

## The Integrated Model of Waste Management for Ekurhuleni – Gauteng: Towards Zero Landfill

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### ABSTRACT

The project is based on two experiences as new strategies related to environmental protection, sustainability and economic growth: the first with the project "NETSAFRICA" realized in Wattville and Actonville - Ekurhuleni, where was made the first experiment of organized separate waste collection service, with the creation and formation of cooperatives of informal pickers; the second in Tembisa, with the project "Get Answers", always with Oxfam Italia, Cispel Toscana and Municipality of Ekurhuleni, approved and co-financed by the European Community. "Get Answers" duplicates the organizational experience in 3 Wards of Tembisa with 240,000 inhabitants and will provide all the elements necessary to initiate the municipality of Ekurhuleni, to the separate collection of the organic fraction of the waste. The evolution of the project "Get Answers", starting with "dry-wet" separate collection, poses the conditions for setting up a model of a strategic plan for the integrated waste management for Ekurhuleni metropolitan area.

### 1. PREREQUISITE: THE PROJECT NETSAFRICA

The project in question was aimed at the start-up of micro-business initiatives related to the collection and exploitation and marketing of materials for recycling, such as paper, cardboard, plastic, glass and cans. With the initiative of NETSAFRICA, have been undertaken actions aimed at training technical organization of cooperatives already formed on the territory and engaged in the collection as "informal pickers". These workers were given the basics of an efficient industrial organization of waste collection in the area, concepts and organizational models to the corporate structure of the cooperative, as well as the provision of equipment and systems useful for the start-up of an activity that can turn a marginal effort and pure survival, in an activity organized and profitable, so as to be able to guarantee profits to redistribute to the members of the cooperative. The design and technical economic analysis, also based on a market survey on the recovery of recycled materials in South Africa, have been designed to ensure that members of the cooperative are self-sustaining, with a decent entry-level salary, with a good chance of growth in time, in relation to the increased production capacity of work organization. From an operational point of view has been made a sorting and storage centre (Drop Off Point), equipped to accommodate and manage the activities of collection, sorting and transportation of the exploitable fractions of "dry" waste, produced in the communities of Wattville and Actonville in Ekurhuleni, corresponding to a basin of c.ca 90,000 inhabitants. Were purchased all the equipment necessary and sufficient to provide an organized and efficient as the phases of collection, sorting, transport and selection of different fractions of waste, to be sent for recycling market, employing at start 44 people, became autonomous in production process, stamped by the need to resort to the action of intermediaries that would have reduced the magnitude of the potential revenues from the sale of the material. The contribution of education has also given rise to the technical and administrative component (Waste Department of the Municipality of Ekurhuleni) of desirable expectations of support for the development of an integrated waste management system in urban centres, today addressed to the simple garbage collection as such and at their landfill. The project NETSAFRICA then gave an initial response, partial but effective, on a new model for the development of waste collection, as economic activity of self-support for disadvantaged social groups, to be replicated in space and time, in urban areas of Gauteng that have similar characteristics from socio-economic point of view of and urban development, to that experienced in communities of Wattville and Actonville.

In the current phase the results achieved and the degree of involvement of stakeholders (cooperatives and Municipalities), have demonstrated the validity of the model, with a wide scope for improvement in both production yields for materials sent for recovery, in the efficiency of the collection system and in the increased per capita income for workers in cooperatives. From a pre-existing situation, just one year later, when there were only "informal pickers" with productions per capita and very low income, the situation photographed by mid-2013, has the following results: 2 integrated cooperatives with the daily commitment of 44 people on the collection and sorting of glass, plastic, cans, tetrapak, with door-to-door method on households, both with collections targeted at schools, shopping malls, taverns etc.; 1,600 households, as well as a 5% non-domestic users, serviced daily with the collection door to door; 11,500 kg of material collected each month, with a start to the recovery of 138 t / year, reclaimed from the landfill; consolidated revenues of c.ca 20,000 ZAR amounted to € 1,660.00 per month average, but with proposed contract with the recycling company, with payments already quadrupled over the present year (1,000,000 ZAR/year); from monthly income per capita of € 37.73, the present outlook is close to an income of € 150.00 per person;

subtraction to landfill of 138 t/year of waste, by reducing the production of 5,611 cubic meters/year of biogas, corresponding to a mixture of CH<sub>4</sub> and CO<sub>2</sub> total of 5,233 cubic meters, 3,030 cubic meters of natural gas and 2,203 cubic meters of carbon dioxide equivalent total, from the point of view of the climate conditioning (ability to trap heat) to 71 887 cubic meters of Co<sub>2</sub>.

## 2. THE DEVELOPMENT OF THE PROJECT IN TEMBISA - THE SEPARATE COLLECTION OF DRY WASTE IN 3 WARDS

One of the problems identified in the urban areas of Gauteng, but common to most of the urbanized area of South Africa, in addition to the social problem of unemployment and HIV, is the indiscriminate use of the land, both for the widespread presence of abandoned mines, both for the widespread presence of landfills (abusive and subsidiaries) of waste, with a dissipation of potential factors of socio-economic and environmental development of considerable importance. A further factor is the energy crisis, in a country that at an early stage of its economic development, largely depends on the extraction of coal, with all the implications of an environmental nature that entails. The gradual phasing out of the coal mines, on which more than 80% of electricity supply in the country, is creating difficulties in the energy system in South Africa, with a more frequent incidence of blackouts, in urbanized areas. This situation has prompted the Department of Energy of South Africa to issue an international tender for the construction of plants for the production of electricity from renewable sources.

