The City of Cape Town
Republic of South Africa

PILOT SURVEY FOR DISSEMINATING SMALL AND MEDIUM ENTERPRISE TECHNOLOGIES FOR RECYCLING WASTE PLASTIC TO FUEL TOWARDS SUSTAINABLE WASTE MANAGEMENT

SUMMARY REPORT

JULY 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE CONSORTIUM OF CFP CORPORATION AND KANEMIYA CO., LTD.

1. BACKGROUND

In the Republic of South Africa (here after referred to as “the RSA”), the amount of waste plastic has been increasing, becoming one of its major waste materials (6% increase in total; 2011). However, South African recycling rate is still low (18%; 2011) and the majority of waste is sent to landfilled. Since plastic waste is non-biodegradable, its environmental impact is negative, long-lasting and significant. According to the National Waste Management Strategy (2011), the RSA aims to achieve a 25% recycling rate of landfill waste and therefore the introduction of new recycling technologies for plastic waste is necessary for South Africa to achieve its goal and to create a sustainable future.

The City of Cape Town is one of the leading cities promoting waste recycling in the RSA and operates advanced recycling facilities where new technology can be introduced and integrated. Additionally, the RSA is the only G20 member in Africa and is considered a newly industrialized country however, the unemployment rate in the RSA is still high (25.2%; 1st quarter of 2013). The new plastic recycling technology to be introduced in the Survey will contribute to the RSA’s job market and has the potential to create multiple avenues of development opportunities for the Japanese private sector to become involved in the RSA.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME’S TECHNOLOGIES

(1) Purpose

This Survey aims to improve environmental issues caused by solid waste which threatens the sustainable development of South Africa. This will be done through the recycling of waste plastic materials by the pyrolysis pilot plant thereby reducing the amount of waste sent to landfill. This Survey will also introduce a range of sustainable, environmental management systems to the City of Cape Town’s Kraaifontein Integrated Waste Management Facility (KIWMF) (location of Survey Pilot Plant). In the short-term, the Survey will create cracked oil which can be used as fuel in heavy duty machinery such as generators thereby saving the Kraaifontein Facility money on fuel expenses but this Survey is also planned to have long term benefits for RSA as this pyrolysis technology grows and creates jobs in the recycling industry and developing solutions towards unemployment in the RSA.

(2) Activities

i. Authority Approvals

An Environmental Authorization (EA) and Provisional Atmospheric Emission License (PAEL) were required for the operation of the plant. The EA was issued by the Western Cape Government's Department of Environmental Affairs and Development Planning (DEADP) on the 17th of April 2015 after the Final Basic Assessment Report (FBAR) was submitted to DEADP by the City of Cape Town on the 12th of February 2015. The PAEL was issued from DEADP on the 9th of July 2015. And Building Approval (BA) including fire approval, was issued the 16th of September 2015 by the City of Cape Town.

ii. Installation and Commissioning

The Waste Plastic to Oil Pilot Pyrolysis Plant was delivered to KIWMF in Cape Town on the 29th of September 2015 after obtaining the EA, FBAR and BA.

Installation and commissioning of the plant was completed on the 23rd of October 2015.

iii. Survey Operation

The Survey was conducted over a six month period of operation from the 26th of October 2015 to the 26th of April 2016. During this time the plant was operated by a Japanese survey team and the City's survey team. Three full load tests were conducted using three types of waste plastics to obtain operation data and to confirm the plant's manufacturing capability of processing 500kg of waste plastics per day.

iv. Seminars

During the six month survey period, a total of 191 people from private South African companies, universities and the Development Bank of Southern Africa participated in two seminars, consisting of a workshop and plant tour, held at the Kraaifontein Integrated Waste Management Facility in February and April of 2016.

v. Hand-Over

The plant was handed over from JICA to the City of Cape Town on the 26th of April 2016.

(3) Information of Product/ Technology to be Provided

i. Oil Production through Pyrolysis

CFP Corporation has succeeded in commercializing pyrolysis technology for cracking the oil component of naphtha, diesel and heavy oil that is derived from waste plastic, at high rates of efficiency. The plant can convert a maximum of 500 kilograms of waste plastic to 500 liters of cracked oil per day. The cracked oil can be used as a fuel for power generation and boilers. Suitable waste plastics that can be converted into oil are PE (polyethylene), PP (polypropylene) and PS (polystyrene).

The waste plastic washing machine invented by KANEMIYA Co., Ltd. is extremely water and electricity efficient, and is able to clean and prepare multiple grades of plastic for recycling using only a small quantity of water and electricity. This enables the plant's staff to process large amounts of waste plastic quickly and cost effectively.

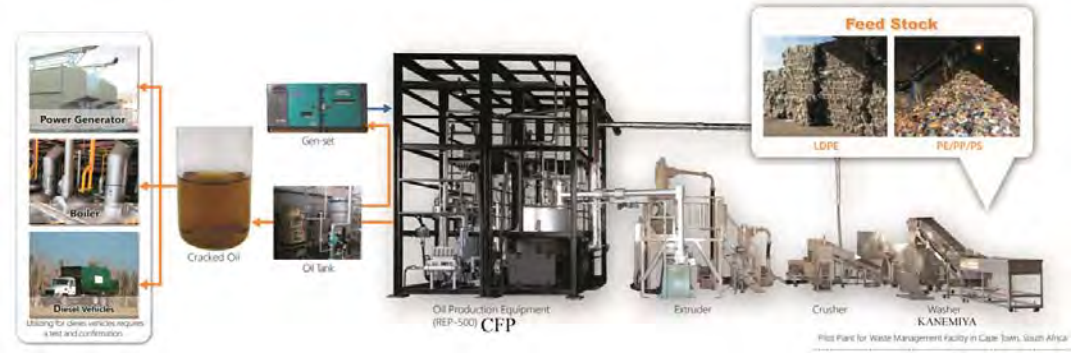


Figure 2-1 Waste Plastic-to-Oil Production System

(4) Counterpart Organization

The City of Cape Town's Solid Waste Management, Utility Services

(5) Target Area and Beneficiaries

Citizens of the City of Cape Town (Population: 3,740,025 in 2012)

(6) Duration

Approximately 25 months from the signing of the agreement between the City of Cape Town, JICA and the Survey team in March 2014 to the hand-over of the plant in April 2016

