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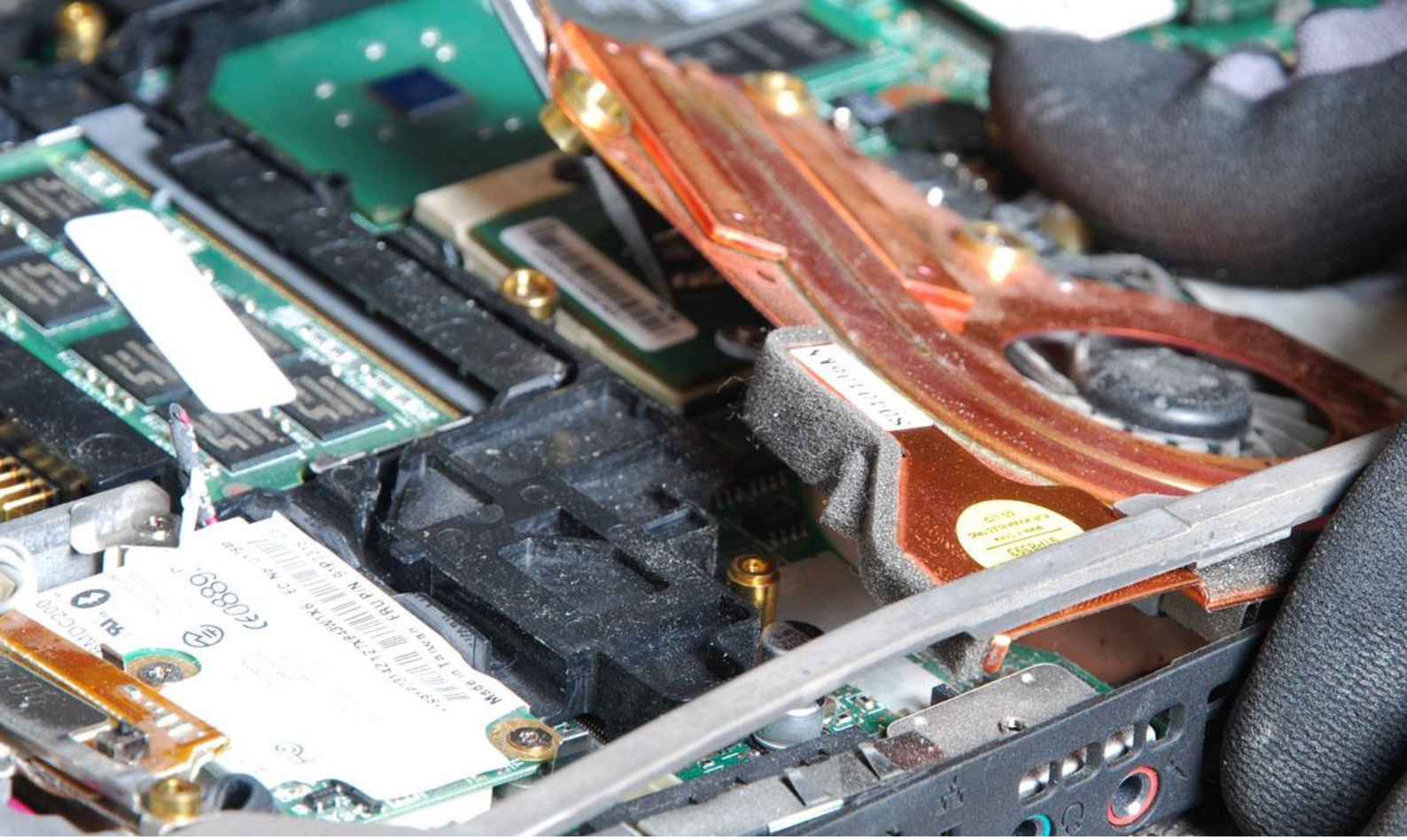

Business Plan for a manual e-Waste Dismantling Facility in Cambodia

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Summary

Under the auspices of the UNIDO project "**Creating Employment Opportunities and Ensuring Effective E-waste Management in Cambodia**", UNIDO together with Samsung have implemented interventions in the refurbishment sector, targeting at small business operators. During the project implementation it has become apparent that such interventions for small business development should be extended to the recycling sector. This report aims to provide a basis for such interventions by presenting a business plan for a manual e-waste dismantling facility in Cambodia, operating according to internationally acknowledged standards in the Phnom Penh area. The **objective** of the business model is to provide a 5-years business plan based on realistic assumptions described in a reference scenario.

The **reference scenario** assumes the 30% of the waste will be delivered to the facility by scavangers, 30% can be collected from businesses, another 30% from junkshops and the remaining 10% from repair shops. Prices and volumes of accessible waste materials were estimated based on a recent baseline report by COMPED. It was assumed that collected volumes will increase from 50 tonnes in the first year to 300 tonnes in the fifth year. For the downstream market of recovered materials, it was assumed that metals, such as aluminum and iron can be sold to the local market in Cambodia, while other metals, such as copper, stainless steel, but also plastics will be exported and sold to neighboring countries. Printed wiring boards containing precious metals is assumed to be sold to the global market, i.e. via overseas shipment. At the absence of facilities to treat hazardous fractions in Cambodia it was assumed that some residual waste can be assigned to intermediate storage in Cambodia, while for other more critical wastes (batteries, capacitors, etc.) disposal option will have to be found on a regional scale.

The report contains a **detailed calculation** of the expected revenues, an overview and recommendations for the required human resources and infrastructure, as well as numbers for the expected investment and operational costs. Based on this a profit and loss statement is presented as summarized in the table below.

Based on the business model a manual e-waste dismantling facility in Cambodia could generate a positive result after 2 years. However due to credit costs for the initial investments and negative operating results in the first 2 years, the facility would be profitable only after 3 years. It has to be noted that without seed funds the facility would not be profitable in the first 5 years, hence such support needs to be considered, e.g. in a possible extension of the UNIDO e-waste project in Cambodia.

Profit and loss statement in USD per year

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues	18,900	37,800	75,600	113,400	113,400
Operational costs	-32,400	-42,900	-58,500	-74,200	-74,200
Operating result	**-13,500**	**-5,100**	**17,100**	**39,200**	**39,200**
Investment	-31,800	-	-	-	-
Funded Investment	15,900				
Operating + Investment	**-29,400**				
Credit costs	-2,300	-2,500	-2,800	-1,700	-
Net income before taxes	**-31,700**	**-7,600**	**14,300**	**37,500**	**39,200**
Taxes			-2,900	-7,500	-7,800
Net income after taxes	**-31,700**	**-7,600**	**11,400**	**30,000**	**31,400**
Remaining profit	**-26,700**	**-30,700**	**-22,000**	**6,200**	**38,200**

Although results suggest that e-waste recycling could be initiated as a profitable business in Cambodia, calculations presented in this report still contain uncertainties, and changes in market and political conditions could change the outcome of the business plan. Issues to be clarified in more detail include:

- The feasibility of **business to business collection from institutions and corporates** have to be evaluated as this is the potential source of appliances with the most value.
- For the sales of fractions on the global market (processors, PWBs) the **minimal tradable lot size** has to be taken into account, as this potentially could hamper cash-flow.
- The commercialization of plastics containing brominated flame retardants needs to be re-evaluated, as this could lower revenues.
- The possibility of intermediate storage and/or export of **hazardous fractions** needs to be clarified.

In addition, the development of recycling businesses still depend very much on political support and the appropriate framework conditions. Therefore it is recommended that the development of a manual e-waste dismantling facility should be supported by or integrated into the wider context of e comprehensive national e-waste strategy for Cambodia.

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1 Introduction

1.1 Background

The e-waste landscape in Cambodia is characterized by relatively low volumes processed by an entrepreneurial informal sector composed of small family businesses and some larger semi-formal dismantling units. Though some material fractions such as plastics are valorized inside the country, the majority of valuable fractions are exported for their end refining.

The recycling sector is tightly linked to a vivid refurbishing market, reassembling used equipment with spare parts and some new components thus extending the useful lifespan of appliances. Under the auspices of this project, UNIDO together with Samsung have implemented interventions in the refurbishment sector, targeting at small business operators. During the project implementation it also has become apparent that such interventions for small business development should be extended to the recycling sector. This report aims to provide a basis for such interventions by presenting a business plan for a manual dismantling facility in Cambodia, operating according to internationally acknowledged standards in the Phnom Penh area.

