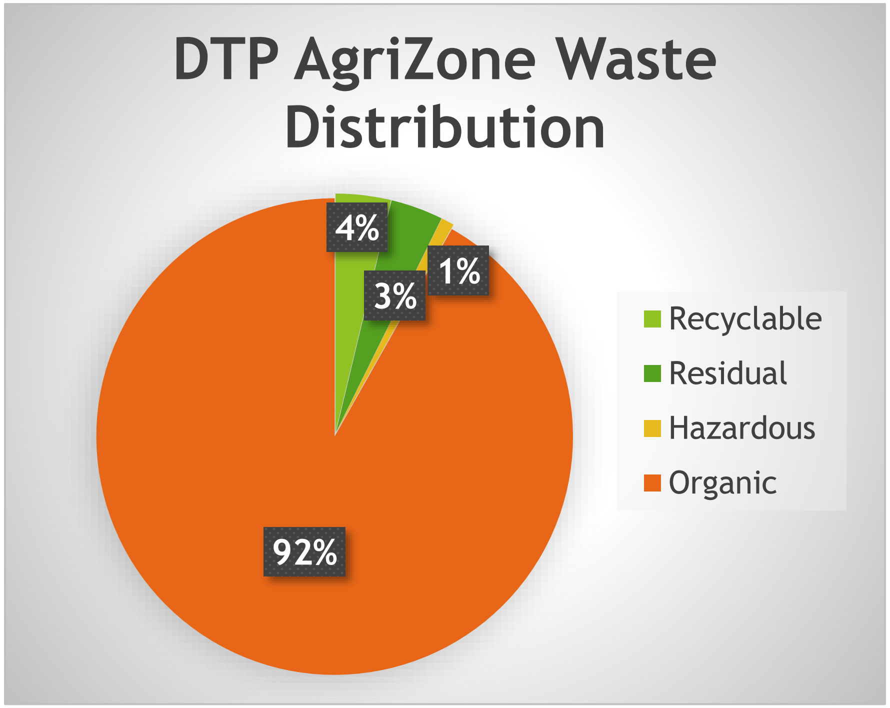
- Conduct a full waste stream analysis at the AgriZone
- Characterise the organic fruit and vegetable waste
- Determine the biochemical methane potential of organic fruit and vegetable waste for anaerobic digestion
- Analyse various waste management scenarios using the Waste and Resource Optimisation Scenario Evaluation (WROSE) model
- Evaluate the best waste management scenario using various indicators of sustainability

# Waste Streams

- General waste
- Recyclables
- Organic waste
- Hazardous waste
- Wastewater Treatment Works

**AVERAGE WASTE VOLUMES :**

| Waste Stream | Amount Generated per Month |
|---|---|
| **Recyclable** | 5.25 tons |
| **General/Residual** | 4.99 tons |
| **Hazardous** | 1.24 tons |
| **Organic** | 128.81 tons |



# Waste management strategy (I)

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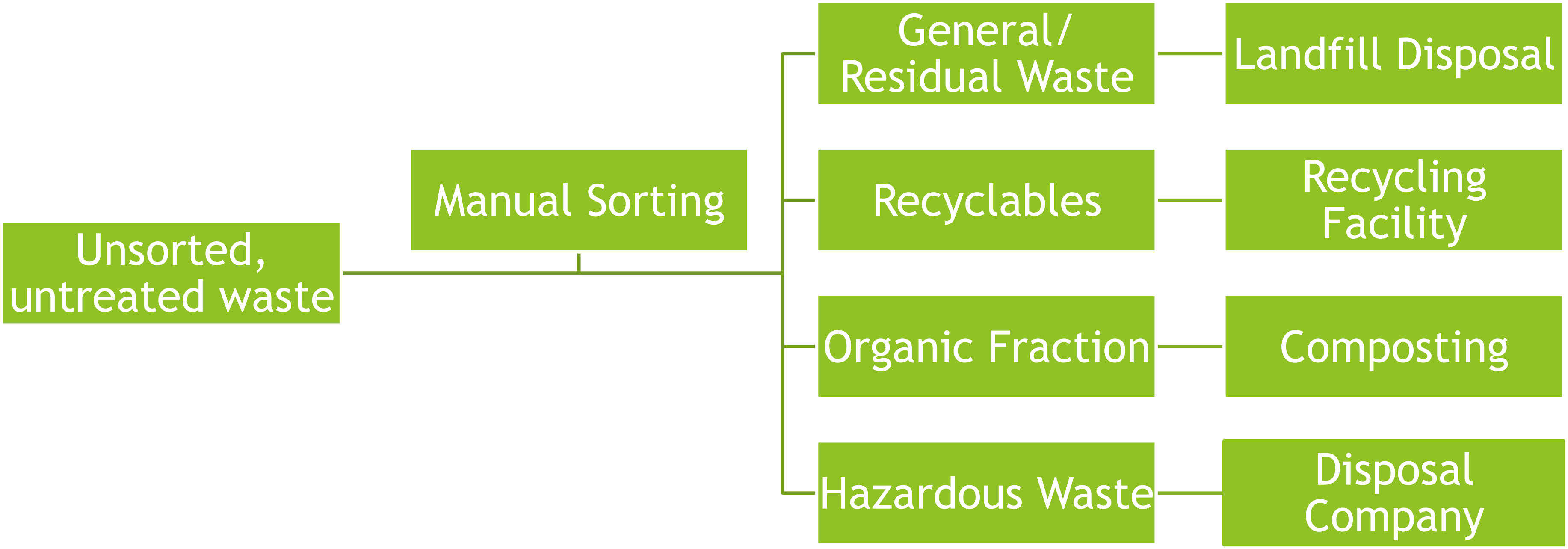
**PHILOSOPHY:**

Separate as much waste at each source, conduct further separation at a central facility and finally dispose at a licensed facility.