(7) Progress Schedule

Progress schedule is shown in Table 2-1

Table 2-1 Progress Schedule

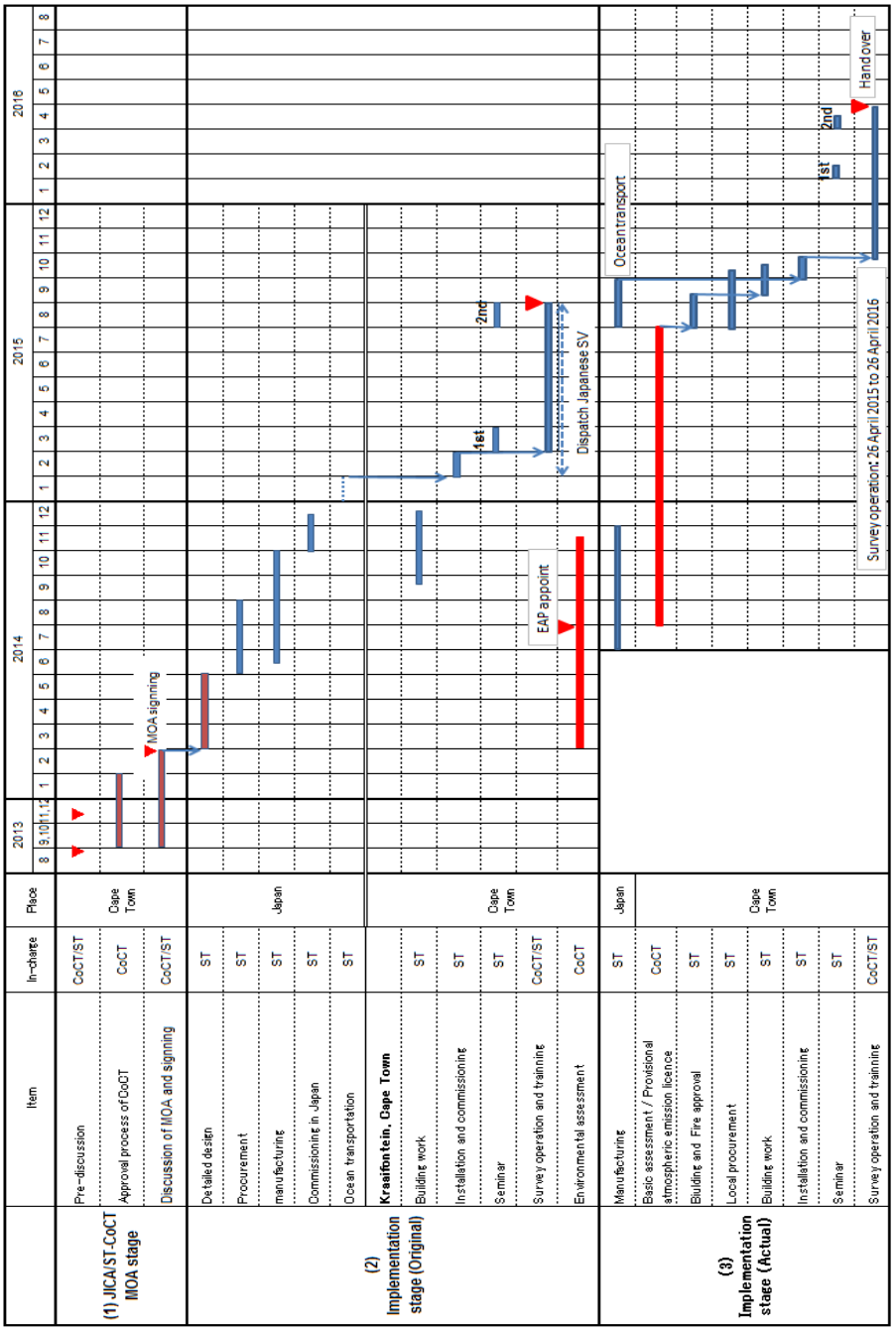
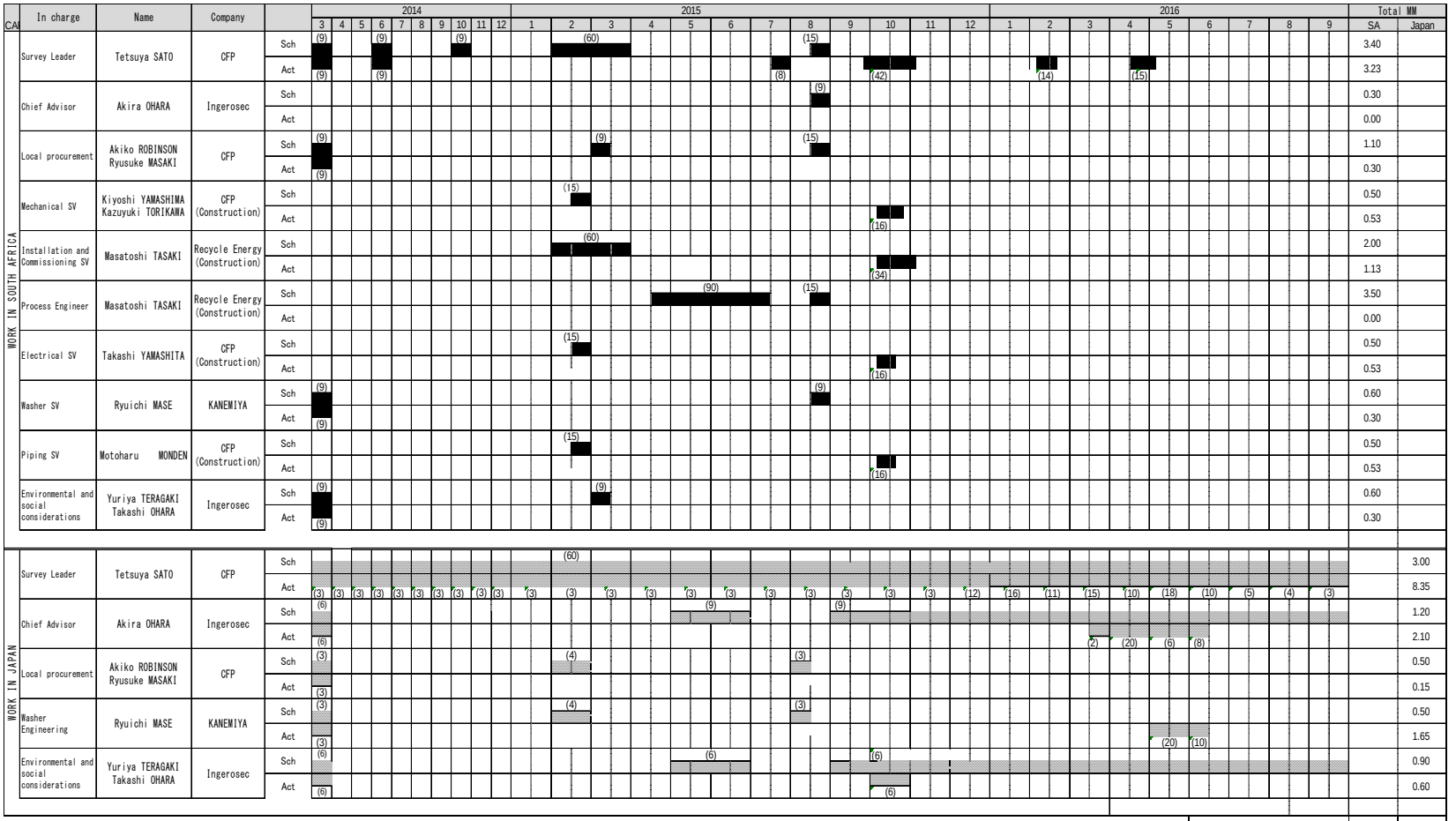


