

## Recovery of Compact Fluorescent Lamps from the general household waste stream

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### **Abstract**

During recent years Compact Fluorescent Lamps (CFLs) have played a key role in energy efficient campaigns worldwide. Their energy saving properties present a simple, but effective measure against ever-increasing, global, energy constraints, rising energy costs and concerns for climate change.

As the use of CFLs becomes increasingly widespread so also increases the concerns relating to their mercury content and the associated hazards. While the risk associated with an individual CFL is generally concerned negligible, the cumulative impact of millions of CFLs does however become a more significant issue and could represent a potential risk to the environment.

The current legislative framework governs large-scale users of mercury-containing lamps, but legislation pertaining to industry regarding industry-specific waste is vague and as yet unresolved<sup>1</sup>. Similarly, the legal requirements of residential consumers relating to any hazardous waste is inferred and practically non-existent. With the exception of a few, periodic pilot studies, waste separation and recycling are not generally practiced and hence unfamiliar concepts to most South Africans

An initiative by Eskom, the City of Cape Town and the Provincial Government has therefore been challenged to develop an appropriate solution for the Western Cape in this voluntary environment.

The development of a potentially suitable collection approach incorporated several selection and screening iterations to identify the best theoretical and practical solution for South Africa. But it was recognised that a key consideration would be the opinion of the general public. A public consultation process was expected to provide insight into the suitability of alternative services, level of support that could be expected, possible motivators and/or required incentives to solicit participation.

This paper provides an overview of the selection processes for the development of a suitable CFL recovery solution for the Western Cape and the resulting findings and recommendations.

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<sup>1</sup> The expectation is that the promulgation of the long-awaited Waste Bill will present a significant step towards formalising these requirements.

## **Introduction**

Approximately 5 million Compact Fluorescent Lamps (CFLs) were distributed in the Western Cape within a period of 4 months during 2006 as part of large scale efficiency drive. These lamps are now nearing the end of their natural life cycle. Whilst normal incandescent lamps (common light bulbs) are relatively easy to dispose of, the disposal of the CFLs (similar to linear fluorescent tubes) pose a challenge because of the small amount of mercury<sup>2</sup> they contain.

Currently South Africa has limited legislation and infrastructure to accommodate CFL recycling and disposal from domestic use. The risk of failed CFLs being sent to general landfill en masse prompted a collaborative effort by the City of Cape Town, Provincial Government Department of Environmental Affairs and Development Planning (DEADP) and Eskom to develop a solution suited to the Western Cape with the objective to identify a suitable solution for the diversion of spent CFLs from the general waste stream that would enable responsible handling thereof as hazardous waste.

A comprehensive effort over a two-year period, incorporating input from all identified stakeholders, has culminated in several retailer take back offerings supported by a set of minimum requirements and implementation guidelines to direct best practice and compliance with relevant legislative requirements.

This necessitated careful consideration of all aspects of the waste supply chain from point of generation to eventual disposal or material re-use. Several aspects such as hazardous waste handling, transportation, storage, treatment and disposal represented a technical problem and required primarily optimisation and refinement for a final solution. The most significant challenge was considered to be a suitable option for recovery of the CFLs from the household waste stream.

This paper focuses on the processes used to select the preferred recovery options for CFLs from households and will discuss in more detail the three methodologies used in the selection process and the outcomes from each. In conclusion, a brief look is taken at the resulting findings and recommendations with the hope that this will incorporate valuable output for other challenging waste streams in South Africa.

## **Understanding the Challenge**

Compact Fluorescent Lamps (CFLs), commonly referred to amongst consumers as “Energy Saver Lamps” or simply “Energy Savers”, contain an average of 5mg mercury (Hg) per lamp, a bio-accumulative toxicant that is easily absorbed through the skin, respiratory and gastro-intestinal tissues. Spent CFLs should therefore be treated as part of the Household Hazardous waste collective. The disposal of Hazardous Household waste is currently not being addressed through policy and enforcement in South Africa, as quantities have unofficially been considered sufficiently small and innocuous to be treated as part of the general household waste stream.