# Waste management strategy (II)

- **Sorting of waste streams conducted at the source**
  - Allocated bins for each waste stream
  - Further separation conducted by external companies
  - Disposal of each waste stream handled by respective companies
- **Waste Disposal Companies:**
  - Living Earth – All organic waste
  - RE-Ethical – Recyclables, general and hazardous waste

- **On average 50% of waste generated is recycled and reprocessed**
- **The other 50% consists of a small quantity of hazardous waste and residual municipal solid waste**
- **100% of organic waste is recycled into compost**

# Sources of Recyclable Waste

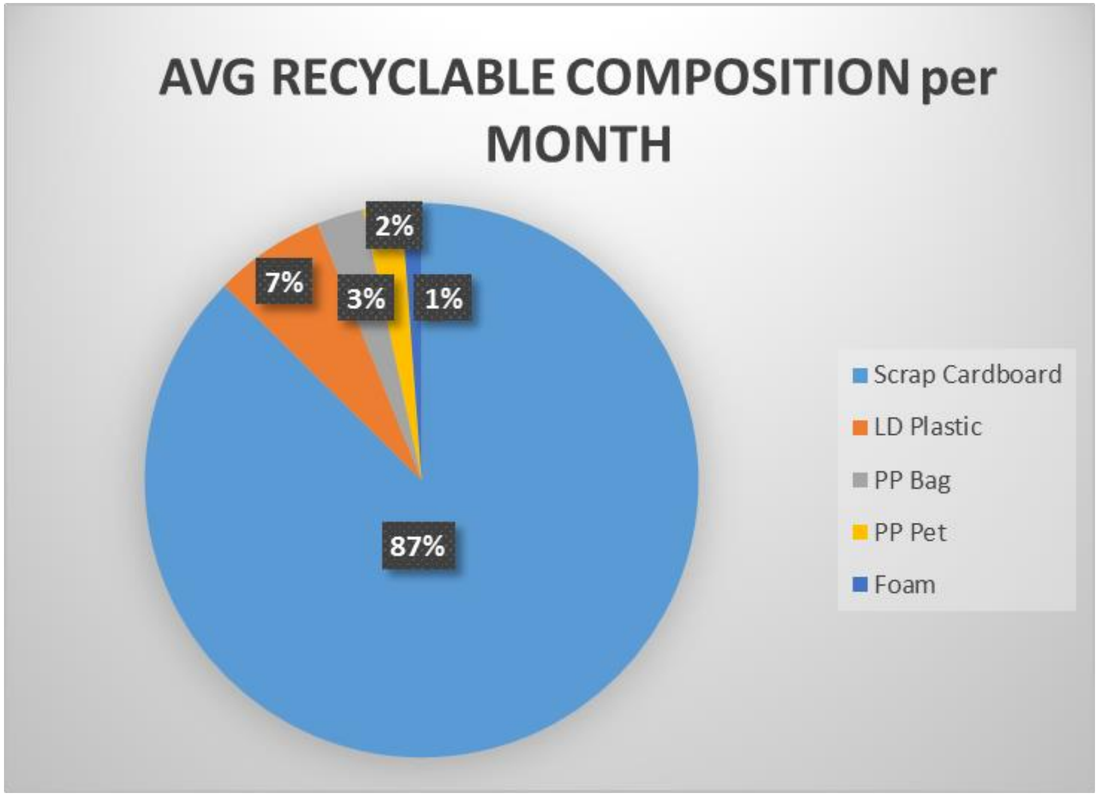
**SOURCES OF RECYCLABLE WASTE:**

- AgriZone offices
- Cafeteria
- Farmwise Pack house
- Day-to-day Greenhouse operations
- Packing and distribution centre
- Dube AgriLab

**RECYCLABLE WASTE MATERIALS:**

- Scrap cardboard & office paper
- Tetrapak post-consumer
- LD film, plastic & strapping
- HD bottles
- PP Bag & PET
- PVC
- Scrap metal & steel cans
- Glass
- CMW
- Foam

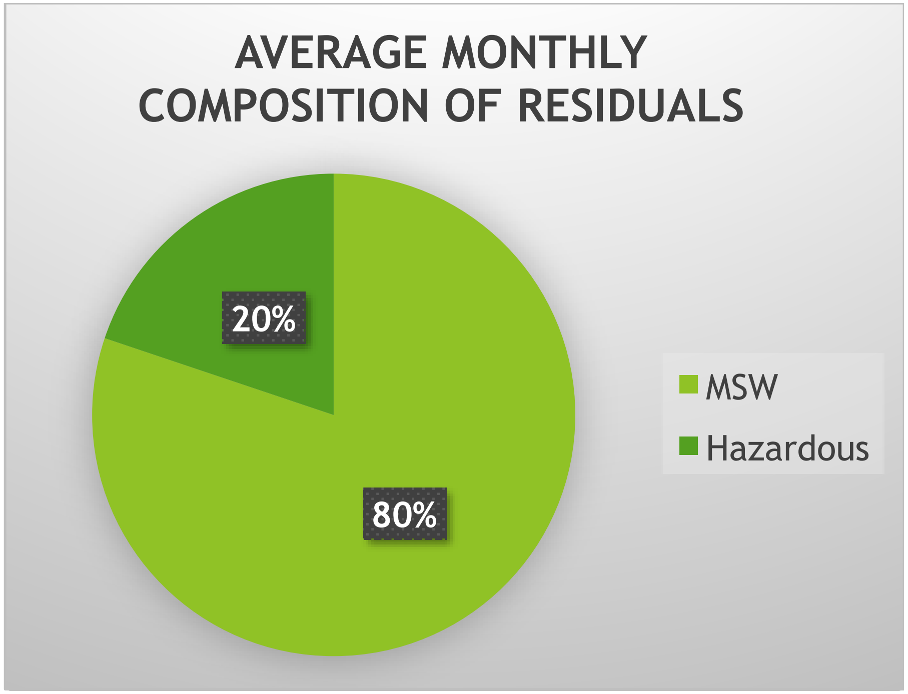
## RECYCLABLE



# Sources of Residual Waste

- **Sources of Residual Waste from Recycling:**
  - AgriZone offices
  - Cafeteria
  - Farmwise Pack house
  - Day-to-day Greenhouse operations
  - Packing and distribution centre
  - Dube AgriLab
- **Composition:**
  - 80.2% Municipal Solid Waste
  - 19.8% Hazardous Waste