Table 2-2 Manning Schedule



CAT	In charge	Name	Company		Total MM SA	Total MM Japan
WORK IN SOUTH AFRICA	Survey Leader	Tetsuya SATO	CFP	Sch	3.40	
				Act	3.23	
	Chief Advisor	Akira OHARA	Ingerosec	Sch	0.30	
				Act	0.00	
	Local procurement	Akiko ROBINSON Ryusuke MASAKI	CFP	Sch	1.10	
				Act	0.30	
	Mechanical SV	Kiyoshi YAMASHIMA Kazuyuki TORIKAWA	CFP (Construction)	Sch	0.50	
				Act	0.53	
	Installation and Commissioning SV	Masatoshi TASAKI	Recycle Energy (Construction)	Sch	2.00	
				Act	1.13	
	Process Engineer	Masatoshi TASAKI	Recycle Energy (Construction)	Sch	3.50	
				Act	0.00	
	Electrical SV	Takashi YAMASHITA	CFP (Construction)	Sch	0.50	
				Act	0.53	
	Washer SV	Ryuichi MASE	KANEMIYA	Sch	0.60	
				Act	0.30	
	Piping SV	Motoharu MONDEN	CFP (Construction)	Sch	0.50	
				Act	0.53	
	Environmental and social considerations	Yuriya TERAGAKI Takashi OHARA	Ingerosec	Sch	0.60	
				Act	0.30	
WORK IN JAPAN	Survey Leader	Tetsuya SATO	CFP	Sch		3.00
				Act		8.35
	Chief Advisor	Akira OHARA	Ingerosec	Sch		1.20
				Act		2.10
	Local procurement	Akiko ROBINSON Ryusuke MASAKI	CFP	Sch		0.50
				Act		0.15
	Washer Engineering	Ryuichi MASE	KANEMIYA	Sch		0.50
				Act		1.65
	Environmental and social considerations	Yuriya TERAGAKI Takashi OHARA	Ingerosec	Sch		0.90
				Act		0.60

Order receiving company (Sch) MM	12.70	4.00
Order receiving company (Act) MM	6.57	10.15
Exterior collaborators (Sch) MM	0.90	2.10
Exterior collaborators (Act) MM	0.30	2.70
Total (Sch) Man-Month	13.60	6.10
Total (Act) Man-Month	6.87	12.85

(9) Implementation System

The implementation system of this Pilot Survey, including the roles of both the Japanese and South African officials, are shown in Figure 2-2. This pilot survey was implemented by the Consortium consisting of CFP Corporation and KANEMIYA Co., Ltd, two Japanese SME companies. Local counterparts from the City of Cape Town were from the City's Waste Management Department. INGEROEC Corporation in Japan and Akura Manufacturing Engineering Company (Pty) Ltd in RSAsupported the Consortium in the implementation this pilot survey.