The proposal for a development project that gives some possible answers to the real needs of the metropolitan area of Gauteng, which would also be useful if extended to other areas of the country, consists of:

- development of an integrated system of separate collection for maximum utilization of waste, both for the recovery of materials and energy;
- progressive emancipation from the indiscriminate use of land for landfill, with significant reduction in the production of CO<sub>2</sub>;
- creating jobs through the development and marketing of waste destined for recycling;
- training and specialization of personnel for the collection and recovery of materials from waste collection;
- production of compost from separate collection of organic and vegetable waste, to be used as fertilizer for the environmental restoration of the former mines and other polluted urban areas and for the eventual start of projects of urban agriculture;
- setting up a strategic development model for integrated waste collection system for the area of Gauteng - South Africa;
- form and grow an industrial organization of separate waste collection services, based in part on the promotion of cooperatives of waste pickers and in part on the structure of municipalities; and
- use the waste policy, understood as resources for the recovery of materials and energy, as a supplementary tool for the development of areas with large socio-economic imbalances.

### 2.1 CHOICE OF THE URBAN AREA BASE OF THE PROJECT: THE STATE OF THE FACT

The project aims therefore, from the results obtained from the program NETSAFRICA, to develop a phased plan for the transformation of collection services based on the following basic form. In agreement with the Municipality of Ekurhuleni, three urban areas were chosen in the North of Tembisa - Ekurhuleni. The areas are defined with the administrative terminology of Ward and are characterized by the following demographic characteristics and production of waste:

Table 1: Summary table of administrative data, demographic and production of waste for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng

| Highlights - Estimated weighted | waste products (ton/year) | Inhabitants (evaluation) | Homes (n°) | Sections (evaluation) | Kg/in/d | kg/us/d | in/us (evaluation) |
|---------------------------------|---------------------------|--------------------------|------------|-----------------------|---------|---------|--------------------|
| Ward 6                          | 10.579                    | 63.480                   | 10.580     | 63                    | 0,46    | 2,74    | 6,00               |
| Ward 9                          | 7.261                     | 43.572                   | 7.262      | 43                    | 0,46    | 2,74    | 6,00               |
| Ward 89                         | 22.270                    | 133.614                  | 22.269     | 133                   | 0,46    | 2,74    | 6,00               |
| Total                           | 40.110                    | 240.666                  | 40.111     | 240                   | 0,46    | 2,74    | 6,00               |

These three urban areas were also chosen for the presence of recycling cooperatives, substantially formed from "informal pickers". The production data of the material collected separately by the three cooperatives already operating in their respective Ward, can be seen from the following tab

Table 2: Comparison Chart of the production data of the quantities of waste and recycling carried out by the three co-operatives for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng

| Analysis of data on the area of project | Total Solid Waste produced (ton/year) | Recycled materials collected (ton) | % SC current on Ward | % SC on served areas | Current homes (n°) | Served homes (n°) | % served homes | Homes to serve (n°) | sections to serve (n°) |
|---|---------------------------------------|------------------------------------|----------------------|----------------------|--------------------|-------------------|----------------|---------------------|------------------------|
| Ward 6                                  | 10.692                                | 113                                | 1%                   | 22%                  | 10.580             | 500               | 5%             | 10.080              | 60                     |
| Ward 9                                  | 7.482                                 | 221                                | 3%                   | 14%                  | 7.262              | 1500              | 21%            | 5.762               | 34                     |
| Ward 89                                 | 22.357                                | 87                                 | 0,4%                 | 17%                  | 22.269             | 500               | 2%             | 21.769              | 130                    |
| Total                                   | 40.531                                | 421                                | 1,0%                 | 17%                  | 40.111             | 2.500             | 6%             | 37.611              | 225                    |

The three cooperatives still manage to cover the 6% of homes now existing in the three Ward, through a collection system that uses both the "door to door ", not always supported by the municipality, and the recovery of material at the numerous illegal dumps scattered around the area. From about 40,500 tons of waste produced in the three Ward, co-operatives are able to intercept only a fraction, 421 tons / year, accounting for only one percent of the total waste in the area, while, in the areas served, the percentage rises to 17% of total rejection.

Table 3: Comparison Chart of the production data of the collection made for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng and the composition of the resources of the three cooperatives.

| State of the fact       | Ward | Staff used |     |       | Users served |             |       | Separate waste collected |          |         |
|-------------------------|------|------------|-----|-------|--------------|-------------|-------|--------------------------|----------|---------|
|                         |      | Women      | Men | Total | homes        | other users | Total | kg/mounth                | ton/year | kg/us/d |
| Coop ward 6             | 6    | 9          | 6   | 15    | 500          | 23          | 523   | 9.422                    | 113      | 0,60    |
| Coop Ward 9             | 9    | 13         | 3   | 16    | 1.500        | 12          | 1.512 | 18.400                   | 221      | 0,41    |
| Coop ward 89            | 89   | 7          | 3   | 10    | 500          | 23          | 523   | 7.234                    | 87       | 0,46    |
| Total state of the fact |      | 29         | 12  | 41    | 2.500        | 59          | 2.559 | 35.056                   | 421      | 0,49    |