RESIDUAL



# Sources of Hazardous Waste

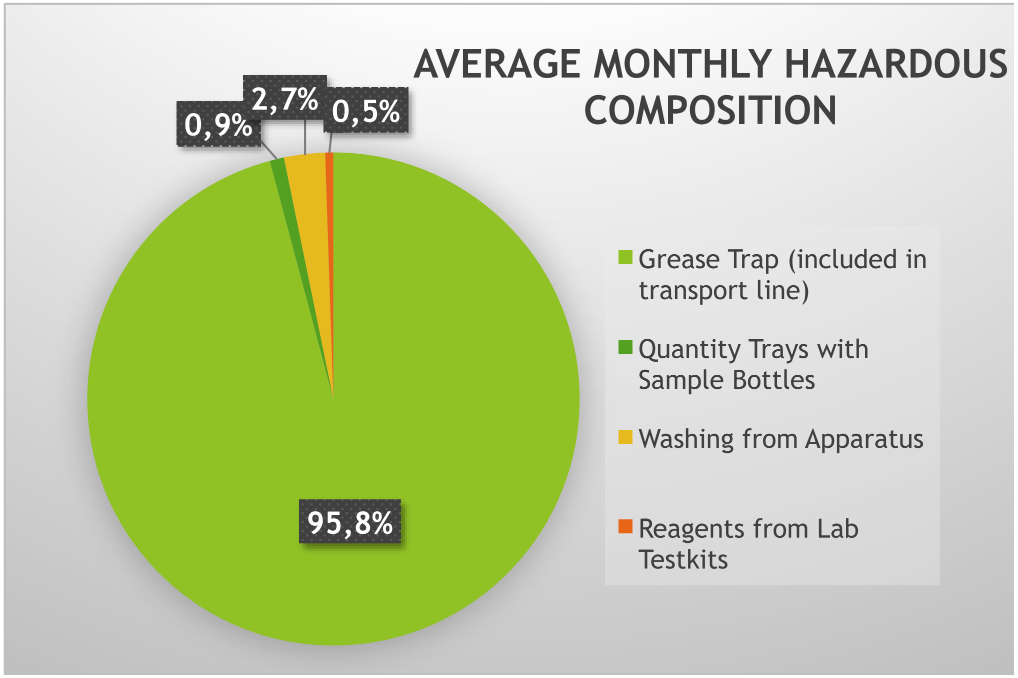
**SOURCES OF HAZARDOUS WASTE:**

- **Oil Separators**
- **Water Testing Laboratory**
  - Washing apparatus
  - Diluted testing chemicals
  - Concentrated testing chemicals
- **Reverse Osmosis Process**
  - Chemicals

**HAZARDOUS WASTE MATERIALS:**

- 95.8% Grease trap (incl. in transport line)
- 0.9% Quantity trays with sample bottles
- 0.5% Reagents from lab test kits
- 2.7% Washing from apparati

## HAZARDOUS



# Wastewater Works Operations

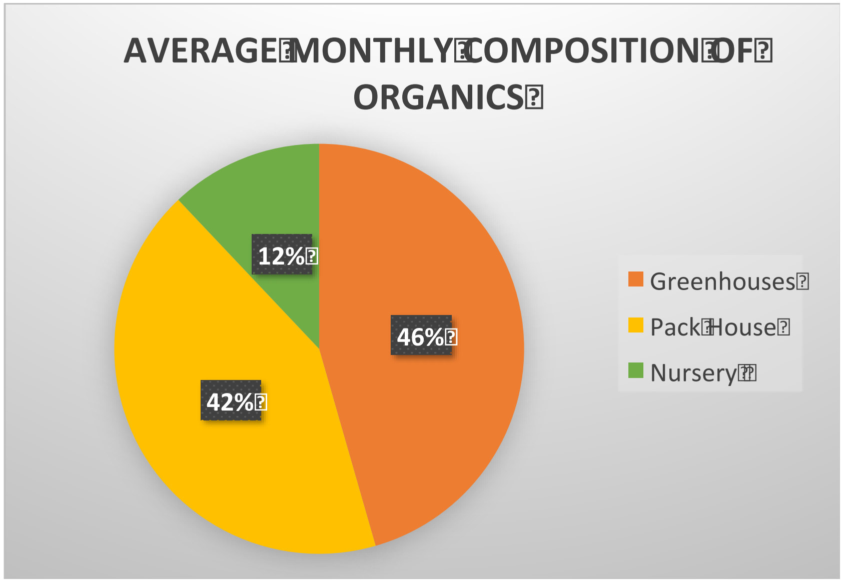
- **Plant running at 25% recovery rate - 8hrs/day, 5 days a week.**
- **NO Sludge produced. Wastewater is high in COD, electrical conductivity and sodium content.**

- **Source of wastewater:**
  - Partial airport effluent
  - Run-off from leached greenhouse irrigation
- **Dilute wastewater with rainwater, which is then used to irrigate nearby sugarcane fields for Tongaat-Hullet Co.**

