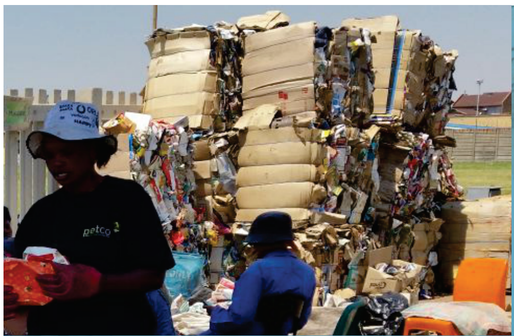
Chapter 5

PROMOTING TECHNOLOGIES - SHORT TERM



5. Promising Technologies – Short Term

5.1 Introduction

Chapter 5 presents AWT technologies that are assesed as being applicable in the short-term. These technologies have already been identified in KP2 as suitable short-term solutions, and on further review still remain the most price competitive and comparable cost to the business as usual (i.e. BAU landfill) scenario.

This section presents a specific cost structure for investment and operation, the potential revenues, and compares these to net cost of indicative baseline scenarios.

The cost/tonne charts are presented in each sub-section. The costs for a given technology vary depending on the local situation, labour costs, size of the facilities and other related factors. The costs information presented in this section should therefore be interpreted as indicative of the magnitude of costs that can be expected when implementing a certain technology, but should not be assumed as definitive estimates.

Promising technologies in the short-term are those technologies that focus on treating specific waste streams. There are incentives in place in South Africa for a select number of promising technologies. The promising AWT technology options include windrow composting, recycling of construction and demolition (C&D) waste (builders' rubble) and material recovery facility as (MRF) for recyclable fractions of MSW. For a detailed description of each technology, please refer to *Knowledge Product 2*: *Appropriate Technology for Advanced Waste Treatment – Guideline.*

5.2 Windrow Composting

5.2.1 Scale Factors

Composting facilities are generally small scale, and therefore have only limited overhead and maintenance costs. For a facility of approximately 8,000 tonnes per year, a staff of approximately six workers would be sufficient. The situation will vary depending on the local context and level of technology. Key characteristics of windrow composting facilities are presented in Table 11.

Table 11: Key characteristics of windrow composting

Characteristic	Description
Typical capacity	5k – 500k tonnes per annum
Indicative capital cost	A range of 6 to 10 m ZAR for small scale, simple windrow systems
Human resource requirement	Mostly unskilled workers, drivers and mechanics

5.2.2 Cost benchmarks

Specific costs for windrow composting, besides the typical costs mentioned under Section 4.2 (i.e. land acquisition, engineering works and regulatory compliance), arise from the type of equipment used for this AWT technology. Equipment may include: tractors, compost turners, excavators, shredders, sieves, loaders and dumper trucks.

Most of the equipment required for composting is available on the South African market. Only compost turners and chippers need to be procured internationally. Electricity/energy costs will be minimal since the composting is undertaken in open air, and no energy is used in the process itself.

A comparison of indicative costs for windrow composting in South Africa and industrialised countries is illustrated in Figure 10.

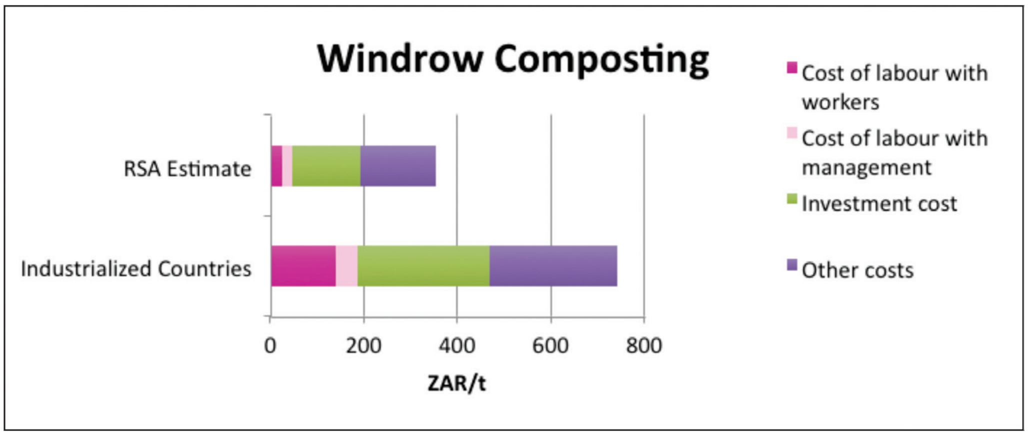


Figure 10: Full cost breakdown for windrow composting[30]

Windrow composting costs are estimated to be in a range of between 300 to 400 ZAR per tonne. Composting is not highly mechanised and not highly labour intensive; as such, the operational costs are relatively low. The cost of repair and maintenance may be relatively high, especially where windrow turners and chippers have been purchased from abroad. Table 12 presents general characteristics of open windrow composting and the main factors influencing revenue.

