ブラジル国
開発商工省（MDIC）
環境省（MMA）
サンパウロ市都市清掃機構（AMLURB）

ブラジル国
E-waste リバースロジスティクス
改善プロジェクト

プロジェクト事業完了報告書

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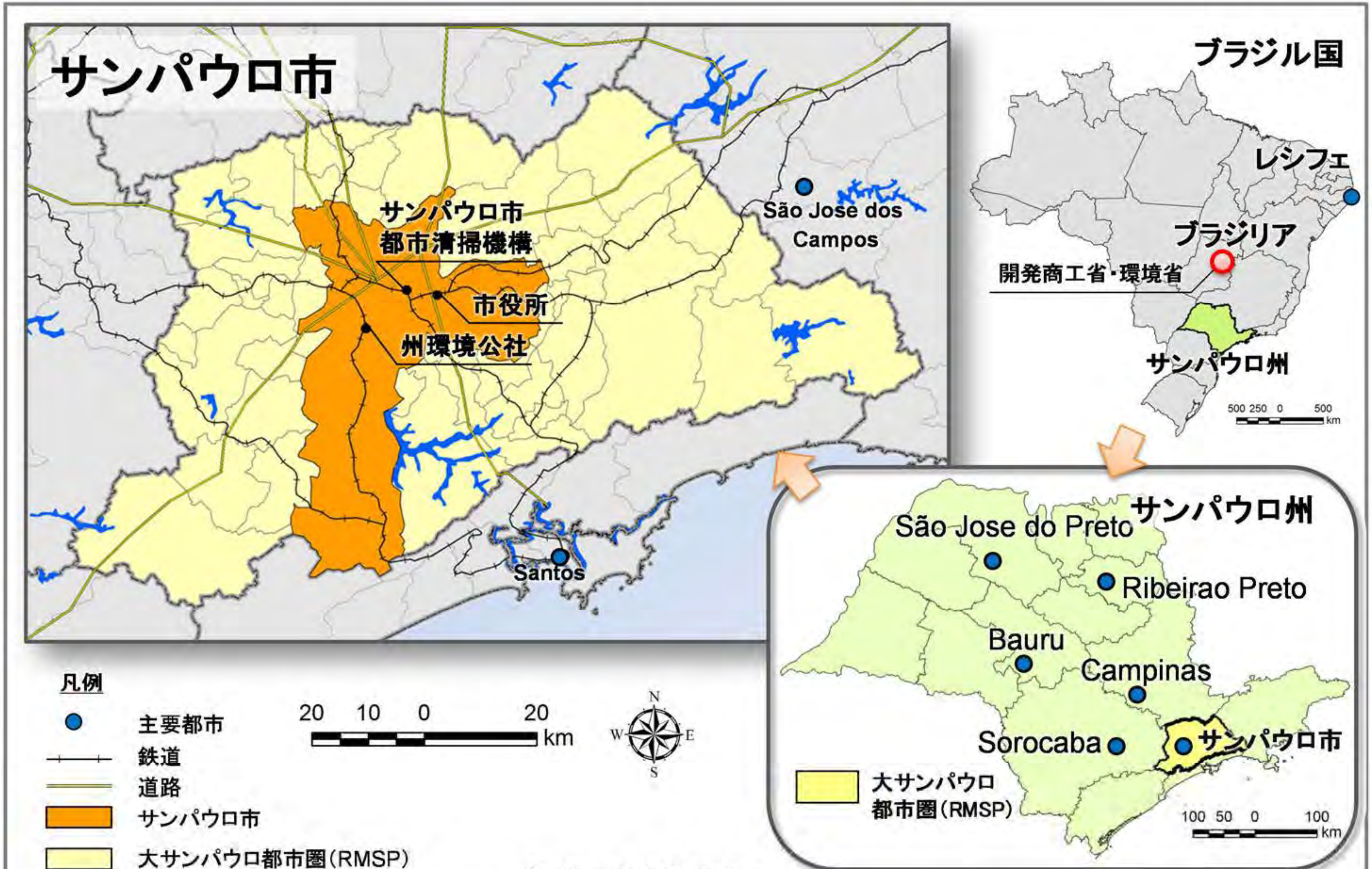

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略 語 表

No.	略語	正式名称	日本語訳
1	ABC	Agência de Brasileira de Cooperação	ブラジル国際協力庁
2	Abinee	Associação Brasileira de Indústria Elétrica e Eletrônica	ブラジル電気・電子機器産業協会
3	ABNT	Associação Brasileira de Normas Técnicas	ブラジル技術規格協会
4	ABRAS	Associação Brasileira de Supermercados	ブラジルスーパーマーケット協会
5	ABREE	Associação Brasileira de Reciclagem de Eletroeletrônicos e Eletrodomésticos	ブラジル家電リサイクル協会
6	AC	Air-conditioner	エアコン
7	AMLURB	Autoridade Municipal de Limpeza Urbana	サンパウロ市都市清掃機構
8	APAS	Associação Paulista de Supermercados	サンパウロ州スーパーマーケット協会
9	C/C	Consolidation Center	一時保管施設
10	C/P	Counter Part	カウンターパート
11	CADRI	Certificado de Movimentação de Resíduos de Interesse Ambiental	環境利害廃棄物移動許可証
12	CETESB	Companhia Ambiental do Estado de São Paulo	サンパウロ州環境公社
13	CFC	Chlorofluorocarbon	クロロフルオロカーボン
14	CMS	Content Management System	コンテンツマネジメントシステム
15	CORI	Comitê Orientador	オリエンテーション委員会
16	CRT	Cathode‐Ray Tube	ブラウン管
17	CTF	Cadastro Técnico Federal	連邦技術登録
18	DfE	Design For Environment	環境適合設計
19	ELETROS	Associação Nacional de Fabricantes de Produtos Eletroeletrônicos	全国電気・電子機器産業協会
20	FECOMERCIO-SP	Federação do Comércio de Bens, Serviços e Turismo do Estado de São Paulo	サンパウロ州商業連盟
21	GDP	Gross Domestic Product	国内総生産
22	GPA	Grupo Pão de Açúcar	ポンデアスーカグループ
23	GTA	Grupo Técnico de Assessoramento	技術助言グループ
24	HCFC	Hydrochlorofluorocarbons	ハイドロクロロフルオロカーボン
25	HFC	Hydrofluorocarbon	ハイドロフルオロカーボン
26	IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis	ブラジル環境・再生可能天然資源院
27	ID	identification	個体識別
28	IRR	Internal Rate of Return	内部収益率
29	JCC	Joint Coordinating Committee	合同調整委員会
30	JET	JICA Expert Team	JICA 専門家チーム
31	JICA	Japan International Cooperation Agengy	国際協力開発機構
32	LCD	Liquid Crystal Display	液晶画面
33	MCTI/CTI	Ministério da Ciência, Tecnologia, Inovações e Comunicações/Centro de Tecnologia da Informação Renato Archer	科学技術革新省/技術情報センター
34	MDIC	Ministério da Indústria, Comércio Exterior e Serviços	ブラジル開発商工省
35	MMA	Ministério do Meio Ambiente	ブラジル環境省

No.	略語	正式名称	日本語訳
36	NBR	Norma da ABNT	ABNT 標準
37	NGO	Non-Government Organization	非政府組織
38	PC	Personal Computer	パソコン
39	PCB	Print Circuit Board	プリント基板
40	PGIRS-SP	Plano de Gestão Integrada de Resíduos Sólidos da Cidade de São Paulo	サンパウロ市廃棄物統合管理計画
41	PNRS	Política Nacional de Resíduos Sólidos	国家固形廃棄物管理政策法
42	PP	Pilot Project	パイロットプロジェクト
43	PR	Public Relations	パブリックリレーションズ
44	R/D	Record of Discussion	協議録
45	RL	Reverse Logistics	リバースロジスティックス
46	SEFAZ	Secretaria da Fazenda do Estado de SP	サンパウロ州財務局
47	SINIR	Sistema Nacional de Informações sobre a Gestão dos Resíduos Sólidos	国家廃棄物管理情報システム
48	SMA	Secretaria do Meio Ambiente do Estado de São Paulo	サンパウロ州環境局
49	SP	São Paulo	サンパウロ
50	T/C	Technical Committee	テクニカルコミッティ
51	TOR	Terms of Reference	付託条項
52	TV	Television Set	テレビ
53	USD	US-Dollar	アメリカドル
54	WG	Working Group	ワーキンググループ

1. プロジェクトの概要

1.1 プロジェクトの背景・経緯

ブラジル国（以下、ブ国）は、いわゆる BRICs の一つとして近年の経済成長が著しく、その結果、廃棄物の発生量が急増し、適正な廃棄物管理が喫緊の課題となっている。都市廃棄物に関しては基本的に地方自治体等の公的機関が回収・処分を行っているが、その過程において多くの民間事業者やカタドールと呼ばれるウエストピッカー、またそのカタドール組合などが関わっている。また、他国同様、都市近郊においては既往最終処分場の残余年数が少なくなると共に、新規立地も難しくなっており、3R（減量化・再利用化・再資源化）による廃棄物の減量化が求められている。

これらの社会背景のもと、ブ国政府は長い年月の議論を経て 2010 年 8 月に「国家固形廃棄物管理政策法」を策定し、同年 12 月に政令を公布した。同法の政策目的の 1 つである「製品のライフサイクルにおける関係者の責任の共有」の観点から、「廃棄後の製品を民間事業者へ還元し、再利用、再資源化又適正処理・処分を行うリバースロジスティクス（RL）」を確立することになっている。消費後の家電製品である E-waste も RL の対象品目の一つであり、その RL 構築に向けて、官民の各ステークホルダーの連携及び役割分担の明確化等の具体的展開が求められている。このため、連邦政府開発商工省は、日本に対して、このブラジルで実施される E-waste の RL システム構築の一助とすべく、日本の経験も踏まえた技術協力を目的とした技術協力プロジェクトを要請した。本要請を踏まえて、国際協力機構（JICA）は 2013 年 9 月～10 月に詳細計画策定調査を実施してブ国側と本格協力の枠組みについて協議し、2014 年 6 月に開発商工省や環境省等の関係機関との合意を経て、協議記録（R/D）の締結に至った。

この R/D に基づき、2014 年 10 月より JICA の委託を受けた JICA 専門家チームが派遣されて、本プロジェクトの活動を開始した。

JICA と専門家チームとの業務契約は、第 1 年次（2014 年 10 月～2015 年 9 月）と第 2 年次（2015 年 11 月～2017 年 9 月）の 2 契約に区分される。本完了報告書は、3 年間に渡る第 1 年次及び第 2 年次契約の活動として 2014 年 10 月から 2017 年 9 月までのプロジェクト活動の成果を取りまとめたものである。

1.2 プロジェクトの目的・概要

1) プロジェクトの目的

本プロジェクトの目的は、JICA とブ国側関係機関との間で合意した「E-waste リバースロジスティクス改善プロジェクト」に関する R/D に基づき活動を実施することによって、所定の成果を発現し、プロジェクト目標を達成することである。

2) プロジェクトの範囲

本プロジェクトは、R/D に基づき実施される技術協力プロジェクトの枠内で、前述の「プロジェクトの目的」を達成するため、ブラジル側関係者の能力向上に留意するとともに、JICA の業務指示書による「実施方針及び留意事項」に十分に配慮して活動を実施し、進捗に応じた報告書並びに技術成果品を作成するものである。

3) プロジェクトの対象地域

本プロジェクトの対象地域は現況調査及びパイロットプロジェクト（PP）の対象地域として、まず「サンパウロ市（SP 市）及びサンパウロ州（SP 州）内の関連地域」がある。関連地域とは、サンパウロ市を中心とする PP の対象 E-waste の RL のバリューチェーンが存在する限定された地域である。

次に、連邦政府として、RL 及び廃棄物管理を所管する環境省と RL 構築に向けた産業開発等を所管する開発商工省の位置するブラジリアも、パイロットプロジェクトは実施しないものの、協議・報告等のプロジェクト活動の対象地域となる。さらに、PP の成果を他州へ展開するために、サンパウロ市と条件の異なる 2 都市（ブラジリア、レシフェ）に対しても基礎的な調査を行うことから、これらの都市もプロジェクトの対象地域となる。

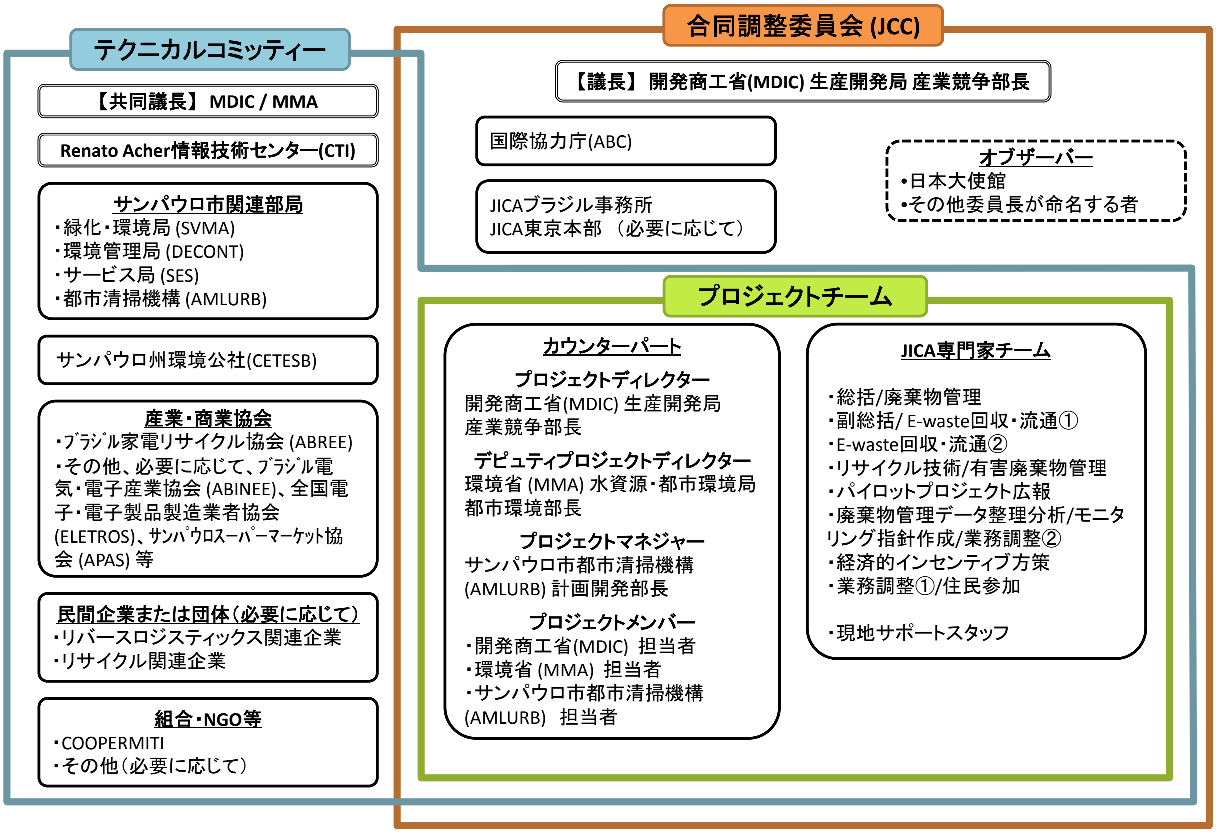
4) カウンターパート機関

本プロジェクトのカウンターパート（C/P）機関は、R/D で合意された以下の 3 機関であり、連邦政府（ブラジリア）と地方自治体（サンパウロ）にまたがるものである。

- 開発商工省（MDIC）：生産開発局　産業競争部
- 環境省（MMA）：水資源・都市環境局　都市環境部
- サンパウロ市都市清掃機構（AMLURB）

5) プロジェクトの実施体制

本プロジェクトの実施体制を下図に示す。プロジェクト活動は JICA 専門家チームとブラジル側カウンターパートから構成される JICA プロジェクトチームが実施し、プロジェクト実施にあたっての調整、助言等を行う合同調整委員会（JCC）が設置されている。また、サンパウロ市を中心に実施するパイロットプロジェクトの計画、実施に当たってはステークホルダーで構成されるテクニカルコミッティを設置している。



出所：JICA 専門家チーム

図 1-1 プロジェクトの実施体制

6) プロジェクトの構成

PDM で設定された本プロジェクトの目標、成果、活動は以下に示すとおりである。

(1) 上位目標

リバースロジスティック実施（RL）が促進される。

(2) プロジェクト目標

連邦政府においてリバースロジスティック実施の改善のためのアクションが提示される。

(3) 成果

- 成果1.サンパウロ州におけるe-wasteの発生・RLのバリューチェーン、リサイクル活動の現況が把握される。
- 成果2. サンパウロ州におけるRLシステムのパイロットプロジェクトにより、連邦レベルでのRL構築に係る教訓を抽出する。
- 成果3.「国家固形廃棄物管理政策法」下の RLのモニタリング・レポーティング体制が提案される。

(4) 活動（下線部は本報告書対象期間に実施した活動）

- 1-1 サンパウロ州におけるe-waste の発生・リサイクル・処理・潜在量の現況を調査し、インベントリを作成する。

- 1-2 サンパウロ州における現在のe-waste の流れの詳細を調査し、e-wasteの流れ図(waste stream chart)を作成する。
- 1-3 パイロットプロジェクトを行うエリア、対象品目、RLシステムに参画するステークホルダーを同定する。
- 2-1 テクニカルコミッティを設立する。
- 2-2 対象品目のRLシステムのパイロットプロジェクト実施に係る仮説、諸条件[1]及び調整方法を検討、合意する。
- 2-3 パイロットプロジェクトにおけるRLシステムフロー[2]の運営プロセスを検討し、システムを試行する。
- 2-4 パイロットプロジェクト実施に当たっての事業者向け、消費者向け広報・普及活動を実施する。
- 2-5 RLへの民間の設備投資を促進するために、税制優遇策ならびに融資優遇制度など経済的インセンティブの検討協議に参加する。
- 2-6 2-3で提案されたRLシステムフローを、選定された他州の都市に導入するための基礎的な調査を行う。
- 2-7 パイロットプロジェクトの実施結果を検証し、セクター協定のオリエンテーション委員会(CORI)に対しての報告・提言のための教訓を抽出する。
- 3-1 RLを監督するシステムを構築するために、モニタリングすべきポイント、必要な許認可、技術的基準を検討する。
- 3-2 2-3で試行したRLシステムに対して、モニタリング・レポーティング体制を検討し、試行する。
- 3-3 連邦レベル、州レベル、市レベルの行政向けにRL 監督のためのガイドラインを作成する。
- 3-4 民間セクター向けのRLレポーティングのためのガイドラインを作成する。

[1] 取扱廃棄物の定義・位置づけ、費用概算および負担案、回収メカニズム、ステークホルダー(家電業界、流通業界等関係団体、カタドール組合、住民、行政)との調整手段、セクター協定との整合性確認手段

[2] 回収・一時保管、運搬、選別・解体・リサイクル資源の回収・売却、残さの処理・処分

2. プロジェクト目標の達成度

プロジェクト目標である「ブラジルの連邦政府において E-Waste のリバースロジスティック実施の改善のためのアクションが提示される」の達成度は、以下に示すとおり、プロジェクト終了時段階での達成度を、定められた 2 つの指標で測定した結果、「十分に達成された」ものと考える。

1) 指標 1 による達成度

指標 1 による達成度は以下の表に示すとおり、経済的優遇策として「初期投資への補助金」「低利のソフトローン」及び「事業税の免税」を提案して、事業収益の改善効果を検証し、「初期投資への補助金」の効果が比較的最も大きいことが確認された。

表 2-1 指標 1 及びその達成度

指標1	連邦政府においてプロジェクト期間中に設備投資への融資、税制優遇策等の優遇策が少なくとも1つ提案される。	
達成度	終了時評価時点（2017年5月）	プロジェクト終了段階（2017年8月）
	現地調査やパイロットプロジェクトによって得られた教訓を元に、以下のインセンティブに係わる事項が検討されている。 1) E-Waste排出者である消費者へのインセンティブ付与 2) E-Waste輸送に係わる輸送税等の免除 3) E-Wasteのリサイクル施設等の建設に係わる低金利ローン より詳細な検討や他の優遇策の検討のため、引き続き関係者と協議を継続する。	左記の3つのインセンティブのうち、1)については回収率を向上し、上位目標を達成するための提言とし、2)についてはパイロットプロジェクトの計画・実施に際してサンパウロ州財務局（SEFAZ）と様々な議論を行っている。 他方、今後のE-wasteのリバースロジスティクス構築に当たっては、その受け皿となる大型家電の破砕施設やフロン等の有害物質処理機能を有する本格リサイクル施設の新規整備は必須であることから、3)のインセンティブについて低金利ローンだけでなく、補助金や事業税免税について収益改善効果を比較し、検討条件下では補助金の効果が大きいことが確認された。 この提案を踏まえて、MDICではその財源確保の必要性を認識し、検討を開始する予定である。 したがって、本指標は達成された。

2) 指標 2 による達成度

指標 2 による達成度は以下の表に示すとおり、パイロットプロジェクトの教訓が連邦政府及びその他の地方政府に反映されている、あるいは反映される見込みである。

表 2-2　指標 2 及びその達成度

<table>
<tr><td>指標2</td><td colspan="2">パイロットプロジェクトの教訓が連邦政府の固形廃棄物の政策に反映される。</td></tr>
<tr><td rowspan="2">達成度</td><td>終了時評価時点（2017年5月）</td><td>プロジェクト終了段階（2017年8月）</td></tr>
<tr><td>指標はまだ十分には達成していないものの、プロジェクトを通じて様々な教訓が得られてきており、プロジェクト終了時には連邦政府に提案されるものと思われる。一方で、それらの提案が確実に政策に反映されるかどうかは不透明な部分もある。

現時点で、有益な教訓としては、以下が挙げられる。

1) パイロットプロジェクト計画に当たってのステークホルダー間の議論の結果、2016 年 6 月の CETESB 通達（120/2016/C）において、「解体前のE-Wasteは非有害物である」旨、明示された。

2) 本邦研修での経験も踏まえてパイロットプロジェクトで導入試行された一時保管施設（Consolidation Center）は店頭回収、下取回収、どちらにおいても効率的に機能したといえる。

3) パイロットプロジェクトに参加したカタドール組合によるE-Waste回収、選別、保管作業の質は高く、今後、カタドール組合もE-WasteのR/Lのアクターとして巻き込むことの潜在性が示唆された。</td><td>プロジェクト終了段階では連邦レベルでのセクター協定の協議中であり、具体的な政策反映には至っていないが、左記のCETESB通達は連邦全体でも踏襲される予定である。

また、パイロットプロジェクトでは中・小型E-wasteと大型E-wasteを区分して異なる回収方法を試行したが、この成果を踏まえてサンパウロ州でもE-wasteの種類別に関連業界と「セクター確約書」によるリバースロジスティクス構築に向けた準備が進められている。

サンパウロ市では、廃棄物処理基本計画の見直しにおいて、E-wasteの回収拠点を民間店舗だけでなく、学校や役所といった公共施設、あるいは市の管轄するeco pontなどの活用を検討し、積極的に拠点拡大を図ることを検討している。

このようにパイロットプロジェクトの成果や教訓が連邦レベル、州・市レベルで活用されつつあることから、本指標は達成されたと言える。</td></tr>
</table>

3. プロジェクトの成果一覧

3.1 成果 1 に係る活動

【1-1】サンパウロ州における E-Waste の発生・リサイクル・処理・潜在量の現況を調査し、インベントリーを作成する。

サンパウロ市における E-waste の発生・リサイクル・処理・潜在量の現況を調査し、インベントリを作成して添付資料 1 として整理した。なお、E-waste の発生量はサンパウロ市で発生している量を推定し、リサイクル及び処理については市を超えて流通している状況を踏まえて、サンパウロ州レベルで把握した。

以下に、インベントリの概要を示す。

1) インベントリ作成対象

(1) インベントリの定義

E-waste のインベントリをここでは E-waste の種類ごとに以下の通り定義する。

- 販売量（供給量）
- 排出量（再使用分含む量、含まない量）
- ストック量
- 処理フロー

(2) 対象 E-waste の種類

E-waste 全体に占める割合、有害性、資源性を考慮して以下の 7 品目 10 種類を対象としてインベントリを作成した。

- テレビ（CRT）
- テレビ（フラット）
- 冷蔵庫
- 洗濯機
- エアコン
- パソコン（デスクトップ、CRT）
- パソコン（デスクトップ、LCD）
- パソコン（ノートブック）
- 携帯電話
- 小型電気電子機器（普及率の高い掃除機、アイロン、ミキサー、電子レンジ、ドライヤーで代表）

(3) 対象 E-waste の範囲

- 家庭由来 E-waste
- 事業所由来 E-waste

(4) 対象地域

- サンパウロ市（ただし、処理フローはサンパウロ州レベルで把握した）

(5) 対象期間

- 2005 年から 2012 年までの販売量実績より、1990 年から 2030 年までの予測値を推定した。

2) インベントリ調査手法

インベントリの作成手順は以下の通りである。

- E-waste の種類ごとの国内販売台数を GDP を用いサンパウロ市に縮小推計し、
- 販売台数を家庭向け消費、事業所向け消費に仕分けし、
- 各 E-waste の寿命（平均使用年数）を考慮して各年の不用台数（再使用され再び消費段階に戻るものを含む）を推定し、
- 廃棄台数を算出して、
- 家庭由来 E-waste の処理フロー、事業所由来 E-waste の処理フローを適用し、
- 家庭由来 E-waste と事業所由来 E-waste を足し合わせることによって E-waste 全体を推計した。

また、E-waste 台数に一台当たり平均重量を与えることによって、重量換算を行い、さらに E-waste に含まれる有害物（鉛で代表）、貴金属（金、銀、白金、パラジウムで代表）の重量換算を行った。

上記推定のための各パラメータの設定のために、2015 年 3 月～5 月にかけて再委託調査として行った家庭アンケート調査、事業所アンケート調査等を用いた。

本インベントリ調査手法において特筆すべき点は、以下のようにあげられる。

- 現在の家電製品の普及率を考慮して家電の販売台数を家庭向けと事業所向けに仕分けし、家庭由来 E-waste と事業所由来 E-waste の処理フローの違いを考慮した。
- 再使用率の高さを重視して、ひとたび不要となった家電製品が再使用を通じて再び消費段階に戻ってストック量に算定されるというモデルとした。なお、再使用後、製品の寿命はリセットされずに、もともとの平均使用年数を経過して廃棄されるという前提条件で計算することにより、修理品等の寿命の短さを表現した。
- パーソナルコンピュータと携帯電話については退蔵・死蔵を考慮した。
- 2016 年からテレビ放送のデジタル化が予定されており、テレビの買い替えが進むと考えられる。これを廃棄量の推定において考慮した。

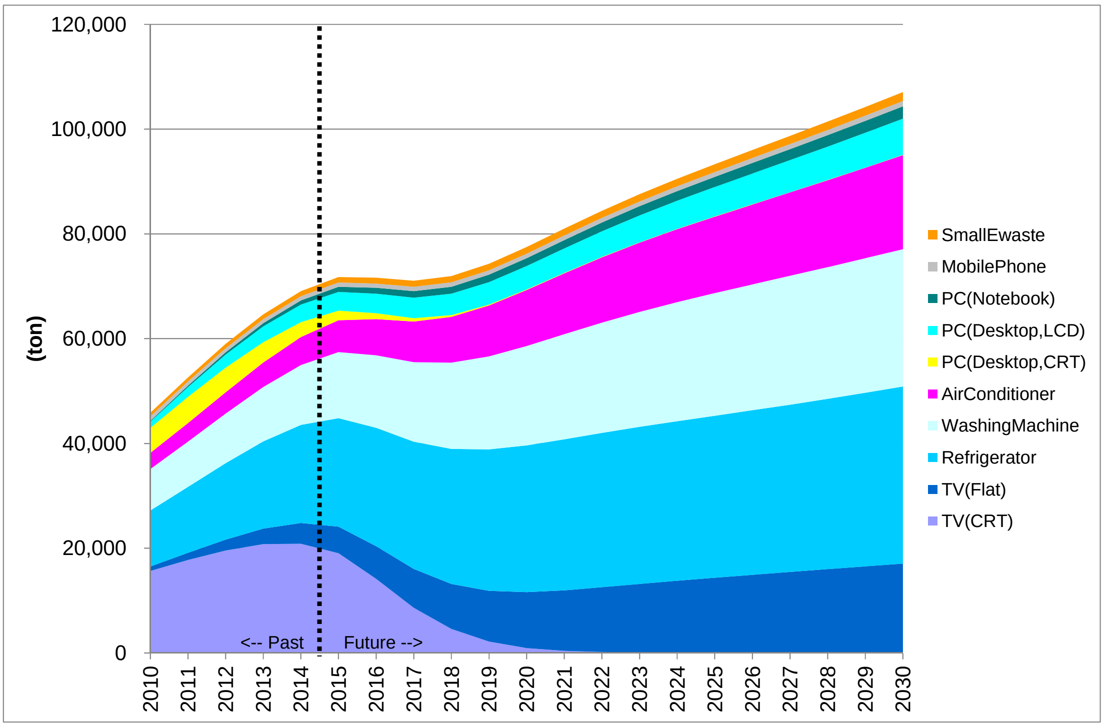
3) インベントリ結果

インベントリ結果を以下に示す。

(1) 廃棄重量(再使用含まず)

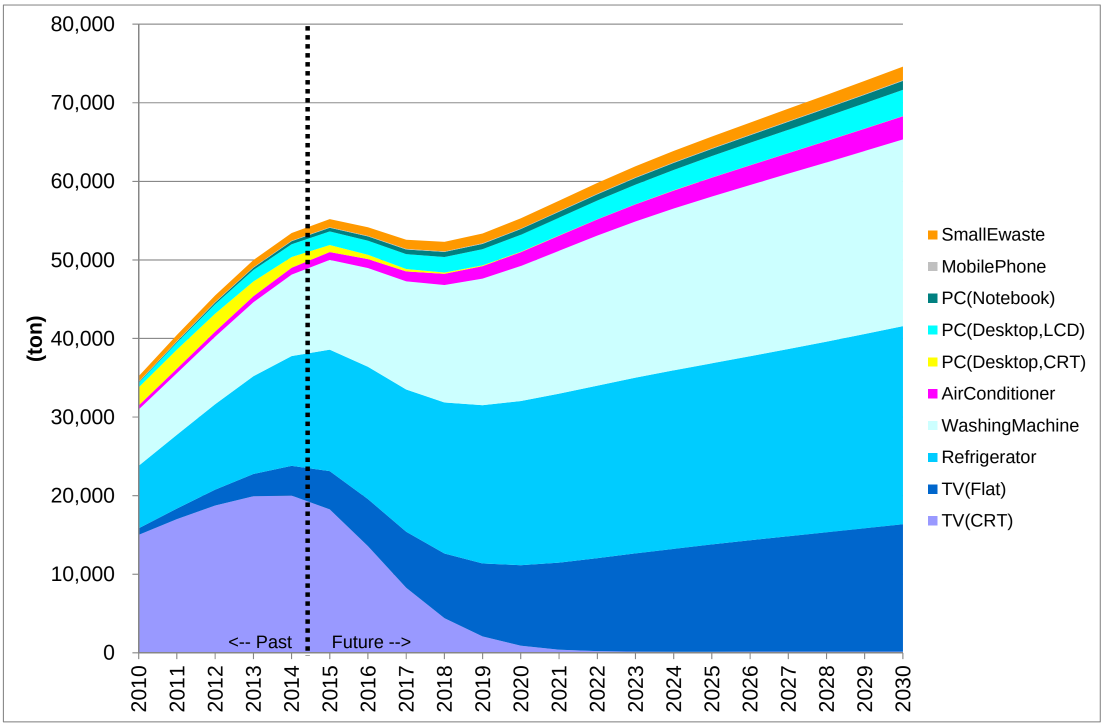
E-waste ごとの廃棄重量を下図に示す。その特徴は以下の通り要約できる。

- 現在においてサンパウロ市から排出される E-waste の廃棄量は年間約 72 千トンであり、今後 100 千トン超まで徐々に伸びていく。
- テレビ、冷蔵庫、洗濯機、エアコンで E-waste 全体廃棄量の 8 割以上を占める。
- CRT テレビの廃棄量は今後急激に減少する。このため家庭由来の E-waste 廃棄量は今後数年で一時的に下がる。



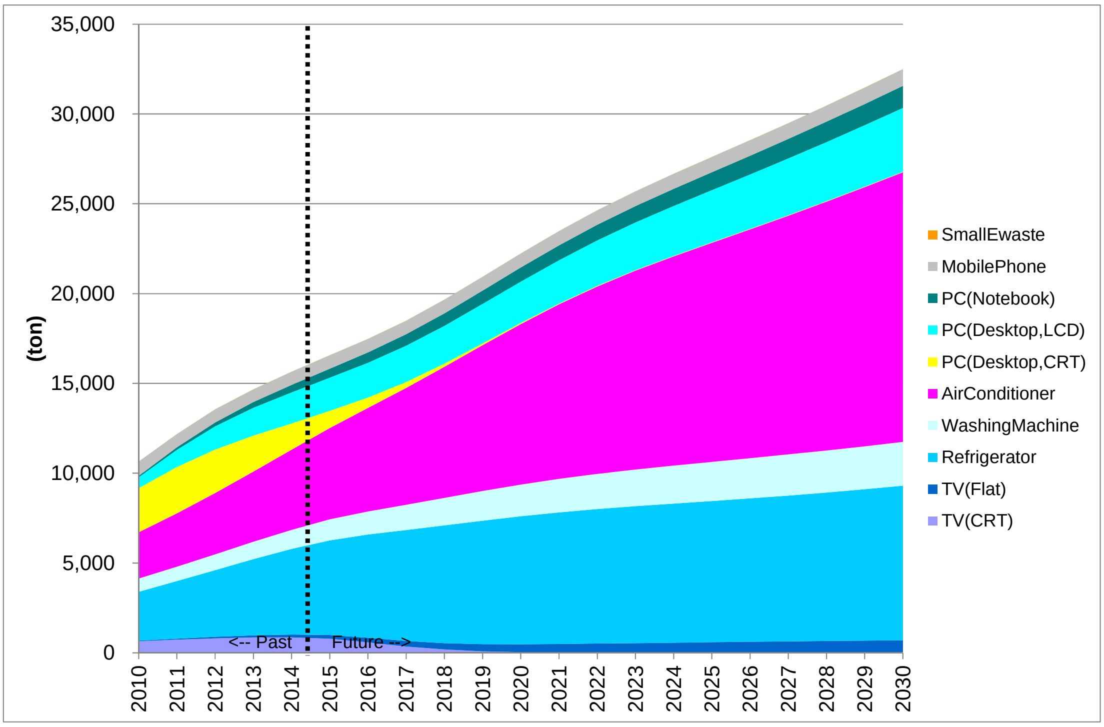
出所:JICA 専門家チーム

図 3-1 サンパウロ市における E-waste 廃棄重量推移(再使用含まず)【全体】



出所：JICA 専門家チーム

図 3-2　サンパウロ市における E-waste 廃棄重量推移（再使用含まず）【家庭】



出所：JICA 専門家チーム

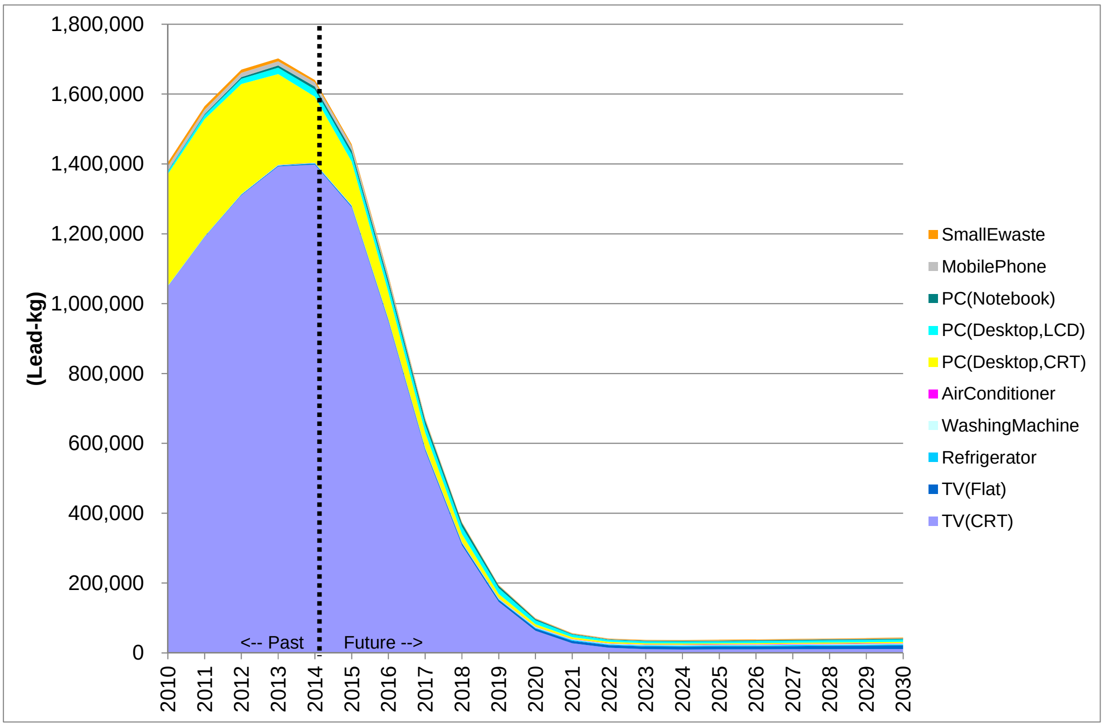
図 3-3　サンパウロ市における E-waste 廃棄重量推移（再使用含まず）【事業所】

(2)　E-waste に含まれる有害物の廃棄推移

上記 E-waste 廃棄量に有害物質（鉛）含有率を与え、廃棄される E-waste に含有される有害物（鉛）の量を下図の通り推計した。

その特徴は以下の通り要約できる。

- 2016 年のテレビ放送デジタル化に向けて CRT テレビが一時的に大量に廃棄され、それに伴って鉛の廃棄量が増大する。
- Rohs 規制によって製品中の鉛含有率は 2006 年以降激減される。これを反映して E-waste 中の鉛量は 2020 年にはほとんどゼロとなる。



出所：JICA 専門家チーム

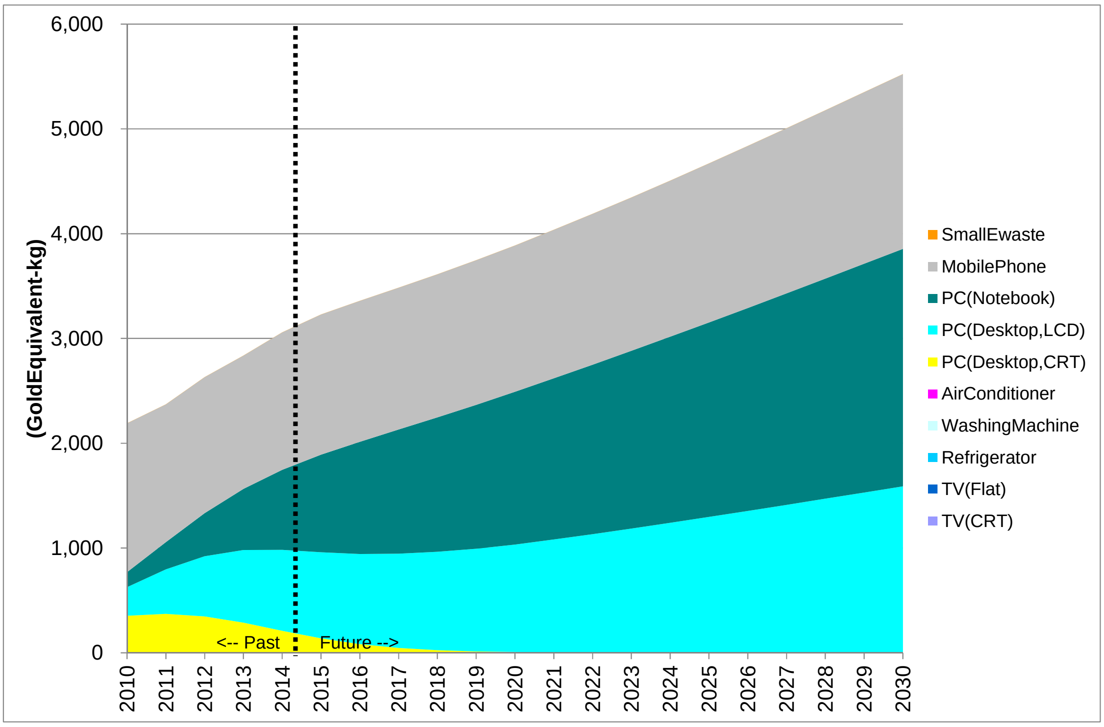
図 3-4　E-waste に含まれる有害物質（鉛）の廃棄量推移

(3)　E-waste に含まれる貴金属の廃棄量推移

上記 E-waste 廃棄量に貴金属（金、銀、白金、パラジウム）を与え、廃棄される E-waste に含有される貴金属の量を下図の通り推計した。

その特徴は以下の通り要約できる。

- 貴金属を含有する製品はパソコン、携帯電話であり、現在においては年間 3 トン程度の貴金属が E-waste に付随して排出されており、いずれも今後増大傾向にある。



出所：JICA 専門家チーム

図 3-5　E-waste に含まれる貴金属の廃棄量推移

【1-2】サンパウロ州における現在の E-Waste の流れの詳細を調査し、E-Waste の流れ図（waste stream chart）を作成する。

1)　E-waste 処理フロー

2015 年における E-waste 処理フローを図 3-6 以降に示す。

処理フローはパイロットプロジェクトの骨格を検討できるように、以下の 3 区分に簡素化して設定した。

- 現在、カタドール等多様なルートを通じてスカッテイロ等に流れているもの（インフォーマル回収経由）
- 同様に、粗大ごみ回収と言った公共収集等へ混入して排出されるもの（公共収集経由）
- 現在、既に E-waste 解体ルートに流れ、適正にリサイクルされているもの（フォーマル回収経由）

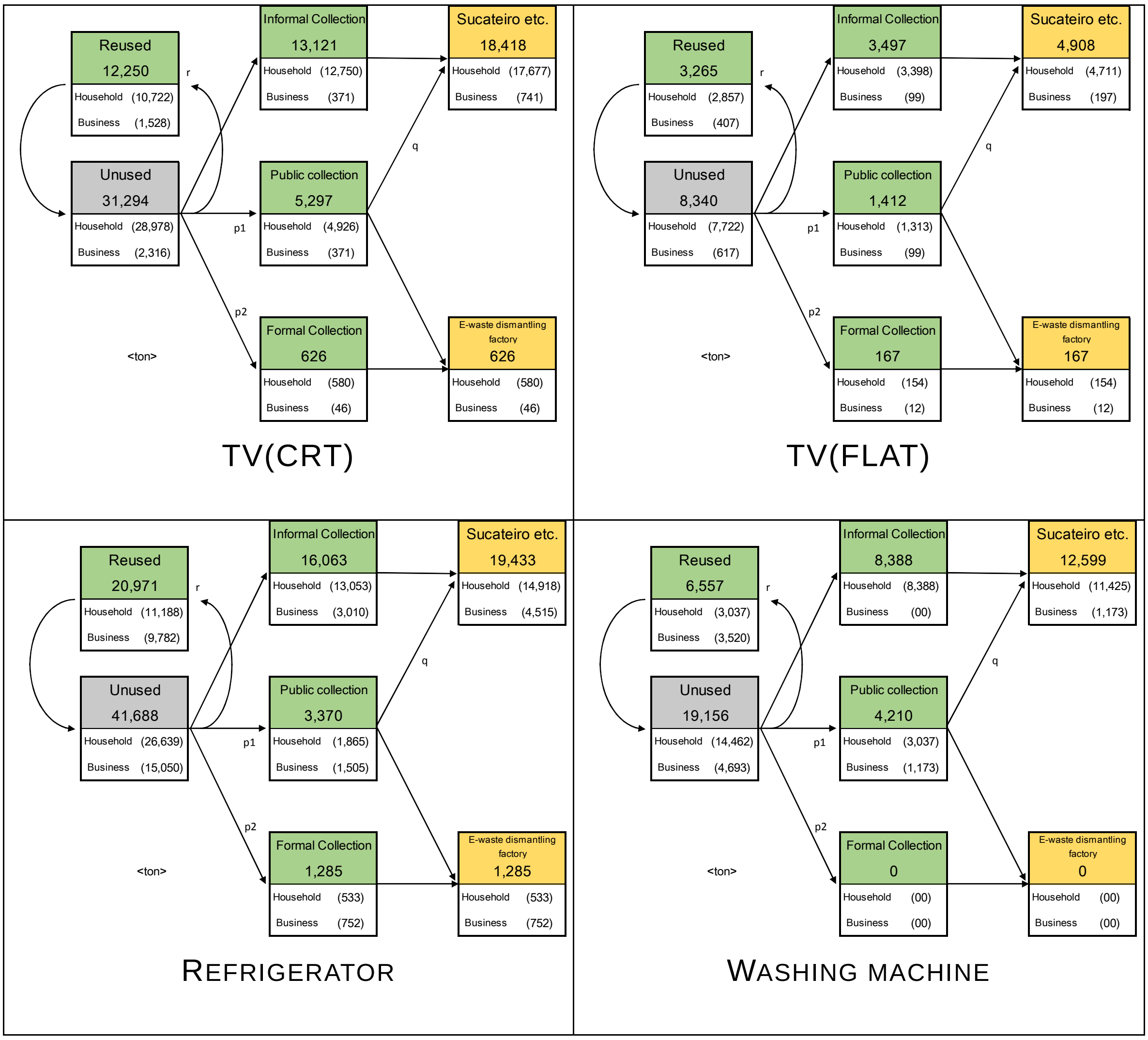
なお、不用 E-waste 量（unused）は再使用されるもの（reused）、スカッテイロ等に流れているもの（informal）、公共収集等に流れているもの（public collection）を通じて及び適正解体リサイクルが行われているもの（formal）の総量である。（再使用率＋インフォーマル回収率＋公共収集率＋フォーマル回収率＝１００％）。

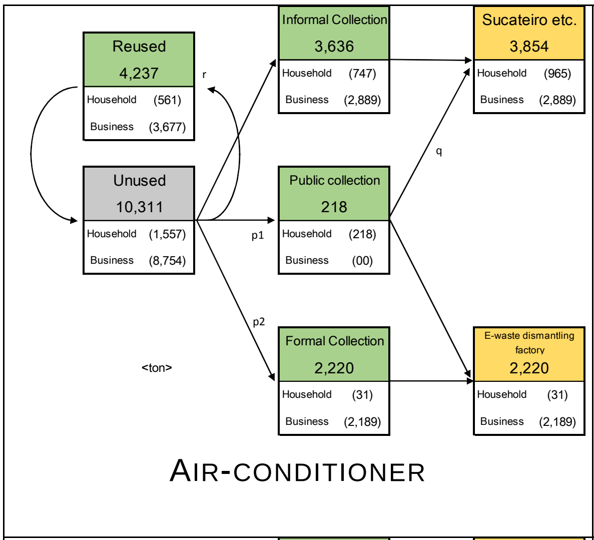
これらの結果を俯瞰すると、全体的に以下の傾向が読み取れる。

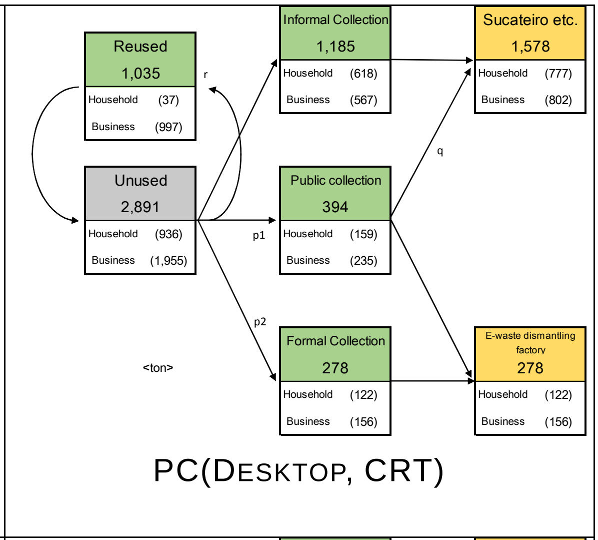
- 中古販売・修理店・譲渡等の E-waste の再使用率は約 34%（家庭由来）、約 58%（事業所由来）であるが、それ以外はそのまま廃棄されている。
- 家庭由来の E-waste のうち公共ごみ収集サービスへの混入が約 15%を占めており、行政コストとなっている。
- 家庭由来の E-waste のうちスカッテイロやジャンクショップ等による処理が約 50%を占めており、不適正処理の可能性が高い。
- E-waste が適正に回収・リサイクルされている割合は 2%（家庭由来）、10%（事業所由来）にしか満たない。

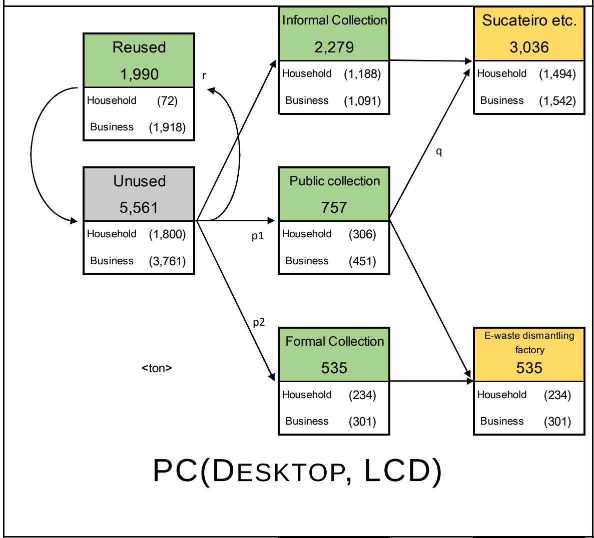
上記を鑑みて、下記の E-waste 処理フローの現状を適正な方向に制御する方向性は次の 2 つである。

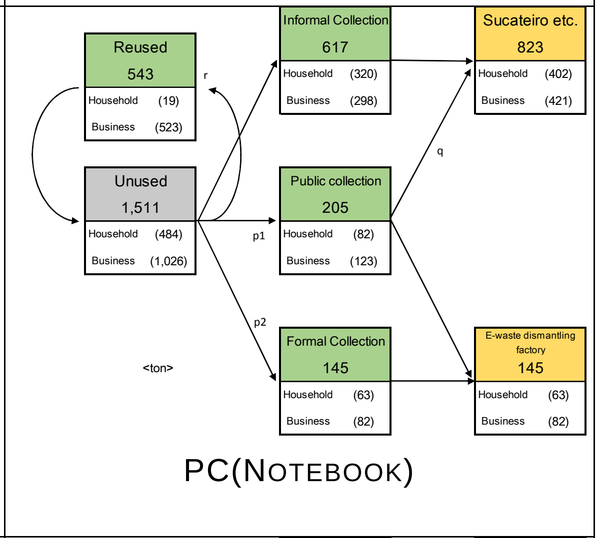
- フォーマル回収経由で適正リサイクルに流れる量を増やす（パイロットプロジェクトで試行する）。
- 現状、公共収集経由で回収されている E-waste を適正な解体工場に誘導する。

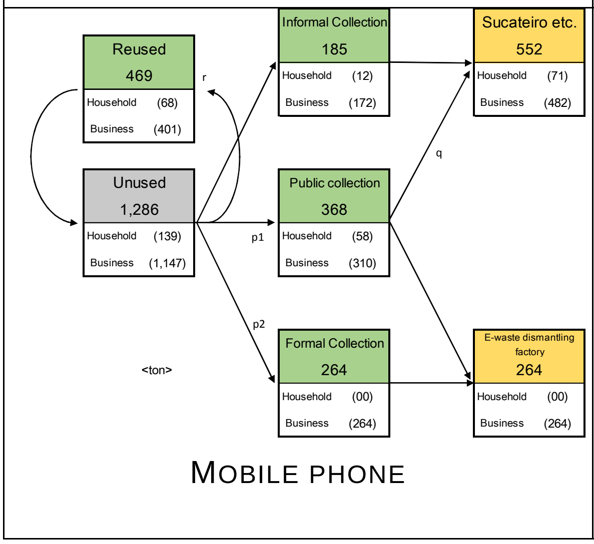


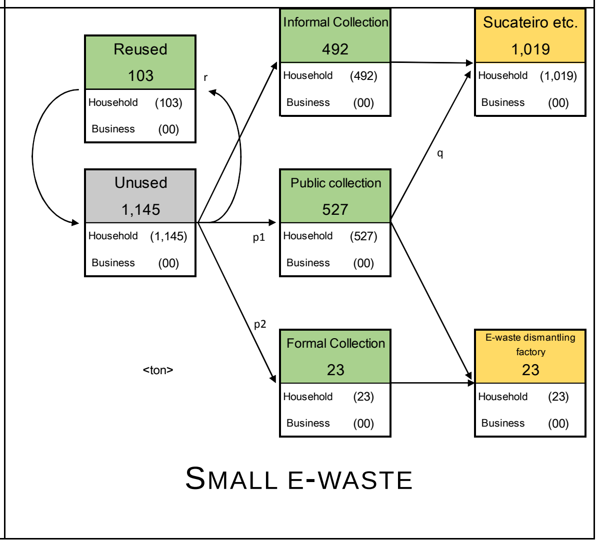

Reused
4,237
Household (561)
Business (3,677)
Unused
10,311
Household (1,557)
Business (8,754)
Informal Collection
3,636
Household (747)
Business (2,889)
Public collection
218
Household (218)
Business (00)
Formal Collection
2,220
Household (31)
Business (2,189)
Sucateiro etc.
3,854
Household (965)
Business (2,889)
E-waste dismantling factory
2,220
Household (31)
Business (2,189)
r
p1
p2
q
<ton>
AIR-CONDITIONER

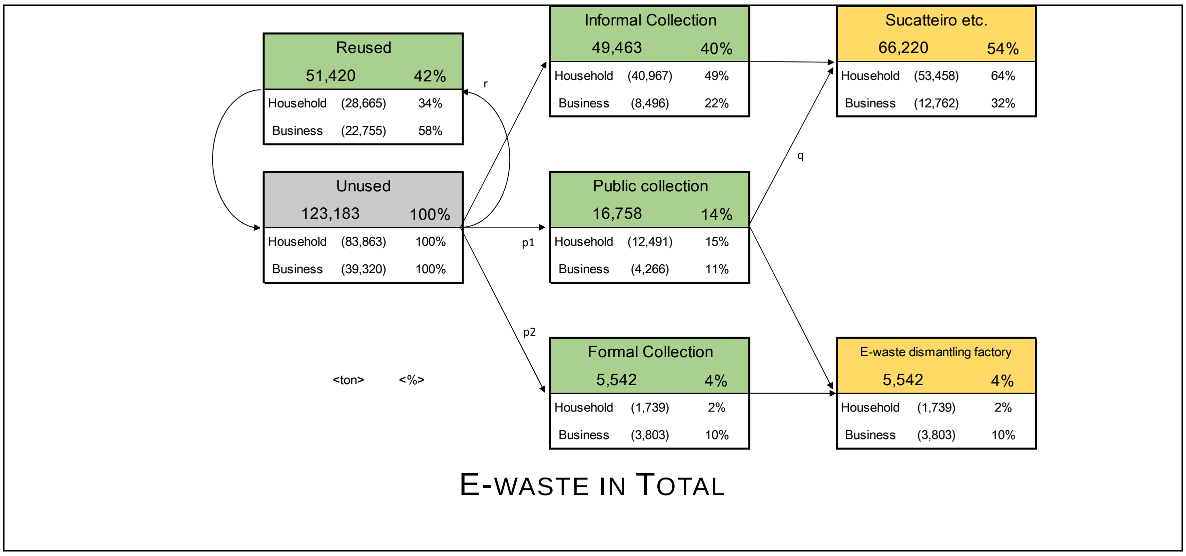

Reused
1,035
Household (37)
Business (997)
Unused
2,891
Household (936)
Business (1,955)
Informal Collection
1,185
Household (618)
Business (567)
Public collection
394
Household (159)
Business (235)
Formal Collection
278
Household (122)
Business (156)
Sucateiro etc.
1,578
Household (777)
Business (802)
E-waste dismantling factory
278
Household (122)
Business (156)
r
p1
p2
q
<ton>
PC(DESKTOP, CRT)


Reused
1,990
Household (72)
Business (1,918)
Unused
5,561
Household (1,800)
Business (3,761)
Informal Collection
2,279
Household (1,188)
Business (1,091)
Public collection
757
Household (306)
Business (451)
Formal Collection
535
Household (234)
Business (301)
Sucateiro etc.
3,036
Household (1,494)
Business (1,542)
E-waste dismantling factory
535
Household (234)
Business (301)
r
p1
p2
q
<ton>
PC(DESKTOP, LCD)


Reused
543
Household (19)
Business (523)
Unused
1,511
Household (484)
Business (1,026)
Informal Collection
617
Household (320)
Business (298)
Public collection
205
Household (82)
Business (123)
Formal Collection
145
Household (63)
Business (82)
Sucateiro etc.
823
Household (402)
Business (421)
E-waste dismantling factory
145
Household (63)
Business (82)
r
p1
p2
q
<ton>
PC(NOTEBOOK)


Reused
469
Household (68)
Business (401)
Unused
1,286
Household (139)
Business (1,147)
Informal Collection
185
Household (12)
Business (172)
Public collection
368
Household (58)
Business (310)
Formal Collection
264
Household (00)
Business (264)
Sucateiro etc.
552
Household (71)
Business (482)
E-waste dismantling factory
264
Household (00)
Business (264)
r
p1
p2
q
<ton>
MOBILE PHONE


Reused
103
Household (103)
Business (00)
Unused
1,145
Household (1,145)
Business (00)
Informal Collection
492
Household (492)
Business (00)
Public collection
527
Household (527)
Business (00)
Formal Collection
23
Household (23)
Business (00)
Sucateiro etc.
1,019
Household (1,019)
Business (00)
E-waste dismantling factory
23
Household (23)
Business (00)
r
p1
p2
q
<ton>
SMALL E-WASTE



出所：JICA 専門家チーム

図 3-6　E-waste 処理フロー・全体(2015 年)

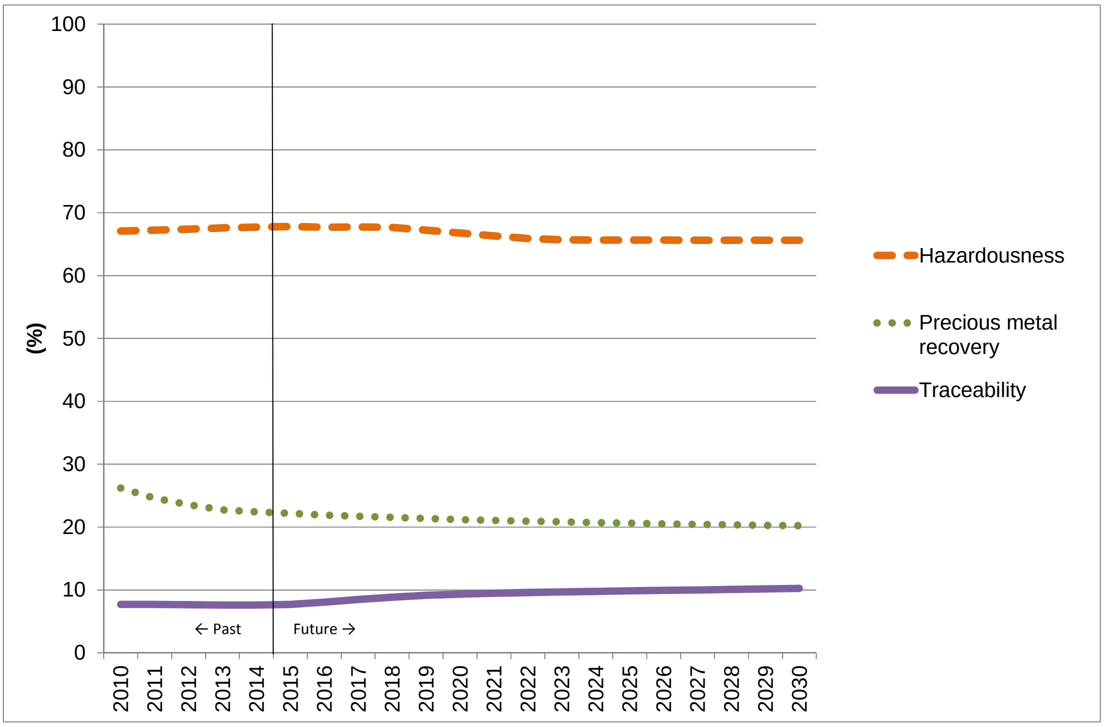
2)　E-waste 管理政策評価指標

E-waste 管理政策評価指標として以下の 3 つの指標を今後の検討ツールとして設定した。

- 有害性：鉄屑問屋などに流れてしまいモニタリング不可能な E-waste に含まれる有害物質（鉛）の量
- 資源回収：E-waste 適正解体工場に搬入される回収可能な貴金属（金、銀、白金、パラジウム）の量
- トレーサビリティ：E-waste 適正解体工場に搬入されるモニタリング可能な E-waste の量（重量）

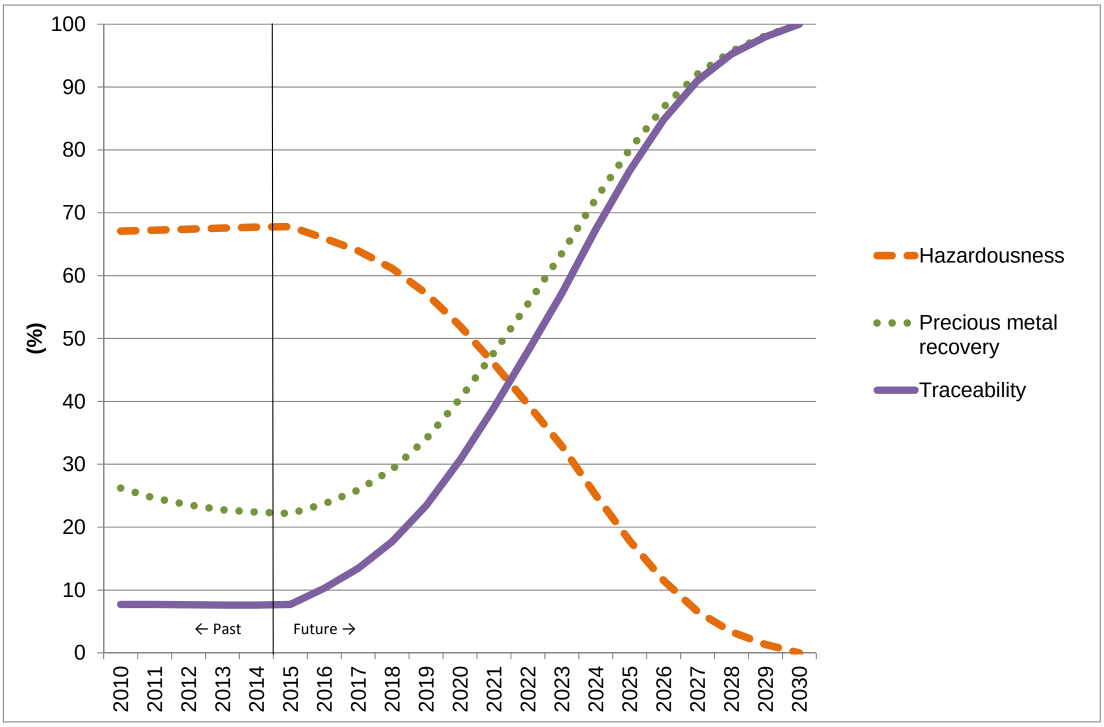
図 3-7 は、E-Waste のリバースロジスティクスという公共政策が導入されず、現状のまま推移した場合の 3 つの政策評価指標の推移を示し、図 3-8 はその政策が入った場合（2030 年に 100%の政策展開を実現すると仮定）の政策評価指標の推移を示す。

今後、現実的な政策目標値を設定すれば、このツールを政策指標の推移を評価するためのツールとして活用できる。この場合、例えば政策目標値を低く抑えれば、貴金属回収量も低いものとなる。