1.2 General aim of the facility

The general aim of the e-waste treatment facility in Cambodia is to ensure that high volumes of both valuable and non-valuable waste materials are collected equally and that those materials reach the facility. Hence the collection strategy has to ensure:

- Convenience for the consumer: it is convenient and attractive for the consumer to give back their end-of-life appliances. This means that the logistical effort for the consumer is minimal.
- Competitiveness: It is attractive for either the consumer or specialized collectors to deliver their waste material to the facility (instead of selling it to somebody else). This means that competitive market prices have to be paid for the waste material.
- Quality of waste: scavenging is avoided and waste is ideally collected as an untouched unity. I.e. neither non-valuable / hazardous parts nor valuable parts have been separated before the waste collected reaches the facility. This means that facility rules and purchase prices have to be set as such as it is more attractive for the consumer / collector to hand-in entire appliances instead of parts (e.g. whole CRT monitors instead of only the copper coil / an exceptional case are repair shops, who are usually disposing off parts of appliances only)

1.3 Objectives of the business plan calculations

This business plan pursues the following main objectives:

- The financial balance for e-waste dismantling is calculated for a 5-years' business plan including profit & loss forecast calculation as well as a break-even estimation. Estimated revenues and costs should be based on realistic assumptions concerning input of e-waste from different streams, process calculation and downstream options.

- Barriers identified in previous studies should be adapted by realistic assumptions concerning required framework conditions as remunerations from financing mechanisms, etc.
- Apart from the profit & loss calculation the written business plan should provide information concerning space requirements and proposals to design the layout of the facility, required number of employees, equipment and so on.

The current business plan calculates revenues and costs for material recycling of e-waste only. In many cases it could make sense to establish the recycling facility together with a refurbishment center or extend an existing refurbishment center by the dismantling facility selecting reusable EEE from the input streams. Revenues and costs for refurbishment have to be calculated separately and are not included in this business plan.

2 Methodology

2.1 Data source

The field data used in this report are based on the inventory compiled by the Cambodia Education and Waste Management Organization [COMPED-WM][1] and previous studies executed under UNIDO's activities related to e-waste management in developing countries.

2.2 Calculation tool

Calculations have been made with an excel based business plan calculation tool which has been applied in a similar UNIDO project. The tool has been slightly adapted to reflect the specific situation pertaining in Cambodia.

The business plan calculation tool is targeted to calculate the financial performance for the first five years of operations based on expected input quantities and the composition of appliances groups. Based on the provided general data and considering the chosen modeling parameters (dismantling depth, dismantling efficiency) the calculation tool calculates the following results:

- required human resources
- physical layout and space requirement
- required equipment
- profit & loss forecast
- break-even estimation

[1] COMPED-WM, 2015. Report for data collection required for a business model for a manual e-waste dismantling facility in Cambodia of project entitles „Transforming e-waste into job and business opoortunities in Cambodia". Waste Management Projects Group oft he Cambodian Education and Waste Management Organization.

2.3 Target appliances

Target appliances for the facility include

- small household appliances (EU WEEE cat. 2): in general
- IT and telecommunications equipment (EU WEEE cat. 3): focus on desktop PCs, IT accessories, CRT and LCD monitors, laptops, printers, scanners, copiers
- consumer equipment (cat. 4). The focus is set on CRT and LCD TVs.

It was decided to base the business plan calculations on these types of appliances due to the following reasons:

- The selected types of appliances are most relevant concerning quantities, content of resource efficient substances and potential negative environmental impact due to hazardous components.
- The calculations had to focus on typical appliances concerning the mentioned aspects to allow modeling procedures concerning output composition and financial performance.

It is expected that other types of appliances will be found in the input as well, like irons or other small household appliances. However, such devices can be treated in the facility as well without relevant influence on technical and financial aspects. An exception are end-of-life cooling and freezing appliances, which are a of public concern due to their content of climate-relevant gases and hazardous substances. Contrary to other equipment they are also relevant concerning quantities. **Hence the depollution and recycling of cooling and freezing appliances is not considered in this business plan. Including those appliances would require a separate business plan.**

2.4 Defining the reference scenario

In order to chose a realistic reference scenario for the calculation of the business model, various calculation steps have been performed, whereas results are summarized in the Annex.

1. Different purchase scenarios have been modeled according to the description in the previous chapters. Based on this the most realistic purchase option has been chosen as the reference scenario.
2. Different commercialization and disposal scenarios have been modeled according to the description in the previous chapters. Based on this the of most adequate and achievable reference scenario has been defined.
3. In order to identify the most adequate dismantling level, financial operating results have been calculated for different inputs from 100 tonnes/year to 1000 tonnes/year. Based on this the most beneficial option for Cambodia has been chosen as the reference scenario.
4. In order to analyze achievable profits, different financing scenarios have been calculated and a realistic option has been chosen as the reference scenario.

3 Reference Scenario

3.1 Collection

Based on previous findings and reports the facility will receive e-waste through 4 types of input streams.

Input stream 1: Delivery to facility

E-waste can be handed in directly at the e-waste treatment facility. The facility will pay competitive purchase prices in order to ensure that it is attractive to hand in waste material directly at the facility. This scheme is mainly addressing individual collectors from the informal sector and private consumers (households).

Concerning facility layout and resources the e-waste receiving area has to be designed that individuals can hand in devices. This area needs to be run by the administrative staff and has to include weighing equipment and a cash desk.

Input stream 2: B2B-collection from institutions and corporates:

The facility collects e-waste directly from companies or authorities. It depends on the kind of agreement (tender offer, donation, etc.) if a price is paid and how much it is. Average purchase conditions are given in the following sub-chapter.

The business plan is based on the assumption that the facility has its own truck and e-waste from companies and authorities are collected using this truck. Besides the driver one co-driver for loading and unloading is considered.

Input stream 3: B2B collection from junk shops

Collection from junk shops is a special version of B2B-collection. Junk shops are small collection businesses gathering waste materials from various sources and selling it further as bulk materials to interested downstream businesses. The composition of the waste material might be slightly different, i.e. in addition to entire appliances the waste material is also composed of broken single components and already dismantled material fractions.

Input stream 4: B2B collection from repair stores

Repair and refurbishment stores are also a special version of B2B-collection. E-waste is mainly resulting from non-useable components generated through their repair and refurbishment services. Therefore the composition is usually mainly composed of broken single components. And less of entire appliances.

According to the possible input streams described above is assumed that e-waste collected can be attributed to the following sources:

- 30% through delivery to the facility (input stream 1 from “scavangers”)
- 30% through B2B collection from institutions and corporates (input stream 2 from “companies”)
- 30% through B2B collection from junkshops (input stream 3)
- 10% through B2B collection from repair stores

3.2 Price, volume and composition

The calculations of the business model are based on the assumptions that the facility will collect the following amount of e-waste in the first 5 years.

- Year 1: 50 tonnes / year
- Year 2: 100 tonnes / year
- Year 3: 200 tonnes / year
- Year 4: 300 tonnes / year
- Year 5: 300 tonnes / year

The chosen purchase conditions are summarized in Table 1 and the expected input volumes for the first 5 years are given in Table 2. In addition assumptions were made about how the input stream will be composed of in relation to the input streams and appliances groups. These assumptions are based on the numbers gathered in the COMPED report**Error! Bookmark not defined.**. Numbers are summarized in Table 3 (for number of appliances) and Table 4 (in weight-%).

Table 1: Chosen purchase conditions

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	-0.05 /piece		-0.06 /piece	-0.05 /piece
Small household appliances cloths	-0.25 /piece		-0.31 /piece	-0.25 /piece
PC/ Server	-1.77 /piece	-1.77 /piece	-2.21 /piece	-1.77 /piece
Notebook	-0.50 /piece	-0.50 /piece	-0.63 /piece	-0.50 /piece
Printer/Scanner/Copier	-0.13 /piece		-0.16 /piece	-0.13 /piece
IT accessories (mix keyboard, mouse)	-0.05 /piece		-0.06 /piece	-0.05 /piece
Mobile phone (incl. recharger)	-0.20 /piece	-0.20 /piece	-0.25 /piece	-0.20 /piece
CRT monitor	-0.60 /piece		-0.75 /piece	-0.60 /piece
FPD monitor	-0.60 /piece	-0.60 /piece	-0.75 /piece	-0.60 /piece
Audio appliances (CD-/Radiorecorder)	-0.25 /piece		-0.31 /piece	-0.25 /piece
Video appliances (CD-/DVD-Player)	-0.25 /piece		-0.31 /piece	-0.25 /piece
CRT TV	-0.60 /piece		-0.75 /piece	-0.60 /piece
FPD TV	-0.60 /piece		-0.75 /piece	-0.60 /piece

Table 2: Expected input volumes for the first 5 years in relation to the input streams.