Table 12: Factors influencing revenues – windrow composting

Technology Heading	Outline Description	Factors Influencing Revenue
Open windrow composting	Garden waste generally has lower moisture content and fewer potentially hazardous elements than mixed organic waste and is therefore best suited to aerobic composting processes.	Revenue/price of compost product in market Distance to outlet for compost Quality requirements/bagging of compost Quantity of contaminants and subsequent screening costs Disposal costs of contaminants

Gate fees for composting will vary depending on the local market demand, logistics and costs for the collection and delivery of source-aggregated green wastes to the facility, and available subsidies.

According to published literature from the UK (hereafter referred to as the *"2014 UK WRAP Report")*[31], composting gate fees in the UK are approximately 24 UK pounds per tonne (430 ZAR per tonne equivalent[32]). In comparison, the approach with the City of Cape Town is somewhat different. The City of Cape Town has contracted collection, chipping and composting of green garden waste and pays a fee to private contractors for the green waste handling service. The fee paid ranges between 500 ZAR to 1,300 ZAR per tonne (100 to 255 ZAR per cubic metre) of green waste handled depending on the distance from the drop-off centre to the composting plant. In both South Africa and the UK, composting requires a gate fee that reflects the net costs of composting after revenues from sale of compost.

The market in South Africa for compost began in the 1990s when the use of organic compost as fertiliser became a criterion for being able to sell table grapes as organic produce. To date, the largest composter in the country is a farmer who started composting to fertilise his own vineyards.

30 Cost information for industrialized countries derived from, and cost ranges for South Africa adapted from, Pfaff-Simoneit, 2013
31 WRAP (Waste Resource Action Programme), "Gates Fees Report", UK, 2014
32 The exchange rate used throughout this document is 1 EUR = 12.97 ZAR (European Central Bank exchange rate April 20th, 2015)

Case Study 3: Reliance Composting Facility in Cape Town

A farmer from the Cape Boland region who needed organic fertiliser for his vineyard started the company Reliance Compost as a side activity in the 1990s. The business gradually grew and today is a multifaceted enterprise. The owner has considered differentiating in to other secondary materials and specific waste stream treatment processes.

The waste treatment activities: The City of Cape Town has 25 drop-off centres in the metropolitan area that receive green garden waste. Reliance Compost Ltd. is contracted to operate 10 of these centres, of which eight are equipped with chippers. The company collects chips and transports the waste to a central composting plant.

At the composting plant, windrow composting is carried out using the Austrian Controlled Compact Microbial method. Compost maturation takes six to eight weeks and does not require the use of additives, with the exception of water and clay.

Input capacity and quality: Approximately 90% of green garden waste generated by households and commercial units in the City of Cape Town is directed to the composting facility. The capacity of the facility has been doubled in recent times, from approximately 500,000 to 1 million cubic metres per annum.

Diversion from the landfill: The volume of green waste diverted from landfill is calculated prior to being chipped; whilst the throughput at the compost facility refers to chipped material (chipping roughly halves the volume of the green waste). The volume of landfill diversion is approximately 2 million cubic meters of green material per annum. Since 2008, approximately 13 million cubic meters of green waste have been diverted from landfill.

Area of land utilised for the licensed composting facility: Approximately 14 ha in total, inclusive of the recent extension that effectively doubled the treatment capacity.

Equipment used: Shredders/chippers and compost turners are imported, whilst trucks, loaders, and other vehicles are sourced locally.

- 35 x trucks, loaders and others, purchased locally;
- turners and chippers are procured from overseas; and
- a workshop for repair and maintenance.

Human resources and labour intensity: There are approximately 220 workers at Reliance Compost, 170 of them at the composting site. The company also has its own in-house maintenance team.

Market for compost: The most important buyers of compost are landscapers and landscape architects. The second most important market is agriculture. 80% of the revenue is generated *via* the price per cubic metre of green waste handled, and paid by the municipality, whilst 20% is generated from the sale of compost and related products. The contract with the City is for a period of three years.