出所：JICA 専門家チーム

図 3-7　公共政策が適用されない場合の政策評価指標の推移



出所：JICA 専門家チーム

図 3-8　公共政策を適用する場合の政策評価指標の推移

【1-3】パイロットプロジェクトを行うエリア、対象品目、RL システムに参画するステークホルダーを特定する。

【1-1, 1-2】の結果、ならびに【2-1】で設置したテクニカルコミッティー（TC）での議論を通じてパイロットプロジェクトの対象品目、ステークホルダー、及びエリアを以下の通り特定した。

1)　対象品目の特定

TC での議論の結果、パイロットプロジェクトにおいて取り扱う対象品目を以下の通り特定した。基本的には家庭で使用されている全ての E-waste を対象とする一方、既に他のリバースロジスティックスで対象となっている電池類や蛍光灯などについては回収の対象外とした。

出所：JICA 専門家チーム

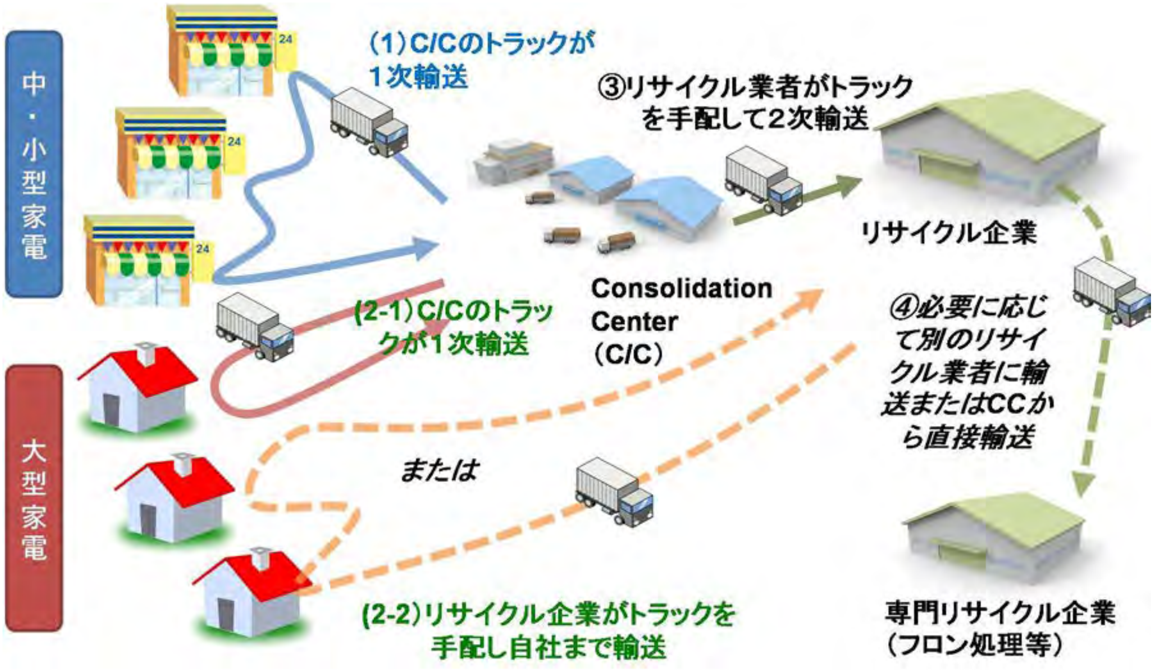
図 3-9　パイロットプロジェクトでの対象品目

2)　回収方法

パイロットプロジェクトでは中・小型 E-Waste の回収方法と、大型 E-Waste の回収方法をそれぞれ検討することとし、中・小型 E-Waste については家電販売店および家電を販売するスーパーマーケットに回収ボックスを設置することによる「店頭回収（Drop-off）」を、また大型 E-Waste については新品購入者を対象に E-Waste の戸別回収を行う「下取り回収（Trade-in）」を試行した。

図 3-10 はパイロットプロジェクトにおける E-waste 回収システムの全体イメージである。中・小型 E-Waste についてはコンソリデーションセンター（一時保管施設）運営者が直接小売店舗を回って回収ボックスに集められた E-waste を回収する。大型 E-Waste については、新品を購入した消費者が不要となった家電の引き取りを希望する場合に、コンソリデーションセンターまたはリサイクル企業が消費者宅から E-Waste を回収する。このコンソリデーションセンターは、日本の

事例も踏まえて、効率的な E-Waste 回収を図るために、ブラジル側から提案され、採用、試行されたものである。なお、詳細なパイロットプロジェクト計画は【2-2】において記載する。



出所：JICA 専門家チーム

図 3-10　パイロットプロジェクトにおける E-waste 回収システムの全体イメージ

3)　ステークホルダーの特定

パイロットプロジェクト（PP）へ参加するステークホルダーとその役割を表 3-1 に示す。将来の E-waste の RL システムの運営には E-waste の回収だけでなく、解体・リサイクル、広報・普及啓発活動、R/L に係るデータや情報のモニタリング・報告、資金管理まで R/L のバリューチェーン全般に係るステークホルダーの関与が必要であり、本 PP においても同様のステークホルダーの参加が実現した。

表 3-1　パイロットプロジェクトに参加するステークホルダーと役割

	ステークホルダー	役割
①	MMA,　MDIC	セクター協定や連邦政府政策を踏まえた助言・支援 プロジェクト関係者との調整支援 モニタリング結果・データ確認
②	サンパウロ市、 AMLURB	住民への広報、啓蒙（広報マテリアルは JICA 専門家チームが提供） プロジェクト関係者との調整 メディア対応、説明会の開催（JICA 専門家チームと共同実施）
③	消費者(PP 対象地域で家電を購入する消費者、住民等)	中・小型 E-Waste を回収拠点まで持ってくる 下取り回収（Trade-in）サービスを申し込み、決められた場所・日時に決められた方法で大型 E-Waste を配送業者に引き渡す

④	小売店(PP に参加する家電販売店、家電を販売するスーパー)（Extra、Extra Hyper、PONTO FRIO、CasasBAHIA、Walmart、Lojas Americanas、Pernambucanas）	回収ボックスの設置スペースの提供（回収ボックスは JICA 提供） 下取り回収（Trade-in）サービスの試行（住民からの大型 E-Waste の引き取り、C/C への輸送・保管（小売店が自ら試行する場合。コストは一部 JICA 負担） 広報キャンペーンの実施協力（マテリアルは JICA 提供）
⑤	小売・流通業界団体（FECOMERCIO、ABRAS、APAS）	パイロットプロジェクト参加小売店との調整、プロジェクト広報への助言
⑥	Coopermiti	Consolidation Center（C/C）としての運営（コストは JICA 負担） 回収拠点や住民からの E-waste の積み込み、1 次輸送（コストは JICA 負担）
⑦	リサイクル業者（OXIL、GM&C）	C/C からの E-waste の積み込み、二次輸送、適正処理・処分、データ報告。ただし、一部、大型 E-Waste の住民からの積み込みも行なう。（これらすべてのコストは JICA 専門家チームが負担）
⑧	製造業界団体（ABREE、ABNIEE、ELETROS）	リサイクル業者のモニタリング・訪問検査実施（JICA と共同実施） 広報キャンペーンの実施協力（広報誌やウェブサイト等）
⑨	サンパウロ州環境局（SMA）・CETESB、財務局（SEFAZ）、サンパウロ市財務局	パイロットプロジェクト実施に必要となる許認可 セクター協約や州政府政策を踏まえた助言・支援

出所：JICA 専門家チーム

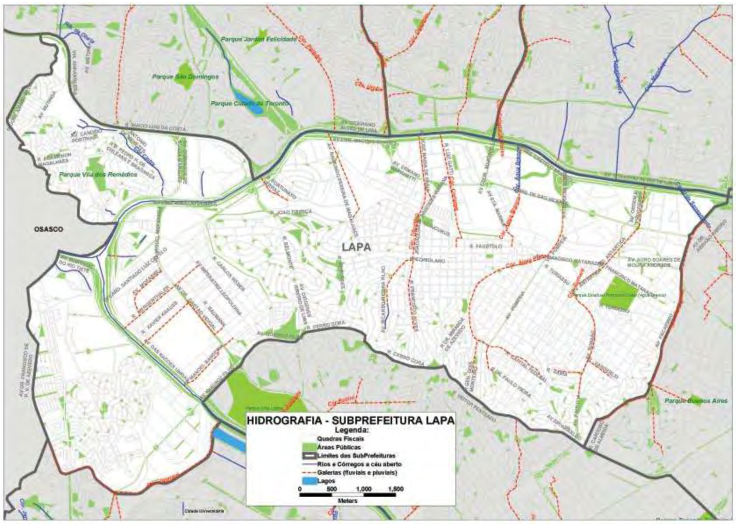
4) 対象エリア（規模）の特定

（1） E-waste 回収参加店舗立地エリア

パイロットプロジェクト（PP）の対象エリアとして、PP に参加する小売店の立地範囲を図 3-11 に示したラパ区に特定した。選定の理由については以下の通りである。

- 第一に、ラパ区は駅/バスターミナルに隣接した商業区域があり、ほぼ全ての家電小売企業が立ち並んでいる。家電の購入を目当てに大勢の人（主に低中所得者層）が徒歩で訪れる。この区域で E-waste 回収キャンペーンを実施すれば宣伝効果が非常に高い。
- 第二に、商業地区をダウンタウンとすれば、高台の住宅地であるアップタウンもラパ区内にあり、この地区に居住する中・高所得者層は郊外型の大型スーパーマーケットやショッピングモール内にある家電販売店で家電を購入すると想定され、商業区域との比較をすることができる。

- 第三に、2013-2014 年の 1 年間、サンパウロ市はごみ分別キャンペーンをラパ区全域で実施した[3]。分別品目には E-waste も含まれており、区内の数ヶ所に回収ボックスが設置された。この経験によりラパ区住民には、リサイクル等に対するある程度の理解と知見があると考えられ、パイロットプロジェクトの活動が受け入れられやすいことが期待される。
- 第四に、ラパ区には低所得者から高所得者までの様々な所得層の住民が居住しており、サンパウロ市を代表するパイロット地域として適切と考えられる。



出所：サンパウロ市ウェブサイト[4]

図 3-11　P/P の参加小売店対象エリア（ラパ区）

(2)　E-waste 回収対象エリア

ラパ区内の店舗で家電を購入する消費者はラパ区民とは限らない。ラパ区は北と東にバイパスが通っており、大型店舗は車でのアクセスが圧倒的に多い。商業区域はバスターミナルおよび駅に隣接している。大型 E-Waste 回収（Trade-in 方式）において、参加店舗はラパ区内店舗に限定するが、回収先はラパ区外にもおよぶこととなる。その一方、回収対象範囲を無制限に広げると回収にかかるコストが大幅に増加しかねず、有益なコスト情報を収集することが出来ないため、一定の制限を設ける必要がある。そのため、今回のパイロットプロジェクトにおける大型 E-Waste 回収（Trade-in 方式）では回収対象エリアをサンパウロ市内に限定した。

(3)　E-waste 解体･リサイクル等の実施エリア

解体・リサイクルを行う施設はサンパウロ市内外に立地しており、それぞれ独自の回収網等を踏まえて活動をしている。解体・リサイクルを行う施設は、所定の基準を満たしたサンパウロ州内の立地企業を対象に、入札による現地再委託を行った。業者選定は、一時保管施設（C/C）の場所と解体・リサイクル施設の相対的な距離などから、運搬コスト・解体費用などの市場経済の観点より選定された。

[3] http://consumosustentaveleacao.org.br/

[4] http://www.prefeitura.sp.gov.br/cidade/secretarias/meio_ambiente/umapaz/caderno_das_aguas/index.php?p=24598

3.2　成果 2 に係る活動

【2-1】サンパウロの E-waste に関係するステークホルダー間でパイロットプロジェクトに関する調整を行うためのテクニカルコミッティーを設立する。

テクニカルコミッティー（TC）については、パイロットプロジェクトに関するステークホルダーの調整の場として継続的に開催した。メンバーは下記のメンバーを基本として構成し、パイロットプロジェクトの進捗に合わせて参加小売店舗関係者やリサイクル業者などを加えて開催を行った。

表 3-2　TC 参加メンバー

ポジション	団体名
共同議長	開発商工省（MDIC）/環境省（MMA）
基本メンバー	サンパウロ市都市清掃機構（AMLURB） サンパウロ州環境公社（CETESB） 技術革新省情報技術センター（MCTI/CTI） ブラジル家電リサイクル協会（ABREE） ブラジル電気・電子機器産業協会（ABNIEE） 全国電気・電子製品製造業者協会（ELETROS） ブラジルスーパーマーケット協会（ABRAS） サンパウロ州スーパーマーケット協会（APAS） サンパウロ州商業連盟（FECOMERCIO-SP） COOPERMITI（E-Waste 専門カタドール組合）
追加メンバー	PP 参加小売店舗（Casas BAHIA,PONTO FRIO, Walmart, Extra Hiper, Lojas Americanas、Pernambucanas）、 リサイクル業者

出所：JICA 専門家チーム

プロジェクト期間中、以下に示す通り合計 13 回の TC を開催した。

表 3-3　テクニカルコミッティの開催状況

回数	開催日	開催場所	議事
第 1 回	2014 年 12 月 17 日	AMLURB	・ 民間ステークホルダーに対するプロジェクト概要の説明
第 2 回	2015 年 4 月 10 日	AMLURB	・ テクニカルコミッティ設置の目的及び機能、運営方法 ・ TC の全体スケジュールの説明 ・ 本邦研修の実施
第 3 回	2015 年 5 月 21 日	AMLURB	・ SP 市内での PP 実施にあたってのアドバイス、留意事項のとりまとめ ・ 本邦研修の実施
第 4 回	2015 年 8 月 5 日	AMLURB	・ 現況調査結果概要 ・ PP 計画骨子案 ・ 今後の予定 ・ 本邦研修関連事項
第 5 回	2015 年 12 月 10 日	ELETROS	・ 2 年次全体活動概要説明 ・ PP 計画案説明・協議
第 6 回	2016 年 2 月 2 日	LOGA	・ PP 計画案説明・協議 ・ 今後の予定
第 7 回	2016 年 3 月 8 日	Abinee	・ PP 計画最終案説明・協議 ・ 今後の予定
第 8 回	2016 年 4 月 26 日	BUNKYO	・ PP 開始直前セレモニー ・ PP 計画の説明 ・ 家電リサイクル制度に関するプレゼン・意見交換
第 9 回	2016 年 7 月 25 日	Abinee	・ PP の進捗報告 ・ 広報活動の改善について ・ Abree/GPA からの提案（下取り回収）
第 10 回	2016 年 10 月 17 日	ELETROS	・ PP の進捗報告 ・ GPA/ABREE の下取り回収（trade-in）方法説明 ・ 回収促進方策の協議 ・ PP の継続について
第 11 回	2016 年 12 月 13 日	Abinee	・ PP の進捗報告 ・ 店頭アンケートの結果 ・ PP の終了について
第 12 回	2017 年 2 月 15 日	Abinee	・ PP の結果報告 ・ PP の結果評価 ・ PP 参加者からの意見
第 13 回	2017 円 8 月 9 日	Japan House	・ PP 結果を踏まえたコスト分析 ・ 他都市調査結果 ・ 経済インセンティブ施策

出所：JICA 専門家チーム

また、TC の下で開催されるワーキンググループ（WG）について、開催状況を以下に示す。

表 3-4　WG 開催状況

開催日	場所	議題
2015 年 8 月 13 日	AMLURB	・PP の実施について
2015 年 12 月 2 日	ABINEE	・PP における回収方法 ・E-waste のモニタリングシステム ・Consolidation Point について
2015 年 12 月 7 日	ABREE	・Consolidation Point について ・下取り回収（Trade-in）の回収方法について

		・E-waste のモニタリングシステム
2016 年 2 月 25 日	FECOMERCIO	・広報 WG の設置 ・PP 広報実施予定内容 ・セレモニーの紹介
2016 年 3 月 14 日	FECOMERCIO	・PP のロゴ及びスローガン ・Web site の開設 ・回収ボックスのデザインについて ・ソーシャルメディア
2016 年 3 月 31 日	FECOMERCIO	・Drop-off ルールについて ・下取り回収クーポン利用案について ・広報マテリアルの種類・数量について　他
2016 年 5 月 25 日	FECOMERCIO	・PP 広報の現状共有 ・広報物の部数決定 ・広報ルール　他
2016 年 10 月 20 日	GPA	・下取り回収促進について
2016 年 11 月 22 日	GPA	・店頭アンケート調査結果の報告 ・下取り回収の進捗報告 ・PP の終了について

出所：JICA 専門家チーム

【2-2】対象品目の RL システムのパイロットプロジェクト実施に係る計画を検討し、ステークホルダー間で合意する。

1) パイロットプロジェクトの位置づけ

パイロットプロジェクト（PP）の目的は、国家固形廃棄物管理政策法（PNRS）に基づき、連邦、州、市レベルで今後、セクター協定あるいはセクター確約書で実施される E-Waste のリバースロジスティクス計画の参考となる知見やデータを、PP を通じて取得することであり、以下の成果が期待される。

- 現在、連邦レベルで協議中のセクター協定に関して必要に応じて PP の成果が活用される。
- サンパウロ市固形廃棄物基本計画 2014 における E-Waste リバースロジスティクス計画の具現化に向けた知見等が得られる。
- 将来、ブラジルの他都市で同様のリバースロジスティクス計画を検討する際に PP の成果が活用される。

2) パイロットプロジェクトの実施主体

本 PP は、テクニカルコミッティによる主導の下、前述の参加するブラジル側ステークホルダーが主体となって実施するものであり、JICA 専門家チームはそれを技術的、財政的に支援するものである。

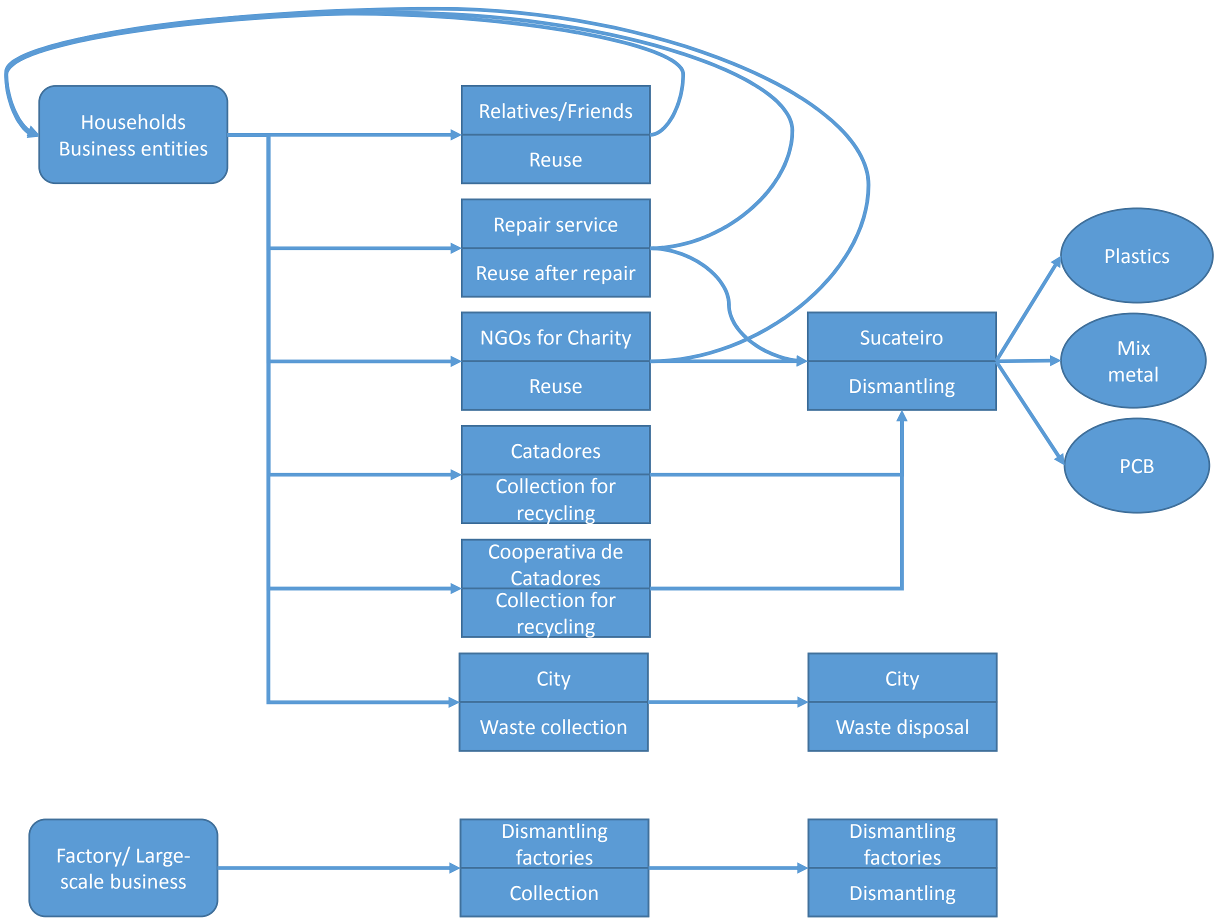
3) 現在の E-waste の流れ

現在の E-waste の流れについて以下の図に示す。現在の E-waste の流れは以下のようにまとめることが出来る。

- 排出される E-waste は使用可能なものもあることから、それらを必要とする親戚や友人に与えられ、マテリアルリサイクルのための排出は主要なルートとはなっていない。
- 同様に再利用を目的とした寄付団体への寄付や修理サービスといった中古市場へのルートも活発に行われている。
- 一方で、これら再利用ルートから排出される E-waste が存在し、”スカッテイロ”と呼ばれる従来からのリサイクル業者によって処理される。
- カタドール個人あるいはカタドール組合によって回収され、スカッテイロへ送られるルートもある。

一方、これらの現在の E-waste の流れの課題として以下が挙げられる。

- 大型 E-waste を適切なリサイクル業者に流す、使い勝手の良い回収・取引システムが存在しない。
- 慈善団体やカタドール、カタドール組合からの E-waste の多くはスカッテイロに排出されるが、これらスカッテイロは必ずしも E-Waste を適切に分解してリサイクルしていない。
- サンパウロ市の公共ごみ収集に混入し、そのまま最終処分場で埋め立てられている E-Waste が存在する。



出所：JICA 専門家チーム

図 3-12　サンパウロ市における既存の E-waste の流れ

4) E-waste 回収システムの検討

現状の E-waste の流れとその課題を踏まえて、以下のとおり、パイロットプロジェクトにおける E-Waste 回収システムを検討した。

(1) 既存の回収ルートの活用

- マテリアルリサイクルを主たる目的として E-waste を扱う既存のアクターはカタドールとカタドール組合である。
- 特にカタドール組合は通常、オーソライズされた組織であり、既にごみ収集といった公共サービスへ関与できるシステムとなっている。
- 一方で、カタドール組合による E-Waste の解体行為の技術的妥当性、合法性には留意する必要がある。
- 回収された E-Waste は、スカッテイロではなく、適切なライセンスを有する E-waste のリサイクル業者で解体、リサイクルする必要がある。

(2) 新たな回収ルートの試行

- 大型 E-waste の下取り回収の機会を新品購入時に提供することは、日本の経験からも効率的であり、その回収ルートを検討する。
- サンパウロ市のごみ処理基本計画では、市内の一定規模の売り場面積を有する小売店舗に E-Waste の回収拠点を設置することを計画しており、その回収ルートを検討する。

(3) パイロットプロジェクトで試行する回収ルートの決定

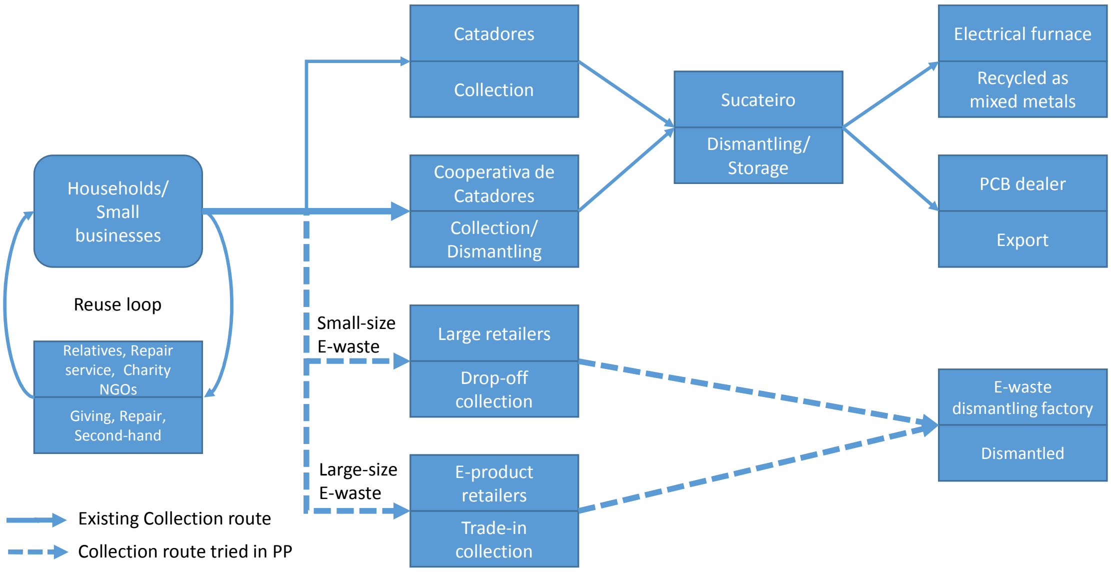
上記、①および②を勘案して、パイロットプロジェクトでは次の 4 つの回収ルートの試行が検討され、関係者との協議結果やパイロットプロジェクトの期間、規模、予算等を勘案して、ⅰとⅱの二つの回収ルートによる回収システムを構築することとした。

i. <u>中小型 E-waste の回収に店頭回収ルートを試行する。</u>

ii. <u>大型 E-waste の回収に下取り回収を試行する。</u>

iii. 一般ごみを扱うカタドール組合による回収を強化し、回収された E-waste は適切なリサイクル業者に搬送する（今回のパイロットプロジェクトでは実施しなかった）。

iv. 慈善団体や修理サービスによる再利用ルートから排出される E-Waste を適切なリサイクル業者に搬送する（今回のパイロットプロジェクトでは実施しなかった）。



出所：JICA 専門家チーム

図 3-13　検討される E-waste のリバースロジスティックスシステム

5)　パイロットプロジェクト計画

前項及び【1-3】で記載した通り、パイロットプロジェクトのフレームワークを形成するためにプロジェクトチーム内及び関連する様々なステークホルダーとの協議を重ね、下記、パイロットプロジェクト計画に至った。

(1)　パイロットプロジェクトの目的

パイロットプロジェクトに期待される成果を踏まえ、その目的を以下の三点とした。

- E-waste 回収性能の検証:
  どの程度の量の E-waste が回収できるかを検証する。
- E-waste リサイクルシステムの不具合の抽出:
  関係者間の協力に基づく E-waste 回収システムが良好に機能するかを検証する。
- E-waste リサイクルコストの算出:
  E-waste をリサイクルするためにどの程度のコストを要するかを明らかとする。

(2)　パイロットプロジェクト実施概要

パイロットプロジェクトを検証するための十分な量のデータが得られる期間として、当初 6 か月のパイロットプロジェクト期間を設定したが、大型廃家電の回収量が当初の想定を大幅に下回ったため、2 ヶ月間の期間延長を決定した。また、パイロットプロジェクトの実行度合いを高めるためラパ区に立地する小売店に限定して行った。

- 実施時期:2016 年 4 月下旬～12 月 31 日(8 か月)
- 対象地区:サンパウロ市ラパ区

(3)　参加小売店

参加小売店舗は下表に示すとおりであり、店頭回収（Drop-off）で 10 店舗、下取り回収（Trade-in）で 8 店舗が参加した。

表 3-5　パイロットプロジェクト参加小売店舗

小売店舗名	店頭回収参加 小売店舗数	下取回収参加 小売店舗数
Casas Bahia	2	2
Ponto Frio	2	2
Extra Hiper	1	1
Extra	1	1
Pernambucanas	1	0
Lojas Americanas	1	0
Walmart	2	2
合計	10	8

出所：JICA 専門家チーム

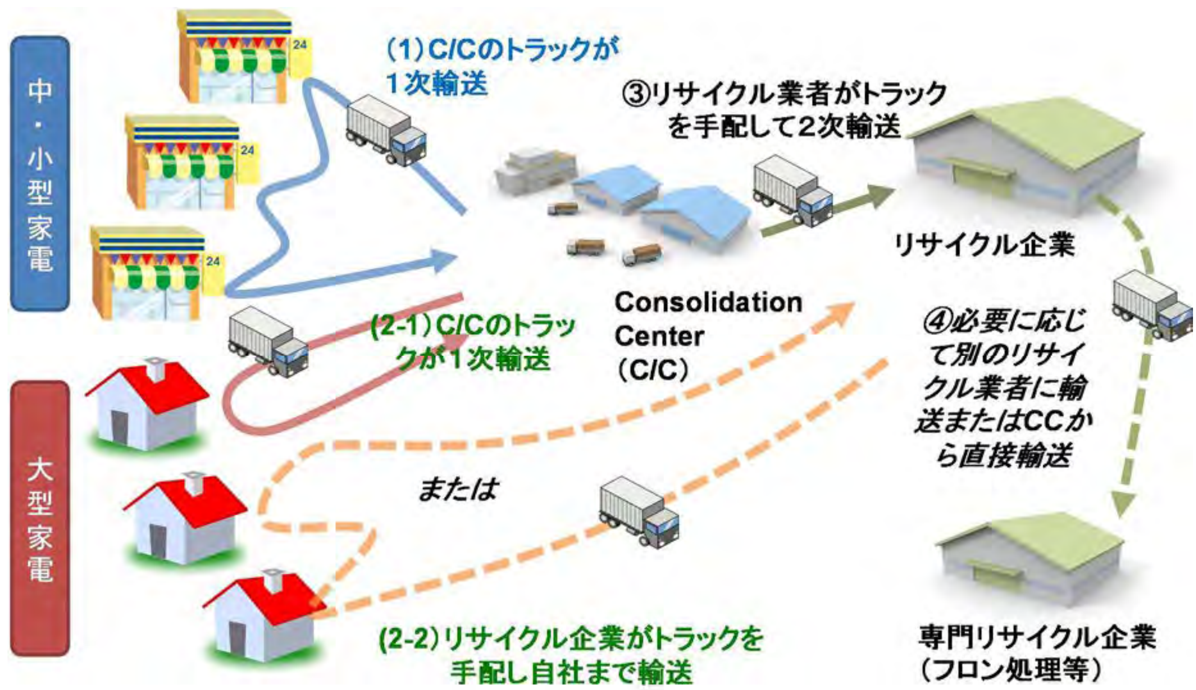
(4)　対象 E-Waste

【1-3】で既述の通り、PP ではすべての電気・電子廃棄物を対象とすることとし、E-Waste の特性を考慮して大型 E-Waste5 品目と中・小型 E-Waste に区分して回収することとした。

- 大型 E-Waste（5 品目）：冷蔵庫、洗濯機、エアコン、テレビ、オーブンレンジ
- 中・小型 E-Waste：パソコン、携帯電話を含むその他小型 E-Waste（白系、青系、緑系、茶系）
- 回収除外品：蓄電池・乾電池、蛍光管、プリンター用トナー

(5)　E-Waste 回収システム

下図に示す通り、大型 E-Waste は排出者の申し込みに応じて下取り回収を行い、中・小型 E-Waste は家電小売店に設置する回収ボックスで回収することとした。回収された E-Waste は一旦、一時保管施設（C/C）で保管、選別された後、あるいは直接、解体・リサイクル施設へ搬送され、適正に処理される。



出所：JICA 専門家チーム

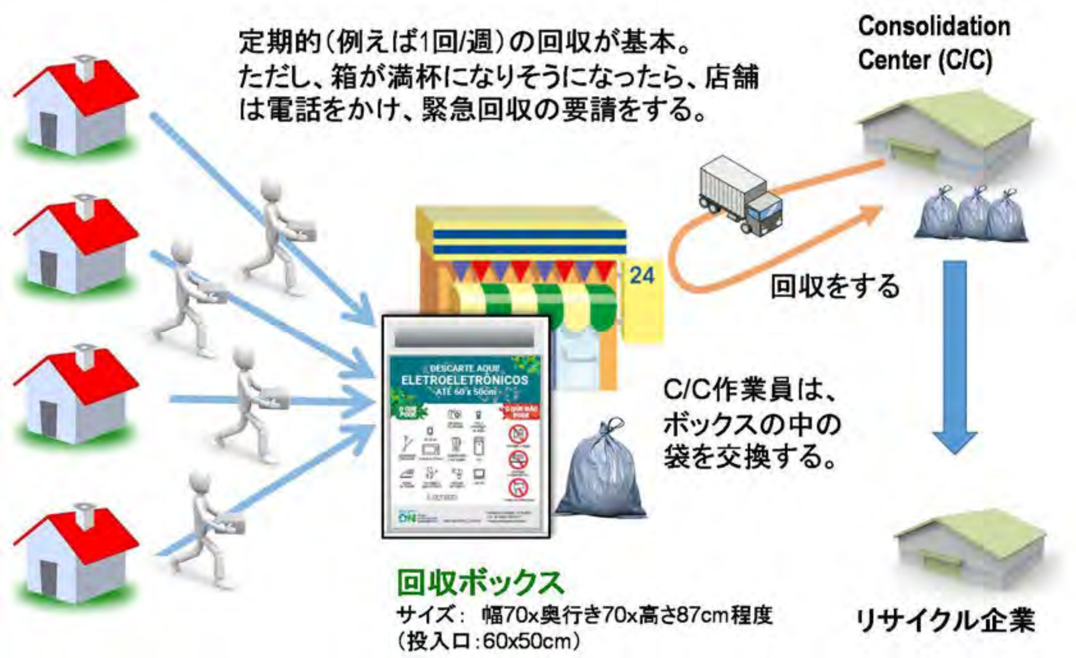
図 3-14　全体の E-waste 回収システム

＜中・小型 E-Waste 回収（Drop-off）＞

中・小型 E-Waste は、小売店に設置されたコンテナで回収する。誰もがいつでも中・小型 E-Waste を持ち込むことができる。その手順は以下のとおりである。

- 小売店は回収ボックスを設置する場所を用意するとともに回収を行っていることを宣伝する。
- 排出者は中・小型 E-Waste を小売店常設の回収ボックスに投入する。回収ボックスの中には回収袋を設置してあり、E-Waste は袋の中に蓄積される。
- Coopermiti は原則週 1 回小売店を巡回し、回収ボックスの中の回収袋を回収し、新しい回収袋を仕掛ける。
- 小売店は回収ボックスをモニターし、満杯になりそうになったら Coopermiti に電話をする（緊急回収）。Coopermiti は緊急回収の求めに応じて、速やかに中・小型 E-Waste を回収する。
- Coopermiti は自らの一時保管施設において回収袋の中身を空け、定められた種類に仕分けして計量し、二次輸送が容易となるようにパレットないしラックに載せて保管する。
- 中・小型 E-Waste を対象とした一時保管施設での仕分けは、ブラジル国での家電の分類方法（青系、緑系等）を踏まえて以下の通りとした。
  1. モニター（CRT）
  2. モニター（LCD）
  3. パソコン（デスクトップ）
  4. パソコン（ノートブック）
  5. その他白系
  6. その他茶系
  7. その他青系
  8. その他緑系
  9. その他(分類できない E-waste、乾電池など E-waste 以外)
- Coopermiti は解体・リサイクル施設と連絡を取り、適宜 E-waste を引き渡す。
- 解体・リサイクル施設は定められた方法により E-waste を適正にリサイクルする。

店頭回収のために必要となる 1 次輸送、一時保管施設での仕分け・保管、解体・リサイクル・処理経費はプロジェクトで負担した。



出所：JICA 専門家チーム

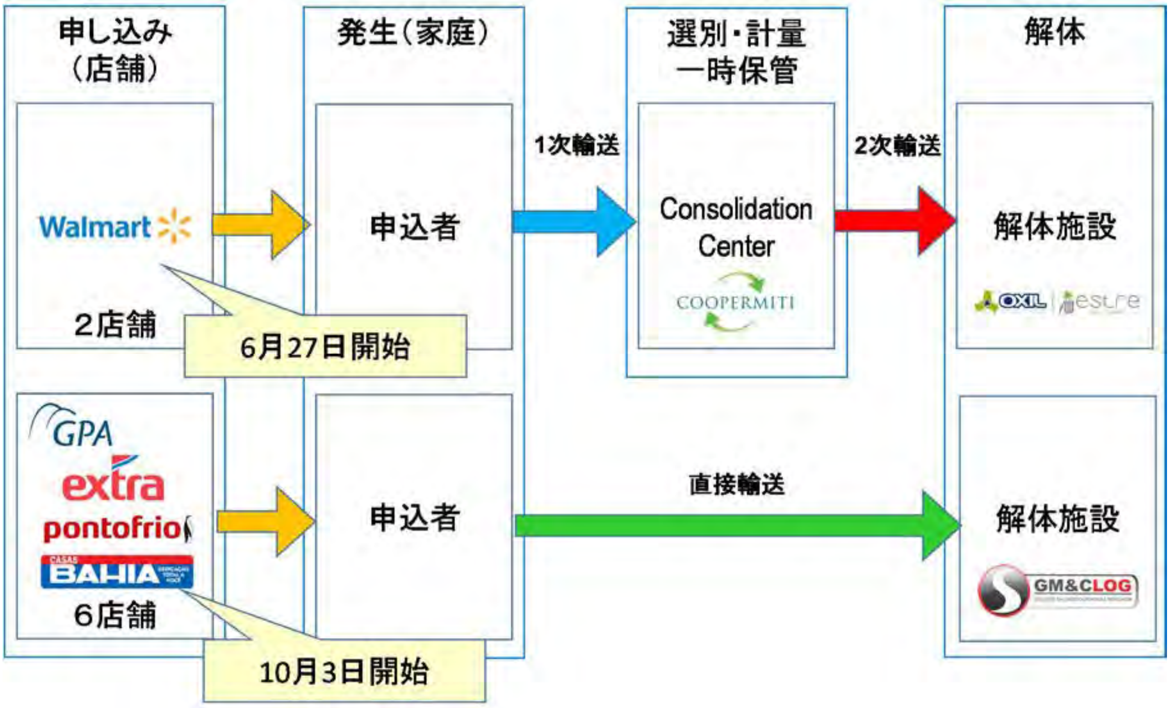
図 3-15　中・小型 E-waste 回収システム（Drop-off）の概要

＜大型 E-Waste 回収（Trade-in）＞

大型 E-Waste は家電製品店で家電製品を購入した顧客の求めに応じて顧客の家から回収する。購入製品納品時に引き取る方法も検討したが、廃棄物との混載等の課題があり、E-waste 回収専用車によって行った。なお、下取り回収（Trade-in）サービスは、ラパ区の PP に参加する小売店で購入したサンパウロ市居住者のみに対して提供される。下取り回収（Trade-in）のために必要となる 1 次輸送、仕分け・保管、解体・選別経費はプロジェクトで負担した。

大型 E-waste 回収は参加店舗によって以下の図に示すように 2 種類の回収方法を試行した。1 つは Walmart の 2 店舗を対象として、コンソリデーションセンター（C/C）を運営する Coopermiti によって回収され、C/C で一時保管してからリサイクル企業へ搬送する方法で、2 つ目は GPA の 6 店舗を対象として、リサイクル企業によって回収され、E-waste を直接リサイクル企業へ搬送する方法である。

それぞれの回収は、小売店との協議・調整に時間が掛かったことから、開始時期に違いが出ている。

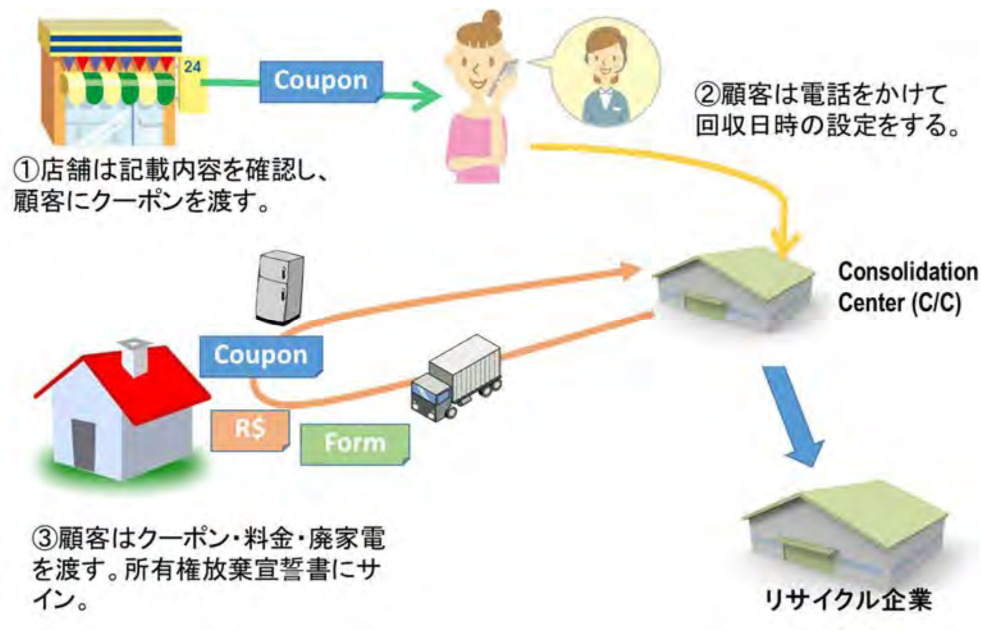


出所：JICA 専門家チーム

図 3-16　大型 E-waste 回収（Trade-in）システムの概要

Walmart の 2 店舗を対象として実施されている大型 E-waste 回収の基本は以下のとおりである。

- 小売店は大型 E-Waste5 品目（冷蔵庫、洗濯機、エアコン、テレビ、オーブンレンジ）を販売した場合に、販売した品目と同じ種類の E-waste の引き取りを勧める。希望する顧客にはクーポンを渡す。
- 排出者はクーポンに記載されている情報をもとに回収担当企業と連絡を取り、回収日・時間を調整する。
- 回収に当たって排出者は E-waste1 台当たり 10R$を回収者に渡す。
- 回収された大型 E-Waste は一時的に保管されたのち、解体され、適切にリサイクル、残さは適切に処理される。
- 解体・選別事業者はリサイクルした E-waste の量に応じてプロジェクトチームに輸送・解体・処理費用を請求する。



出所：JICA 専門家チーム

図 3-17　下取り回収（Trade-in）システムの概要（Walmart 方式）

No.

CUPOM para **Coleta na sua Casa**

Para solicitar a coleta ou em caso de dúvidas, entre em contato com:

Coopermiti: (11) 3666-0849
Atendimento: de seg. a sex. das 9:00 às 17:00, exceto feriados

☐ Refrigerador ☐ Ar Condicionado ☐ Fogão ☐ Televisor ☐ Lavadora

Carimbo da Loja

Atenção!

- Será considerado inválido o cupom para coleta com erro de preenchimento e/ou que não tenha o carimbo da Loja.
- Não será possível a reemissão em caso de perda ou roubo.
- O prazo de validade deste cupom é de **30 dias corridos** da data da compra do eletroeletrônico correspondente. Sugerimos que faça seu pedido de coleta o mais breve possível.
- Para a utilização deste cupom haverá cobrança de **R$ 10,00**. Em nenhuma hipótese haverá devolução deste valor.
- O cupom para coleta pode ser utilizado apenas por **pessoa física**, residente no **município de São Paulo**, comprador do tipo de eletroeletrônico de grande porte (alvo do projeto) em uma das lojas participantes do projeto e que deseje descartar o eletroeletrônico usado do mesmo tipo e quantidade adquirido. O cupom é **intransferível** e não contempla o uso por pessoa jurídica.
- A coleta deverá ser na sua residência.

O eletroeletrônico que você irá descartar será transportado, desmontado e processado adequadamente sob responsabilidade do projeto descarte ON.

Procedimentos de coleta

1. AGENDAMENTO DA COLETA COOPERMITI: (11) 3666-0849

Entre em contato com a **Coopermiti**, organização credenciada pelo projeto, para agendar a data da coleta (horário para agendamento, de segunda a sexta das 9h às 17h, exceto feriados). A alteração da data agendada será possível, contatando a **Coopermiti** até às 16h do dia anterior ao da coleta.

2. ACOMPANHAMENTO DA COLETA

É necessária a presença de um responsável no local, na data e hora agendada para acompanhar a coleta (não precisa ser obrigatoriamente o comprador), com os itens citados abaixo em mãos.

a. O cupom para coleta com carimbo da Loja.
b. Nota Fiscal ou Cupom Fiscal.
c. **Valor de R$ 10,00 em dinheiro**. Não serão aceitos cartões de débito ou de crédito e cheques.

3. VALIDAÇÃO DO CUPOM

Durante a coleta, o colaborador da **Coopermiti** vai conferir a documentação (especificada no item 2) e os itens abaixo relacionados. **Em caso de inconsistência em algum item, a coleta não será realizada**. Recomendamos que estes itens sejam verificados com antecedência. Se a coleta não puder ser realizada, o cupom será invalidado.

☐ O produto/quantidade a ser descartado deve ser igual ao que consta na Nota Fiscal ou Cupom Fiscal do novo eletroeletrônico. Exemplo: comprou uma geladeira poderá descartar uma geladeira, independente do modelo.
☐ O eletroeletrônico a ser descartado, deve estar pronto para ser carregado imediatamente e em local para fácil carregamento (Ex. deixar próximo ao portão de entrada e saída, geladeira vazia, ar condicionado desinstalado, etc.).

4. PAGAMENTO DE R$ 10,00

5. DOCUMENTO CONTROLE DE COLETA E CARREGAMENTO

Será solicitada verificação e assinatura pelo cliente no documento denominado **Controle de Coleta**, onde constará a descrição da coleta. Após assinatura deste documento, uma das vias será entregue ao usuário do cupom para coleta. Em seguida, será realizado o carregamento.

6. NOTA FISCAL DE SERVIÇO

A Nota Fiscal de Serviço para esta retirada será enviada de forma eletrônica posteriormente.

Esclarecimentos

- Este cupom para coleta faz parte das atividades do projeto **descarte ON** e será utilizado para coleta de eletroeletrônico de Grande Porte (televisor, refrigerador/freezer, lavadora/secadora de roupas, aparelho de ar condicionado e fogão) para ser dada destinação adequada.
- O valor de R$ 10,00 irá cobrir parte do custo de transporte para coleta na sua residência do eletroeletrônico usado. Quanto aos demais custos de transporte, armazenamento, desmontagem, processamento e destinação adequada, serão cobertos pela JICA (Japan International Cooperation Agency).

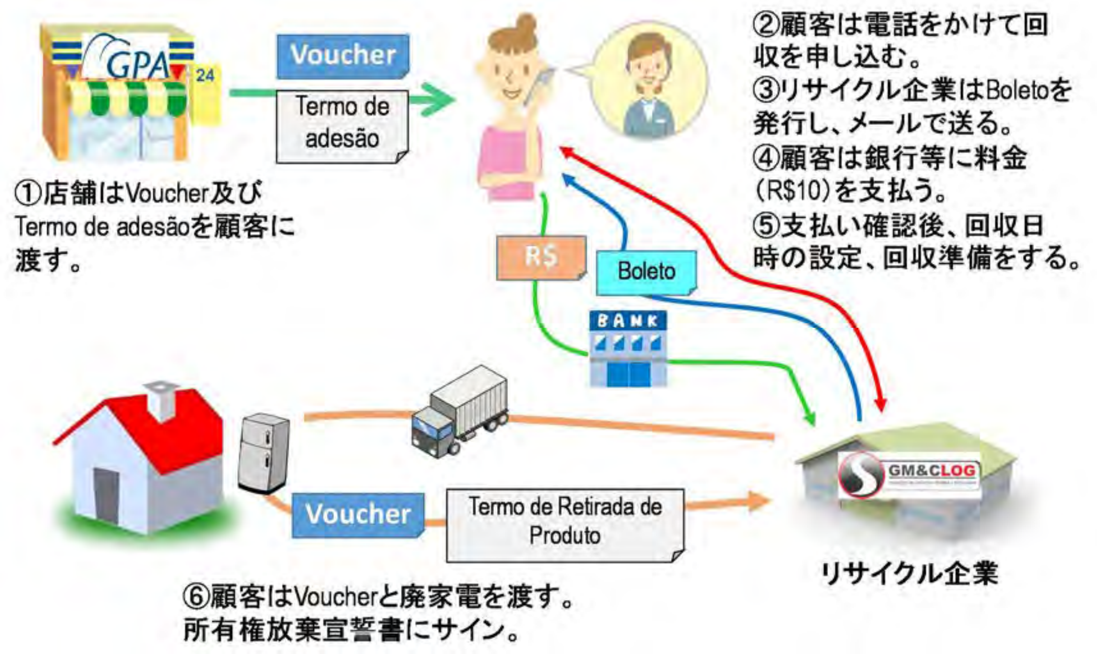
descarte ON
www.descarteon.jica.eco.br

出所：JICA 専門家チーム

図 3-18　E-waste 回収申し込み用クーポン（Walmart で用いられたもの）

GPA の 6 店舗を対象として実施されている大型 E-Waste 回収の基本は以下のとおりである。

- 小売店は大型 E-Waste5 品目（冷蔵庫、洗濯機、エアコン、テレビ、オーブンレンジ）を販売した消費者に、販売した品目と同じ種類の E-waste の引き取りを勧める。希望する消費者にはバウチャーと" Termo de adesão"（参加同意書）を渡す。
- 排出者はバウチャーに記載されている情報をもとに回収担当企業と連絡を取り、回収を申し込む。
- 回収担当企業は Boleto（支払チケット）を発行し、申込者にメールで送る。
- 申請者は銀行等で料金（10R$）を支払う。
- 回収担当企業は、10R$の振込みが行われたことを確認した後、回収日時の設定、準備を行う。
- 回収された大型 E-Waste は保管されたのち、解体され、適切にリサイクル、残さは適切に処理される。
- 解体・選別事業者はリサイクルした E-waste の量に応じて ABREE 経由でプロジェクトチームに輸送・解体・処理費用を請求する。



出所：JICA 専門家チーム

図 3-19　下取り回収（Trade-in）システムの概要（GPA 方式）

出所：GPA

図 3-20　E-waste 回収申し込み用バウチャー（GPA で用いられたもの）

6)　パイロットプロジェクト計画の論点と検討経緯

（1）　新品と回収品の混載について

Walmart や GPA(Via varejo)、FASTshop からの聞き取りでは、不良品や返品・交換の下取り回収（Trade-in）を行っており、新品配送時のトラックで各戸から回収している。すべて各社の配送システムで管理している。Walmart や FastShop ではこれを文字通り「リバースロジスティクス」呼んでいる。Walmart からの聞き取りでは、このシステムに載せて E-waste としての家電の引取りを新品配送時に行うことは可能である、との回答であった。ただし、システム変更にあたっては時間とコストがかかること、パイロットプロジェクト期間が短いことから行わなかった。

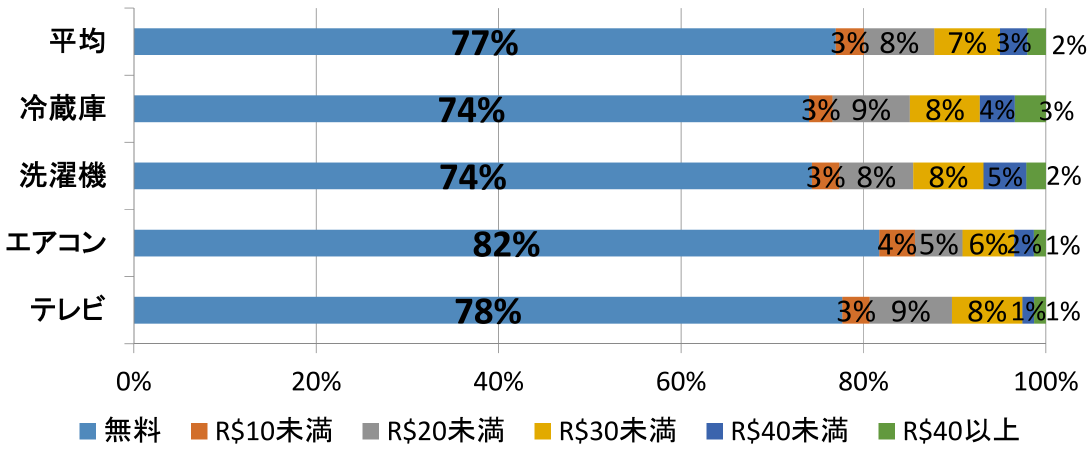
回収された返品商品は、各社とも配送センターに集約され、メーカー各社から派遣されたエンジニアによる修理の可否の判断、修理可能なものは修理、メーカー工場へ返送、修理不可能なものは E-waste としてメーカー責任で E-waste 処理がおこなわれる。本パイロットプロジェクトでは配送センター内に場所を設け CC とし、リサイクル業者が引き取りに来る、という方法も検討していた。しかし、配送センターは出入口のセキュリティー・チェックが非常に厳しく、パイロットプロジェクト期間のみの限定使用は困難であると判断された。

（2）　回収料金の徴収について

回収料金の徴収については、TC メンバーの間でも意見が分かれ、産業界側は一部の費用を消費者に負担してもらうことを主張する一方、回収率の向上や消費者への負担を懸念する行政側は無償での引き取りを提言するなど、意見を交換してきた。そして第 7 回の TC で大型 E-Waste 一台

あたりの回収料金として 10R$（≒300 円）を消費者から徴収することが決定された。10R$の根拠については、以下のようなことが協議された。

- プロジェクトが行ったサンパウロ市民に対するアンケートでは、不要になった家電は約半数が譲渡など再使用にまわすという調査結果であった。残りはカタドールや不適正なリサイクルルートにまわっていることになる。さらに、同調査結果によれば、約 8 割の住民が大型 E-Waste の無償引取を希望している。
- 回収料金を徴収する場合、回収率は最大でも（その他の要因による不参加率が 0%と仮定して） R$ 30~39 で 5%、R$ 20~29 で 12%、R$10~19 で 20%となる。認知度、利便性等を考慮すると、実際の回収率はさらに低いと想定される。
- 第 1 年次の現況調査結果によれば、無料回収を希望する住民が多く、少しでも排出時に料金を徴収する場合、回収率の大幅な低下が予測される。そのため、大型 E-Waste を含めた 17%の回収率目標を将来達成するためには、排出時の料金を無料とする回収システムを整備することが推奨される。
- しかし、将来のリバースロジスティクスにおいて回収料金徴収の可能性が否定できないことから、PP においては R$ 5〜10 程度の象徴的な金額を徴収し、「今回は P/P で JICA の支援により安価な料金となっている」ことを広報として明示することとした。
- また、PNRS の Shared Responsibility（責任分担）の考え方の中で消費者の責任を示した第 33 条第 4 項の解釈の下、消費者にもリバースロジスティクスへの協力責任があることを周知するためにシンボリックに 10R$を徴収することとした。この 10R$は「料金」ではなく、E-waste の回収コストのうち、一次回収（消費者から一時保管施設等までの返却）コストの一部を負担するものである旨をクーポンに明記した。



出所：JICA 専門家チーム

図 3-21　E-Waste の引取回収サービスに対して 1 台当たりの支払意思額（第 1 年次調査結果）

(3)　回収料金の徴収時期（新品購入時、E-Waste 回収時）

家電購入時に、クーポンをサービスの一環として販売することも検討された。通常、家電購入時には顧客は設置やメンテナンス、保険などの追加サービスの購入を勧められるので、これらの一つとして回収サービスを販売することが検討された。

しかし、Walmart や GPA においても、PP 期間という短期間のみのクーポン販売および物流のシステム変更が非常に困難であることがわかった。クーポンを販売してかつ小売店が回収サービスのコールセンターの機能を果たすことも困難であった。さらに、小売店がクーポンを販売すれば小売店が税金を支払うことになるため、小売店は回収サービス提供者に税引き後の金額を支払わなければならないことや、10R$では一次回収費用はまかなえないためプロジェクトが回収サービス提供者に残りの金額を負担することに対してのブラジルの複雑な税制度、金銭の授受を伴う契約関係について法的な問題を整理するのに時間がかかるため、この方法は実施しなかった。

なお、下取りサービスの店舗での販売は、Descarte Certo（リサイクル会社）が Carrefour で 2011 年から行っている。顧客が要望した場合、電気電子製品のオンコール回収サービスを行っている。新品を買った時のみ、そのサービスを買うことができる。その排出クーポンだけを買うことだけはすすめていない。全ての電気電子機器が対象である。DescartoCerto のサービスを、Carrefour が代理で売っているという形である。2014 年ごろまではカードを店頭で販売していたが、2015 年に JET が訪問調査した際は、顧客が店員に申し出ることで、回収品目別の料金を調べてくれるようになっていた。取扱量は多くないとのことであった[5]。

(4)　E-commerce(オンラインショッピング)参入の協議

Walmart および GPA とは、大型 E-waste 回収を E-commerce(オンラインショッピング)からの対象家電購入者もパイロットプロジェクトへの参加が可能かどうかを協議した。

Walmart はウェブサイトのなかで、さまざまなサービスを販売している。ウェブサイト自体がショッピングモールのような形になっており、サービス提供会社はウェブサイト上に店舗を構えている。そのサービス提供会社のひとつに、Ecoasist 社があり大型家電を含む回収サービスを提供している[6]。同社の大型家電回収サービス料は一台あたり R$149.9 である。Coleta na sua Casa をこのショッピングモール内で実現できないか検討・協議した。技術的には回収エリアの特定等可能であり問題はないが、法人格を持たないプロジェクトチームおよびパイロットプロジェクトの実施体制のなかで、オンラインショップを開くことができるのかという手続き上の問題、およびコストの問題から断念した。GPA も技術的な問題はないが、システムの変更にかかるコストの問題から断念した。

【2-3】パイロットプロジェクトにおける RL システムの運営プロセスを検討し、一連のシステムを試行的に実施する。

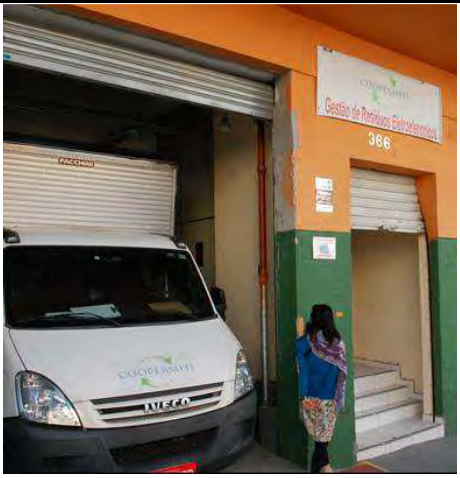
1)　パイロットプロジェクトの実施状況

パイロットプロジェクトのうち店頭回収（Drop-off）は予定通り 2016 年 4 月 26 日から順次 10 店舗において開始された。他方、下取り回収（Trade-in）は 2016 年 7 月に開始され、7 月下旬に最初の回収が行われた。申し込み店舗へのてこ入れ、GPA 傘下店舗での実施を通じて回収実績を上げる努力を行ったが、ブラジルの経済状況の低迷（GPA の家電販売は昨年比 50%減など）から、家電の販売台数自体が非常に低くなっていると想定され、下取り回収の申し込みも推計よりも低くなった。以下、店頭回収、下取り回収の様子を記す。

[5] 2015 年 7 月 24 日 JET 訪問調査より

[6] https://www.walmart.com.br/marca/ecoassist/118855?utmi_p=wm-desktop/servicos&utmi_cp=wm-servicos-marcas&utmi_pc=x52-cm-ecoassist

表 3-6　店頭回収（Drop-off）の流れ（一次輸送）

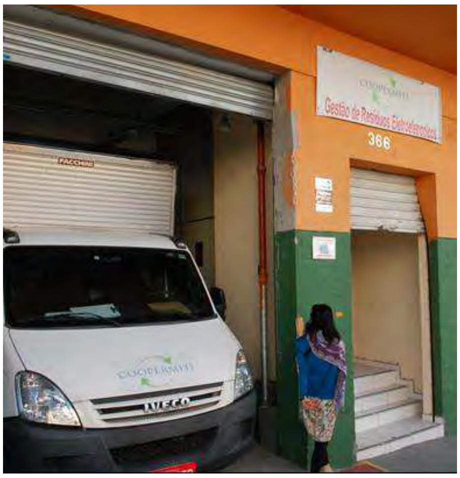
作業段階	写真
(1) Coopermiti を出発 (持ち物：1. 回収ボックスの鍵、2. ID 番号を付したプラスチック製タグ、3. プロジェクト向けモニタリングシート、4. プロトコル番号を掲載したコーペルミティ用伝票、5. 空の回収袋、6. 搬送車)	
(2) 1 番目の小売店へ移動	
(3) 1 番目の店舗の前で回収準備（到着時間、走行距離を記録）	
(4) 鍵を使って回収ボックスを開ける。	

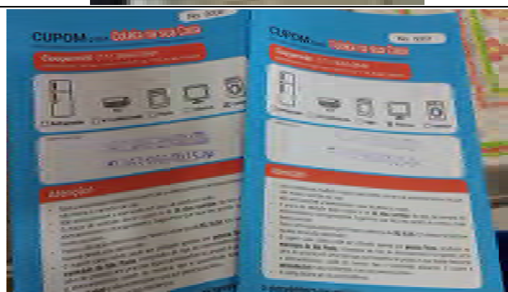
作業段階	写真
(5) 中身をチェック	
(6) 中身を記録	
(7) 回収袋を ID 番号の付されたタグで縛る。	

作業段階	写真
(8) 必要データの記録	
(9) 店舗と回収者の双方で回収完了確認	
(10) 空の袋を仕掛ける	

<table>
<tr><th>作業段階</th><th>写真</th></tr>
<tr><td>(11) E-waste を回収袋ごと回収する。</td><td>
</td></tr>
<tr><td>(12) 回収袋ごと積載する。</td><td></td></tr>
<tr><td>(13) 次の回収対象店舗へ移動する。</td><td></td></tr>
</table>

表 3-7　下取り回収（Trade-in）の流れ（一次輸送）

作業段階	写真
(1) Coopermiti を出発 (持ち物： 1. プロジェクト向けモニタリングシート、 2. プロトコル番号を掲載したコーペルミティ用伝票 3. 搬送車)	
(2) その日に予定している家庭へ移動	
(3) 回収対象家庭の前で回収準備 (到着時間と走行距離を記録)	
(4) 回収対象世帯を訪問	

作業段階	写真
(5) 中へ入る	
(6) E-waste を確認	
(7) クーポン記載事項と回収対象 E-waste の一致を確認	
(8) 必要項目を記録し両者で引き渡し確認書に署名（コピー1部を家庭に渡す）	

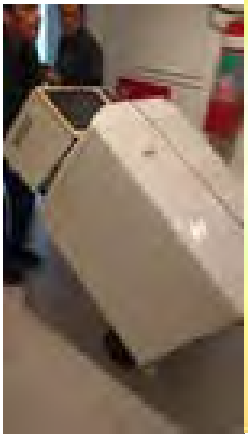
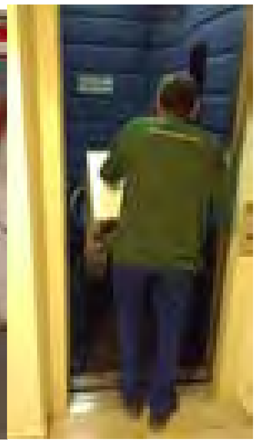
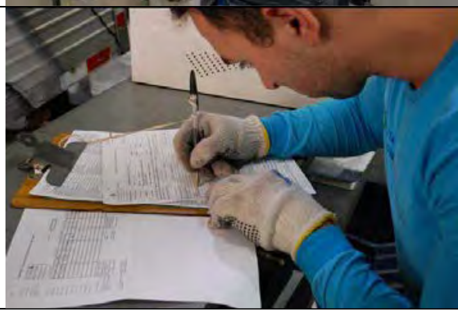
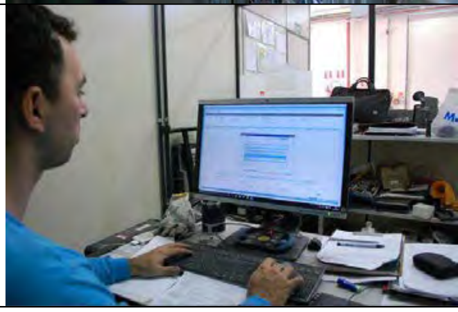
作業段階	写真
(9) E-waste を持ち出し	 
(10) E-waste を積み込み	
(11) 一保管場所へ輸送 (GPA 店舗向けの Abree システムでは解体工場へ直送)	