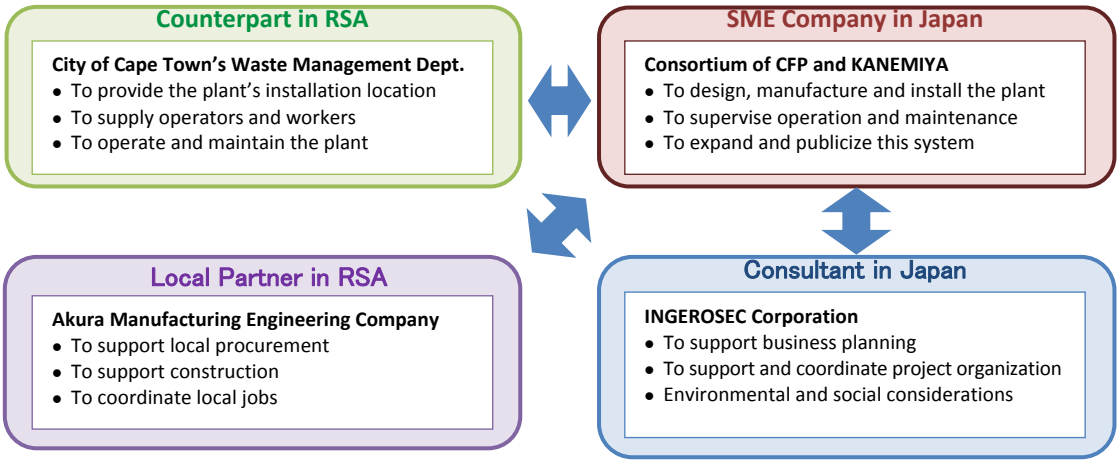


Figure 2-2 Implementation System

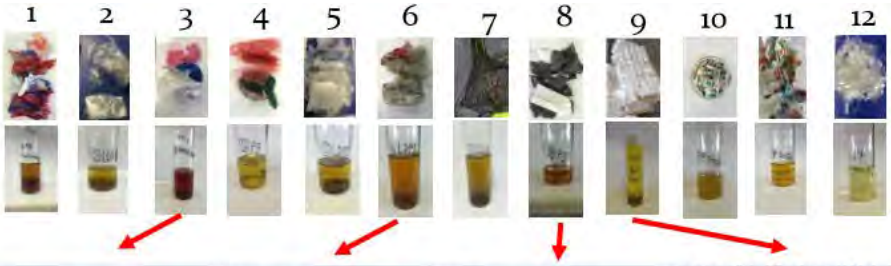
3. ACHIEVEMENTS OF THE SURVEY

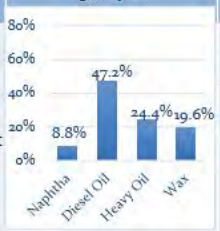
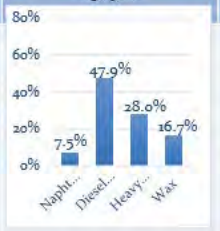
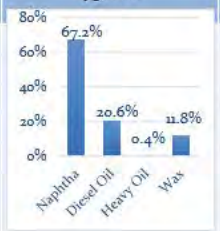
(1) Outputs and Outcomes of the Survey

i. Feedstock Materials

For the duration of the Survey, feedstock (waste plastics) for the pilot plant was sourced from the Material Recovery Facility (MRF) located at the KIWMF. Waste Materials containing PE, PP and PS were sorted into12 types of raw materials and were sent to CFP's laboratories in Japan for testing. These materials were tested to confirm their characteristics and whether or not they would be suitable to convert into cracked oil through the pyrolysis process. The results of these tests are shown in Table 3-1.

Table 3-1 Analysis of 12 Material Types



Raw material	3 Plastic bag (PE)	6 Plastic bag (PE)	8 Fruits tray (PS)	9 Rapping for magazine (PP)
Color	Red-brown	Brown	Gold	Gold
Clarity	Low	High	High	High
Odor	Normal	Burnt odor	PS odor	Normal
Deposit	A small amount of solid deposit	A small amount of wax	Not exist	A small amount of EVA deposit
Yield (reference only)	58.4%	65.9%	73.1%	75.9%
Oil component fraction				
Oil quality	Diesel rich oil. Low yield because raw material contains additive of calcium carbonate.	Diesel rich oil High possibility of usage for diesel generator etc.	Naphtha rich oil Further study for use naphtha rich oil is required	Naphtha rich oil Further study for use naphtha rich oil is required

According to the results of the analysis, some of the materials were unsuitable to be converted into oil through pyrolysis because they contained materials such as EVA, EVOH, PVC, PA etc. In addition, the test results also revealed that there are other materials which could possibly be used as feedstock by mixing them with known suitable materials to be converted into oil through pyrolysis as detailed in Table 3-2.

Table 3-2 Classification of Raw Materials

Suitable Raw Materials (Diesel Rich Oil)

i. Plastic bag (PE)
A large amount of residue is produced

ii. Plastic bag (PE)
Small amount of wax is produced

iii. Milk bottle (PE)
The crusher installed in the pilot plant is for film plastics. Therefore another type of crusher is required to process this type of plastic

Unsuitable Raw Materials (Naphtha Rich Oil)

iv. Food Packaging (PP)
A large amount of water is produced because EVOH and PA are included in the raw materials

v. Stretch Film (PE)
A large amount of water is produced because EVOH and PA are included in the raw material

iv. Clear Film with Labels (PE)
PVC and EVA are included in raw material

Usable with other Raw Materials

vii. Netting (PP)
The crusher installed in the pilot plant is for film plastics. Therefore another type of crusher is required

viii. Foods Tray (PS)
Naphtha ratio of cracked oil is very high

ix. Wrapping for Magazines (PP)
A small amount of EVA is included

x. Clear Film (PP)
Naphtha ratio of cracked oil is very high

xi. Snack Bags (PP)

A large amount of residue is produced because Aluminum is laminated to the film

xii. Pudding Cups (PP)

The crusher installed at the pilot plant is for film plastics. Therefore another type of crusher is required to process this material

ii. Plant Productivity and Full Load Tests (Max 500kg/day)

To assess the processing ability of the pilot plant using local, raw material; three Full Load Tests (Full Load Test describes the maximum processing ability of the plant - 500kg per day) were carried out over the 6 month survey period, each time using different types and combinations of plastics as feedstock. The results of the Full Load Tests are as follows (Table 3-3).

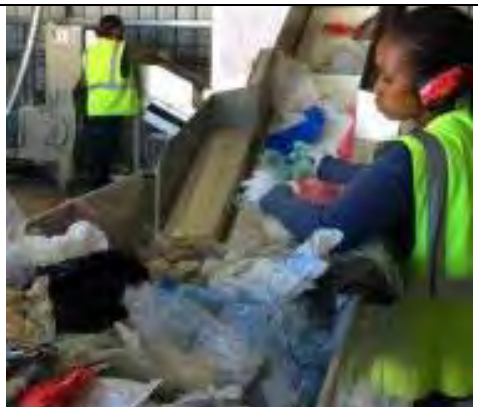
Table 3-3 Comparison of Cape Town's Pilot Pyrolysis Plant's Full Load Test Results Compared Against Fukuyama's (Japan) Pyrolysis Plant

No	Item	Test in JP (25/5/2015)	1st test in SA (15/1/2016)	2nd test in SA (25/3/2016)	3rd test in SA (4/4/2016)	1st-3rd test on average
1	**Material**					
	Type of Materials	Clean PE film PE (100)	Dirty PE film PE (100)	Dirty PE,PP PE (80) : PP (20)	Dirty PE, PP, PS, PE (80) : PP (15) : PS (5)	Dirty PE,PP,PS
	Quantity of Materials (kg)	500	500	500	500	500
2	**Productivity**					
	Cracked Oil (L)	512	348	378	341	355
	Yield (%)	80%	54%	59%	53%	55%
	Generated Electricity (kwh)	-	394	392	459	415
	Consumption & Utilization					
	Cracked oil for generator (L)	150	140	130	156	142.0
	Cracked oil for burner (L)	84	108	84	90	94.0
	Electricity (kw)	-	6	6	5	5.7
	Water (L)	0	177	107	122	135.3
4	**Storage of Cracked Oil (L)**	278	100	164	95	120
5	**Waste**					
	Residue (kg)	11	65	49	53	56
	Waste from washer (kg)	1	35	25	30	30
6	**Operation & Maintenance by Hour**					
	Operating (hr)	15:00	20:00	14:00	15:15	16:25
	Maintenance (hr)	0:00	0:00	0:00	0:40	0:13
7	**No. of Operators & Workers**					
	Operators	2	2	2	2	2
	Worker	4	6	5	6	5.6