The cooperatives are composed largely of women, which cover 71% of the average composition of the resources now devoted to the collection. The average composition of the cooperatives is about 14 people and each of them is dedicated to both phases of collection, and to those of screening, sorting and cleaning of the collected material. The method of collection is mixed, in some cases mixed materials are collected in a single bag, placed in front of the homes on the day of collection of separated waste. The selection of the material, in some cases it can be done indoors, in rehabilitated facilities abandoned by the owners, other temporary structures in reading, in other even outdoors, in areas with no coverage of it kind of sanitation it safe. The sale of the material is usually carried out through brokers (middle men), being provided with transport vehicles, are able to relay directly to the recycling company, profiting from the purchase price of materials at the cooperatives and the final sale price, with a markup of 100%. The degree of efficiency of the three cooperatives, although in absolute deficiency of vehicles (are used largely still trolleys or wheelbarrows dragged by hand, with big bags 1 - 2 mc that are filled with the collected material) is also proportional profitability specific to individual operators.

2.2 THE PROPOSED REORGANIZATION OF SEPARATE COLLECTION, THE SELECTION AND SALE OF MATERIALS.

The proposed reorganization is clearly influenced by the budget, both in terms of quantifying the resources to be allocated, both in terms of the actions that you can perform over the three years of the plan. Its validity and effectiveness are therefore to be judged in relation to the constraints imposed, but anyway prepare the ideal conditions for the extension and the repurposing of the model on a large scale territorial. The actions foreseen, however, will be a stimulus to influence the administrative decisions of the Municipality of Ekurhuleni towards a strategic choice and systems, not possible with the limitations of time and budget of this project, but in times immediately following the three year duration of the notice. In other words, the project is divided into two strategic phases:

Table 4: Hypothesis of the time schedule for the completion of the project financed by the European Union and the integration of long-term finance

| Subjects Involved       | Activity   | Years of project |      |      |      |      |      |      |      |   |
|-------------------------|--|------------------|------|------|------|------|------|------|------|---|
|                         |  | 2014             | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |   |
| Europe Ald              | Realization of 1 <sup>st</sup> Drop Off Point North Tembisa                        | █                |      |      |      |      |      |      |      |   |
| Europe Ald              | Separate collection "Dry Waste" Tembisa 1  | █                |      |      |      |      |      |      |      |   |
| Oxfam                   | Realization 2 <sup>nd</sup> Drop Off Point North Tembisa                           |                  | █    |      |      |      |      |      |      |   |
| Rg Toscana              | Separate collection "Dry Waste" Tembisa 2  |                  | █    |      |      |      |      |      |      |   |
| Cispel                  | Realization 3 <sup>rd</sup> Drop Off Point North Tembisa                           |                  |      | █    |      |      |      |      |      |   |
| EMM                     | Separate collection "Dry Waste" Tembisa 3  |                  |      | █    |      |      |      |      |      |   |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" Tembisa 1, 2, 3.               |                  |      | █    |      |      |      |      |      |   |
| EMM and private Company | Realization anaerobic digestion plant  |                  |      |      | █    | █    | █    | █    | █    | █ |
|                         | Electricity production plant from landfill gas and from organic waste              |                  |      |      | █    | █    | █    | █    | █    | █ |
| EMM and partners        | Realization 4 <sup>th</sup> Drop Off Point Ekurhuleni                              |                  |      |      |      | █    |      |      |      |   |
| COOPS                   | Separate collection "Dry Waste" 4 <sup>th</sup> urban area EMM                     |                  |      |      |      | █    |      |      |      |   |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" 4 <sup>th</sup> urban area EMM |                  |      |      |      | █    |      |      |      |   |
| EMM and partners        | Realization 5 <sup>th</sup> Drop Off Point Ekurhuleni                              |                  |      |      |      |      | █    |      |      |   |
| COOPS                   | Separate collection "Dry Waste" 5 <sup>th</sup> urban area EMM                     |                  |      |      |      |      | █    |      |      |   |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" 5 <sup>th</sup> urban area EMM |                  |      |      |      |      | █    |      |      |   |
| EMM and partners        | Realization 6 <sup>th</sup> Drop Off Point Ekurhuleni                              |                  |      |      |      |      |      | █    |      |   |
| COOPS                   | Separate collection "Dry Waste" 6 <sup>th</sup> urban area EMM                     |                  |      |      |      |      |      | █    |      |   |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" 6 <sup>th</sup> urban area EMM |                  |      |      |      |      |      | █    |      |   |
| EMM and partners        | Realization 7 <sup>th</sup> Drop Off Point Ekurhuleni                              |                  |      |      |      |      |      |      | █    |   |
| COOPS                   | Separate collection "Dry Waste" 7 <sup>th</sup> urban area EMM                     |                  |      |      |      |      |      |      | █    |   |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" 7 <sup>th</sup> urban area EMM |                  |      |      |      |      |      |      | █    |   |
| EMM and partners        | Realization 8 <sup>th</sup> Drop Off Point Ekurhuleni                              |                  |      |      |      |      |      |      |      | █ |
| COOPS                   | Separate collection "Dry Waste" 8 <sup>th</sup> urban area EMM                     |                  |      |      |      |      |      |      |      | █ |
| EMM Waste dep.          | Integrated Separate collection "Wet-residual Waste" 8 <sup>th</sup> urban area EMM |                  |      |      |      |      |      |      |      | █ |