Input Stream	Year 1	Year 2	Year 3	Year 4	Year 5	Share
1-Delivery to facility (scavengers)	15 t/a	30 t/a	60 t/a	90 t/a	90 t/a	30%
2-B2B-collection from companies	15 t/a	30 t/a	60 t/a	90 t/a	90 t/a	30%
3-B2B-collection from junk shops	15 t/a	30 t/a	60 t/a	90 t/a	90 t/a	30%
4-B2B-collection from repair stores	5 t/a	10 t/a	20 t/a	30 t/a	30 t/a	10%
Total	**50 t/a**	**100 t/a**	**200 t/a**	**300 t/a**	**300 t/a**	**100%**

Table 3: Expected input composition in number of appliances

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores	Average weight
Small household appliances coffee	30%		25%	30%	2.5 kg/piece
Small household appliances cloths	39%		30%	25%	1.5 kg/piece
PC/ Server	2%	34%	1%	1%	9.5 kg/piece
Notebook	2%	4%			2.8 kg/piece
Printer/Scanner/Copier	1%	10%	31%	2%	4.5 kg/piece
IT accessories (mix keyboard, mouse)	2%	11%	1%	4%	1.0 kg/piece
Mobile phone (incl. recharger)	10%				0.3 kg/piece
CRT monitor	2%	39%	1%	2%	17.0 kg/piece
FPD monitor	1%	2%	4%		5.0 kg/piece
Audio appliances (CD-/Radiorecorder)				10%	3.1 kg/piece
Video appliances (CD-/DVD-Player)				10%	2.5 kg/piece
CRT TV	11%		1%	8%	39.0 kg/piece
FPD TV			6%	8%	17.0 kg/piece
Total	**100%**	**100%**	**100%**	**100%**	

Table 4: Expected input composition in weight-%

Appliance Group	WEEE-Sub	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	2A	11.8%		14.4%	11.1%
Small household appliances cloths	2A	9.2%		10.3%	5.6%
PC/ Server	3A	3.0%	30.0%	2.2%	1.4%
Notebook	3A	0.9%	1.0%		
Printer/Scanner/Copier	3A	0.7%	4.0%	32.0%	1.3%
IT accessories (mix keyboard, mouse	3A	0.3%	1.0%	0.2%	0.6%
Mobile phone (incl. recharger)	3A	0.5%			
CRT monitor	4A	5.3%	63.0%	3.9%	5.1%
FPD monitor	4A	0.8%	1.0%	4.6%	
Audio appliances (CD-/Radiorecorde	3B				4.6%
Video appliances (CD-/DVD-Player)	3C				3.7%
CRT TV	4B	67.5%		9.0%	46.4%
FPD TV	4C			23.4%	20.2%
Total		**100.0%**	**100.0%**	**100.0%**	**100.0%**

3.3 Dismantling depth and efficiency

Due to low staff costs and missing further treatment options a deep dismantling depth is the adequate treatment option within the facility, where collected appliances are manually dismantled up to a point, where only further mechanical processes can achieve higher material purities of the produced output fractions.

Due to missing mechanical recycling options in Cambodia at the moment this dismantling approach is the only way to ensure that hazardous components are securely separated from recyclable fractions (i.e. power supplies from computers).

Concerning further treatment steps the business plan only includes CRT-processing to separate lead glass and the fluorescent powder from the barium glass and other components as

there do not exist other recycling facilities offering this treatment steps and this recycling step is unconditionally necessary to ensure an environmentally sustainable recycling solution.

Cable stripping and shredding of plastics can become economically feasible options over the time, especially if there exist possibilities to purchase further power supply cables (from cars or housings for example). The currently assumed input of cables from e-waste results in volumes, which are not enough in sustaining the investment of a cable stripping or shredding machine.

The workers skills level is a key financial driver for the facility, hence dismantling efficiency have been assumed as summarized in Table 5. This takes into account that the workers will improve their skills significantly over the years and hence the throughput per worker will increase. Low efficiency means that workers need double the time for doing the same job as with high efficiency; "middle" counts with 25% more of required dismantling time compared to high efficiency.

Table 5: dismantling efficiency for the first 5 years of operations.

Dismantling Efficiency	Year1	Year2	Year3	Year4	Year5
Dismantling	low	middle	high	high	high
Further Treatment CRT-Tubes	low	middle	high	high	high

3.4 Downstream options

Based on the above selected processing options the dismantling and further treatment results in 25 output fractions. The major part of them (15 fractions) can be destined to material recycling. It is assumed that residual waste can be disposed of locally and that 6 fractions are hazardous waste, which need to be shipped to recycling and disposal facilities overseas. From previous studies it is understood that local recycling options are only available for 4 fractions (aluminum, iron/steel, unleaded CRT glass and printer cartridges).

Concerning the recycling from WEEE-plastics it has to be considered that part of them contain BFRs (brominated flame retardants) and therefore have to be separated from plastics without BFRs before further recycling. Plastics containing BFRs can emit dioxins and furans when not recycled under optimal conditions. In addition some BFRs are internationally banned chemicals and should not be reintroduced into secondary raw materials and therefore need special treatment and separation.

Although there is currently a lack of possibilities for the special treatment of BFR plastics in Cambodia, the business plan calculations have been based on the assumption that both recycling of plastics without BFRs and disposal of plastics containing BFRs can be done regional / cross-national. It was further assumed that sales revenues for recyclable plastics can cover the costs for the disposal of non-recyclable plastics. For the future implementation of a dismantling facility the special treatment or disposal of BFR plastics in Cambodia, in the nearby region or overseas, as well as its impact on the cost structure need to be evaluated again.

Furthermore it is assumed that Printed wiring boards (PWBs) that contain precious metals, can be extracted only within sophisticated physical-chemical processes, hence nned to be shipped overseas, including specialized companies in the Asian region (Korea, Japan, Singapore, among others). Hazardous fractions like batteries, capacitors, leaded CRT funnel glass, etc. also need to be shipped overseas for further treatment. Fractions that are produced in

very low quantities like the fluorescent powder probably have to be stored for several years until transportable lot sizes are reached.

Table 6: Selected downstream options for the fractions resulting from the dismantling process.

Output fractions	Type of Commercialisation
Aluminium	Local
Iron/ Steel	Local
Copper	Regional Cross-National
Neodym Magnet	Overseas Shipment
Bronze/Brass	Regional Cross-National
Stainless Steel	Regional Cross-National
Plastics	Regional Cross-National
Cable without plugs	Regional Cross-National
Processors	Overseas Shipment
Printed Wired Board, Q1	Overseas Shipment
Printed Wired Board, Q2	Overseas Shipment
Printed Wired Board, Q3	Regional Cross-National
Motors/Inductors/Transformers	Regional Cross-National
Deflection coil	Regional Cross-National
Getterpill - electrogun	Intermediate storage
Mixed scrap	Regional Cross-National
Glass	Local
Residual waste	Local
Batteries	Regional Cross-National
Capacitors	Regional Cross-National
LCD-displays	Regional Cross-National
Fluorescent Tubes	Regional Cross-National
Printer Cartridges	Local
Fluorescent powder	Intermediate storage
Leaded CRT glass	Regional Cross-National

Related to the selected processing and downstream options, recycling operations leads to a recycling output as depicted in Table 7. Almost half of the output by weight can be recycled or disposed of locally.

Furthermore it is assumed, that about the same amount of output can be shipped for material recovery and further treatment/ disposal to the region (cross-national). CRT glass is the dominant output fraction for cross- national treatment and it is therefore suggested that Cambodia should consider for a safe deposit of leaded CRT glass within national borders. However it is anticipated that this will need a longer political process and hence such a solution is not expected within the near future.

Table 7: Resulting output volumes by fractions for the first 5 years.

	Output after Dismantling and CRT-Treatment [t/a]				
	Year1	Year2	Year3	Year4	Year5
Aluminium	1.0	2.0	4.1	6.1	6.1
Iron/ Steel	10.1	20.2	40.5	60.7	60.7
Copper	0.2	0.5	0.9	1.4	1.4
Neodym Magnet	0.0	0.0	0.0	0.0	0.0
Bronze/Brass	0.0	0.0	0.0	0.0	0.0
Stainless Steel	0.0	0.1	0.1	0.2	0.2
Plastics	12.4	24.8	49.6	74.4	74.4
Cable without plugs	1.1	2.2	4.5	6.7	6.7
Processors	0.0	0.0	0.1	0.1	0.1
Printed Wired Board, Q1	0.9	1.7	3.5	5.2	5.2
Printed Wired Board, Q2	0.5	1.0	1.9	2.9	2.9
Printed Wired Board, Q3	0.8	1.6	3.3	4.9	4.9
Motors/Inductors/Transformers	1.1	2.2	4.4	6.7	6.7
Deflection coil	0.8	1.6	3.2	4.8	4.8
Getterpill - electrogun	0.0	0.0	0.1	0.1	0.1
Mixed scrap	3.2	6.3	12.6	18.9	18.9
Glass	0.8	1.7	3.3	5.0	5.0
Residual waste	0.9	1.8	3.6	5.4	5.4
Batteries	0.1	0.2	0.3	0.5	0.5
Capacitors	0.1	0.3	0.5	0.8	0.8
LCD-displays	0.4	0.8	1.5	2.3	2.3
Fluorescent Tubes	0.1	0.1	0.2	0.3	0.3
Printer Cartridges	0.3	0.6	1.2	1.8	1.8
Fluorescent powder	0.0	0.0	0.0	0.0	0.0
Leaded CRT glass	6.0	12.1	24.1	36.2	36.2
Unleaded CRT glass	9.0	18.1	36.2	54.3	54.3
Total	**50.0**	**100.0**	**200.0**	**300.0**	**300.0**

The chosen downstream result in different achievable prices/costs per output fraction, as has been discussed earlier in the description of different possible downstream scenarios. However they also need to be associated with related external transport costs. Related numbers have been summarized in Table 8.