# Sources of Organic Waste

- **Organic waste of an acceptable standard is sent to local underprivileged schools.**
- **Excess waste is sent for composting.**
- **Sources of organic waste:**
  - Farmwise Pack House
  - Greenhouse Produce
  - Occasional garden refuse from Nursery
- **Composition and variability:**
  - Various fruit and vegetables
  - Greenhouse operation stays constant throughout the year but the type of plant waste varies daily
  - Range of products at the pack-house remains constant throughout the year but the exact composition varies daily

## ORGANIC




- **Greenhouses operated at 75% capacity in 2014, 2015 and 50% in 2016 and 2017.**
- **Maximum waste volumes are approximately 460m$^3$/month at full capacity.**

# Experimental Methods and Results

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METHODOLOGY

- **Characterisation tests**
  - Pack house
  - Greenhouses
  - Mix samples
  - Inoculum from WWTP
- **BMP tests on all the above**

RESULTS

- The waste characterisation tests conducted on fruit and vegetable samples showed favourable characteristics of the feedstock for AD.
- Main disadvantage: high acidity of the samples
- Rapid acidification and accumulation of VFAs hindered methane production and resulted in an initial lag phase of approximately 20 to 30 days before the system reached full methanogenesis

| |
|---|
| **% Moisture Content** |
| **%TS Solid** |
| **%VS Solid** |
| **TS Eluate (g/l)** |
| **VS Eluate (g/l)** |
| **TSS Eluate (g/l)** |
| **VSS Eluate (g/l)** |
| **pH** |
| **COD (mg/l)** |
| **BOD (mg/l)** |
| **BOD:COD Ratio** |
| **Nitrate (mg/l)** |
| **Ammonia (mg/l)** |
| **Respirometric Index (mg/g Dry Mass)** |

# W.R.O.S.E model – Scenario 1

## SCENARIO 1:

Unsorted, untreated Waste → Landfill Disposal

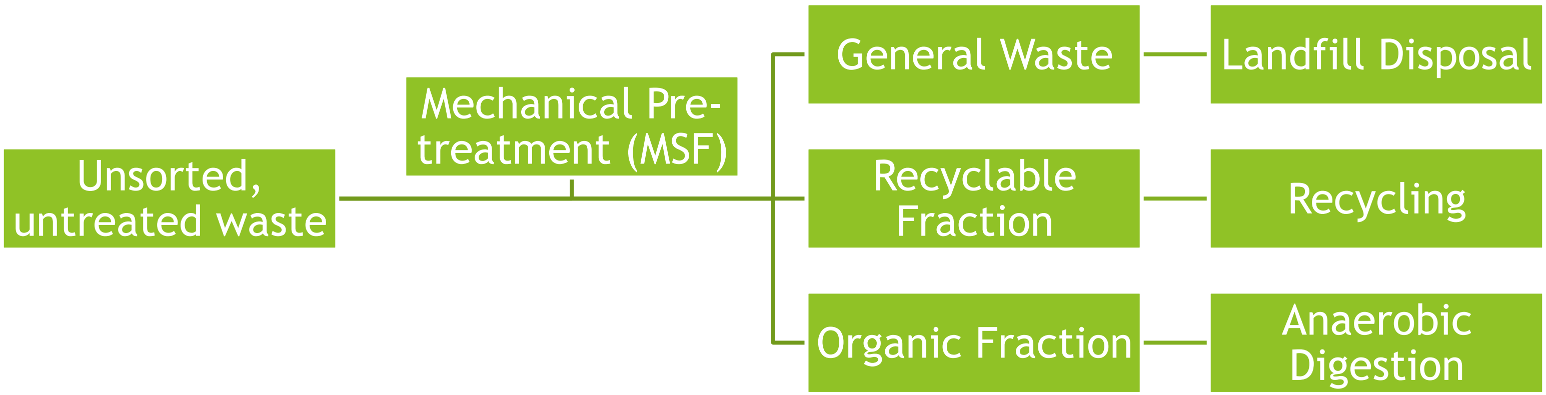
- **Baseline scenario: No waste management strategy employed on site**
- **All waste sent to landfill**
- **No sorting**
- **No pre-treatment**

Dube AgriZone Waste (1652.29 tons) → Landfill Disposal with Gas Recovery →

Quality = 100%
Quanity = 1652.29 tons
GHG Emissions = 220.02 MTCO2EQ
LSS = 0 m3

# W.R.O.S.E model – Scenario 2

## SCENARIO 2:




- **Future waste management strategy at Dube AgriZone**
- **Martial recovery facility for dry fraction**
- **0.5MW electricity bio-digester on site for organic fraction**

# W.R.O.S.E model – Scenario 3

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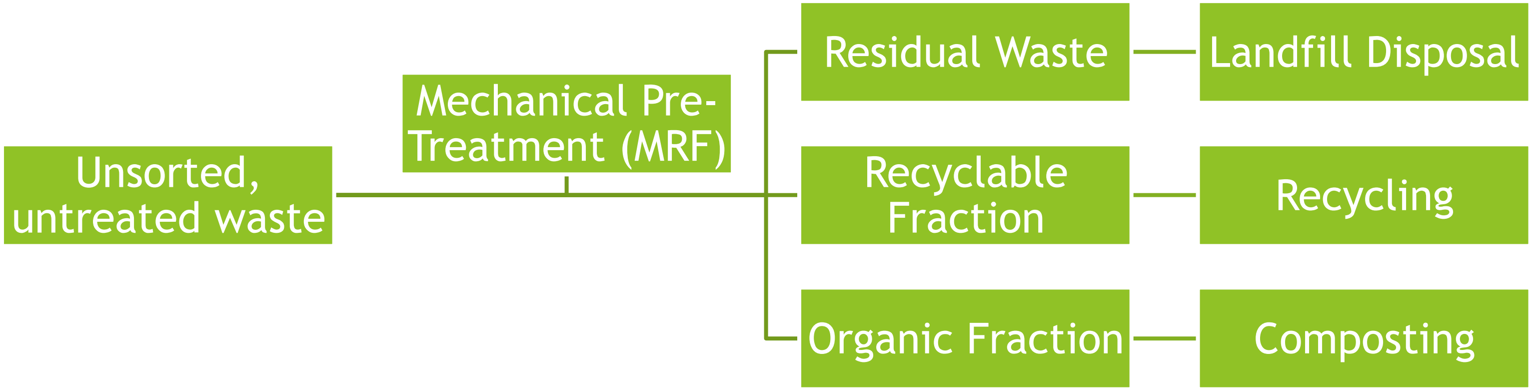
## SCENARIO 3:




- **Current waste management strategy at Dube AgriZone**
- **Basic sorting of waste streams conducted at source**
- **Recyclables and General waste recycled/disposed of by RE-Ethical**
- **Organic waste composted by Living Earth**

# W.R.O.S.E model – Scenario 2 Results

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## SCENARIO 2 RESULTS

**Dube AgriZone Waste (2468.17 tons)**

- **Landfill Disposal with Gas Recovery**
  - Quality = 10.39%
  - Quanity = 256.51 tons
  - GHG Emissions = 34.16 MTCO2EQ
  - LSS = 0 m3
- **Materials Recovery Facility**
  - Quality = 1.46%
  - Quanity = 35.99 tons
  - GHG Emissions = 21.10 MTCO2EQ
  - LSS = 29.99 m3 (Mixed MSW Density)
  - = 81.50 m3 (US EPA Landfill)
- **Anaerobic Digestion**
  - Quality = 88.15%
  - Quanity = 2175.67 tons
  - GHG Emissions = 591.43 MTCO2EQ
  - LSS = 1813.06 m3 (Mixed MSW Density)
  - = 1834.46 m3 (US EPA Landfill)

### ADVANTAGES

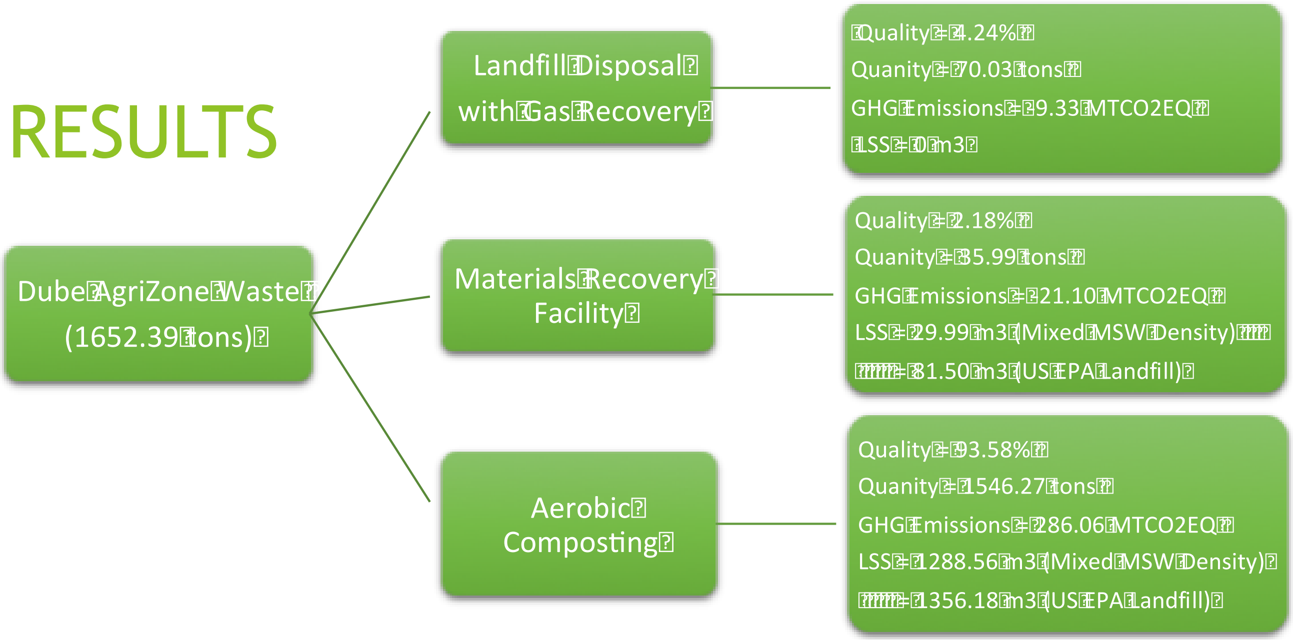
- Recyclables recovered on site
- No external costs from waste companies
- Job creation
- Degradation of organic waste occurs in a controlled environment
- Various benefits from by-products produced in the AD process
- AgriZone becomes an independent power producer
- Highest overall GHG reduction