Investment and operation costs: An indicative full specific cost was estimated with an assumption of a 10% profit margin in the range of 800 to 1,000 ZAR/t, inclusive of cost of collection. Investment and operation cost information are captured in the Table 13 for all company activities.

Table 13: Investment and operation costs information for composting case study

Investment cost information	ZAR
Cost of equipment	90 million
Operation costs information	ZAR/annum
Cost of collection	18 million
Cost of composting	5 million
Other operation costs	4 million
Total operation cost	**27 million**

Certification and GHG reduction: The company's organic status is certified annually by an independent certification body. Reliance is also Clean Development Mechanism (CDM)-registered since 2008 (i.e. Reliance Compost is eligible to obtain credits for CO_2 reduction under the (CDM) of the Kyoto Protocol); revenue has been dropping in time, as the international market for certified CDM credits has been reduced substantively the company's revenue from CO_2 credits has subsequently dropped to approximately 1 – 2 million ZAR/year.

The Reliance case study illustrates that the market demand in agriculture for organic compost has driven the implementation of composting in Cape Town. The municipality is reallocating saved costs from landfilling to paying for composting. It is unclear from the case study data whether the overall cost to the municipality is higher than business as usual, but benchmark data suggests that composting and landfilling costs are about the same (Table 9). Therefore as soon as there is a market demand for compost, green waste composting has a high probability of being a promising technology for the short-term.

5.3 Construction and demolition waste recycling

5.3.1 Scale factors

In 2011, construction and demolition (C&D) waste amounted to approximately 4.7 million tonnes in South Africa. Approximately 10-15% of the C&D waste can be utilised as coverage material for landfills and could be used for layering works in the construction of new landfill cells; the remainder 90% could be diverted from landfilling by processing it in material recovery facilities (MRF). Currently, 16% of the total quantity of C&D waste is recycled[33].

Table 14 quantifies some of the typical characteristics of such a facility.

Table 14: Key characteristics of construction and demolition waste recycling

Characteristic	Description
Typical capacity	50 k– 500 k tonnes per annum
Indicative capital cost	c. 25-35 million ZAR for a 100 ktpa C&D recycling facility
Human resource requirement	Low and mostly unskilled workers, manual sorters

As can be seen from Table 14, C&D waste is feasible at large scale, the required investments are relatively low and operating the equipment is rather straightforward, low and unskilled workers being required.

33 *Department of Environmental Affairs, South Africa, National Waste Information Baseline Report, pp 15, November 2012*

5.3.2 Cost benchmarks

The C&D waste, or as it is often called 'builders' rubble', can be processed in a MRF type facility by crushing and sorting operations. The resulting crushed aggregates can be used in concrete, as backfill, for land reclamation, and in some instances for road construction. Metals separated in the sorting phase, such as reinforced steel, can be recycled at market price. Other materials separated at the sorting phase, such as wood, paper, cardboard or plastics can be processed at energy recovery plants or other specific facilities.

The C&D waste recycling plants take up a relatively small area and personnel requirements include a plant operator, drivers and labourers. The diversion from landfill for this type of waste in the City of Johannesburg is estimated at 6.5%. For Cape Town the diversion from landfill can be as much as 50% to 60% due to the well-developed rubble/builders' waste recycling industries being operated by private companies. The technology is well-proven and already applied in South Africa.

The C&D waste has various compositions depending on the source of the waste. Stream management is often lacking and mixed, contaminated, streams are often landfilled. Charging higher gate fees for contaminated builders' rubble is a simple mechanism for increasing the landfill diversion rate.

The C&D waste processing facilities need to have separate storage areas and processing equipment for the various types of waste received, due to their different structure and particle size: waste from road construction/demolition, building construction/demolition, land reclamation, mixed composition waste, materials with high non-mineral content.

Key/primary equipment required in C&D waste processing facilities include waste crushing and sorting equipment such as: excavators for separating large pieces of material, hydraulic hammers for crushing large pieces of materials, ball mill crushers with magnetic separators, a variety sieves for sorting different particle sizes, feed-in equipment and containers for sorted materials.

Maintenance and repair is one of the most important operation costs. Equipment used in the crushing and sorting operations is subject to a high degree of wear and tear. Other significant operation costs for C&D processing facilities include electricity, fuel, labour and the control measures for noise and air pollution. The design of the installation and adjoining spaces should prevent contamination of separated fractions, thus ensuring the quality of output is maintained.

Economies of scale can be achieved in C&D waste recycling facilities in terms of full cost/tonne, as depicted in Figure 11: Economies of scale in recycling facilities for C&D waste34, implying that the larger the capacity of the construction and demolition waste facility, the smaller the unit operation costs.