Table 8: Achievable prices or costs for output fractions and related external transport costs.

Output fractions	Type of Transport	Price/ Costs per ton*	External Transport Costs	Price/ Costs per ton**
Aluminium	own truck	1,100 /ton	0 /ton	1,100 /ton
Iron/ Steel	own truck	130 /ton	0 /ton	130 /ton
Copper	container - external transport costs	5,500 /ton	-60 /ton	5,440 /ton
Neodym Magnet	container - external transport costs	5,350 /ton	-36 /ton	5,314 /ton
Bronze/Brass	container - external transport costs	2,350 /ton	-60 /ton	2,290 /ton
Stainless Steel	container - external transport costs	250 /ton	-60 /ton	190 /ton
Plastics	container - external transport costs	150 /ton	-60 /ton	90 /ton
Cable without plugs	container - external transport costs	2,000 /ton	-60 /ton	1,940 /ton
Processors	container - external transport costs	65,000 /ton	-303 /ton	64,697 /ton
Printed Wired Board, Q1	container - external transport costs	6,500 /ton	-258 /ton	6,242 /ton
Printed Wired Board, Q2	container - external transport costs	2,500 /ton	-258 /ton	2,242 /ton
Printed Wired Board, Q3	container - external transport costs	500 /ton	-60 /ton	440 /ton
Motors/Inductors/Transformers	container - external transport costs	550 /ton	-60 /ton	490 /ton
Deflection coil	container - external transport costs	1,375 /ton	-60 /ton	1,315 /ton
Getterpill - electrogun			0 /ton	0 /ton
Mixed scrap	container - external transport costs	140 /ton	-60 /ton	80 /ton
Glass	own truck	0 /ton	0 /ton	0 /ton
Residual waste	own truck	-1 /ton	0 /ton	-1 /ton
Batteries	container - external transport costs	800 /ton	-60 /ton	740 /ton
Capacitors	container - external transport costs	-500 /ton	-60 /ton	-560 /ton
LCD-displays	container - external transport costs	-500 /ton	-60 /ton	-560 /ton
Fluorescent Tubes	container - external transport costs	-500 /ton	-60 /ton	-560 /ton
Printer Cartridges	own truck	0 /ton	0 /ton	0 /ton
Fluorescent powder			0 /ton	0 /ton
Leaded CRT glass	container - external transport costs	-50 /ton	-60 /ton	-110 /ton

3.5 Financing options

It is assumed that the facility is seed funded by 50% of the initial investments and receives USD 5000 equity capital.

4 Revenues

Revenues were calculated for the reference scenario as described in the previous chapter and hence depend on the amount of volumes collected and the price achieved on the market for the recovered materials. Results are summarized in Table 9.

Table 9: Revenues from the sales of fractions (USD/a)

	Revenues Commercialisation Fractions [USD/a]				
	Year1	Year2	Year3	Year4	Year5
Aluminium	1,116 /a	2,232 /a	4,464 /a	6,697 /a	6,697 /a
Iron/ Steel	1,315 /a	2,631 /a	5,261 /a	7,892 /a	7,892 /a
Copper	1,299 /a	2,598 /a	5,197 /a	7,795 /a	7,795 /a
Neodym Magnet	32 /a	63 /a	126 /a	190 /a	190 /a
Bronze/Brass	2 /a	4 /a	9 /a	13 /a	13 /a
Stainless Steel	7 /a	15 /a	30 /a	45 /a	45 /a
Plastics	1,861 /a	3,722 /a	7,445 /a	11,167 /a	11,167 /a
Cable without plugs	2,234 /a	4,467 /a	8,934 /a	13,401 /a	13,401 /a
Processors	1,518 /a	3,037 /a	6,074 /a	9,110 /a	9,110 /a
Printed Wired Board, Q1	5,669 /a	11,338 /a	22,677 /a	34,015 /a	34,015 /a
Printed Wired Board, Q2	1,217 /a	2,433 /a	4,866 /a	7,299 /a	7,299 /a
Printed Wired Board, Q3	412 /a	824 /a	1,649 /a	2,473 /a	2,473 /a
Motors/Inductors/Transformers	611 /a	1,222 /a	2,445 /a	3,667 /a	3,667 /a
Deflection coil	1,103 /a	2,207 /a	4,413 /a	6,620 /a	6,620 /a
Getterpill - electrogun					
Mixed scrap	441 /a	882 /a	1,765 /a	2,647 /a	2,647 /a
Glass					
Residual waste					
Batteries	67 /a	133 /a	267 /a	400 /a	400 /a
Capacitors					
LCD-displays					
Fluorescent Tubes					
Printer Cartridges					
Fluorescent powder					
Leaded CRT glass					
Unleaded CRT glass					
Total	**18,905 /a**	**37,811 /a**	**75,621 /a**	**113,432 /a**	**113,432 /a**

5 Human resources

The dimensioning of the facility concerning human resources has been based on the general staff requirements and typical employment conditions for Cambodia as summarized in Table 10 and Table 11. In general it was assumed that the facility will need 1 general manager to manage the company and that 1 department manager can coordinate up to 30 workers; i.e. also in the case of this business model where the overall amount of workers is below 30 the cost of at least 1 department manager is included. No sales manager was considered, but sup-

posed that sales and material acquisition issues will be covered by the general manager. It was assumed that 10% of all workers are skilled workers and 10% of all required human resources are administrative staff. Employment conditions as summarized in Table 11 should reflect fair and legal conditions and are based on common conditions found in Cambodia for similar businesses.

The calculated annual working hours are listed in Table 12. More than 70% of required working hours are necessary for dismantling, while the remaining is necessary for transport and logistics. Based on the required working hours the theoretically required full-time equivalents were calculated (Table 13) and interpreted towards the effective required staff composition (Table 14). According to these calculations the facility will need between 4 (year 1) and 10 employees (year 5).

Table 10: General staff requirements and related costs.

Employees	Quantities	Calculation bases	Salary [USD/month]	Taxes on Salaries	NSSF [USD/y]	Personal costs [USD per employee/a]
General Manager	1	per total facility	-600	10%	-58	-7,978
Department Manager	1	per 30 dismantling workers	-300	5%	-29	-3,809
Skilled workers	10%	of all workers	-200	5%	-19	-2,539
Unskilled workers	90%	of all workers	-120		-12	-1,452
Administrative Staff	10%	of total staff	-200	5%	-19	-2,539
Drivers	1	per truck	-200	5%	-19	-2,539
Co-Drivers	2	per truck	-120		-12	-1,452

NSSF – National Social Security Fund

Table 11: Typical employment conditions assumed for the facility in Cambodia

NSSF	0.8%
Saleries per year	12
Working hours per week	8 hs
Working days per week	6 days
Average sick leave per worker	3%
Official Holidays per Year	10 days
Holiday Entitlement per year	2 weeks
Working days per year	280 days
Annual working hours	2,243 hs

NSSF – National Social Security Fund

Table 12: Required working hours per year.

Dismantling Groups	Year1	Year2	Year3	Year4	Year5
smallWEEE	2,400 hs	3,200 hs	4,800 hs	7,201 hs	7,201 hs
CRT	671 hs	894 hs	1,341 hs	2,012 hs	2,012 hs
FPD	412 hs	549 hs	824 hs	1,236 hs	1,236 hs
Total Dismantling	3,483 hs	4,644 hs	6,965 hs	10,448 hs	10,448 hs
CRT Treatment	101 hs	201 hs	402 hs	604 hs	604 hs
Cable Stripping					
Plastic Shredder					
Total Further Treatment	101 hs	201 hs	402 hs	604 hs	604 hs
Weighing/ Take Over	226 hs	452 hs	904 hs	1,357 hs	1,357 hs
Internal Logistics	537 hs	727 hs	1,105 hs	1,658 hs	1,658 hs
Transport: Drivers	128 hs	256 hs	512 hs	772 hs	772 hs
Transport: Co-Drivers	256 hs	512 hs	1,024 hs	1,544 hs	1,544 hs
Total Transport and Logistics	1,147 hs	1,947 hs	3,545 hs	5,330 hs	5,330 hs
Total Workers	**4,731 hs**	**6,792 hs**	**10,913 hs**	**16,382 hs**	**16,382 hs**

Table 13: Theoretical required full-time equivalents.