### DISADVANTAGES

- High capital costs
- Maintenance costs

# W.R.O.S.E model – Scenario 3 Results

## SCENARIO 3 RESULTS



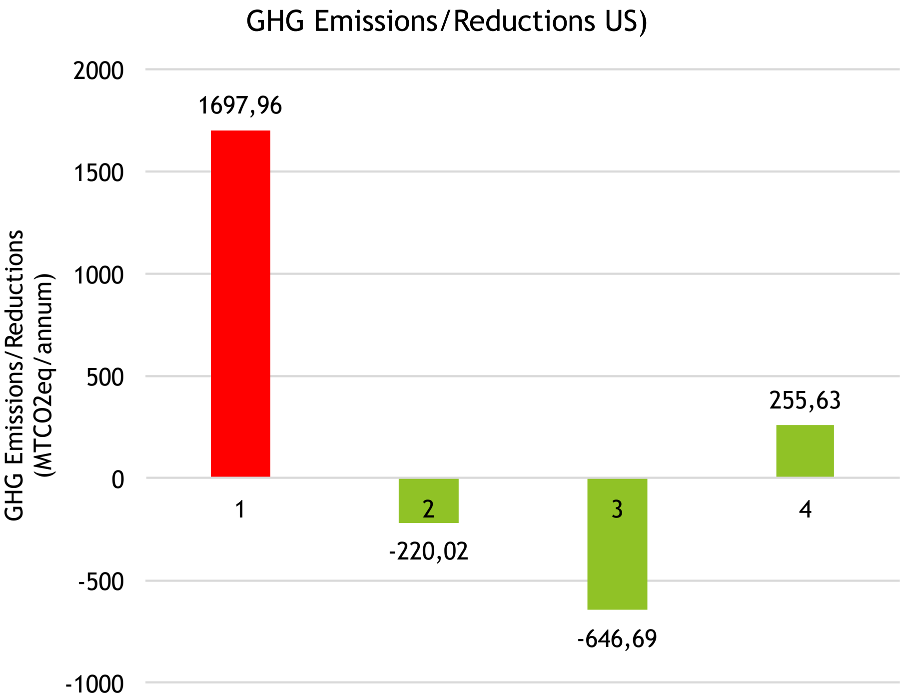

**ADVANTAGES**

- **Sorting of waste streams at the source.**
- **Less capital contribution required for composting.**
- **Composting is environmentally friendly.**

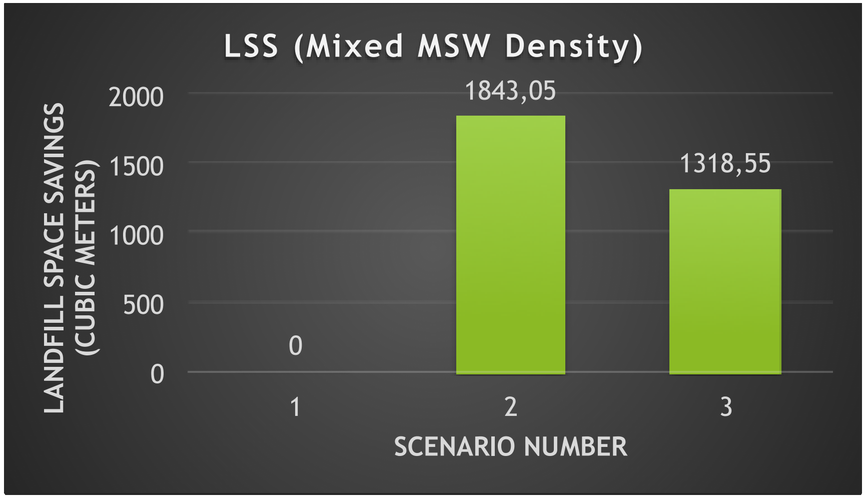
**DISADVANTAGES**

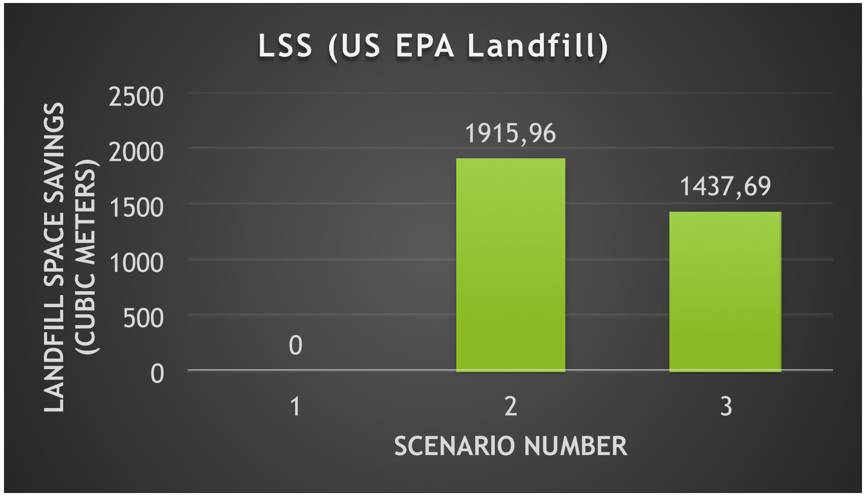
- **Composting results in GHG emissions**
- **Unnecessary costs incurred by hiring external companies**
- **Nutrient content in compost often has to be upgraded resulting in excess costs**
- **Composting has no energy recovery (required energy input)**

# W.R.O.S.E model – Scenario Comparison




1. Landfill Disposal
2. LFG
3. LFG - MRF 48%RR - AD
4. LFG - MRF 48%RR - AC



# W.R.O.S.E – Economic Analysis: MRF

## MRF PLANT

### ECONOMIC FEASIBILITY OF BREAK EVEN CASE

**ASSUMPTIONS:**

| | | |
|---|---|---|
| 1 | Project life | 20 |
| 2 | Payback period | 20 |
| 3 | Debt Interest rate | 10.3% |
| 4 | Debt percentage | 50.0% |