Mid term project financed

Long term project not financed

The first phase (operational), covers designing, reorganization and strengthening of the separate collection of materials ("dry waste") to be allocated to direct sales (glass, plastic, cans, paper and cardboard and tetrapak), in favor of cooperatives already established on the territories of the three Wards. The second phase (formative and design) relates to the preparation of the ideal conditions to encourage the creation of an anaerobic digestion plant for the organic fraction ("wet waste"), as well as the transformation of the collection service for the recovery of the same fraction from unsorted municipal waste, to care and burden of the Municipality of Ekurhuleni, in the period immediately following the completion of the first phase.

2.2.1 THE COLLECTION OF "DRY WASTE"

The project is based on the following elements, setting of the base module standard for each of the 3 Ward, comprising: a support structure constituted by the Centre for Collection and Selection of Dry Refusal (Drop Off Center), structured and equipped to meet the needs of the entire production of recyclables for each Ward; a team of 12 operators involved in the collection,; a team of 8 operators at the Drop Off Center; rules for the implementation of the separate collection: weekly emptying of bags of 50-60 liters, delivered to individual households, filled with dry waste multi-material (paper, cardboard, glass, plastic, cans, tetra), with at least 6 discharges at the Drop Off Center. Here the waste collected is unloaded, selected, cleaned, pressed and stored by the operators of the collection Center and transported at full load by type of material, at private recycling companies; operational capacity of the collection operator with cargo Tricycle: 20 bags, collected in an hour of work; 120 users served in a shift of 6 hours; 1,200 users served per week, with 6 days of work (Monday to Saturday); 7,200 total users served in a week of work from the team of 12 operators of collection. The total number of users served in the 3 Wards: 21,600, plus 731 non-domestic users, c.ca equal to 130,000 population equivalents. The total number of components for each cooperative will be (minimum) : 20 operators, of which 14 women tended (71%) and 6 men (29%); monthly return of waste collection for the three Wards: 327 664 kg, equivalent to 3,930 tons / year; monthly return of waste collection for the three Wards: 327 664 kg, equivalent to 3,930 tons / year; goal reached with the average yield (revenue per employee) of the separate collections of departure: target revenue per employee: 692.00 €/month; target return of separate waste collection with the first step (second year): 18%; target return of waste collection with the second step (third year): 25%.

2.2.2 PROJECT OBJECTIVES FOR THE PERFORMANCE OF RECYCLING ON THE THREE WARDS

Table 5: Table of the project with production data collection to be carried out for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng and the future composition of the resources of the three cooperatives

| Separate collection project | Ward | staff used |     |                  | Users to serve |             |        | Separate waste to collect |          |         |
|-----------------------------|------|------------|-----|------------------|----------------|-------------|--------|---------------------------|----------|---------|
|                             |      | women      | men | total            | Domestic users | other users | total  | Kg/mounth                 | Ton/year | kg/us/d |
| <b>Tembisa - Ekurhuleni</b> |      |            |     |                  |                |             |        |                           |          |         |
| Coop Ward 6                 | 6    | 14         | 6   | 20               | 7.200          | 338         | 7.538  | 110.529                   | 1.326    | 0,49    |
| Coop Ward 9                 | 9    | 14         | 6   | 20               | 7.200          | 56          | 7.256  | 106.405                   | 1.277    | 0,49    |
| Coop ward 89                | 89   | 14         | 6   | 20               | 7.200          | 338         | 7.538  | 110.529                   | 1.326    | 0,49    |
| <b>Total project</b>        |      | 42         | 18  | 60               | 21.600         | 731         | 22.331 | 327.464                   | 3.930    | 0,49    |
| Staff composition           |      | 71%        | 29% | inhab/equivalent | 129.600        |             |        |                           |          |         |

Table 6: Table of project profitability of recycling made for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni – Gauteng.

| SC project   | Revenues from the sale of the selected material |                    |                 |               |                 | output per worker |               |
|--------------|---|--------------------|-----------------|---------------|-----------------|-------------------|---------------|
| Tembisa      | ZAR/month                                       | €/month            | €/wo/month      | €/kg/SC       | ZAR/kg/SC       | kg/wo/month       | kg/wo/d       |
| Coop Ward 6  | ZAR 168.894                                     | € 14.018,22        | € 700,91        | € 0,13        | ZAR 1,53        | 5.526             | 184,22        |
| Coop Ward 9  | ZAR 162.592                                     | € 13.495,16        | € 674,76        | € 0,13        | ZAR 1,53        | 5.320             | 177,34        |
| Coop ward 89 | ZAR 168.894                                     | € 14.018,22        | € 700,91        | € 0,13        | ZAR 1,53        | 5.526             | 184,22        |
| <b>Total</b> | <b>ZAR 500.381</b>                              | <b>€ 41.531,60</b> | <b>€ 692,19</b> | <b>€ 0,13</b> | <b>ZAR 1,53</b> | <b>5.458</b>      | <b>181,92</b> |

Table 7: Table of comparison of profitability of recycling between the status quo and the project with the goal of starting (same production yield per user of the status quo) for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng .

| Data Analysis<br>Project aims to start<br>(same SC performance<br>for user status quo) | Total<br>UW<br>produced<br>(ton) | SC<br>collected<br>state<br>of the<br>fact<br>(ton) | % SC<br>current<br>on Ward | % SC<br>current on<br>served<br>areas | current<br>homes<br>(n°) | Current<br>users<br>served<br>(n°) | % current<br>served<br>users | home sto<br>serve in<br>project<br>(n°) | % SC of<br>project on<br>served area |
|--|----------------------------------|---|----------------------------|---------------------------------------|--------------------------|------------------------------------|------------------------------|---|--------------------------------------|
| Ward 6   | 10.692                           | 113   | 1,06%                      | 20,68%                                | 10.580                   | 547                                | 5,17%                        | 6.991                                   | 18%                                  |
| Ward 9   | 7.482                            | 221   | 2,95%                      | 13,46%                                | 7.262                    | 1.641                              | 22,59%                       | 5.616                                   | 18%                                  |
| Ward 89  | 22.357                           | 87  | 0,39%                      | 15,87%                                | 22.269                   | 547                                | 2,46%                        | 6.991                                   | 18%                                  |
| <b>Total</b>   | <b>40.531</b>                    | <b>421</b>  | <b>1,47%</b>               | <b>16,67%</b>                         | <b>40.111</b>            | <b>2.735</b>                       | <b>10,07%</b>                | <b>19.597</b>                           | <b>18%</b> → <b>25%</b>              |

2.2.3 THE ACTUAL ENVIRONMENTAL BENEFITS OF RECYCLING IN THE THREE WARDS (LOWER PRODUCTION OF BIOGAS IN RELATION TO WASTE REMOVED FROM THE LANDFILL)

Table 8: Table of verifying the environmental benefit of recycling at the state of affairs for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng.

| Analysis of the effects on the environment (current state) | biogas removed from the landfill (mc) | Methane CH4 and CO2 carbon dioxide removed from the landfill (mc) | Carbon dioxide CO2 removed from the landfill (mc) | Methane CH4 removed from the landfill (mc) | Co2 equivalent subtracted from the landfill (mc) | CO2 equivalent Subtracted in the three years (mc) |
|--|---------------------------------------|---|---|--|--|---|
| Ward 6   | 4.597                                 | 4.287   | 1.805   | 2.482                                      | 58.896   | 176.688   |
| Ward 9   | 8.978                                 | 8.373   | 3.525   | 4.847                                      | 115.018  | 345.055   |
| Ward 89  | 3.530                                 | 3.292   | 1.386   | 1.906                                      | 45.220   | 135.659   |
| <b>Total</b>   | <b>17.105</b>                         | <b>15.952</b>   | <b>6.716</b>                                      | <b>9.235</b>                               | <b>219.134</b>                                   | <b>657.403</b>                                    |

## 2.2.4 THE EXPECTED ENVIRONMENTAL BENEFITS OF THE PROJECT (LOWER PRODUCTION OF BIOGAS IN RELATION TO WASTE REMOVED FROM THE LANDFILL)

Table 9: Table of verifying the environmental benefits of recycling to the second stage of the project (recycling to 25%) for Ward 6, 9 and 89 of the North Tembisa - Ekurhuleni - Gauteng.

| Analysis of the effects on the environment (second step: SC 25%) | biogas removed from the landfill (mc) | Methane CH4 and CO2 carbon dioxide removed from the landfill (mc) | Carbon dioxide CO2 removed from the landfill (mc) | Methane CH4 removed from the landfill (mc) | Co2 equivalent subtracted from the landfill (mc) | CO2 equivalent Subtracted in the three years (mc) |
|--|---------------------------------------|---|---|--|--|---|
| Ward 6   | 107.110                               | 99.890  | 42.058  | 57.832                                     | 1.372.241  | 4.116.722   |
| Ward 9   | 74.954                                | 69.901  | 29.432  | 40.470                                     | 960.271  | 2.880.812   |
| Ward 89  | 223.933                               | 208.838   | 87.930  | 120.908                                    | 2.868.917  | 8.606.752   |
| <b>Total</b>   | 405.997                               | 378.630   | 159.420   | 219.209                                    | 5.201.429  | 15.604.286  |

## 2.2.5 TH ORGANIZATIONAL PHASES OF THE PROJECT

By taking full advantage of the experience already gained success with the project NETSAFRICA, the project includes the following organizational steps:

**a) Design and implementation of 3 collection centers and selection (Drop Off Center)**

The target areas are those where informal pickers already have settled with their job selection and storage of collected materials. The project plans to build three buildings of standard size (c.ca 16,00 x 8,00), in a single volume, designed to house the equipment useful for the selection, pressing and storage of materials from the collection. In addition to the preparation of the structural design of the building will be designed also works projected for the area of private garden, which is also the functional operations of handling, storage, loading and unloading of materials collected and sorted (fencing, paving and services). The phases of design, execution of the contract for the construction work, award, implementation and execution of the construction works will start in this sequence occurred in the financing and will last at least 10 months;

**b) Acquisition of equipment for the structuring of the new collection service and selection.**

The project includes the purchase of all the equipment necessary and sufficient for activating both the centre of both the collection and selection service provided, for every module, corresponding to a Drop Off Centre. The preparatory actions the purchase of materials cited are to be undertaken in second place, at least 3 months after the start of the project and at last six months, so that you can install and make operational the start of the Drop Off Center.