Required Workers [n]	Year1	Year2	Year3	Year4	Year5
Dismantling small WEEE	1.1	1.4	2.1	3.2	3.2
Dismantling CRT	0.2	0.3	0.4	0.6	0.6
Dismantling FPD	0.1	0.1	0.2	0.3	0.3
CRT Treatment	0.0	0.1	0.2	0.3	0.3
Cable Stripping					
Plastic Shredder					
Weighing/ Take Over	0.1	0.2	0.4	0.6	0.6
Internal Logistics	0.2	0.3	0.5	0.7	0.7
Transport: Drivers	0.1	0.1	0.2	0.3	0.3
Transport: Co-Drivers	0.1	0.2	0.5	0.7	0.7
Total	**1.9**	**2.8**	**4.5**	**6.8**	**6.8**

Table 14: Effective required staff composition

Required Staff [n]	Year1	Year2	Year3	Year4	Year5
General Manager	1	1	1	1	1
Department Manager	1	1	1	1	1
Sales Manager					
Skilled workers	1	1	1	1	1
Unskilled workers	1	2	4	6	6
Administrative Staff		1	1	1	1
Security					
Total Staff	**4**	**6**	**8**	**10**	**10**

6 Infrastructure

6.1 Physical layout and required space

The proposed layout for the dismantling facility has been developed based on practical dismantling experiences of the D.R.Z – Dismantling and Recycling Centre in Vienna and some experiences from African pilot projects. The proposed layout is an indication on how a facility

could be set up. It provides the bases for the space requirements calculations but does not fully correspond with the suggested numbers. E.g. it provides space for cable stripping or shredding as well as crushing of plastics which was not considered in the calculations of this business plan.

The designed layout intends to give an impression about the overall dimensions and workflow through the whole facility. Layout and workflow have to be redesigned corresponding with the actual conditions of the estate to be found.

General aspects regarding the layout that should be considered:

- The spatial arrangement of the registration and weighing area is crucial to provide an efficient workflow. It should be located where it can be reached both by incoming streams and outgoing fractions. The required size of the area depends on the way e-waste is delivered and transported: delivery of individuals and/or handling with big trucks, forklift truck and so on. Sufficient space for sorting e-waste should be considered when reuse activities are integrated.
- Depending on the expected fluctuations concerning the input quantities the layout should include a sufficient large input storage. It is important that dismantling workers can constantly take e-waste for dismantling from this input storage.
- In principle the spatial arrangement of the different operational departments (dismantling, treatment of CRT-tubes, etc.) should follow the process flow. It should be avoided that intermediate fractions have to be transported long distances to the followed workstations.
- Dismantling workstations should be arranged in a way that input to be dismantled can be placed close to the dismantling workstations. The area surrounding the dismantling workstations should provide as well enough space for boxes receiving the various output fractions.
- Furthermore the dismantling department has to provide an area for intermediate storage of hazardous fractions, where dismantling workers can place batteries, capacitors etc. removed from the electronic devices in receptacles appropriate to receive hazardous materials.
- Full receptacles have to be transferred from this intermediate storage into a lockable storage for hazardous substances (**Error! Reference source not found.**). Following international quality standards this storage has to have a sealing ensuring that eventual leaking hazardous substances cannot pollute the subsurface.
- Provided space for storing output fractions is a further crucial criteria to ensure an efficient workflow. The storage should be situated where it can be easily reached from the department producing relevant quantities. Some output fractions can be stored outdoor in open space, some should be locked due to high economic value. The required space further depends on the available logistic equipment. Forklift trucks for example can lift grid boxes to be stored in up to 3 layers. This way required storage space can be significantly reduced.

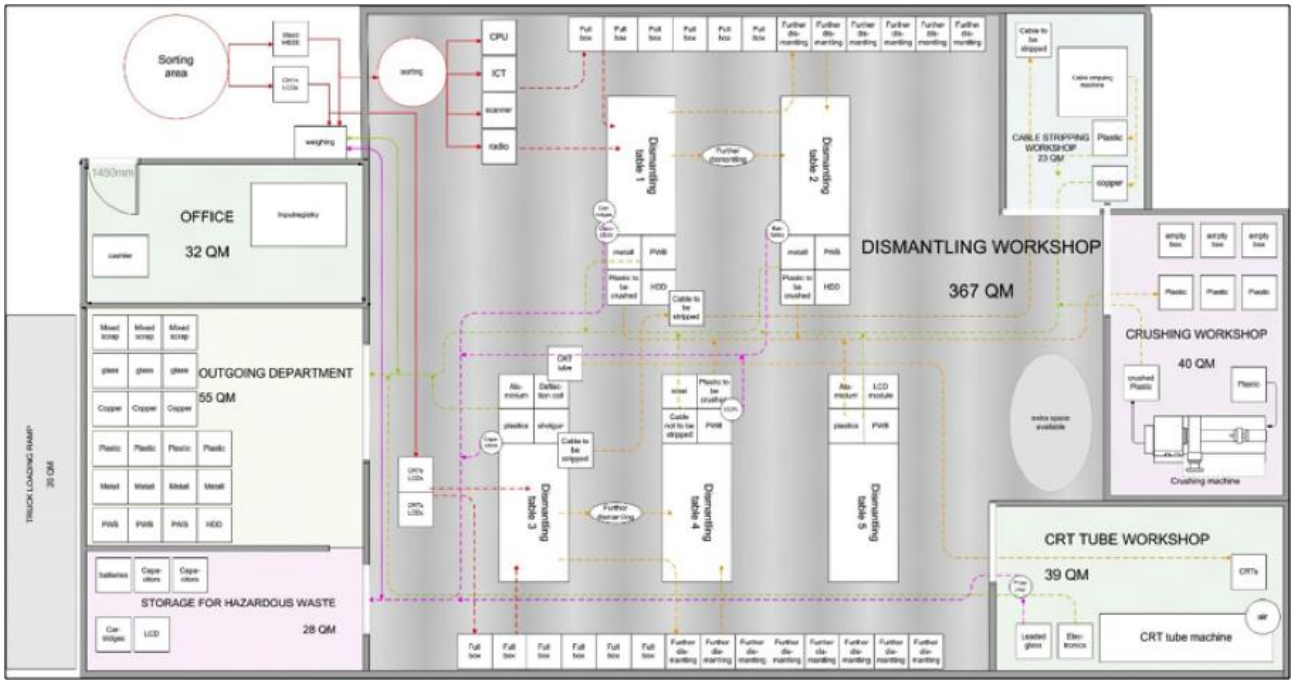

Figure 1: Possible physical layout for a manual e-waste dismantling facility.

Table 15 gives an overview about the required space for the whole dismantling facility. Calculations have been based on experiences from such businesses and the assumed amount of employees, anticipating the possibility of growth in the future to some extend. Space for storage is required to buffer fluctuant input that cannot be treated immediately on the one hand and for output fractions that have to be stored until specific lot sizes have been achieved on the other hand. Output storage can be stored in the output storage or in open shelters, hazardous fractions have to be stored in a separate area that has to comply with higher requirements concerning floor sealing. For highly valuable fractions like processors, neodymium magnets etc. a locked storage is advised which can be included in the storage for hazardous fractions.

The input storage was set up on the condition to cover 2,000 kg of input, a specific storage weight of 178 kg/m^3 and the possibility to be stored in 1 layer of collection boxes. Required space for storage has been calculated using the following assumptions and specific data:

- type of storage for the output fractions listed earlier,
- different specific storage weights: from 100 kg/m^3 for fractions like plastics, mixed scrap, fluorescent tubes up to more than 1,000 kg/m^3 for the most heavy fractions like motors, batteries, etc.
- the possibility of 2 layer storage for all fractions stored in collection boxes, 1 layer storage for hazardous fractions and a maximum height of 2 m for bulk storage

It was assumed that the storage space has to cover at least the lot size for each fraction that is commercialized locally and regionally. For international shipment the possibility of mixed lots (i.e. shipment of batteries together with printed circuit boards in 1 container) have been considered.

Table 15: Required space for the dismantling facility.

	Required Space
WEEE-receiving area	20 m²
Management/ Administration	45 m²
Recreation and sanitary rooms	25 m²
Total Administration and Sanitary Rooms	**90 m²**
Dismantling smallWEEE and FPD	80 m²
Dismantling CRT	20 m²
Additional Dismantling Space	25 m²
Charging Stations Lift Truck	
Total Dismantling Area	**125 m²**
CRT-treatment area	20 m²
Cable Stripping area	
Plastic Shredder area	
Total Further Treatment	**20 m²**
Input Storage	22 m²
Output Storage	176 m²
Storage Hazardous Fractions	22 m²
Locked Storage	2 m²
Total Indoor Storage	**222 m²**
Open Shelter	77 m²
Parking Area	20 m²
Total Open Area	**97 m²**
Total Indoor Area	457 m²
Total Open Area	97 m²
Total Required Area	**554 m²**

6.2 Equipment

According to the expected input of waste material and the corresponding processing steps a set of working equipment is required as listed in Table 16. Chosen average life span has been based on experiences in European dismantling facilities.