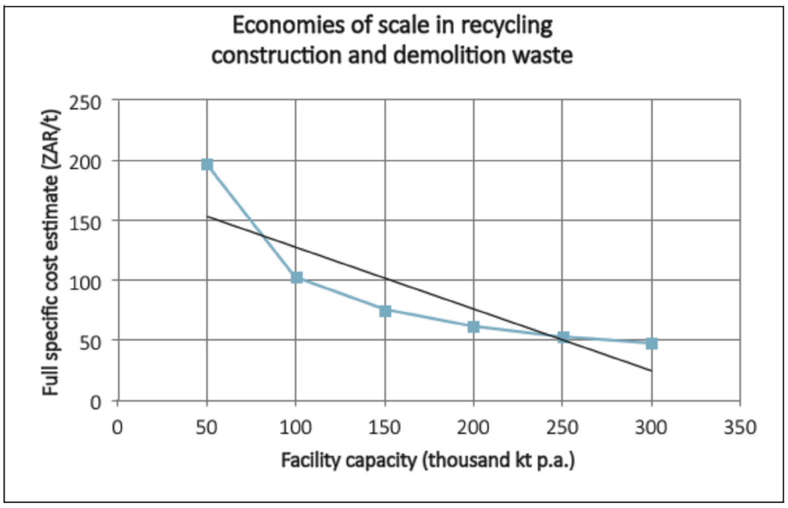


Figure 11: Economies of scale in recycling facilities for C&D waste[34]

Several factors contribute to the success of a C&D waste processing facility, including local market conditions and an enabling policy environment. Measures that promote the recycling of C&D waste in European countries include banning C&D waste from landfill or setting high landfill gate fees for this type of waste (higher than the gate fees of C&D waste processing facilities). Other instruments include taxes on use of virgin aggregates in construction materials, so that construction materials with recycled content have lower market prices than virgin materials.

34 *Brantner GmbH, Feasibility study for Inert Waste Recycling facility, 2008*

As noted from the economic analysis of a C&D recycling facility project from Portugal presented below, revenues from recycled materials need to be supplemented by gate fees in order to have a viable business case for C&D waste processing facilities.

Case study 4: Construction and demolition waste processing facility project in Amadora, Portugal – an economic analysis[35]

The project of the Construction and demolition waste processing facility in Amadora, Portugal is intended to serve Lisbon and its outskirts, a densely populated area. As Portugal has no regulatory or economic instruments for recycling Construction and demolition waste, the economic analysis of this intended project provides a clear view of the economic viability and environmental benefits of the Construction and demolition recycling plant.

Waste treatment activities: Highly mechanised facility, capable of receiving a complete mixture of Construction and demolition waste and separating all the main valuable/marketable materials and rejecting only hazardous materials and wet sludge.

Input capacity and quality: 840,000 tonnes per year input capacity. The intended plant is pre-set for two basic operation modes: when Construction and demolition waste arrives mixed (considered to be the case in approximately 70% of time), and when separate mineral aggregate (ceramic, concrete, rock) is a separate input (approximately 30% of time).

Gate fees: The gate fees taken in consideration for the economic analysis are based on average gate fees charged by Construction and demolition waste recycling companies in the area and amount to 48 EUR/tonne (620 ZAR equivalent) for mixed waste and 8/EUR tonne (100 ZAR equivalent) for source separated material.

Land take of the Construction and demolition waste processing plant: 27,500 m^2.

Equipment: The necessary equipment for the operation of the facility includes weighing devices, excavator, crusher, vibrating feeder, magnet, eddy current generator, vibrating screens and air sifters, horizontal screens, spirals and conveyors. The average service life of the equipment ranges between six and 30 years.

Human resources and labour intensity: Personnel required for the Construction and demolition waste recycling facility include management staff, supervisor, excavator operator and manual sorting workers. 10 un-skilled workers are needed for manual separation. This amounts to 100,000 EUR/year (1.3 mil ZAR equivalent) in labour cost, representing approximately 1.5% of total annual costs.

Market for outputs: The marketable outputs consist of different recyclables, ceramic aggregates and concrete aggregates. Concrete and ceramic aggregates are used in the cement manufacturing industry, as road building base or as fill in material for foundation pits and slab bases in the construction industry, depending on their characteristics.

Investment and operation costs: Investment cost for the 840k tonnes per annum facility is estimated to 4.7 million EUR (approximately 61 million ZAR equivalent).