The South African legislative framework aims to establish an integrated waste management approach with waste minimisation and reclamation for re-use taking precedence before disposal. Under the Constitution and the Municipal Systems Act the obligation for integrated waste management and specifically the provision of waste services to households resides with local authorities. The ‘duty of care’ principle is

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<sup>2</sup> These lamps contain an average of 5mg mercury (Hg) per lamp that should be regarded as a hazardous substance or waste type as it is a bio-accumulative toxicant that is easily absorbed through the skin, respiratory and gastro-intestinal tissues.

furthermore contained in the National Environmental Management Act (NEMA) and the Waste Bill makes allowance and establishes tools for the Extended Producer Responsibility principle. It is therefore reasonable to expect that over time a solution would be forthcoming from either or both Municipalities and the Manufacturers.

In South Africa, as a largely developing country, the current focus is on addressing historically distorted patterns of resource distribution and meeting basic needs (i.e. ensuring that all citizens have proper housing, water supply and sanitation, electricity, health care and other services) in order to improve the quality of life among all South Africans. An extension of traditional waste collection services to appropriately incorporate Household Hazardous waste therefore represents a significant infrastructure and cost challenge that is not at the top of the immediate priority rankings.

Informal sector salvaging, both at the street level, and at the landfill, constitutes the bulk of recycling activities in South Africa<sup>3</sup>. Recovered quantities and types of material is highly dependent on the market demand, price and industry organised collection, buy back and redemption systems. As a consequence waste separation and formal recycling remains a concept foreign to most South African households.

The diversion of CFLs that have no associated value, for which no organised collection system exist and that is also a fragile and hazardous waste, from the general waste stream and recovery for safe disposal, or ideally recycling, requires a unique and specific solution.

Lighting Waste has internationally been incorporated under e-waste (electronic and electrical waste) hence a further opportunity exist for collaboration with the greater e-waste collective.

These constitute some of the main considerations that had to be taken into account in the development of a CFL Recovery solution for the Western Cape.

It was furthermore recognised that in the South African context management of the waste stream from collection to eventual disposal or re-use of material is relatively well understood and hence manageable even if costly). The greatest challenge was therefore expected to be a presenting a sufficiently **convincing** and **convenient** solution to homeowners to realise acceptable levels of CFL recovery.

In selecting the preferred recovery options, several iterations of screening and selection were applied. These are discussed in subsequent paragraphs.

### **First Screening: Broad Stakeholder Workshop**

A broad stakeholder workshop with representation from, amongst others, local Government, the City of Cape Town, the waste fraternity, the lighting industry and environmental organizations was held during July 2006. The workshop objective was to identify the most viable options to divert used CFLs from the general household waste stream either for recycling or to a hazardous landfill site.

### **Evaluation Process**

Proposed recovery mechanisms were simplistically evaluated against a set of criteria and given a fit rating on a scale of 0 – 5 with 5 indicating full compliance or a positive

<sup>3</sup> A few exceptions should be noted including collection pilots (e.g. yellow/blue bag systems), school/church/community fund raising projects, recycling services offered at a fee in urban centres (e.g. Resolution recycling, Mama She, Whole Earth, etc) and retailer take back services (e.g. Makro, Pick 'n Pay, Woolworths)

impact, 1 indicating limited or no compliance or negative impact and 0 indicating complete non-compliance and hence disqualification as a viable option. A five rating was also given if not applicable to or no impact on the specific criteria was expected. This meant that the highest scoring option(s) was also the preferred option(s).

### Criteria for Evaluation

The criteria was logically grouped into three categories i.e. Environmental Objectives, Practicality of Implementation and Demand Side Management (DSM) Objectives (i.e. maintaining the energy efficiency or savings objectives that prompted the roll out of CFLs). Criteria was not weighted to indicate priority, but the number of criterion did unintentionally skew the relative importance somewhat towards practicality of implementation.