Table 16: Working equipment, corresponding space requirement and costs

Items	Costs [/unit]	Lifespan [a]	Required space	Required quantity	Calculation bases
WEEE-receiving and sorting area		25	20.0 m²	1	total per facility
Administrative Working Place (PC, table, chair)	-1,000	15	15.0 m²	1	per administrative staff member
Recreation and sanitary rooms		25	2.5 m²		per total staff member
Dismantling Working station (table, chair)	-200	10	20.0 m²	1	per dismantling worker
CRT-treatment unit	-10,000	25	40.0 m²	1	total per facility
Cable stripper	-5,000	25	25.0 m²	0	total per facility
Plastic Shredder	-10,000	25	40.0 m²	0	total per facility
Lift truck	-14,000	20	6.0 m²	0	per 1000 t/a Input
Truck	-18,000	20	20.0 m²	1	per 1000 t/a Input
Container (for transport)	-2,000	25	20.0 m²	0	total per facility
Working tools	-300	1		1	per dismantling worker
HSE (shoes, helm, gloves, etc.)	-149	1		1	per worker
Ventilator	-50	10		1	per total staff member
Collection box	-90	15		10	per 100 t/a Input
Palette	-5	10		5	per 100 t/a Input
Scale	-1,190	20		1	per 2000 t/a Input
Pallet truck (internal transport)	-500	20		4	per 1000 t/a Input

7 Investment costs

Since it is assumed that the premises for the facility will be rented the only actual investment costs are related to the working equipment, which has to be purchased for the facility. The corresponding investment costs for this business plan are listed in Table 17.

Table 17: Investment costs for the working equipment.

Items	Costs [/unit]	Required units [number]	acquisition costs
Administrative Working Place (PC, table, chair)	-500	3	-1,500
Dismantling Working station (table, chair)	-200	4	-800
CRT-treatment unit	-15,000	1	-15,000
Truck	-10,000	1	-10,000
Working tools	-150	4	-600
HSE (shoes, helm, gloves, etc.)	-50	7	-350
Ventilator	-10	10	-100
Collection box	-50	40	-2,000
Palette	-5	20	-100
Scale	-250	1	-250
Pallet truck (internal transport)	-500	4	-2,000
Total			**-31,750**

8 Operational costs

Operational costs are divided into variable and fixed costs. Variable costs include the purchase costs for the various appliance groups as defined in the reference scenario, the disposal costs for hazardous fractions which cannot be sold on the market as recovered materials, as well as external transport costs associated with the sales of recovered materials and the disposal of hazardous fraction. Numbers are summarized in the tables below. Fixed costs include staff costs, infrastructure costs, equipment costs, internal transport costs, administration costs and deprecation costs. A summary of the operational costs can be seen in

Table 18: Operational costs (USD/a)

	Year 1	Year 2	Year 3	Year 4	Year 5
Purchase of waste	-2,600	-5,300	-10,500	-15,800	-15,800
Disposal costs	-1,000	-2,000	-4,200	-6,200	-6,200
External transport	-2,500	-5,000	-9,900	-14,900	-14,900
Total variable costs	**6,100**	**12,300**	**24,600**	**36,900**	**36,900**
Human resources	-15,800	-19,800	-22,700	-25,600	-25,600
Infrastructure	-5,000	-5,000	-5,000	-5,000	-5,000
Equipment	-300	-500	-700	-1,000	-1,000
Internal transport	-700	-800	-1,000	-1,200	-1,200
Administration	-3,000	-3,000	-3,000	-3,000	-3,000
Depreciation	-1,500	-1,500	-1,500	-1,500	-1,500
Total fixed costs	**26,300**	**30,600**	**33,900**	**37,300**	**37,300**
Total operational costs	**32,400**	**42,900**	**58,500**	**74,200**	**74,200**

9 Profit & Loss-Forecast and Break-Even

The profit and loss forecast has been calculated based on the following financial assumption:

Interests on Credits	10%
Interests on Savings	5%
Tax on Earnings	20%

Furthermore, it was assumed that profit is not taken out of the company and not reinvested, but remains at the bank account. It is also assumed that half of the investment costs originates from seed funds.

From the results summarized in xx it can be seen that the facility generates a positive result after 2 years. However due to credit costs for the initial investments and negative operating results in the first 2 years, the facility will be profitable only after 3 years. It has to be noted that without seed funds the facility would not be profitable in the first 5 years.

Table 19: Profit and loss forecast, indicating a possible break-even in year 4.

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenues	18,900	37,800	75,600	113,400	113,400
Operational costs	-32,400	-42,900	-58,500	-74,200	-74,200
Operating result	**-13,500**	**-5,100**	**17,100**	**39,200**	**39,200**
Investment	-31,800	-	-	-	-
Funded Investment	15,900				
Operating + Investment	**-29,400**				
Credit costs	-2,300	-2,500	-2,800	-1,700	-
Net income before taxes	**-31,700**	**-7,600**	**14,300**	**37,500**	**39,200**
Taxes			-2,900	-7,500	-7,800
Net income after taxes	**-31,700**	**-7,600**	**11,400**	**30,000**	**31,400**
Remaining profit	**-26,700**	**-30,700**	**-22,000**	**6,200**	**38,200**

*assumption: profit is not taken out of the company and not reinvested, but remains at the bank account = accumulated money apart from positive net income after taxes and credit is paid back

10 Annex

10.1 Purchase scenarios

The prices that have to be paid to the suppliers of e-waste (i.e. informal collectors, households, companies, authorities) are summarized below. Numbers are based on a special survey to gather base data (COMPED 2015) and should reflect a competitive and realistic market price. Since those prices depend on several factors, such as the international raw material market prices, they are in constant change. Hence once a treatment facility has been set-up and is running they need to be re-evaluated on a regular base.

Since the treatment of CRT monitors and TVs will be one of the main cost drivers of the facility, special assumptions have to be made. While in some of the scenarios it is assumed that B2B channels will pay the facility to treat CRTs, this cannot be assumed for the other input streams. On the contrary individual collectors and consumers will expect remuneration; otherwise they would scavenge the CRT for the copper coil, sell it separate and dump the rest. Therefore the facility will have to pay a price, which is set as such as CRTs will be collected and brought to the facility as an untouched device.

As outlined in the general objectives, in general purchase prices will be paid only for delivered entire devices and not for components. This is to ensure that all hazardous components will enter the recycling process and an environmental sustainable business can be set up. Exemptions might have to be made concerning e-waste from junk and repair shop, when it is clear that the collected components origin from repair processes, where broken pieces had to be replaced.

The business model was calculated for the following four different purchase scenarios:

- P1) Pay CRT for purchase from all input streams
- P2) Pay CRT for purchase from input stream 1,3 and 4; 2-B2B free of charge
- P3) Pay CRT for purchase from input stream 1,3 and 4; 2-B2B charged for disposal
- P4) Purchase CRT from input stream 1,3 and 4 w/o payment; 2-B2B charged for disposal

Furthermore the following assumptions were made:

- Scavanger deliver appliances to the dismantling facility according to the process described in the COMPED study.
- Waste materials from junk and repair shops are purchased at a surcharge of 25% compared to purchases prices for scavangers.

Purchase Scenario P1

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	-0.05 /piece		-0.06 /piece	-0.05 /piece
Small household appliances cloths	-0.25 /piece		-0.31 /piece	-0.25 /piece
PC/ Server	-1.77 /piece	-1.77 /piece	-2.21 /piece	-1.77 /piece
Notebook	-0.50 /piece	-0.50 /piece	-0.63 /piece	-0.50 /piece
Printer/Scanner/Copier	-0.13 /piece		-0.16 /piece	-0.13 /piece
IT accessories (mix keyboard, mouse)	-0.05 /piece		-0.06 /piece	-0.05 /piece
Mobile phone (incl. recharger)	-0.20 /piece	-0.20 /piece	-0.25 /piece	-0.20 /piece
CRT monitor	-2.50 /piece	-2.50 /piece	-3.13 /piece	-2.50 /piece
FPD monitor	-1.50 /piece	-1.50 /piece	-1.88 /piece	-1.50 /piece
Audio appliances (CD-/Radiorecorder)	-0.25 /piece		-0.31 /piece	-0.25 /piece
Video appliances (CD-/DVD-Player)	-0.25 /piece		-0.31 /piece	-0.25 /piece
CRT TV	-2.50 /piece		-3.13 /piece	-2.50 /piece
FPD TV	-1.50 /piece		-1.88 /piece	-1.50 /piece

Purchase Scenario P2

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	-0.05 /piece		-0.06 /piece	-0.05 /piece
Small household appliances cloths	-0.25 /piece		-0.31 /piece	-0.25 /piece
PC/ Server	-1.77 /piece	-1.77 /piece	-2.21 /piece	-1.77 /piece
Notebook	-0.50 /piece	-0.50 /piece	-0.63 /piece	-0.50 /piece
Printer/Scanner/Copier	-0.13 /piece		-0.16 /piece	-0.13 /piece
IT accessories (mix keyboard, mouse)	-0.05 /piece		-0.06 /piece	-0.05 /piece
Mobile phone (incl. recharger)	-0.20 /piece	-0.20 /piece	-0.25 /piece	-0.20 /piece
CRT monitor	-0.60 /piece		-0.75 /piece	-0.60 /piece
FPD monitor	-0.60 /piece	-0.60 /piece	-0.75 /piece	-0.60 /piece
Audio appliances (CD-/Radiorecorder)	-0.25 /piece		-0.31 /piece	-0.25 /piece
Video appliances (CD-/DVD-Player)	-0.25 /piece		-0.31 /piece	-0.25 /piece
CRT TV	-0.60 /piece		-0.75 /piece	-0.60 /piece
FPD TV	-0.60 /piece		-0.75 /piece	-0.60 /piece