**ESTIMATED REVENUE:**

| | Tons/year | Sale price/ton | Raw material/ton | GM/Ton | REVENUE |
|---|---|---|---|---|---|
| Newspaper | 0 | R 500.00 | R 0.00 | R 500.00 | R 0.00 |
| CWM | 0 | R 500.00 | R0.00 | R 500.00 | R 0.00 |
| K4 | 31.20963768 | R 600.00 | R0.00 | R 600.00 | R 18 725.78 |
| LDPE | 2.51639856 | R 1 500.00 | R0.00 | R 1 500.00 | R 3 774.60 |
| HDPE | 0.02042352 | R 2 700.00 | R0.00 | R 2 700.00 | R 55.14 |
| PET | 0.79474824 | R 2 500.00 | R0.00 | R 2 500.00 | R 1 986.87 |
| PP | 0.9828 | R 2 000.00 | R0.00 | R 2 000.00 | R 1 965.60 |
| PVC | 0 | R 1 000.00 | R0.00 | R 1 000.00 | R 0.00 |
| PS | 0.4169412 | R 1 000.00 | R0.00 | R 1 000.00 | R 416.94 |
| Glass | 0 | R 380.00 | R0.00 | R 380.00 | R 0.00 |
| FE Cans | 0.04935528 | R 1 060.00 | R0.00 | R 1 060.00 | R 52.32 |
| AL Cans | 0 | R 1 060.00 | R0.00 | R 1 060.00 | R 0.00 |
| | | REVENUE/YEAR | R 26 977 | | |

| YEAR | RAMP UP | REVENUE | CAPITAL THROUGH DEBT | CAPITAL RECOVERY | INTEREST | OPERATING COSTS | GROSS PROFIT | DEPRE-CIATION |
|---|---|---|---|---|---|---|---|---|
| 0 | | | -R 15 625 458 | | | | -R 15 625 458 | |
| 1 | 80% | R 21 581.80 | | -R 265 168 | -R 1 601 609 | -R 10 148 376 | -R 11 993 571 | R 6 250 183 |
| 2 | 85% | R 22 930.66 | | -R 292 347 | -R 1 574 430 | -R 10 782 649 | -R 12 626 496 | R 6 250 183 |
| 3 | 90% | R 24 279.53 | | -R 322 313 | -R 1 544 464 | -R 11 416 923 | -R 13 259 420 | R 6 250 183 |
| 4 | 95% | R 25 628.39 | | -R 355 350 | -R 1 511 427 | -R 12 051 196 | -R 13 892 345 | R 6 250 183 |
| 5 | 100% | R 26 977.25 | | -R 391 773 | -R 1 475 004 | -R 12 685 470 | -R 14 525 270 | R 6 250 183 |
| 6 | 100% | R 26 977.25 | | -R 431 930 | -R 1 434 847 | -R 12 685 470 | -R 14 525 270 | R 0 |
| 7 | 100% | R 26 977.25 | | -R 476 203 | -R 1 390 574 | -R 12 685 470 | -R 14 525 270 | R 0 |
| 8 | 100% | R 26 977.25 | | -R 525 014 | -R 1 341 763 | -R 12 685 470 | -R 14 525 270 | R 0 |
| 9 | 100% | R 26 977.25 | | -R 578 828 | -R 1 287 949 | -R 12 685 470 | -R 14 525 270 | R 0 |
| 10 | 100% | R 26 977.25 | | -R 638 158 | -R 1 228 620 | -R 12 685 470 | -R 14 525 270 | R 0 |
| | | | | ######## | -R 13 162 068 | IRR = | #NUM! | |

| | | |
|---|---|---|
| ESTIMATED CAPITAL COST: | R | 31 250 916.84 |
| ESTIMATED OPERATING COST: | R | 12 685 469.80 |

# W.R.O.S.E – Economic Analysis: Composting Plant

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## AEROBIC COMPOSTING PLANT

### ECONOMIC FEASIBILITY OF BREAK EVEN CASE

**ASSUMPTIONS:**

| | | |
|---|---|---|
| 1 | Project life | 10 |
| 2 | Payback period | 10 |
| 3 | Debt Interest rate | 10.3% |
| 4 | Debt percentage | 50.0% |

12/04/2016

**ESTIMATED REVENUE:**

| | | |
|---|---|---|
| Sale price/Ton of compost | R 210.00 | ? |
| Raw Material/Ton of compost | R 0.00 | ? |
| GM/Ton of compost | R 210.00 | |
| Tons of compost/day | 3.2214 | |
| Tons of compost/month | 96.642 | |
| Tons of compost/year | 1159.704 | |

**REVENUE/YEAR = R 243 538**

| YEAR | RAMP UP | REVENUE | CAPITAL THROUGH DEBT | CAPITAL RECOVERY | INTEREST | OPERATING COSTS | GROSS PROFIT BEFORE TAX | DEPRE-CIATION |
|---|---|---|---|---|---|---|---|---|
| 0 | | | -R 23 535 | | | | -R 23 535 | |
| 1 | 80% | R 194 830.27 | | -R 1 459 | -R 2 412 | -R 188 089 | R 2 870 | R 9 414 |
| 2 | 85% | R 207 007.16 | | -R 1 609 | -R 2 263 | -R 199 844 | R 3 292 | R 9 414 |
| 3 | 90% | R 219 184.06 | | -R 1 774 | -R 2 098 | -R 211 600 | R 3 713 | R 9 414 |
| 4 | 95% | R 231 360.95 | | -R 1 955 | -R 1 916 | -R 223 355 | R 4 134 | R 9 414 |
| 5 | 100% | R 243 537.84 | | -R 2 156 | -R 1 716 | -R 235 111 | R 4 556 | R 9 414 |
| 6 | 100% | R 243 537.84 | | -R 2 377 | -R 1 495 | -R 235 111 | R 4 556 | R 0 |
| 7 | 100% | R 243 537.84 | | -R 2 620 | -R 1 251 | -R 235 111 | R 4 556 | R 0 |
| 8 | 100% | R 243 537.84 | | -R 2 889 | -R 983 | -R 235 111 | R 4 556 | R 0 |
| 9 | 100% | R 243 537.84 | | -R 3 185 | -R 686 | -R 235 111 | R 4 556 | R 0 |
| 10 | 100% | R 243 537.84 | | -R 3 512 | -R 360 | -R 235 111 | R 4 556 | R 0 |
| | | | | **-R 23 535** | **-R 14 820** | **IRR =** | **10.87%** | |