表 3-8　一時保管施設での仕分け

作業段階	写真
(1) 回収袋を積み下ろす。	
(2) タグ番号を確認し、回収伝票と突き合わせどの店舗から回収された E-waste かを特定する。	
(3) 袋を開ける。	
(4) 回収袋から E-waste を取り出し、計量する。	
(5) 重量他必要な情報を記録する。	

作業段階	写真
(6) 仕分け項目に従って E-waste を保管する。	
(7) 記録したデータを入力する。	

2) パイロットプロジェクトの課題

計画したパイロットプロジェクトの実施を通じて得られた課題を以下に整理する。

(1) 小売店販売員の協力

パイロットプロジェクトは小売店本部との議論を通じて計画・準備を行ったが、小売店への徹底には課題が残った。例えば、宣伝用リーフレット等が配布されていなかった。販売員は製品保証など顧客に多くのことを説明しなければならず、E-waste 回収についての説明まで手が回らない、Coopermiti が回収に行っても担当者がいない等である。店舗販売員の行動原理を変えることは容易ではないことを念頭に置くべきである。また、店舗販売員は多様なシフトの中で働いているのでなおさら困難となる。

(2) 対象物以外の廃棄物の混入

店頭回収では乾電池、プリンターインクカートリッジなど対象品目以外のものがしばしば見られた。これらは回収対象ではなない旨顧客に徹底するとともに、店頭回収ボックスの横にこれらの品目を回収するための回収ボックスを設置するなどの措置が考えられる。

(3) 店頭回収ボックスの耐久性

店頭回収ボックスには盗難防止のために蓋を付けた。しかしながら、蓋の構造的欠陥により、この蓋がしばしば故障し、故障したボックスを交換するという手間が発生した。回収ボックスの十分な耐久性を確保する必要がある。

(4) データ整合性

データは概ね良好に管理されたが、しばしば整合性を欠くことがあった。データ入力ミスによる回収データの ID と仕分け後時の ID が一致しないなどである。

本格実施時にはかかるデータの不整合を検出する機能がコンピュータシステムに求められる。

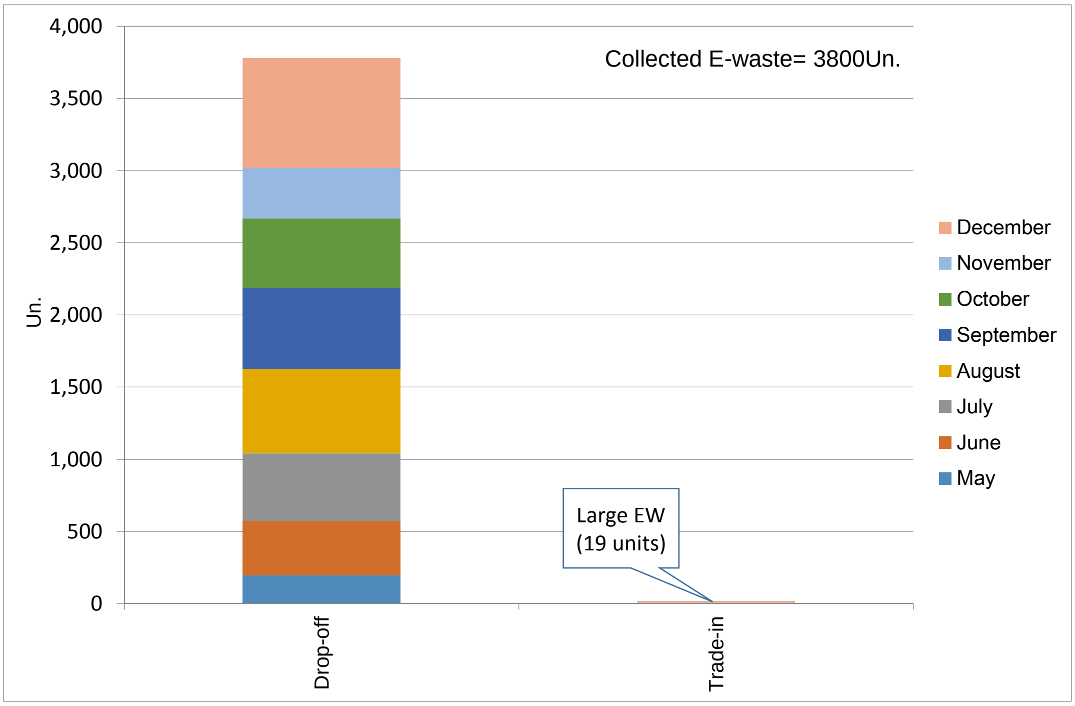
（5）　仕分け施設におけるマテリアルバランス

仕分けは Coopermiti によって行われた。仕分け施設では回収袋ごとの重量を計量し、仕分け後 E-waste ごとの重量が計量された。両者の重量は一致するべきであるが、計量誤差等によって必ずしも一致しない。仕分けを行う場合のマテリアルバランスをどのように確認するかは、本格実施時に考慮すべき課題である。

3) E-waste 回収実績

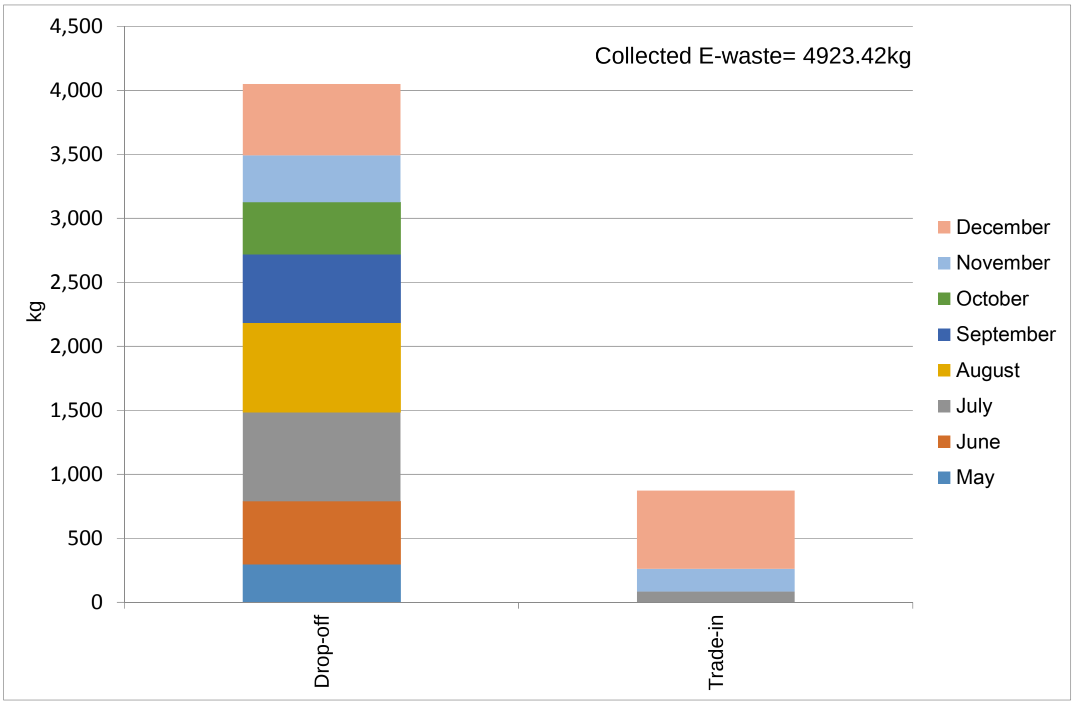
（1）　回収方法別回収実績

店頭開始以来 3,781 個、4,050.02 kg の E-waste が 2016 年 12 月末までの約 8 か月間に回収された。下取り回収（Trade-in）では 19 台、873.4 kg の E-waste が 2016 年 12 月末までに回収された。



出所：JICA 専門家チーム

図 3-22　E-waste 回収実績【回収方法別、台数】

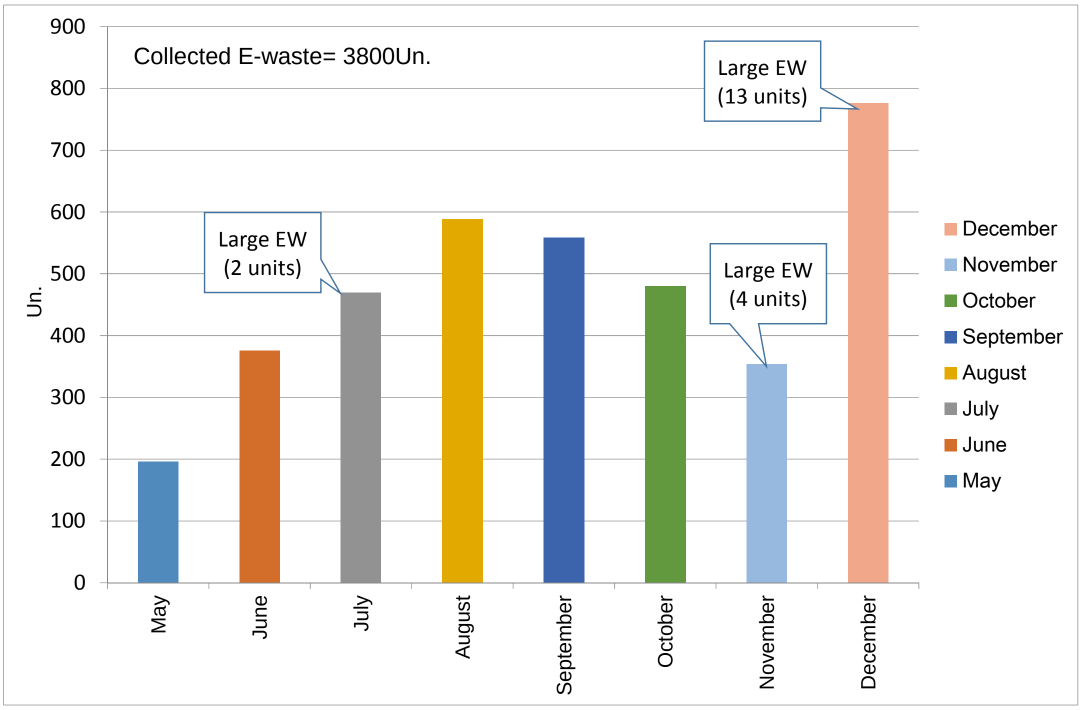


出所：JICA 専門家チーム

図 3-23　E-waste 回収実績【回収方法別、kg】

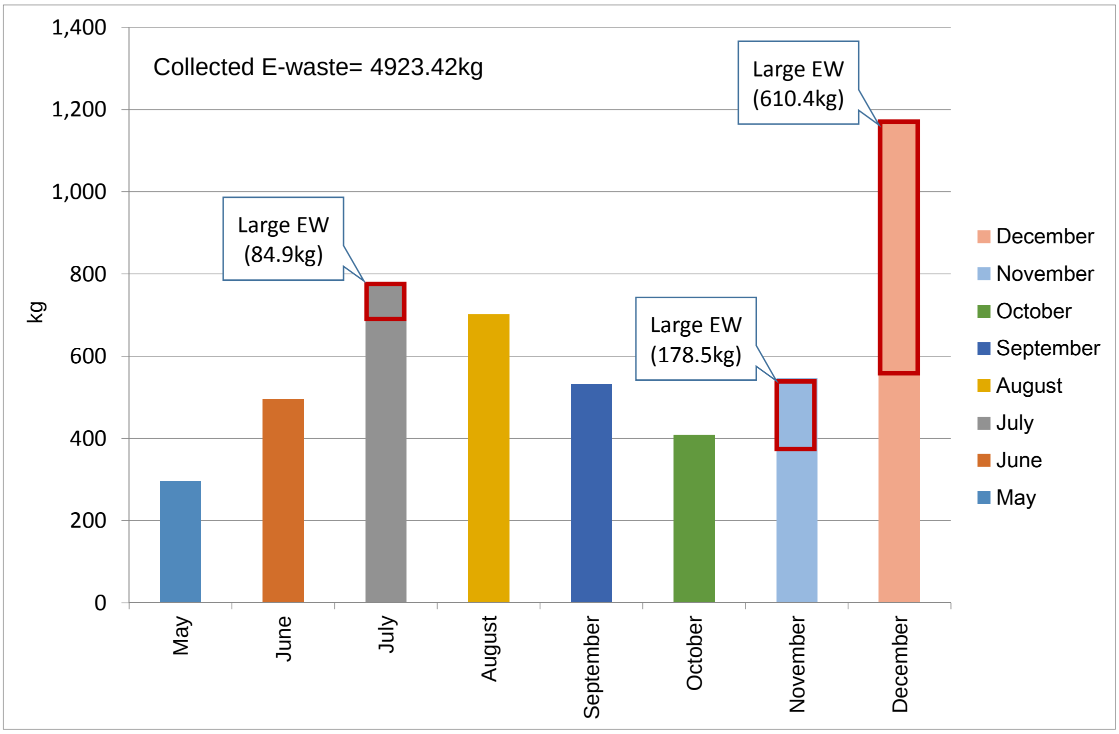
(2)　月別回収実績

回収 E-waste 台数は 2016 年 8 月まで増加し、11 月まで減少し、12 月には再び増加し、最大数となった。回収 E-waste 重量も同様に変動した。



出所：JICA 専門家チーム

図 3-24　E-waste 回収実績【月別、台数】



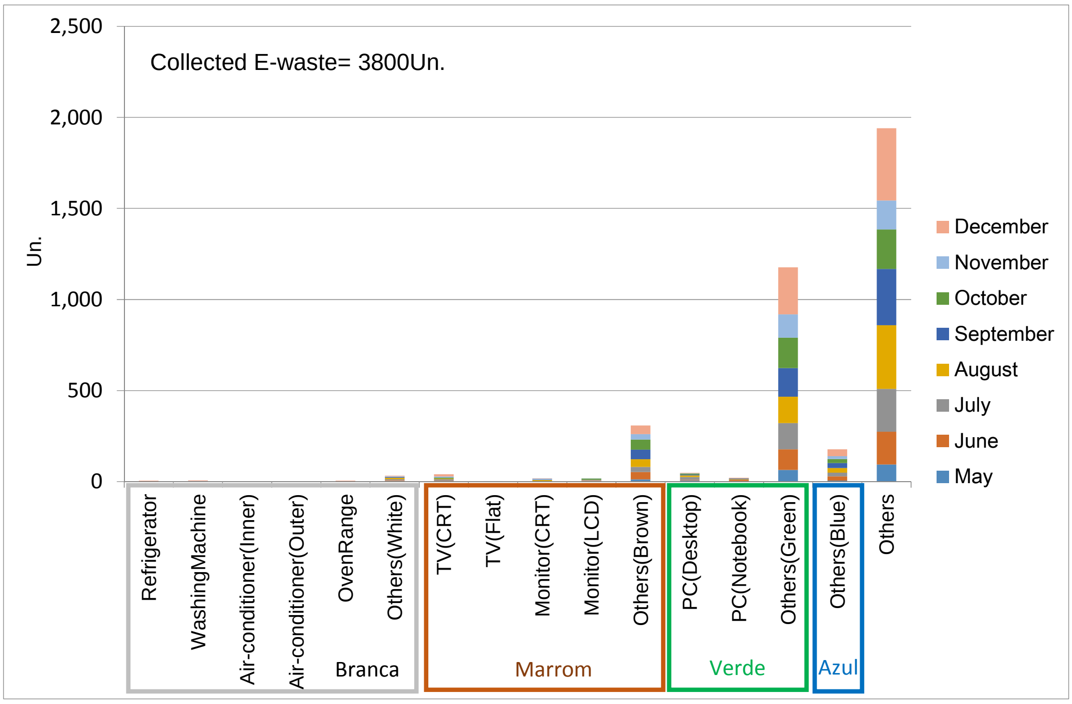
出所：JICA 専門家チーム

図 3-25　E-waste 回収実績【月別、kg】

(3)　E-waste 種類別回収実績

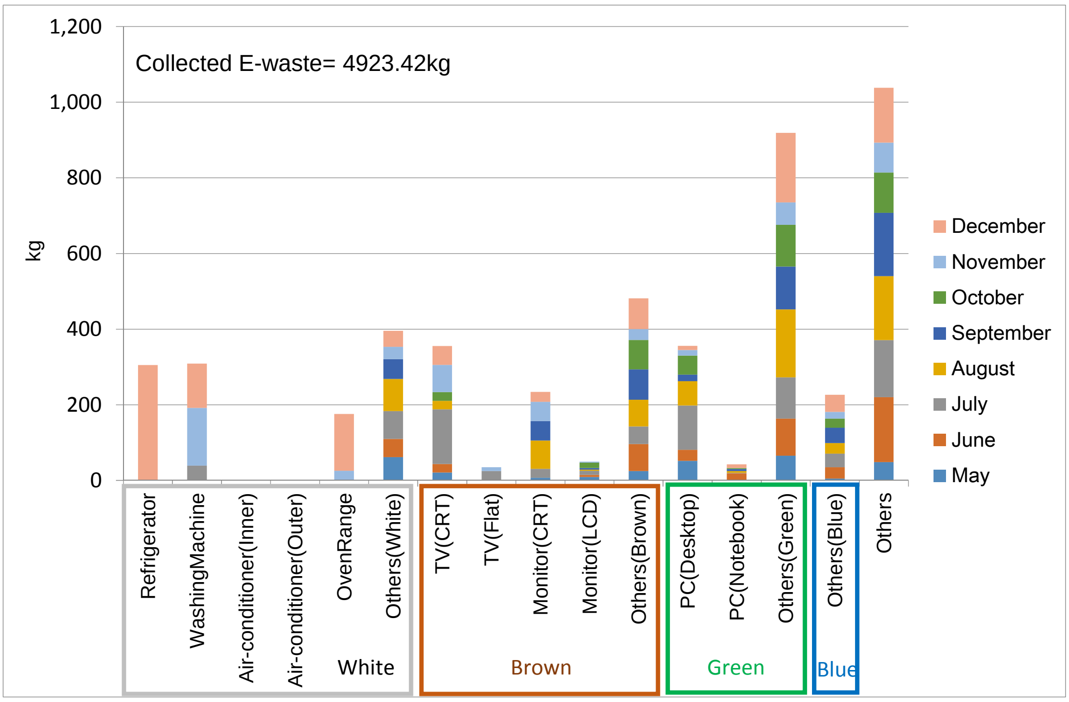
E-waste 種類別の回収実績の要点は以下の通りである。

- 「その他」の E-waste が個数、重量ともに最も多い。
- 「TV(CRT)」「パソコン（デスクトップ）」「その他（白）」「その他（茶）」は個数では多くを占めないものの、重量では無視できない。
- 店頭回収では大型家電は回収されなかった。



出所：JICA 専門家チーム

図 3-26　E-waste 回収実績【E-waste 種類別、台数】



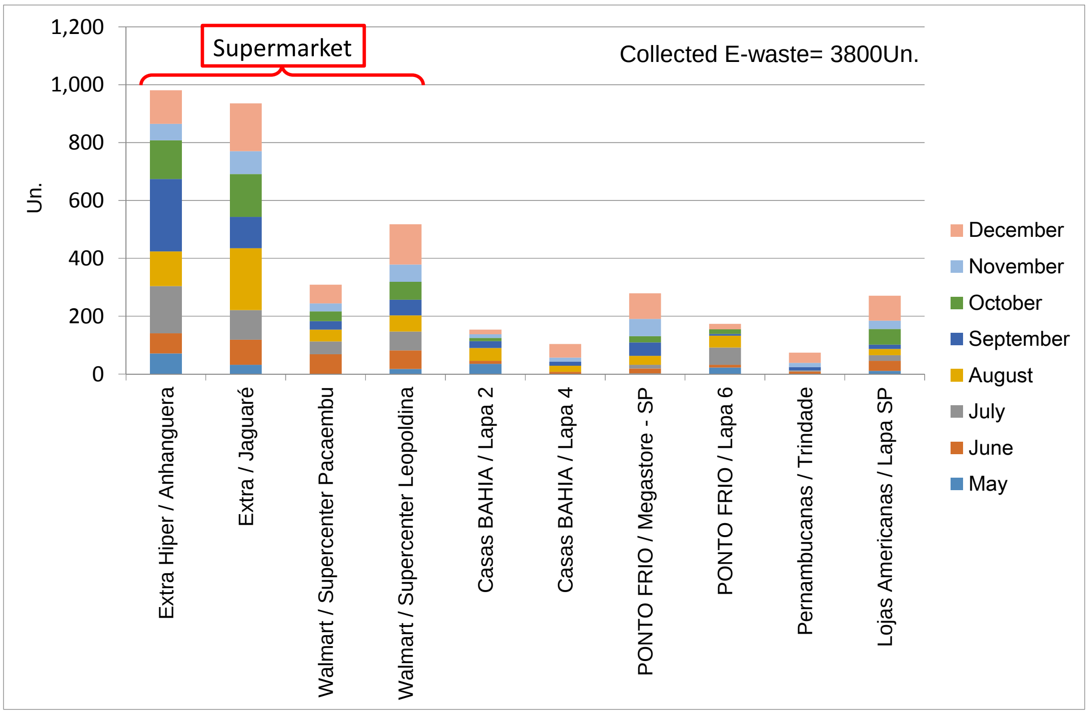
出所：JICA 専門家チーム

図 3-27　E-waste 回収実績【E-waste 種類別、kg】

(4)　回収店舗別回収実績

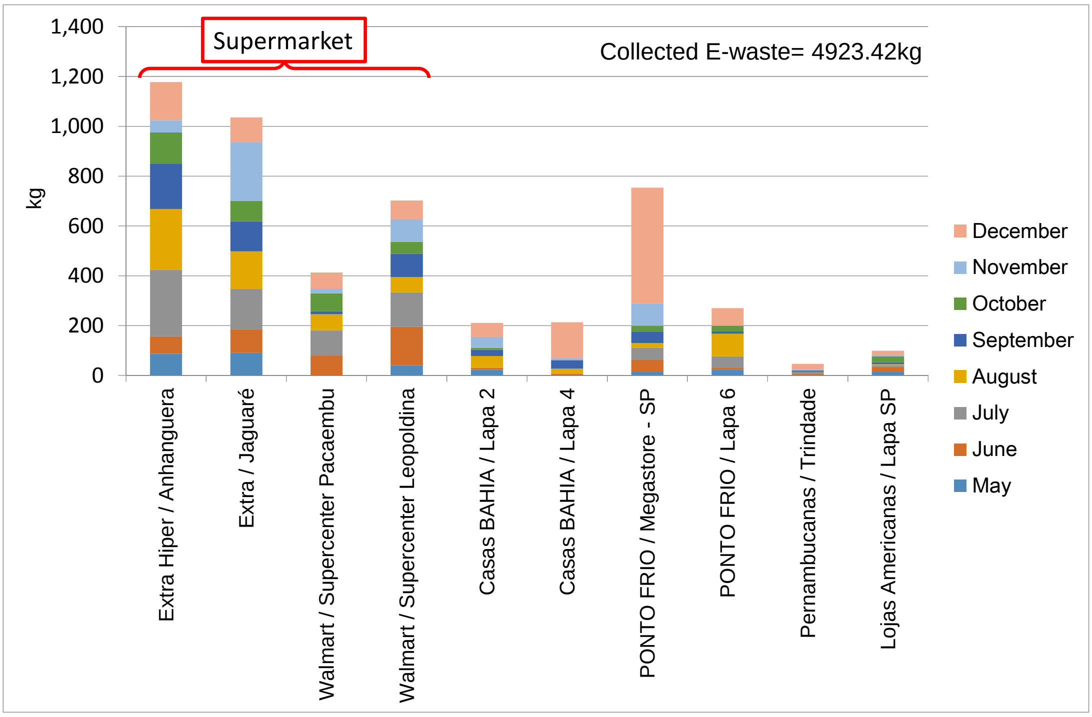
“Extra (Jaguare)”、“Extra Hiper (Anhanguera)”、“Walmart (Leopoldina)”では多くの E-waste を回収できた。これらの店舗は食材を含む日用品を取り扱う大型スーパーマーケットである。これらの店舗で多くの E-waste を回収できた理由は以下の通りである。

- 顧客は繰り返しこれらの店舗を訪問していると考えられ、E-waste を持参する機会が何度もあり、店舗来訪時に回収ボックスを見かけた。
- これらの店舗には大型駐車場が整備されており、E-waste を持参する利便性が高かった。



出所：JICA 専門家チーム

図 3-28　E-waste 回収実績【店舗別、台数】



出所：JICA 専門家チーム

図 3-29　E-waste 回収実績【店舗別、kg】

4) パイロットプロジェクトの E-waste 回収率推定

回収実績を評価するために E-waste 回収率を計算した。回収率の算出に当たり、パイロットプロジェクトがラパ区において行われたこと、実施は 1 年未満であったことを踏まえ、

- ラパ区からの廃棄量
- ラパ区住民からの参加率
- パイロットプロジェクト実施期間

を考慮した。

パイロットプロジェクトで回収された E-waste の回収率は下表に示すとおりである。店頭回収（Drop-off）で最大で 2 から 3%と低く、下取り回収（Trade-in）ではいずれも 1%未満とさらに低い回収率であった。

表 3-9 パイロットプロジェクトの E-waste 回収率推定値

E-waste の種類	店頭回収（%）	下取り回収（%）
TV(CRT)	0.0	0.12
TV(Flat)	0.0	0.00
Refrigerator	0.0	0.28
Washing Machine	0.0	0.42
AC(Inner)	0.0	0.00
AC(Outer)	0.0	0.00
Oven Range	0.0	0.16
Monitor(CRT)	0.6	-
Monitor(LCD)	0.1	-
PC(Desktop)	0.2	-
PC(Notebook)	0.1	-
Others(White)	2.7	-
Others(Brown)	3.3	-
Others(Blue)	1.6	-
Others(Green)	1.6	-
Others	1.3	-

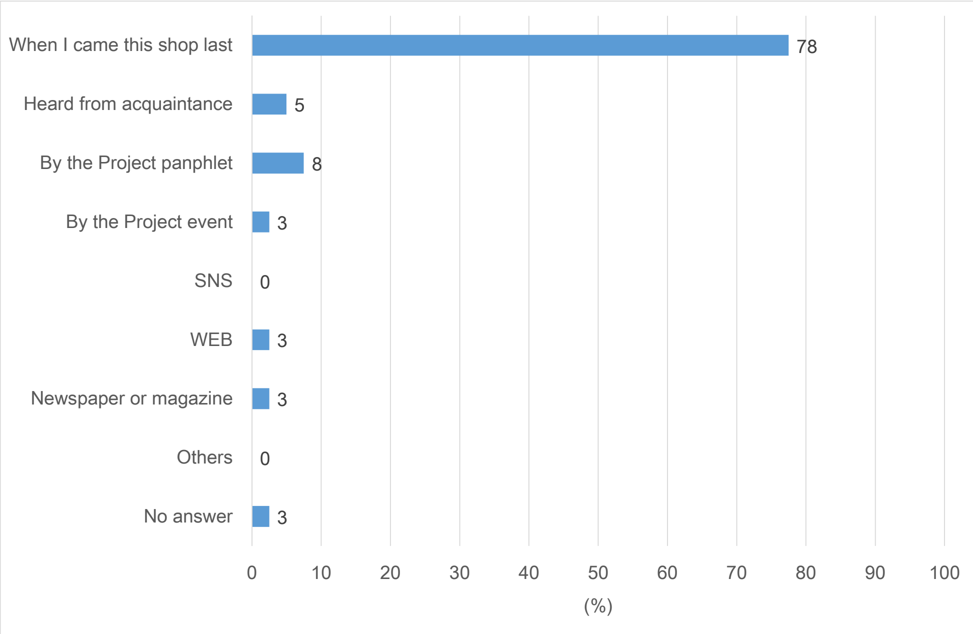
出所：JICA 専門家チーム

5) パイロットプロジェクト実施店における顧客対象アンケート

パイロットプロジェクト実施期間中に店頭回収（Drop-off）、下取り回収（Trade-in）に関するアンケートを実施店への顧客に対して実施した

(1) 店頭回収に関するアンケート

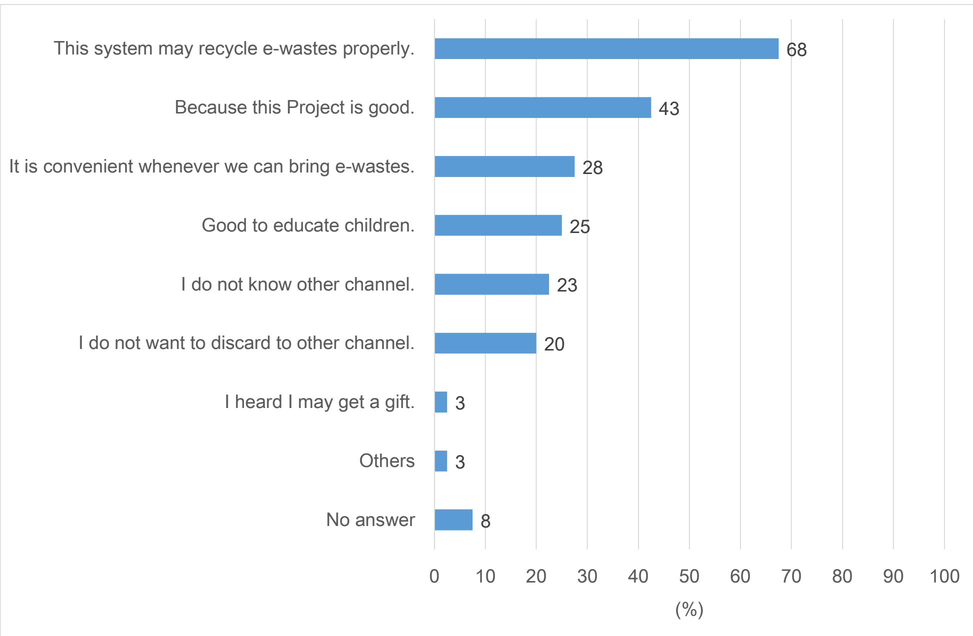
- 回答者:店頭回収に E-waste を持参した人、40 名
- 78%の回答者が前回店舗に来た時に店頭回収の実施を知ったと回答しており、店舗での宣伝が重要であることが分かる。



出所：JICA 専門家チーム

図 3-30　店頭回収をどのようにして知ったか？（N=40）

プロジェクトにポジティブな意見を持つ人の参加が多いが、店頭回収の便利さを支持した人も28％であり、便利な回収方法とすることの重要性を示している。



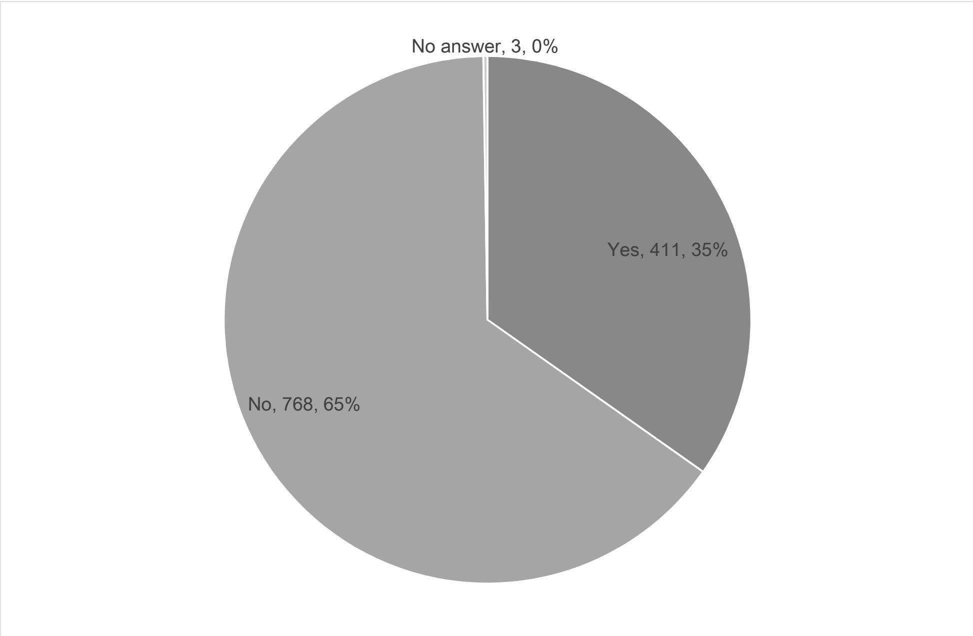
出所：JICA 専門家チーム

図 3-31　店頭回収に参加した理由　（複数回答、 N=40）

(2)　下取り回収(Trade-in)に関するアンケート

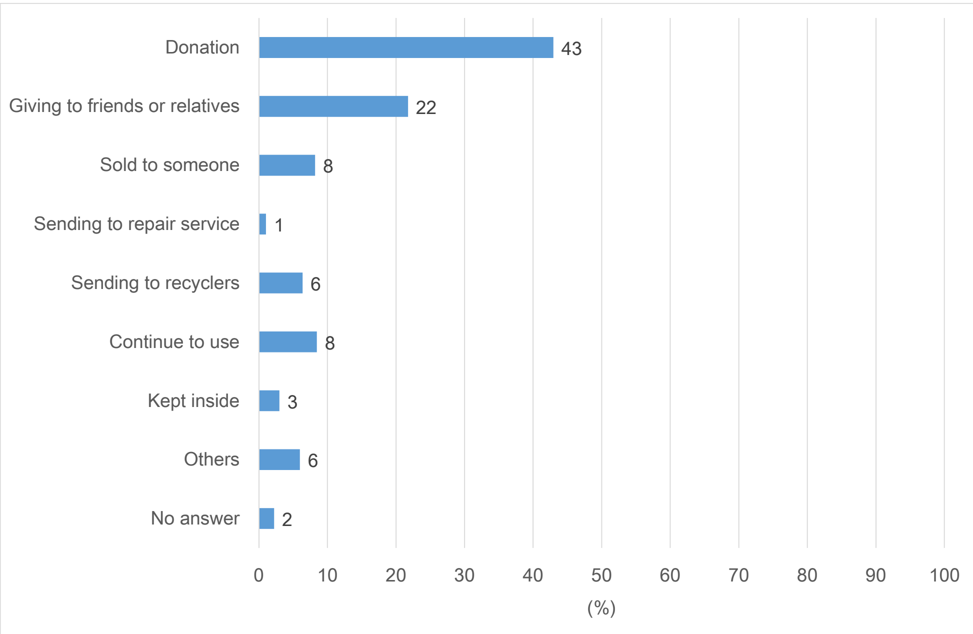
- 回答者：パイロットプロジェクト実施店の家電売り場を訪れた顧客 1,182 名（購入したかどうかは問わない）

- 不要となった E-waste は寄付、知人譲渡などによって処理することが一般的となっており、65%の回答者がパイロットプロジェクトに E-waste を排出する気がないと回答している。寄付、知人譲渡など再使用ルートに出す顧客の比率は 80%である。



出所：JICA 専門家チーム

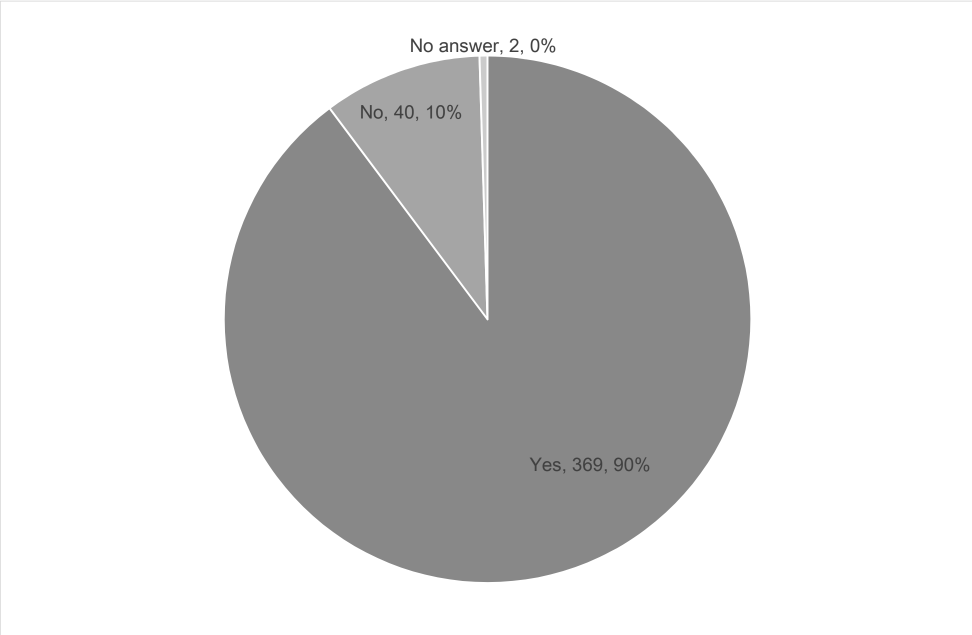
図 3-32　E-waste をパイロットプロジェクトなどに廃棄するか？（従来のリサイクル・再使用ルートは"No"と回答）　（N=1182）



出所：JICA 専門家チーム

図 3-33　予定している従来型の E-waste リサイクルルート　（N=768）

- R$10 支払ってもパイロットプロジェクトに参加したいという回答者は 31%である（35%×90%）。



出所：JICA 専門家チーム

図 3-34　R$10 支払ってもパイロットプロジェクトに参加するか？（N=411）

6)　バウチャーの配布と E-waste 回収

各店舗におけるバウチャーの発行枚数（Distributed）、回収申込件数（Subscripted）、R$10 及び R$10 の支払いをして実際に回収依頼まで至った件数(Collected)は下表のとおりである。特徴は下記の通りである。

- 店舗によって配布枚数が大きく異なる。
- バウチャーを数多く配布したとしてもそれが回収に結びついているというわけではない。
- 申し込みされたにも拘らず料金が支払われなかったために回収されなかった E-waste が 5 件ある。

表 3-10　下取り回収におけるバウチャー配布・回収申込・回収実施の関係

	Distributed	Subscripted	Collected
Extra Jaguare	7	3	3
Extra Anhanguera	4	0	0
Pontofrio Megastore	45	11	8
Casa Bahia Lapa 2	4	3	2
Casa Bahia Lapa 4	7	2	2
Ponto Frio Lapa 6	4	3	2
Walmart Pacaembu	56	2	2
Walmart Leopoldina	22	0	0
Total	149	24	19

出所：JICA 専門家チーム

7)　パイロットプロジェクトに基づく E-waste リサイクルコスト推定

パイロットプロジェクトで得られたコストデータを用いて、将来の E-waste リサイクルコストを推定した。計算条件は以下のとおりである。

(1)　コスト推定範囲

- 対象地域：　サンパウロ市全域
- 対象 E-waste：　2016 年に廃棄された E-waste(回収率 20%)

(2)　評価対象システム

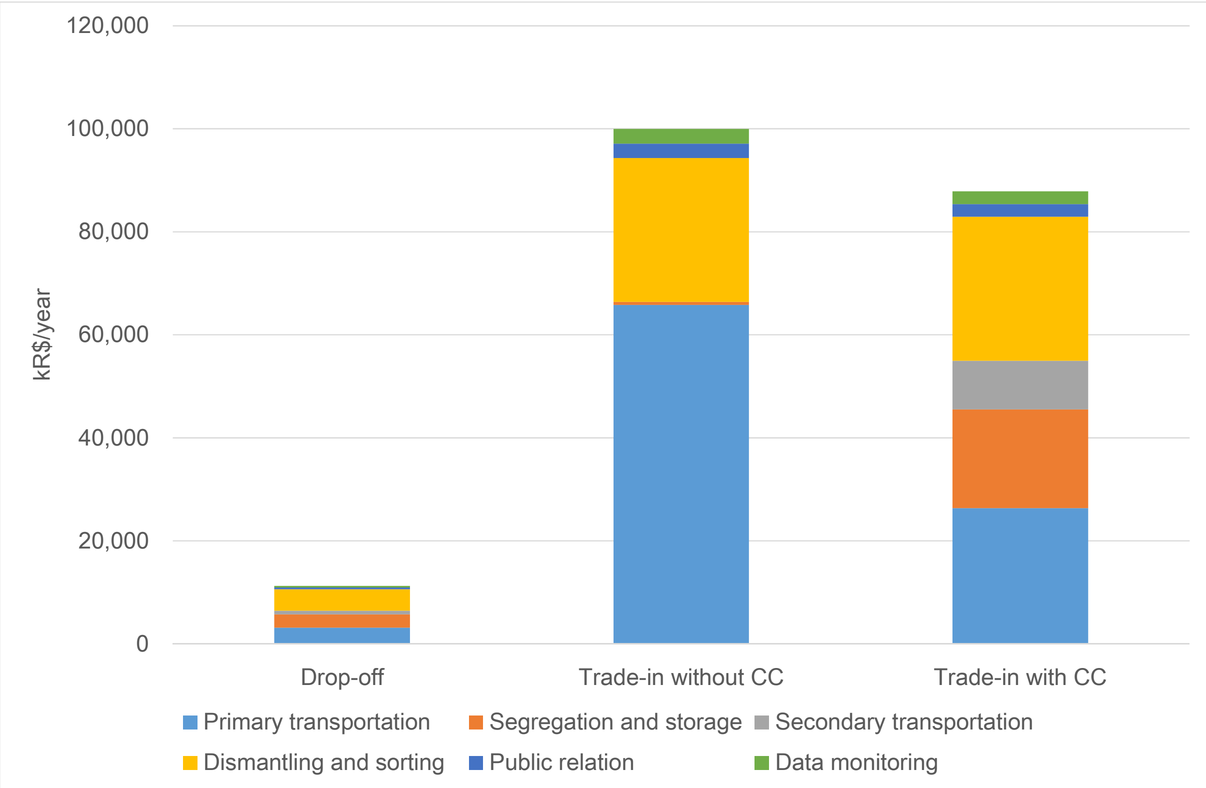
以下の 3 ケースについて一次輸送、仕分け、二次輸送、解体までの一連のコストを算出した。

- 店頭回収（コンソリデーションセンターあり）
- 下取回収（コンソリデーションセンターなし）
- 下取回収（コンソリデーションセンターあり）

(3)　E-waste リサイクルコスト算出結果

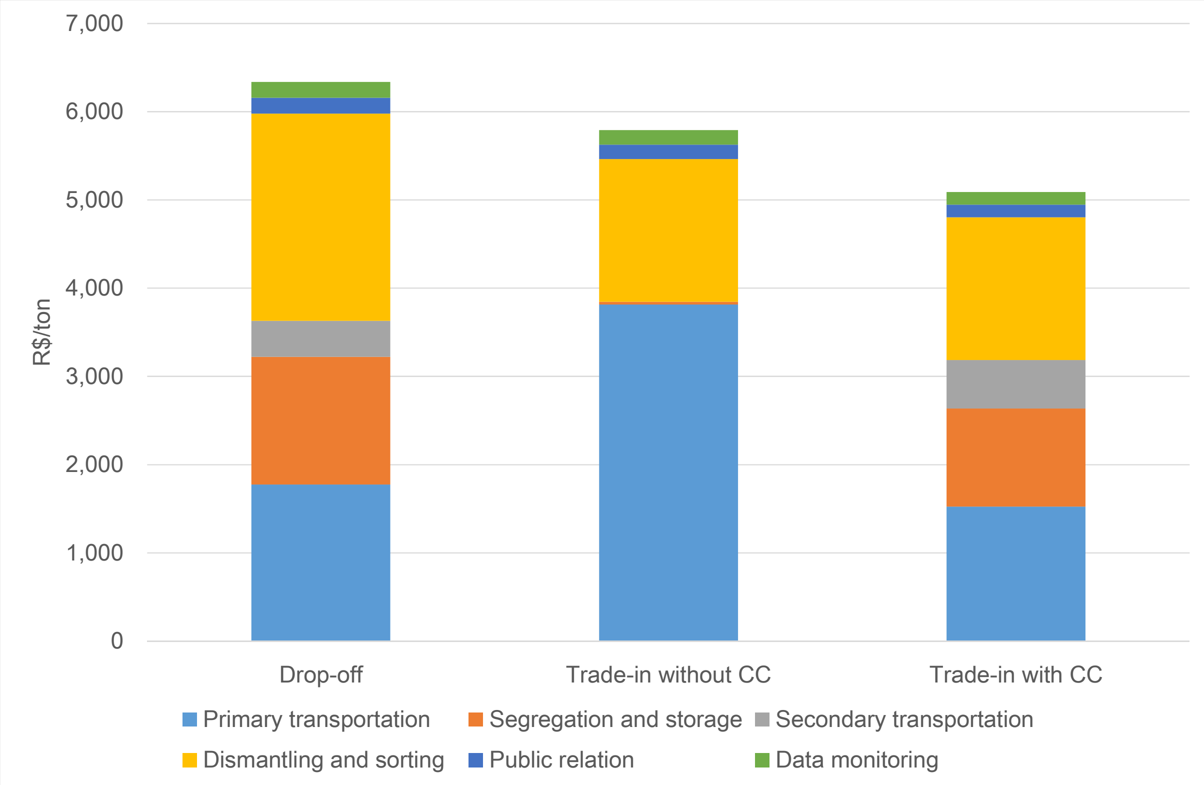
図 3-35 に年間必要経費、図 3-36 にトン当たりコストを示した。その特徴は以下のとおりである。

- コスト構成は回収・輸送が概ね 6 割、解体・選別が 3 割、残りはその他 PR・啓発などに掛かる費用である。
- 店頭回収の年間必要経費は下取り回収の十分の一程度であるが、トン当たり経費では下取回収を上回る。
- 下取回収についてコンソリデーションセンターありの方が、なしのケースよりも本計算では 1 割程度安い。



出所：JICA 専門家チーム

図 3-35　E-waste リサイクルのための年間必要経費（サンパウロ市、2016 年）



出所：JICA 専門家チーム

図 3-36　トン当たり E-waste リサイクルコスト（サンパウロ市、2016 年）

当然のことながら、下取り回収（Trade-in）のコンソリデーションセンターあり、なしの比較は解体・選別工場までの距離に従う。サンパウロ市を前提とした本試算では解体・選別工場までの距離は 100km であったが、地域によってはより長距離の輸送が必要になると考えられるので、他地域での検討のために二次輸送コストを解体・選別工場までの距離をパラメータとして数式化した。

表 3-11　解体・選別工場までの距離をパラメータとした輸送コスト

Types of collection	Estimated cost	Expression (R/ton)
Drop-off collection	Secondary transportation	1.8*X(km) + 227
Trade-in without consolidation centers	Collection and transportation	$\frac{69000H(hr)+1750X(km)}{60H-2X-164}$
Trade-in with consolidation centers	Secondary transportation	1.4*X(km) + 400

Note: X=secondary transportation distance (km)

H=Working hours for collection and transportation (hr)

出所：JICA 専門家チーム

(4)　大型家電一台当たりのコストとリサイクル料金（Visible Fee 等）の試算

上記リサイクルコスト試算を一台当たりコストに換算し、またそれを用いてリサイクル料金（Visible Fee 等）を試算した。結果を下表に示す。E-waste 種類別の一台当たりのコストの算定にあっては各 E-waste の資源価値のみを考慮し、それ以外のコストは種類によらず一定とした。リサ

イクル料金（Visible Fee 等）の算定にあっては同年(2016 年)に販売された家電の台数でリサイクルコストを割ることによって算出した。

一台当たり大型 E-waste のリサイクルコストは含有する有価資源の価値を反映して、銅を多く含むエアコンが最も安く、逆に断熱材フロンを含む冷蔵庫が最も高くなった。

また、リサイクル料金（Visible Fee 等）は、E-waste の回収率を 20%としていることと、現在の販売台数が過去に比べて増加していることから、新規家電製品一台当たりに課せられるリサイクル料金は同種の E-waste 一台あたりのリサイクルコストの十分の一以下となる。

表 3-12　一台当たり大型家電リサイクルコストとリサイクル料金（Visible Fee 等）の試算（下取回収、C/C ありのケース）

E-waste	Recycling cost (R$/Unit)	Recycle Fee (Visible fee etc. (R$/Unit)) (Year: 2016, Collection rate: 20%)
Television set	211	20
Refrigerator	231	17
Washing machine	194	15
Air-conditioner	89	5
Oven range	192	14
Average	201	16

出所：JICA 専門家チーム

8)　パイロットプロジェクトからの教訓

(1)　対象廃棄物

これまでも多くの E-waste 回収のパイロットプロジェクトが試みられてきたが、冷蔵庫、洗濯機を含む大型家電を取り扱った本格的な試みは本パイロットプロジェクトが初めてである。定められる回収率目標によっても異なるが、廃棄される大型家電の重量は中小型家電の 10 倍であり、回収率目標達成のためには大型家電を対象とする必要がある。

(2)　回収率目標の達成を目指して

下取り回収による大型家電の回収を促進するには店舗店員の協力が最も重要である。パイロットプロジェクトでは廃棄時に R$10 を徴収したのに対して、本格実施時には購買時での徴収となると考えられるものの、その金額は R$10 よりも高い R$16-18 となる。本パイロットプロジェクトの下取り回収が振るわなかったのは、必ずしも R$10 を徴収したからとは言えないが、料金が回収率目標達成の阻害要因とならないように顧客に対する何らかのインセンティブを検討する必要があろう。

また、店頭回収においても広報活動に加えて何らかのインセンティブを検討することが必要と考えられる。

(3)　新規産業創出の視点

E-waste リバースロジスティックは規制的側面のみならず新産業創出の側面を持っている。サンパウロ市では回収率が 20%の時、年間約 R$100 million に相当する新規産業が創出されることがパイロットプロジェクトで得られたパラメータを用いて推定された。さらに広い地域、全土をカバーするためにはその 10 倍以上の市場が創出されると考えられる。

創出される新規産業は単に E-waste の回収、解体・リサイクルのみならず、DfE（Design for Environment）達成のためのリバースマニュファクチャリング、市民意識変革のための PR 活動事

業、E-waste リバースロジスティックシステムを制御するためのデータモニタリングシステムなど多岐に渡り、それらが組み合わさって最も効率的となるような仕組みが形成されることが望まれる。

(4)　パイロットプロジェクトと将来の本格システム

パイロットプロジェクトの特徴を以下の通り挙げることができる。

- プロジェクトが必要コストを負担したこと
- 下取り回収（Trade-in）では廃棄時に料金徴収を行ったこと
- 下取り回収（Trade-in）では購入製品納品車とは別の車両が E-waste を回収したこと

他方、本格システムにおいては以下のようになると想定される。

- リサイクル料金（Visible Fee 等）を原資として一義的責任を課せられる生産者がコスト負担をする
- リサイクル料金（Visible Fee 等）は製品購買時に徴収され、Historical Waste のリサイクルに充てられる

本格システムにおいては上記相違点を念頭に置き、以下の視点から検討を進めることが必要である。

- リサイクル料金（Visible Fee 等）の金額をどのように定めるのか？
- リサイクル料金（Visible Fee 等）を原資とする限られた予算の中で、購入製品納品時に引き取ることによる効率的な回収の実現、寄付団体等との連携による小売店ルート以外との適切な連携によるコスト削減などの取り組みを通じた、最も効率的な Historical Waste の回収、適正リサイクルを模索する必要がある。

【2-4】パイロットプロジェクト実施に当たっての事業者向け、消費者向け広報・普及活動を実施する。

パイロットプロジェクトについて、サンパウロ市民の理解および参加促進のため、プロジェクト参加団体である小売店舗および回収および解体業者、および行政の協力体制を築きながら、広報活動を実施した。活動の詳細については「添付資料 7 プロジェクト広報資料」に記載するものとし、ここでは活動の概要を示す。

1)　プロジェクトタイトル、ロゴ、タグライン制作

パイロットプロジェクトを周知するには、市民が受け入れやすく、認知しやすいプロジェクトタイトル、ロゴ、タグラインが必要と考え、ステークホルダーとワーキンググープなどで検討し、タイトル、ロゴ、タグラインを以下の通り決定・制作した。

descarte ON

Se ligue
no descarte correta
de eletroeletrônicos!

出所：JICA 専門家チーム

図 3-37　プロジェクトロゴおよびタグライン

2) オンラインコミュニケーション

パイロットプロジェクトの活動を効率的に発信できるように、オンラインコミュニケーションとして以下の活動を実施した。

- オフィシャルサイトの開設
- Facebook ページの開設
- Instagram ページの開設

3) 印刷配布物および掲示物の制作・配布

参加小売店および各種イベントで、市民にプロジェクト参加を呼びかけるため、以下の広報物を制作した。

表 3-13 印刷物一覧

内容	印刷物	制作数量
セレモニー	PR ボード	1
descarte ON プロジェクト	バナー (1.5x0.6m)	4
	バナー(1.5x1.5m)	1
	バナー (1.5x1.5m)	3
	ポスター(40x50cm)	76
	ポスターに設置する紙箱	16
	ストッパー	20
	メッセージタグ(ノベルティ)	5,000
	リボン(ノベルティ)	5,000
	T シャツ	65
	広報物に貼るステッカー(終了アナウンス)	36
	ポスター(終了アナウンス)	12
Coleta nas Lojas	立体パネル(トーテム)および回収ボックス	12
	ポスター(A4)	320
	スタンド付きポスター(A4)	55
	リーフレット バージョン1	12,000
	リーフレット バージョン 2	23,500
Coleta na sua Casa	リーフレット バージョン1	6,300
	リーフレット バージョン 2	8,200
イベント	リーフレット	11,000
	ポスター(A3)	4

出所：JICA 専門家チーム

4) イベントおよびキャンペーンの実施

パイロットプロジェクトの活動を市民に広く広報するために、以下に示すようなイベント及びキャンペーンを実施した。

表 3-14　イベントおよびキャンペーン一覧

タイトル	実施時期	開催場所	概要
LAPA 地区・監視者会議	2016 年 3 月 3 日	LAPA 区役所	LAPA 地区の住民に対する PP の紹介。
開始直前セレモニー	2016 年 4 月 26 日	BUNKYO	PP 開始を関係者及びメディア向けに発信。
開始告知キャンペーン	2016 年 5 月 14 日	参加小売店舗	店舗を訪れた消費者に PP の紹介を実施。
市民向け啓発イベント	2016 年 6 月	Tendal da Lapa	PP 実施地区である LAPA 地区において、市民向け E-waste 啓発イベント及びセミナーを開催
下取り回収促進キャンペーン	2016 年 11 月	参加小売店舗	店舗を訪れた消費者に下取り回収促進のために広報を実施。

出所：JICA 専門家チーム

その他、スクールキャンペーンとしてラパ区周辺への学校（7 校）へ E-waste リバースロジスティックスに関するセミナーおよび descarte ON の紹介を行った。

5) メディアリレーション（マスメディアを通じた広報活動）

プロジェクト開始直前からその時々の状況に合わせたプレスリリースを制作・発信し、積極的なメディアリレーションを実施した。プレスリリース発信にあたってはメディアリストを作成し、プレスリリースの特徴に合わせ、14 本のプレスリリースを発信した。

6) 広告の実施

パイロット期間中に実施したイベントや PP 実施店舗の周知のために、地域紙への折り込み広告や Facebook 上での広告を実施した。

7) ステークホルダーとの連携

パイロットプロジェクトを成功させるにはステークホルダーによる協力が不可欠であるため、プロジェクト広報に関連した以下の活動を行った。

(1) 広報協力体制構築のための取り組み

本プロジェクトに参加する行政、メーカー、複数の小売り、リサイクル業者は、それぞれのブランディングの方向性および通常の広報活動への意欲や方向性がそれぞれ違う。また、既存の各団体のコミュニケーション活動（マーケティングおよびブランディング戦略）に沿う形でなければ、それぞれによるプロジェクト広報活動の実施は難しい。そのため各団体が自発的にプロジェクト広報活動をできるよう、広報ルール、プレスキット及び Web バナーを作成し配布した。

(2) ステークホルダーイベントへのプロジェクトメンバー参加

2016 年 7 月 8・9・10 の 3 日間にわたり、サンパウロ市でおこなわれた日本祭りの JICA ブースにて、JICA ブラジルの協力を得て本プロジェクトの紹介、広報物展示を行った。9 日には JET メ

ンバーも参加し、来場者に対してプロジェクトの紹介やオフィシャルサイトに掲載しているアンケートを実施した。

(3) ステークホルダー自身によるプロジェクト広報

AMLURB、FECOMERCIO、Pernumbucanas、Coopermiti が本プロジェクトへの参加および協力についてプレスリリースを実施しており、ステークホルダーによるプレスリリースの発信は計 10 本であった。その他の団体も、WEB ページや自身の広報誌で、本プロジェクトへの参加や 6 月イベントについての掲載を行っている。また、GPA の各店舗では独自の予算で Coleta na sua Casa の広報活動を店頭で実施した。

8) パイロットプロジェクト終了に伴う広報

2016 年 12 月 31 日にプロジェクトが終了することを消費者に対し事前にアナウンスするため、12 月 14 日に全参加店舗の回収箱とトーテムに「31 日までに捨ててください」と書いたシールを貼った。また、回収箱を撤収したことを消費者にアナウンスするメッセージを書いたポスターを 2017 年 1 月 10 日に全 Coleta nas Lojas 参加店舗に掲示した。オフィシャルサイトのメインビジュアルも変更し、Facebook や Instagram でもその画像を投稿した。

また、本プロジェクトで回収した E-waste の量（全回収量、回収方法ごと）、アンケート調査結果およびそれに対するプロジェクトチームのコメントをまとめ、2017 年 2 月 15 日のプレスリリースおよび descarte ON オフィシャルサイトで、公表した。

【2-5】RL への民間の設備投資を促進するために、税制優遇策ならびに融資優遇制度など経済的インセンティブの検討協議に参加し、提言を行う。

1) 民間設備投資促進に係わる基礎情報の収集・整理

第 1 年次では、RL への民間設備投資促進のための経済的インセンティブとしての優遇措置等についての初期的調査・検討を行った。

国家廃棄物管理政策法で定められた E-Waste の R/L を構築し、実施するためには、力強い資金調達と経済的インセンティブの仕組みによって E-Waste の処理・資源化の確かな市場の発展とより積極的なビジネス環境の創出が行われる必要がある。

この新規ビジネスの創出への投資は、民間セクターによって、起業や以下に示すような公的銀行あるいは投資市場の活用を通じて行われる。

- BNDES：気候ファンド（持続可能都市及び気候変動）
- FUNTEC：固形廃棄物に対するクリーンでグリーンな非返済型研究開発ファンド
- CAIXA：クリーン開発メカニズムのトータル実施ファイナンス
- BANCO DO BRAZIL：カタドール組合開発ファンド
- DESENVOLVE SP：グリーン経済

投資形態にはプライベート・エクイティやベンチャーキャピタル投資などがあり、例えば、ブラジルベンチャーキャピタル協会（ABVCAP）と一緒にブラジル産業開発庁（ABDI）が VENTURE

FORUM と呼ばれるプログラムを運営している。これは、年間売り上げが 500 万 R＄以上の企業を選択し、民間や公的資金（BID、世銀、BNDES、FINEP）からその企業への投資を促進あるいは助言するプロセスとしてとらえられている。

しかし、いずれの投資方法も、E-waste 関連の企業が利用するには典型的な困難性を伴っている。したがって、その困難性を解消するような政策をとることが出来れば、多くの E-waste 関連企業が利用できるような経済的インセンティブとして有望になる可能性がある。

通常、消費済みの家電製品へのファイナンスの仕組みは、拡大製造者責任（EPR）の考え方に基づいて形成され、E-Waste に係る EU 指令やブラジルの国家廃棄物管理政策法（12.305/2010）といった法廷要求をベースに形成される。一方で、インフォーマルには E-Waste の経済価値そのものをベースに形成される。

現在、最も利用されている E-Waste に関するフォーマルなファイナンスとして、コンプライアンスコストあるいは支払済みコンプライアンスコストがある。どちらの場合においても、製造業者や輸入業者は E-Waste の回収及び処理・資源化に係るコストを負担する責任がある。コンプライアンスコストはそのコストを製品価格に内包するものであり、支払済みコンプライアンスコストはそのコストをビジブルフィー（Visible Fee）として、製品の販売を通じて回収するものである。

このコストの内部化や家電の新規購入時に消費者に直接課金するようなファイナンスが行われる場合、製品当たりのコンプライアンスコストは以下の数式で表すことが出来る。

コンプライアンスコスト＝リバースロジスティクスコスト／（新規販売台数×実施期間：年）

今後、新規購入時にこのコンプライアンスコストが課されると想定した場合、通常の ICMS や PIS&CONFIS、IPI といった課税が行われると販売価格への影響は大きくなると予測される。この影響は非課税の Visible Fee を導入し、請求書を分割することで軽減することは可能ではあるが、既存の税制度の変更には相応の高い努力が必要とされる。

また、最終製品価格への R/L コストの影響を軽減させる方策の一つとして、例えば、文化・スポーツと言った他の社会投資に見られるように、E-waste の R/L に係るインフラ整備への投資から所得税等を軽減することが考えられる。その他の方策としては、ICMS（商品流通サービス税）の猶予、IPI（工業製品税）あるいは PIS/CONFINS（社会統合基金/社会保険融資納付金）の減免措置なども可能性として考えられる。

製造業が再生材（スクラップ）を原材料としての利用するための経済的インセンティブの導入によってもまた循環経済が創出される。再生材は、その最初の原材料としての使用時に課税されていることから、再生材利用時においては ICMS や PIS/CONFIS の減免措置による便益が期待される。その他のオプションとしては、製品中に再生資源を利用する場合の IPI の減税がある。

上記の全ての経済的インセンティブのオプションは、E-Waste の R/L を構築する際の消費者への経済的影響を軽減するとともに、消費者の R/L システムへの参加を促すことにもなる。したがって、消費者の参加を誘引するような奨励制度の導入が重要である。例えば、E-Waste の回収ポイントにおける回収量向上のために、製造業者、輸入業者あるいは小売・流通業者が参加する DOTS や Multiplus、NET ポイントといったブラジルにおけるマイレージプログラムのような仮想通貨報酬システムを導入することも考えられる。

その他にも、消費者が小売店において新規購入時に、古い E-Waste を返還した場合には割引を受けられるサービスや、買い替えによる省エネ効果や再生資源活用によるエネルギー消費の節約に相応する電気料金の割引サービスなども考えられ、実際に類似するプログラムも行われている。

2) E-waste リサイクル施設の新規立地時の経済的インセンティブ方策

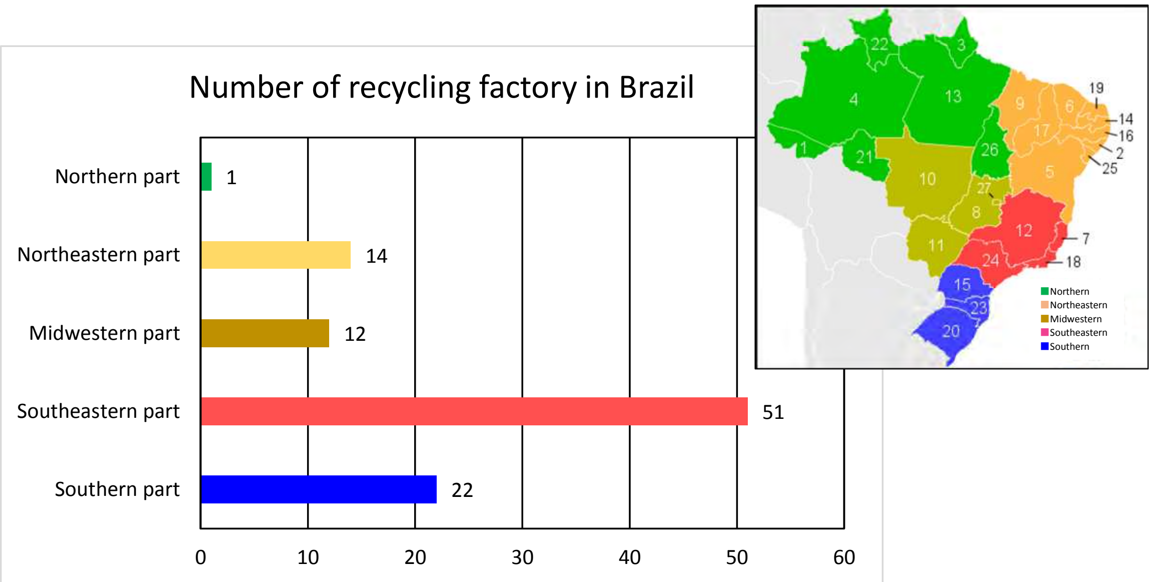
(1) E-waste リサイクル施設現況

ブラジル全国には合計 100 か所の E-waste リサイクル施設が存在しているが、そのほとんどはパソコンなど中小型家電を解体するための施設のみを有しており、本格的施設に必要となる冷蔵庫の緩衝材フロンの回収、大型家電破砕設備を有している施設は 2 施設のみである。