Purchase Scenario P3

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	-0.05 /piece		-0.06 /piece	-0.05 /piece
Small household appliances cloths	-0.25 /piece		-0.31 /piece	-0.25 /piece
PC/ Server	-1.77 /piece	-1.77 /piece	-2.21 /piece	-1.77 /piece
Notebook	-0.50 /piece	-0.50 /piece	-0.63 /piece	-0.50 /piece
Printer/Scanner/Copier	-0.13 /piece		-0.16 /piece	-0.13 /piece
IT accessories (mix keyboard, mouse)	-0.05 /piece		-0.06 /piece	-0.05 /piece
Mobile phone (incl. recharger)	-0.20 /piece	-0.20 /piece	-0.25 /piece	-0.20 /piece
CRT monitor	-0.60 /piece	0.50 /piece	-0.75 /piece	-0.60 /piece
FPD monitor	-0.60 /piece		-0.75 /piece	-0.60 /piece
Audio appliances (CD-/Radiorecorder)	-0.25 /piece		-0.31 /piece	-0.25 /piece
Video appliances (CD-/DVD-Player)	-0.25 /piece		-0.31 /piece	-0.25 /piece
CRT TV	-0.60 /piece		-0.75 /piece	-0.60 /piece
FPD TV	-0.60 /piece		-0.75 /piece	-0.60 /piece

Purchase Scenario P4

Appliance Group	1-Delivery to facility (scavengers)	2-B2B-collection from companies	3-B2B-collection from junk shops	4-B2B-collection from repair stores
Small household appliances coffee	-0.05 /piece		-0.06 /piece	-0.05 /piece
Small household appliances cloths	-0.25 /piece		-0.31 /piece	-0.25 /piece
PC/ Server	-1.77 /piece	-1.77 /piece	-2.21 /piece	-1.77 /piece
Notebook	-0.50 /piece	-0.50 /piece	-0.63 /piece	-0.50 /piece
Printer/Scanner/Copier	-0.13 /piece		-0.16 /piece	-0.13 /piece
IT accessories (mix keyboard, mouse)	-0.05 /piece		-0.06 /piece	-0.05 /piece
Mobile phone (incl. recharger)	-0.20 /piece	-0.20 /piece	-0.25 /piece	-0.20 /piece
CRT monitor		0.50 /piece		
FPD monitor	-0.60 /piece		-0.75 /piece	-0.60 /piece
Audio appliances (CD-/Radiorecorder)	-0.25 /piece		-0.31 /piece	-0.25 /piece
Video appliances (CD-/DVD-Player)	-0.25 /piece		-0.31 /piece	-0.25 /piece
CRT TV				
FPD TV	-0.60 /piece		-0.75 /piece	-0.60 /piece

10.2 Downstream scenarios

10.2.1 Recyclable fractions

For the commercialization of the recyclable fractions the following scenarios have been chosen in order to reflect different possible options to sell the material fractions to the market:

- C1) Local Commercialisation: all material fractions are sold on the local market in Cambodia. Since for some fractions no specialized downstream industries exist in Cambodia most fractions would be sold to middlemen, hence prices are lower than in other options. Prices given below are taken from the COMPED study.
- C2) Regional Cross-National Commercialisation: Aluminium and iron/steel are sold on the local market, while all other fraction are sold to regional, cross-national downstream partners. Also in the region specialized recycling industries are not available as direct downstream partners, hence also in this case prices are lower for some of the fractions (namely for processors, printed wiring boards and mobile phones)
- C3) Global Commercialisation: This is the optimized scenario where most middlemen are avoided and fractions are sold for the highest price according to the availability of end-processors to the local market, regional / cross-national downstream partners or through overseas shipment.

Prices of the three scenarios are summarized in Table 20.

Table 20: Achievable sales prices for recyclable fractions for three different downstream scenarios.

Output fractions	Local Commercialisation	Regional Cross-National Commercialisation	Global Commercialisation	Local Commercialisation	Regional Cross-National Commercialisation	Global Commercialisation
	[USD/ton]	*[USD/ton]*	*[USD/ton]*	*Type of Commercialisation*	*Type of Commercialisation*	*Type of Commercialisation*
Aluminium	700	1,100	1,100	Local	Local	Local
Iron/ Steel	70	130	130	Local	Local	Local
Copper	4,000	5,000	5,500	Local	Regional Cross-National	Regional Cross-National
Neodym Magnet	100	130	5,350	Local	Regional Cross-National	Overseas Shipment
Bronze/Brass	2,000	2,350	2,350	Local	Regional Cross-National	Regional Cross-National
Stainless Steel	250	250	250	Local	Regional Cross-National	Regional Cross-National
Plastics	50	100	150	Local	Regional Cross-National	Regional Cross-National
Cable with plugs	188	1,500	1,500	Local	Regional Cross-National	Regional Cross-National
Cable without plugs	250	2,000	2,000	Local	Regional Cross-National	Regional Cross-National
Processors	500	40,000	65,000	Local	Regional Cross-National	Overseas Shipment
HDD with PWB	624	1,391	1,591	Local	Regional Cross-National	Regional Cross-National
HDD without PWB	665	1,045	1,045	Local	Regional Cross-National	Regional Cross-National
Power supply	250	600	650	Local	Regional Cross-National	Regional Cross-National
Drives	250	550	650	Local	Regional Cross-National	Regional Cross-National
Printed Wired Board, Q1	250	4,500	6,500	Local	Regional Cross-National	Overseas Shipment
Printed Wired Board, Q2	250	2,000	2,500	Local	Regional Cross-National	Overseas Shipment
Printed Wired Board, Q3	250	500	500	Local	Regional Cross-National	Regional Cross-National
Mobile Phones without batteries	225	4,050	5,850	Local	Regional Cross-National	Overseas Shipment
Motors/Inductors/Transformers	400	500	550	Local	Regional Cross-National	Regional Cross-National
Deflection coil	1,000	1,250	1,375	Local	Regional Cross-National	Regional Cross-National
Mixed scrap	89	124	140	Local	Regional Cross-National	Regional Cross-National
Batteries	600	800	800	Local	Regional Cross-National	Regional Cross-National

chosen downstream options and achievable prices sales of recyclable fractions in the scenarios (only fractions with different options in the scenarios listed)

10.2.2 Disposal of Hazardous Fractions

For the disposal of hazardous fractions the following scenarios were chosen. In all scenarios it assumed that Capacitors, LCD-displays and Fluorescent tubes cannot be treated in Cambodia and need to be shipped to countries in the region. Hence the scenarios only differ in their approach to treat CRT tubes and leaded CRT glass.

C1) Local disposal of CRT tubes and leaded CRT glass, assumes that those fractions can be stored in controlled landfills in Cambodia

C2) Regional cross-national disposal of CRT tubes and leaded CRT glass, assumes that those fractions can be treated and disposed of in specialized facilities in the region

C3) Global disposal (overseas shipment) of CRT tubes and leaded CRT glass, assumes that those fractions need to be shipped elsewhere for further treatment and disposal.

Table 21: Disposal costs for hazardous fractions for three different downstream scenarios.

Output fractions	Local Disposal	Regional Cross-National Disposal	Global Disposal	Local Disposal	Regional Cross-National Disposal	Global Disposal
	[USD/ton]	*[USD/ton]*	*[USD/ton]*	*Type of Disposal*	*Type of Disposal*	*Type of Disposal*
Capacitors	-500	-500	-500	Regional Cross-National	Regional Cross-National	Regional Cross-National
LCD-displays	-500	-500	-500	Regional Cross-National	Regional Cross-National	Regional Cross-National
Fluorescent Tubes	-500	-500	-500	Regional Cross-National	Regional Cross-National	Regional Cross-National
CRT-tubes	-150	-350	-350	Local	Regional Cross-National	Overseas Shipment
Leaded CRT glass	-10	-50	-100	Local	Regional Cross-National	Overseas Shipment

10.3 Operational costs

Table 22: Purchase costs for the various appliance groups (USD)

Appliance Group	Year 1	Year 2	Year 3	Year 4	Year 5
Small household appliances coffee	-100 /a	-201 /a	-401 /a	-602 /a	-602 /a
Small household appliances cloths	-599 /a	-1,199 /a	-2,398 /a	-3,597 /a	-3,597 /a
PC/ Server	-1,011 /a	-2,023 /a	-4,045 /a	-6,068 /a	-6,068 /a
Notebook	-50 /a	-101 /a	-202 /a	-302 /a	-302 /a
Printer/Scanner/Copier	-179 /a	-357 /a	-714 /a	-1,071 /a	-1,071 /a
IT accessories (mix keyboard, mouse)	-6 /a	-12 /a	-24 /a	-36 /a	-36 /a
Mobile phone (incl. recharger)	-47 /a	-94 /a	-189 /a	-283 /a	-283 /a
CRT monitor	-63 /a	-126 /a	-252 /a	-378 /a	-378 /a
FPD monitor	-135 /a	-271 /a	-542 /a	-813 /a	-813 /a
Audio appliances (CD-/Radiorecorder)	-19 /a	-37 /a	-74 /a	-111 /a	-111 /a
Video appliances (CD-/DVD-Player)	-19 /a	-37 /a	-74 /a	-111 /a	-111 /a
CRT TV	-217 /a	-435 /a	-869 /a	-1,304 /a	-1,304 /a
FPD TV	-191 /a	-381 /a	-763 /a	-1,144 /a	-1,144 /a
Total	**-2,637 /a**	**-5,274 /a**	**-10,548 /a**	**-15,822 /a**	**-15,822 /a**