In summary, the Japanese plant based in Fukuyama produced 512L of cracked oil with a yield of 80% compared to the Cape Town plant which produced 355L of cracked oil with a yield 55% based on 500kgs of feedstock per day. The difference in cracked oil produced and quality of yield is attributed to the type of raw materials used as feedstock. In the Japanese test, clean PE film was used as feedstock which is known to have a high yield however in the South African tests, raw materials such as plastic bags (PE) and food trays (PS) were used and these contain additives such as $CaCO_3$ that are added to reduce the cost of the product. The type of feedstock used in the two tests also affected the amount of residue formed in the rector – In the Japanese test 11kgs (2.2%) of residue was formed compared to the average 56kg (11.2%) formed during the 3 Full Load Tests at the Cape Town Pilot Plant.

The cracked oil which was produced by the South African pilot pyrolysis plant is suitable to fuel the plant's burner and can be used to fuel the plant's generator. Additionally, during the 1st seminar, cracked oil produced by the plant was used to fuel a diesel powered forklift without issue. Scenes from the Full Load Tests in Cape Town are shown in Figure 3-1.

1st Full Load Test (15 January 2016) – Work began



1st Full Load Test (15 January 2016) – Feeding of the raw materials to washer

2nd Full Load Test (25 March 2016) – Feeding of the raw materials was very smooth thanks to the improved cooperation of the workers

2nd Full Load Test (25 March 2016) – Operator A monitoring the oil production machinery while Operator B supervises the pre-treatment area

	
3rd Full Load Test (4 April 2016) – Raw materials used are a mix of PE, PP,PS	3rd Full Load Test (4 April 2016) – Members of the 3rd Full Load Test (2 operators and 6 workers)

Figure 3-1 Full Load Tests in Cape Town

During the 1st Full Load Test, it took 20 hours of plant operation for 500kgs of feedstock to be processed at the Cape Town plant compared to the 15 hours of operation it took at the Japanese plant to process the same amount of feedstock, leaving a 5 hour difference in performance between the Japanese and South African plants.

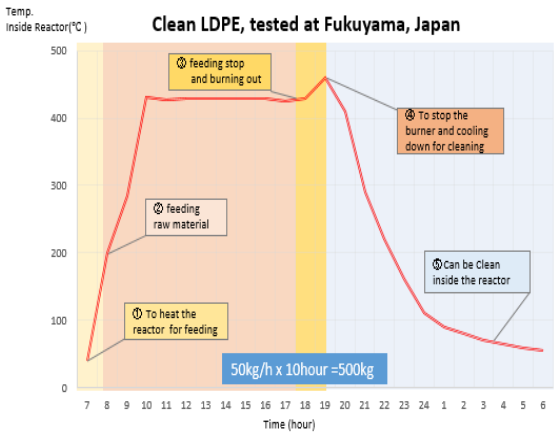
The reason behind the 5 hour difference was the lack of experience of the South African workers. This resulted in the feeding speed of the raw materials being too fast which caused blockages at the hopper on the extruder and resulted in an inconsistent flow of materials to the stack.

By the 2nd and 3rd Full Load Tests, the operating time had decreased to around 15 hours, due to the workers becoming more experienced with the feeding of raw materials into the plant. This stable feeding of materials also decreased the amount of fuel, electricity and water used during the 2nd and 3rd tests when compared to the 1st Full Load Test.

Comparison of Operating Patterns between the Fukuyama and Cape Town Plants (Table 3-4)

Table 3-4 Comparison of Operating Patterns between the Fukuyama and Cape Town Plants

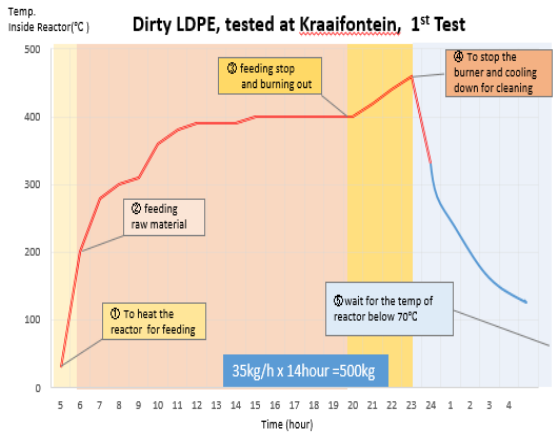
Japan Full Load Test Result（25/05/2015）



Date of test	22/5/2015	Ambient Temp (℃)	16-30
Feed Stock	Clean PE film PE(100)	Number of worker (Nos)	6
Quantity (kg) (Input)	500	Cracked Oil (L) (Output)	512
		Waste from washer (kg)	1
		Residue(kg) 2.2%	11
Operating hour (hr)	15	Yield (%)	80

Utilized of Crakced oil	Oil storage tank(L)	54.3%	278
	Burner fuel(L)	16.4%	84
	Diesel generator fuel(L)	29.3%	150

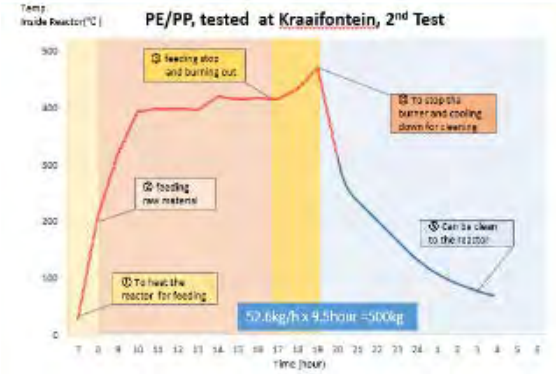
The 1st Full Load Test Result（15/01/2016）