既存 100 施設の投資意欲を刺激することによって、E-waste リバースロジスティクスシステムを支える本格的リサイクル施設を整備することが可能である。ここではその促進策を検討した。

ここで本格的 E-waste リサイクル施設とは以下の機能を有するものである。

- 大型家電を年間 50 万台程度処理できること
- 冷蔵庫の断熱材フロンを回収できること
- 大型家電を破砕できる破砕機を有すること



出所：JICA 専門家チーム

図 3-38 ブラジルにおける E-waste リサイクル施設現況

(2) 経済的インセンティブ検討の方法

本格的 E-waste リサイクル施設の 10 年間キャッシュフローを推定できる計算ツールを開発し、これを用いて各経済的インセンティブが採算性をどう改善するかを検討した。計算の前提条件は以下のとおりである。

① 検討対象とした経済的インセンティブ

- 施設整備補助（整備費の 50%）
- ソフトローン(現況利率 15%を 10%で)
- 法人事業税免除（現況利率 21%を 0%に）

② 採算性評価インデックス

- 10 年間累積収益
- 10 年間内部収益率（IRR: Internal Rate of Return）

③ 対象 E-waste の種類と量

- テレビ(ブラウン管テレビ、フラットテレビ)、冷蔵庫、洗濯機、エアコン
- 2018 年から 2027 年までにサンパウロ市から排出される量のうち、回収率を 2018 年で 20%、2027 年で 80%と想定して全体リサイクル量を推定し、これを 5 つの施設で按分してリサイクルするものとした

④ 採算性改善の評価

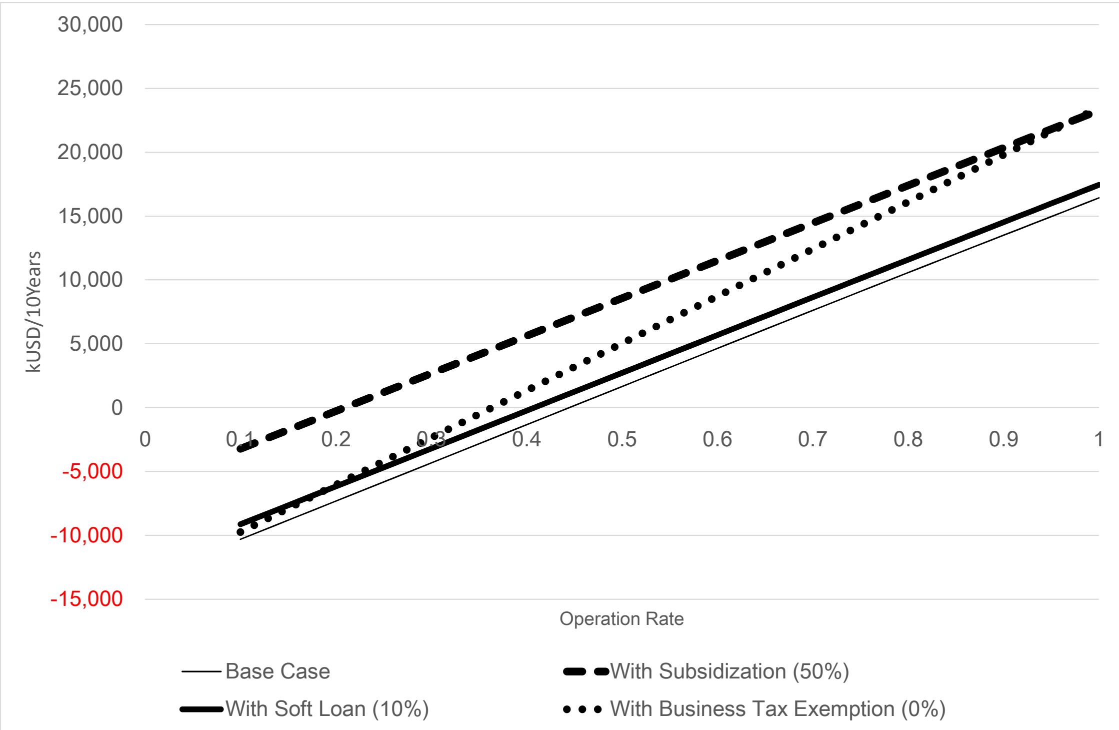
- 施設稼働率を 10%から 100%まで変化させて対象 E-waste の採算性がどう変化するかを評価

(3) 経済的インセンティブ評価結果

経済的インセンティブ評価結果として、10 年累積収益を図 3-39 に、10 年内部収益率を図 3-40 に示した。評価結果は以下の通りである。

① 累積収益

- 経済的インセンティブ方策がない場合、同事業が収益を上げるためには施設稼働率は 40%～50%以上が必要である。
- 3 つの経済的インセンティブ方策のうち、施設整備補助が比較的最も累積収益の改善効果が大きい。
- 法人事業税免除は施設稼働率が高いほど、累積収益の改善効果も高い。
- ソフトローンは少なくとも利率 10%では採算性改善にあまり貢献しない。



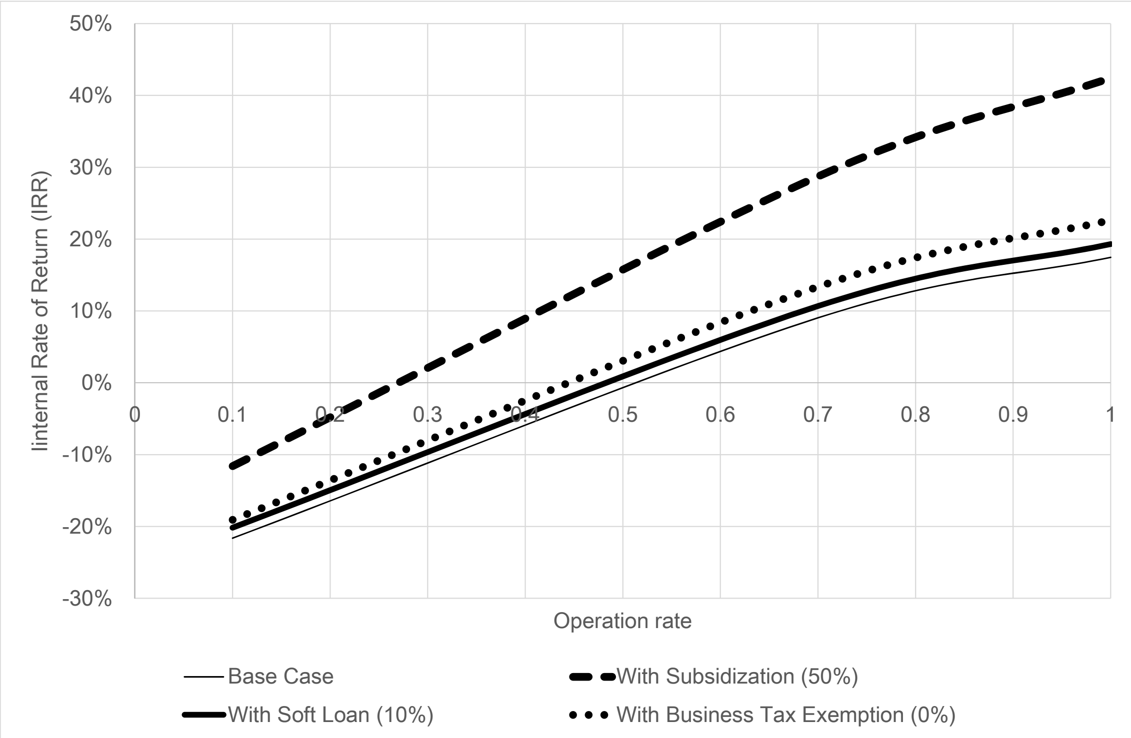
出所：JICA 専門家チーム

図 3-39 経済的インセンティブが E-waste リサイクル施設の採算性に与える影響【10 年累積収益】

② 内部収益率

- 仮に経済的インセンティブが付与されない場合、一般的な金利が 15%であると、本事業は稼働率 90%以上でなければ魅力的とは言えない。

- 施設整備補助は検討した経済インセンティブの中では最も内部収益率を改善する。
- ソフトローンと法人事業税免除は内部収益率の改善には大きく貢献しない。



出所:JICA 専門家チーム

図 3-40　経済的インセンティブが E-waste リサイクル施設の採算性に与える影響【10 年内部収益率】

【2-6】2-3 で提案された RL システムフローを、サンパウロとは条件（人口、経済規模）が異なる他州の都市に導入する際の留意点を提言するための基礎的な調査を行う。

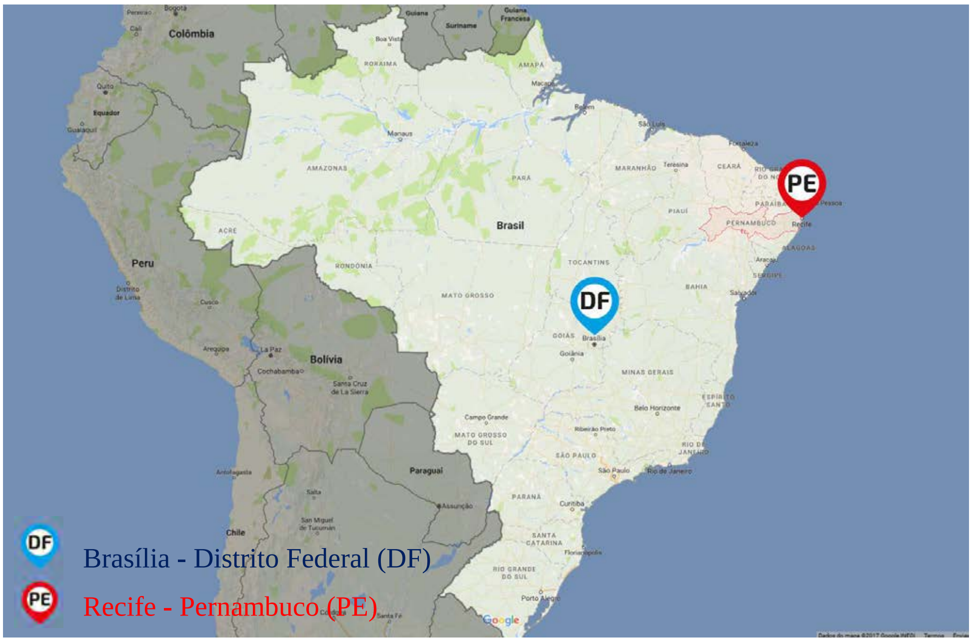
サンパウロとは条件の異なる他州の都市において、サンパウロ市において試行した P/P の導入における留意点を提言するための基礎的な情報収集調査を行い、添付資料 3 としてとりまとめた。以下に概要を示す。

1)　調査対象都市の選定

ブラジル側との協議の結果、ブラジリアとレシフェの 2 都市を調査対象とした。それぞれの選定理由は以下の通りである。

ブラジリア：ブラジルの首都であり、人口も 200 万人以上おりブラジルの中西部における中核的な都市。

レシフェ　：ブラジルの北東部における代表的な中核都市。ペルナンブコ州の州都であり人口も 100 万人以上いて一定量の E-waste の発生が見込まれる。



出所：JICA 専門家チーム

図 3-41　調査対象都市位置図

2)　調査方法

調査対象都市における情報収集は、以下に示す項目で行った。これらの調査項目のうち、ブラジリア、レシフェの現地調査については 2016 年 12 月から 6 月にかけて現地再委託調査として行った。

(1) E-waste 排出量の推計

- 各都市における E-waste 排出量推計のための情報収集（人口、世帯数、GDP 等）
- E-waste 排出量の推計
- E-waste フローの推計

(2) リサイクル企業の調査

- コンソリデーションセンターを運営できる可能性のある企業調査
- 適切なライセンスを持ったリサイクル工場調査

(3) E-waste RL の関係者へのインタビュー調査

- 行政機関へのインタビュー
- 産業セクターへのインタビュー
- 小売業界へのインタビュー

(4) サンパウロ市で試行したパイロットプロジェクトの適用性に関する提言

3)　基礎情報の収集

ブラジリア、レシフェにおける基礎情報は以下の通りである。

表 3-15　ブラジリア、レシフェの概況

項目	ブラジリア	レシフェ
州	連邦直轄区	ペルナンブコ州
人口	257 万人（2010 年センサス）	153 万人（2010 年センサス）
面積	5,780 km^2	217 km^2
人口密度	444.6 人/km^2	7,053.7 人/km^2
域内 GDP	171 百万　R$（2012 年）	37 百万　R$（2012 年）

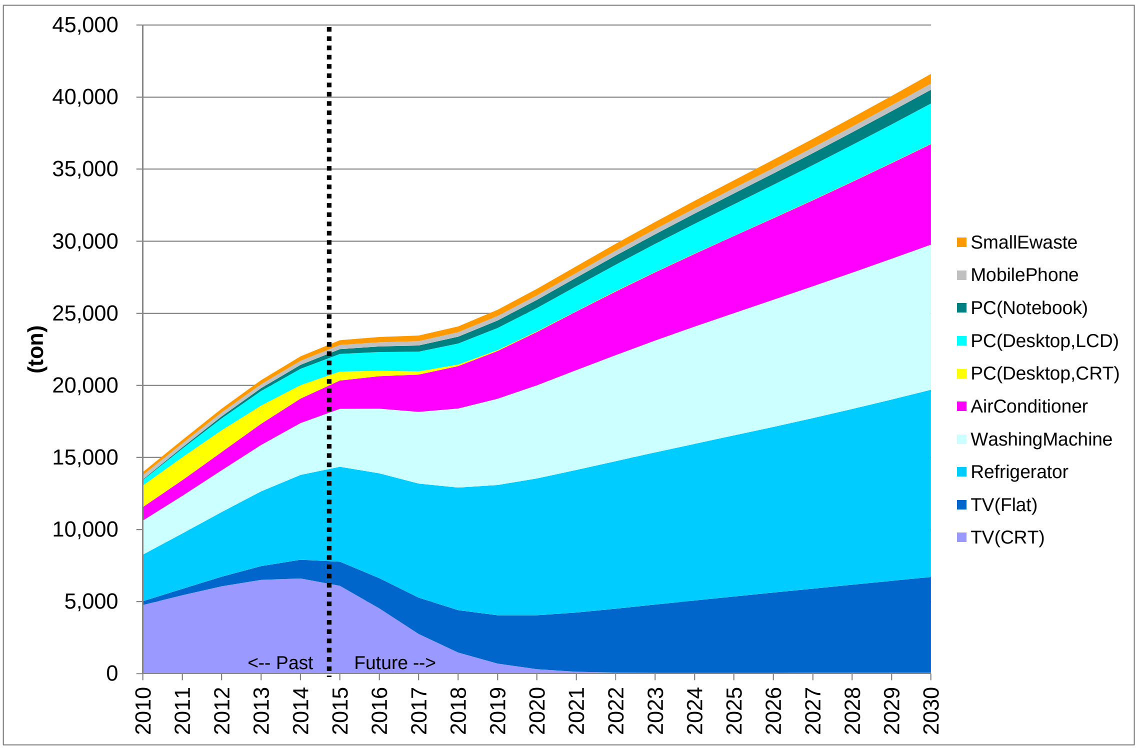
出所：JICA 専門家チーム

4)　各都市における E-waste 排出量の推計

調査対象都市における E-waste の排出量の推計を行った。推計にあたっては各都市で得られた基礎情報を元に、【1-1】及び【1-2】で行ったサンパウロ市における E-waste の排出量推計方法と同様の方法で行った。E-waste ごとの廃棄重量を下図に示す。その特徴は以下の通り要約できる。

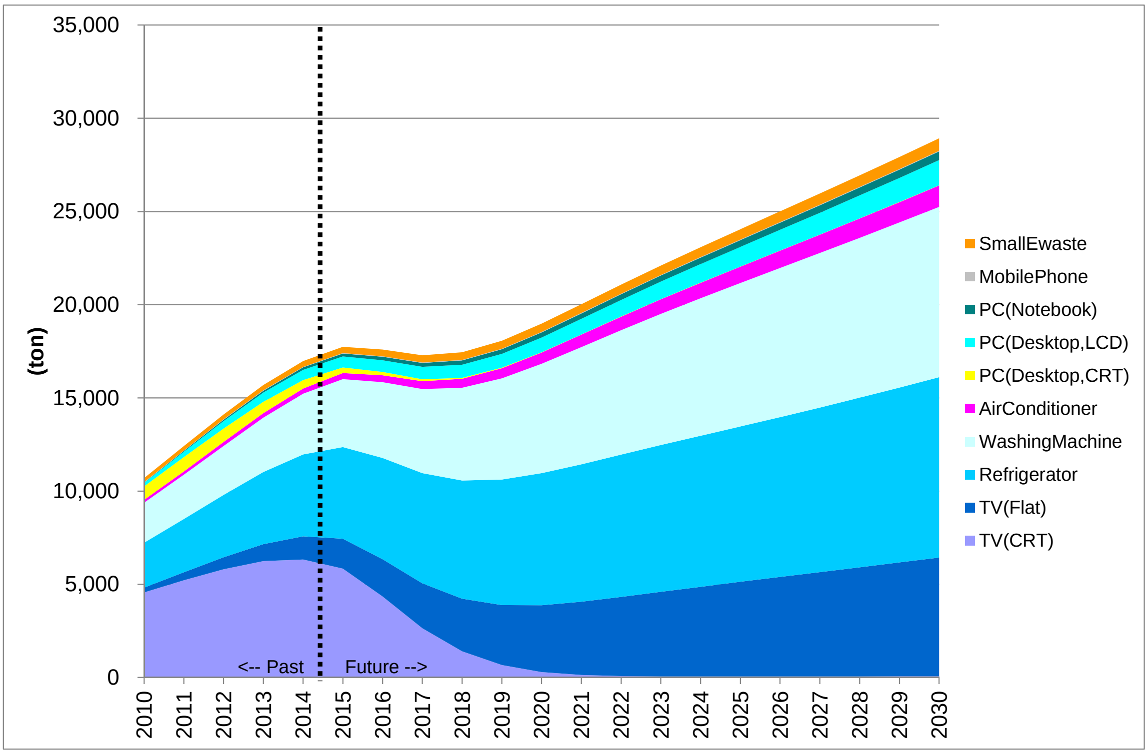
- 現在においてブラジリアから排出される E-waste の廃棄量は年間約 23 千トンであり、今後 400 千トン超まで徐々に伸びていく。
- 現在においてレシフェ市から排出される E-waste の廃棄量は年間約 4 千トンであり、今後 11 千トン超まで徐々に伸びていく。
- サンパウロ市と同様にテレビ、冷蔵庫、洗濯機、エアコンで E-waste 全体廃棄量の 8 割以上を占める。
- CRT テレビの廃棄量は今後急激に減少する。このため家庭由来の E-waste 廃棄量は今後数年で一時的に下がる。

(1)　ブラジリア



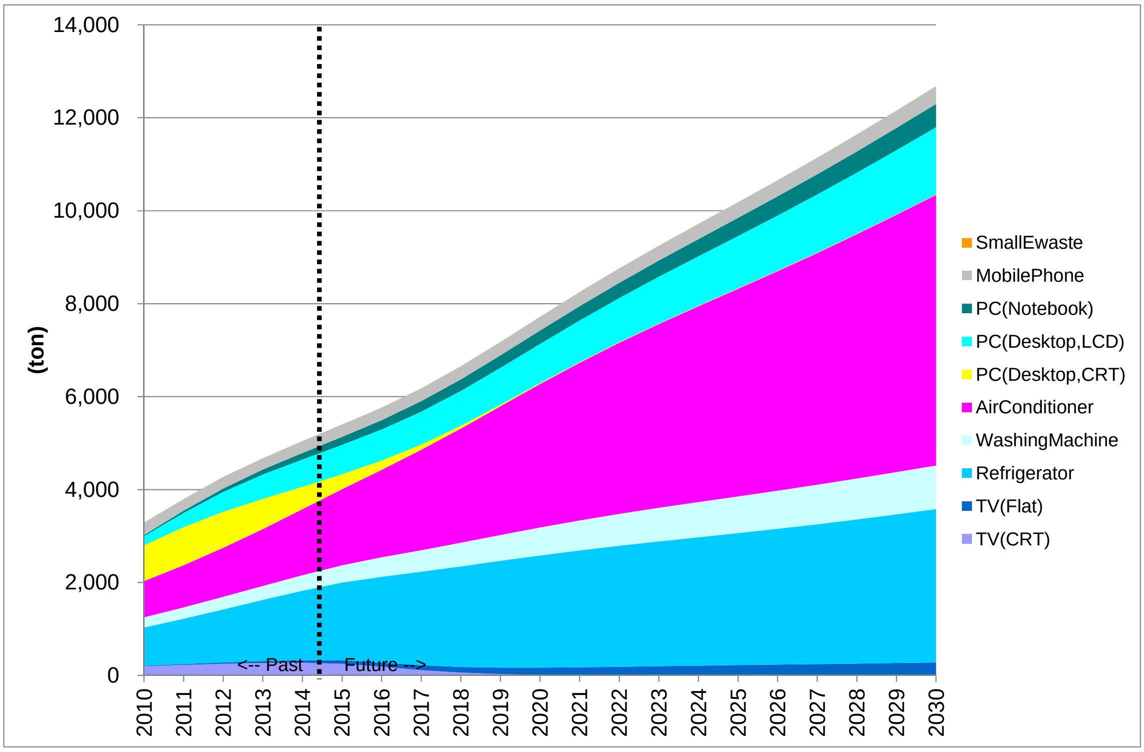
出所：JICA 専門家チーム

図 3-42　ブラジリアにおける E-waste 廃棄重量の推移（再使用含まず）【全体】



出所：JICA 専門家チーム

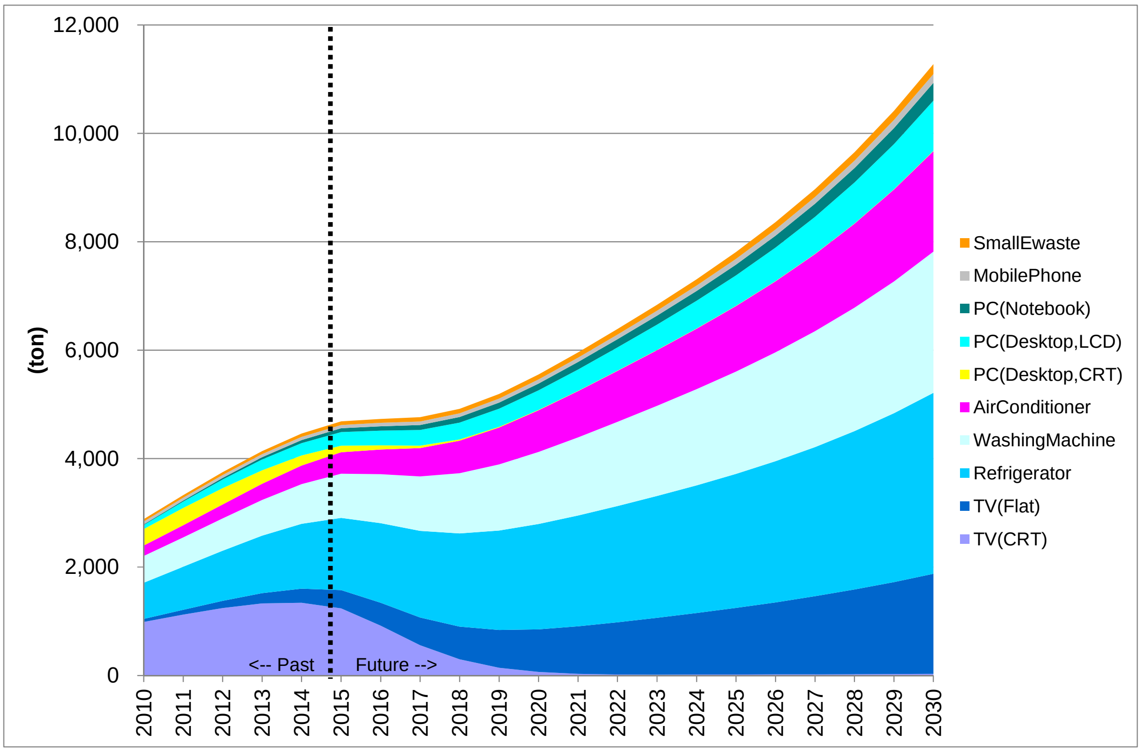
図 3-43　ブラジリアにおける E-waste 廃棄重量の推移（再使用含まず）【家庭】



出所：JICA 専門家チーム

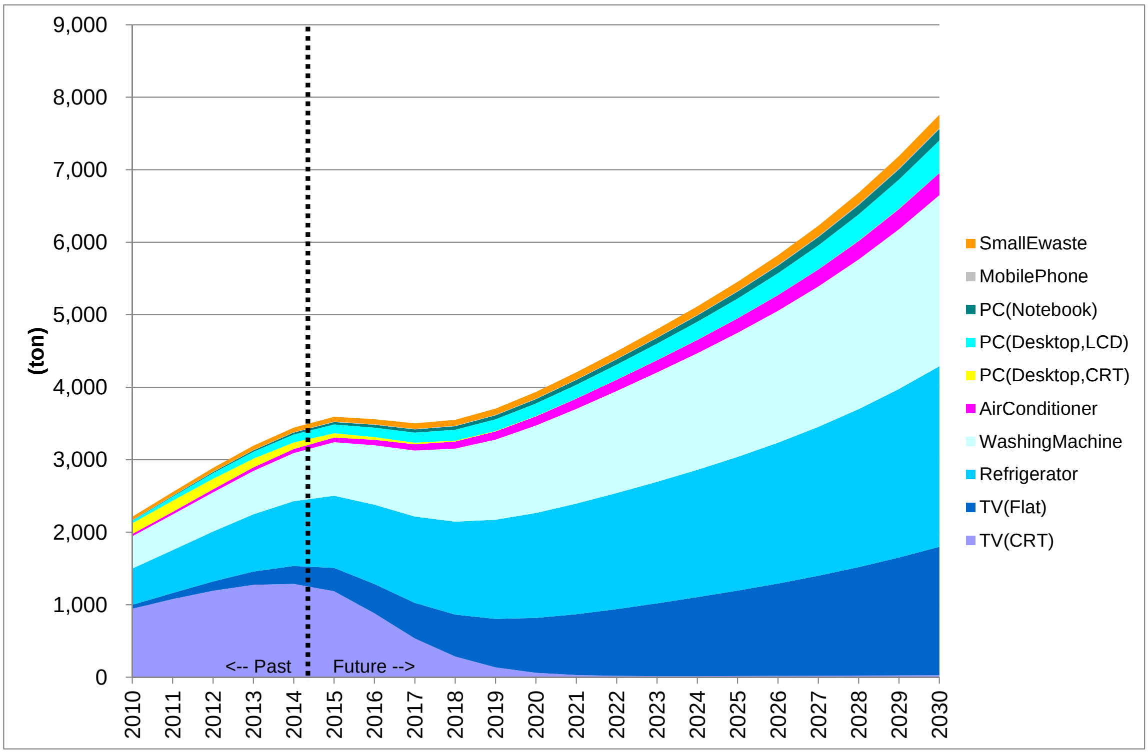
図 3-44　ブラジリアにおける E-waste 廃棄重量の推移（再使用含まず）【事業所】

(2) レシフェ



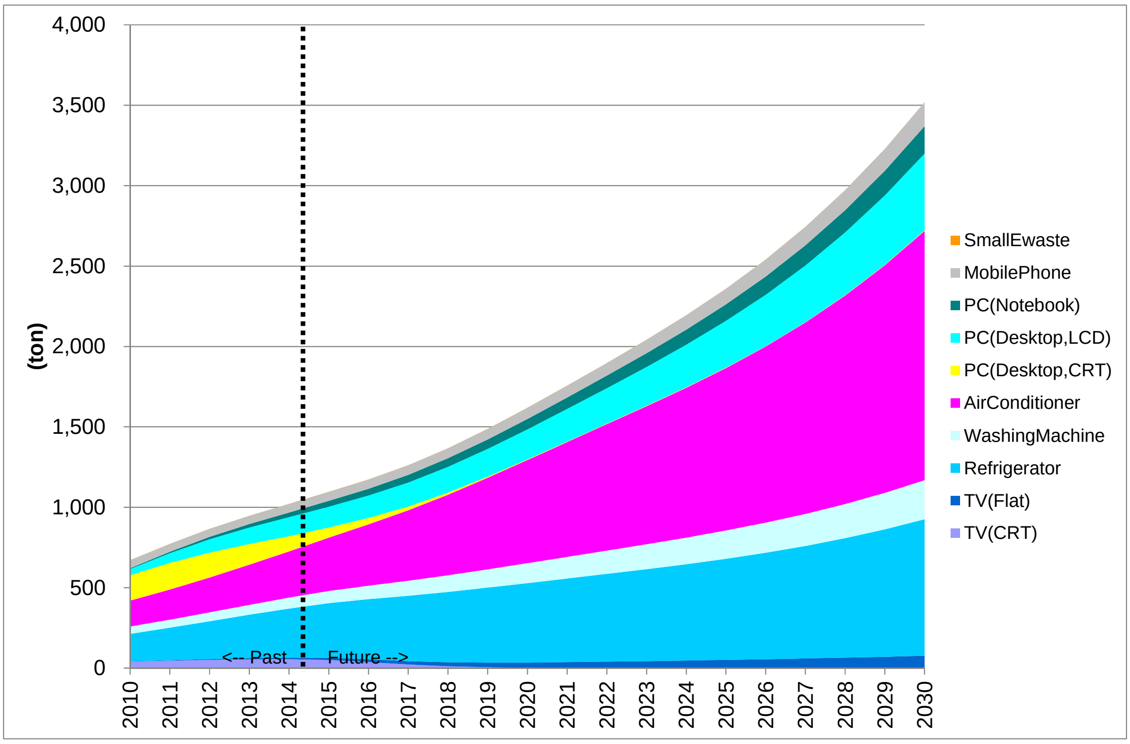
出所：JICA 専門家チーム

図 3-45 レシフェにおける E-waste 廃棄重量の推移（再使用含まず）【全体】



出所：JICA 専門家チーム

図 3-46 レシフェにおける E-waste 廃棄重量の推移（再使用含まず）【家庭】



出所：JICA 専門家チーム

図 3-47　レシフェにおける E-waste 廃棄重量の推移（再使用含まず）【事業所】

5)　リサイクル企業及びステークホルダーの調査

各調査対象都市において関係者へのインタビュー調査を以下の通り実施した。

表 3-16　各都市におけるインタビュー先及び訪問数一覧

インタビュー先	ブラジリア	レシフェ
Cooperatives（カタドール組合）	18	8
リサイクル企業（解体・選別業者）	5	8
NGO	4	13
行政機関	5	12
小売店関係者	30	25
合　計	62	66

出所：JICA 専門家チーム

インタビュー調査の結果を取りまとめると以下のようになる。

- 両都市におけるカタドール組合では、サンパウロ市における Coopermiti のような E-waste 専門の組合は無く、現時点で適正に E-waste の解体を行えるところはない。
- リサイクル企業はサンパウロ市に比べて数も少なく施設の整備レベルとしても脆弱である。

- 両都市において E-waste のリサイクルを専業にしてはいないが、取り扱いに興味を持っている NGO（宗教団体等）が複数存在している。
- 市、州レベルの行政機関では E-waste のリバースロジスティックスについて必要性を認識しつつも、どのような役割を担うか試行錯誤している。
- 小売店では個別の企業と連携して E-waste の回収に関して試行的な取組が行われている。

【2-7】パイロットプロジェクトの実施結果を検証し、セクター協定のオリエンテーション委員会（CORI 等）や技術助言グループ（GTA）に対しての報告・提言のための教訓を抽出・整理する。

1) パイロットプロジェクトの実施結果からの教訓

パイロットプロジェクトの実施を通じて得られた教訓は以下の通りである。

(1) 回収率向上に向けた教訓

大型 E-waste は重量ベースで中小型 E-waste の約十倍廃棄されていると推定されており、大型 E-waste の回収を図らない限り、中小型 E-waste のみの回収では将来設定される回収率目標を達成することは難しい。

パイロットプロジェクト（PP）ではこの大型 E-waste を下取り回収によって回収することとしたが、結果として十分な数の大型 E-waste を回収することができなかった。PP 実施中の経験や消費者調査の結果から、回収率の向上には小売店における顧客への働きかけなど、小売店の役割が極めて重要であることが認識された。

さらに、小売店の役割に加えて、消費者に対する何らかの経済的インセンティブも重要であると考えられる。パイロットプロジェクトにおいては大型の廃棄対象 E-waste 一台当たり R$10 が象徴的に徴収された[7]が、この廃棄時料金徴収が、PP 実施中に実施した消費者アンケート結果では明らかではなかったものの、実質的には消費者のリサイクル意欲を創出できなかった要因となった可能性は否定できない。

パイロットプロジェクトで得られたデータをもとに推定された E-Waste の回収及びリサイクルに係わる全体的な料金は、製品購入時に課金されることを前提として算定され、その金額は製品一台当たり R$16 から R$18 である。廃棄時に課金されるわけではないので、リサイクル意欲を削ぐことは少ないと考えられるが、効率化を通じた料金のさらなる低減に加えて、ブラジルにおいて家電製品は高所得者から低所得者へカスケード的に再利用されていることもあり、最終消費者のリサイクル意欲を引き出す何らかの経済インセンティブが重要であると考えられる。

他方、パイロットプロジェクトにおいて店頭回収で回収された中小型 E-waste の量も政策目標達成に大きく貢献できる十分な量とは言えず、協力依頼を求める集中的な広報に加えて、大型 E-Waste 同様に、E-waste の持ち込みを誘引するような何らかの経済的インセンティブの付与も検討すべきである。

[7] 象徴的とは、国家廃棄物管理政策法（PNRS）の理念に基づき、消費者が大型 E-Waste の小売点等流通機関までの返還コストの一部を負担すべきとの考えから、プロジェクト初年次に実施した消費者意識調査結果も踏まえて、便宜的に R$10 に設定したことを指す。

(2) 新規ビジネス創出に係わる教訓

E-waste のリバースロジスティックは規制的な側面のほか、新規ビジネス創出という視点も重要である。E-Waste 全体の回収率目標を 20%として試算したサンパウロ市において新規に創出されると期待される市場は毎年 R$100 百万に上ると試算された。連邦国家全域で事業が行われた場合にはこの 10 倍以上の新規ビジネスが期待できると考えられる。

E-waste リサイクルの新規ビジネスは、リバースロジスティック（RL）のみならず、リバースマニュファクチャリング[8]、住民啓発、データモニタリングシステムなど多要素から構成され、多様なビジネス分野からの参加が必要である。結果、これらの多様なビジネスがうまく融合し、最大効率のシステムが形成されることが期待される。

(3) パイロットプロジェクトを踏まえた将来の本格実施に向けた教訓

パイロットプロジェクトは限られた条件下、とりわけ

- JICA が実施コストを負担する。
- セクター協定未締結下において購入時料金徴収が行えない。

という条件の下で実施されたことから、将来予定される本格実施とは前提条件が異なっている。ここではパイロットプロジェクトの内容と将来の本格実施の内容がどのように異なるのかを比較検討し、将来の本格実施に向けた参考となるよう整理する。

表 3-17 パイロットプロジェクトと将来の本格実施の仕組みの相違点

項目	パイロットプロジェクト	将来の本格実施の仕組み（想定）	考慮事項
消費者からの大型 E-Waste 回収料金徴収	- 流通への返還費用の一部として、R$10が象徴的に徴収された。	- より高い料金の徴収	- 料金の徴収時点によっては料金の増大は回収率の低下につながる。
下取り回収申込可能者	- 当該製品を購入した消費者のみ（同種の E-waste のみ回収可能） - サンパウロ市在住者のみ	- 希望者なら誰でも	- 参加資格の広がりは下取り回収への参加率改善につながる。
下取り回収サービスの受益者	- クーポンを購入した消費者とサービスの受益者が一致（廃棄時負担）	- 製品購入時に Visible Fee として徴収する場合、その Visible Fee を原資として形成される基金を Historical Waste のリサイクルに使用することを検討する必要がある（徴収された Visible Fee は購入された製品のリサイクルには用いられない）。	- 短期的には受益者と負担者が一致しないが、長期的には問題とはならない。 - パイロットプロジェクトとは全く異なる制度設計となる。
下取り回収車両	- ブラジルの商慣習として、製品配送車とは別に下取り回収専用車が配車された。	- 製品配送車が下取りを同時に行うことは検討に値する。	- 製品配送車が下取りを行うことによって回収コストを削減する可能性が高い。
一義的責任	- PNRS では、小売への返還は消費者、小売から生産者への返還は小売店	- 生産者に一義的責任が課され、回収率目標達成努力が生産者に求められた場	- 生産者の創意工夫によって回収システムが改善されていくような制度設計が

[8] 効率的なリサイクルのため、解体が容易になる、あるいはリサイクルしやすい素材を利用するといった商品設計・製造を行うこと

項目	パイロットプロジェクト	将来の本格実施の仕組み（想定）	考慮事項
	の責任、返還された E-WAATE のリサイクルは生産者の責任と規定されており、パイロットプロジェクトもその考え方の下で行われた。	合、小売店の理解、協力なくして生産者による回収率改善の努力が効果を上げにくくなる。	なされることが望ましい。例えば、製品納品時に E-waste を引き取ってくるような回収システム上の工夫。

出所：JICA 専門家チーム

(4) パイロットプロジェクトで行わなかった回収ルートに係わる教訓

パイロットプロジェクトでは家電製品の小売店ルートで回収を行ったが、他のルートで回収することも可能である。ここではパイロットプロジェクトで採用されなかったルートの可能性を検討する。

表 3-18 E-waste 回収ルートの可能性

代替ルート	利点と可能性	課題
修理サービス	- 二つのタイプの修理サービスが存在する。一つは生産者による修理サービスであり、もう一つは独立系の修理サービスである。	- 修理サービスは回収ルートとして活用可能と考えられるが、もともと修理可能な品目のみを取り扱っており、大きな効果は望めないと考えられる。
慈善寄付団体	- 慈善寄付団体への寄付は無料で回収まで行っており、50％以上の E-waste が慈善寄付団体によって取り扱われている（店舗における消費者アンケートによる）。高い回収効果を得られるルートとして期待できる。 - 慈善団体によって回収された E-waste のすべてが再販できるというわけではなく、例えば 10%の再販不可製品が発生しているとすると、このルートの可能性は 5%程度にとどまる（50％×10％）。現在再販不可なものはスカッテイロへ流れているものと考えられる。	- 通常慈善寄付団体は寄付された E-waste をそのまま、あるいは修理して再販しているが、解体作業を伴う場合には確実な環境対策が必要となってくる。 - 生産者はブランド維持のために再販を嫌うと考えられ、再販を行っている慈善寄付団体との連携が可能かどうかの検討が必要である。
カタドールによる回収、スカッテイロによる受入	- このアクターの効率は高く、また価格への応答性が高いので、仮に生産者ルートが既存ルートよりも高く買い取れば高い回収率を期待できる。 - 現在一定程度の E-waste がこのアクターに流れており、システムの設計によっては回収率向上に貢献すると考えられる。	- 生産者とスカッテイロが協働していくためには、ブランドイメージを損なわないための多くの措置が必要となろう。
カタドール組合	- 本アクターは公共セクターと協働してきている点において E-waste の回収においても協力が得やすい。	- カタドール組合が E-waste を回収するに当たり、E-waste の適正管理の徹底が課題となる。また、カタドール組合をどう動機づけるかも重要である。
資源引取りサービス（市）（“Eco Ponto”）	- サンパウロ市が“Eco Ponto”（廃棄物一次貯留場所）を E-waste 回収に活用すれば、かかる公共セクターからの貢献は非常に好ましいと考えられる。	- 生産者が主体となって最も効率的な回収ルートを模索する中で、公共ルートは民間ルートよりも効率が低いと判断される可能性もある。

出所：JICA 専門家チーム

2) 今後の展開のための論点

今回実施したパイロットプロジェクトの特徴をまとめると以下の通りとなる。

- コンソリデーションセンターを設置した回収方法を試行した。
- 大型E-wasteと中小型E-wasteで回収方法を変えた。
- 比較的近郊（サンパウロ州内）の解体・選別事業者が参加した。
- 様々なステークホルダーが参加してT/Cを形成し、合意形成を行った。

これを踏まえて必ずしもこれらの条件を満たさない他都市で E-waste リサイクルシステムを創出する際の論点を以下に整理する。

(1) 州を越えたリサイクル圏の形成

パイロットプロジェクトでは、サンパウロ市から排出されるE-wasteはサンパウロ州内のリサイクル企業にて処理を行った。これらのリサイクル企業はサンパウロ市の中心部から100kmほどの距離に既に複数存在していることから、州内でE-wasteの運搬が経済的に可能な範囲でのリサイクル経済圏が形成されていると考えられる。一方、他都市で行う場合には、E-wasteを回収・処理する施設が同一経済圏内で必ずしも得られるわけではなく、州を越えてE-wasteを輸送する必要が出てくる場合があると考えられる。

サンパウロ市のパイロットプロジェクトで課題となった事項として、①有害廃棄物としてのE-wasteの移動に関する許認可免除、②E-wasteの移動に伴う税の免除、が挙げられた。これらの課題について、①についてはCETESBが解体されないE-wasteは有害物に該当しないという省令を発出することで解決し、②の免税措置についても公表には至らならなかったが、SEFAZにおいて州内の移動については免税するといった検討もされている。

しかし、これらの課題解決策は同一州内に限った措置であり、州を跨ぐ場合はそれぞれの州での、あるいは新たな州の法律に則った制限が課せられることになる。

他都市でのE-wasteのリサイクルを検討する場合、経済圏を形成する隣接した州と連携してRL活動の支障とならないような法体系の整備を行っていくことが望まれる。

(2) コンソリデーションセンターの設置

サンパウロ市で試行したパイロットプロジェクトのステークホルダーのうち、他都市で同様のシステムを構築しようとした場合、E-Wasteの回収に係わる解体・選別事業者、コンソリデーションセンター、小売店の参加があれば可能である。

小売店については他都市においてもサンパウロとほぼ同様の水準であると考えられ、E-waste回収を行うにあたっての大きな課題とはならない。

コンソリデーションセンターは、効率的な輸送を考えた際には有効な施設である。つまり、他都市においては、将来発生するE-wasteを適切に処理できるリサイクル企業が近傍に十分存在しない場合は、コンソリデーションセンターを利用することによって遠隔地にあるリサイクル企業へE-wasteを一括して効率的に搬送することが可能となる。

コンソリデーションセンターの機能としては、以下のような機能を保持することが必要であると考えられる。これらの機能を満たす候補が他都市においても得られる場合には、既存の施設を流用することで設置は可能である。

＜コンソリデーションセンターに必要な機能＞

・E-wasteを保管する建屋（屋根、コンクリート製の床、保管スペース） ・配車サービスの経験（コールセンター含む） ・フォークリフト（E-wasteの場内移動用） ・計量設備（トラックスケール等）

なお、サンパウロ市周辺に立地する解体・選別事業者の処理規模、解体技能といったキャパシティと同様の解体・選別事業者を確保することも重要であり、他都市でE-waste回収を行う場合にはそのキャパシティの見極め、必要に応じた対策が必要である。

(3)　リサイクル企業の育成、新規立地

コンソリデーションセンターを設置したとしても、搬送先のリサイクル企業が遠方にあればコストは増大する。短期的な対策としてコンソリデーションセンターの活用は有効であるが、長期的に見ると各地域の中核都市近郊に一定規模以上のリサイクル企業（工場）を適切に配置することが望まれる。

(4)　セクター協定による新規ビジネス創出への期待感

レシフェ及びブラジリアでの調査において、既存リサイクル関連企業の中には、セクター協定締結を睨んでリバースロジスティックの受け皿となるべく今から仕組みづくりに取り組む動きがあることが分かった。例えば、大規模経済圏サンパウロ市までの高い搬送コストに対して、地域内でのリサイクルの完結が比較優位となるという点に着目した修理・再販・再資源化を組み合わせた総合的なE-wasteリサイクルサービスの提供、そのサービスの広域化のための複数企業間での協力の模索などの動きである。これらリサイクル企業の発意に基づく新たな仕組みづくりは、セクター協定における位置づけの確認は必要であるが、効率的なE-wasteリバースロジスティックの形成につながるものとして大いに期待される。他都市においてE-waste回収を行う際には、上記のような動きと連動して効率的・効果的な仕組みの形成が望まれる。

(5)　ステークホルダー機関の拡充

パイロットプロジェクトを実施したサンパウロ市では、E-wasteのRL構築に係るステークホルダー（製造業界、管理機関、小売店業界、行政機関）が十分存在したため、PP試行に関する協議・調整を行うことが比較的容易であった。

一方で地方都市の場合は、これら関係者が不在の場合もあり、RL構築に係る調整が十分行えないことが想定される。そのため、業界団体の支所の設置や本部との連絡を容易に実施できるような体制の構築などの対策が必要である。

(6)　家電の種類別の取り組み

パイロットプロジェクトの教訓のひとつとして、大型E-Wasteと中・小型E-Wasteとではその特徴、回収方法、関連するステークホルダーが異なり、RLシステム構築に当たってのアプローチも異なるものであったことが挙げられる。このため、他都市においても、同様に区分した形でのRLの構築が現実的であると考えられる。特に大型E-Wasteの回収については、パイロットプロジェクトでも苦労した点も踏まえ、慎重に検討する必要がある。

3.3　成果 3 に係る活動

【3-1】RL を監督するシステムを構築するために、モニタリングすべきポイント、必要な許認可、技術的基準を検討する。

1)　モニタリング項目

E-waste の RL システムの構築においては、E-waste の回収・適正処理状況に関し、物質および資金の流れを把握するモニタリング・レポーティングシステムの構築が必要である。セクター協定の協議においてはセクターによる管理機関（Gestora）及びそれらを統括するチャンバーを設立し、資金管理やモニタリングデータの管理を行うことが検討されており、モニタリングは以下の段階により行うことが想定される。

① 製造業界からの製品投入量データの提出
② 回収実施小売店、輸送業者、リサイクル業者から管理機関への一次データ提出
③ 管理機関による一次モニタリングデータの取りまとめ、環境省（MMA）への報告
④ 解体後の有害物質発生量、処理量データの IBAMA への提出
⑤ 州政府や連邦政府によるモニタリングの実施

E-waste の RL における必要なモニタリング項目としては、回収、輸送、解体・再資源化、有害物質・残渣処理に関する下表の項目が想定される。PP においても RL システムの本格施行時に取得すべきと考えられる一次データを小売店、輸送業者、リサイクル業者などから取得した。また、コストデータについては本格実施においてはあらかじめ設定された単価が支払われることも想定されているため、詳細なデータの取得ではなく、管理団体としての会計報告の実施を行うために必要な収入・支出状況を整理することになると考えられるが、PP においては将来の RL コストの推計のためにより詳細なデータを取得した。

表 3-19　E-Waste の R/L モニタリング項目（案）

分類	モニタリング項目	備考
回収率	・回収台数または重量 ・回収率（販売台数、発生台数推計から計算）	店舗、製品、回収方法毎のデータ取得による回収量比較
輸送状況	・輸送の実施状況	店舗における回収量と解体工場への搬入量の一致
解体、再資源化状況	・解体台数または重量 ・解体工場で産出された資源重量 ・再資源化率（重量比により計算）	解体工場における搬入量と搬出量（マスバランス）の確保
有害物質、残渣処理状況	・有害物質の解体工場からの搬出重量 ・有害物質の処理工場における処理重量 ・解体工場で発生した非有害残渣重量	有害廃棄物オペレーター登録（CNROP）システムにおける有害廃棄物の量・種類・処分先に関する年次報告書（RAPP）との統合
PP におけるコスト	・店頭回収コスト ・トレードイン回収コスト ・保管、輸送コスト	P/P においては可能な範囲で詳細なコストデータを取得し、RL 実施に

分類	モニタリング項目	備考
	・ 解体コスト ・ 有害物質処理、残渣処分コスト	かかるコスト推計を行うための基礎資料とする

出所：JICA 専門家チーム

2) 必要な許認可・技術基準

(1) E-waste の有害性に関する定義

ブラジル環境・再生可能天然資源院（IBAMA）細則 2012 年 12 月 18 日付第 13 号（IBAMA Instrução Normativa No 13, de 18 de dezembro de 2012）により「ブラジル固形廃棄物リスト」が定められており、E-waste に関連する以下の品目が有害廃棄物に指定されている。E-waste に関しては CFC を含む廃棄された電気・電子機器が有害物質と明確に指定されており、冷蔵庫・エアコンがこれに該当する。電池・蓄電池に関しては単体であれば有害物質となる。また、PCBs, HCFC, HFC に関しては多くの E-waste がこれらを含むが、解体前に関しても運用上有害物質と扱うについては連邦、州、市の行政機関により見解が異なっており、統一された運用が定まっていないことが課題である。

表 3-20 E-waste に関連する有害廃棄物

大分類	有害物質に該当する品目	考察
電気・電子機器廃棄物（1602 番）	・ PCBs を含むトランスフォーマー、キャパシター、その他の電子部品、PCBs を含む廃棄された機器（160209, 160210 番） ・ アスベストを含む廃棄された機器（160212 番） ・ CFC, HCFC, HFC を含む廃棄された機器（160211,160213 番） ・ その他の有害物質を含む廃棄された機器、機器から取り出された有害廃棄物（160213 番、160215 番） ・ 鉛、ニカド、水銀、電解液を含む電池・蓄電池（160601, 160602, 160603, 160606 番）	PCBs, CFC, HCFC, HFC に関しては解体後の部品等は有害物質とされるが、解体前の E-waste も運用上有害物質として取り扱うかどうかが課題である
分別排出された都市固形廃棄物（2001 番）	・ CFC を含む廃棄された電気・電子機器（200123 番） ・ 蛍光灯、ナトリウム、水銀ランプ（200121 番） ・ 200121, 200123 番以外の有害物質を含む廃棄された電気電子機器および部品（200135 番） ・ 160601, 02, 03 番を含む電池・蓄電池およびこれらを含む選別されていない電池・蓄電池（200133 番）	電池･蓄電池に関しては単体では有害物質であるが、これらが E-waste 機器内に含まれている場合は有害物質ではない。 CFC を含む E-waste は有害物質と定義されている

出所：JICA 専門家チーム（IBAMA 細則 2012 年 12 月 18 日付第 13 号を参考）

(2) E-waste 解体工場・有害物質処理工場

ブラジル国における E-waste 解体・リサイクル工場の操業に関連する許認可は下表のとおりである。なお、現況調査結果によればサンパウロ市首都圏には解体・リサイクル業に必要と思われる許認可を必ずしも取得していないインフォーマルな施設も存在しており、全ての許認可を包括的に網羅し、取得しているリサイクル工場はごく限られている。その理由としては次のものが挙げられる。

- 許認可の申請・更新に時間がかかる場合や行政側の手続きの遅延が頻繁に遅延する場合もあり、許認可が申請中・更新中である場合がある。
- リサイクル工場の規模や取扱品目、営業形態によっては免除される許認可もあるが、E-waste が有害性であるか等に関する統一された見解が存在しない。

したがって、P/P における E-waste リサイクル工場は必要な全ての許認可を取得している工場を選定し、家庭由来 E-waste の適正処理を行うモデルとする。

RL システムの制度の構築へ向けては、許認可を取得した工場の R/L バリューチェーンへの積極的な関与促進や融資支援を進めるとともに、新規参入企業への投資促進や、既存のリサイクル工場に対する技術指導や許認可取得促進を行うことが必要である。

表 3-21 E-waste 解体工場・有害物質処理工場に関連する許認可

許認可名	概要	申請先	根拠法令等
運営ライセンス Licença de Operação (LO)	総称として環境ライセンス（Licenciamento Ambiental）とも呼ばれるものの 1 つ。環境ライセンスには事業の実施フェーズに合わせて予備ライセンス(LP: Licença Prévia)、設置ライセンス（LI: Licença de Instalação）、運営ライセンス（LO: Licença de Operação）の 3 段階がある。LP, LI が設計・工事フェーズでの許認可であるのに対し、LO は実際の事業活動を行う際に必要とされる。 連邦レベルで影響のある大規模事業（大規模発電所や送電線、交通インフラ等）は IBAMA が申請先となるが、それ以外の一般的な事業は基本的に州の権限で許認可が発行される。また、自治体内でのインパクトにとどまる小規模な事業等については CETESB ではなく市政府が運営ライセンスを発行する場合もある。取得義務対象は州法 8468 番 57 条に定められている。E-waste リサイクル施設は以下の条項に該当すると考えられる。 ・ II – 工業活動 ・ IV - 廃棄物または固形・液体・気体物質の処理・処分に関する公共システム ・ VII - 廃棄物または固体・液体・気体物質の焼却処理（注 : E-waste では CFC ガスの破壊処理等がこれに相当）	サンパウロ州内であれば、基本的にサンパウロ州環境公社（CETESB）	サンパウロ州法 1976 年 5 月 31 日月第 997 号 Lei Nº 997, de 31 de Maio de 1976 サンパウロ州施行規則 1976 年 9 月 8 日付 8468 号 Decreto Estadual Nº 8468 de SP, de 08 de Setembro de 1976

許認可名	概要	申請先	根拠法令等
連邦技術者登録 Cadastro Técnico Federal（CTF/APP）	CTF は、潜在的環境汚染活動者（Atividades Potencialmente Poluidoras - APP）や天然資源利用者となる個人･法人が実施しなければならない連邦レベルでの登録の仕組みである。CTF/APP の義務対象者は、IBAMA 細則第 6 号の附属書 I にリストアップされる事業種類の活動を行なう個人･法人である。指定された事業種類の活動を有する事業者は IBAMA に毎年の活動報告書及び環境監督管理手数料の納付を行なう必要がある。廃棄物管理に関連する事業種類としては下記があり、また有害物質を取り扱う場合には本登録は必須とされる。 ・ 17-2　固体・液体産業廃棄物の処理・処分 ・ 17-4　浄化槽由来を含む下水･都市固体廃棄物の処分 ・ 17-53, 57, 58, 59　液体・固体産業廃棄物の処理･処分：バッテリーの廃棄、固体廃棄物のエネルギー回収、固体廃棄物の最終処分、固体廃棄物の処理	ブラジル環境･再生可能天然資源院（IBAMA）	IBAMA2013 年 3 月 6 日付細則第 6 号 IBAMA Instrução Normativa No 06, de Março de 2013）
有害廃棄物オペレーター登録台帳 Cadastro Nacional de Operadores de Resíduos Perigosos（CNROP）	有害廃棄物を取り扱う業者に関しては固形廃棄物管理政策法により有害廃棄物オペレーター登録台帳（CNROP）への登録、資格を有する技術責任者の配置義務、登録業者による有害廃棄物管理計画の策定と行政への提出、毎年の廃棄物の量・種類・処分先を記した報告書の提出、事故発生時の行政への報告義務が定められている。CNORP 登録の電子システムは、同じく IBAMA が運用する CTF/APP に相乗りする形で提供されている。CTF で登録された潜在的汚染源に区分される企業の技術責任者が、さらにその企業で有害廃棄物も取り扱う場合には CNORP 上で有害廃棄物オペレーター登録を行ない、その登録後には有害廃棄物の量・種類・処分先に関する年次報告書（RAPP）を毎年提出する義務がある。有害廃棄物の輸送、保管、処理、最終処分が対象とされる。	ブラジル環境･再生可能天然資源院（IBAMA）	IBAMA2013 年 1 月 25 日付細則第 1 号 IBAMA Instrução Normativa No 01, de 25 de janeiro de 2013
環境利害廃棄物移動許可証 Certificado de Movimentação de Resíduos de Interesse	サンパウロ州において､環境に対して重大な影響を与えうる廃棄物（ブラジル技術規格 ABNT NBR 10004 におけるクラス I および本州法に別に定められる処分場へ輸送される都市廃棄物等）を再処理、貯蔵、処理、最終処分する場所に輸送する際に CETESB により与えられる許可。ただし、セクター確約が交わされている廃棄物に関しては、例えば、	サンパウロ州環境公社（CETESB）	サンパウロ州法第 27397 号 Decreto Estadual Nº 47397/2002

許認可名	概要	申請先	根拠法令等
Ambiental（CADRI）	サンパウロ州での携帯電話の場合、CETESB は、一次回収拠点（店舗）への許認可は免除する事に合意している。また、解体工場までの輸送を含む一次ロジステイクスまでは有害廃棄物ではないと定義している。 なお、CADRI は廃棄物の有害性とは関係が無い。		

出所：各根拠法令等を参考に JICA 専門家チーム作成

E-waste の解体に関してはブラジル技術規格協会（ABNT）による下表の基準がある。現況把握調査における既往リサイクル業者へのヒヤリングによれば、E-waste 解体に関する NBR 規格に対する認知度は高くなく、まだ存在を詳しく把握していない業者もあった。また、技術基準に準拠した解体を行っているかどうかの認証制度も整備されていない。これは、基本的に NBR は自主的（voluntary）であり、法律等で別途指定されない限りにおいては義務（mandatory）ではないためである。現時点では NBR 16156（E-waste 解体）は自主的な基準にとどまっている。

しかしながら、PP においては ABNT 基準に準拠した解体を行うリサイクル工場を選定することとし、その解体実態に関するデータの提出の義務付けや訪問監査等を行い、適切な解体を行っているかどうかを確認する必要がある。PP の結果を踏まえて、RL システムの制度の本格施行において、ABNT 基準をリサイクル工場の要件としての指定や監査・認証等の制度整備の検討が行われることが期待される。

表 3-22　E-waste 解体工場・有害物質処理工場に関連する技術基準

技術基準名	対象品目	概要
ABNT NBR 16156（2013年3月18日）	電気・電子廃棄物全般	E-waste に RL に関する環境保護、労働安全衛生管理に関する主に以下のような要件を定めたもの。 ・　有害物質の管理 ・　工場への搬入、搬出重量のマスバランス ・　資源、残渣量、行先のモニタリング記録 ・　次工程も含めた追跡可能性の確保 ・　電子データの保護（製品の非特定化） ・　法的要件の順守、必要な許認可の取得維持 ・　計画、トレーニング、内部監査、書類作成
ABNT NBR 15833	家庭・事業系冷蔵庫、冷凍庫およびこれらの混合装置 エアコン（容量 17,600 W 迄）	冷却装置に関する輸送、保管、解体、再利用、マテリアル回収、残渣の最終処分に関する以下を含む手順を定めたもの。 ・　収集、輸送、受け入れ、保管方法 ・　冷媒の回収、断熱材（特に CFC 類を含むポリウレタンフォーム）の除去方法 ・　計画、記録、監査、トレーニング、安全確保

出所：NBR 規格を参考に JICA 専門家チーム作成

(3) 回収･流通

E-waste の回収・流通に必要となることが想定される許認可・書類は下表の通りである。リサイクル工場に搬入され解体されるまでの回収・保管・流通における E-waste が有害廃棄物とみなされるかどうかにより必要な許認可は大きく異なる。

PP の実施においてはプロジェクトチームよりサンパウロ州環境局（CETESB）に対して「解体されていない E-waste は有害廃棄物でない」旨の確認を行い、下記許認可が不要となった。同文書は 2016 年 6 月 3 日に正式に公布されサンパウロ州全体に適用された。

表 3-23 PP における E-waste の回収・流通に関する許認可・必要書類と課題

許認可・書類	対象	概要及び課題
環境ライセンス(LO)	・ 店頭回収実施小売店舗 ・ トレードイン回収実施配送センター	E-waste の取り扱いによっては環境ライセンス（LO）または CETESB の臨時許可（同意書 Carta de Anuência）が必要になる可能性がある。
廃棄物の輸送・保管に関する基準	・ 回収実施小売店舗、配送センター ・ 解体および二次輸送実施業者	回収・流通時の E-waste が有害物質とみなされる場合には有害物質の輸送･保管を行う許認可[9]が必要となるほか、関連する基準を満たす必要がある。運用上、非有害物質とみなされる場合には非有害廃棄物に関する輸送上の基準を参照した上での対処となる。
税務・輸送に関する書類発行	・ 回収実施小売店舗、配送センター ・ 解体および二次輸送実施業者	E-waste が有価物とみなされる場合には税務伝票（Nota Fiscal）、非有価物とみなされる場合には輸送に関する宣誓書等の代替書類の発行・携行・保管が必要となる。 回収時に全ての排出者に対して一枚ずつ書類を発行することは現実的ではないため、回収ボックスまたはトリップ毎にまとめて搬入伝票を作成する等の工夫が必要となる。
所有権の放棄に関する書類	・ 回収実施小売店舗、配送センター	排出者が回収拠点に E-waste を持ち込んだり、トレードイン回収に排出したりする際に、所有権を放棄して譲渡した旨の書面を受領する必要性について、確認が必要である。
配送センターに関する許認可・基準	・ トレードイン回収実施配送センター	トレードイン回収を実施する配送センターにおける E-waste の保管に関し、E-waste の取り扱い次第では基準や許認可が必要となる可能性がある。 また、通常、配送センターは国税局の管轄下であることにも留意する必要がある。

出所：JICA 専門家チーム

[9] IBAMA による有害廃棄物オペレーター登録（CNROP）、CETESB による環境利害廃棄物移動許可証（CADRI）が必要となる。なお、州をまたがる移動の場合には運輸省配下の国家陸運局（ANTT）による陸上輸送の許認可取得に加え、IBAMA による危険物輸送環境許可が必要となる。

【3-2】2-3 で試行した RL システムに対して、モニタリング・レポーティング体制を検討し、試行する。

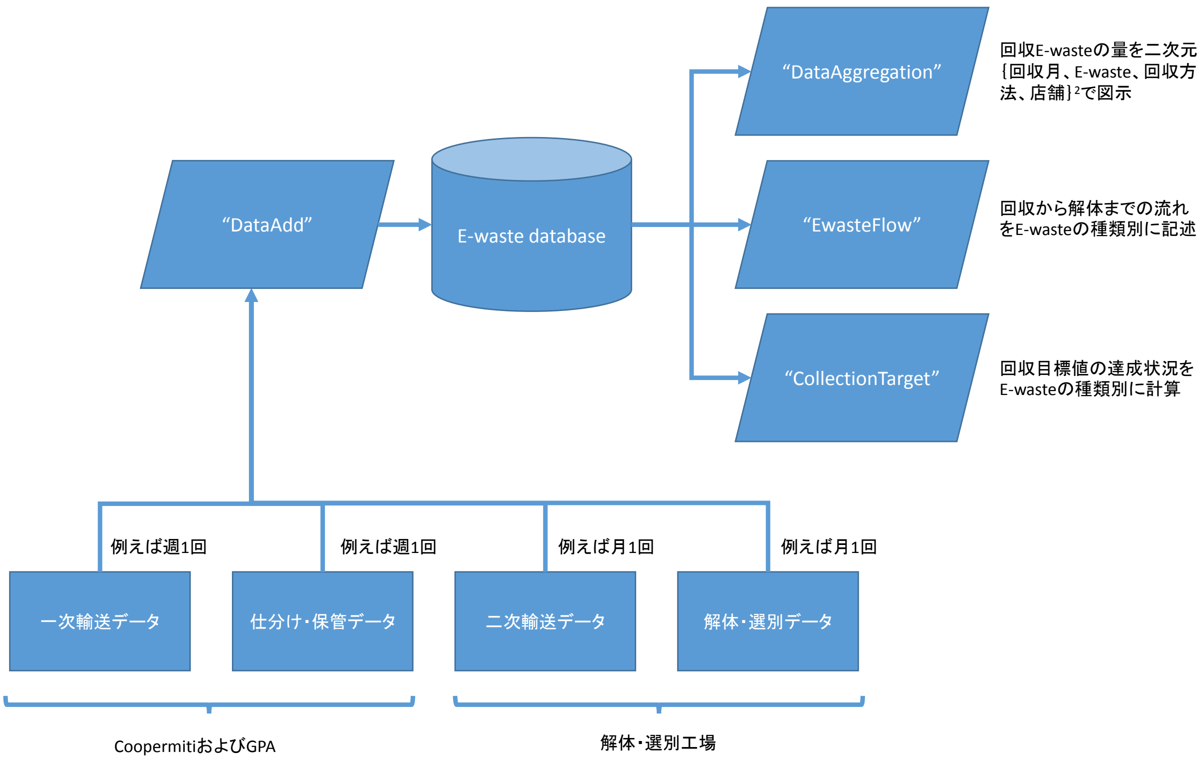
1) モニタリングデータの種類と分析ツール

E-waste の回収量に関するデータと回収・選別等のためのデータをモニタリングするシステム“descarteCALC”を開発し活用した。descarteCALC では効率的なシステムとするため Coopermiti が仕入れ管理に使用している汎用リレーショナルデータベース“Proteus System”®を前提として開発し、同システムの出力からデータを吸い上げ、これに一次輸送関連データ、二次輸送関連データ、解体・選別関連データを統合させることによって RL システム全体をカバーできるようにした。