**c) Formative action towards cooperatives and Municipality for the start of the reorganization and strengthening of services of separate collection of "dry waste".**

The training will have two specific targets: first for cooperative, to be involved in an educational process, organizational and corporate; national and international regulatory principles that govern the waste in terms of safety in the workplace; strategies of market separate waste collection; communication with users and organizational modalities of the services of collection, sorting and transportation, personnel management and industrial strategies; second for the department of the Municipality of Ekurhuleni, which will take the burden of authorize, coordinate, direct and record all activities carried out by cooperatives, which become, in effect, the operating partner of the Municipality. The phases of the training, the start of the functional reorganization of the services of collection, will be launched at 6 months after the project and will have a total duration of 4 more months.

**d) The start of the communication of the draft collection on the three Wards**

The start of the implementation phase of the collection can be made at the conclusion of the work of the Drop Off Centre, then at 10 months after the project. At this stage the involvement of Cooperatives will be activated on the above communication to the users and on the joint distribution of information material, prepared in collaboration with the Municipality of Ekurhuleni, as well as the reusable bags, recycled plastic material to individual households. The same operators used for collection will be involved in the process of communication and distribution of the material, in order to establish immediate contact and collaboration with residents. The communication phase will have a duration of 2 months c.ca.

**e) The start of the operational phases of the collection of "dry waste"**

The collection is structured with the new organizational model will start exactly one year after the project. On a monthly basis, reports will be prepared to yield the new service and discussed in working groups with the participation of representatives of the Cooperative, Municipality and representatives of the Group of the European project. Every three months, the returns will be analysed, the issues raised and strategies to address and improve the performance of the service, aimed at optimizing the performance in terms of both quantity and cost. The quarterly meetings will be reported also possible improvements agreed with the same recycling company, who will show interest and involvement in the expansion of the service. With these deadlines and appointments periodicals, the ordinary operations of the project will last for two years, until the conclusion of the three-year project.

### 3. THE SEPARATE COLLECTION OF "WET WASTE" AND THE PLANT WASTE STRATEGY TOWARDS "ZERO LANDFILL"

#### 3.1 THE TRAINING STRATEGY OF SEPARATE COLLECTION OF "WET WASTE"

This type of activity will be "smeared" over the three years of the project with the aim to support the process of planning by the Ekurhuleni Municipality, for the financing, design and construction of an anaerobic digestion plant, to be carried out at the end and all occurred consolidation of the draft collection of "dry waste". This action will be structured as a natural continuation of a new waste strategy, linked to the progressive reduction of unsorted waste to landfills, reuse and recovery of secondary materials required by the market, the use of biogas from organic waste and landfill purposes energy, the use of compost as a useful material for the remediation of contaminated sites (former mines) and for the conversion of production for agricultural purposes (urban gardens). This first part of the address and support the decisions of the Municipality will be conducted through regular meetings and comparison with interdisciplinary contributions with the heads of the various municipal departments, Economic Development, Waste Department, Planning and Energy. The training, once defined the timing of construction of the anaerobic digestion plant, will be finalized on the same workers of the Municipality, today dedicated solely to the collection of unsorted waste, to the redesign of the collection service, with the separation between organic and residual waste. The project will cover the same areas served by collection of dry waste, in order to complete the full cycle of recycling the territories of the urban districts of Ward 6, 9, and 89. The new collection plan will have its Start Up in the fourth year after the beginning of the project.

##### 3.1.1 THE EXPECTED EFFECTS OF THE ACTIVATION OF THE ORGANIC WASTE COLLECTION

At the conclusion of the three-year project, dedicated to collection of dry waste, the activation of the organic waste collection, with conversion to electricity in an anaerobic digestion plant, in the same areas already covered, would lead to the following benefits: separate collection overall on the three Ward 55%; 22,292 tons / year of waste removed from the landfill; no more than 494,395 cubic meters of biogas released into the atmosphere; 6,333,933 cubic meters / year of CO<sub>2</sub> equivalents are no longer dissipated into the atmosphere; 303,980 kw/h of electricity production; 7,296 tons / year of compost to be used in environmental restoration and conversion of land for agricultural purposes unproductive.



3.1.2 THE ENVIRONMENTAL BENEFITS OF RECYCLING PLAN

Table 11: Table of estimates of the environmental benefits of recycling plan, the areas of the three Ward of the project, with treatment and anaerobic digestion plant in the production of electricity and compost.

| Annual quantity of Organic subtract from the landfill in the rest of the project |         |          |         |         |           |            |
|--|---------|----------|---------|---------|-----------|------------|
| 12.159   | Biogas  | Ch4 +Co2 | Co2     | Ch4     | Co2 eq.   | Co2 eq X 3 |
| 30% organic  | 494.395 | 461.069  | 194.131 | 266.938 | 6.333.933 | 19.001.799 |
| Electricity can be produced  |         |          |         | KW/H    |           | 303.980    |
| Compost to be allocated to environmental restoration                             |         |          |         | Ton     |           | 7.296      |