Date of test	15/1/2016	Ambient Temp (℃)	20-35
Feed Stock	Dirty PE film PE(100)	Number of worker (Nos)	9
Quantity (kg) (Input)	500	Cracked Oil (L) (Output)	348
		Waste from washer (kg)	35
		Residue(kg) 13%	65
Operating hour (hr)	20	Yield (%)	54

Utilized of Cracked oil	Oil storage tank(L)	28.7%	100
	Burner fuel(L)	31.0%	108
	Diesel generator fuel(L)	40.2%	140

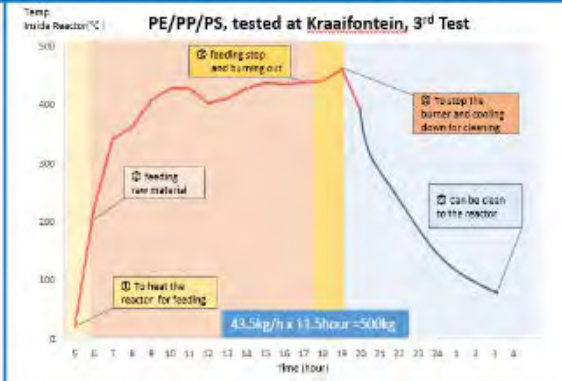
The 2nd Full Load Test Result（25/03/2016）



Date of test	25/3/2016	Ambient Temp (℃)	15-25
Feed Stock (※2)	Dirty PE,PP (PE80/PP20)	Number of workers (Nos)	7
Quantity (kg) (Input)	500	Cracked Oil (L) (Output)	378
		Waste from washer (kg)	25
		Residue(kg) 9.8%	49
Operating hour (hr)	14	Yield (%)	59

Utilized of Crakced oil	Oil storage tank(L)	54.0%	164
	Burner fuel(L)	22.2%	84
	Diesel generator fuel(L)	23.8%	130

The 3rd Full Load Test Result（04/04/2016）



Date of test	4/4/2016	Ambient Temp (℃)	15-25
Feed Stock	Dirty PE,PP PS (PE80 /PP15/PS5	Number of workers (Nos)	8
Quantity (kg) (Input)	500	Cracked Oil (L) (Output)	341
		Waste from washer (kg)	30
		Residue(kg) 10.8%	54
Operating hour (hr)	15:15	Yield (%)	53

Utilized of Cracked oil	The Tank of oil plant(L)	27.9%	95
	Burner fuel(L)	26.4%	90
	Diesel generator fuel(L)	45.7%	156

iii. Result of Tailings Classification

At the Kraaifontein MRF, a sorting process takes place which separates waste from recyclable items. This leftover, non-recyclable waste is known as “tailings” and is disposed of as rubbish into the City’s landfill sites. In this survey, trained staff from the Kraaifontein MRF, re-sorted the tailings after the initial sorting process and separated the materials containing PE/PP/PS plastics to be surveyed as potentially suitable feedstock for the pyrolysis pilot plant.

Method of Survey:

Separation of PE/PP/PS material from tailings

Step 1: A 50kg mixed waste selection of tailings was used as a sample

In total, three 50kg samples were taken at different points of the tailings pile

Step 2: Separation of the 50kg samples into PE/PP/PS and other materials which were then weighed. The survey data is as follows:

The results of the tailings classification survey is shown in Table 3-5 and Figure 3-2.

Table 3-5 Results of Tailings Classification Survey

No	Date	Total (Kg)	Type of materials (kg)/(%)						
			PE	PP	PS	Other Plastics (PET etc)	Can	Papers	Other (waste)
1	18 March 2016	50.0 (100%)	10.0 (20%)	16.0 (32%)	4.0 (8%)	4.0 (8%)	1.0 (2%)	4.0 (8%)	11.0 (22%)
2	22 March 2016	51.0 (100%)	5.0 (10%)	11.0 (21%)	3.0 (6%)	11.0 (22%	1.0 (2%)	14.0 (27%)	6.0 (12%)
3	23 March 2016	61.0 (100%)	5.0 (8%)	11.0 (18%)	4.0 (6%)	17.0 (28%	1.0 (2%)	11.0 (18%)	12.0 (20%)
Total		162.0 (100%)	20.0 (12%)	38.0 (23%)	11.0 (7%)	32.0 (20%	3.0 (2%)	29.0 (18%)	29.0 (18%)

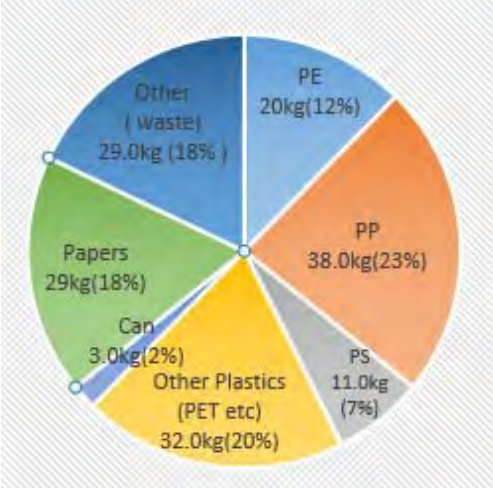


Figure 3-2 Classification of Tailing Materials from the 3 Collected Samples

When reviewing the contents of the total amount of tailing materials, the ratio of PE, PP and PS was 42.6% which highlights the possibility of suitable raw material being sourced from tailings at the MRF to be then converted into oil by the pilot plant. In addition, 20% of the other plastics were PET plastics which are recyclable. Each 50kg tailings sample took 2 hours to be sorted. Sorting and classification of tailings are shown in Figure 3-3.

Mixed waste tailings sampled from the MRF's tailings pile

Around 50kg for each sample was selected

Information on plastic types to confirm selection

Workers from the pyrolysis plant were assisted by staff from the MRF who are trained and experienced in sorting waste

Sorting of the tailing sample

Weighing of the sorted material

Figure 3-3 Sorting and Classification of Tailings

iv. Running and Maintenance Cost

Maintenance of the plant included the changing of the burner filter and nozzle as well as periodic inspections of the generator by the generator company's technician (one inspection per 250 hours of running time). These maintenance costs totaled R5, 185.00 over the 6 month survey period as shown in Table 3-6. There was no maintenance cost incurred for the pre-treatment equipment i.e. the washer and crusher, because the survey period (6 months) was too short to require maintenance or replacement of parts.