2) descarteCALC 機能一覧

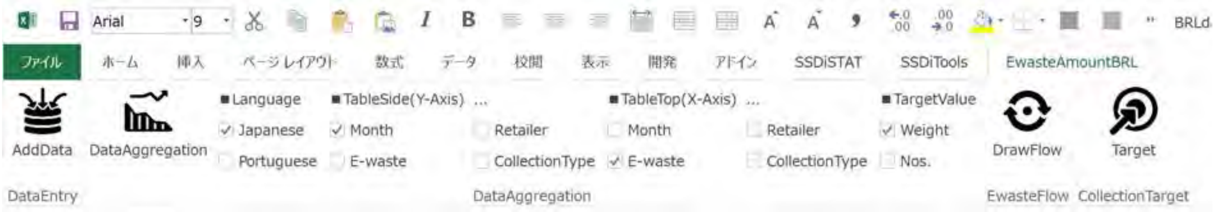
descarteCALC は Coopermiti と解体・リサイクル施設からのデータを吸い上げ、以下の情報を出力する。

- 月・E-waste・小売店・回収方法・製造者×月・E-waste・小売店・回収方法・製造者の任意の組み合わせによる回収量(台数、重量)の集計と図示
- 任意の時点までの E-Waste リサイクリングフローの描画
- 想定回収量と比較した回収率目標達成状況モニタリング



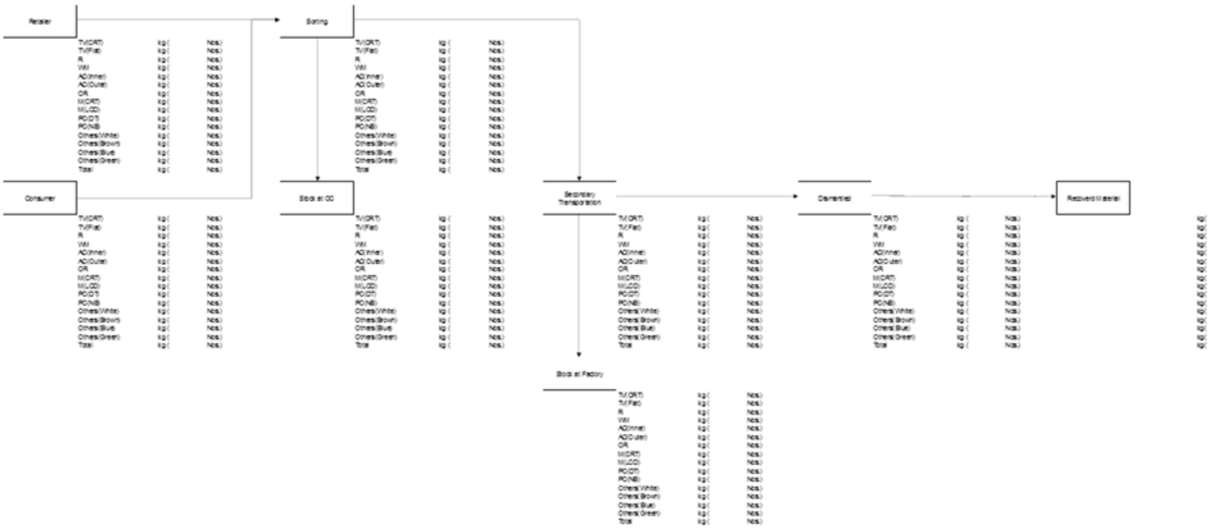
出所：JICA 専門家チーム

図 3-48 データ集計システム“descarteCALC”の全体構造



出所：JICA 専門家チーム

図 3-49　データ集計システム“descarteCALC”メニュー

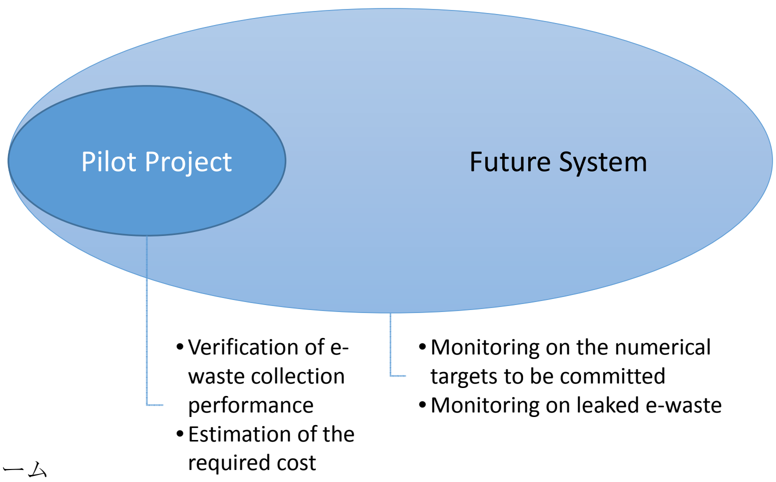


出所：JICA 専門家チーム

図 3-50　出力例：リサイクルフローの描画

3)　モニタリングシステムの将来像

本パイロットプロジェクトでは、①E-waste 回収量の特定、②回収・リサイクルコストの特定を目的としてモニタリング活動を行ったが、将来におけるモニタリングの狙いは、回収率目標・リサイクル率の達成度合いのモニタリングが主たる目的となる。加えて、他のルートへのリーケージの把握も重要となって来よう。



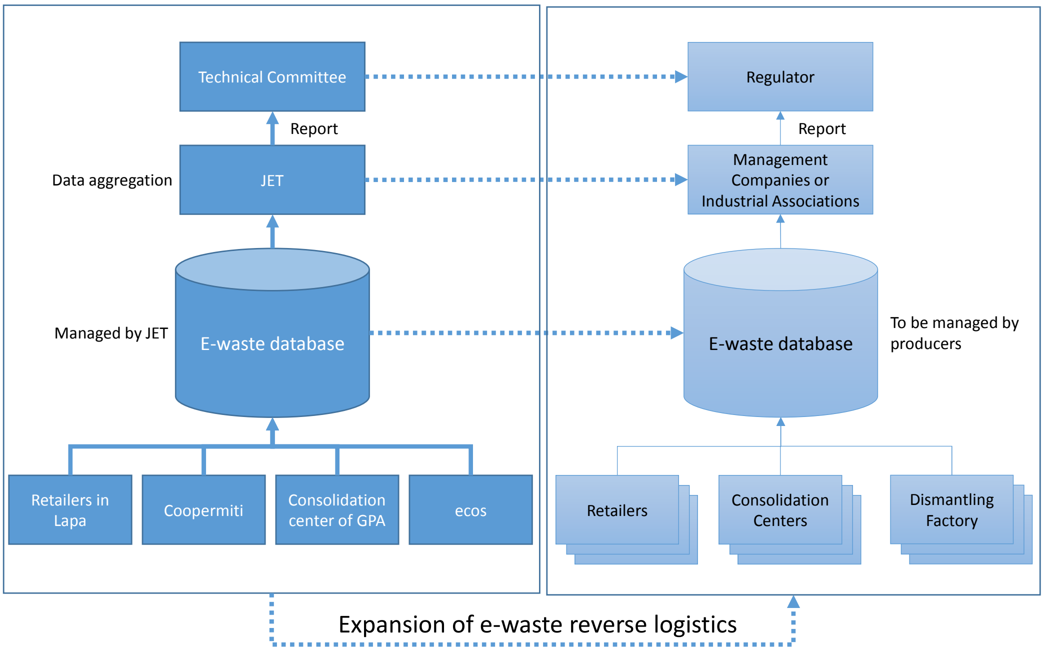
出所：JICA 専門家チーム

図 3-51　パイロットプロジェクトと将来におけるデータモニタリングに求められる機能

パイロットプロジェクトにおけるデータモニタリング体制と将来におけるデータモニタリング体制は下図のように対比できる。

構造は同じであるが、以下の点で相違している。

- 将来における回収店舗、関係リサイクル企業の数はパイロットプロジェクトよりもはるかに多い。
- パイロットプロジェクトにおいてはプロジェクトチームがデータモニタリングにあたったが、将来においては関係民間企業の役割となる。
- パイロットプロジェクトにおいてはテクニカルコミッティに報告されたが、将来においては特定の政府機関に報告されることとなる。



出所：JICA 専門家チーム

図 3-52　パイロットプロジェクトと将来におけるデータモニタリング体制の対比

【3-3】連邦レベル、州レベル、市レベルの行政向けに RL 監督のためのガイドラインを作成する。
【3-4】民間セクター向けの RL レポーティングのためのガイドラインを作成する。

行政向けモニタリングガイドライン、民間向けレポーティングガイドラインは、データ管理システムをどちらのサイドから見るかの違いであり、裏腹の関係にあるため、ここでは両者を一体的に検討した。

1)　データ管理システム（モニタリングシステム＝レポーティングシステム）の検討の視点

データ管理システムは官民で合意した達成目標数値を管理するために開発される。何を管理対象数値とするかはセクター協定を含む制度設計の根幹である。そこでモニタリング・レポーティングガイドラインの作成に当たり、望ましいリバースロジスティック制度の骨格をまず検討し、それを踏まえたガイドラインとした。

2) 各国 E-waste リサイクル制度

ガイドラインを作成するに当たり、既存文献調査によって各国の E-waste リサイクル制度を整理した。調査対象国は代表的な E-waste リサイクル制度をすでに導入している国を中心として、および地理的条件を考慮してコロンビアを加えた。調査対象国は以下の 5 か国である。

- 米国（カリフォルニア州）
- ドイツ
- オーストラリア
- カナダ（ブリティッシュコロンビア州）
- コロンビア

各国リサイクル制度の整理から得られた知見は以下のとおりである。

(1) リサイクル制度分類の視点

各国リサイクル制度の分析を通じて、以下の二つの要因でリサイクル制度を大別できることが分かった。

- リサイクル料金が Visible fee として徴収されるか、製品価格に内部化されるか？
- 料金を原資とする基金の使途に政府が関与するかどうか？

調査対象とした五か国のなかでは、米国及びカナダが Visible fee 制度を導入しており、それ以外の国、すなわちドイツ、オーストラリア、コロンビアでは製品価格に内部化されている。

また、米国では基金の使途に政府の関与があるが、それ以外の国では生産者によって使途が決められている。

(2) 制度の対象

米国とオーストラリアでは CRT に焦点を合わせた制度としているが、それ以外の三か国ではすべての電気・電子製品が対象となっている。大型家電製品と中小型家電製品では可搬性などにおいて大きく異なるため、適用される制度を対象廃棄物の特性に応じて柔軟に設定することが重要である。

(3) 政策目標

E-waste の回収率目標は調査対象としたすべての国で設定されている。回収率目標の設定は環境負荷を低減するという政策目標を表す重要な指標であり、設定することが望ましい。回収率目標の定義については、ドイツでは、回収実績を直近の販売台数で除すことにより回収率を算出しているのに対して、カナダでは推定値を用いている。回収率は各国において製品の特性を考慮して柔軟に定めている。

(4) リサイクル料金の徴収方法

E-waste 廃棄時において料金を徴収している国は調査対象国にはなかった。製品に内部化されて徴収されているか、製品購入時に Visibl Fee として徴収されている。

(5) リサイクル料金による基金の使途

調査対象とした国においては徴収されたリサイクル料金は当該製品が E-waste となった際のリサイクルに用いられるのではなく、Historical waste のリサイクルに使われている。これは当該製品

が廃棄されるまで徴収された料金を保管・管理し、当該製品のリサイクルに使用することが実際的ではないことによると考えられる。

(6)　従来ルートから新規ルートへの E-waste の流れの誘導

調査対象としたすべての国においては、廃棄時においてはリサイクル料金は課されない。これによって廃棄時における従来ルートへの流れが最小限となっており、また、廃棄時の不法投棄を最小限とするように作用していると考えられる。

(7)　DfE (“Design for Environment”)へのフィードバック

調査対象の国においては、DfE へのフィードバックが生産者の役割として重視されている。

3) E-waste リサイクル制度の論点

E-waste リサイクル制度に関する論点のうち、モニタリング・レポーティングガイドラインに関連した論点を以下の通り検討した。

(1)　誰がリバースロジスティックシステムを設計するのか？

＜オプション＞

- オプション1：一義的にリサイクル責任を課される生産者がリバースロジスティックシステムを設計する。
- オプション2：リサイクル責任を課される全セクターが協力してリバースロジスティックシステムを設計する。
- オプション3：政府が関与してリバースロジスシックシステムを設計する。

＜比較検討＞

- 一義的にリサイクル責任を課される生産者のイニシアティブの下、リバースロジスティックシステムは形成されるべきである。生産者の努力・工夫によって最も効果的・効率的なシステムが形成されることが期待される。
- 全セクターの協力を前提としたシステム設計においては関係者の合意形成コストが嵩み、機動力あるシステム形成を損なう恐れがある。
- システム形成における政府の関与は効率的なシステム形成を損ないかねない。

＜方向性（提案）＞

- 一義的にリサイクル責任を課される生産者が主となりリバースロジスティックシステムを柔軟に形成し、他セクターはこれに協力するという体制が提案できる。
- ただし、生産者によって提案されるリバースロジスティックシステムの妥当性を検証するために、生産者は政府に対して具体的システムを提案し、政府がこれを承認するというプロセスは必要と考えられる。

(2)　リバースロジスティックシステムの料金徴収システムはどうあるべきか？

＜オプション＞

- オプション1：購入時 Visible Fee
- オプション2：廃棄時 Visible Fee
- オプション3：製品価格に内部化

＜比較検討＞

- 購入時 Visible Fee、廃棄時 Visible Fee 共に消費者からの料金徴収を約束するものであり、リサイクル技術改革を含む生産者によるリサイクルコスト削減動機、生産者による製品への環境配慮設計動機を損ないかねない。製品価格にリサイクル経費を内部化することによってコスト削減、環境配慮設計を促進できる。
- 購入時 Visible Fee、製品価格に内部化のいずれも製品販売時にリサイクル料金を徴収するものであり、料金の支払者と受益者が一致せず、不公平である。製品購買時に支払われたリサイクル料金は過去に販売された E-waste の処理に充てられるからである（Historical Waste）。また、そもそも製品販売時に徴収されるリサイクル料金を Historical Waste の処理に用いることについての国民合意を取り付けておく必要がある。
- 廃棄時 Visible Fee は料金回避のための不法投棄を誘発しやすい。

＜方向性（提案）＞

- 料金徴収の容易性、料金の使途の広さなどを考慮すると購入時 Visible Fee が現実的な選択肢と考えられるものの、同選択肢の弱点を補償するための対策が講じられることが望ましい。例えば、生産者による継続的リサイクルコスト削減努力の確保、生産者による製品環境配慮設計の推進などである。

(3)　リバースロジスティックシステムが効率的・効果的に機能するための推進メカニズムは何か？

＜オプション＞

- オプション1：消費者への経済的インセンティブ（E-waste を廃棄すると得をする）
- オプション2：消費者の自主的行動を促す意識啓発
- オプション3：法制度による強制

＜比較検討＞

- 意識啓発によって消費者の自主的行動を促すことは基本であるが、啓発効果が顕在化するまでの時間を想定することはできない。
- 法制度による強制は効果的な面もあるが、違反の防止・摘発・処理等に一定以上のコストを要し、必ずしも効率的とは言えない。

＜方向性（提案）＞

- 消費者行動を促すためには経済的インセンティブが最も効果的であり、これに意識啓発、法制度による規制を組み合わせることが妥当であると考えられる。
- 消費者への経済的インセンティブとは、単に E-waste を廃棄すると「お金がもらえる」ということのみを意味するのではなく、「家の中で E-waste が占有していた場所が空く」、「他のルートに出すよりも楽である」などを含んで検討する必要がある。

(4)　E-waste 回収率をどう定義すればよいか？

＜オプション＞

回収実績を割り返して回収率を算出するための数値（分母）には以下のオプションが考えられる。

- オプション1：過去の販売台数からの一定の計算方法による推定値

- オプション2：過去の販売台数から再使用分を控除した量
- オプション3：直近の販売台数から再使用分を控除した量

＜比較検討＞

- オプション1は計算方法が複雑になりがちで合意しづらい反面、オプション2でも概ね同様の値が得られる。しかしながらオプション2であってもデータは得にくい。オプション3は最もデータを利用しやすい。
- 近年急激に普及しつつある家電製品ではオプション3によっては E-waste の廃棄量が過大となってしまう。

＜方向性（提案）＞

- データ利用度が最も高いオプション3が現実的であると考えられるが、再使用率、過去の普及度合いによって補正する必要がある。

(5)　回収率目標は E-waste の種類ごとに定めるべきか？

＜オプション＞

- オプション1：E-waste の種類ごとに回収率目標を定める。
- オプション2：E-waste 全体で一つの回収率目標を定める。

＜比較検討＞

- オプション1は各 E-waste の処理現況を踏まえた現実的な目標値を設定でき、また各 E-waste に対する政策の強弱を考慮して目標値を設定することができる。
- オプション2は設定される目標値の高さにもよるが、回収実績の高い品目が回収実績の低い品目を補い、目標値の達成を助ける方向に作用する。

＜方向性（提案）＞

- E-waste の処理現況を踏まえることができ、政策の強弱を考慮できるオプション 1 が柔軟な目標値を設定することが可能であると考えられる。

(6)　回収率目標は州ごとに定めるべきか？

＜オプション＞

- オプション1：州ごとの回収率目標
- オプション2：ブラジル全体で一つの回収率目標

＜比較検討＞

- オプション2では E-waste 回収コストの低いと考えられる都市部から順に E-waste 回収が開始され、回収率目標の引き上げにしたがって徐々により人口密度の低い地域に回収サービスが広げられていき、結果最も効率的な回収システム展開が自動的に実現されるものの、他方回収サービスが受けられない地域が発生してしまうという懸念が生じる。これに対してオプション1は各州の E-waste 処理現況を目標値に反映するなど、効率性のみならず重点的な管理が必要な州や、特定の州でのモデル的な取り組みの実施など政策意図を反映できる。

＜方向性（提案）＞

- 導入しやすい州から E-waste を開始できるオプション1が現実的な案と考えられる。ただし、回収開始時期と Visible Fee 等の徴収開始時期を合致させる必要があり、政府と産業界の密な協議・調整が必要となる。

(7) リサイクル料金は孤児製品に使われるべきか？(購入時 Visible Fee 徴収、およびリサイクル料金を生産者が負担するケース)

＜オプション＞

- オプション1：孤児製品[10]を対象製品に含む。
- オプション2：孤児製品を対象製品に含まない。

なお、廃棄時 Visible Fee 徴収のケースでは廃棄される E-waste が明確であり、孤児製品のリサイクルコストを誰が負担するかの議論は該当しない。

＜比較検討＞

- Visible Fee 等は実質的に製品価格を押し上げ、Visible Fee 等が課されない孤児製品生産者の販売競争力を有利に導いてしまう。孤児製品を対象としないオプション2はこの不公平を解消する一つの手立てと考えられる。しかしながらオプション2には、孤児製品を対象としないことに依る手続きコストの上昇、仮に孤児製品が間違って廃棄された場合の例外的コスト負担がもたらす煩雑さという好ましくない側面がある。
- 他方、孤児製品を対象とするオプション1においては、不公平感は残るものの上記課題は解消される。さらに孤児製品が回収率実績にカウントされ、回収率目標達成に加担するという産業界にとって好ましい点も指摘できる。

＜方向性（提案）＞

- 孤児製品を対象としないオプション2を採用して手続きコスト等の上昇を招くのであれば、対象とするオプション1を選択し、回収率実績にカウントするほうが E-waste 由来の環境負荷低減、貴金属回収促進という制度の目的にも合致しており好ましいと考える。

4) E-waste リサイクル制度の骨格を踏まえたモニタリング・レポーティングガイドライン

以上を踏まえて、モニタリング、レポーティングガイドライン（案）を作成した。以下、モニタリング、レポーティングすべき数値にしたがってその概要を説明する。

(1) 回収率・再資源化率

回収率と再資源化率をモニタリング・レポーティング対象数値として提案する。

回収率を算出するに当たり、回収率の定義、E-waste 推定廃棄量(または代替指標)、再使用率の推定方法の確立、および政府・産業界での合意が必要となる。

再資源化率についてはエネルギー回収を再資源化に含むかどうかが検討課題となる。適正処理が必要となる個別物質、例えばブラウン管に含まれる鉛の処理、冷蔵庫等に含有する CFC ガスなどの適正処理方法も重要なモニタリング対象となる。

(2) トレーサビリティ

回収した E-waste のトレーサビリティの管理は E-waste が適正リサイクルルートからリークすることを未然に防止するために重要である。下取り回収（Trade-in）によって回収される大型 E-waste のトレーサビリティは比較的容易であるが、コンソリデーションセンターで仕分けされる中

[10] ここで「孤児製品」とは、生産者不詳の製品、廃棄段階において生産者が不在の製品をいう。

小型 E-waste については仕分け前後でのマテリアルバランスをどのようにして確保するかが管理システムを設計する際に重要となろう。

(3) リサイクルコスト

リサイクルコストのモニタリングは同コストの上昇回避、継続的コスト削減努力維持を確保するために必要となる。

以上のモニタリング・レポーティング項目については一定の様式によって産業界が取りまとめ、年に 1 回など定められた頻度で連邦政府または州政府に提出、政府サイドでその妥当性を検証し、確定することとなる。

3.4 全成果共通の活動

【0-1】インセプション・レポートおよびワーク・プランの作成・協議

各年次のプロジェクト開始当初に、プロジェクト実施の基本方針・方法、実施体制、スケジュール等をインセプション・レポート、ワーク・プランとして取りまとめた。

表 3-24 インセプション・レポート及びワーク・プラン一覧

レポート名	提出時期	部数
インセプション・レポート	2015 年 1 月	和文:3 部、葡文:15 部、CD-R:2 枚
第 2 年次ワーク・プラン	2016 年 2 月	和文:2 部、葡文:3 部

出典：JICA 専門家チーム

【0-2】合同調整委員会（JCC）の設置及び定期開催支援

プロジェクトの実施期間において、本プロジェクト運営にかかる年間活動計画の合意、プロジェクトの進捗状況・成果の報告、重要事項に関する協議・合意等を行うための JCC の開催を支援した。JCC の構成員は、以下の通りである。

議長：開発商工省（MDIC）生産開発局 産業競争部長

メンバー：開発商工省（MDIC）、環境省（MMA）、サンパウロ市都市清掃公社（AMLURB）、国際協力庁（ABC）、JICA ブラジル事務所、JICA 専門家チーム

オブザーバー：在ブラジル日本大使館、その他議長が任命する者

JCC は以下に示すとおり合計 5 回実施された。開催内容については 8 章に示すとおりである。

第 1 回：（日時）2014 年 12 月 19 日、 （場所）MDIC

第 2 回：（日時）2015 年 8 月 7 日、 （場所）MDIC

第 3 回：（日時）2015 年 12 月 15 日、 （場所）MDIC

第 4 回：（日時）2017 年 5 月 26 日、 （場所）MDIC

第 5 回：（日時）2017 年 8 月 24 日、 （場所）MDIC

【0-3】プロジェクト業務進捗報告書およびプロジェクト完了報告書の作成

プロジェクト活動の実施状況をプロジェクト業務進捗報告書およびプロジェクト完了報告書として、C/P と協働で取りまとめた。業務進捗報告書には半期毎のモニタリングシート、技術協力成果品（英文、葡文）等を添付するとともに、今後に向けた課題を整理した。

表 3-25　提出報告書一覧

レポート名	提出時期	部数
プロジェクト業務進捗報告書 1	2015 年 9 月	和文:3 部、葡文:15 部、CD-R:2 枚
プロジェクト業務進捗報告書 2	2016 年 11 月	和文:3 部、葡文:15 部、CD-R:2 枚
プロジェクト事業完了報告書ドラフト	2017 年 8 月	和文:3 部、葡文:15 部、CD-R:2 枚
プロジェクト事業完了報告書	2017 年 9 月	和文:3 部、葡文:15 部、CD-R:2 枚

出典：JICA 専門家チーム

【0-4】本邦研修の実施

本邦研修は 2015 年 8 月から 9 月にかけた約 2 週間で実施した。詳細を 4 章に示す。

【0-5】プロジェクト進捗状況のモニタリングおよびキャパシティ・アセスメント

1)　プロジェクト進捗状況のモニタリング

プロジェクトの進捗状況は所定のモニタリングシートを用いておおよそ半年毎に、下表に示すとおり、C/P と共同でモニタリング及び評価を実施した。

表 3-26　進捗モニタリング実施結果

回数	実施時期	主たる内容
第 1 回	2015 年 4 月	プロジェクト進捗は予定通り。 本邦研修実施時期を 5 月から 8 月下旬に変更した。 Project Director（MDIC）および Project Manager（AMLURB）の交代報告。
第 2 回	2015 年 9 月	プロジェクト進捗は予定通りで、成果 1 は概ね達成した。 サンパウロ州における現況調査報告書を作成した。 パイロットプロジェクト（P/P）実施に向けたテクニカルコミッティ（T/C）会議を適宜、開催中であるが、ステークホルダーとの協議、調整に時間を要している。 本邦研修を 8 月 22 日～9 月 6 日に実施した。
第 3 回	2016 年 4 月	2015 年 11 月から第 2 年次業務を開始し、進捗は予定通り。 4 月 28 日から P/P の一部（中・小型 E-Waste の店頭回収）を開始することとなり、4 月 26 日に開始直前セレモニーを開催。 4 月 25 日～29 日に JICA 運営指導ミッションによるプロジェクト視察、協議、指導が行われた。
第 4 回	2016 年 9 月	プロジェクト進捗は予定通り。 P/P については、大型 E-Waste の下取回収を開始するとともに、実施期間を 12 月末まで延長することとした。

		P/P 実施に当たっての各種広報活動を継続すると共に、T/C メンバーに向けた月次報告を実施。
第 5 回	2017 年 4 月	プロジェクト進捗は予定通り。 パイロットプロジェクトは予定通り 12 月末に終了し、2017 年 2 月の T/C 会議で結果が共有された。 2016 年 10 月のサンパウロ市長選挙の結果、Project Manager を含む AMLURB の幹部が交代した。 ブラジリアとレシフェを対象とした基礎的現況調査を実施中。
第 6 回	2017 年 9 月	プロジェクト進捗は予定通りで、同年 8 月で全ての現地活動を終了し、8 月 24 日に最終の JCC 会議を開催した。 また 8 月 9 日に最終の TC 会議を開催しパイロットプロジェクトで得られたコスト分析結果や 2 都市での基礎的現況調査結果概要、E-waste の RL に係わるモニタリング・ガイドライン案の説明を実施した。

出典：JICA 専門家チーム

2) キャパシティ・アセスメントの結果

キャパシティ・アセスメントは、カウンターパートの組織（MMA、MDIC、AMLURB）ごとに質問形式での「キャパシティ・アセスメントシート」を作成・活用してプロジェクト期間中に以下に示すとおり 3 回実施した。

第 1 回： 2015 年 7 月～8 月、

第 2 回： 2016 年 9 月～10 月、ただし MDIC は実施しなかった。

第 3 回： 2017 年 7 月～8 月、ただし MMA 及び AMLURB は実施しなかった。

キャパシティ・アセスメントの結果は以下のとおりである。

表 3-27 キャパシティ・アセスメント結果

【MMA】（2016 年 10 月 4 日実施）

開発すべきキャパシティ	・ RL システム運営に係る産業界や関係諸団体との調整能力 ・ E-waste の現状把握能力（インベントリ及び流れ図） ・ モニタリング・レポーティングに係る政策立案・運営能力 ・ 有害物質管理に関する技術基準、許認可の政策立案能力 ・ 具体的な E-waste RL に係るモニタリングノウハウ ・ 他州展開に係る考え方、JICA モデルの活用方法
体制	MMA で E-Waste の R/L に係る部局は、都市環境部有害廃棄物課であり、専任の職員はいないものの 3 名の職員が担当しており、自己評価では、現上の体制は、リバースロジスティクスを直接実施する機関（民間）を支援する上では適切との評価である
現状理解	E-Waste の R/L に係る現状理解は進んでおり、また、セクター協定に係る民間団体との協議ならびに JICA プロジェクトの実施によって、ステークホルダーの整理と関係の密接化が図られつつある。また、連邦政府と州及び自治体との責任分担及び連携についても具体化しつつある。
RL 構築推進計画	国家固形廃棄物管理政策法に基づく E-Waste の RL 構築に向けた手順、及び環境省の役割は既に明確に規定されている。現在、その手順に沿って R/L 制度導入のためのオリエンテーション委員会の事務局として機能しており、今後の進捗にしたがって、RL の実施計画やモニタリング計画の立案や、その専任担当者の選任が行われる予定である。

調整機能	E-Waste の RL 構築に係る関係者との様々な調整事項に係る連邦政府の役割は明確に理解されており、民間セクター、州政府、自治体等の役割分担も明確である。一方、NGO やカタドール組合との折衝は、RL の実施主体である民間セクターが実施するものとして、連邦政府は干渉しないこととしている。
教育・訓練計画	E-Waste の RL に係る教育・訓練の機会はいくつかあり、特に日本や EU との国際協力プロジェクトを通じて提供されるが、職員個人の関心ベースで機会が与えられることが多く、構造化はされていない。E-Waste のみならず固形廃棄物・有害廃棄物全般の管理、運営に係る能力向上が求められている。
RL に係る法制度	環境省は E-Waste の RL 構築の所管省庁であり、現状の法制度は十分に理解し、E-Waste 以外の RL 対象品目のモニタリングも行っている。一方、自己報告に依存するモニタリングと取締に関しては改善の必要性が指摘されている。
有害廃棄物に係る法制度	前項と同様、環境省は有害廃棄物管理の所管官庁であり、現状の法制度の理解は十分である。一方、適切な有害廃棄物管理に係る財政上の仕組みや、優遇措置、あるいは有害廃棄物の適正処理に係る技術情報の整理等、今後、検討すべき課題も認識されている。
社会配慮	自己分析の結果では、E-Waste の RL ならびに E-Waste に含まれる有害物に係る市民及び社会的弱者の理解はまだまだ低いと認識されている。一方、R/L の構築主体である事業者の理解はやや高いが十分ではない。
回収・流通システム	国家固形廃棄物管理政策法では具体的な E-Waste の回収・流通システムについては定めて折らず、セクター協定の協議ならびにその実施の中で検討されるべきものである。現在、まさにセクター協定の交渉中であり、地域の特性に応じた適切なシステム構築が民間セクターならびに関連する地方自治体に求められている。
広報・PR	E-Waste の RL に係る情報公開については既往の国家廃棄物管理情報システム（SINIR）を通じて行われる予定であるが、E-Waste の回収方法といった市民向けの広報・PR の具体的な方法や他事例については把握されていない。今後の R/L 構築・実施の中での経験の蓄積が期待されている。
レポーティング・モニタリング	前述の SINIR、あるいは連邦技術登録（CTF）を活用したレポーティング・モニタリング制度に係る方針の検討中であるが、まだ実施には至っていない。行政間の縦横断的な制度の基本方針やガイドラインも未整備である。

【MDIC】（2017 年 8 月 18 日実施）

開発すべきキャパシティ	・ RL システム運営に係る産業界や関係諸団体との調整能力 ・ RL 産業育成のための経済的インセンティブ政策立案能力 ・ 他州展開に係る考え方、JICA モデルの活用方法
体制	省内には E-waste の RL に特化した部局はないが、エネルギー・持続性調整課が、MMA 等と連携し産業界における持続性促進に係わる部分について 2 名の担当者を決めている。E-waste の RL 関連で予算は計上されておらず、自己評価では、現状の体制は必ずしも十分とはいえないと考えられている。
現状理解	JICA プロジェクトによる知見・情報に加えて既往の調査結果などは省内に蓄積されてはいるが、RL に関連する民間企業情報は十分に把握、アップデートされておらず、その信頼性から関係者への情報共有や外部への情報公開も行われていない。これらは情報不足や要因・予算不足にも起因している。
RL 構築推進計画	MDIC は RL 構築に向けた主要官庁のひとつであり、技術的、政治的な係わりは深いが、特に同省としての RL 構築推進計画は策定していない。MMA 等の

	関連省庁と協力した早期の RL 構築に向けた活動のための人材や予算は必ずしも十分ではない。
調整機能	MMA と同様に、連邦レベルでの調整や情報共有は行われているが、市や州といった地方政府とは必要に応じて情報共有は行うが、個別の調整は行っていない。民間セクターとは NGO を除いて何らかの情報共有や連携・調整は行われている。
教育・訓練計画	E-waste あるいはその他の廃棄物管理・資源化に係わる教育・訓練の機会は、ほとんどが国際協力の結果として付与される場合が多い。これらのテーマでの学識機関による教育・訓練もなく、継続計画も含めた研修計画は策定されてはいない。
RL に係る法制度	国家廃棄物管理政策法が基本法であるが、連邦政府と地方政府間での技術支援や財政支援の仕組みは MDIC で有していない。また、法令の実施に関してはほぼ全てのセクターで実施が遅れており、動きも非常に遅い。
有害廃棄物に係る法制度	有害物質に関しての基本政策は MMA の管轄であるが、省庁間、あるいは市や州といった地方政府との連携の仕組みはない。有害廃棄物処理事業者に対する経済的インセンティブ関連の制度はあるもののその活用は十分ではない。
社会配慮	自己分析の結果では、E-Waste の RL ならびに E-Waste に含まれる有害物に係る市民及び社会的弱者の理解はまだまだ低く 50%以下と認識されている。一方、R/L の構築主体である事業者の理解は 70%程度と考えられているが、関係アクターの関与に係わる適正な情報は不十分である。
回収・流通システム	国家廃棄物管理 E-waste の基本的な回収に係わる方針は示されていると認識しているが、具体的なリサイクル料金の設定やその資金管理に係わる方針・方法は民間セクターにゆだねられている。リサイクル企業に対する税優遇策はあるが、RL そのものをモニターする仕組みはまだない。E-waste の回収、流通に係わるステークホルダーとの協議の場はあるが、十分に機能してない。
広報・PR	E-waste の RL に係わる広報・PR に係わる戦略や実施方針、苦情窓口などについて MDIC は関与していない。JICA プロジェクトの経験以外の事例や協力メディアも承知していない。
レポーティング・モニタリング	連邦政府間、あるいは地方政府との E-waste R/L のレポーティング・モニタリングに関する MDIC の基本方針やガイドラインは準備されていない。先行している農業化学品の容器包装やタイヤ、潤滑油の RL 事例も参考としつつ、JICA プロジェクトの成果であるガイドライン案を今後吟味していく予定である。

【AMLURB】（2016 年 9 月 30 日実施）

開発すべきキャパシティ	・ RL システム運営に係る産業界や関係諸団体との調整能力 ・ E-waste の実態把握能力（インベントリ及び流れ図の調査・作成能力） ・ 具体的な E-waste 回収・流通システムの運営支援・管理能力 ・ E-Waste RL に係る具体的な広報・PR 活動の実施・管理能力 ・ 具体的な E-waste R/L に係るレポーティング能力 ・ 具体的な E-waste R/L に係るモニタリング能力
体制	サンパウロ市は、サンパウロ市廃棄物統合管理計画（PGIRS-SP）において、E-Waste の R/L 導入に関する全体的な戦略を定めている。具体的な取り組み方法は、サンパウロ市緑環境局（SVMA）を統括とするサンパウロ市局間委員会で検討されることとなっている。パイロットプロジェクトの実施は、これらの取り組みを推進する上で貴重な経験と理解されている。
現状理解	本プロジェクトにより、サンパウロ市における E-Waste の現状理解は進んでいるが、十分には整理されていない。

R/L 構築推進計画	前述の PGIRS-SP での戦略に沿った推進計画がある。連邦レベルでのセクター協定に加えて、必要であれば市独自でセクター確約（Commitment Term）を構築する計画となっている。
調整機能	E-Waste の R/L 構築に係る関係者、特に連邦政府、州政府および市政府間での調整機能は不十分との認識である。これらも含め、パイロットプロジェクトを通じてサンパウロ市に求められる調整機能を把握する予定である。
教育・訓練計画	サンパウロ市にとっても新たなチャレンジである E-Waste の R/L 構築に係る教育・訓練の機会は不十分であり、JICA プロジェクトと通じた機会提供は貴重との認識である。
R/L に係る法制度	現状の法制度は十分に理解されている。一方で、行政間の統合性が必要との認識である。
有害廃棄物に係る法制度	前項と同様、現状の法制度の理解は十分である。一方、技術支援・財政支援の仕組みはない。また、AMLURB の管轄である医療固形廃棄物（RSSS）の適正管理に関しては、一部、既往の法規制の改正の必要性が示唆されている。
社会配慮	自己分析の結果では、環境省同様に、E-Waste の R/L ならびに E-Waste に含まれる有害物に係る市民及び社会的弱者の理解はまだまだ低いと認識されている。一方、サンパウロ市では既に E-Waste 専門のカタドール組合（COOPERMITI）との協定を有しており、社会配慮が成されている。今後、関係者との一層のコミュニケーション活動の推進や環境教育の必要性が認識されている。
回収・流通システム	前述の PGIRIS に沿った活動の中で民間セクターとの協議を通じて具体化されていく予定である。
広報・PR	サンパウロ市では、例えばドライ廃棄物の分別回収など、これまで様々な固形廃棄物の適正管理に関する広報・PR 活動を実施、あるいはその実施主体への支援・協力を行ってきている。E-Waste の R/L に関しても、パイロットプロジェクトを通じて、サンパウロ市に求められる広報・PR 活動を把握していく予定となっている。
レポーティング・モニタリング	前述の SINIR によって、連邦政府によって実施されるという理解であり、サンパウロ市としてのレポーティング・モニタリング方法については、その必要性も含めて検討が不十分と認識されている。

【0-6】プロジェクト広報

本プロジェクトにおける広報活動はプロジェクト全体広報と PP の広報活動がある。前者は本項に記載し、後者は【2-4】に記載する。

2016 年 1 月からは、PP 広報準備および PP 広報活動に重点を置いたが、その活動の中で PP は 2014～2017 年の 3 年間で実施されるブラジル国 E-waste リバースロジスティクス改善プロジェクトのパイロットプロジェクトであることを主張し、プロジェクト認知拡大を目指した。

PP がこの全体プロジェクトのなかで、期間限定で行われる活動であることの周知は、PP の実施意義および目的を市民に理解してもらうために重要であり、また PP は全体プロジェクトを市民に知らしめる好機であったため、PP 広報時には、“descarte ON は、ブラジル国 E-waste リバースロジスティクス改善プロジェクトのパイロットプロジェクトです”という一文およびを全体プロジェクトのロゴを可能な限り記載している。具体的活動を以下に示す。

1) 関係機関へのプロジェクト進捗情報の共有

PP 準備期および実施期前半においては、日々プロジェクトの進行を関係機関と調整・確認・決定していたため、進捗情報の共有は、個別打ち合わせ、E-mail、電話など、日常業務の中で行い、協議が必要な事項については、ワーキンググループおよび TC で情報共有を実施した。

また 2016 年 6 月から、回収回数・数量・品目などの情報およびそれについての考察をパイロットプロジェクトの進捗状況として、TC メンバーへ月次共有した。

2) 関係機関の広報活動によるプロジェクト紹介

1)で記したように日々、関係機関との連絡が発生し、プランが変化する状況下では、印刷版ニュースレターの発行は業務に即さないため実施しなかった。

また AMLURB はニュースレターの発行を停止したため（2016 年 1 月に広報担当に確認）、それ以降、本プロジェクトの AMLURB ニュースレターへの情報掲載は行われなかった。一方で、【2-4】に記載した通り、関係機関によるプレスリリースの実施や広報誌でのプロジェクト紹介および PP 紹介は PP 計画期と比べ、より積極的に行われ、PP 紹介と共に全体プロジェクトへの言及が行われた。

3) ブラジル国民対象全体広報

（1） プロジェクトウェブサイト運営

2015 年 9 月に公開したプロジェクトウェブサイト(reee.jica.eco.br)の運営を継続的に行っている。本サイトは、JICA プロジェクトメンバーが新着情報およびメンバーページを CMS で編集・管理できる設計にしており、主に News や Members の情報を適宜更新している。またサイトへのアクセスは、PP ほど多くはないが、PP 開始後も減少することなく一定の数字を保っており、以下のようになっている。

Google Analytics で調査した 2015 年 9 月 1 日～2017 年 6 月 30 日現在までのアクセス状況は以下の通りである。PP と同様に滞在時間が長いことおよび国外からのアクセスも多いことが特徴といえる(多い順からブラジル 45.7%、米国 9.61%、英国 7.84%、日本 6.51%)。

- アクセス総数：3,381（うち 28.66%がサンパウロ市からのアクセス）
- 平均ページ閲覧数：2.22
- 平均滞在時間：2:38

（2） Facebook ページの運営

PP 開始にあたり、プロジェクト Facebook ページ[11]を、PP 用にページに書き換えることを検討したが、主に以下の理由によりプロジェクト Facebook ページを継続運営し、PP Facebook ページは、【2-4】のとおり別途制作した。

- PP と全体プロジェクトの区別をつけることは市民への積極的な広報を行い、参加を呼びかける PP の意義および目的を説明する際に必要と考えた

[11] ポルトガル語：https://www.facebook.com/Projeto-JICA-de-Log%C3%ADstica-Reversa-de-Res%C3%ADduos-Eletroeletr%C3%B4nicos-no-Brasil-366291166887995/?ref=bookmarks
英語：https://www.facebook.com/Projeto-JICA-de-Log%C3%ADstica-Reversa-de-Res%C3%ADduos-Eletroeletr%C3%B4nicos-no-Brasil-366291166887995/

- PP 終了後に、そこで得た情報や知見がどのようなものだったか、どのように活用されるかを市民に共有する場として、全体プロジェクトが主体となるメディアの存在が必要であり、Facebook ページがそれに適していると考えた
- PP 実施中にも、TC 実施などの全体プロジェクトとして発信すべき情報があると考えた

PP 実施中継続的に運営されたプロジェクト Facebook ページには、主にパイロットプロジェクト Facebook ページの投稿を Share するなどして活用した。PP Facebook ページの影響で、プロジェクト Facebook へのアクセスや Like も微量ではあるが増加している。

(3) JICA ブラジル事務所ホームページへのニュースレター掲載

本プロジェクトのパイロットプロジェクトである descarte ON の開始にあわせて、JICA ブラジル事務所の facebook ページならびに JICA BRASIL 便り（2016 年 6 月号）で descarte ON の活動内容が紹介された。

4) 日本国民向け広報

第 1 年次に JICA ホームページ上の「プロジェクトニュース」用のプロジェクト概要および日本語ニュース原稿を作成し、JICA 地球環境部経由で広報部に提出した。その後、プロジェクトニュースについては JICA ブラジル事務所と調整することとなっている。なお、この「プロジェクトニュース」は日本国民向けの日本語ページのみとし、ブラジル関係者・国民に対しては前述したプロジェクトウェブサイト（ポルトガル語、英語）にて行うものである。

5) 報道機関を通じて実施する全世界に向けた広報活動

報道機関を通じたプロジェクト全体広報は、上述のとおり積極的 PP 広報活動と同時に行った。現地日本語メディアおよび日本のマスメディアのサンパウロ支局等にもプレスリリースを配信した。

表 3-28　プロジェクト広報の対象者・手段・内容・原稿作成者・言語

対象者	広報手段と内容	原稿作成者	言語
関係機関	TC 会議等での直接的な広報 ・プロジェクト進捗状況報告	専門家チーム	葡語
関係機関・ブラジル国民	プロジェクトウェブサイトの制作および運営 ・本協力の意義、案件概要、成果の紹介 ・プロジェクト組織図・協力団体、関連企業の紹介		葡語 英語
	関係機関広報誌への掲載	関係機関作成、専門家チーム確認	葡語
日本国民	JICA ホームページへの「プロジェクトニュース」の掲載	専門家チーム	日本語

出所：JICA 専門家チーム

4. 研修員受入実績

本邦研修は 2015 年 8 月 24 日から 9 月 5 日までの約 2 週間、以下の概要で実施された。

(1) 参加者

本邦研修への参加者は合計 11 名であった。カウンターパート機関（MMA、MDIC、AMLURB）のほか、R/L を形成する民間団体等の多様な関係者が参加した。

表 4-1 本邦研修参加者一覧

No.	氏名	所属・肩書き
1	Sabrina Gimenes de Andrade	環境省(MMA) 都市環境部有害廃棄物管理課々長（環境アナリスト）
2	Beatriz Martins Carneiro	開発商工省(MDIC) 産業競争部担当課長
3	Marcos Batista CotoviaPimentel	科学技術革新省/技術情報センター(MCTI/CTI) 電子・電気製品分析・品確課々長
4	Helena Maria Rivello Terzella	サンパウロ市都市清掃機構(AMLURB)プログラムコーディネーター
5	Pedro Penteado C. Neto	サンパウロ州環境公社(CETESB) 土地管理・利用セクター評価・支援担当課長
6	Vanderlei Niehues	ブラジル家電リサイクル協会(ABREE)代表
7	Ademir Brescansin	ブラジル電気・電子機器産業協会(Abinee)サステナビリティ部担当課長
8	Luis Carlos Machado	全国電気・電子機器産業協会(ELETROS)サステナビリティ・品質部持続可能性担当課長
9	Fabio Augusto Luiz Pina	サンパウロ州商業連盟(FECOMERCIO-SP)シニアエコノミスト
10	Paulo Pompilio	ブラジルスーパーマーケット協会(APAS)コーポレートリレーション部長
11	Alex Luiz Pereira	E-waste 専門カタドール組合(Coopermiti)代表

出所：JICA 専門家チーム

(2) スケジュール

日本における研修期間は 2015 年 8 月 24 日〜9 月 5 日の 13 日間であり、その研修日程は以下のとおりである。

表 4-2　本邦研修日程

月日	曜日	午前	午後	宿泊地
8/22	土	移動（サンパウロ・ブラジリア発）		機内泊
8/23	日	移動		機内泊
8/24	月	移動（東京着）		東京
8/25	火	研修ブリーフィング	研修オリエンテーション	東京
8/26	水	● 家電リサイクルにおける家電製品協会の役割	● 経済産業省・環境省合同意見交換 ● ブラジルの E-Waste 政策等の紹介（ブラジル側発表）	東京
8/27	木	● 日本におけるパソコンリサイクルの現状	● 東京都における E-Waste 回収・処理及びエコタウン ● 宅配業者を収集委託先とした処理スキームについて	東京
8/28	金	● 家電リサイクル工場の視察	● 小型家電回収事業の紹介	東京
8/29	土	資料整理		東京
8/30	日	移動（東京→神戸：新幹線）		神戸
8/31	月	● E-Waste 指定保管施設の視察	● 家電リサイクル工場の視察・管理団体の役割	神戸
9/1	火	移動	● E-Waste からの金属回収・製錬工場の視察 ● 地方自治体における廃小型家電回収の取り組み	大館
9/2	水	● エコタウン計画及び家電リサイクル	● 市内こでん回収 BOX 設置場所（公共施設）の視察 ● 家電リサイクル工場視察 移動	東京
9/3	木	研修のとりまとめ（TIC）	● 家電量販店での家電下取り回収	東京
9/4	金	評価会 ※研修結果の発表	閉講式	東京
9/5	土	資料整理	移動（東京発）	機中泊
9/6	日	移動（サンパウロ・ブラジリア着）		―

出所：JICA 専門家チーム

5. 活動実施スケジュール

活動実績スケジュールを以下に示す。

表 5-1 活動実績スケジュール

活動	工程		
	2014/10～2015/9	2015/11～2016/9	2016/10～2017/9
【1-1】 サンパウロ州における e-waste の発生・リサイクル・処理・潜在量の現況を調査し、インベントリを作成する。			
【1-2】 サンパウロ州における現在の e-waste の流れの詳細を調査し、e-waste の流れ図（waste stream chart）を作成する。			
【1-3】パイロットプロジェクトを行うエリア、対象品目、RL システムに参画するステークホルダーを同定する。			
【2-1】 テクニカルコミッティを設立する			
【2-2】対象品目の RL システムのパイロットプロジェクト実施に係る仮説、諸条件及び調整方法を検討、合意する。			
【2-3】パイロットプロジェクトにおける RL システムフローの運営プロセスを検討し、システムを試行する。			
【2-4】パイロットプロジェクト実施に当たっての事業者向け、消費者向け広報・普及活動を実施する。			
【2-5】RL への民間の設備投資を促進するために、税制優遇策ならびに融資優遇制度など経済的インセンティブの検討協議に参加する。			
【2-6】2-3 で提案された RL システムフローを、選定された他州の都市に導入するための基礎的な調査を行う。			
【2-7】パイロットプロジェクトの実施結果を検証し、セクター協定のオリエンテーション委員会（CORI)に対しての報告・提言のための教訓を抽出する。			
【3-1】RL を監督するシステムを構築するために、モニタリングすべきポイント、必要な許認可、技術的基準を検討する。			
【3-2】2-2 で試行した RL システムに対して、モニタリング・レポーティング体制を検討し、試行する。			
【3-3】連邦レベル、州レベル、市レベルの行政向けに RL 監督のためのガイドラインを作成する。			
【3-4】民間セクター向けの RL レポーティングのためのガイドラインを作成する。			

凡例： ：連続的活動、 ：断続的活動

出所：JICA 専門家チーム

6. プロジェクト実施・運営上の課題・工夫・教訓

1) プロジェクトの実施体制

プロジェクトの実施体制は、第 1 年次から継続して図 1-1 に示した通り合同調整委員会とテクニカルコミッティ、及びブラジル側カウンターパートと JICA 専門家チームで構成されるプロジェクトチームの有機的な組み合わせを基本とした。

しかしながら、第 2 年次においても、第 1 年次と同様に主要メンバーの交代が多く、2017 年 1 月にはプロジェクトマネージャーであるサンパウロ市都市清掃公社（AMLURB）の計画開発部長が再度交代し、3 年間のプロジェクト期間中において 4 人目のプロジェクトマネージャーとなった。実務担当であった AMLURB の担当課長も 2016 年 10 月のサンパウロ市長選挙により政権政党が交代したことで退職した。AMLURB 総裁も同市長選挙の結果を受けて再度交代し、こちらもプロジェクト期間中で 4 人目の総裁となった。また、プロジェクト終盤の 2017 年 5 月に MDIC のプロジェクトダイレクターも前任者の昇進に伴う交代をしている。

このような、頻繁に度重なる主要な関係者の交代によるプロジェクト運営への影響は大きかったが、ブラジル側も可能な限りプロジェクト内容の引き継ぎを後任者に図るなど影響の軽減に努めていた。その一方で、プロジェクトの成果がきちんとブラジル側にフィードバックされ受け継がれたかと言う点については不安が残る結果となっており、ブラジル側における JICA プロジェクトの成果・経験を共有するための仕組みについて確立することが望まれる。

2) 多様なステークホルダーとの合意形成

E-Waste の RL においては、連邦レベル、州レベル、地方レベルでの様々な公的セクター、製造業界、小売流通業界、廃棄物回収・資源化業界、広報・広告業界といった民間セクター、研究機関、NGO やカタドール組合といった社会的団体など関連するステークホルダーが非常に多岐にわたっていることが特徴である。

これら多様なステークホルダーとの合意形成には時間と労力を要するものであるため、ステークホルダーとの意見交換や調整の場としてテクニカルコミッティ（TC）を設置した。同コミッティーはパイロットプロジェクト実施に際してのステークホルダー間の調整等を含め、プロジェクトの円滑な実施に貢献した仕組みとなった。

一方、JICA 専門家の派遣期間や日程は限定的であることから、TC やワーキンググループ（WG）といった全体会議の準備段階として、各ステークホルダーとの事前個別協議を複数回実施するなどの工夫を行ったが、合意形成のスピードアップには至らなかった。多様なステークホルダー間での合意形成に際しては慎重な配慮と諸手続きが求められるものの、一方でプロジェクトとしての定められたスケジュールや専門家の投入量に限りがあるため、プロジェクトチームはしっかりと目標と期限を共有し、相互に協力して活動を行わなければならない。

3) パイロットプロジェクトの広報活動

広報活動の基本として、広報の方法には複数の媒体が存在し、そのどれかひとつだけを実施すれば効果が得られるというものではなく、目的に応じて複数の媒体を用いた戦略的な取組が必要となる。その一方で TV メディアを通じた広報については、他の広報媒体と比べても依然として市民に向けた影響力があり、ブラジルにおいても有力な広報媒体の一つとなっている。また、その影響力に比例して TV 広報の広告料金は他の媒体と比較しても高額となっている。

本プロジェクトでは限られた予算の中で効果的な広報活動を実施するために戦略的な広報計画を立案して活動を行ってきたが、影響力の高い TV メディアについては直接広告料金を支払って利用するのではなく、マスコットキャラクターの制作やイベントの開催など、先方からの取材を受ける形（無償）でプロジェクト情報を発信する戦略とし、実際に複数の TV メディアの取材を受けることに成功した。

このように、本プロジェクトが広く周知されたことは望ましいことであるが、一方で、これは限られた広報予算の中でプロジェクト広報担当者のみならず他のスタッフ、カウンターパート、再委託事業者が昼夜なく努力した結果であり、この点は理解されるべきである。また、広報活動は継続した努力が必要であり、専門家が出張を繰り返す技術協力プロジェクトの形態ではおのずと限界があることも事実である。広報担当専門家の現地アサインがない時期にも日本国内からプレスリリースの原稿チェックなどを行うなど時間を拘束されやすいため、今後の JICA プロジェクトに従事する広報担当者には、これらの実態に即したプロジェクト従事の形態を探るべきである。

4) 本邦研修の効果

本プロジェクトの本邦研修では参加者数こそ限られたものの、E-waste のリバースロジスティックスを構成するステークホルダーとしての TC 参加団体全体を網羅するよう選抜することができたことから、ステークホルダー組織間の相互理解を深める効果をもたらした。

研修の実施時期をプロジェクトの 1 年次にしたことにより、その後のパイロットプロジェクト計画の立案・検討などプロジェクトの円滑な実施に貢献しうる時間的な余地を生むことも出来た。また、研修内容についても、様々なステークホルダーが参加することから事前に参加者から要望を集めて研修に反映した。

5) JICA 終了時評価への対応

2017 年 5 月 9 日～26 日の間、JICA による終了時評価調査ミッションが派遣され、プロジェクト期間中の活動に対する提言がなされた。

以下は、その提言内容と対応事項である。

表 6-1　終了時評価ミッションの提言と対応結果（プロジェクト期間中）

対象者	提言内容	対応結果
連邦政府および プロジェクトチーム	**1)　セクター協定の進捗にかかる情報共有** モニタリングガイドラインやレポーティングガイドラインといった、プロジェクトの成果物の最終化に向けて、セクター協定の進捗およびその討議内容をアップデートすることがプロジェクトチームにとって重要となる。連邦政府はその議論にかかる要点や内容について、日本人専門家と情報共有を行なうことを提言する（外国人が政府組織内部の協議に参加することは基本的に認められていないため）。	専門家チームの現地活動が終了するまで MMA 及び MDIC に対してセクター協定の進捗状況についての確認を継続的に実施した。しかしながら、終了時評価時以降、連邦政府関係者が多忙となったこともあり、特筆すべき進展がなかった。専門家チームはブラジリアでの連邦政府との協議機会を可能な限り持つべく努力したが、数回程度に留まった。

<table>
<tr><th>対象者</th><th>提言内容</th><th>対応結果</th></tr>
<tr><td></td><td></td><td>他方、サンパウロ州では ABINEE と FECOMERCIO、その他関係団体による中・小型 E-waste の回収パイロット事業「DESCARTE GREEN」が開始されている。</td></tr>
<tr><td rowspan="3">プロジェクトチーム</td><td>2) 上位目標の指標設定
これまで目標数値が空白のままである、上位目標の指標数値を早期に決定する必要がある。</td><td>目標数値（2017 年における E-Waste 回収量及びリサイクル量）決定のためのデータ入手が困難であったことから、指標の変更が提案され、2017 年 8 月 24 日の JCC 会議で協議、下記のとおり変更が合意された。</td></tr>
<tr><td colspan="2">
<table>
<tr><th>変更前</th><th>変更後</th></tr>
<tr><td>1. 回収された E-waste の量が 2017 年の XXt/年から、2020 年に XXt/年に増加する。</td><td>1. ブラジル国において 2020 年までに連邦レベルまたは自治体レベルで、少なくとも 1 つのセクター協定または確約書、あるいは法令による R/L が開始されている。</td></tr>
<tr><td>2. リサイクルされた E-waste の量が 2017 年の XXt/年から、2020 年の XXt/年に増加する。</td><td>2. 署名されたセクター協定または確約書において、回収率目標が設定される。</td></tr>
</table>
</td></tr>
<tr><td>3) サンパウロ州・市の E-waste 調査結果のレビュー
第一年度に終了したサンパウロ市内の E-waste 調査結果ではあまり強調されなかった情報、例えば慈善団体への E-waste のフローの重要性が、パイロットプロジェクトの実施を通して新たに認識されるようになった。これら新情報についてレビューを行ない、プロジェクトの最終成果物に反映することを提言する。</td><td>サンパウロ市やレシフェ市のいくつかの慈善団体の視察、ヒアリングを実施し、これらの回収ルートでも再使用困難な家電製品については修理店やスクラップショップに流れている可能性が確認できた。このため、パイロットプロジェクト実施結果からの教訓として、これらの回収ルートの可能性について表 3-18 でとりまとめている。</td></tr>
</table>

7. 上位目標達成に向けた提言

上位目標とは、本プロジェクトの終了後 3 年～5 年以内に達成されるべき目標であり、第 1 章で示した通り「リバースロジスティックス実施が促進される。」と設定されている。

本プロジェクトの完了にあたり、上位目標達成に向けた提言は以下の通りである。

1) E-waste の RL システムの早期構築

リバースロジスティックスの実施にあたっては関係者間の合意が必須であり、プロジェクト完了時点において、連邦政府と産業界側とで「セクター協定」の締結に向けた協議が行われている。しかし「セクター協定」は全国で効力が発揮され、署名者以外の関係者全員にも影響を及ぼすことから協議は慎重に進められている。当初は本プロジェクト期間中の締結が期待されていたものの、深刻な経済不況や政治的混乱などの外部条件の影響などもあり、未だに締結されていない状況である。

これに対し、「セクター確約」は署名者のみにその効果が限定されるため「セクター協定」と比較して締結が容易であり、また州レベルでも締結することが可能であることから、サンパウロ州では携帯電話などの分野で先行して「セクター確約」を締結し、回収を実施している。その他の E-waste についても 2017 年 8 月現在、業界団体と「セクター確約」締結に向けた交渉が行われており、セミナーなどでその目的や実施スケジュールなどが紹介されている。

E-waste のリバースロジスティックス構築に向けての制度設計については、未だ解決すべき課題が多い。また、国土が広く、経済的な格差も残っているブラジルでは、全国一律の制度設計を行う難しさがあり、柔軟性を持った制度設計をする必要がある。

これらの状況を勘案すると、最終的には法規制で強制的に RL システムを規定することも選択肢としつつ、まずは州レベルの「セクター確約」を先行して締結し、その地域に即した RL システムの構築を検討することが望ましいと考える。その後、様々な知見を蓄積した上で、全国レベルで必要な規約等を「セクター協定」としてまとめていくことが、現在のブラジルにおいて望ましい形であると考える。

2) 本プロジェクトの成果の積極的且つ有効活用

既述の PP の実施を通じて得られた教訓や経済的インセンティブ方策の検討結果、あるいは RL システムのモニタリング・レポーティングに係わる論点を踏まえた本プロジェクトの成果を十二分に活用して RL システムの構築を図ることが期待される。主たる提言事項を再掲する。

- E-waste の種類別の RL システム構築の検討
- E-waste 回収量の確保のための消費者（排出者）に対するインセンティブ付与の検討
- 同様に E-waste 回収量確保のための小売店舗経由以外の回収ルートの開拓
- 適正なモニタリングのための回収率等の定義、計算方法の確立と合意形成
- RL システム構築によるリサイクルビジネス創出のための各種優遇策や技術導入の検討
- 本プロジェクトでのテクニカルコミッティーのような関係者調整機関の設立
- RL システムの最大効率化への民間努力を促すようなリサイクル料金徴収方法の検討

3) 終了時評価ミッションの提言と対応方針案

JICA 終了時評価調査ミッションでは、プロジェクト終了後のブラジル側への提言もなされており、上述の提言と重複する部分もあるが、以下に提言に対する対応方針案を取りまとめる。

表 7-1 終了時評価ミッションの提言と対応方針案（プロジェクト終了後）

対象者	提言内容	対応方針
連邦政府	**1) セクター協定の早期締結・公布** セクター協定の締結は E-waste の RL を促進するうえで非常に重要なステップとなる。ステークホルダー間の協議を加速させ、早期に同協定もしくは必要があれば他の方策の導入も含めて、促進のためのルールづくりを急ぐよう提言する。	連邦レベルでのセクター協定協議の継続と並行して、地方自治体レベルでのセクター確約書あるいは法令による RL 構築の可能性も検討し、何らか実行可能な地域、仕組みで早期に RL を開始することが望ましい。
	2) ブラジリアとレシフェにおける E-waste の RL 実施に向けたデータ・情報の有効活用 プロジェクトがブラジリアとレシフェの E-waste に関する状況調査を現在進めている。E-waste の RL 促進の次なる対象地等として、両地域で得られたデータ、情報を有効に活用することを提言する。	両都市での調査結果は技術協力成果品として本報告書に添付されており、今後、地域別での RL 構築に向けた取り組みへの活用が望まれる。
	3) モニタリングガイドラインおよびレポーティングガイドラインの改訂 セクター協定やその他方策の進展に伴い、プロジェクトの成果物であるモニタリングガイドラインやレポーティングガイドラインも逐次レビュー、改訂することを提言する。	行政向け監督（モニタリング）ガイドラインと民間向けレポーティングガイドラインは、民間のレポーティングを行政が確認（モニタリングする）という観点から、一体のドキュメントとしてガイドライン案を作成し、技術協力成果品として本報告書に添付している。今後、内容を十分に確認の上、RL 実施時への適用や見直しが行われることが望ましい。
	4) 住民啓発活動の継続 E-waste の RL を促進するにあたり、住民啓発活動を継続することを提言する。	基本的に住民啓発活動は民間セクターまたは地方自治体が主体となるが、連邦政府もこれらの実施状況を把握しておくことが望ましい。
サンパウロ州・市	**5) サンパウロ市廃棄物管理計画への反映** プロジェクトの多様な教訓を、現在作成中であるサンパウロ市廃棄物管理計画に反映させることを提言する。	現在、サンパウロ市廃棄物管理計画（PGIRS）は 2018 年末を目処に改訂作業中である。市内の既存エコポン

対象者	提言内容	対応方針
		トを E-waste 回収拠点として活用することも検討されており、市独自のセクター確約書による RL 構築も含めて CETESB とも情報共有を行いつつ検討を継続することが望ましい。
	6) E-waste の RL に関するトップランナーとしての努力を継続すること サンパウロ州・市は E-waste の RL にかかる取り組みにおいて、全国のトップランナーである。今後もその立場を意識しながら、現場で得た有益な情報を連邦政府に逐次フィードバックすることを提言する。	サンパウロ州では電池類や鉛蓄電池におけるセクター確約書署名に引き続き、E-Waste 分野でも本プロジェクトでの成果、経験を踏まえて、大型 E-Waste については ELETROS と、中･小型 E-Waste については ABINEE と、個々にセクター確約書を発行・署名すべく関係者協議・調整中である。 引き続き、検討を進めると共に、その知見を他州、他都市、連邦政府へフィードバックすることが望ましい。

8. 合同調整委員会開催記録

プロジェクト実施期間において、合同調整委員会は以下の通り開催された。

表 8-1　JCC の開催結果

開催回数	日時	議題
第 1 回	2014 年 12 月 19 日	1) プロジェクトメンバーの紹介 2) インセプション・レポートの説明・合意 3) E-waste セクター協定の現状報告
第 2 回	2015 年 8 月 7 日	1) プロジェクト進捗報告 ・現況調査結果 ・パイロットプロジェクト計画 ・今後の予定 2) E-waste セクター協定の現状報告
第 3 回	2015 年 12 月 15 日	1) ワーク・プラン案の説明 2) パイロットプロジェクト計画の進捗説明・確認 3) プロジェクト責任者の再確認 4) E-waste セクター協定の現状報告
第 4 回	2017 年 5 月 26 日	1) 終了時評価結果報告
第 5 回	2017 年 8 月 24 日	1) プロジェクト結果報告 2) PDM の改訂 3) ブラジル側からのフィードバック

出所：JICA 専門家チーム

協議資料を添付資料 8 に示す。

9. 専門家派遣実績

派遣実績を以下に示す。

1) 現地業務

本業務における専門家の現地派遣実績を下表に示す。

表 9-1 専門家派遣実績（現地業務）

Name	Title	Period of Assignment
Shungo SOEDA/ Mr.	Chief Adviser/ Solid Waste Management Plan	2014: 20/Oct. – 1/Nov., 8/Dec. – 23/Dec. 2015: 3/Apr. – 28/Apr., 26/Jun. – 11/Aug., 24/Nov. – 21/Dec. 2016: 19/Jan. – 4/Feb., 13/Apr. – 3/May, 11/Jun. – 17/Jun., 26/Sep. – 24/Oct. 2017: 12/May - 11/Jun., 28/Jul. – 28/Aug.
Shigeyuki SHOJI/ Mr.	Deputy Chief Adviser/ E-Waste Collection & Logistics (1)	2014: 20/Oct. – 3/Dec., 2015: 20/Jan. – 5/Mar., 6/May. – 6/Jun. 2016: 16/Jan. – 11/Mar., 25/Apr. – 22/May, 19/Nov. – 17/Dec. 2017: 21/Jan. – 20/Feb., 7/May - 9/Jun., 22/July – 28/August
Yuko AOKI/ Mr.	E-Waste Collection & Logistics (2)	2015: 17/Apr. – 16/May, 20/Jun. – 3/Aug., 22/Nov – 21/Dec. 2016: 5/Mar. – 18/Apr., 28/Jun. – 30/Jul., 15/Oct. – 24/Nov. 2017: 21/Jan. – 20/Feb.
Hideki WADA/ Mr.	Recycling technics/ Hazardous waste management	2015: 30/Jan. – 26/Feb., 30/May. – 28/Jun. 2016: 13/Feb. – 18/Mar., 24/Jun. – 24/Jul. 2017: 27/Jan. – 27/Feb. 13/May - 9/Jun.,

		22/Jul. – 13/Aug.
Sayaka OKAMOTO/Ms.	Public Relations	2015: 21/May. – 4/Jul. 2016: 16/Jan. – 29/Feb., 2/Apr. – 20/Jun. 2017: 28/Jan. – 26/Feb.
Ryu KOIDE/ Mr.	Waste Management Data Analysis/ Monitoring Guideline Development/ Coordinator (2)	2014: 30/Oct. – 23/Dec. 2015: 22/Jun. – 25/Aug., 22/Nov. – 21/Dec.
Keita SAITO/ Mr.		2016: 7/May. – 8/Jul., 1/Oct. – 9/Nov. 2017: 4/Mar. – 9/Apr., 4/Jun. – 10/Jul.
Yuko TOGAWA/Ms.	Coordinator (1) / Public Participation	2015: 22/Nov. – 21/Dec. 2016: 15/Mar. – 28/Jun., 14/Nov. – 18/Dec., 17/Jul. – 28/Aug.
Henrique KITAHARA/ Mr.	Economic Incentive Measure	2016: 17/Oct. – 20/Oct., 11/Nov. – 25/Nov., 28/Nov. – 2/Dec., 12/Dec. – 13/Dec. 2017: 30/Jan. – 17/Feb., 20/Mar. – 7/Apr., 23/Apr. – 9/Jun., 23/Jul. – 25/Aug.