| | | |
|---|---|---|
| **ESTIMATED CAPITAL COST:** | R | 47 070.68 |
| **ESTIMATED OPERATING COST:** | R | 235 110.66 |

# W.R.O.S.E – Economic Analysis: AD Plant

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

## ANAEROBIC DIGESTER PLANT

### ECONOMIC FEASIBILITY OF BREAK EVEN CASE

**ASSUMPTIONS:**

| | | |
|---|---|---|
| 1 | Project life | 20 |
| 2 | Payback period | 20 |
| 3 | Debt Interest rate | 10.3% |
| 4 | Debt percentage | 50.0% |

12/04/2016

**ESTIMATED REVENUE:**

| | | | | |
|---|---|---|---|---|
| ? | Production Cost/KWH | R 0.96 | Sale price/Ton of digestate | R 250.00 ? |
| | Raw Materials/KWH | R 0.00 | Raw Material/Ton of digestate | R 0.00 |
| | GM/KWH | R 0.96 | GM/Ton of Digestate | R 250.00 |
| | KWH/H | 278.6 | Tons of digestate/day | 3.576439233 |
| | KWH/m | 200590.5551 | Tons of digestate/month | 107.293177 |
| | KWH/y | 2407086.661 | Tons of digestate/year | 1287.518124 |
| | **REVENUE/YEAR =** | **R 2 632 683** | | |

| YEAR | RAMP UP | REVENUE | CAPITAL THROUGH DEBT | CAPITAL RECOVERY | INTEREST | OPERATING COSTS | GROSS PROFIT BEFORE TAX | DEPRE-CIATION |
|---|---|---|---|---|---|---|---|---|
| 0 | | | **-R 19 374 953** | | | | -R 19 374 953 | |
| 1 | 80% | R 2 106 146.18 | | -R 328 797 | -R 1 985 933 | -R 3 117 903 | -R 3 326 487 | R 7 749 981 |
| 2 | 85% | R 2 237 780.32 | | -R 362 499 | -R 1 952 231 | -R 3 312 772 | -R 3 389 721 | R 7 749 981 |
| 3 | 90% | R 2 369 414.45 | | -R 399 655 | -R 1 915 075 | -R 3 507 640 | -R 3 452 956 | R 7 749 981 |
| 4 | 95% | R 2 501 048.59 | | -R 440 620 | -R 1 874 110 | -R 3 702 509 | -R 3 516 191 | R 7 749 981 |
| 5 | 100% | R 2 632 682.73 | | -R 485 784 | -R 1 828 947 | -R 3 897 378 | -R 3 579 426 | R 7 749 981 |
| 6 | 100% | R 2 632 682.73 | | -R 535 576 | -R 1 779 154 | -R 3 897 378 | -R 3 579 426 | R 0 |
| 7 | 100% | R 2 632 682.73 | | -R 590 473 | -R 1 724 257 | -R 3 897 378 | -R 3 579 426 | R 0 |
| 8 | 100% | R 2 632 682.73 | | -R 650 996 | -R 1 663 734 | -R 3 897 378 | -R 3 579 426 | R 0 |
| 9 | 100% | R 2 632 682.73 | | -R 717 724 | -R 1 597 007 | -R 3 897 378 | -R 3 579 426 | R 0 |
| 10 | 100% | R 2 632 682.73 | | -R 791 290 | -R 1 523 440 | -R 3 897 378 | -R 3 579 426 | R 0 |
| | | | | **-R 5 303 415** | **-R 16 320 446** | **IRR =** | **#NUM!** | |

| | | |
|---|---|---|
| **ESTIMATED CAPITAL COST:** | R | 38 749 906.25 |
| **ESTIMATED OPERATING COST:** | R | 3 897 378.28 |

# W.R.O.S.E – Economic Analysis: Comparison

UNIVERSITY OF KWAZULU-NATAL INYUVESI YAKWAZULU-NATALI

## MRF

| Economic Indicator | Estimated Cost (Rand) |
|---|---|
| Capital Cost | R 31, 250, 917 |
| Annual Revenue | R 26, 977 |
| Annual Operating Cost | R 12, 685 470 |

## AD PLANT

| Economic Indicator | Estimated Cost (Rand) |
|---|---|
| Capital Cost | R 39, 046, 966 |
| Annual Revenue | R 1, 448, 339 |
| Annual Operating Cost | R 3, 917, 857 |

# CONCLUSIONS

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- The implementation of anaerobic digestion at the AgriZone will divert waste from landfill and optimise waste management strategies at DTP by using the waste as a resource to achieve as close to a "zero waste model" as possible.

- **The environmental and social benefits of AD far outweigh those of composting.**

- Unless ideal conditions are established to maximise yields to generate profits from by-products, and/or external capital investment is received, AD is not the most economically feasible technology.

- It is imperative that the optimal conditions are determined for maximum methane production, and **pre- and post-treatment methods are utilised to enhance the nutrient content of the digestate.**

# Way Forward

- Integration of WROSE into the overall policy framework to meet municipal and industry specified needs
- To utilize WROSE to promote integrated waste management as a climate change stabilization wedge for South Africa
- Refine the model through the application of various case studies at national level
- Continuous updating for the insurance of relevance and validity of indicators

# THANK YOU


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**26–30 November 2018**


iwwg international waste working group SOUTHERN AFRICAN REGIONAL BRANCH

NRF National Research Foundation

sanedi South African National Energy Development Institute