The structure and percentage of the total for the full specific operation costs of the facility are provided in Table 15 (figures rounded).

35 *André Coelho, Jorge de Brito, Economic viability analysis of a construction and demolition waste recycling plant in Portugal - Part I: Location, materials, technology and economic analysis, Journal of Cleaner Production. 01/2013; 39:338-352. DOI: 10.1016/j.jclepro.2012.08.024*

Table 15: Operation cost structure for a 840 ktpa Construction and demolition waste processing facility in Portugal

Item	% of total cost
Energy, maintenance and labour	4
Transportation of reject materials to landfill or treatment facility	9
Gate fee paid for rejected materials to landfill or treatment facility*	80
Other operational costs	7

*Landfilling gate fee for hazardous or non-treatable materials ranging from 90 to 150 EUR EUR/tonne (1,150 – 2,000 ZAR equivalent).

Specific full cost: The specific full cost per tonne of waste handled is approximately 20 EUR (260 ZAR equivalent).

Conclusion on Feasibility: The operator of the facility is estimated to be able to make a profit margin of approximately 50% with revenues from sales and the gate fee. It should be noted that the gate fee represents 86% of revenues, that means that sales of output products alone is under no circumstances sufficient for a business case for C&D recycling for this facility.

5.3.3 Revenues and gate fees

The general characteristics and main factors influencing revenue for the material recovery of C&D waste are presented in Table 16.

Table 16: Factors influencing revenues – material recovery for C&D waste

Technology Heading	Outline Description	Factors Influencing Revenue
Material recovery for C&D waste	Revenues generated from the sales of mineral aggregates crushed and sorted by particle size and if appropriate by type (i.e. asphalt, concrete, bricks, roof tiles, etc.) and other recovered material (scrap metal, wood, paper and cardboard, plastic, etc.) that can be either recycled or used for energy recovery.	Amount of contamination in recyclate Additional processing costs associated with contaminate Disposal costs for reject material Composition of recyclate Market value of recyclate Distance to market for recyclables Ratio of technology to manual separation

Gate fees for Construction and demolition waste recycling facilities depend on the market for outputs of these facilities and on the type and characteristics of waste accepted. In general, the factors influencing revenues will also influence gate fees.

Case study 5: RamBrick, an innovative recycling initiative for builder's rubble by Use-It

Use-It, a non-profit company based within the eThekwini Metropolitan Municipality (KwaZulu-Natal), produces compressed earth blocks out of recycled builders rubble and soil, called RamBricks. The mission of the company is to offer a four-in-one solution contributing to resolving the problem of landfilling construction and demolition waste and the need for housing, while creating jobs and combating climate change.

In 2013/2014 this project created 84 direct jobs, and 68 indirect jobs, and has saved eThekwini the equivalent of 3.6 million ZAR through diversion of C&D waste from landfill.

Input capacity and quality: The building bricks are manufactured from 95% recycled materials: waste soil, recycled builders' rubble and 5% cement stabilising agent.

Characteristics of outputs: While similar to conventional building materials in appearance, RamBricks are 10 - 43 % cheaper than conventional building materials and offer superior thermal performance and compressive strength[36].

Investment and operation costs: The RamBrick system can be replicated at an investment cost of 540k ZAR for an 1,800 bricks per day capacity or 4.2 million ZAR for a 5,000 brick/day system. This translates into 20 tons/day of waste soil and rubble diverted from landfill for the small scale system and 58 tons/day for the large scale system. Subsequent cost savings from not paying landfill gate fees (estimated at 420 ZAR/tonne for Construction and demolition waste) are 2.2 million ZAR/year for the small scale system and 6.4 million ZAR for the large scale system.

Labour intensity: The operation of the equipment requires eight employees for the small scale system and 11 employees for the larger scale system.

Other costs: Costs of licensing of the RamBrick system include a 3% royalty fee due on revenue, a once-off fee of 65,000 ZAR for training and know-how transfer and once-off handling fee of 2,000 ZAR for procuring the equipment.

The Use-It model presented in the case study, is a successful example of Construction and demolition waste recycling in South Africa. The success of the business model is dependent on the mobile characteristics of the waste processing installation, as transporting the waste soil and builders' rubble to the processing facility is not factored into the operational cost calculations.

5.4 Materials Recovery Facilities (MRF)

5.4.1 Scale factors

The scale of MRF facilities for municipal solid waste depends on the type and volume of processed materials, the collection practices and market for output materials. Labour needs depend on the type of technology chosen. The sorting stage of the MRF process can be either labour intense (with mostly unskilled workers) or automated. The key characteristics of MRFs are presented in Table 17.