出所：JICA 専門家チーム

2) 国内業務

本業務における専門家の国内業務実績を下表に示す。

表 9-2 専門家派遣実績（国内業務）

Name	Title	Period of Assignment
Shungo SOEDA/ Mr.	Chief Adviser/ Solid Waste Management Plan	2014: 10/Oct. – 11/Oct

		2015: 8/Sep. – 11/Sep. 2016: 27/Oct. – 28/Oct. 2017 4/Sep. – 5/Sep.
Shigeyuki SHOJI/ Mr.	Deputy Chief Adviser/ E-Waste Collection & Logistics (1)	2014: 10/Oct. – 11/Oct 2015: 8/Sep. – 11/Sep. 2016: 8/Jan. – 12/Jan.
	Solid Waste Training Plan	2015 18 – 21, 25 – 28, 30/Aug. 1 – 4, 7/Sep.
Marcus William OLIVEIRA/ Mr.	Economic Incentive Measure	2015 21/May, 1, 3, 10, 13, 15, 17, 22, 24, 29/Jun. 1, 3, 6, 7, 8, 13, 15, 17, 20, 22, 24, 27, 29, 31/Jul. 3, 4, 5, 6, 7, 10/Aug.

出所：JICA 専門家チーム

10. 現地業務費実績

現地業務費実績を以下に示す。

現地業務費実績（円貨、2017年9月14日時点）

	年	2014				2015									1年次
	月	9月	10月	11月	12月	1月	2月	3月	4月	5月	6月	7月	8月	9月	合計
1年次 (2014年9月～ 2015年9月)	一般傭人費	0	0	0	124,164	333,489	326,430	345,187	315,371	344,984	326,759	355,946	360,209	417,565	3,250,104
	特殊傭人費	0	0	576,713	293,597	410,234	535,402	486,357	502,417	829,869	478,362	529,378	1,308,563	1,878,797	7,829,689
	車両関連費	0	32,793	4,749	402,412	208,660	213,798	345,692	59,264	389,414	310,251	507,704	650,469	345,179	3,470,384
	借料損料	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	施設機材保守管理費	0	0	3,994	0	0	0	0	0	0	0	0	0	0	3,994
	消耗品費	0	68,943	83,787	20,509	4,336	58,985	0	9,251	8,062	61,798	8,403	25,562	0	349,636
	旅費交通費	0	137,541	0	9,555	92,006	0	0	0	90,699	0	17,427	103,760	9,003	459,991
	通信運搬費	0	23,875	11,539	4,791	447	17,160	13,575	16,518	19,171	24,324	25,199	20,077	13,574	190,249
	資料作成費	0	0	0	18,297	0	0	0	0	0	0	0	431,812	232,508	682,618
	雑費	0	0	0	0	0	0	0	3,000	0	0	0	8,879	448,731	460,610
	機材費	0	0	423,838	22,114	0	0	0	0	0	0	0	0	0	445,952
	現地再委託費	0	0	0	0	0	5,326,925	0	5,788,403	0	0	0	17,273,009	0	28,388,337
	経費合計	0	263,152	1,104,620	895,439	1,049,172	6,478,700	1,190,810	6,694,224	1,682,200	1,201,494	1,444,057	20,182,340	3,345,357	45,531,563

	年	2015		2016											
	月	11月	12月	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
2年次① (2015年11月～ 2016年12月)	一般傭人費	0	203,440	399,035	541,336	519,772	516,959	506,500	503,008	529,299	327,391	465,606	458,663	477,592	511,998
	特殊傭人費	0	180,098	998,533	1,264,384	1,186,883	1,180,460	1,130,099	1,096,158	1,064,770	2,066,374	991,741	590,835	971,551	1,008,956
	車両関連費	0	200,118	473,897	155,094	240,109	289,938	383,286	478,729	498,739	363,446	95,870	167,994	418,672	309,834
	借料損料	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	施設機材保守管理費	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	消耗品費	6,818	32,449	37,388	6,646	6,537	394,482	199,073	188,940	372,514	2,416	73,856	46,644	0	61,289
	旅費交通費	0	92,643	0	0	0	0	18,935	0	0	0	0	207,227	36,814	0
	通信運搬費	6,830	13,462	17,624	16,602	12,372	30,276	22,281	27,359	12,782	16,014	27,543	29,274	35,301	28,935
	資料作成費	0	121,156	974	232	0	24,299	30,158	0	0	0	0	0	97,896	0
	雑費	5,868	32,448	0	0	100,468	425,164	110,427	183,138	107,073	113,355	110,334	115,065	0	0
	機材費	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	現地再委託費	0	0	0	0	1,687,354	0	0	1,747,408	189,166	206,567	207,798	189,185	2,497,829	999,309
	経費合計	19,516	875,814	1,927,452	1,984,294	3,753,495	2,861,576	2,400,760	4,224,740	2,774,342	3,095,563	1,972,748	1,804,887	4,535,655	2,920,323

	年	2017											2年次	1-2年次
	月	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	合計	総額
2年次② (2017年1月～ 2017年11月)	一般傭人費	510,465	453,322	562,815	557,128	558,281	558,347	562,655	555,373	546,560	0	0	10,825,544	14,075,648
	特殊傭人費	728,847	589,726	1,046,779	1,163,006	1,046,799	1,195,649	1,198,985	1,183,467	1,294,190	0	0	23,178,289	31,007,978
	車両関連費	196,689	249,237	530,624	336,040	306,673	505,120	437,461	444,905	607,746	0	0	7,690,223	11,160,607
	借料損料	0	0	0	0	0	0	0	0	0	0	0	0	0
	施設機材保守管理費	0	0	13,215	0	0	0	0	0	0	0	0	13,215	17,209
	消耗品費	0	13,356	24,332	9,542	12,714	0	0	26,930	0	0	0	1,515,924	1,865,559
	旅費交通費	0	0	265,347	0	59,342	549,988	85,115	34,182	707,119	0	0	2,056,713	2,516,704
	通信運搬費	25,232	37,226	27,476	23,078	39,993	26,077	39,127	26,221	6,403	0	0	547,490	737,740
	資料作成費	0	0	0	0	0	0	0	279,700	0	0	0	554,416	1,237,033
	雑費	3,892	0	0	0	0	0	0	233,540	0	0	0	1,540,772	2,001,382
	機材費	0	0	0	0	0	0	0	0	0	0	0	0	445,952
	現地再委託費	1,280,216	8,901,042	869,577	4,262,836	0	0	5,426,722	0	0	0	0	28,465,009	56,853,346
	経費合計	2,745,342	10,243,909	3,340,166	6,351,630	2,023,802	2,835,181	7,750,065	2,784,316	3,162,019	0	0	76,387,595	121,919,158

11. 先方からの投入実績

ブラジル側からの投入実績として、プロジェクトに参加したカウンターパートは以下の通り。

1) 開発商工省 (MDIC)

No.	Name of Counterpart	Position/ Department	Duration
1	Mr. Alexandre Comin	Director of Department of Industrial Competitiveness	Oct./2014 – Jan./2015
2	Mr. Igor Nogueira Calvet		Apr./2015 – May/2017
3	Ms. Andrea Macera		May/2017 – Up to Now
4	Ms. Beatriz Martins Carneiro	General Manager of Analyst of Competitiveness Analysis and Sustainable Development	Oct./2014 – Mar./2016
5	Mr. Demétrio Florentino de Toledo Filho	Foreign Trade Analyst of Competitiveness Analysis and Sustainable Development	Oct./2014 – Up to Now
6	Mr. Gustavo Saboia Fontenele e Silva	General Coordinator of Energy and Sustainable Development	Apr./2016 – Up to Now

出所：JICA 専門家チーム

2) 環境省（MMA）

No.	Name of Counterpart	Position/ Department	Duration
1	Ms. Zilda Maria Faria Veloso	Director of Department of Urban Environment	Oct./2014 – Up to Now
2	Ms. Sabrina Gimenes de Andrade	Manager of Department of Urban Environment	Oct./2014 – Up to Now
3	Ms. Maria Luiza Shloegl	Analyst of Infrastructure, Department of Urban Environment	Oct./2014 – Up to Now
4	Ms. Marilia Viotti	Analyst of Department of Urban Environment	Oct./2014 – Up to Now

出所：JICA 専門家チーム

3) サンパウロ市都市清掃機構（AMLURB）

No.	Name of Counterpart	Position/ Department	Duration
	(Mr. Silvano Silverio)	President (is not counted as the counterpart)	Oct./2014 – Feb./2015
	(Mr. José Antônio Bacchim)		Mar./2015 – Feb./2016

	(Mr. Ricardo Brandão Figueiredo)		Feb./2016 – Dec./2017
	(Mr. Edson Tomaz de Lima Filho)		Feb./2017 – Up to Now
1	Ms. Julia Moreno Lara	Director of Planning and Development Department	Oct./2014 – May/2015
2	Mr. Tadeu Dias Pais	Director of Planning and Development Department	May/2015 – Jan./2016
3	Mr. Samuel Oliveira		Jan./2016 – Dec./2016
4	Mr. Monty Dahan		Dec./2016 – Up to Now
5	Ms. Ivete Nobue Kaneko Teixeira	Manager of Planning and Development Department	Mar./2015 – Jan./2016
6	Mr. Flávio Martins		Mar./2016 Feb./2016
7	Mr. Claudio Alexandre Lombardi		Apr./2016 – Up to Now
8	Ms. Helena Maria Rivello Terzella	Information and Research Management of Planning and Development Department	Jan./2015 – Up to Now
9	Mr. Leopoldo Scharff	Coordinator of Planning and Development Department	Dec./2014 – Dec./2016

出所：JICA 専門家チーム

12. 技術協力成果品

技術協力成果品は、契約書の要求事項に基づいて以下の通り作成した。

表 12-1　技術協力成果品一覧

技術協力成果品(契約書)	作成資料	提出時期 （添付した報告書）
ア)サンパウロ市首都圏の E-waste 現況調査報告書	The Survey of Current Situation of E-waste Reverse Logistics in Sao Paulo	業務進捗報告書 1 事業完了報告書 (添付資料 1)
イ)パイロットプロジェクト計画	Pilot Project Plan	業務進捗報告書 2
ウ)パイロットプロジェクト実施結果報告書	Pilot Project Report	事業完了報告書 (添付資料 2)
エ)他都市における E-waste の現状の情報収集調査報告書	The Survey of the Current Situation of E-waste Reverse Logistics in other cities	事業完了報告書 (添付資料 3)
オ)経済的インセンティブ方策提言に関する報告書	Report on Required Facilities and Investment Promotion	事業完了報告書 (添付資料 4)
カ)行政向け RL モニタリングのためのガイドライン	Report on Monitoring/Reporting Guideline (Trial Draft)	事業完了報告書 (添付資料 5)
キ)民間向け RL レポーティングのためのガイドライン		
ク)プロジェクトで作成したセミナー資料	TC 開催資料(第 1 回～13 回)	業務進捗報告書 1 業務進捗報告書 2 事業完了報告書 (添付資料 6)
ケ)プロジェクト広報資料	Promotional materials of the project	事業完了報告書 (添付資料 7)

出所：JICA 専門家チーム

Federal Republic of Brazil
Project for E-waste Reverse Logistics Improvement

The Survey of Current Situation of E-waste Reverse Logistics in Sao Paulo

Part II - E-waste Inventory

August 2015
Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.
Sustainable System Design Institute Co., Ltd.
Kokusai Kogyo Co., Ltd.
Nippon Koei Latin America-Caribbean Co., Ltd.

Preface

This survey has been made by JICA Expert Team under the Project for E-waste Reverse Logistics Improvement to capture a current status of generation, collection, transportation and treatment of post consumer E-waste in the Metropolitan Area of Sao Paulo (RMSP). The results of the survey shall be a base for the planning of a pilot project in Sao Paulo under the project, and to be utilized by the Brazilian counter parts and stake holders for policy formation of E-waste reverse logistics in Brazil.

This report consists of the following three parts, and some parts – Part I and III - are sub-contracted to a local consultant: Green Domus Desenvolvimento Sustentavel Ltda, while the other part – Part II – is the result of analysis and estimation by JICA Expert Team.

Part I – Result of Surveys

Methodology and results of E-waste generation source survey (households and organizations) in Sao Paulo city

Methodology and results of E-waste reverse logistics facility survey in the Metropolitan Area of Sao Paulo.

Part II – E-waste Inventory

Estimation methodology and results of E-waste generation in Sao Paulo city: E-waste amounts and flows

Substance flow analysis for policy evaluation

Part III – Facility Survey Summaries

Summary tables of the all surveyed facilities from the E-waste reverse logistics facility survey

Geographical border of this survey is classified into two: Sao Paulo city in terms of generation source, and Metropolitan Area of Sao Paulo (RMSP) in terms of destination of E-waste. The E-waste generation source survey (households and organizations) has been made in Sao Paulo city and E-waste inventory (generation amount) was estimated for Sao Paulo city, while the E-waste reverse logistics survey has been made in the Metropolitan Area of Sao Paulo (RMSP)

The results described in this report, especially contents of Part III, shall be carefully handled and shall not be disclosed to the public without permission of Brazilian counter parts of the project: Ministry of Development, Industry and Foreign Trade (MDIC), Ministry of Environment (MMA) and Municipal Authority of Urban Cleaning , Sao Paulo city (AMLURB)

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Abbreviations

TV	Television
CRT	Cathode Ray Tube
LCD	Liquid Crystal Display
PC	Personal Computer
IBGE	Instituto Brasileiro de Geografia e Estatística
IDC	International Data Corporation

1 Preconditions and estimation method

1.1 Preconditions for estimating the e-waste disposal and recycling flow

1.1.1 Target e-wastes

The following ten e-wastes were targeted, considering the shares in the total amount of e-wastes, hazardousness and resource recovery.

- Television sets (CRT)
- Television sets (FLAT)
- Refrigerator
- Washing machine
- Air conditioner
- Personal computer (Desktop, CRT)
- Personal computer (Desktop, LCD)
- Personal computer (Notebook)
- Mobile phone
- Small electrical and electronic equipment[1]

1.1.2 Target area

- City of Sao Paulo

1.1.3 Target duration

The latest data up to 2013 were used for estimating the amount of e-waste after year 2014. The past data were regressed back to 1990 by considering the lifetimes of the target e-wastes. The future data were regressed up to 2030 so as to provide the enough information for discussions on future policies.

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[1] Small e-wastes were represented by some highly penetrated products such as cleaners, irons, mixers, ovens and hair-dryers.

1.2 Procedure for estimation of e-waste disposal and recycling flow

1.2.1 Procedure for estimation of e-waste disposal and recycling flow

Step 1. Estimation of the supply of E-products

The future numbers of the supplied e-waste in the City of Sao Paulo are estimated based on the past number of the supplied e-waste.

Step 2. Estimation of the amount of generated e-wastes

The numbers of the reused, discarded and stocked e-wastes are estimated by applying the supply rates to households, average used years and reused rates to the past supplies.

Step 3. Estimation of e-waste flow

The e-waste flow can be estimated by applying the flow parameters to the numbers estimated in Step 2. The flow parameters are obtained from the questionnaire surveys on households/businesses and the e-waste flow survey.

1.2.2 Sub-contracted work for e-waste flow

Two kinds of sub-contract works were conducted. One is the questionnaire survey on households and businesses; another one is the e-waste flow survey.

Questionnaire survey on households and businesses

The questionnaire surveys were conducted in April and May, 2015. The samples of the surveys are shown below.

- Household 715 households
- Business 325 businesses
- (Office 66)
- (Retailer 68)
- (Restaurant 67)
- (Hotel 63)
- (School 61)

As for the household survey, the households selected by the sampling by household income levels were visited and asked the questions. As for the businesses, the questionnaire survey was conducted by means of the automatic answering system of the telephones.

E-waste flow survey

The e-waste flow survey was conducted in 89 facilities related to e-waste recycling. The visited companies are shown below.

● Licensed e-waste factory	38 facilities
● Licensed hazardous waste treatment factory	4
● Non-licensed e-waste recycling factory	16
● Repair shop	10
● E-waste collector/Junkshop/dealer	13
● Secondhand shop	6
● Take-back to retailers	2

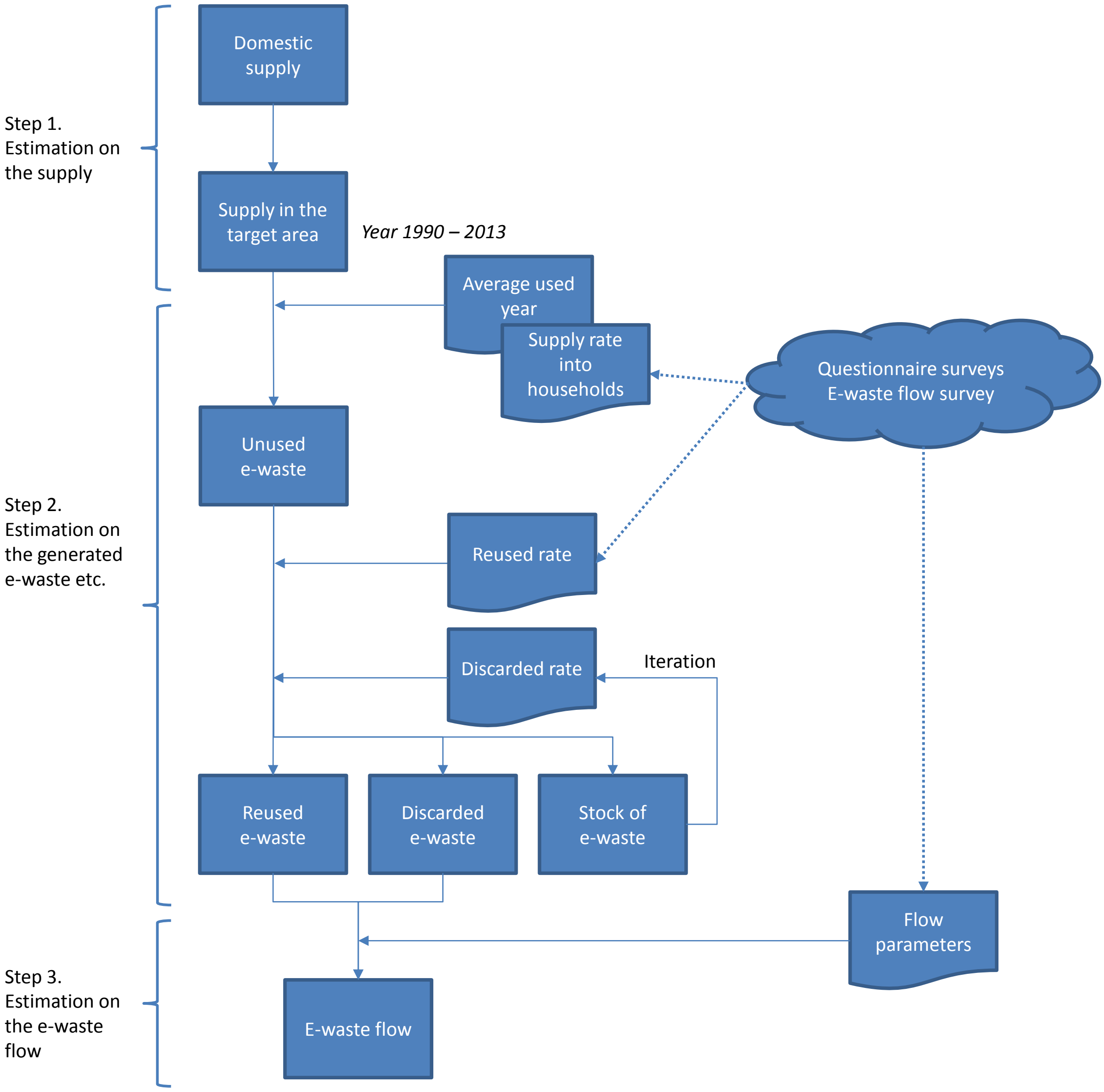


Figure 1 Procedure for estimating generated and recycled e-waste flow

Source： JICA Expert Team

2 E-waste flow estimation in detail

2.1 Step 1. Estimation of electrical and electronic products supply

2.1.1 Estimation Procedure

The supply of electrical and electronic products are estimated by the following steps.

- Data collection of numbers of electrical and electronic products sold in Brazil in the past
- Estimation of the numbers of electrical and electronic products sold in Sao Paulo

2.1.2 Supply in Brazil

Figure 2 shows the trend of the domestic supply of electrical and electronic products in Brazil. The fauture numbers were regressed by using the data between 2005 and 2012 provided by “Instituto Brasileiro de Geografia e Estatística” (IBGE) based on the considerations contained in, and the past trends were also regressed smoothly. The data of television sets and personal computers were split to CRT TV and FLAT TV and to CRT Desktop type, LCD Desktop type and notebook type respectively by using the procedure described below.

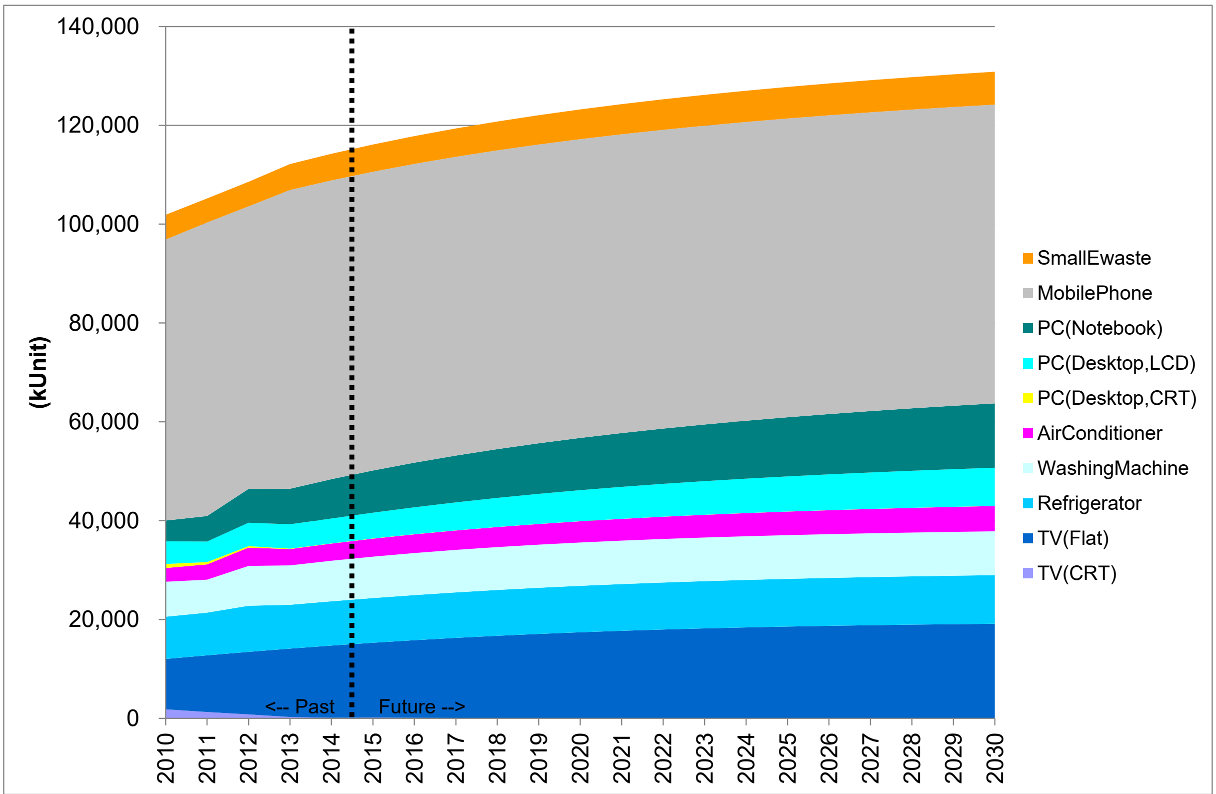


Figure 2 Unit of electrical and electronic products sold in Brazil

Source: JICA Expert Team

Table 1 Future trend of sales of electrical and electronic products in Brazil

	Penetration rate in Sao Paulo City (Household questionnaire)	Analysis on the penetration rate	Future trend considered in the regression
Television sets	192%	Saturated already. However, big demands of replacement towards 2016 when the digital broadcasting is started.	Rising slowly up to 20 million units.
Refrigerator	100%	Saturated already.	10 million units in 2030, keeping the present sales
Washing Machine	89%	To be penetrated a little more	Rising up to 9 million units
Air-conditioner	7%	To be penetrated more	Growing up to 5 million units in 2030
Personal computer	81%	The penetration rate is not 100%, but the shift from personal computers to tablets is expected after the present.	Growing at the present growing speed to reach at 20 million units in 2030
Mobile phone	215%	Saturated already. Replacement by smartphones is expected after the present	Keeping the present sales.
Small e-waste	70%	To be penetrated a little more.	Growing slowly to reach at 7 million units in 2030

Source: JICA Expert Team

Splitting of television sets

IBGE does not prepare the data of television sets with the categories of CRT TV and FLAT TV. Here, the IBGE data were split by the production rate shown in the following figure.

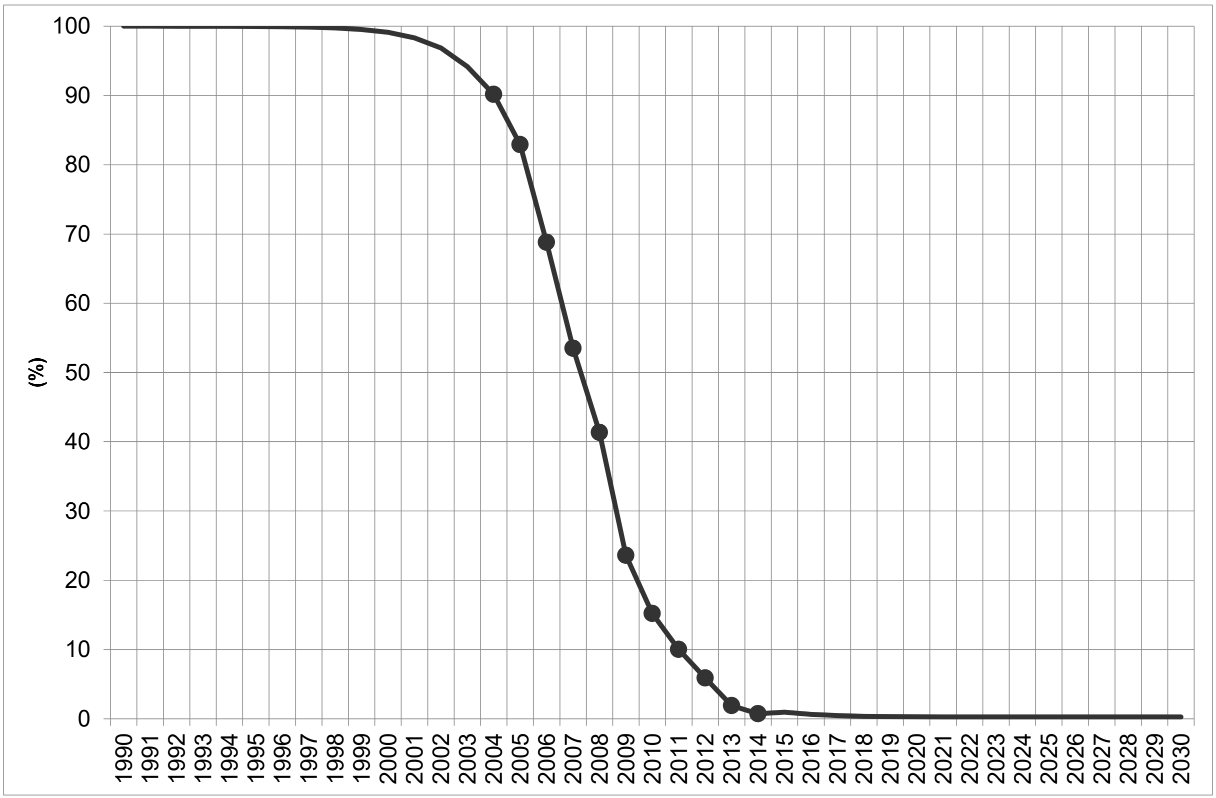


Figure 3 The rate of CRT television in the total production of televisions

Source: Display Search NPD DisplaySearch Advanced Quarterly Global TV Shipment and Forecast Report

URL:http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/120103_lcd_tv_shipment_growth_to_improve_in_2012_driven_by_40_and_larger_sizes.asp (confirmed on 2 June 2015)

Splitting of personal computers

IBGE does not prepare the data of personal computers with the categories of CRT desktop type, LCD desktop type and notebook type. Here, the IBGE data were split by the production rate of desktop computers prepared by International Data Corporation (IDC). The data for desktop computers were split to CRT type and LCD type by using the data of Figure 3 .

Figure 4 Rate of sales of desktop computers in the total personal computer sales
Source: IDC

Sales of small appliances

The category of small appliances were represented by the products of

- Vacuum cleaner
- Iron
- Mixer
- Electrical oven
- Hair-dryer,

considering their penetration rates in Brazil. The number of units of small appliances were calculated by the following formula.

- Supplied units of small appliances$= \frac{w_1 * N_1 + w_2 * N_2 + \cdots + w_n * N_n}{w_1 + w_2 + \cdots + w_n}$

Where,

- w_i: weight of each product
- N_i: supplied unit of each product。

2.1.3 Conversion to the supply to Sao Paulo City

The domestic supply in Brazil is converted to the supply to Sao Paulo City by the following formula, assuming that the supplies are determined according to the population and the GDP per capita.

$$DS_{SP} = \frac{DS_{BR}}{POP_{BR}} * POP_{SP} * \frac{GC_{SP}}{GC_{BR}} = \frac{DS_{BR}}{POP_{BR}} * POP_{SP} * \frac{GDP_{SP}/POP_{SP}}{GDP_{BR}/POP_{BR}} = DS_{BR} * \frac{GDP_{SP}}{GDP_{BR}}$$

Where

- DS: $Domestic\ supply$
- GC: $GDP\ per\ capita$
- GDP: $Gross\ Domestic\ Products$
- POP: $Population$
- Suffix PS: $Sao\ Paulo$
- Suffix BR: $Brazil$。

The data of GDP in Brazil and Sao Paulo City were prepared as shown in Figure 5 and Figure 6 . The supplies of e-products in Sao Paulo were calculated as shown in Figure 7 .

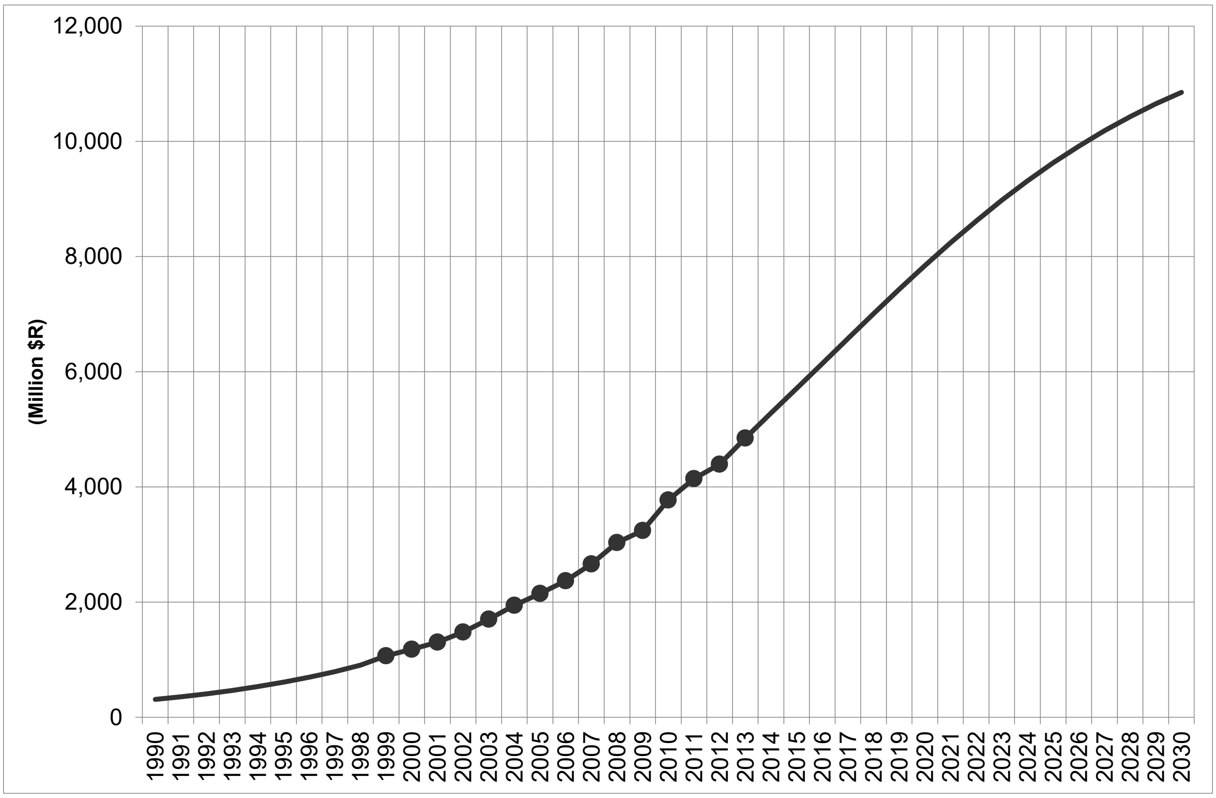


Figure 5 Trend of GDP of Brazil

Source: Brazilian Institute of Geographic and Statistic

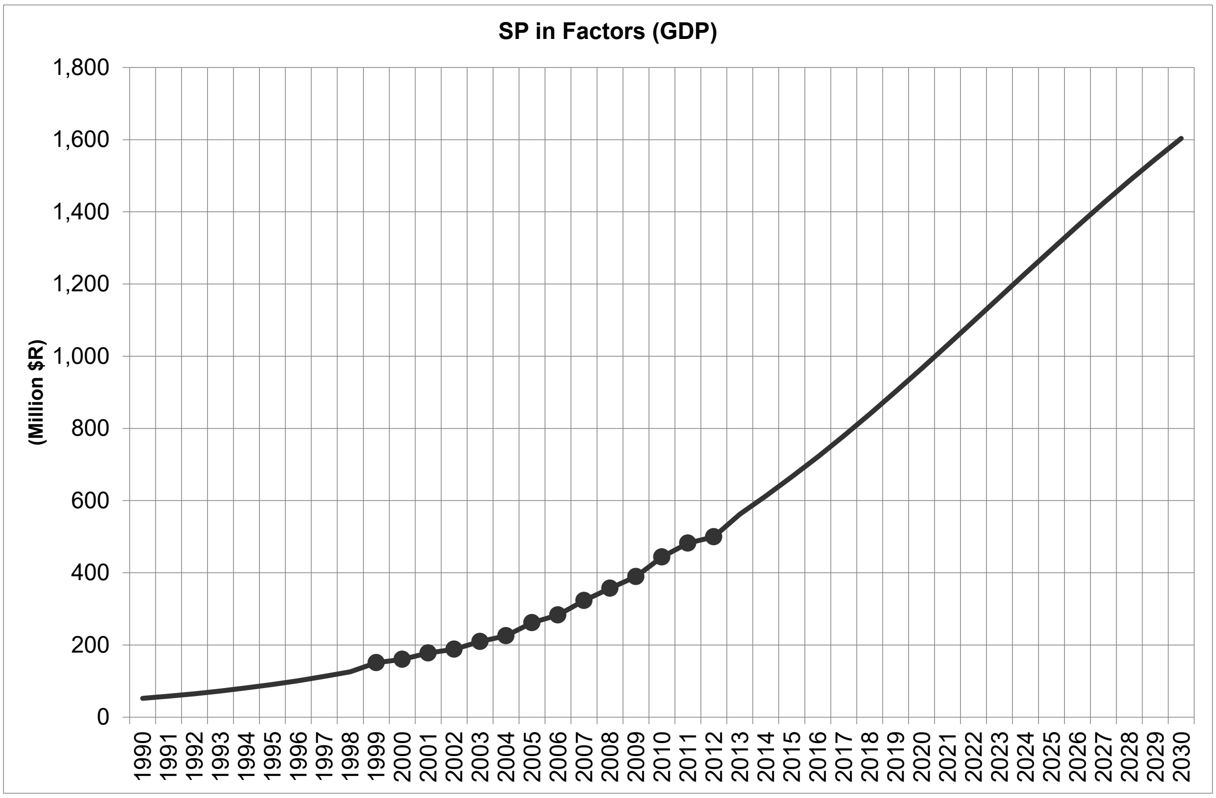


Figure 6 Trend of GDP in Sao Paulo City

Source: Brazilian Institute of Geographic and Statistic

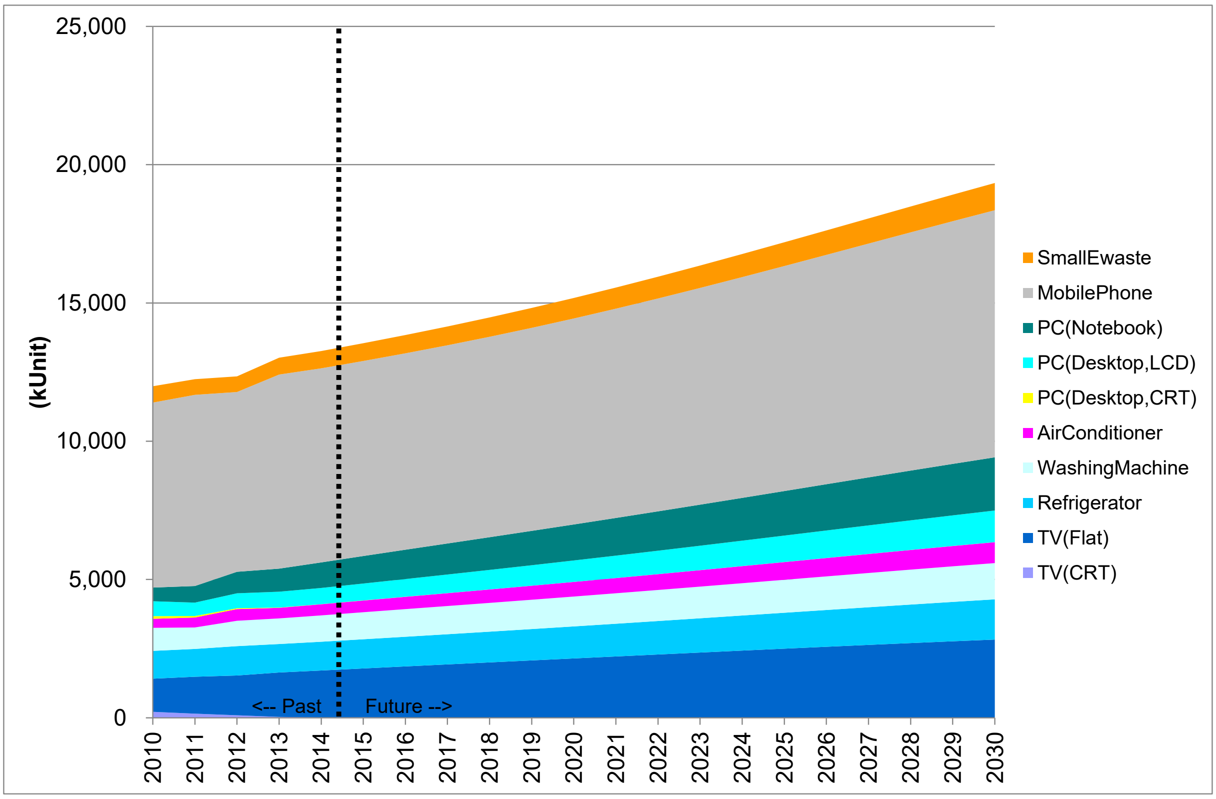


Figure 7 Supply of electrical and electronic products in Sao Paulo City

Source: JICA Expert Team

2.1.4 Unit weight of each kind of e-wastes for converting to weight

The table below contains the unit weight of e-wastes for converting the values into weight.

Table 2 Unit weight of e-wastes

	TV (CRT)	TV(FLAT)	Refrigerator	Washing machine	Air-conditioner	PC(Desktop, CRT)	PC(Desktop, LCD)	PC(Notebook)	Moble phone*	Small e-waste*
Unit weight(kg/unit)	37.2	12.0	58.0	36.5	50-60	37.2	12.0	2.4	0.2	2.4

Source: Inventta 2012 report (Inventta Consultoria / MDIC / ABDI, 2013) (Small e-wastes was set by aggregating vacuum cleaner, iron, mixer, electrical oven and hair-dryer)

The weight of air-conditioners was taken from the catalogue of a product.

2.2 Step 2. Estimation of generated e-wastes

2.2.1 Procedure for estimation

The procedure for estimation of generated e-waste is shown in the following figure.

- The supplies of electrical and electronic products are divided to the supplies to households and the supplies to businesses by setting the supply rates to households by types of e-wastes.
- The amount of unused e-wastes, discarded e-wastes and stocked e-wastes are calculated based on the discarded probability distribution and reused rates. The rates of dead stocks in generators are set as zero in this estimation.

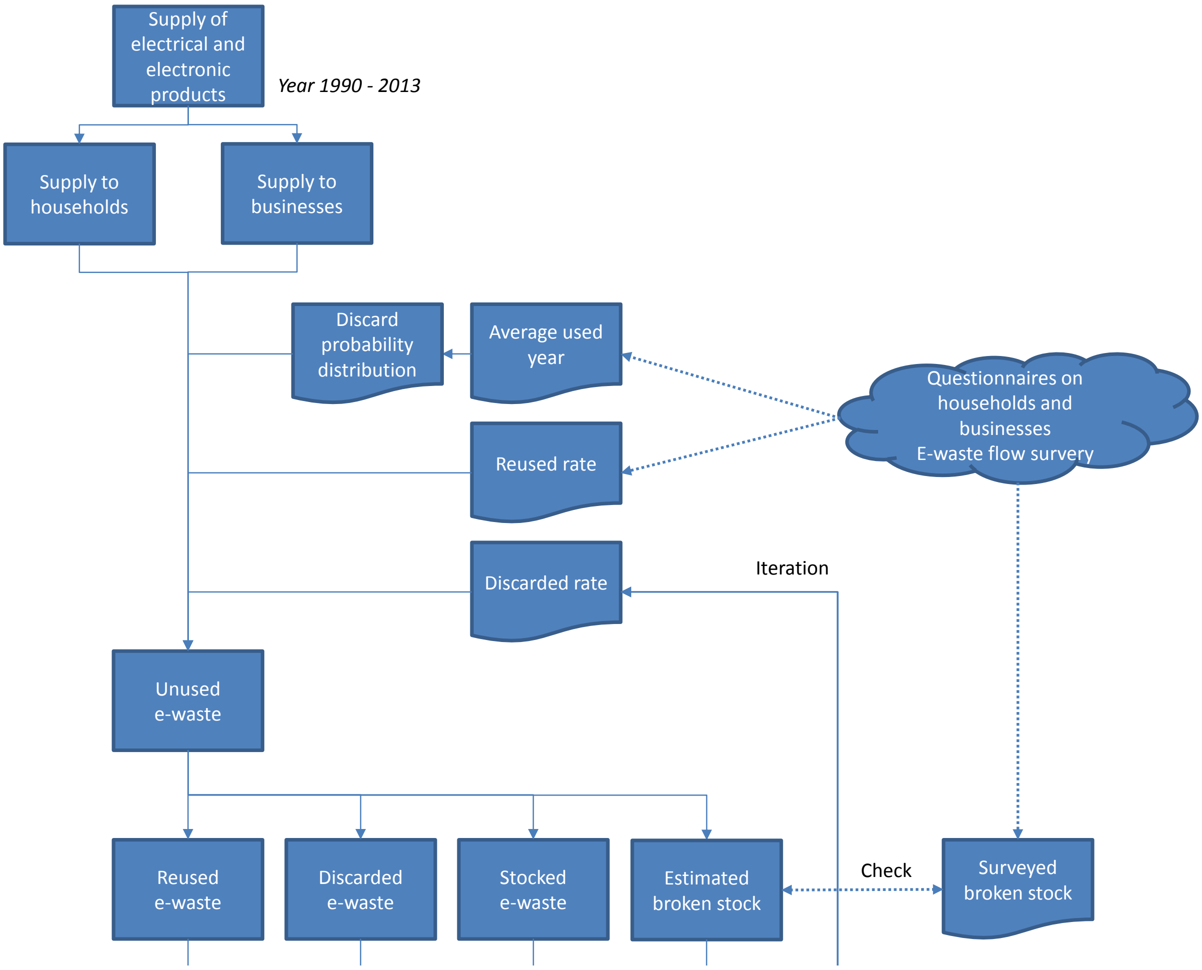


Figure 8 Procedure for estimation on generated e-wastes etc.

Source: JICA Expert Team

2.2.2 Model for estimation

Discard probability distribution

The discard probability distribution rises from zero and reach at the peak in the year of average used year. The Weibull distribution is commonly used as the function form. The accumulated probability distribution of the Weibull distribution can be expressed as:

- $W_t(y) = 1 - exp\,[-\left(\frac{y}{\bar{y}_t}\right)^b * \{\Gamma(1+\frac{1}{b})\}^b]$
- Where
- $W_t(y)$: the accumulated discard probability until year-y
- y_t: average used year
- Γ: Gamma function,

and according to Yoshida et. al.[2], the parameters of b can be set as 3.0 – 4.0. Here, b was set as 3.5.

The discarded probability in each year can be given as

- $W'_t(y) = W_t(y) - W_t(y-1)$
- Where $W_t(0) = 0$.

Unused e-waste

The amount of unused e-wastes in year-i can be estimated by the step 2. The unused e-wastes include the amount of e-wastes returning to the consumption stage as reused e-wastes.

- $D_i = \sum_{j=1}^{i} DS_j * W'_t(i-j)$

Where

- D_i: The amount of unused e-wastes in year-*i*
- DS_j: The amount of inputted e-products in year-*j*

Reused rate and stock

The relation among unused e-waste, reused e-waste and discarded e-waste can be expressed as:

- $R_i = r * D_i$
- $W_i = (1-r) * D_i$

Where

- r: Reused rate (shown in Table 8),

and the stock S_i can be expressed by

- $S_i = S_{i-1} + P_i - W_i$.

---

[2] Tomohiro Tasaki, Masahiro Oguchi, Takashi Kmeya and Kohei Urano: A prediction method for the number of waste durable goods, Journal of the Japan Society of Waste Management Experts, Vol. 12, No. 2, pp. 49 – 58, 2001

Where

- S_i: Stock in year i

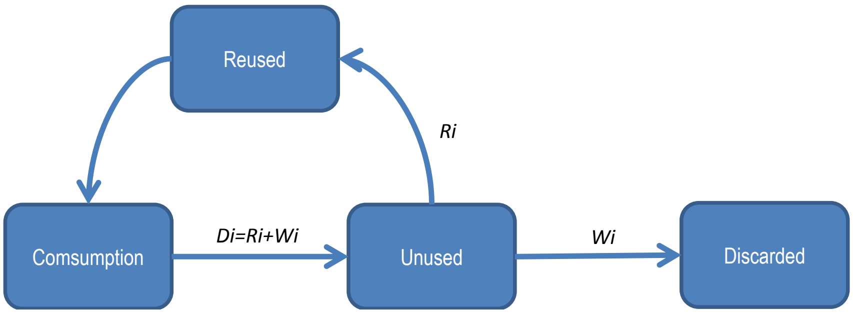


Figure 9 The relation among unused e-waste, reused e-waste and discarded e-waste
Source: JICA Expert Team

2.2.3 Supply to households and businesses

Here, the supplies of e-products are split to the supplies to households and the supplies to businesses. The rates of supplies to households was obtained from the rate of stocks in households in 2015, assuming that the rates of supplies to households do not change. The remaining portions were allocated to the supplies to business uses.

The supply rates were considered for whole television sets and personal computers due to the limitation of available data. After setting the supply rates, television sets and personal computers were split to the types of products by the method shown in 2.1.2.

The stocks in 2015 was estimated by using the data obtained from the questionnaire survey on households. The penetration rates are available from POF survey and the PNAD survey by IBGE, but the latest POF survey is 2008/2009 and the definition of the penetration rate of PNAD has the ceiling at the rate of 100%, so those data were not used here.

Table 3 Estimation of the supply rates of electrical and electronic products for households

	TV(whole)	Refrigerator	Washing machine	Air-conditioner	PC(whole)	Mobile phone	Small e-waste
Penetration rate in households in 2015 (unit/household)	1.916	1.000	0.887	0.069	0.397	2.151	0.698

	TV(whole)	Refrigerator	Washing machine	Air-conditioner	PC(whole)	Mobile phone	Small e-waste
Stock calculated from the penetration rates (thousand UNIT) (Penetration rate X number of households)	13,693	7,147	6,339	493	2,837	15,373	4,988
Estimated stock in 2015 (thousand UNIT)	14,785	11,193	8,397	3,270	7,158	83,786	4,943
Stock in businesses	1,092	4,046	2,058	2,777	4,321	68,413	-45
Supply rate to households	0.926	0.639	0.755	0.151	0.396	0.183	1.009

Source: JICA Expert Team

Note 1: the number of households in Sao Paulo City was estimated as 7,146 million households based on the number of households obtained from PNAD survey.

Note 2: The penetration rates were obtained from the questionnaire survey on households.

2.2.4 Average used year

The average used years obtained from some different sources were compared and selected, because they are very important parameters for estimating the amount of discarded e-wastes.

Method 1: The average used years obtained from the question of "when do you suppose the e-products possesses may be broken?"

The following table contains the average used years obtained from the questions of "When did you buy?" and "When do you expect it breaks?" asked in the questionnaire survey on households (the years to be broken).

Table 4 The years to be broken (estimated from the expected discard timings obtained from the questionnaire on households)

	TV(CRT)	TV(Flat)	Refrigerator	Washing machine	Air-conditioner	PC (Desktop, CRT)	PC (Desktop, LCD)	PC (Notebook)	Mobile phone	Small e-waste
Number of samples (NOS.)	152	588	658	597	35	21	268	122	658	-
Average used year (year)	10.3	9.5	12.1	11.9	11.1	11.4	10.1	8.7	6.1	10.1
Sample standard deviation (year)	3.4	3.3	4.0	4.1	4.6	3.5	3.5	3.3	3.3	-
Upper 5% significance interval (year)	10.8	9.7	12.4	12.3	12.6	12.9	10.5	9.3	6.3	-
Lower 5% significance interval (year)	9.7	9.2	11.8	11.6	9.5	9.9	9.6	8.1	5.8	-

Source: JICA Expert Team

Note: As for the small e-wastes, the average used years of electrical oven, mixer, iron, vacuum cleaner and hair dryer were averaged, considering that they are almost same.

Method 2: The average used years obtained from the question of "How many years did you use the e-waste until discard?"

Table 5 shows the average used years estimated by the question of "How did you used the e-waste when you discarded it?" These years are generally shorter than the years obtained as Table 4.

Table 5 The years until broken (estimated from the discarded years for respondents" past e-waste obtained from the questionnaire on households)

	TV (CRT)	TV (FLAT)	Refrigerator	Washing machine	PC (Desktop, CRT)	Mobile phone	Small e-waste
Number of samples (NOS.)	80	10	42	19	6	98	-
Average used year (year)	7.3	4.8	7.3	8.4	5.8	2.0	4.0
Sample standard deviation (year)	3.6	2.7	3.7	4.1	2.6	1.2	-
Upper 5% significance interval (year)	8.0	6.5	8.4	10.3	7.9	2.6	-
Lower 5% significance interval (year)	6.5	3.1	6.2	6.6	3.7	2.1	-

Source：JICA Expert Team

Note: As for the small e-wastes, the average used years of electrical oven, mixer, iron, vacuum cleaner and hair dryer were averaged, considering that they are almost same.

Only reliable average used years with enough number of samples are contained in the table.

Method 3. Estimation from stocks and domestic supplies

The time-series stocks in cities can be known in Brazil. By using these data, the average used years can be estimated roughly by the following equation.

$$\text{Average used year} = \frac{Difference\ of\ Stock\ between\ year-i\ and\ year-j}{Average\ annual\ supply\ between\ the\ years}$$

The results of the calculations were shown in the following table.

Table 6 Estimated average used year (Estimated by the official data of the past stocks and average annual supply

	TV	Refrigerator	Washing machine	PC	,Mobile phone	Small e-waste
Average used year (years)	10.3–11.8	11.3-13.5	8.3-9.0	7.5-12.5	2.4	8.4-8.7

Source：JICA Expert Team

Evaluations and selection of the average used years

The average used years estimated above three methods were evaluated as below.

- The average used years estimated by the question of “How long do you expect the possessing e-products (Method 1) will be broken?” tend to be longer.
- The average used years estimated by the past experience to discard e-wastes (Method 2) tend to be shorter by the discarders’ unclear memories.
- The average used years estimated by the stock data (Method 3) give nice values in spite of the rough estimation model.

Based on the evaluation, the average used years were set based on the following thoughts.

- The average used years obtained from the stock data (Method 3) were used as the reference data.
- The values obtained by Method 1 were used for the bulky e-wastes such as television sets, refrigerators, washing machines, air-conditioners and small e-wastes, considering that they are discarded when broken, because they are less likely to be dead stocks.
- The values obtained by Method 2 were used for personal computers and mobile phones, considering that they are likely to be unused before broken.

Due to the data reliability and limitations, the average used years used for the calculation are considered to be checked their sensitivities as shown Chapter 4.

The same values were used for the e-wastes derived from business entities, checking the ranges of the values were almost same as the values of households.

Table 7 Selected average used years

	TV (CRT)	TV (Flat)	Refrigerator	Washing machine	Air-conditioner	PC (Desktop, CRT)	PC (Desktop, LCD)	PC (Notebook)	Mobile phone	Small e-waste
Selected average used years	10.3	9.5	12.1	11.9	11.1	5.8	5.1	4.4	2.0	10.1

Source：JICA Expert Team

Note: As for PCs, the average used year of Method 2 was expanded by the values of Method 1.

Consideration on the digitalization of television broadcasting

It is likely happening that the CRT television sets are replaced with the LCD types. In order to consider this tendency in the estimation model, the average used years for CRT television sets for the products after 2007 were calibrated as the number of years by the year of 2016. For example, the average used year for the product of 2007 was set as 9 years of the difference between 2007 and 2015.

2.2.5 Disposal flow (here only reused rates are referred.)

The disposal flows were estimated by the results of the questionnaire surveys.

By the questionnaire surveys, the disposal rates are obtained by the following channels.

- Public collection service
- Containers on streets
- Garbage boxes on streets
- Eco-pont
- Bulky waste collection
- Illegal dumping
- Takeback by retailers
- Private recyclers
- Junk shops
- Second-hand market
- Repair shops
- Giving to acquaintance
- Recycling factories
- others

These disposal options were classified below by considering the characteristics of the options.

- Reused route (Second-hand market, Repair shops, Giving to acquaintance)
- Routes to Sucateiro etc. (Private recyclers, Junk shops)
- Public collection route (Public collection service, Containers on streets, Garbage boxes on streets, Eco-pont, Bulky waste collection, Illegal dumping)
- Proper recycling route (Takeback by retailers, Recycling factories)
- Others

Secondly, the category of “Others” were deleted by distributing the rate to other categories.

The categories of e-wastes were modified so that the disposal rates can be estimated.

- TV=TV(CRT)+TV(FLAT)
- PC=PC(Desktop)+PC(Desktop,CRT)+PC(Desktop,LCD)+PC(Notebook)
- Small e-waste=Electric oven+Mixer+Iron+Vacuum cleaner+Hair dryer

Here, the symbol of “+” means that the data of the categories were analyzed jointly.

Table 8 Disposal flow of e-wastes derived from households

	TV	Refrigerator	Washing machine	Air-conditioner	PC	Mobile phone	Small e-wastes
Number of samples (NOS)	90	42	19	151	20	98	56
Reused route (%): r	37	43	21	36	4	49	9
Public collection route (%): p1	17	7	21	14	20	42	46
Sucateiro etc. route (%): 1-r-p1-p2	47	50	58	47	65	9	44
Proper recycling (%): p2	2	2	0	2	13	0	2

Source: Questionnaire survey on households
Note 1: The data for air-conditioner were estimated by aggregating three categories of TV, Refrigerator and Washing machine, as the data were not obtained from the survey.
Note 2: The symbols in the left columns shows the symbols used in the flowcharts shown later.

Table 9 Disposal flow of e-waste derived from business entities

	TV	Refrigerator	Washing machine	Air-conditioner	PC	Mobile phone	Small e-wast
Number of samples (NOS)	50	20	4	12	92	27	44
Reused route (%): r	66	65	75	42	51	35	50
Public collection route (%): p1	16	10	25	0	12	27	24
Sucateiro etc. route (%): 1-r-p1-p2	16	20	0	33	29	15	24
Proper recycling (%): p2	2	5	0	25	8	23	2

Source: Questionnaire survey on business entitties
Note: The symbols in the left columns shows the symbols used in the flowcharts shown later.

2.2.6 Discarded rate

By using above parameters, the unused e-waste, discarded e-waste and stocked e-waste can be calculated. However, some types of e-waste is not suitable the estimation model due to their stock behavior. People continue to keep e-wastes even after they are broken. Here, the following e-wastes were considered to have such characteristics and they are given the parameter of discarded rate. Other types of e-waste were given 100% as the discarded rate.

- Personal computers
- Mobile phone

The discarded rate was explored by repeating the procedure of step 2 until the calculated number of broken e-waste in the stock is equal to the estimated number of broken e-waste by the survey.

The estimated number of broken e-waste surveyed and the discarded rates calculated are shown in the following table.

Table 10 Broken e-waste in stock and estimated discarded rate

	PC (Desktop)	PC (Notebook)	Mobile phone
Rate of broken e-waste in stock (surveyed) (%)	30%	18%	29%
Discarded rate (estimated) (%)	73%	72%	54%

Source: JICA Expert Team

2.3 Step 3. Flow estimation

2.3.1 E-waste flow

Among various types of e-waste flows, the following flow was proposed by considering the actual situations of Sao Paulo so as to discuss the contents of the pilot project. The points of this flow can be summarized below.

- All e-wastes collected by catadores etc. and dismantled by sucateiros etc. would be brought to scrap dealers and finally utilized by steel industries as mix metals.
- The path from public collection services to e-waste recycling factories were remained for the future consideration, although all e-waste collected by catadores unions done as one of the public collection services may flow to scrap dealers.
- The pilot project has to be designed so as to flow to proper recycling route.
- The flow can be described by four parameters of r, p1, p2, q (q=1 at present).