*Table 1: First Screening Criteria*

<b>Environmental Objectives</b>	<b>Practicality of Implementation</b>	<b>DSM Objectives</b>
Effectiveness of implementation <sup>4</sup>	Cost Effectiveness <sup>5</sup>	Sustainability of DSM initiative <sup>6</sup>
Alignment with central, provincial & local Government objectives and legislation	Practicality of implementation/Infrastructure <sup>7</sup>	Continued market penetration of CFLs <sup>8</sup>
Incorporation of all mercury containing wastes <sup>9</sup>	Ease of participation	
Integration with other e-waste initiatives in South Africa <sup>10</sup>	Speed of implementation	
	Funding sources and administration	
	Acceptability for South Africa	
	Acceptability for Western Cape	
	Sustainability of the Solution	
	Ownership of the Solution	
	Enforceability and Measurability of the Solution	

For the purpose of the assessment the waste supply chain was significantly simplified (refer Figure 1 below), ignoring all common aspects such as transportation and storage.

<sup>4</sup> % of the CFLs diverted from waste stream and participation levels expected by the public

<sup>5</sup> Superficial assessment of relative costs

<sup>6</sup> Avoid replacement with cheap incandescent when fail

<sup>7</sup> E.g. rural and urban, relative positioning of H:H landfills

<sup>8</sup> E.g. additional charges levied on product may impact sales

<sup>9</sup> Including other mercury bearing lamps, thermometers, thermostats and cell phone batteries

<sup>10</sup> Such as cellular phones, PCs

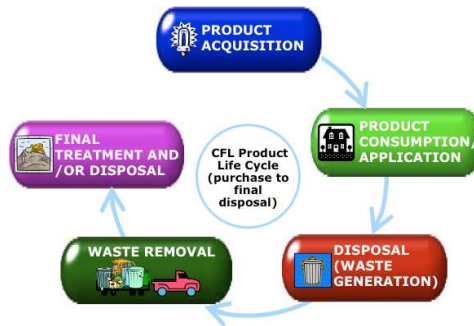


Figure 1: Simplified CFL Life Cycle

The fragile and hazardous nature of a CFL meant that the consumer necessarily has to be involved at the point of generation and would be required to ensure separation of CFLs from the general waste stream.

### Recovery Options

The greater challenge, as alluded to previously, would be the recovery from point of generation. The options that were identified are shown in the mind map below.



Figure 2: CFL Waste Removal Options

### Comparison of Recovery Options

This range of recovery options were evaluated against the stated criteria with the outcome illustrated in Figure 3 below:

CRITERIA	Status Quo	Collect points	Retail x' change	Utility x' change	Curb collect	On call collect
1. Effectiveness of implementation	0	1-4	3-4	2-4	3-4	?
2. Alignment with Gov. objectives and legislation	0	5	5	5	5	5
3. Incorporation of all mercury containing wastes	N.A. (5)	5	3	5	5	5
4. Integration with other e-waste initiatives	N.A. (5)	5	2	1-2	5	3-5
5. Cost Effectiveness	5	3	3	3-4	4-5	0
6. Practicality of implementation/Infrastructure	5	3	4	4	4-5	2-5
7. Ease of participation	5	3	4	3	4-5	4-5
8. Speed of implementation	5	3	3	3	4	2?
9. Funding sources and administration	N.A. (5)	4	4	4	4	2
10. Acceptability for South Africa	? (5)	3	4	4	4	2
11. Acceptability for Western Cape	? (5)	3	4	4	4	2
12. Sustainability of the Solution	5	3	5	5	4	?
13. Ownership of the Solution	5	3	4-5	4-5	4-5	4-5
14. Enforceability and Measurability	N.A. (5)	2-3	3-4	3-4	2-3	2-3
15. Sustainability of DSM initiative	5	3	5	5	4	2
16. Continued market penetration of CFLs	5	3	4-5	4-5	4-5	2
<b>Average Performance</b>	<b>5</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>3</b>

Figure 3: Assessment of Waste Removal/Recovery Options

The **preferred strategy** resulting from the workshop and with consideration of the stated criteria was for the separation of CFLs from the general waste stream at point of generation, collection through retail (and possibly other designated) points and complete reclamation of all material including mercury for reuse. Acknowledging that the establishment of a reclamation facility is a longer term objective, it was accepted that the immediate approach will require that collected CFLs be safely crushed and disposed at an appropriately permitted landfill. Note that although the status quo rated highest, it was fatally flawed and hence discarded as a suitable option.