3.1.3 THE ORGANIZATION OF THE COLLECTION OF ORGANIC WASTE: A SIMULATION FOR THE THREE WARDS AREA

With the project “dry waste” is to reach its target of 25% reduction in the weight of the waste collected. The remaining amount will be collected with dual mode: organic and residual, using the same vehicles used today by the municipality of Ekurhuleni

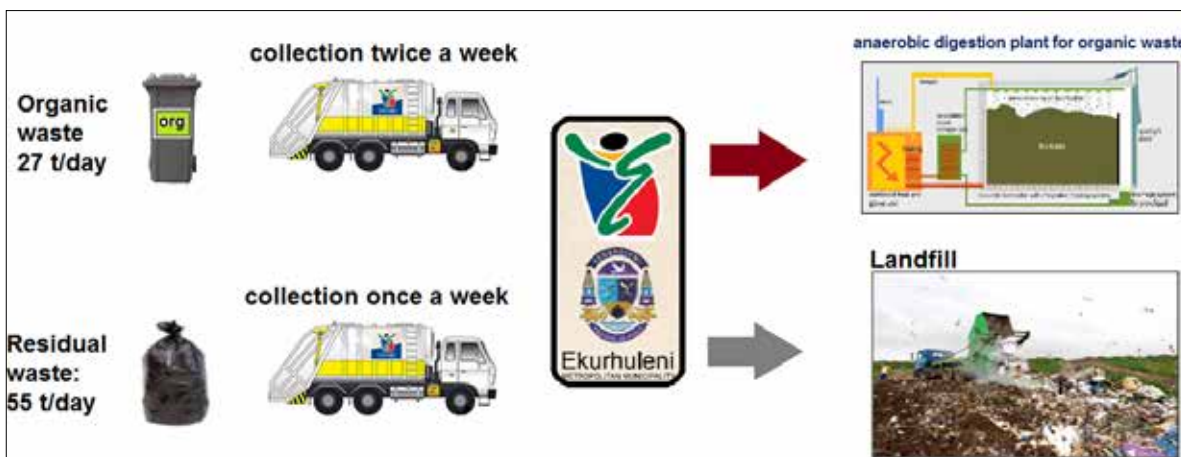


Figure 1:

organizational chart of the simulation of dual waste collection (wet-dry) for the three Wards of Tembisa

3.2 TOWARDS AN INTEGRATED MODEL OF WASTE MANAGEMENT: MAXIMIZE THE RECOVERY OF MATERIALS AND ENERGY

With the construction of a integrated pole plant, the part of waste destined for incineration will be made only by the residual “dry” component, after subtracting, during separate collection, the “dry” part intended to the recycling market (paper, cardboard, plastic, glass, cans, tetra, etc.), the organic waste collected (food scraps and vegetable scraps) and the “wet” part of the residual waste, after mechanical selection. The share of non-recyclable dry waste destined for incineration, having implanted the collection “wet-dry”, will be almost 35% of unsorted municipal waste produced by the entire area. In this manner can be designed a WTE plant for much lower quantities than at present. The plan lays the basis for transforming the current system of waste disposal, based primarily on the use of landfills, in an integrated management model that, on the one hand adopting the best practices for efficient waste collection based on the separation of wet-dry, the other calls for the implementation of a real pole plant, leading gradually to the maximum recovery of materials and energy and the abandonment of the use of landfills.

### 3.2.1 THE POLE PLANT: PRODUCTION OF ELECTRICITY FROM LANDFILL BIOGAS

The headquarters of the pole plant, for logistical reasons and transport optimization of technological equipment, it is appropriate to place it on the site of an existing landfill and running. One of the first plants to be built on the site of the landfill is that of the biogas collection connected to an electricity generator that burns the methane extracted from biogas.

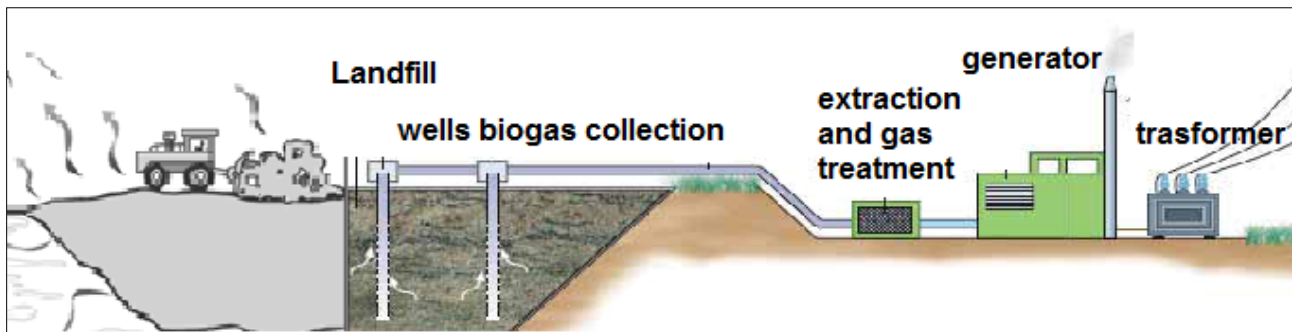


Figure 2: functional diagram for the use of biogas for energy extracted from the landfill

### 3.2.2 THE POLE PLANT: THE MECHANICAL SORTING PLANT FOR DRY AND WET WASTE

The share of separated waste residual waste collection, can be treated with mechanical processes useful in the separation of dry waste from the wet. The separate part of "dry waste" may be initiated to energy recovery, while the "wet waste" may be initiated anaerobic digestion plant for the extraction of biogas, useful for the production of electrical energy, with a residual product defined: "stabilized organic fraction", different from compost, which is useful in agriculture, but useful for environmental remediation (disused mines).