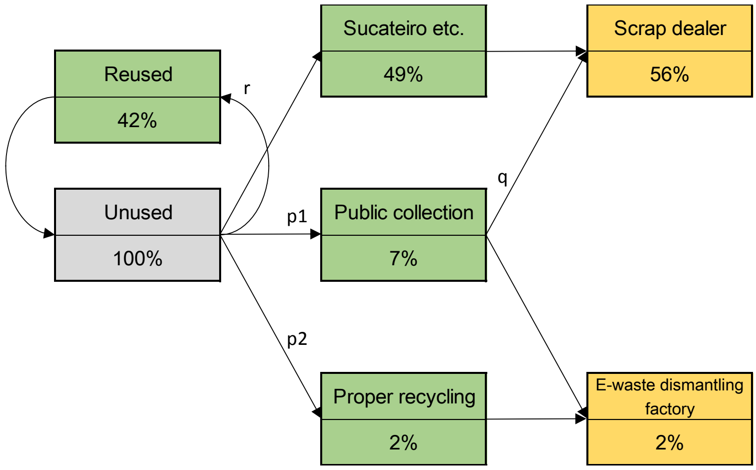


Figure 10 The e-waste flow used in this Project (the numbers are just examples.)
Source: JICA Expert Team

2.4 Results of estimations

2.4.1 Domestic supply to Sao Paulo

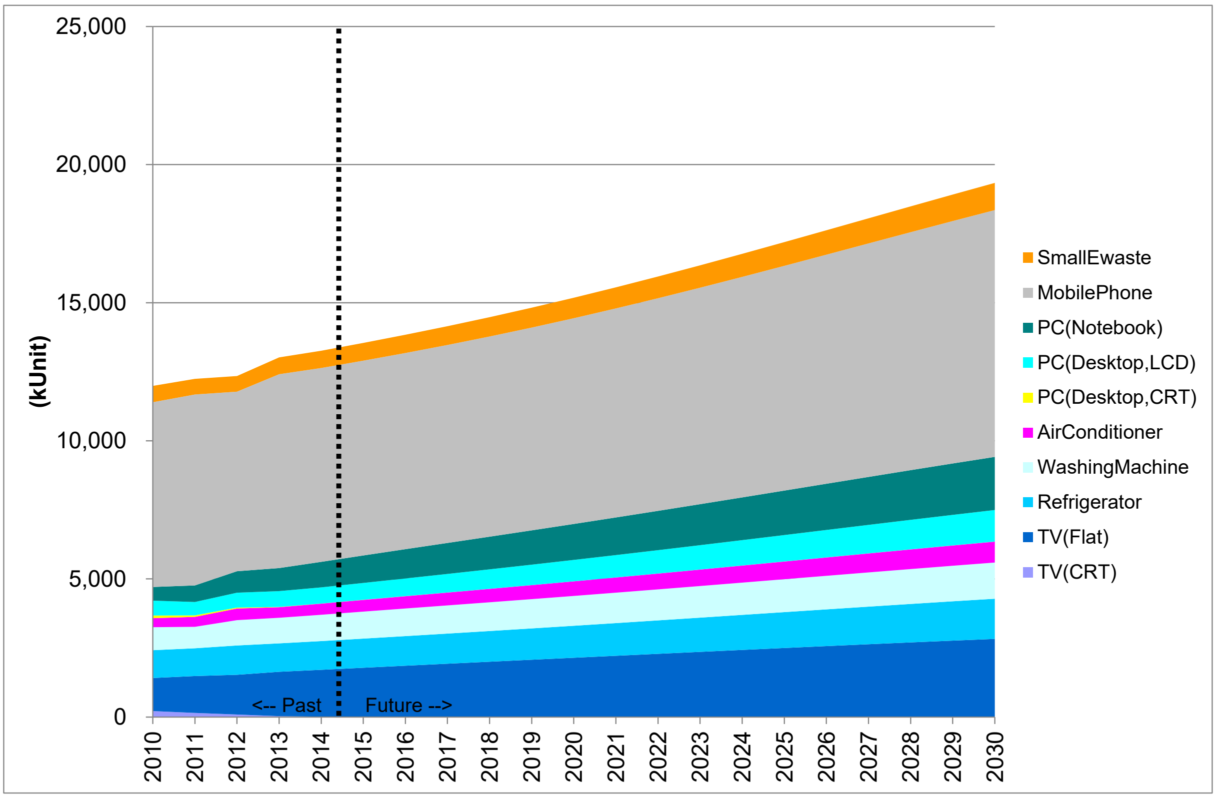


Figure 11 Supplied units to households and businesses
Source: JICA Expert Team

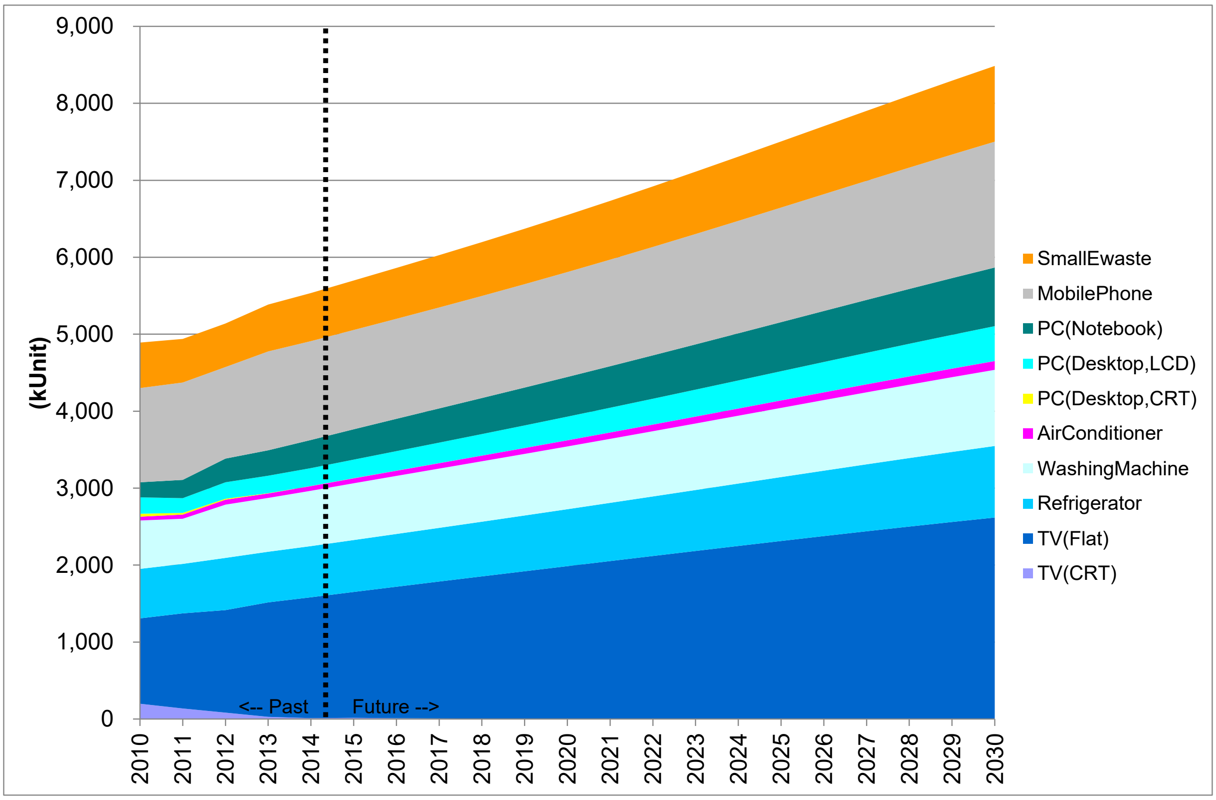


Figure 12 Supplied units to households

Source: JICA Expert Team

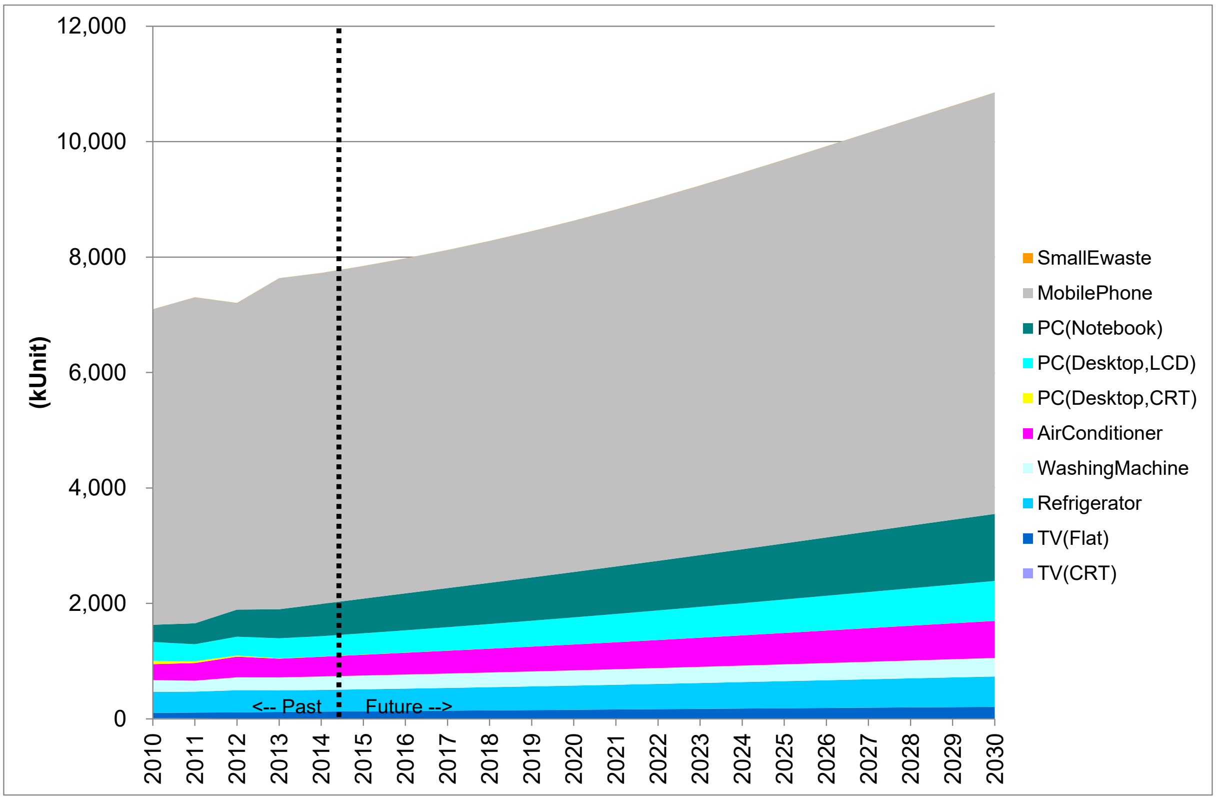


Figure 13 Supplied units to businesses

Source: JICA Expert Team

2.4.2 Stocked units

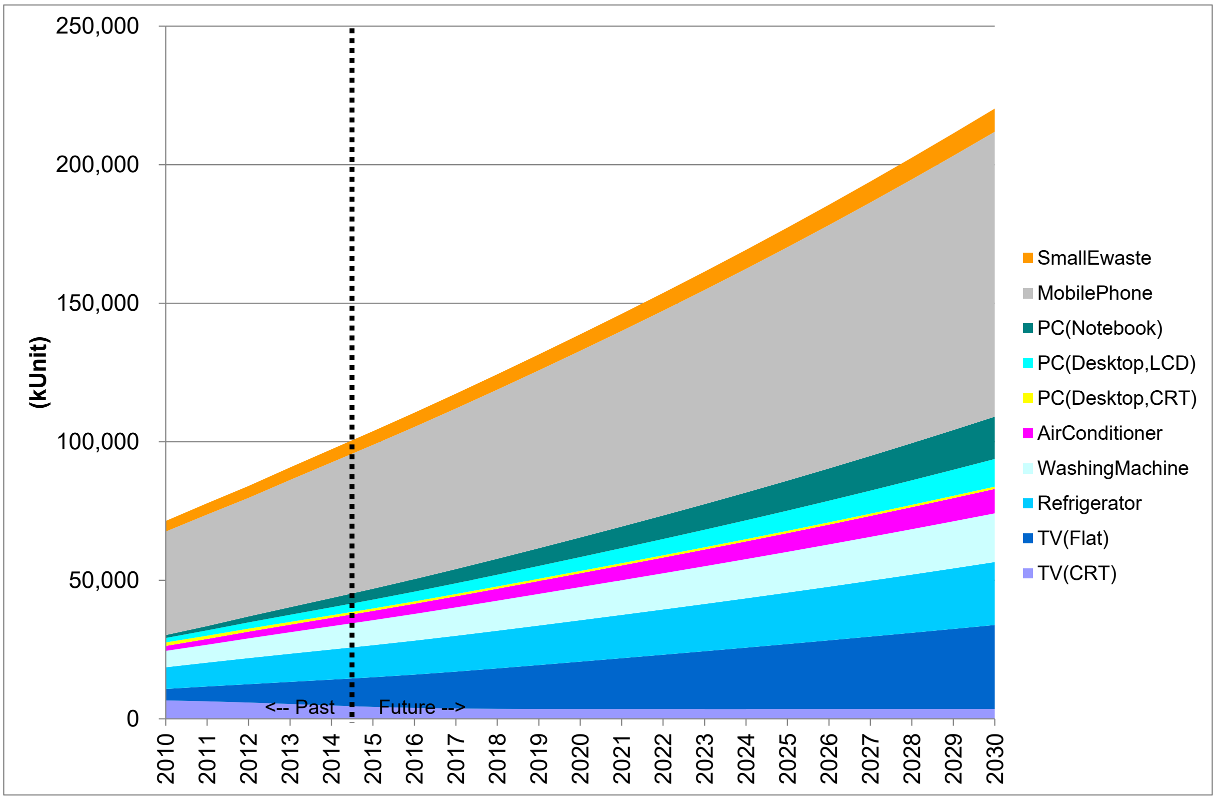


Figure 14 Stocked units in households and businesses

Source： JICA Expert Team

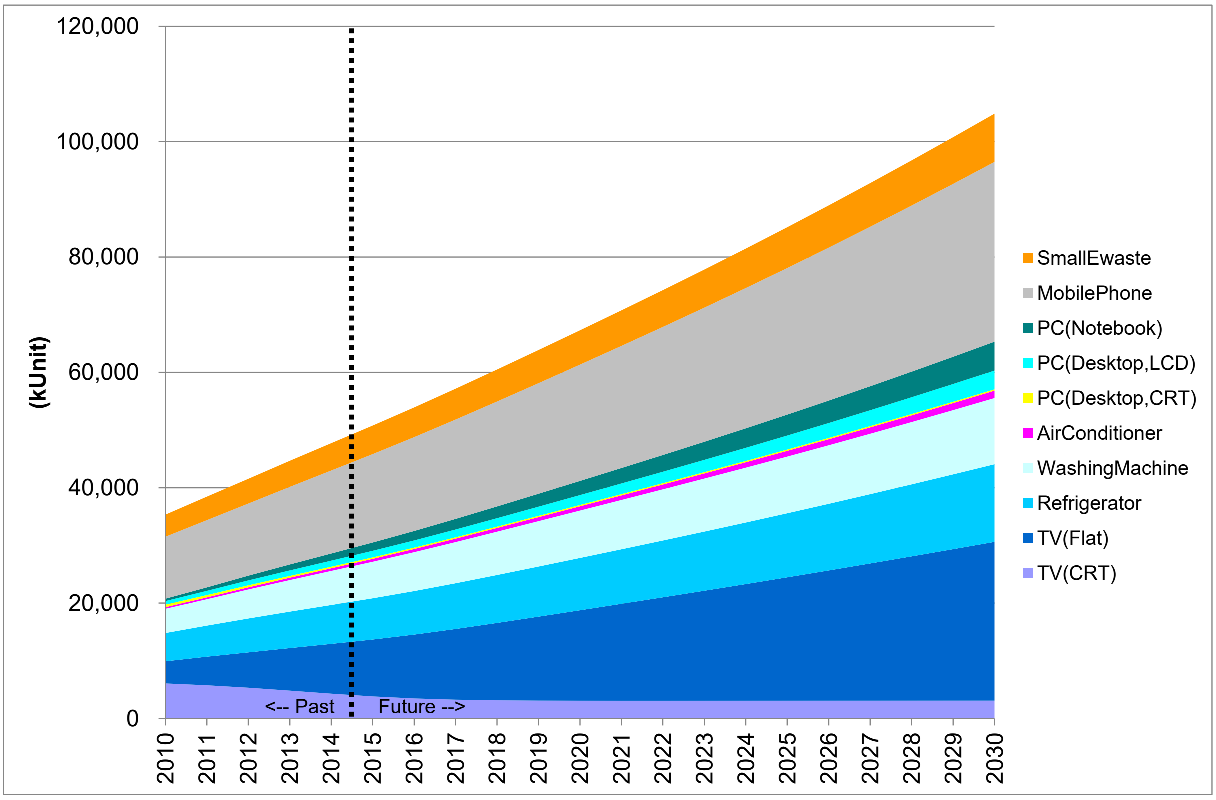


Figure 15 Stocked units in households

Source： JICA Expert Team

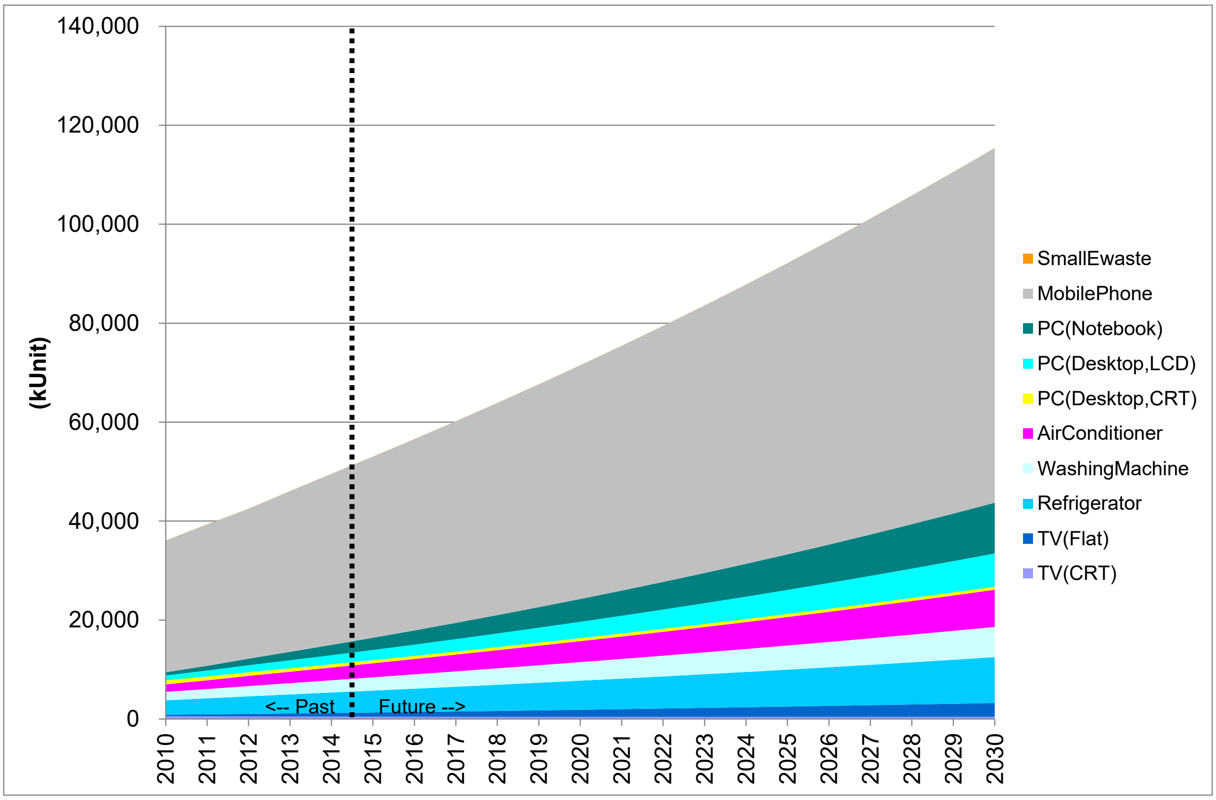


Figure 16 Stocked units in businesses

Source： JICA Expert Team

2.4.3 Discarded weight including reused

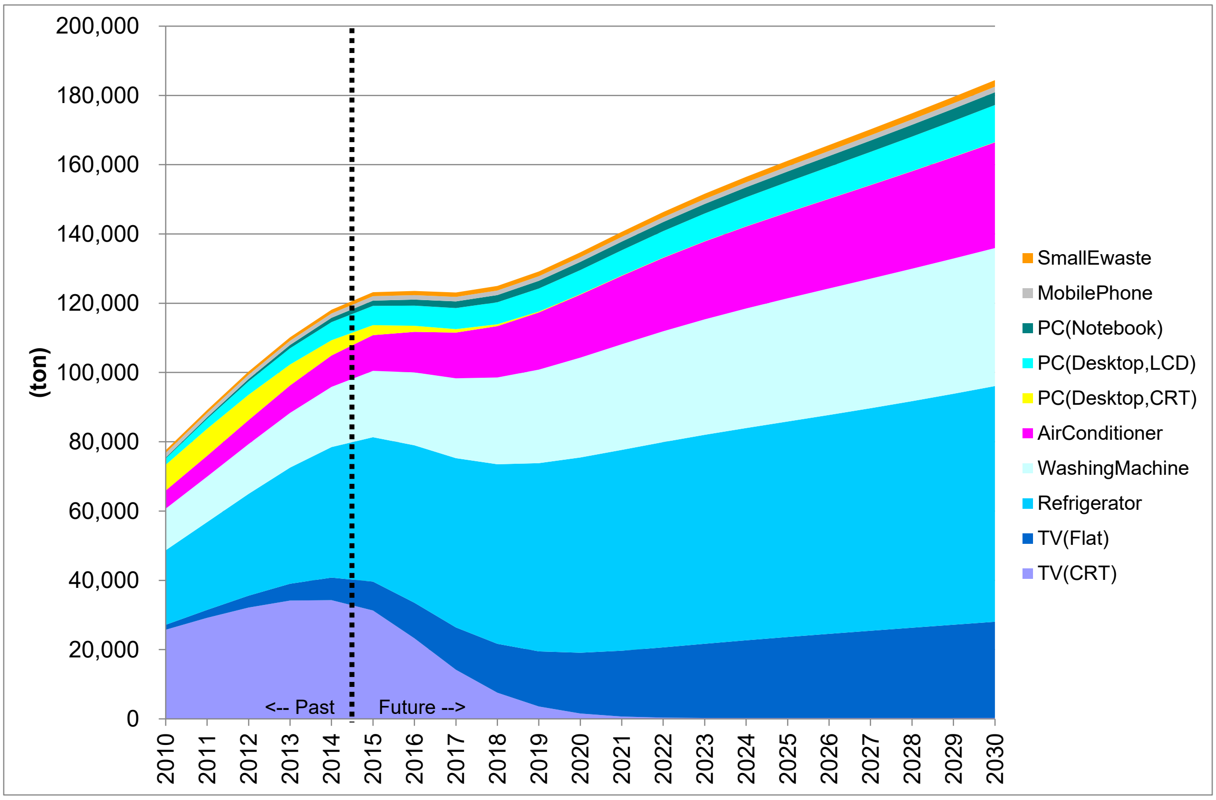


Figure 17 Discarded weight including reused from households and businesses

Source： JICA Expert Team

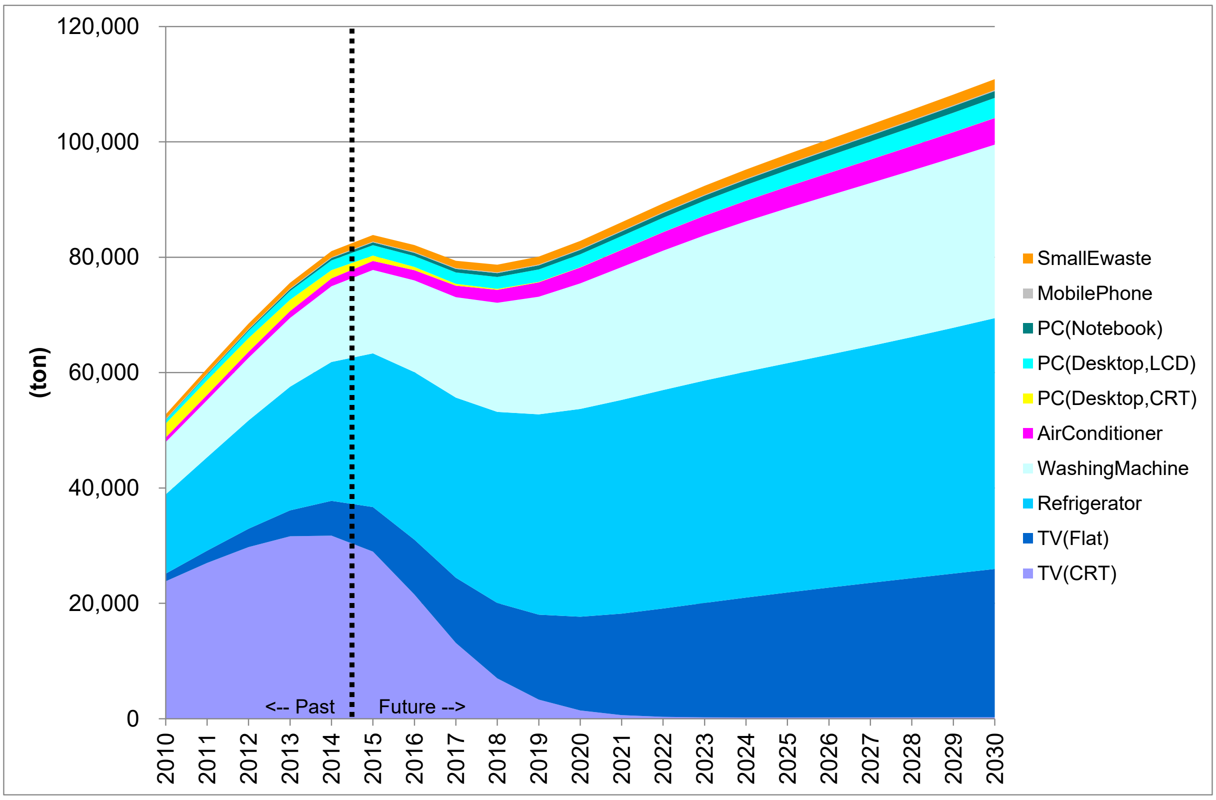


Figure 18 Discarded weight including reused from households

Source： JICA Expert Team

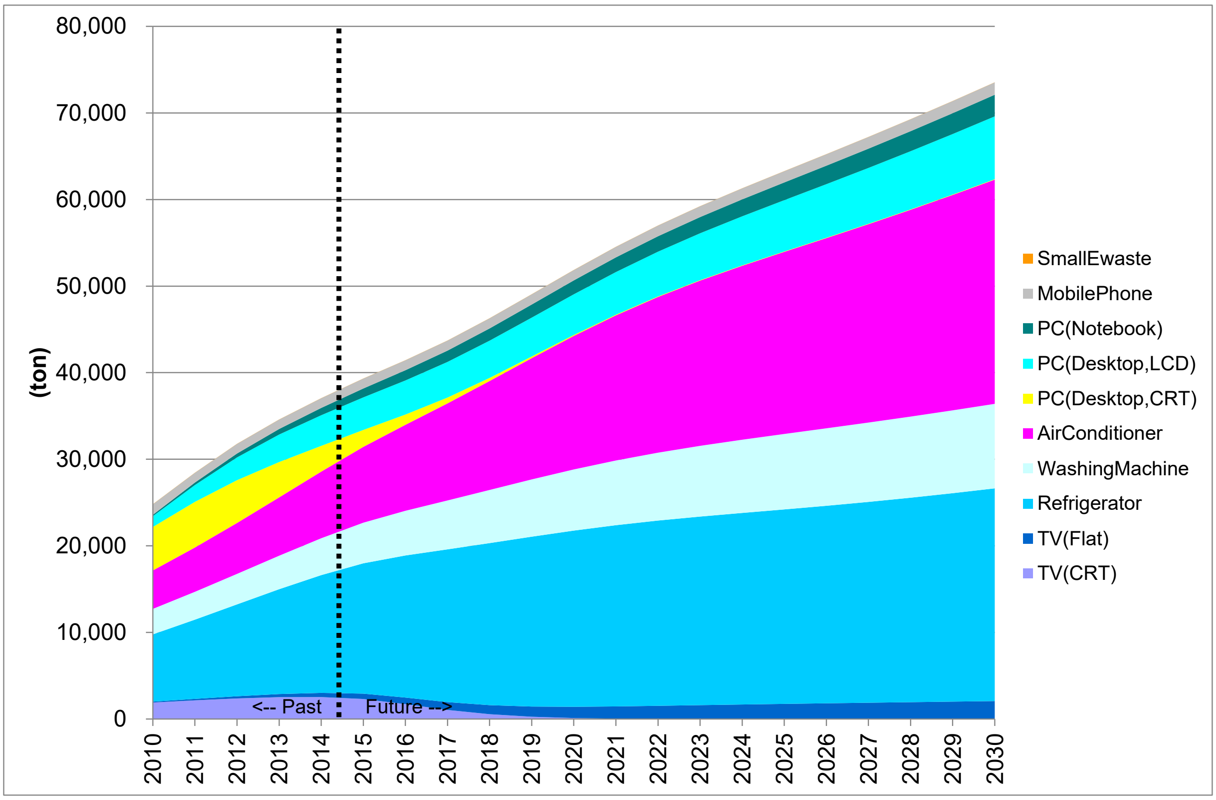


Figure 19 Discarded weight including reused from businesses

Source： JICA Expert Team

2.4.4 Discarded weight excluding reused

Figure 2.4-1 Discarded weight excluding reused from households and businesses

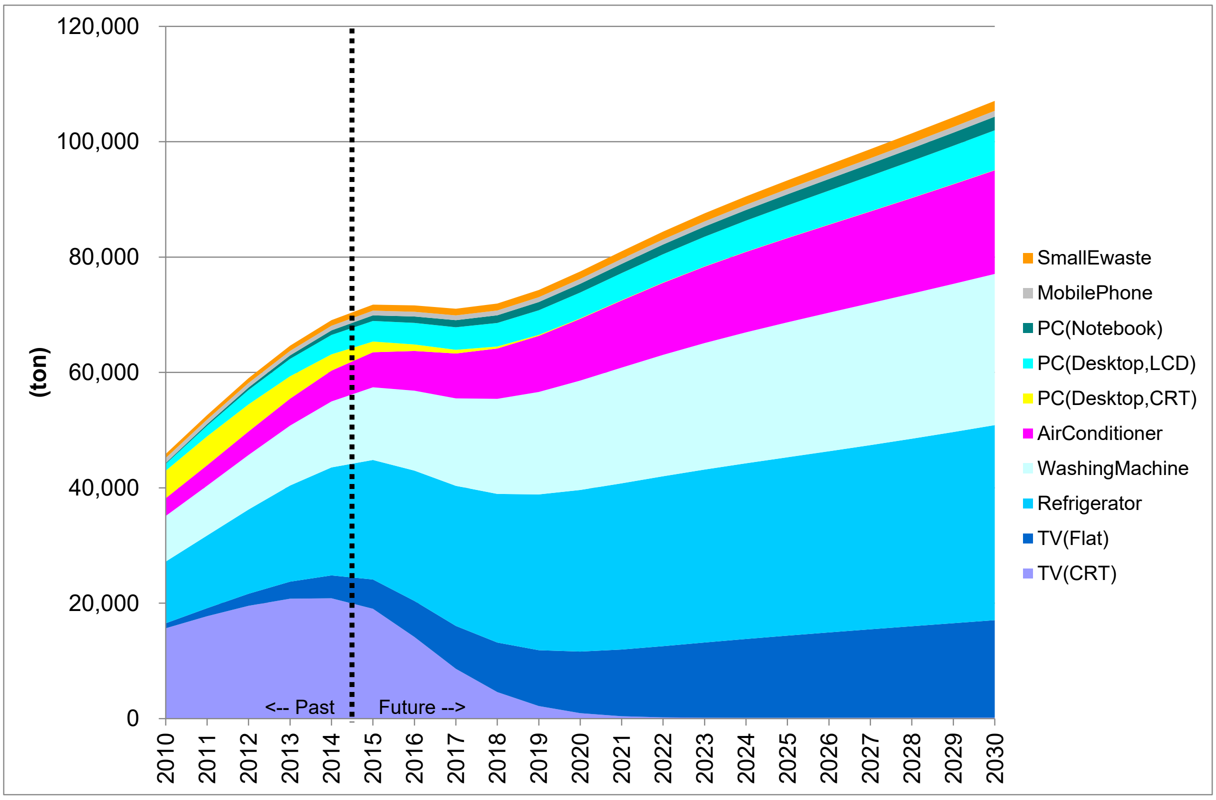


Figure 20 Discarded weight excluding reused from households and businesses

Source: JICA Expert Team

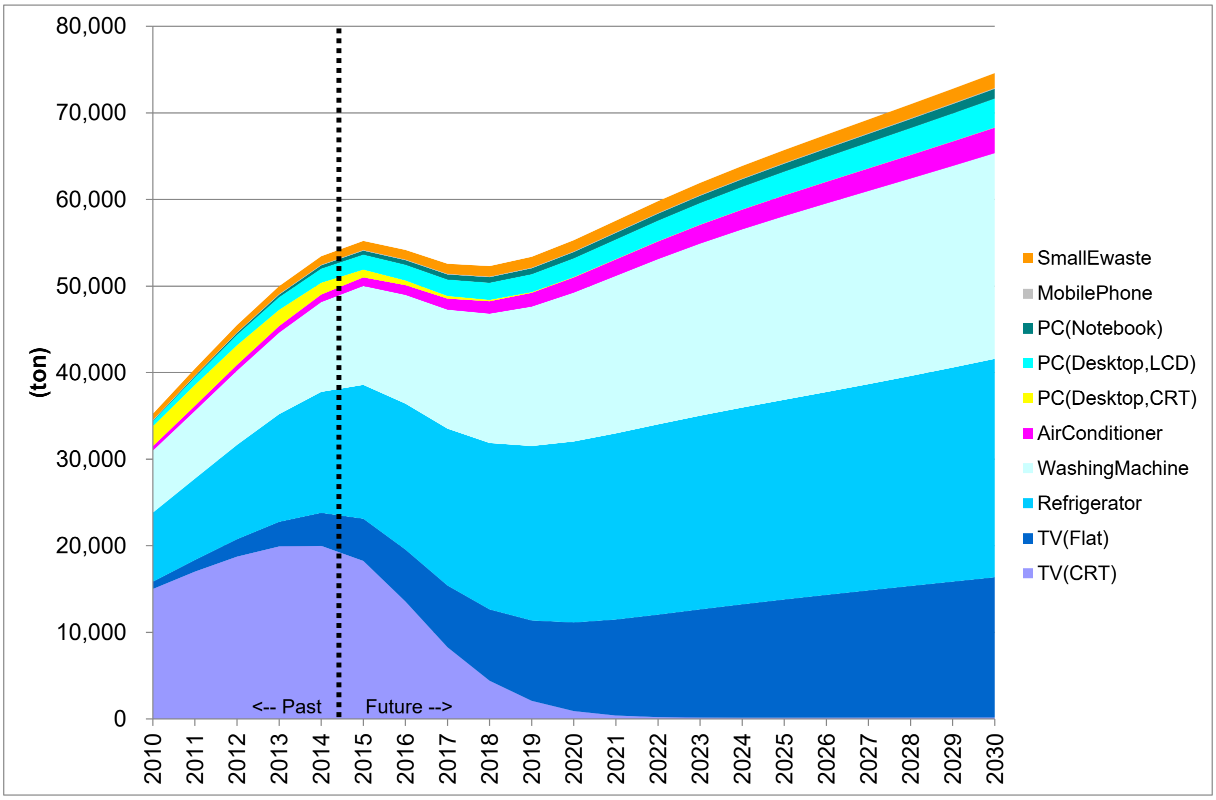


Figure 21 Discarded weight excluding reused from households

Source: JICA Expert Team

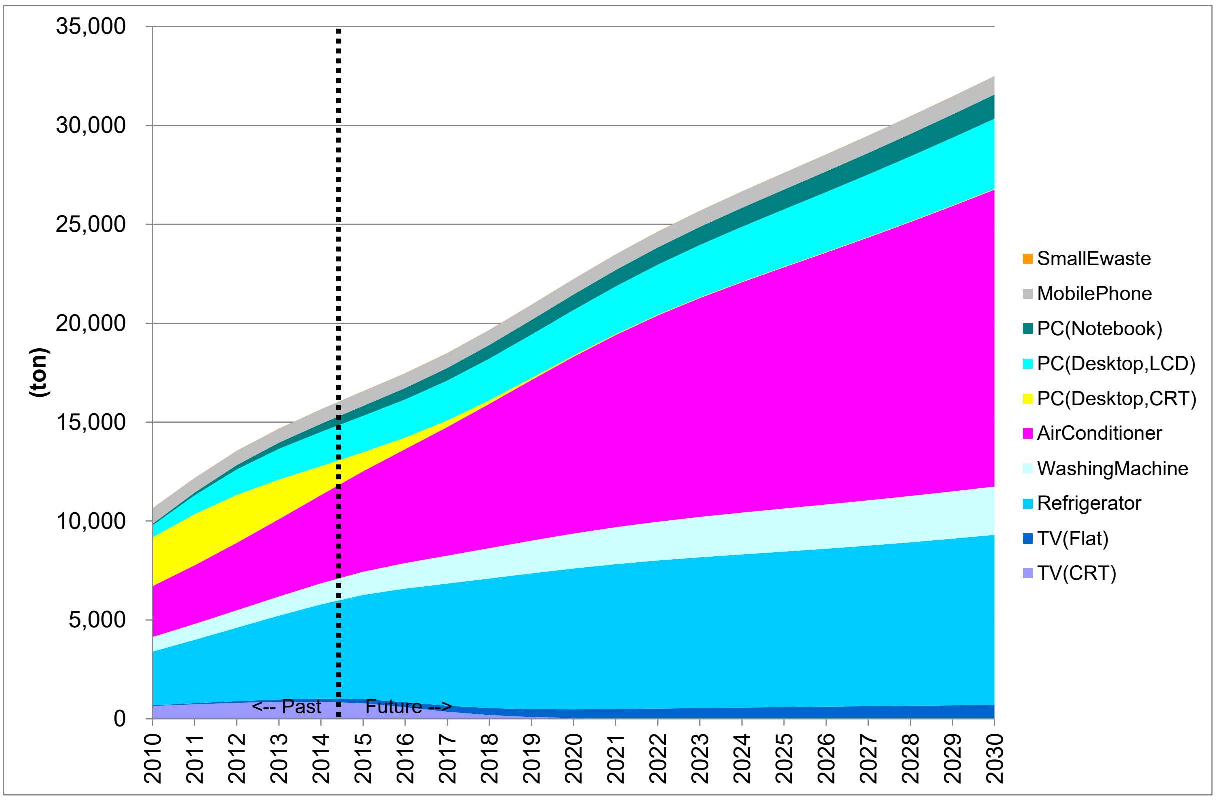


Figure 22 Discarded weight excluding reused from businesses

Source： JICA Expert Team

2.4.5 Disposal rate

Disposal rate from households

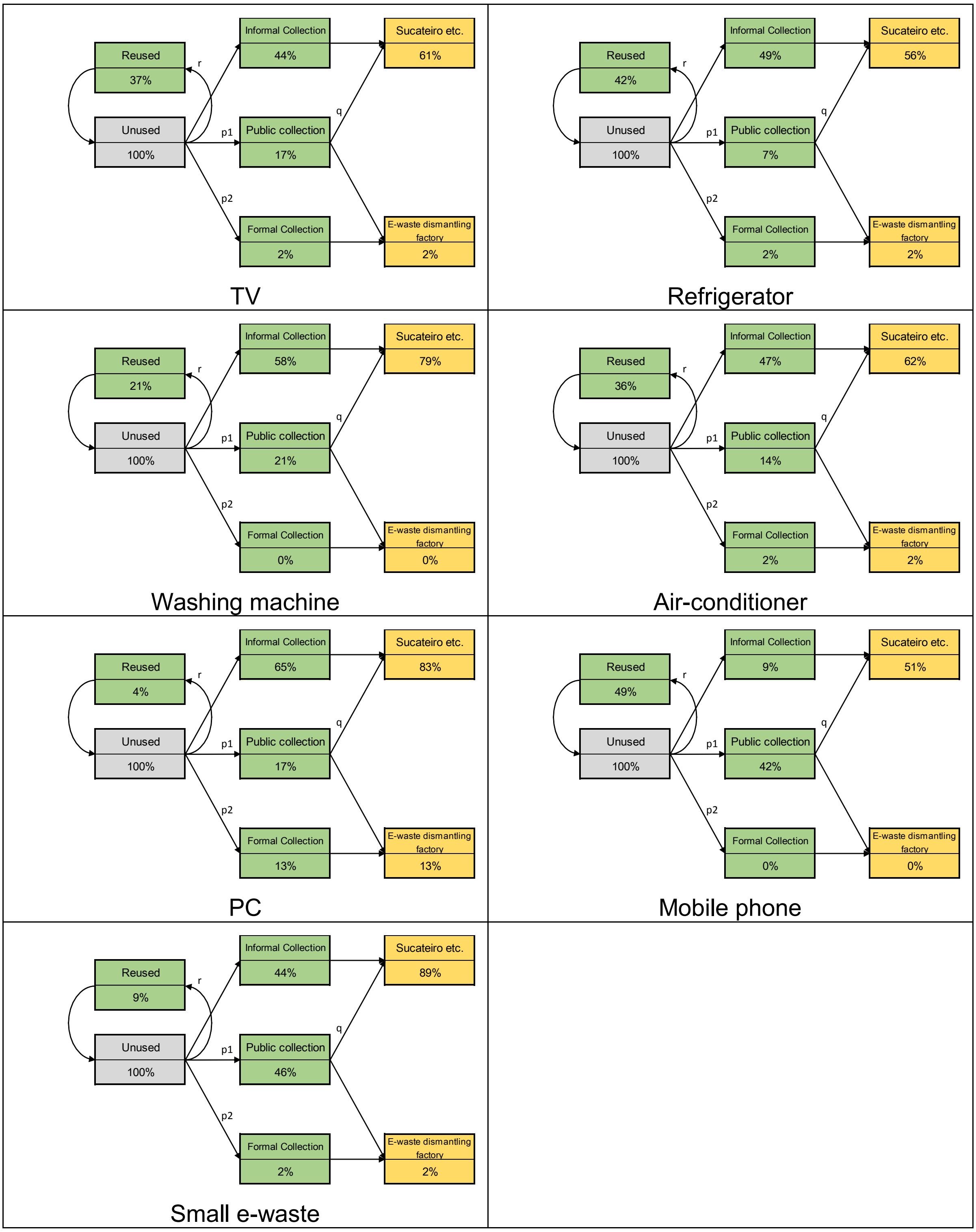


Figure 23 Disposal rate of e-waste from households

Source: JICA Expert Team

Disposal rate from businesses

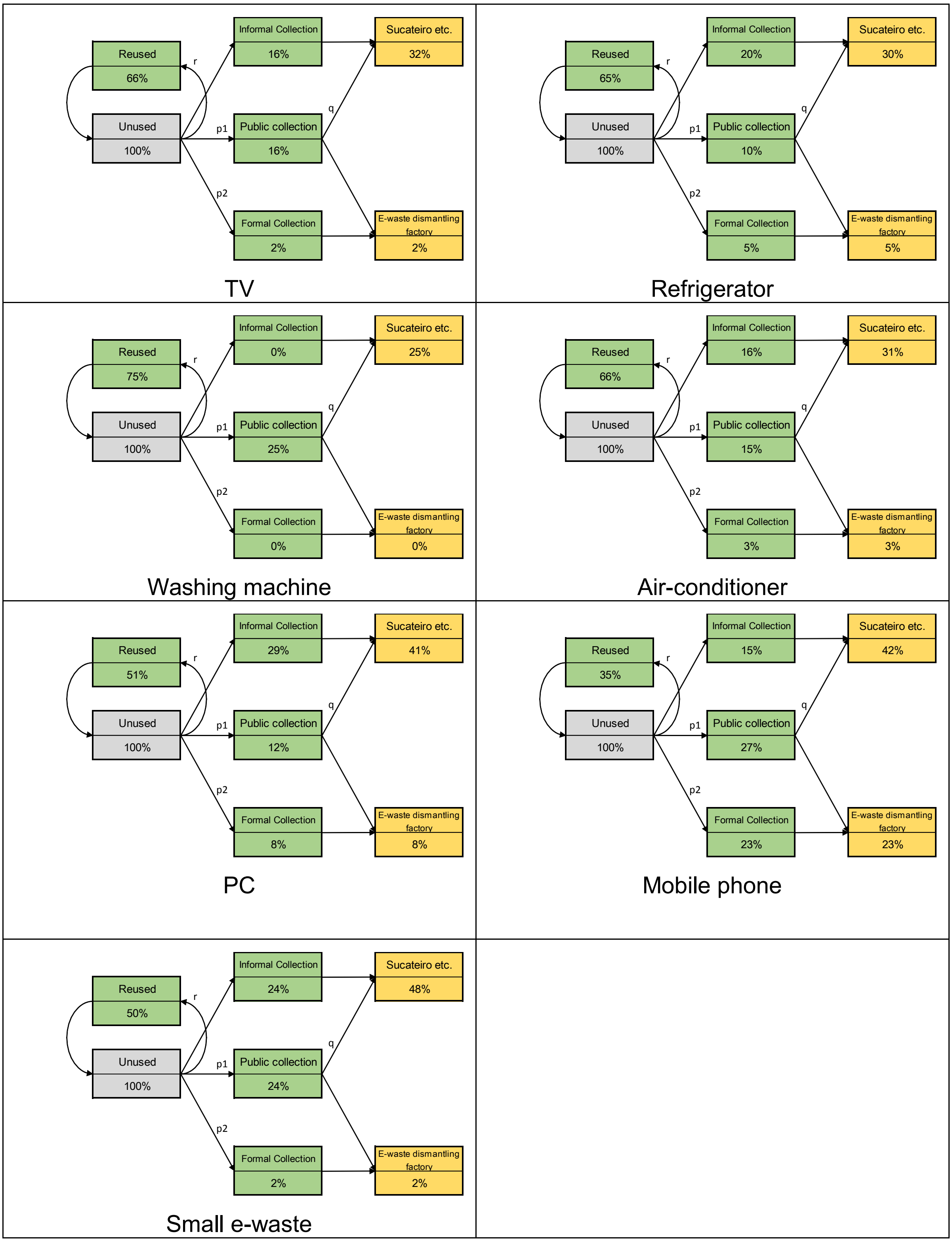
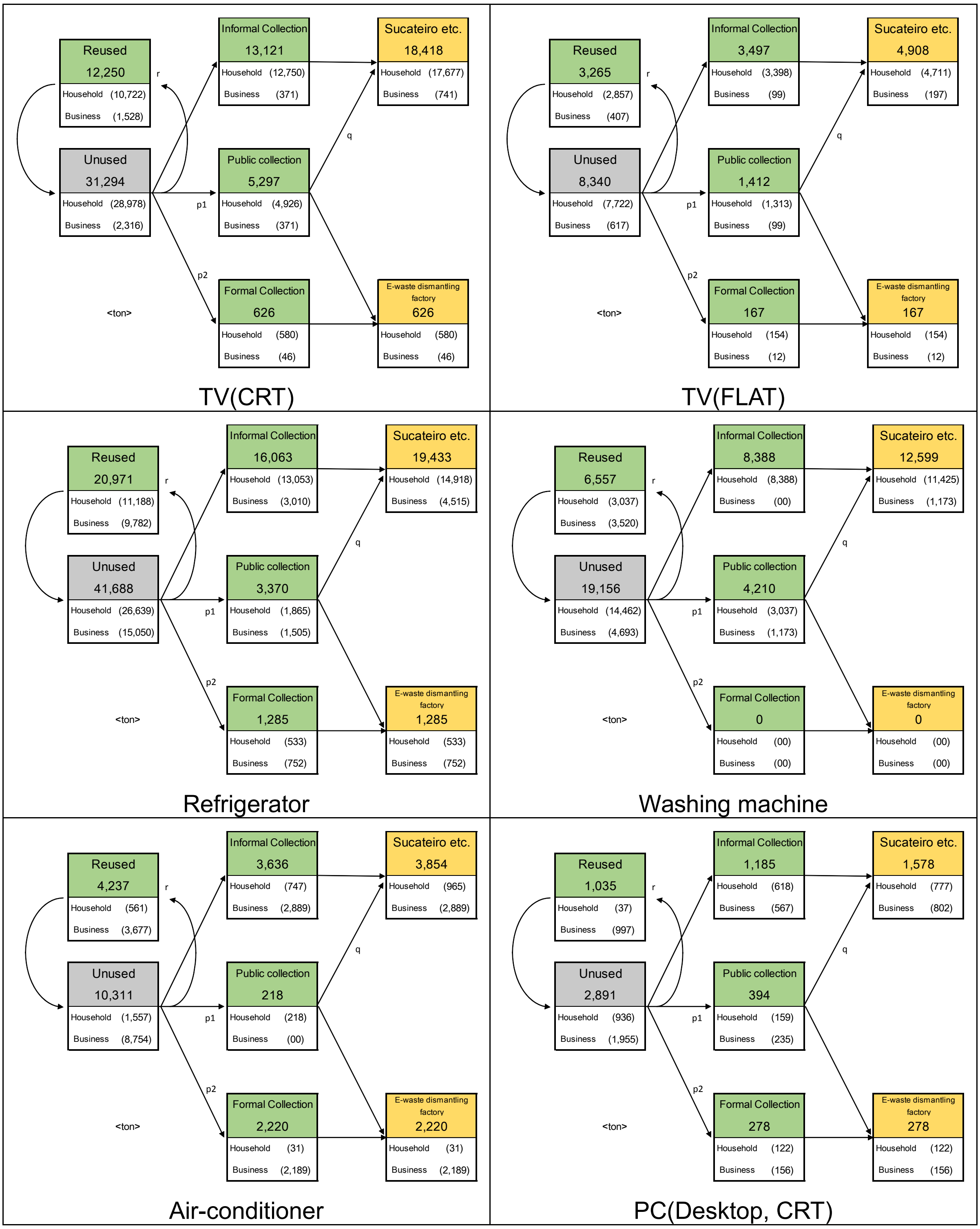


Figure 24 Disposal rate of e-waste from businesses

Source： JICA Expert Team

2.4.6 E-waste flow



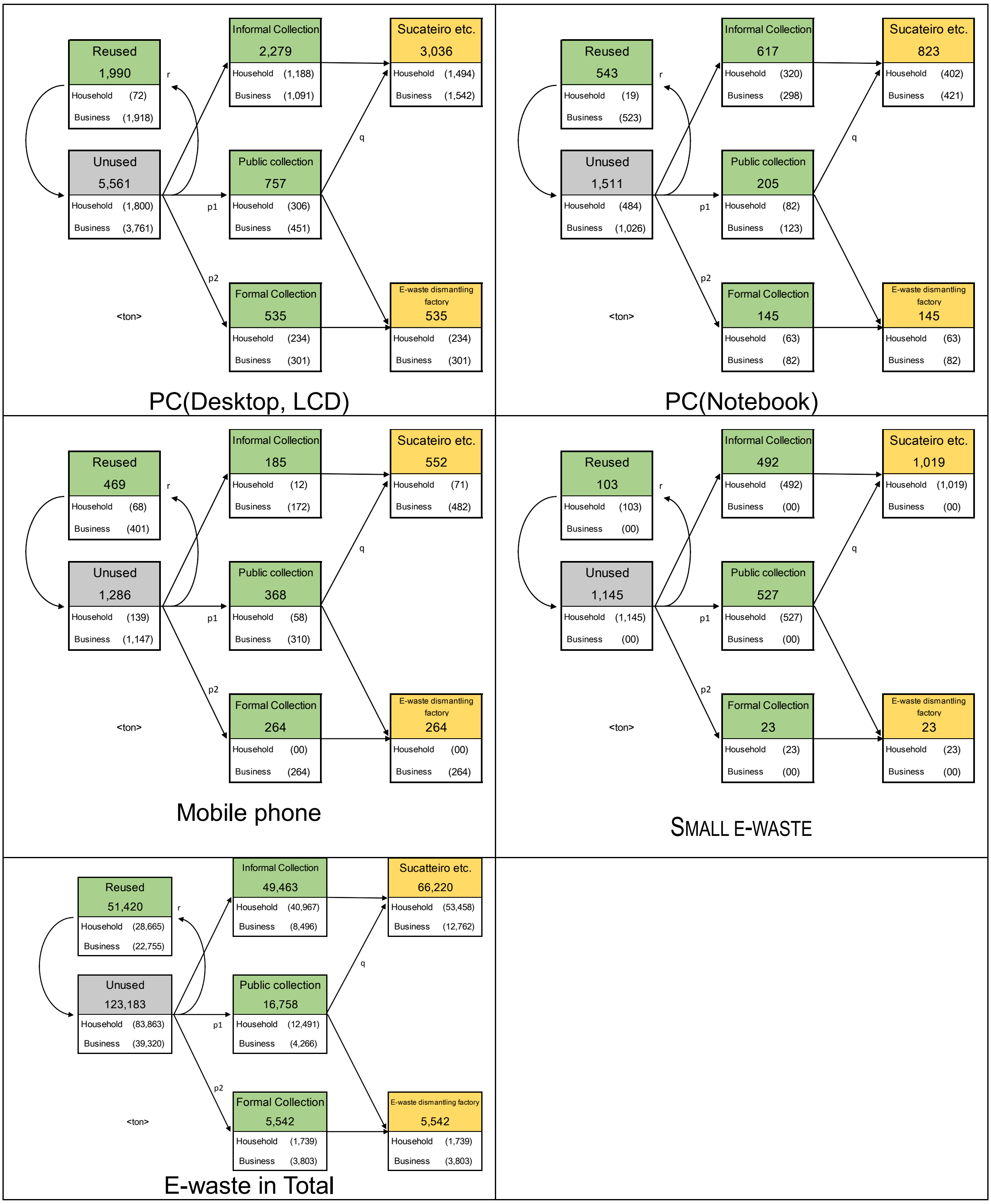


Figure 25 E-waste flow from households and businesses in 2015

Source: JICA Expert Team

3 Substance flow mode for policy evaluation

3.1 Policy evaluation indexes

The e-waste flow can be converted to the flow in terms of hazardousness and contained precious metals by giving the concentration rates. By focusing specific stage in the flow, the following three policy evaluation indexes can be defined.

Table 11 Three policy evaluation indexes

Index	Unit	Definition	Explanation	Focal substances
1. Hazardousness	%	$1-\frac{LR}{W}$	The amount of hazardous substances contained in the unmonitored e-wastes	Lead
2. Resource recovery	%	$\frac{LR}{W}$	The amount of precious metals to be recovered	Gold, Silver, Platinum, Palladium (equivalent to gold by LME prices)
3. Traceability	%	$\frac{LR}{W}$	The amount of e-waste to be monitored	The amount of e-wastes

Source: JICA Expert Team

Note: “W” means the amount of discarded e-waste excluding reused. ”FR” means the amount of e-wastes dealt by the licensed recyclers.

3.2 Data used

3.2.1 Data for evaluation on hazardousness

The concentration of hazardousness contained in e-wastes can be shown in the following table. The hazardousness is expressed by the amount of lead here.

Table 12 Concentration of hazardousness (lead) contained in e-wastes (wt/unit)

	TV	Refrigerator	Washing machine	Air-conditioner	PC (Desktop)	PC (Notebook)	Mobile phone	Small e-waste
Lead	CRT 2.5 kg 1) FLAT 7.1g 1)	5.2 g 1)	2.8 g 1)	4.6 g 2)	CRT 2.5 kg 3) LCD 132 g 4)	45.6 g 4)	3.4 g 5)	40.8 g

Note: After year 2006, the concentration was set to 0.1% for lead, mercury and hexavalent chromium, and 0.01 % for cadmium according to RoHS directive. But the products which do not exceed these rates even before year 2005 were given the original rates.

Source:
1) Tomoo Sekido, Nobutoshi Tanaka, Toshihiko Matsutou, Hiroko Kouda: Estimation on the amount of lead contained in home electric appliances, The 9th proceedings of the Japan Society of Waste Management, 1988

2) Average of refrigerator and washing machine

3) The same data for CRT television was used.

4) Japan Oil, Gas and Metals National Corporation (JOGMEC): Report of a project to develop technologies for more efficient energy use and rare metal recovery, March 2008

5) Tohoku Bureau of Economy, Trade and Industry: Feasibility study report on precious and rare metal recycling network from end-of-use digital home electric appliances, March 2007

3.2.2 Data for calculating precious metals

The data of precious metals concentration contained e-waste by product types is summarized in the following table. The precious metal concentrations were aggregated to gold equivalent concentration by using the prices in London Metal Exchange.

Table 13 Concentration of precious metals in e-wastes (wt/unit)

	PC (Desktop)	PC (Notebook)	Mobile phone	LME Price [3] (USD/oz)
Gold	0.094 [1]	0.022 [1]	0.16 [2]	1181.4
Silver	0.11 [1]	0.057 [1]	0.24 [2]	15.93
Platinum	0.0003 [1]	0.0002 [1]	0.0008 [2]	1077
Palladium	0.036 [1]	0.011 [1]	0.034 [2]	734

Source:
1) Japan Oil, Gas and Metals National Corporation (JOGMEC): Report of a project to develop technologies for more efficient energy use and rare metal recovery, March 2008

2) Average of JOGMEC and data from Tohoku Bureau of Economy, Trade and Industry: Feasibility study report on precious and rare metal recycling network from end-of-use digital home electric appliances, March 2007

3) Prices in London Metal Exchange Market, as of 15 Jan. 2015

3.3 Projection of hazardousness and precious metals

The hazardousness and precious metals contained in e-wastes to be discarded can be calculated as shown in Figure 26 and Figure 27 .

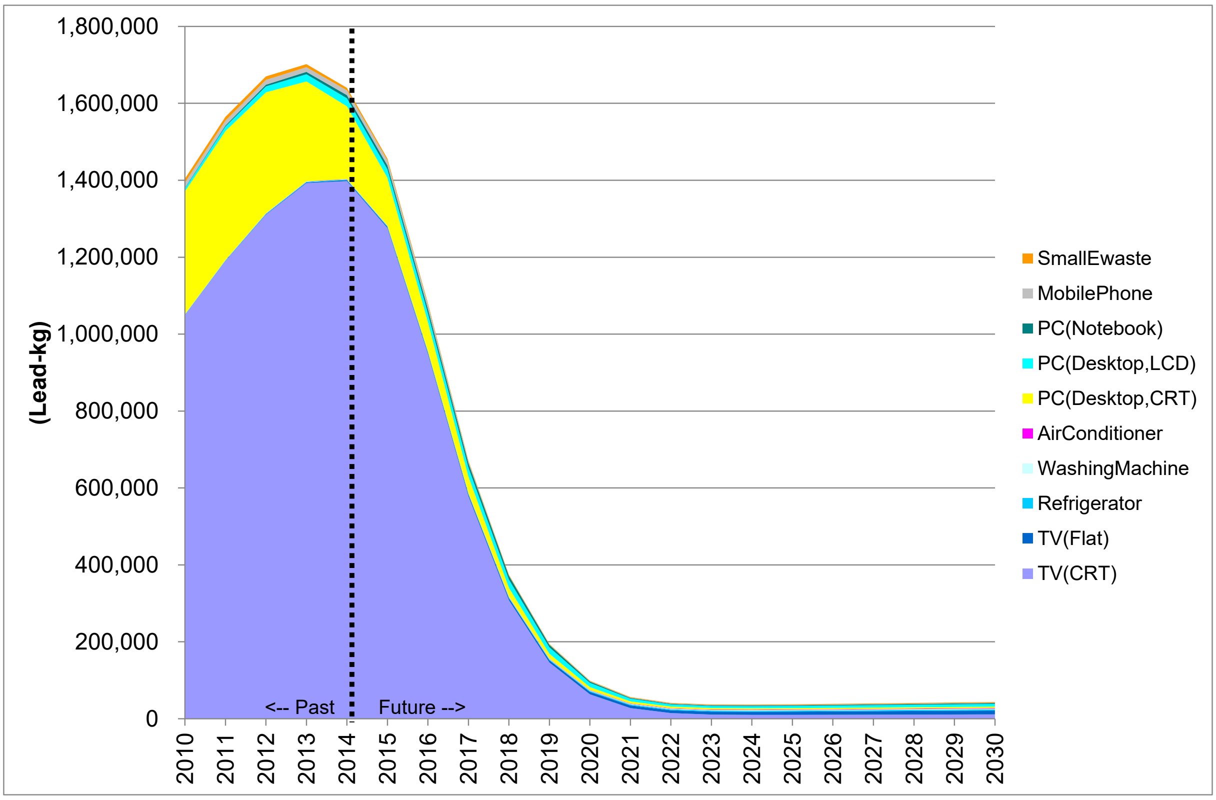


Figure 26 Hazardous substance (Lead) contained in e-wastes to be discarded
Source: JICA Expert Team

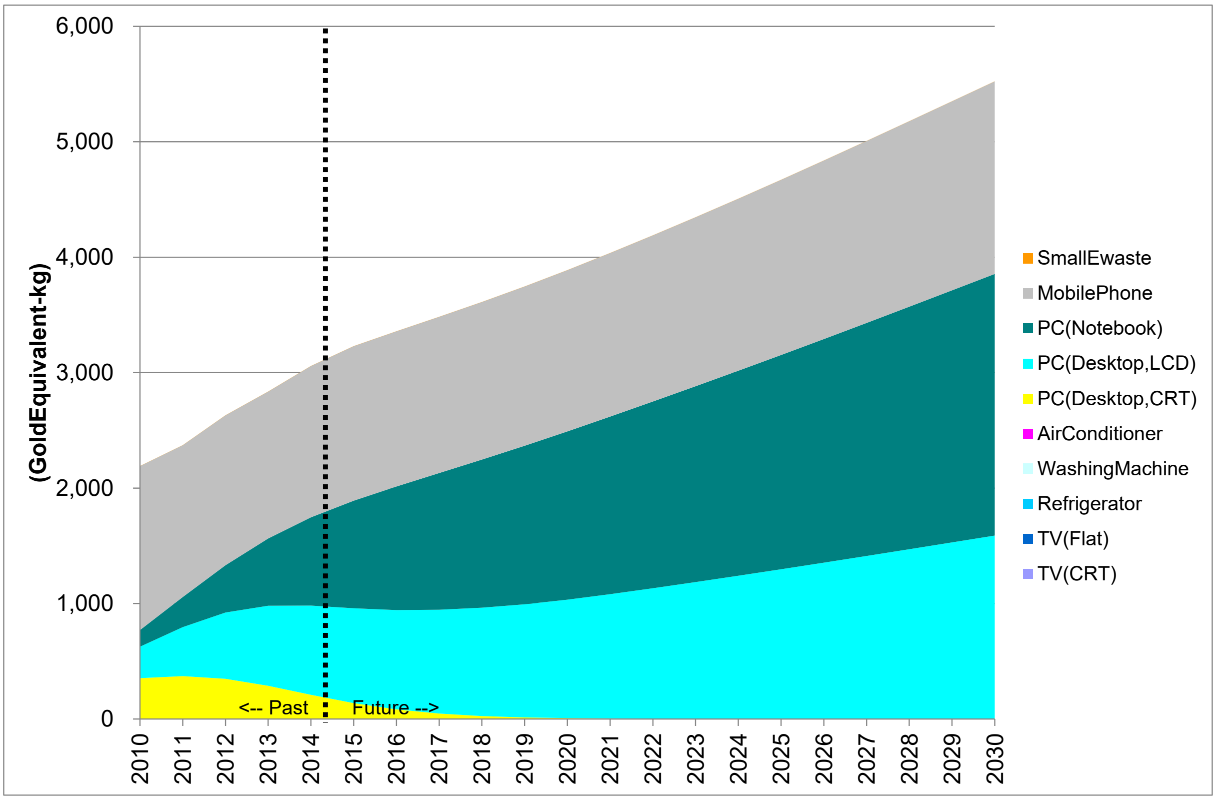


Figure 27 Precious metals contained in e-wastes to be discarded

Source： JICA Expert Team

3.4 Change of policy evaluation indexes

3.4.1 Business as usual (BAU)

The three indexes will remain at the present values without any policies.

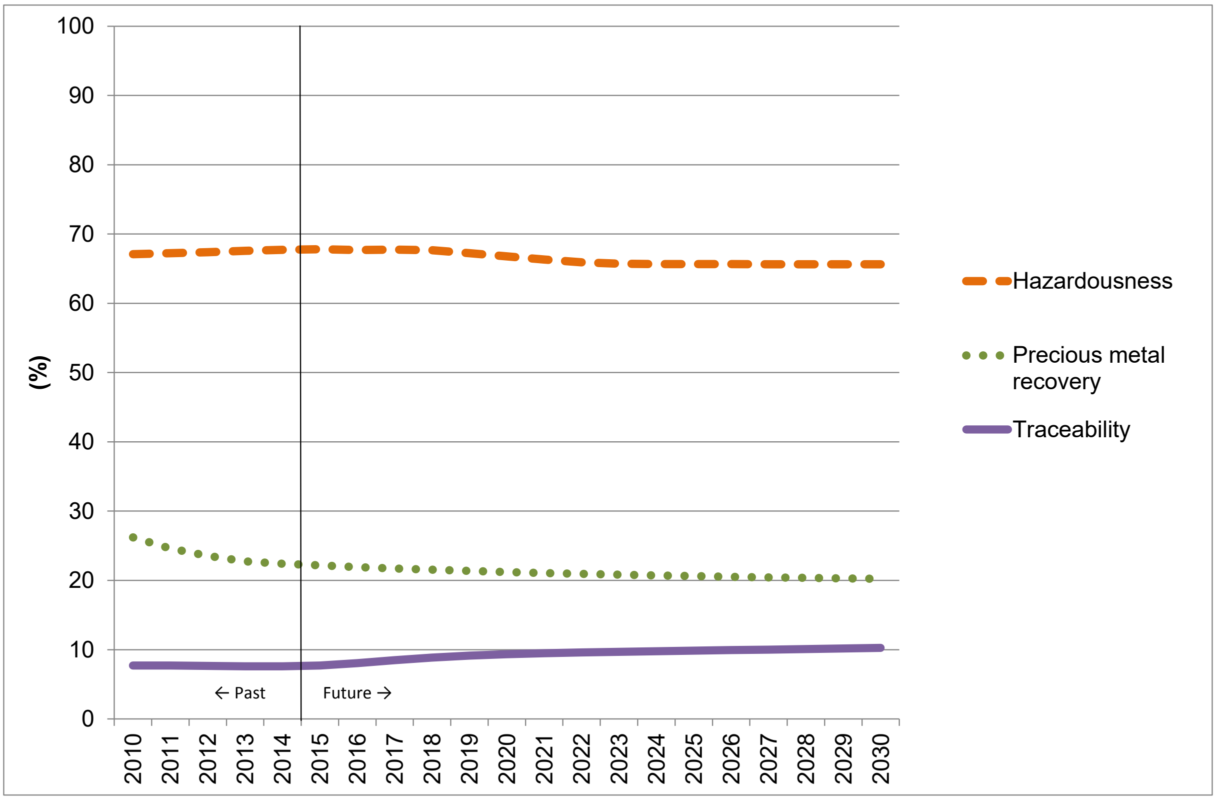


Figure 28 Change of policy evaluation indexes (without policy)

Source： JICA Expert Team

3.4.2 Policy evaluation indexes under e-waste collection polity

The change of the policy evaluation indexes were estimated by setting the e-waste flow parameters as shown in the following table. The result is shown in Figure 29 .