This screening was however considered a preliminary finding to be used as an indication only and subject to a more scientific and comprehensive assessment included in the scope of work of a dedicated and specialist<sup>11</sup> project team.

## **Second Assessment: Due Consideration of Alternatives**

### **Evaluation Process**

The second assessment round for recovery options was preceded by the development of logic diagrams depicting all logical waste flows from the household to the ultimate end point(s). The logic diagrams (refer Figure 4 for an example) effectively modelled all available options and permutations facilitating the evaluation process through a systematically defensible approach.

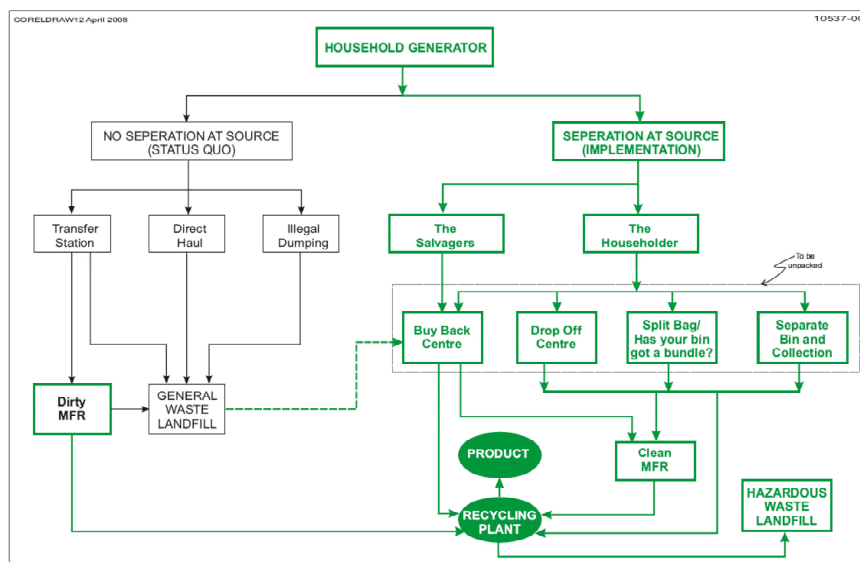


Figure 4: Sample Logic Diagram

The logic diagram enabled the identification of a number of alternatives which required comparison and ranking. The possible alternatives identified from the Logic Diagram formed the basis for a process of elimination. Each alternative was assessed and, where alternatives failed in terms of fundamental criteria, they were deemed to have a fatal flaw and were discarded immediately.

Remaining alternatives were then tabulated in a simple matrix and measured against appropriate criteria as a means of evaluating, comparing and ranking them. Based on

<sup>11</sup> Initial work culminated in a scope of work for which a consortium of waste and recycling specialists were appointed.

experience, the literature and the status quo, the criteria were divided into the following basic categories:

- Public and safety related aspects;
- Environmental related aspects;
- Practicability related aspects; and
- Implementation related aspects.

Finally, the ranked alternatives were discussed and conclusions were drawn. The alternatives were also considered in terms of urban high, medium and low income areas, as well as rural areas.

### Recovery Options

As before, it was recognised that household separation is a necessity for successful recovery of CFLs from the general waste stream. Effectively two options, or categories of options, were defined for removal of the separated CFLs from the household as follows:

- Separate Collection (by salvagers, separate bag collection or dedicated CFL and HHW collection);
- Drop off centres (incorporating a broad variety of options).

**Separate collection** as a category was discarded as a viable option after an initial screening. An overview of the screening process is provided in the table below:

*Table 2: Separate Collection Options*

Collection Option	Description	Status
Salvagers	Sidewalk collection of select material with recycling value by informal sector. <b>Flaws:</b> Primarily the health risk of repeat exposure to individuals. Secondly, lack of incentive (i.e. no current recycling value)	Both unacceptable and unfeasible. <b>Discarded</b>
Separate bag, collection with general waste	Separate colour-coded bags collected by standard waste collection service and either diverted to hazardous landfill/treatment facility or disposed at general landfill for recovery by landfill salvagers. <b>Flaws:</b> Logistics of diversion to hazardous landfill prohibitive. Recovery by salvagers at landfill presents same risks/challenges as above.	Landfill Recovery by salvagers unacceptable. <b>Discarded.</b> Diversion to treatment facility/hazardous landfill is unfeasible with high risk of breakages. <b>Discarded.</b>
Dedicated CFL and HHW Collection	CFL (and HHW) collected in coloured bags or specially provided bins by a dedicated service. Volumes expected to be small hence collection intervals extended. <b>Flaws:</b> Collection schedules potentially challenging and logistics costs enormous <sup>12</sup>	Although most likely to achieve better levels of participation the logistics costs are considered too prohibitive. <b>Discarded.</b> (Opportunities for synergies and logistics optimisation may change this status in future)

<sup>12</sup> In developed countries, separate collection is invariably subsidised. Sustained subsidies unlikely given current service delivery priorities and in the light of better alternatives.

Recovery of CFLs from households would therefore require transportation by the householder to a suitable drop-off centre. As a result the selection focus was on identifying the most appropriate and convenient drop-off centres.

It should be noted that finding synergies and pursuing collaboration with other initiatives were considered both desirable and logical and was to be given priority in the development of a solution. The selection process therefore had to take cognisance of any additional requirements and risks associated with hazardous household and/or electronic and electrical waste types. Consequently the requirement for a manned drop-off centre was identified to mitigate poor housekeeping, resulting in breakages, spillage and associated risks. Unmanned collection points were therefore immediately to be classified as fatally flawed and discarded from further evaluation.

An overview of the initial screening of drop-off centres is provided below.

*Table 3: Drop Off Centre Options*

<b>Collection Option</b>	<b>Description</b>	<b>Status</b>
Retail outlets	Individual, general (e.g. supermarket) or specialist (e.g. lighting shops, building suppliers) retailers. Points of sale of CFLs are considered logical drop off points, provided they are properly manned. <b>Advantages:</b> Accessible. Retailers are interested and affected parties and perceived to have responsibility with regard to CFLs. More specifically, this is seen as a logical extension of concept of extended producer responsibility. Can integrate with select items from other waste types e.g. e-waste or HHW	Included in full assessment
Shopping Malls	A single collection point positioned at a shopping mall. <b>Advantages:</b> As above for retailers. <b>Disadvantages:</b> Risks associated with safety. Shopping mall drop off points would only be acceptable if manned. If this is not the case, this option is discarded.	Safety risk associated with facility being unmanned. <b>Discarded.</b>
24-hour operation centres	A 24-hour drop-off centre, often also a point of sale and already familiar with handling other hazardous wastes/materials e.g. gas. As before only acceptable if manned. <b>Advantages:</b> Accessible. 24 hour operation, familiarity with hazardous material. Easy to integrate with other waste types i.e. e-waste or HHW.	Included in full assessment.
Buy-back centres	Centres that takes back or purchase recyclable material as broker between public or salvager and material recycler. <b>Advantages:</b> Familiarity with waste, but possibly not hazardous wastes. Often centrally located. <b>Disadvantages:</b> Currently no value hence no incentive for participation.	Included in full assessment.
Eskom facilities	Eskom walk-in or customer centres to function as drop-off centres for CFLs. <b>Advantages:</b> Assumed familiarity with CFLs and perceived responsibility for CFLs. Potentially good publicity. Proper operation is likely. Will not easily integrate other waste types.	Included in full assessment
Municipal facilities	Municipal facilities include free garden refuse sites and other civic amenities. <b>Advantages:</b> Usually under proper control. Even if not	Included in full assessment.