Table 23: Disposal costs for hazardous fractions (USD/a)

	Disposal Costs [USD/a]				
	Year1	Year2	Year3	Year4	Year5
Aluminium					
Iron/ Steel					
Copper					
Neodym Magnet					
Bronze/Brass					
Stainless Steel					
Plastics					
Cable without plugs					
Processors					
Printed Wired Board, Q1					
Printed Wired Board, Q2					
Printed Wired Board, Q3					
Motors/Inductors/Transformers					
Deflection coil					
Getterpill - electrogun					
Mixed scrap					
Glass					
Residual waste	-1 /a	-1 /a	-3 /a	-4 /a	-4 /a
Batteries					
Capacitors	-67 /a	-134 /a	-268 /a	-402 /a	-402 /a
LCD-displays	-192 /a	-384 /a	-769 /a	-1,153 /a	-1,153 /a
Fluorescent Tubes	-28 /a	-55 /a	-110 /a	-165 /a	-165 /a
Printer Cartridges					
Fluorescent powder					
Leaded CRT glass	-302 /a	-603 /a	-1,206 /a	-1,809 /a	-1,809 /a
Unleaded CRT glass	-452 /a	-905 /a	-1,809 /a	-2,714 /a	-2,714 /a
Total	-1,041 /a	-2,083 /a	-4,165 /a	-6,248 /a	-6,248 /a

Table 24: External transport costs (USD/a)

	External Transport Costs Fractions [USD/a]				
	Year1	Year2	Year3	Year4	Year5
Aluminium					
Iron/ Steel					
Copper	-14 /a	-28 /a	-57 /a	-85 /a	-85 /a
Neodym Magnet	-0 /a	-0 /a	-1 /a	-1 /a	-1 /a
Bronze/Brass	-0 /a	-0 /a	-0 /a	-0 /a	-0 /a
Stainless Steel	-2 /a	-4 /a	-7 /a	-11 /a	-11 /a
Plastics	-744 /a	-1,489 /a	-2,978 /a	-4,467 /a	-4,467 /a
Cable without plugs	-67 /a	-134 /a	-268 /a	-402 /a	-402 /a
Processors	-7 /a	-14 /a	-28 /a	-42 /a	-42 /a
Printed Wired Board, Q1	-225 /a	-449 /a	-899 /a	-1,348 /a	-1,348 /a
Printed Wired Board, Q2	-125 /a	-251 /a	-501 /a	-752 /a	-752 /a
Printed Wired Board, Q3	-49 /a	-99 /a	-198 /a	-297 /a	-297 /a
Motors/Inductors/Transformers	-67 /a	-133 /a	-267 /a	-400 /a	-400 /a
Deflection coil	-48 /a	-96 /a	-193 /a	-289 /a	-289 /a
Getterpill - electrogun					
Mixed scrap	-189 /a	-378 /a	-756 /a	-1,135 /a	-1,135 /a
Glass					
Residual waste					
Batteries	-5 /a	-10 /a	-20 /a	-30 /a	-30 /a
Capacitors	-8 /a	-16 /a	-32 /a	-48 /a	-48 /a
LCD-displays	-23 /a	-46 /a	-92 /a	-138 /a	-138 /a
Fluorescent Tubes	-3 /a	-7 /a	-13 /a	-20 /a	-20 /a
Printer Cartridges					
Fluorescent powder					
Leaded CRT glass	-362 /a	-724 /a	-1,448 /a	-2,171 /a	-2,171 /a
Unleaded CRT glass	-543 /a	-1,086 /a	-2,171 /a	-3,257 /a	-3,257 /a
Total	-2,482 /a	-4,965 /a	-9,929 /a	-14,894 /a	-14,894 /a

Table 25: Staff costs for the assumed staff composition

Staff Costs [USD/a]	Year1	Year2	Year3	Year4	Year5
General Manager	-7,978 /a	-7,978 /a	-7,978 /a	-7,978 /a	-7,978 /a
Department Manager	-3,809 /a	-3,809 /a	-3,809 /a	-3,809 /a	-3,809 /a
Sales Manager					
Skilled workers	-2,539 /a	-2,539 /a	-2,539 /a	-2,539 /a	-2,539 /a
Unskilled workers	-1,452 /a	-2,903 /a	-5,806 /a	-8,709 /a	-8,709 /a
Administrative Staff		-2,539 /a	-2,539 /a	-2,539 /a	-2,539 /a
Security					
Total Staff	**-15,777 /a**	**-19,768 /a**	**-22,671 /a**	**-25,574 /a**	**-25,574 /a**

Table 26: Infrastructure costs

Infrastructure	
rental costs [USD/m².a]	-1.00
Electricity [USD/kWh]	-0.20

Cleaning, maintenance and repair: 10% of rental costs

Estimated energy demand: 40 kWh/ m^2.a (experience DRZ)

	Year 1	Year 2	Year 3	Year 4	Year 5
	[USD/a]	*[USD/a]*	*[USD/a]*	*[USD/a]*	*[USD/a]*
Rental Costs	-554	-554	-554	-554	-554
Electricity	-3,659	-3,659	-3,659	-3,659	-3,659
CMR Infrastructure	-366	-366	-366	-366	-366
Business Liability Insurance and Tax	-500	-500	-500	-500	-500
Total Infrastructure Costs	**-5,079**	**-5,079**	**-5,079**	**-5,079**	**-5,079**

Table 27: Annual costs for equipment

	Year 1	Year 2	Year 3	Year 4	Year 5
Working tools	-150	-300	-450	-600	-600
HSE (shoes, helm, gloves, etc.)	-100	-150	-250	-350	-350
Total	**-250**	**-450**	**-700**	**-950**	**-950**

Table 28: Total internal transport costs

Assumptions

Capacity own trucks	1.5 t
fuel consumption	10 l/100km
fuel price	-0.8 /litre
transport trips per day	2 trips
required time per trip	4.0 hs
kilometres driven per trip	40 km
Vehicle Insurance/Tax	-252

CMR Vehicles: 300 USD/a per vehicle

Type of Commercialisation	Transport Costs [USD]	Explanation
Intermediate storage		
Local	-15 /t	0-50 km
Regional Cross-National	-60 /t	50-600 km
Overseas Shipment	-2,000 /container	

	Year 1	Year 2	Year 3	Year 4	Year 5
	[USD/a]	*[USD/a]*	*[USD/a]*	*[USD/a]*	*[USD/a]*
Fuel	-102	-205	-410	-618	-618
Motor Vehicle Insurance and Tax	-252	-252	-252	-252	-252
CMR Vehicles	-300	-300	-300	-300	-300
Total Transport Costs	**-654**	**-757**	**-962**	**-1,170**	**-1,170**

Table 29: Total administration costs

Assumptions

travel costs	-200	per trip
quantity of trips	3	per year
travel costs	-600	per year
Business Liability Insurance and Tax	-500	per year
Office Supplies, Postal and Bank Charges	-500	per year
Telecommunication/ Internet	-750	per year
Consulting Services	-500	per year
Marketing and Public Relations	-500	per year
Permissions and Quality Management	-100	per year

	Year 1	Year 2	Year 3	Year 4	Year 5
	[USD/a]	*[USD/a]*	*[USD/a]*	*[USD/a]*	*[USD/a]*
Travel Costs	-600	-600	-600	-600	-600
Office Supplies, Postal and Bank Charges	-500	-500	-500	-500	-500
Telecommunication/ Internet	-750	-750	-750	-750	-750
Consulting Services	-500	-500	-500	-500	-500
Marketing and Public Relations	-500	-500	-500	-500	-500
Permissions and Quality Management	-100	-100	-100	-100	-100
Total Administration Costs	**-2,950**	**-2,950**	**-2,950**	**-2,950**	**-2,950**

Table 30: Total depreciation costs

Items	Costs [/unit]	Lifespan [a]	Required units [number]	acquisition costs	Depreciation
Administrative Working Place (PC, table, chair)	-500	15	3	-1,500	-100
Dismantling Working station (table, chair)	-200	10	4	-800	-80
CRT-treatment unit	-15,000	25	1	-15,000	-600
Truck	-10,000	20	1	-10,000	-500
Ventilator	-10	10	10	-100	-10
Collection box	-50	15	40	-2,000	-133
Palette	-5	10	20	-100	-10
Scale	-250	20	1	-250	-13
Pallet truck (internal transport)	-500	20	4	-2,000	-100
Total				**-31,750**	**-1,546**