Table 3-6 Maintenance Items & Cost

Maintenance Item	Cost (ZAR)	Times	Total Cost (ZAR)
Replacement of burner filter	120	5	600.00
Replacement of burner nozzle	300	2	600.00
Generator maintenance service (every 250hrs running)	3,985	1	3985.00
Total maintenance cost			5185.00

The Running cost per day was calculated based on average figures from the three Full Load Tests as shown in Table 3-7

Table 3-7 Running Cost

Raw Material Cost	500kg @ R1.75/kg		R875/day
Labour Cost	Operators	R20,000/20days x 2 persons	R2,000/day
	Workers	R5,000/20days x 6 persons	R1,500/day
Electricity Cost	Main supply	5.7kwh @ R1.65/kWh	R10/day
	Generator	415kwh (self-generation)	0
Fuel Cost	For burner	94L (use cracked oil)	0
	For generator	142L (use cracked oil)	0
Water Cost	$0.1353m^3$ @ $R26/m^3$		R4/day
Waste Water Cost	discharge to existing sewer line		0
Residue	56kg storage to container		0
Total Running Cost per Day			**R 4,389**

The oil production cost was calculated based on the 2nd full load test. (PE/PP mixed material) as shown in Table 3-8.

Table 3-8 Cost Analysis Based on 2nd Full Load Test

Item	500kg/d	
	Dirty PE80%/PP20% (R1.75/kg) Yield: 59%	per day (ZAR)
Pyrolysis Oil Conversion		
Waste plastic cost	500kg @ 1.75R/kg	875
Water cost	0.107m^3/d x @ 26R/m^3	3
Electricity cost	Generator 392kw, use cracked oil 130L	0
	Substation 6kw @1.65R/kw	10
Buner fuel cost	cracked oil: 84L/d use	0
Labor cost Operator	R750/d (R2000/20days) x 2p	1,500
Worker	R150/d(R3000/20days) x 4p	600
Maintenance cost	generator R3500/250hrs run x14hr	196
Residue (carbon black)	TBA disposal or recycle, 49kg/d (9.8%)	0
Enviro. Monitoring (R200,000)	TBA	0
Oil analysis	TBA	0
Oil tax (by SARS)	TBA	0
Wastewater cost	discharge to exist sewer line, 107L/d	0
Plant cost	Funded by JICA	
	Oil plant	
	Pre-treatment	0
	Installation	
	Foundation & building	
Total O&M Cost		**3,184**
Oil Production	**500kgx0.59/0.78 =378L**	
Usage of cracked oil	For burner: 84L/d	22.2%
	For generator: 130L/d	34.4%
	For storage tank: 164L/d	43.4%
Oil Production Cost R3,184 / 164L		**R19.41/L**

v. Seminars

During the six-month survey period - a total of 191 people from private South African companies, universities and the Development Bank of Southern Africa participated in the two seminars (workshop and plant tour) held at the beginning of 2016. The South African participants of these seminars were exposed to and showed great interest in the Japanese pyrolysis technology. Activities of the two seminars are shown in Figure 3-4.

1st Seminar Workshop(15–17 February 2016)

1st Seminar Plant Tour (15-17 February 2016)

1st Seminar attendees (15-17 February 2016)

2nd Seminar Site Tour (Students from the University of Cape Town)

Figure 3-4 Seminars

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

i. Operating Log & Maintenance

For a total of 367 hours and 10 minutes of operation, 239 hours were spent on the maintenance of the pilot plant. There are two major reasons as to why so much time was spent on maintenance when compared to operating time. The operation and maintenance log is shown in Table 3-9. and the activities of the plant's operation and maintenance are shown in Figure 3-5.

Table 3-9 Operation and Maintenance Log

SURVEY ITEMS		Oct 2015	Nov	Dec	Jan 2016	Feb	Mar	Apr	**Total**
Operation Record & Maintenance Log	Operation (hr)	13:00	50:00	48:40	95:20	77:05	33:40	49:25	367:10
	Maintenance (hr)	21:00	97:00	21:50	27:30	21:50	39:30	15:10	239:00
	Maintenance Cost (ZAR)	0	0	120	120	4105	840	0	5185

(* Results of data from 26 October 2015 to 26 April 2016)

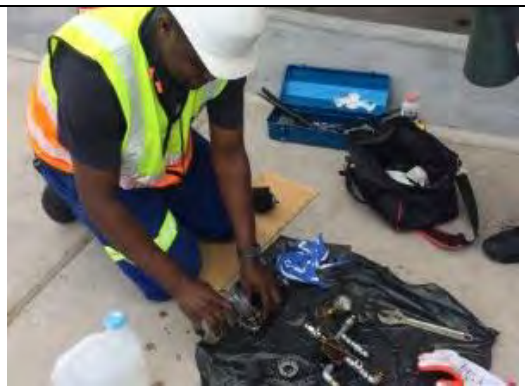
a) Maintenance Training

Maintenance training and gaining experience in maintaining the pilot plant was an important skill that had to be shared with all workers at the plant therefore a lot of time was dedicated to local staff being trained by the Japanese technician.

b) Burner Adjustment & General Maintenance

At the start of the survey period, much time was spent adjusting the burner during the initial months of operation. Stacking of the burner pump also occurred frequently due to the type of materials being used as feedstock which resulted in more time spent on maintaining the burner. Stacking of the burner pump was unprecedented as this issue had never occurred at the Japanese plants.