Table 17: Key characteristics of clean and dirty MRFs

Characteristic	Description
Typical capacity	1k – 500k tonnes per annum for clean MRF 10k – 500k tonnes per annum for dirty MRF
Indicative capital cost	c. 45 m – 80 m ZAR for a 25 ktpa clean MRF c. 60 m – 110 m ZAR for a 50 ktpa dirty MRF
Human resource requirement	Low and mostly unskilled workers, manual sorters. For example, for a semi-automated MRF processing 50t/day of waste 120 workers are needed[37].

36 Chris Whyte, Owner of Use-It, Personal communication and RamBrick Business Prospectus, March 2016
37 Kraaifontein MRF

The use of labour-intensive processes with manual sorting is preferred when high quality output is important. Although equipment is able to distinguish between most types of material, experienced personnel are more effective at extracting materials from the waste flow. This has been the case even in highly automated MRFs, resorting to manual picking for the recovery of large objects or non-ferrous metals, such as copper.

Manual sorters in RSA have been found to process 200 to 250 kg of co-mingled recyclables/day, therefore, a 100 tonnes/day facility would require 400 to 500 sorters. An approach adopted by the City of Cape Town is to achieve a balance between mechanical and manual sorting where large bulk throughput is involved.

5.4.2 Cost benchmarks

The choice of technology, the degree of process control and subsequently the investment costs largely depend on what materials are targeted to be recycled and the volume of materials captured, processed and sold. The degree to which materials are co-mingled, collection practices, and market demand for output materials affect investment levels.

Knowledge on the composition and tonnage of residential and commercial and industrial waste should serve as input data in the design of an MRF. Waste audits are recommended to decide if a single stream, dual stream or mixed waste MRF is the most suitable type of facility [38].

The success of MRFs depends on the degree of control regarding waste inputs. Changes in waste feed, for example switching from clean MRF, to dirty MRF, can affect the integrity of the machinery as well as the quality of outputs and subsequently their market value.

An important feature influencing the cost/tonne of waste processed is the flexibility of the facility in terms of output. The fluctuation in recovered material prices determines the need for the degree of separation of materials. For example, if the price of paper rises, then the effort of separating it from cardboard may prove profitable.

Cost-recovery calculations for each material should be performed to ensure that each output generates positive revenue[39]. The MRF, should be equipped based on the available collection practices in the area and the demand in the market for MRF outputs.

Specific equipment in an MRF may include: feed, transfer, sorting and discharge conveyors. This equipment helps to move the waste automatically from the input to the output point of the facility. Other equipment that are required also include: screens, magnetic separators, inclined disk screens to separate fibre from containers, polishing screen and bag splitters. Certain equipment needs to be imported and would also require spare parts from abroad, which may add significant cost and would have to be factored in to ongoing operation costs.

It is possible to increase the level of mechanisation through using drum separators, trommels and/or vibrating screens to separate recyclables from MSW, air classifiers, eddy currents, optical sorters, glass clean-up systems and equipment to prepare the materials for the market (e.g. balers, glass crushers, can flatteners and densifiers, shredders and granulators).

Tendering Considerations:

- Decide on operator model
- Research composition an tonnage of waste streams
- Take into account current collection practices for the design phase
- Estimate material recovery rates for different types of materials

The full cost of building and operating a MRF is estimated to be in the range of 300 to 400 ZAR per tonne. The breakdown of specific costs estimated for MRFs in RSA and industrialised countries is depicted in Figure 12. The feasibility of MRF also depends on the cost of collection of source separated materials, which may be more expensive than collecting co-mingled waste. Labour intensity of both dirty and clean MRF varies across specific cases.

38 *WRAP (Waste and Resource Action Programme), 'MRF Costing model', UK, 2006*
39 *WRAP (Waste and Resource Action Programme), 'MRF Contracts Guidance: Final Report', UK, May 2008*