Collection Option	Description	Status
	associated with municipal depots, they are usually manned and controlled. If waste related i.e. garden refuse sites, then familiarity with waste related matters.	
Mobile units	A secure, specially designed mobile container placed in a strategic location. Public bring CFLs, HHW and other mercury containing wastes to the unit where it is appropriately sorted and handled. <b>Advantages:</b> Secure and well manned. Relocate regularly to address accumulated wastes. Limits requirement for permitting hazardous waste storage facilities.	Included in full assessment. (highly successful internationally)

### Criteria for Comparison

As indicated previously, the criteria used generally relate to public and safety, environmental, practicability and implementation related aspects. The full set of criteria as used in the comparative evaluation is as follows:

Table 4: Evaluation Criteria

Criteria	Description
Risk	Composite of risks posed to people at collection points especially children, workers handling the HHW and environmental impacts on landfills
Environmental Impact	Incorporate a host of criteria, so that this is a somewhat subjective assessment
Public Acceptance	Based on environmental awareness of the public
Aesthetics	Resistance to the aesthetics associated with drop off centre from a public perspective
Accessibility	Short distances and ease of access to collection points from a public perspective
Public Participation	The willingness of the public to support such a project over a sustained period, perceived willingness
Practicability	Level of ease for implementing with regard to current infrastructure, attitudes and the viability of establishing new infrastructure
Cost	Involve the costs of publicity, establishment of infrastructure, logistics and operation i.e. drop off centres

### Comparison of Recovery Options

The evaluation of options was compiled into a very simple matrix with no weighting of criteria, as a course comparison was considered sufficient for the specific purpose.

The comparative assessment of options is shown in Table 5 below. Please note that a scale of 1 – 3 is used with 1 representing poor performance against the criteria and 3 good performance. The higher scoring option(s) are therefore preferred.

Table 5: Evaluation of Recovery Options

Recovery Options	Risks	Enviro Impact	Public Accept.	Aesthetics	Access	Public Part.	Practicability	Cost	Total
Retail outlet (incl 24-hour shops)	3	2	3	3	3	3	2	3	22
Buy-back centres	2	2	2	2	1	2	2	2	15

Recovery Options	Risks	Enviro Impact	Public Accept.	Aesthetics	Access	Public Part.	Practi-cability	Cost	Total
Eskom facilities	2	2	2	2	1	2	3	3	17
Municipal Facilities	1	2	2	2	1	2	3	3	16
Mobile Units	3	2	3	3	3	3	2	3	22

Based on the assessment Retail Outlet drop-off centres (including 24-hour convenience stores) and Mobile Drop off points were rated as most suited for CFL recovery from homeowners. Both these drop-off centres also have the potential to accommodate a variety of income levels both urban and rural.

### **Third Assessment: Public Consultation**

It was considered prudent to test the proposed recovery mechanisms with the public to verify or contradict the findings of the two 'theoretical' assessments described.

For this purpose a formal research initiative was launched utilising focus groups representative of the spectrum of Western Cape residents located in areas that participated in (and therefore were most likely recipients of) the large scale CFL roll out in 2006. The aim was to determine the target market's support for the proposed solution (CFL collection bins at main retail outlets) and determine other suitable collection points particularly the lower income groups.

In addition to testing preferred type of collection mechanisms, the research scope was extended to assess also the target market's knowledge and understanding of CFLs and its hazardous components, understanding of hazardous waste, e-waste and recycling and their preferences regarding incentives for participation.

The research was also required to test for significant variances between the responses of higher, middle and lower income groupings.

### **Public Consultation Process**

The engagement with the public was designed to address the following formally stated objectives:

- Understand general behaviour in the context of waste management
- Determine knowledge of CFLs
- Explore practical issues related to disposal of CFLs
- Identify the preferred communication channels for communication about the need for safe disposal of CFLs
- Determine synergies, if any, with other initiatives and disposal strategies of similar household goods

Qualitative focus groups consist of representative groups of people, sampled from a larger population, that is interviewed in an open session under guidance of a facilitator or moderator as a form of 'market' research.

Nine (9) focus groups were held across the Cape Town Metro area with approximately 8 respondents per group. Of these, three (3) groups were representative of low-income areas (i.e. earning below R5,000 per household per month); two (2) groups

were representative of medium-income areas (i.e. earning between R5 000 and R15 000 per household per month) and four (4) groups represented high-income areas (with earnings in excess of R15 000 per household per month).

A rigorous recruitment process was followed by an independent research house to ensure that the focus groups were statistically representative of the metro inhabitants that participated in the CFL rollouts and of the stated income groups. Two additional requirements that were applied in the selection process was for focus group participants to be aged between 25 and 60 and be actively involved in the day-to-day running of the household.