Operation of pretreatment area



Burner pump maintenance

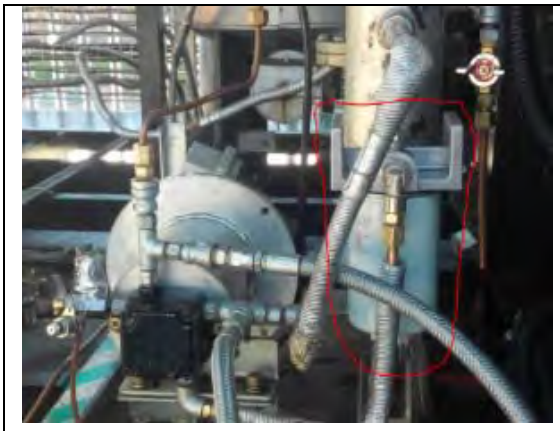
 Replacement of cartridge oil filter	 Generator maintenance service required after every 250 hours of running
 Cleaning of burner – Replacements were required by using up	 Take out and Clean up filter

Figure 3-5 Operation and Maintenance

ii. Class Study for Operation & Maintenance

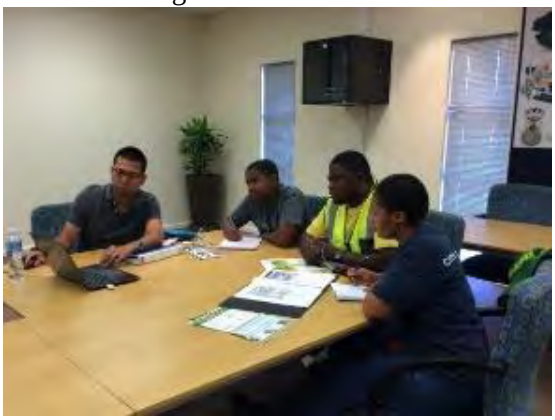
During the six-month survey period, two operators from the City of Cape Town have received training in plant operation and maintenance, which includes plant safety and troubleshooting. They are now at a level of competency where they can operate and maintain the plant without the help of a Japanese technician. Additionally, 10 workers were trained in the pre-processing, separation of plastics and charging of raw materials into the plant. Subjects covered in these classes are shown in Table 3-10. Activities of class study are shown in Figure 3-6.

Table 3-10 Subjects of Study

SUBJECT	Attendance
<<Basic Education for Waste Plastic to Oil Production System>>	
Knowledge of Oil	✓
Knowledge of Plastic	✓
Features of Pyrolysis Oil Production System	✓
Process of Producing Cracked Oil	✓
Analysis Date of the Cracked Oil	✓
Plastic Unsuitable for Converting into Oil	✓
Operating Waste Plastic to Oil Production System	✓
Safety Precautions	✓
Maintenance of Waste Plastic to Oil Production System	✓
Trouble Shooting of Waste Plastic to Oil Production System	✓

1st Day of Class: Subjects covered included basic knowledge

1st Day Attendees: 3 trainee operators from the City of Cape Town and the Japanese technician



2nd Day of Class: Subjects covered included Operation and Maintenance

Certificate of attendance was awarded to the trainee operators

Figure 3-6 Classes for Operation & Maintenance

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

As one of the major waste materials in the Republic of South Africa, waste plastic has been increasing (6% in total; 2011) annually. However, the RSA's recycling rate is still low (18%; 2011) and a large amount of waste is sent to landfill. Since plastic waste is non-biodegradable, its environmental impact is negative, long-lasting and significant.

According to the National Waste Management Strategy (2011), the RSA aims to achieve a 25% recycling rate of current landfill waste and therefore the introduction of new plastic recycling technology is necessary for reaching this goal and sustainable development.

One of the core outcomes of this pilot survey is for pyrolysis technology to be recognized as a possible solution for the RSA's recycling industry. Two seminars (workshop and plant tour) were conducted during the six-month survey period attended by about 200 people ranging from private South African companies, the Development Bank of Southern Africa and universities. The high attendance numbers from these seminars held in February and April 2016, reflect the high levels of interest in this technology in the RSA. The Cape Town based pilot plant has also attracted interest from other African countries and a goal for the future is the sale and installation of a commercial pyrolysis plant in Africa.

(2) Lessons Learned and Recommendations from the Survey

We recommend that the City of Cape Town utilizes this pilot plant for educational purposes to educate the children of the City of Cape Town and to promote the development of a recycling-conscience society. We suggest that this be done by utilizing this technology in collaboration with the University of Cape Town.

ATTACHMENT: OUTLINE OF THE SURVEY

Republic of South Africa (RSA): Pilot Survey for Disseminating SME's Technologies for the Conversion of Waste Plastics to Fuel towards Sustainable Waste management

Company & Site Information

- Proposed companies: The consortium of CFP Corporation and KANEMIYA Co., Ltd.
- Proposed companies location: Fukuyama-city Hiroshima Pref., Handa-city Aichi Pref.
- Project site: Cape Town, South Africa
- Counterpart: Waste Management Department of the City of Cape Town
- Survey period: March 2014 to September 2016

Development issues in RSA ⟷ Meet the Objective ⟷ Technologies of the companies

■ Improve recycling rate of waste plastics

Amount of waste plastic has been increasing as one of the major waste materials (6% in total) in RSA. However, its recycling rate is still low (18%). RSA aims for achieving 25% recycling of the current landfill waste.

■ Improve employment rate

Unemployment rate in RSA is still high (25%). New technology of plastic recycling contributes to job creation.

■ Waste Plastic-to-Oil Production System (CFP)

Waste plastics (PE,PP,PS) can be converted into the cracked oil. The cracked oil can be utilized as a fuel for power generator and boiler. This system is a "Waste to Energy Plant" to convert waste plastic into electricity.

■ Waste Plastic Washing Machine (KANEMIYA)

Dirty film waste plastics can be made clean with high speed and small quantity of water in high efficiency.

The contents of the pilot survey by JICA

- The pilot plant of waste plastic to oil production system is set up in Kraaifontein waste management facility of the City of Cape Town in order to demonstrate that the cracked oil generated from waste plastics (PE, PP, PS) can utilize a fuel for diesel generator. In addition, two seminars during the demonstration period are held to disseminate " Waste plastic-to-oil production system" at the project site to invite local government, waste management company , plastic related company, bank and university.

Outcome of the pilot survey

- By improving the recycling rate of waste plastics, environmental issues is improved by reducing landfill waste. And creating a new source of energy that produce electricity from waste plastics. In addition, new jobs will be created by the waste plastic to energy business.

Business development

- To disseminate " Waste plastic-to-energy plant" in South Africa, then to expand it to other African countries.

Impact on the concerned development issues

- To contribute to development of South Africa by the improvement of environmental issues, the creation of new energy source and the new job.