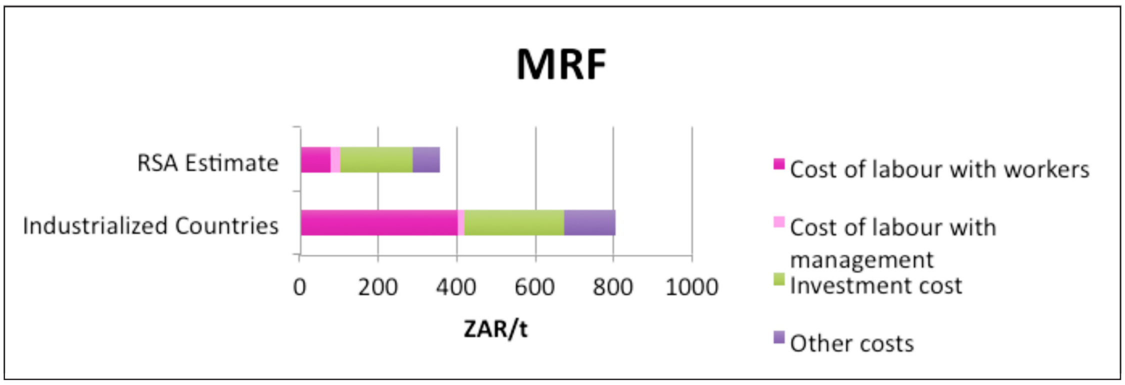


Figure 12: Full specific cost breakdown for Material Recovery Facilities

5.4.3 Revenues and gate fees

Table 18 describes the particularities of clean and dirty MRFs, as well as the factors that influence the revenue of each of the two technologies.

Table 18: Factors influencing revenues - MRFs

Technology Heading	Outline Description	Factors Influencing Revenue
Clean MRF	Mixed dry recyclables are separated into fractions by a mechanical and manual segregation techniques and conveyors. Fractions can be targeted depending on value, with different levels of purity achievable as the end-market dictates.	▫ Amount of contamination in recyclate ▫ Additional processing costs associated with contaminate ▫ Disposal costs for reject material ▫ Composition of recyclate ▫ Market value of recyclate ▫ Distance to market for recyclables ▫ Ratio of technology to manual separation
Dirty MRF	A facility employing a number of separation techniques to recover recyclable materials from mixed waste, usually of a relatively low grade. The remaining residual can be processed into a fuel (refuse-derived fuel (RDF)) for use in cement plants or energy recovery facilities. Small quantities of recyclables may be extracted and sold.	▫ Quality of compost ▫ Cleanliness of recyclables ▫ Disposal costs for reject ▫ Market value of recyclate ▫ Market cost for fuel ▫ Market/facility availability for RDF ▫ Distance to market/outlet for recyclables, fuel and rejects

MRF operators usually require a gate fee to be paid by those delivering waste. The gate fees depend on the market for recyclables, local policy and facility processing conditions. In case of dirty MRFs, it is often difficult for the outputs to comply with the quality requirements of the recycling market. According to the *2014 UK WRAP Report*, gate fees for MRF in the UK are approximately 14 EUR per tonne equivalent (180 ZAR per tonne equivalent).

Case study 6: Kraaifontein clean MRF for Municipal Waste

The Kraaifontein Clean MRF facility was built in 2011 and is owned by the Cape Town Metropolitan Municipality. Operation is contracted out to a private operator known as, Waste Plan. Waste Plan's main line of work has traditionally been cleaner production and assisting companies to reduce their waste.

Waste Plan facilitated the operation of the first large-scale MRF in South Africa for source-separated dry recyclables. Waste Plan was awarded a second three-year contract for the operation of the plant. The lessons learned from the Kraaifontein facility, including cost information, are used in estimating feasibility for establishing MRFs elsewhere in the country.

The waste treatment activities: The company also collects dry recyclables from households and commercial clients and treats these in the MRF. The MRF is partially mechanised, relying on automatic feed in and conveyor belts with manual sorters.

Input capacity and quality: The MRF was built to serve 44,250 households in high-and middle-income areas, where source-separation and collection services are provided. The facility currently serves about 100,000 households and commercial clients, and operates on a two X eight-hour shift basis. The output of the plant is currently 1,800 tonnes/month (80 tonnes/day). The input coming from commercial clients needs little to no sorting.

The material received from households has approximately 15% residual waste. There is no residual waste in the commercially sourced waste stream. Various types of packaging waste is sorted and recovered, except for multi-layer packaging, which is either not collected or returned to landfill as residual waste.

The equipment used: The equipment at the MRF consists of a forklift, feed in conveyor belt, baling equipment, bag-splitter, screen and magnetic separator. Of these, the bag-splitter and screen need spare parts/components from abroad.

Human resources and labour intensity: In MRFs, there is a competing interest between job-creation and mechanising the sorting activity. The technology was scrutinised against labour policy and geared to provide job creation and to promote the transfer of skills. There are 60 workers on site per shift.