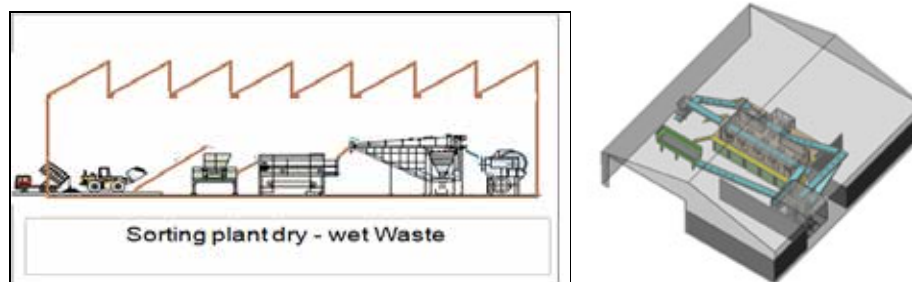


Figure 3: functional diagrams of a wet-dry selection waste plant

### 3.2.3 THE POLE PLANT: THE ANAEROBIC DIGESTION PLANT FOR ORGANIC WASTE

The fractions of organic waste collected by separate collection and those obtained from the mechanical separation of unsorted waste, may be conferred on separate lines of an anaerobic digestion plant, useful for the capture of biogas for electricity production and for the production of quality compost (from the organic fraction collected separately) and stabilized organic fraction (from the mechanical separation of the residual waste to recycling).

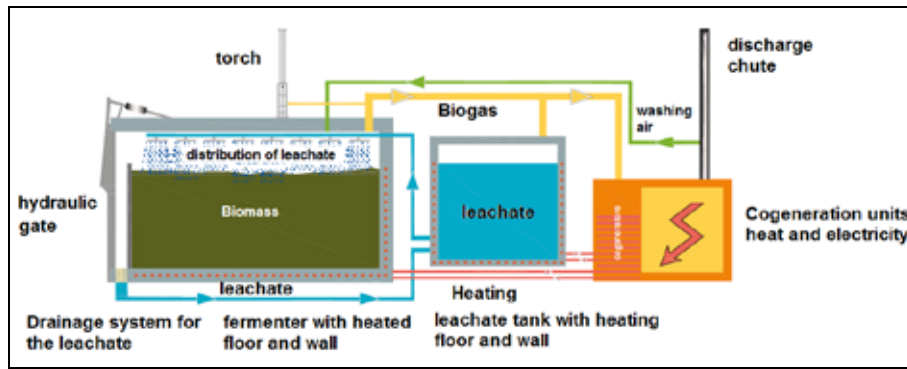


Figure 4: functional diagrams of an anaerobic digestion plant for organic waste

### 3.2.4 THE POLE PLANT: WASTE TO ENERGY PLANT

The dry fraction of the waste from the mechanical sorting plant, plus the portion of the unsorted waste collected, may be undertaken to the heat treatment with recovery of heat and electricity. The plant to be built shall have a minimum size of 200 tons/day, which is useful for serving, according to the project, c.ca an area of 1,000,000 inhabitants. Must be chosen a technology that will extend the capacity of the plant through the inclusion of additional modules that may allow the extension till to three times the area to be served (plant of 600 tons /day for an area of 3,000,000 inhabitants, like the entire extension of Ekurhuleni).

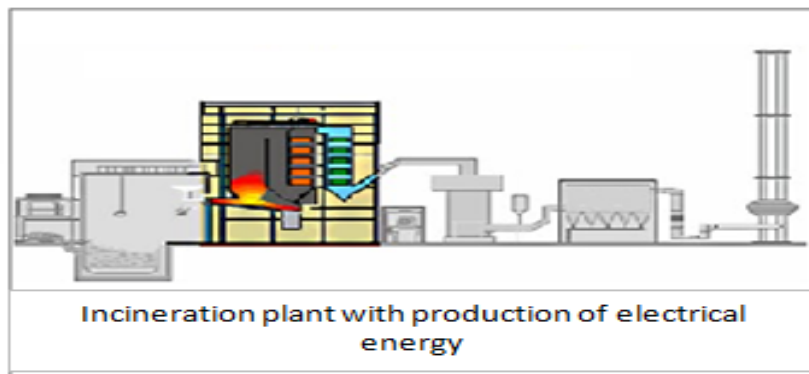


Figure 5: functional diagrams of WTE plant for the residual dry waste.

The project tries to give an answer ("Get Answers") also to the widespread dispute between supporters of recycling and incineration supporters. On the one hand trying to give dignity, development and organization of a sector, that of "waste pickers", marginal, illegal, without guarantees and safeguards of security; on the other trying to optimize the potential recovery of materials and energy , residual to the collection of "dry waste", with appropriate machinery and plant technology.



Figure 6: waste pickers' protests against proposed incinerators in South Africa (November 2013) and the summary of the objectives of the project "Get Answers".