Focus group discussions were aligned with the stated objectives and structured from the general to the specific with discussion topics and questions designed to obtain insight into the public position as it relates to:

1. General recycling perceptions, attitude and behaviour
2. Electricity usage and energy saving lamps perceptions and behaviour
3. Knowledge of mercury (and other) household hazardous materials
4. Suitable options for recovery of CFLs
5. Drivers for change i.e. incentives for participation

### **Broad Overview of findings**

Participants in the focus groups...

*Table 6: Overview of Focus Group Findings*

<b>Point of Interest</b>	<b>Low Income</b>	<b>Medium Income</b>	<b>High Income</b>
Current recycling activity	Reuse plastic bags and some paper recycling	Reuse plastic bags and paper recycling	Recycle the most
In favour of energy saver lamps	YES	YES	YES, but...
Aware of mercury in energy savers?	No awareness	No Awareness	Low awareness
Understand long term impacts on the environment?	Small extent	Some extent	Large extent
Anticipated behaviour change	Still in normal waste (but willing to wrap it up)	Still in normal waste (but may consider if know where take spent CFLs)	Will change behaviour (convenience of utmost importance – collection from home preferred)

Focus group discussions highlighted a number of interesting perceptions and attitudes amongst the general public of relevance to CFLs, but possibly also other hazardous or e-waste waste types, as follows:

1. Significantly, light bulbs (CFLs or otherwise) were not considered hazardous amongst any of the income groups. The greatest danger associated with light bulbs relates to the risk of broken glass. “Hazardous” is also associated with the threat to an individual in a household and not the cumulative threat to the environment. This perceived lack of danger will influence the disposal method and the participation rates for a recovery programme.

2. Hazardous waste products such as poisons, paints and motor oil, were only consciously treated with care where it had to be kept separate from food or out of reach of children. None of the respondents considered separate disposal of these substances necessary. Broad education amongst all residents may be required before any significant numbers of household hazardous wastes may be recovered in South Africa.

3. High income households that are interested in recycling are experiencing high levels of frustration with the perceived inconvenience relating to (un)available information, accessibility of recycling sites and services. Most participants in this income group indicated a preference/expectation for a separate collection service from their homes.

4. Amongst low income households recycling is associated with individuals who collect recyclable material from bins on waste collection days in order to generate an income and hence carries a negative stigma.

### **Recovery Preferences**

Participants in the focus groups responded relatively positively to the proposed drop-off centres at retailers. Across all income groups specially demarcated and suitably safe bins at central locations for the collection of fused bulbs was considered appropriate. Low income groups considered placing of bins within walking distance of where people live essential, while point of sale is an important collection point for higher income groups

For all income categories the convenient location of bins is critical in encouraging proper disposal. But the concept of convenience differed across income categories. Low and medium income groups considered appropriately placed collections points convenient whilst high-income groups considered sidewalk collection from their respective homes the ultimate convenience.

All participants indicated that a recovery programme should be a collective effort by all stakeholders and particularly highlighted the manufacturers, retailers, Eskom and the Municipality as having an obligation to develop a partnered solution.

### **Conclusions**

Based on the analyses described in the previous sections it is concluded that suitably demarcated bins placed at central locations is an acceptable recovery option for spent CFLs. For most, points of sale or retailers would constitute a central location, but in the low income areas 'central' refers to 'within walking distance'. Mobile units would therefore represent a potentially plausible solution in lower income areas.

Concerns from the project team were echoed in the public consultation process regarding the safety of the bins in public areas. Drop-off centres must be properly manned and containers be suitably constructed.

Even though all forms of separate collection was discarded because of risk and primarily cost, sidewalk collection from individual homes would represent the most convenient option and is likely to result in the highest recovery rates. Should cost structures or components change significantly in future, reconsideration of this option would be strongly advised.

Effective recovery of CFLs would rely heavily on a comprehensive education campaign as the current levels of awareness relating to all waste matters and

recycling is very low. Communication and correct messaging to support an initiative of this kind should incorporate a well structured and extensive communication and education campaign to develop an understanding of waste management in general, communicate the importance of waste (and particularly hazardous waste) to the environment and to encourage a culture of recycling.