Operating costs to the City: Based on the public tender information, the operational cost of the MRF to the City is about 53 ZAR/t, which is well below what the City would be paying for landfilling the same waste. The cost for collection of the recyclables to the City is about 64 ZAR/t. The combined cost of about 120 ZAR/t (rounded) is still cheaper for the City than the gate fee calculated at operational cost recovery at 317 ZAR/t for landfilling.

Market for recyclables: Local prices for materials are currently higher than for export - and have been so for four consecutive years. The major share of income is generated from the price per tonne received from the municipality. An agreements in place to share avoided costs of landfill between the municipality and operator.

Case Study 7: Break-even analysis: Naledi Buy-Back Centre/sorting facility[40]

The Naledi Buy-Back Centre is a Buy-Back/sorting facility (clean MRF) operated in the Zondi Depot area of Johannesburg for the sorting of waste separated at source. The Naledi Buy-Back Centre was envisaged as a replicable project that could be rolled-out citywide. This case study presents information on the current experience and the envisaged upgrade.

The waste treatment activities: The waste treatment activity at the Naledi MRF is 100% manual sorting, carried out on a concrete floor or other suitable platform using manual labour.

Input capacity, costs and revenues are presented for the current scenario "As is" and for the "Full Capacity" scenario in Table 19.

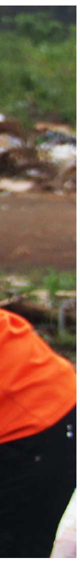
Table 19: Naledi Buy-Back Centre costs information

Input capacity	"As is"	"Full Capacity"
Participation rate	7%	40% (30,000 households)
Quantity of material received	27 t/ month	144 t/month
Amount of recycled material sold to buyers	93% (approx. 25 t/ month)	93% (approx. 134 t/month)
Staffing requirement	26	52
Costs and revenues (ZAR/month)		
Salary costs covered by Co-operative	26,000	52,000
Average revenue from sales	26,525	141,469

All other costs related to the MRF are covered by Pikitup. These include collection of recyclables using six caged trucks, marketing activities, health and safety equipment for the workers, purchasing and maintaining bin liners, storage and processing equipment and facilities, overhead costs and management costs.

From the information presented in Table 19, the present operation at the Naledi Buy-Back Centre has the ability to support a 1,000 ZAR per month wage for 26 people. At full capacity the Centre is estimated to have sufficient profit to enable it to support a wage bill for approximately 52 people.

All other costs, with the exception of salaries, continue to be supported by Pikitup. When taking into account the full cost of MRF operations, including those costs supported by Pikitup, the MRF still functions at a loss in the Full Capacity scenario.



The Kraaifontein MRF is a success both from the point of view of the municipality and the operator, both looking at extending and expanding the experience in the future. Waste quantities captured from households were difficult to estimate in the first phase and the facility is serving more clients than originally planned. Important success factors include the fact that recyclables are sourced from commercial and relatively high-income areas, ensuring a relative high quality of the input material. The municipality pays a fee for collection and treatment of waste but this is below the cost of landfilling, confirming MRF as a cost competitive technology.

The Naledi Buy-Back Centre from the City of Johannesburg is the initiative of the recycling operator, Pikitup, who is subcontracting a co-operative. Pikitup does not receive an additional fee from the municipality for running the MRF. The case study illustrates that at 27 tonnes of waste being recycled per month, the revenues cover only the costs with the manual labour involved in sorting. As tonnes being handled increase, more revenue becomes available to support other related costs. Pikitup operates the MRF at a net loss, as no fee is paid by the municipality for the operation of the manual MRF.

The two case studies illustrate that operating an MRF irrespective of the facility being manual or automated or a combination of both, is a viable alternative when avoided costs of landfill are taken into consideration. To ensure success, the facility should receive a gate fee for operating the MRF, set equal to or below the landfill gate fee, established at operational cost recovery.

40 *Republic of South Africa, Municipal System Act 32 of 2000 (MSA) section 78(3)*

5.5 Concluding Remarks

The generic cost benchmarks and the case studies throughout this chapter indicate that the promising technologies – in the short-term, stand out as possible AWT technologies for which the financial costs are lower or similar to that of the baseline situation of landfilling, i.e. below 400 ZAR/t. These technologies include windrow composting, recycling of construction and demolition waste and material recovery facilities. Adding the wider environmental and social benefits of the AWT solutions increases the attractiveness of these technologies further. Gate fees set at, or close to, the avoided full cost of landfill are an important influencing factor to the business-case for these facilities.