Table 14 E-waste flow parameters assuming e-waste collection policies in 2030

	Parameters in 2030
r	Same as the present
p_1	Same as the present
p_2	1-r-p1 (E-wastes flowing to Sucateiros become zero.)
q_1	0% (E-wastes flowing to Sucateiros become zero.)

Source： JICA Expert Team

Note: The parameters between 2015 and 2030 were interpolated smoothly.

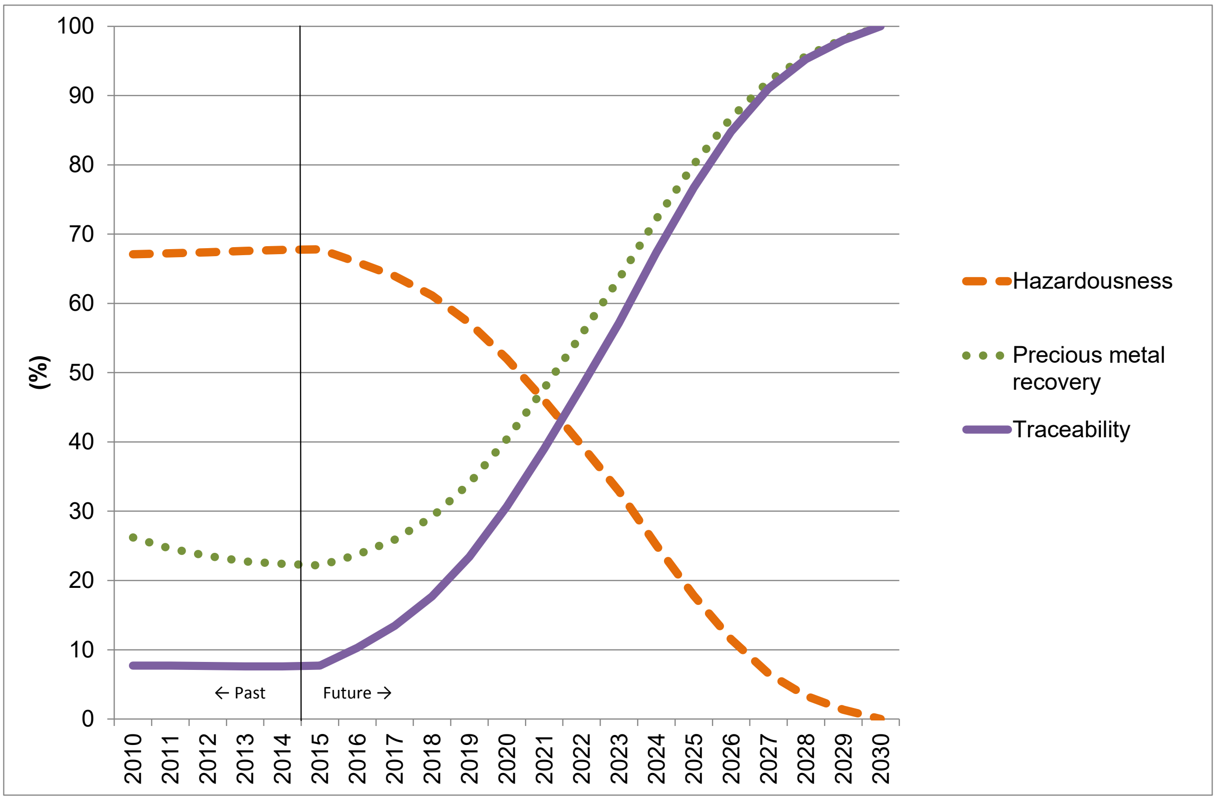


Figure 29 Change of policy evaluation indexes (with policies)

Source: JICA Expert Team

4 Sensitivity analysis

4.1 Ranges of the parameters

The unreliable parameters used in the e-waste inventory analysis were checked their sensitivities. The sensitivities was checked in the household inventory. The target parameters and the range of each parameter are shown in the following table.

Table 15 Targeted parameters and their ranges

Parameter	E-waste	Standard value	Range (upper and lower)
Average used year	TV(CRT)	10.5	7.3
	TV(FLAT)	9.5	4.8
	Refrigerator	12.1	7.3
	Washing machine	11.9	8.4
	Air-conditioner	11.1	6.7
	PC(Desktop, CRT)	5.8	11.4
	PC(Desktop, LCD)	5.1	10.1
	PC(Notebook)	4.4	8.7
	Mobile phone	2.0	6.1
	Small e-waste	10.1	4.0
Average weight per unit	Air-conditioner	55	50-60
Domestic input	PC(Desktop, CRT)	-	30% plus to the standard value (Orphan products and illegal import)
	PC(Desktop, LCD)	-	Ditto
	PC(Notebook)	-	Ditto

Source：JICA Expert Team

4.2 Sensitivity to the target parameters

The change in the amount of discarded e-waste in 2015 was evaluated in accordance to the change in the parameters with the ranges.

The change is basically inside 10% to the total e-wastes discarded in 2015.

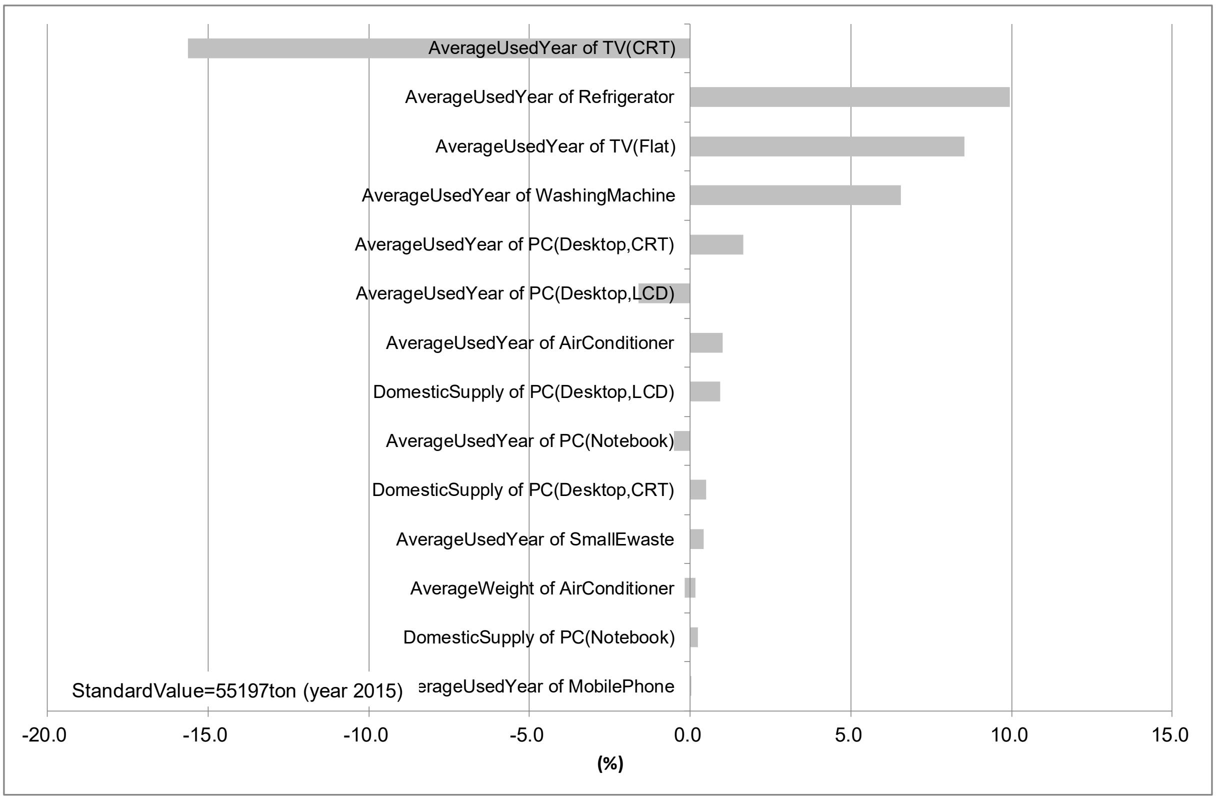


Figure 30 Change of the amount of e-wastes to be discarded from households affected by the parameter changes with the ranges

Source：JICA Expert Team

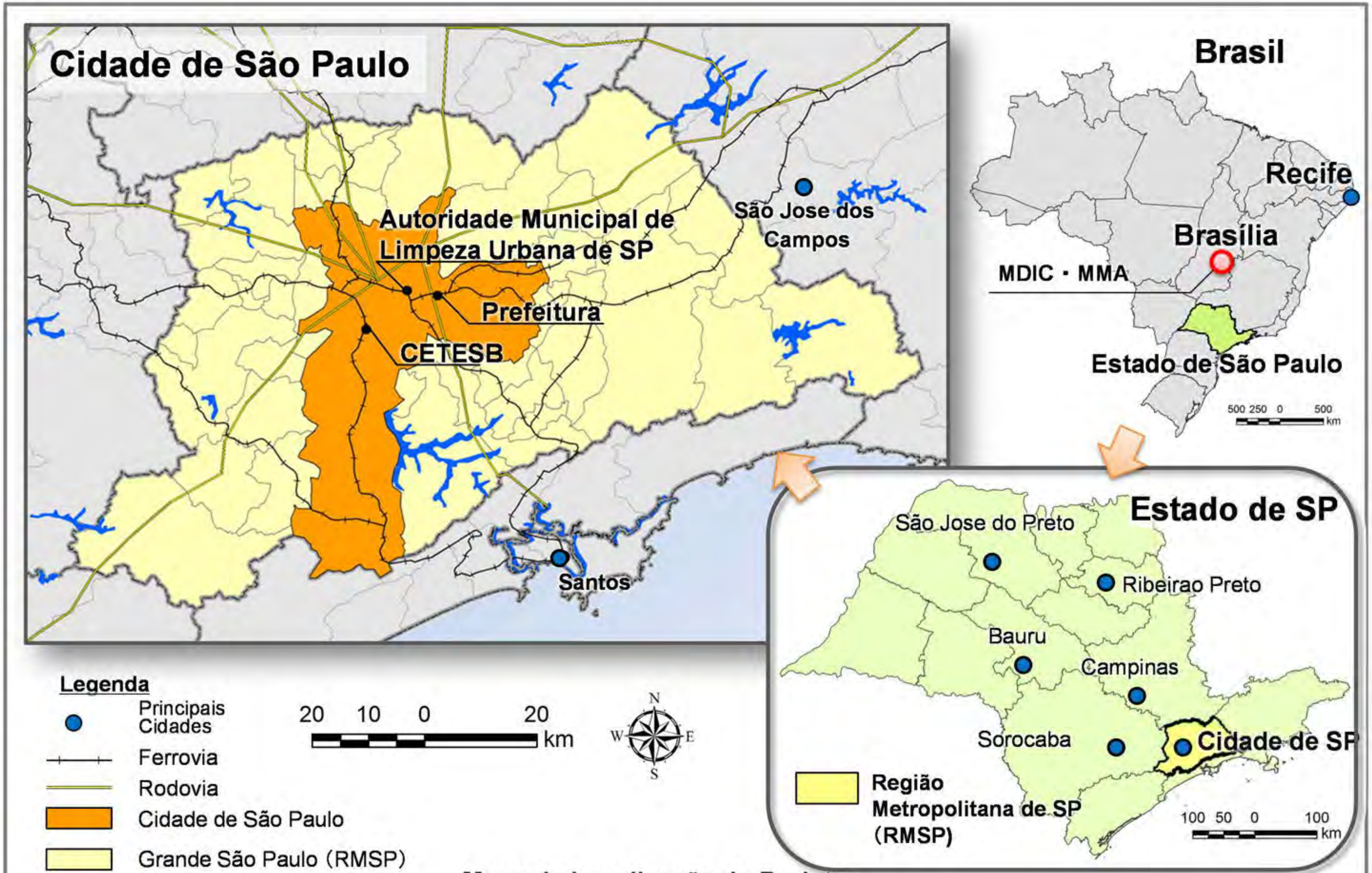
Japan International Cooperation Agency (JICA)

Project for E-waste Reverse Logistics Improvement in the Federative Republic of Brazil

Pilot Project Report (descarte ON)

August 2017

JICA Expert Team



Mapa de Localização do Projeto

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Abbreviation

AC	Air-conditioner
C/C	Consolidation Center
CFC	Chlorofluorocarbon
CRT	Cathode-Ray Tube
JET	JICA Expert Team
JICA	Japan International Cooperation Agengy
LCD	Liquid Crystal Display
NGO	Non-Government Organization
PC	Personal Computer
PCB	Printed Circuit Board
T/C	Technical Committee
TOR	Terms of Reference
TV	Television Set
USD	US-Dollar

1. Pilot Project Planning

1.1 Objective of the Pilot Project Planning

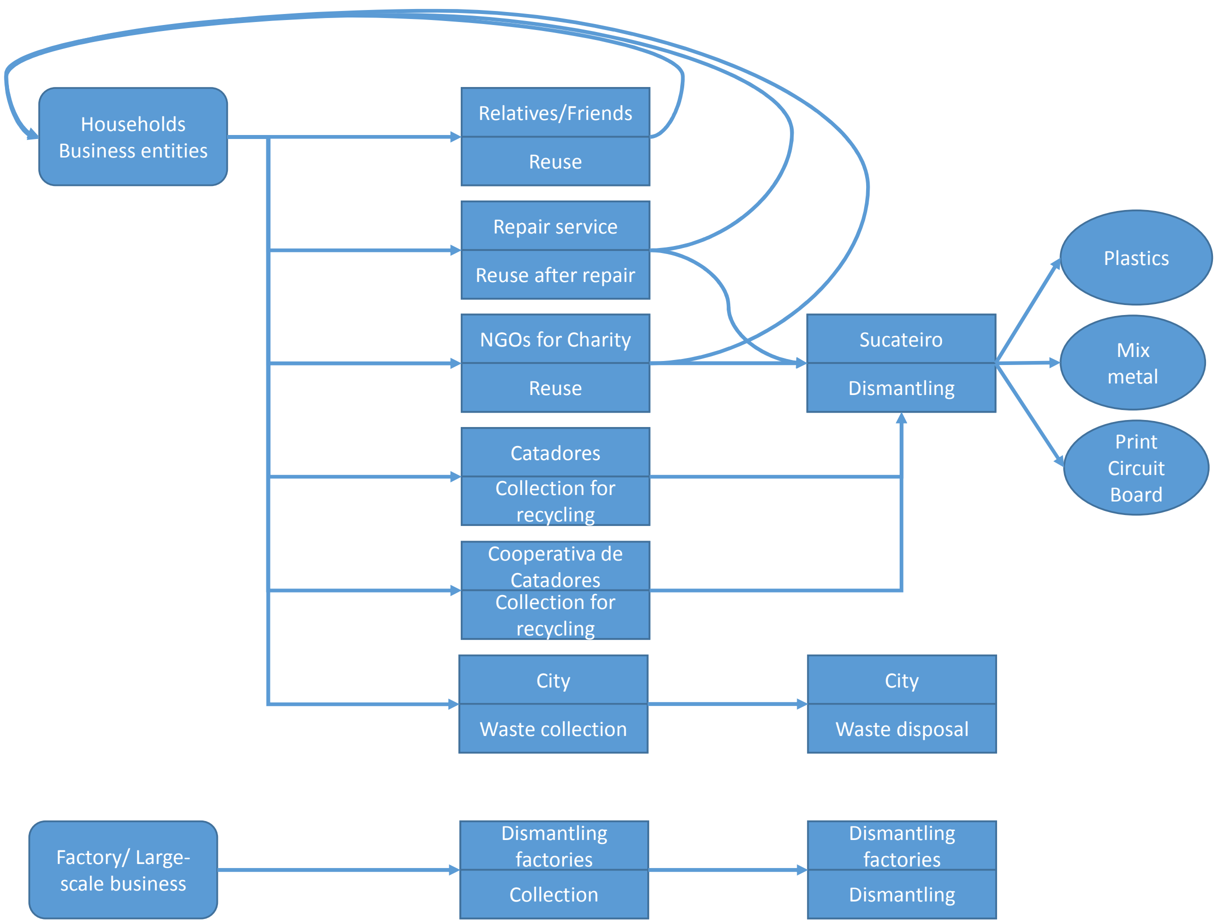
Planning of the Pilot Project aimed at sharing the contents of the proposed Pilot Project in advance of the implementation among related agencies, mainly the member of Technical Committee (T/C), for ensuring smooth implementation of the Pilot Project.

The Pilot Project was also planned to contain the pre-evaluation to be used as a hypothesis of the Pilot Project so as to compare with the post-evaluation after the Pilot Project.

1.2 Observation of Present E-waste Stream

(1) Present e-waste stream

The present e-waste stream survey by JICA Expert Team (JET) is shown in the following figure.



Source: JICA Expert Team

Figure 1-1 Present e-waste stream in Sao Paulo City

As the figure shows, the present e-waste stream can be summarized below.

- Material recycling is not a dominant route for e-waste recycling, as e-wastes are given to relatives or friends who want them.

- Reuse routes such as donation to charity groups and second hand market are vital.
- E-wastes penetrating from above mentioned reuse routes exist and they are dealt by conventional recyclers called as "Sucateiros".
- Individual "Catadores" and "Cooperativa de Catadores" are also collecting e-waste, and then sending to "Sucateiro"
- There are some e-wastes also mixed into the public waste collection managed by municipalities.

(2) Issues of the Present E-waste Stream

The current e-waste stream has the following issues considering the establishment of e-waste reverse logistics system under the policy of National Solid Waste Management Policy Law (PNRS).

- Convenient collection system which guides large-scale e-wastes to proper recyclers such as "trade-in collection" does not exist.
- E-wastes discarded to charity NGOs, "Catadores" and "Cooperativa de Catadores" are sent to Sucateiros which does not have enough skills and authorizations to dismantle and recycle e-waste properly.

(3) Target E-waste stream for the Pilot Project

Considering the present e-waste flow and its issues, the following e-waste routes were set as the target to be improved by the Pilot Project.

- E-waste routes go to Sucateiro through various actors such as repair shops, charity NGOs, "Catadores" or "Cooperativa de Catadores" shall be changed to go to the appropriate recycling facilities.
- E-waste routes collected by "Catadores" , "Cooperativa de Catadores" or municipalities will be changed to collect by the authorized collection bodies.
- E-waste routes which does not exist at this moment such as large-scale e-waste will be set in the Pilot Project.

1.3 E-waste collection system to be developed

(1) Utilization of the existing routes

- The existing actors which deal with e-waste for material recovery are "Catadores" and "Cooperativa de Catadores".
- Cooperation with "Cooperativa de Catedores" can be justified politically, but e-wastes have not to be dismantled by them in case they are not technically authorized to dismantle the e-wastes. In that case, it is necessary to make them send the e-wastes to proper e-waste recyclers not to "Sucateiro".

(2) New routes

- It is the best chance to offer e-waste collection for large-size e-wastes to consumers when they buy e-products.

- Drop-off collection for small-size e-wastes at large retailers is rational, because Sao Paulo City is asking large retailers with certain shop area to contribute in e-wastes collection as the collection points under its Integrated Solid Waste Management Master Plan (PGIRS).

(3) Direction of the Pilot Project

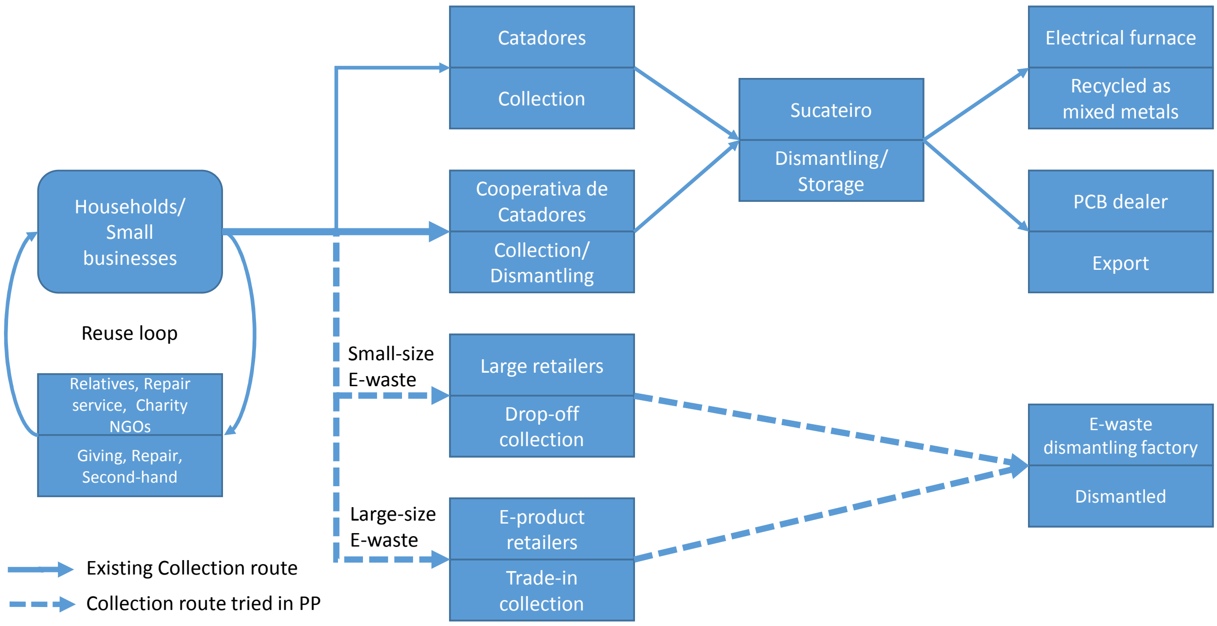
Following four collection routes were considered for direction of the Pilot Project. Then, after the discussions among the T/C members, it was determined that the route A) and B) would be adopted to attempt in the Pilot Project as shown in the figure below:

A) Drop-off collection will be used for collecting small-size e-wastes (tried in the Pilot Project);

B) Trade-in collection will be prepared for large-size e-waste collection(tried in the Pilot Project);

C) The collection by general “Cooperativa de Catadores” who are collecting various kinds of recyclables will be enhanced and the e-waste collected will be sent to proper e-waste recyclers. (not tried in the Pilot Project)

D) Penetration from the reuse routes by charity NGOs and repair services will be sent to proper e-waste recyclers. (not tried in the Pilot Project)



Source: JICA Expert Team

Figure 1-2 E-waste Reverse Logistic Routes developed in the Pilot Project

2. Outline of the Pilot Project

2.1 Objective of the Pilot Project

(1) Proof on e-waste collection performance

- The Pilot Project will prove how much e-waste can be collected.

(2) Finding of e-waste recycling system failure

- The Pilot Project will prove whether the proposed e-waste collection system will work well or not.

(3) Estimation on the e-waste recycling cost

- The Pilot Project will provide data for calculating the e-waste recycling cost.

2.2 Outline of the Pilot Project

(1) Duration

- From the end of April 2016 to the end of December 2016 (eight months)

(2) Target area

- Sub-Prefeitura de Lapa, Sao Paulo City

(3) Participating retailers

Table 1-1 Participating Retailers for the Pilot Project

Name of Retailers	Group	Category	Participating Number: Drop-off (collection from retailers)	Participating Number: Trade-in (collection at home)
Casas Bahia	GPA	e-products shop	2	2
Ponto Frio			2	2
Extra Hiper		Supermarket selling fresh foods	1	1
Extra			1	1
Walmart			2	2
Pernambucanas		Supermarket not selling fresh foods	1	0
Lojas Americanas			1	0
Total			10	8

Source: JICA Expert Team

(4) Participating Cooperativa and Recyclers

Table 1-2 Participating Cooperativa and Recyclers for the Pilot Project

Name	Category	Function
COOPERMITI	Cooperativa	Collection and temporary storage of e-wastes as “Consolidation Center”.
OXIL/estre	Recyclers	Recycling of e-waste collected by Coopermiti
GM&C LOG		Recycling of large size e-waste collected under the management of ABREE

Source: JICA Expert Team

(5) Target e-waste

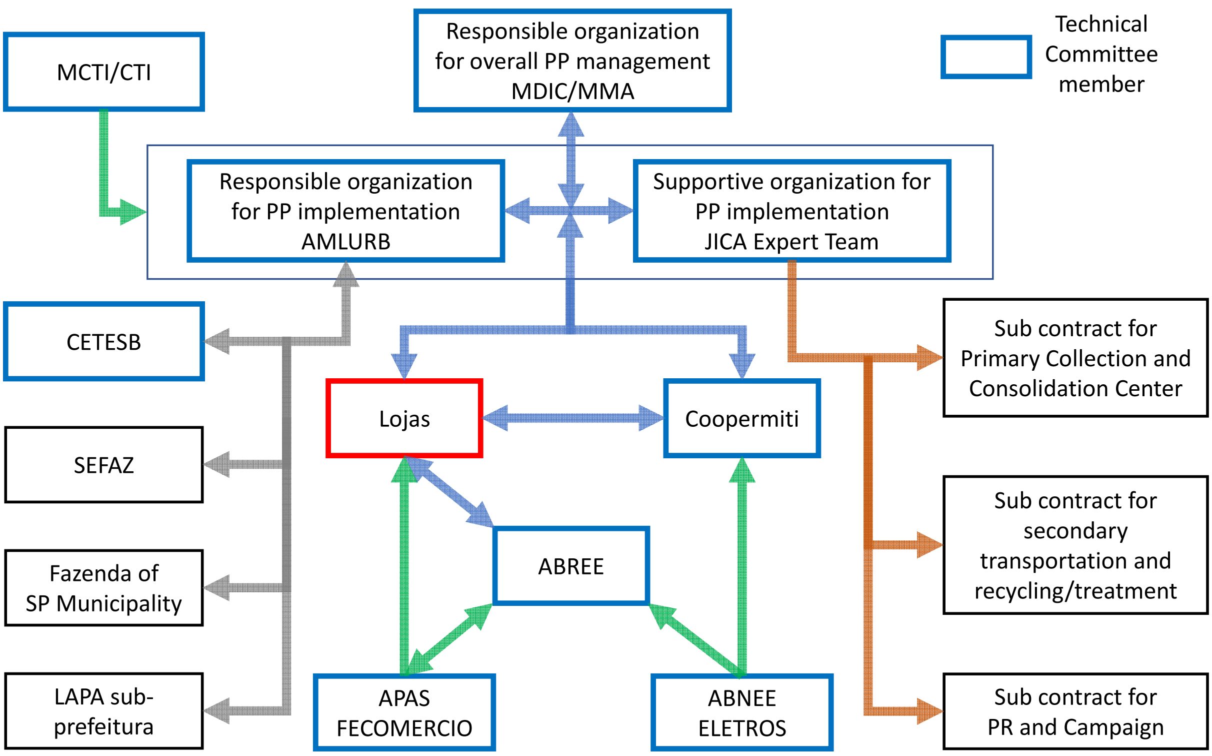
Table 1-3 Target E-waste for the Pilot Project

Large size e-waste (five products)	Middle size and small size e-waste	Excluded products
• Refrigerator • Washing machine • Air-conditioner • Television set • Oven range	• Personal computer • Mobile phone • Other small e-wastes (White, Blue, Green, Brown)	• Rechargeable battery, dry battery • Florescent tube • Toner for printers

Source: JICA Expert Team

2.3 Implementation Structure for the Pilot Project

The Pilot Project was implemented under the implementation structure shown in Figure 2-1 in which all member of T/C are involved.



Source: JICA Expert Team

Figure 2-1 Formation for the Pilot Project

Table 1-4 Technical Committee Member

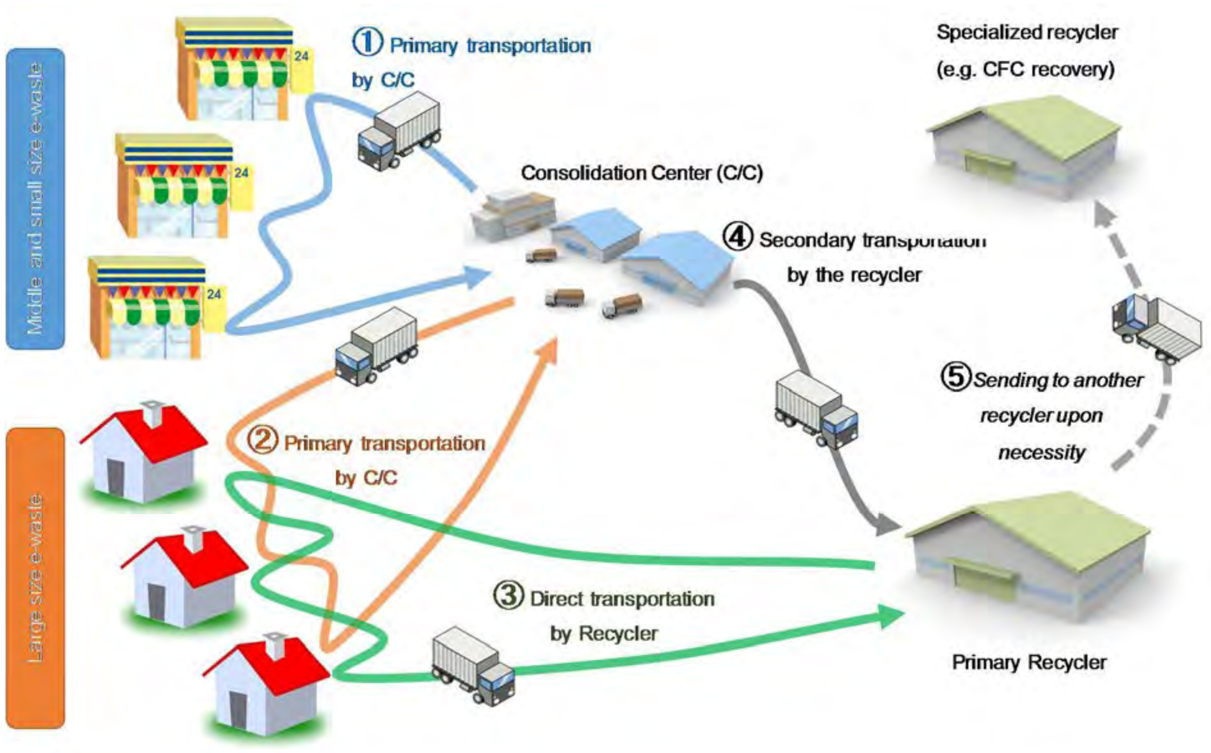
Chair	Government	Manufactures	Retailers	Others
MMA MDIC	AMLURB MCTI/CTI CETESB	ABINEE ELETROS ABREE	ABRAS/APAS FECOMERCIO-SP	COOPERMITI & JET

Source: JICA Expert Team

2.4 E-waste collection system

(1) Overall picture of the e-waste collection system

- The middle size and small size e-wastes are to be collected in the drop-off points by collection box/boxes placed in the electric appliances retailing shops.
- E-waste accumulated at the drop-off points are to be transported to the consolidation center by its collection truck (Primary Transportation).
- Some large size e-wastes are to be collected from the consumers upon their requests by the consolidation center (Primary Transportation).
- E-wastes transported to the consolidation center are to be separated and weighed in accordance to the designated e-waste categories for temporary storage.
- E-wastes temporarily stored at the consolidation center are to be collected by the recycler (Secondary Transportation)
- Some large size e-wastes are to be directly collected from the consumers upon their requests by the recycler (Direct Transportation).
- The collected e-waste will be dismantled and recycled properly at the recyclers.



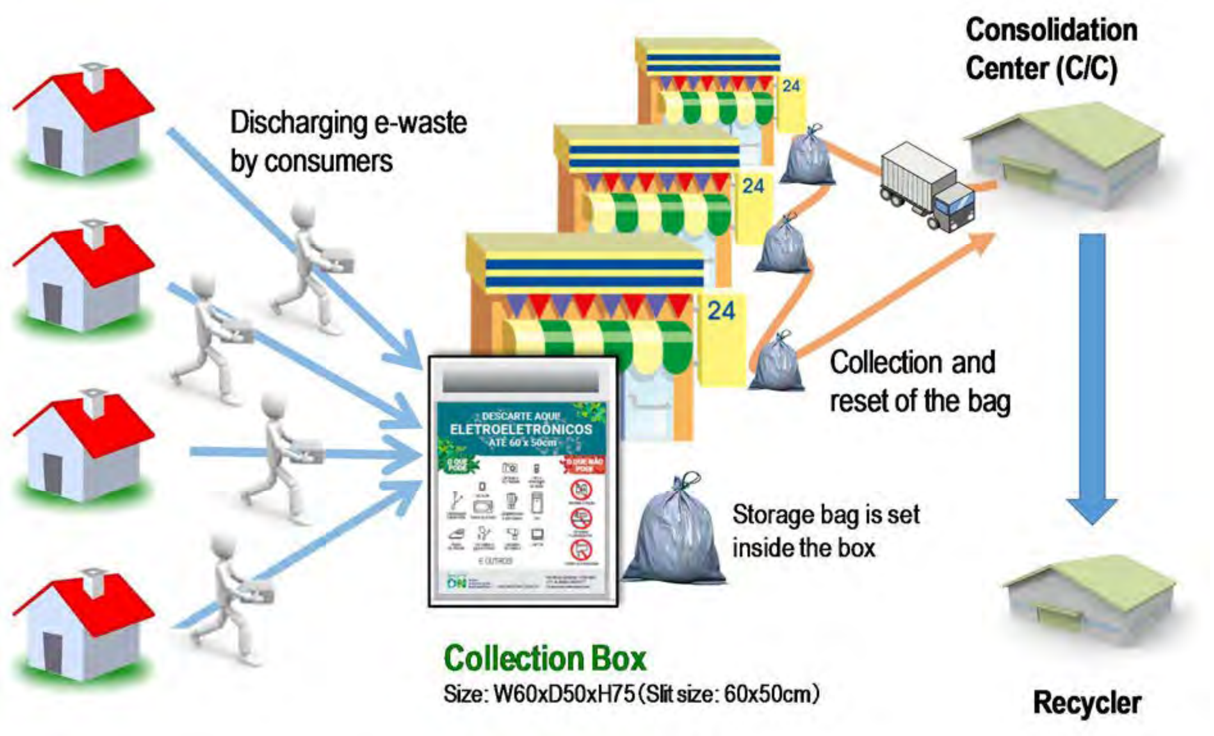
Source: JICA Expert Team

Figure 2-2 Overall picture of e-waste collection system

(2) Drop-off collection system (collection from retailers)

1) Overall picture of the drop-off collection system

Small and middle size e-wastes are to be collected through collection boxes placed in retailers who participated in the Pilot Project. Anyone can bring e-wastes whenever they want, and whatever their size matches the designated size of box, as shown in the following figure.



Source: JICA Expert Team

Figure 2-3 Overall picture of the drop-off collection system

2) Procedure of the drop-off collection

- Discarders put middle size and small size e-wastes into collection boxes placed in retailers.
- The consolidation center, which is Coopermiti for this Pilot Project, collects collection bags set in collection boxes and prepares new bags, once a week on regular base.
- Retailers monitor collection boxes so as not to become full. If it is becoming full before the regular collection, retailers call to Coopermiti asking an urgent collection. Upon the request, Coopermiti collect e-waste urgently.
- Coopermiti opens the collected bags and sorts e-wastes inside in accordance with the designated categories of e-wastes for separate storage so that the secondary transportations can be easier.
- E-wastes are to be sorted by the categories of:

  1. Monitors (CRT type),
  2. Monitors (LCD type),
  3. Personal computers (desktop type),
  4. Personal computers (notebook type),
  5. Others (categorized in the group of “White”),
  6. Others (categorized in the group of “Brown”),
  7. Others (categorized in the group of “Blue”),
  8. Others (categorized in the group of “Green”) and
  9. Others (uncategorizable e-waste and non-target waste such as batteries).

- Coopermiti contacts with the recycler, which is dismantling and sorting factory for secondary transportation of the e-wastes.
- The dismantling and sorting factory recycles the e-waste properly according to the designated manner.

3) Money settlement for the primary transportation of the drop-off collection

Amount of money calculated by the following formula will be paid every month.

- Reimbursed amount for primary transportation=Pd × Nd + $\sum S \times W$+M

  Where

  Pd: Unit price of primary transportation per one trip (collection from retailers) (USD/trip)

  Nd: Number of trips in the month (trip/month)

  S: Unit price for sorting and storage per weight of e-waste (USD/kg)

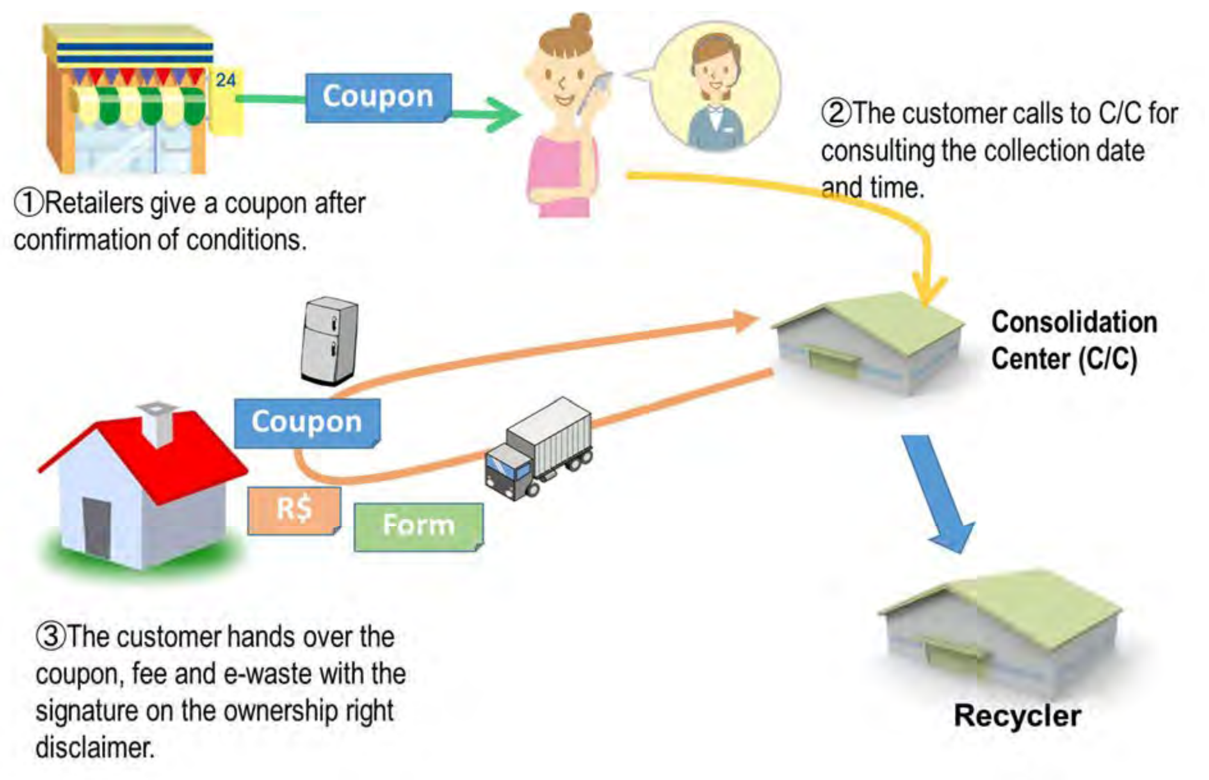
  W: Total weight collected in the month (kg/month)

  M: Monthly management cost (USD/month)

(3) Trade-in collection system (door to door collection)

1) Overall picture of the trade-in collection

Large size e-wastes are to be collected from houses upon requests from the consumers. The e-wastes will be collected by vehicles deployed for e-waste collection.



Source: JICA Expert Team

Figure 2-4 Overall picture of the trade-in collection system

2) Procedure of the trade-in collection

a) Types of the trade-in collection

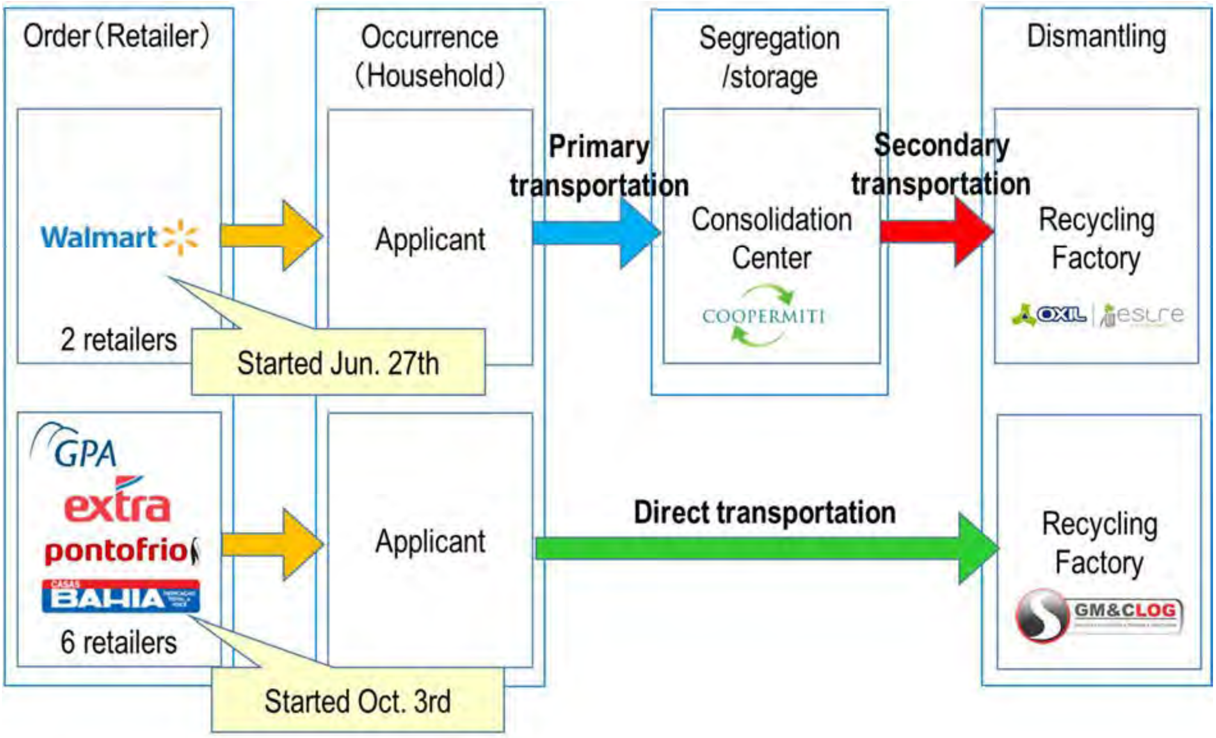
The trade-in collection was conducted differently by Walmart and GPA as shown in the following figure.

<Walmart>

- Collection by Coopermiti and storage by Coopermiti
- Transportation by OXIL to the factory of OXIL

<GPA>

- Collection by GM&C and direct transportation by GM&C to the factory of GM&C

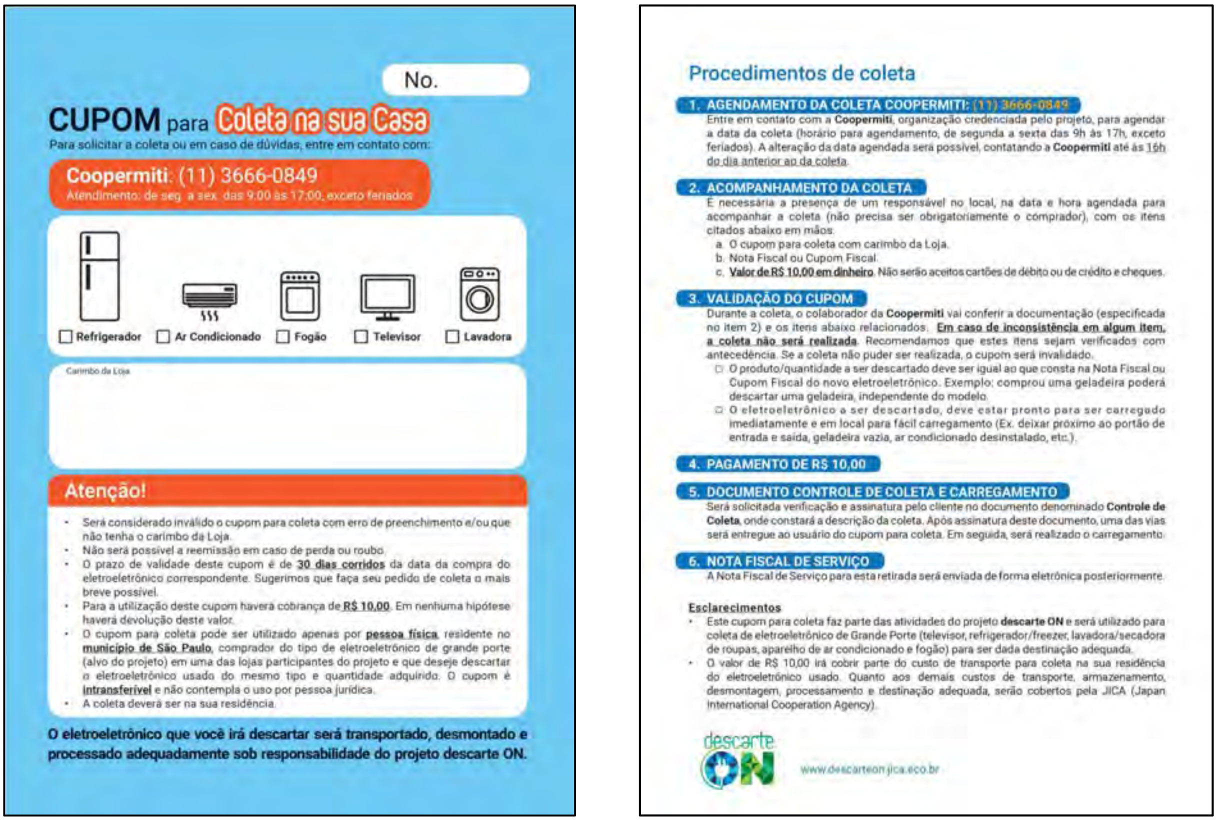


Source: JICA Expert Team

Figure 2-5 Trade-in collection system by Walmart and GPA

b) Procedure of the trade-in for the retailers of Walmart

- Retailers give a coupon to a consumer who offers trade-in collection when he/she purchase large size electric products (refrigerator, washing machine, air-conditioner, oven range)
- The customer calls to Coopermiti and consults the collection date and time. The coupon can be used by the customer. The customer pays R$10 per one unit of e-waste.
- Coopermiti collects the e-waste from the customer and transports to and stores at the Consolidation Center. Coopermiti will be reimbursed the collection cost deducted with R$10 from the project team.
- the e-waste stored at Cooperimiti is then transported by the recycler to its recycling facility.
- The recycler properly recycles the e-waste in accordance with the predetermined manner. The recycler will be reimbursed the recycling cost from the project team in accordance with the recycled e-waste.



No.

CUPOM para Coleta na sua Casa

Para solicitar a coleta ou em caso de dúvidas, entre em contato com:

Coopermiti: (11) 3666-0849

Atendimento: de seg. a sex. das 9:00 às 17:00, exceto feriados

☐ Refrigerador ☐ Ar Condicionado ☐ Fogão ☐ Televisor ☐ Lavadora

Carimbo da Loja

Atenção!

- Será considerado inválido o cupom para coleta com erro de preenchimento e/ou que não tenha o carimbo da Loja.
- Não será possível a reemissão em caso de perda ou roubo.
- O prazo de validade deste cupom é de **30 dias corridos** da data da compra do eletroeletrônico correspondente. Sugerimos que faça seu pedido de coleta o mais breve possível.
- Para a utilização deste cupom haverá cobrança de **R$ 10,00**. Em nenhuma hipótese haverá devolução deste valor.
- O cupom para coleta pode ser utilizado apenas por **pessoa física**, residente no **município de São Paulo**, comprador do tipo de eletroeletrônico de grande porte (alvo do projeto) em uma das lojas participantes do projeto e que deseje descartar o eletroeletrônico usado do mesmo tipo e quantidade adquirido. O cupom é **intransferível** e não contempla o uso por pessoa jurídica.
- A coleta deverá ser na sua residência.

O eletroeletrônico que você irá descartar será transportado, desmontado e processado adequadamente sob responsabilidade do projeto descarte ON.

Procedimentos de coleta

1. AGENDAMENTO DA COLETA COOPERMITI: (11) 3666-0849

Entre em contato com a **Coopermiti**, organização credenciada pelo projeto, para agendar a data da coleta (horário para agendamento, de segunda a sexta das 9h às 17h, exceto feriados). A alteração da data agendada será possível, contatando a **Coopermiti** até às 16h do dia anterior ao da coleta.

2. ACOMPANHAMENTO DA COLETA

É necessária a presença de um responsável no local, na data e hora agendada para acompanhar a coleta (não precisa ser obrigatoriamente o comprador), com os itens citados abaixo em mãos.

a. O cupom para coleta com carimbo da Loja.
b. Nota Fiscal ou Cupom Fiscal.
c. **Valor de R$ 10,00 em dinheiro**. Não serão aceitos cartões de débito ou de crédito e cheques.

3. VALIDAÇÃO DO CUPOM

Durante a coleta, o colaborador da **Coopermiti** vai conferir a documentação (especificada no item 2) e os itens abaixo relacionados. **Em caso de inconsistência em algum item, a coleta não será realizada**. Recomendamos que estes itens sejam verificados com antecedência. Se a coleta não puder ser realizada, o cupom será invalidado.

☐ O produto/quantidade a ser descartado deve ser igual ao que consta na Nota Fiscal ou Cupom Fiscal do novo eletroeletrônico. Exemplo: comprou uma geladeira poderá descartar uma geladeira, independente do modelo.
☐ O eletroeletrônico a ser descartado, deve estar pronto para ser carregado imediatamente e em local para fácil carregamento (Ex. deixar próximo ao portão de entrada e saída, geladeira vazia, ar condicionado desinstalado, etc.).

4. PAGAMENTO DE R$ 10,00

5. DOCUMENTO CONTROLE DE COLETA E CARREGAMENTO

Será solicitada verificação e assinatura pelo cliente no documento denominado **Controle de Coleta**, onde constará a descrição da coleta. Após assinatura deste documento, uma das vias será entregue ao usuário do cupom para coleta. Em seguida, será realizado o carregamento.

6. NOTA FISCAL DE SERVIÇO

A Nota Fiscal de Serviço para esta retirada será enviada de forma eletrônica posteriormente.

Esclarecimentos

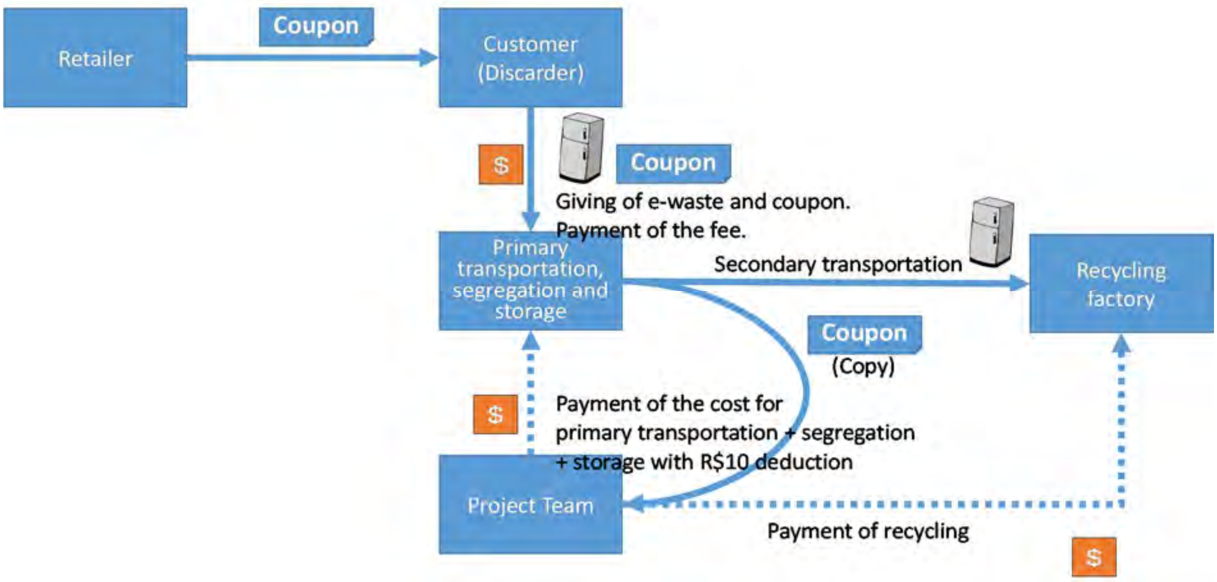
- Este cupom para coleta faz parte das atividades do projeto **descarte ON** e será utilizado para coleta de eletroeletrônico de Grande Porte (televisor, refrigerador/freezer, lavadora/secadora de roupas, aparelho de ar condicionado e fogão) para ser dada destinação adequada.
- O valor de R$ 10,00 irá cobrir parte do custo de transporte para coleta na sua residência do eletroeletrônico usado. Quanto aos demais custos de transporte, armazenamento, desmontagem, processamento e destinação adequada, serão cobertos pela JICA (Japan International Cooperation Agency).

descarte ON

www.descarteon.jica.eco.br

Source: JICA Expert Team

Figure 2-6 Coupon used for e-waste trade-in collection for Walmart (front side, rear side)



Source: JICA Expert Team

Figure 2-7 E-waste flow and money flow in the trade-in collection by Walmart

c) Procedure of the trade-in collection in the retailers of GPA

The trade-in collection systems in the retailers of GPA have the following different points from the Walmart system..

- The trade-in of GPA was managed by ABREE and the Project Team paid the required cost to ABREE.
- The payment of R$10 by consumers is done in advance through bank remittance (Boleto).
- The e-wastes collected from consumers were directly transported to the dismantling factory without any temporary storage.

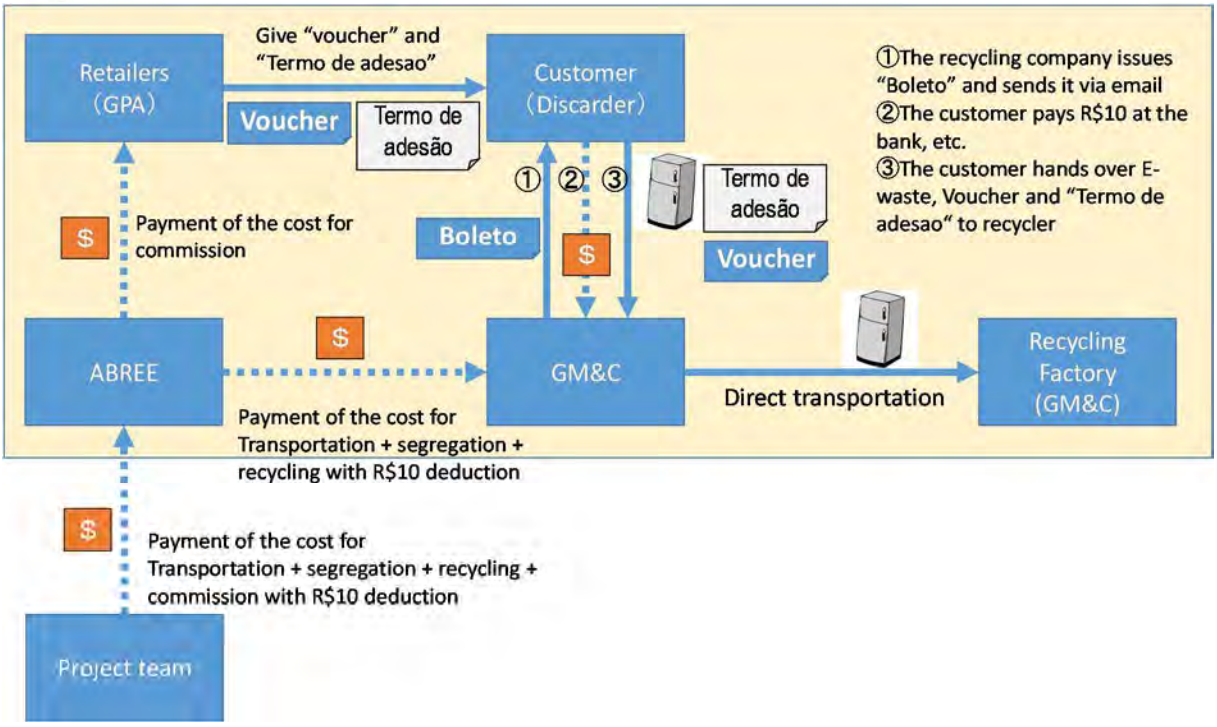
Source: JICA Expert Team

Figure 2-8 Voucher used for e-waste trade-in collection for GPA (front side, rear side)

＜Contents＞
Basic collection rules
- ✓ Purpose of "descarte ON"
- ✓ Implementation period of descarte ON
- ✓ Collection order method
- ✓ Deadline for the collection request (within 10 business days of purchase)
- ✓ Payment term (within 10 business days after the issue of the ticket)
- ✓ Deadline for collection (within 10 business days after confirmation of payment)
- ✓ Rules in preparation for delivery
- ✓ Rules on collecting days change
- ✓ Others

Source: JICA Expert Team

Figure 2-9 "Termo de adesão" used for e-waste trade-in collection for GPA



Source: JICA Expert Team

Figure 2-10 E-waste flow and money flow in the trade-in collection by GPA

d) Money settlement for the trade-in collection

The amount of money calculated by the following formula will be reimbursed every month.

- Reimbursed amount of primary transportation=$\mathrm{Pt} \times \mathrm{Nt} + \sum S \times W + \mathrm{M} - \mathrm{F} \times \mathrm{k}$
  where
  Pt: Unit price of primary transportation per one trip (door to door collection) (USD/trip)
  Nt: Number of trips in the month (trip/month)
  S: Unit price for sorting and storage per weight of e-waste (USD/kg)
  W: Total weight collected in the month (kg/month)
  M: Monthly management cost (USD/month)
  F: Amount of money borne by consumers (symbolic price borne by consumers defined by a coupon) (USD/unit)
  k: Total unit collected in the month (Unit/month)
  where
- S=0 in the system of GPA
- F=10R$

e) Target of the trade-in collection

The trade-in collection is to be provided under the following conditions.

- Households living in Sao Paulo City
- Collection from the address printed on the coupon
- Collection of the e-waste specified by the coupon

(4) Secondary transportation, dismantling and sorting

1) Money settlement

Amount of money calculated by the following formula will be paid every month.

- Reimbursed amount for secondary transportation, dismantling and sorting=$Q \times m + \sum S \times w + M$
  where
  Q: Unit price of secondary transportation per one trip (USD/trip)
  m: Number of trips in the month (trip/month)
  S: Unit price for dismantling and sorting (USD/kg)
  w: Total weight collected in the month (kg/month)
  M: Monthly management cost (USD/month)

2.5 Plan of Public Relations and Communications

Various public relations and communication activities referred to in the report of "Materials for Project Publicity" for enhancing the Pilot Project were conducted.

2.6 Licensing under the Pilot Project

E-waste somehow contains the hazardous substances and collection/transportation of them may require licenses of the state. In the Pilot Project, the Project Team consulted to CETESB whether e-wastes themselves are hazardous or not, as far as they are not dismantled. Then CETESB announced the collection/transportation of the e-wastes before dismantling does not require any license for the handling of hazardous waste. The official document was issued on 3 June, 2016 and applied to the whole area of the State of Sao Paulo.

Different from the official licensing, the Project Team also concluded the partnership agreements with supermarket chains upon necessity. The Project Team exchanged the designated document with Walmart for its participation.

2.7 Monitoring system

(1) Monitoring system for Coopermiti for the drop-off collection and the trade-in collection in Walmart retailers

1) Compatibility with the software used by Coopermiti

Coopermiti uses a software of "Protheus" for managing e-waste and the following items are recorded and managed with an identified number called as "Protocol Number".

- Collection date
- Protocol number
- Consumer name
- Consumer's identification number
- E-waste code
- E-waste name
- E-waste category

- E-waste family
- Weight
- Unit
- Producer
- E-waste category color

The monitoring system for the Pilot Project was developed with the compatibility with "Proteus" adding some information items lacked in "Proteus".

2) Additional data required in the Pilot Project

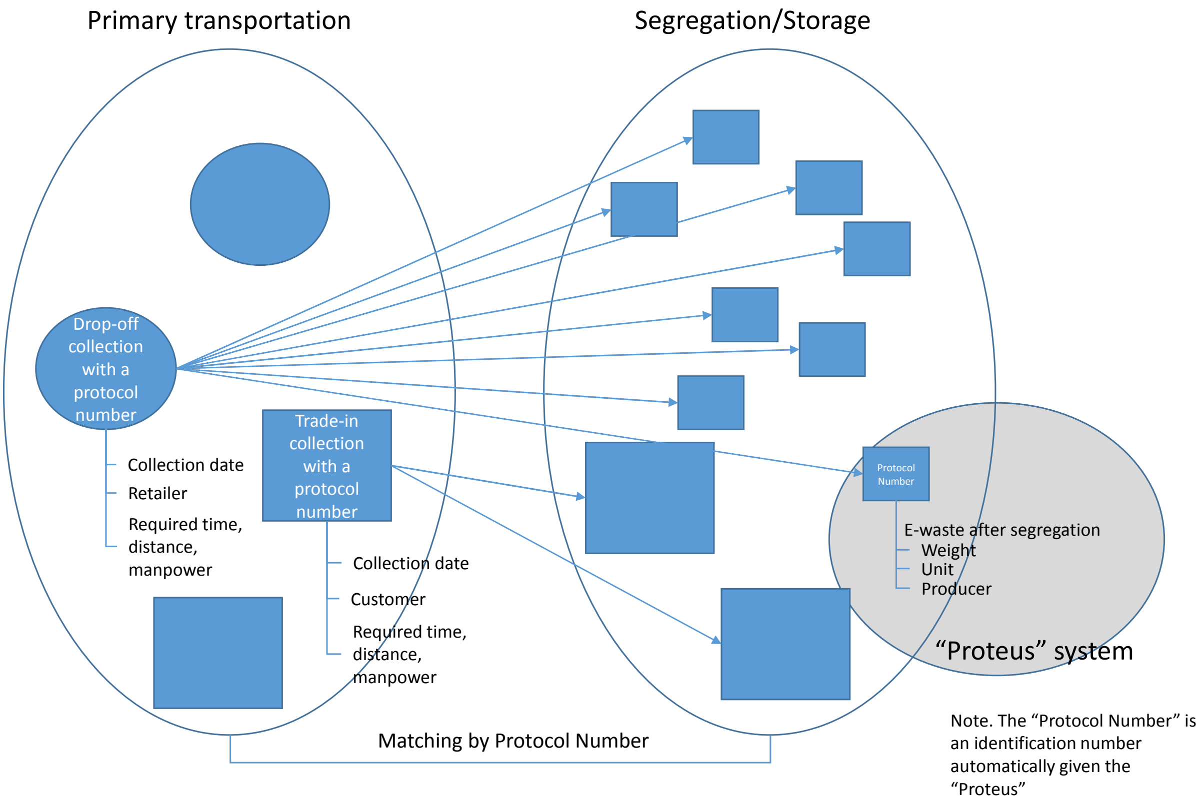
In the Pilot Project, the following information added in addition to the information managed by Coopermiti.

- Amount data and cost data of the primary transportation
- Cost data for segregation

3) Monitoring system designed for the Pilot Project

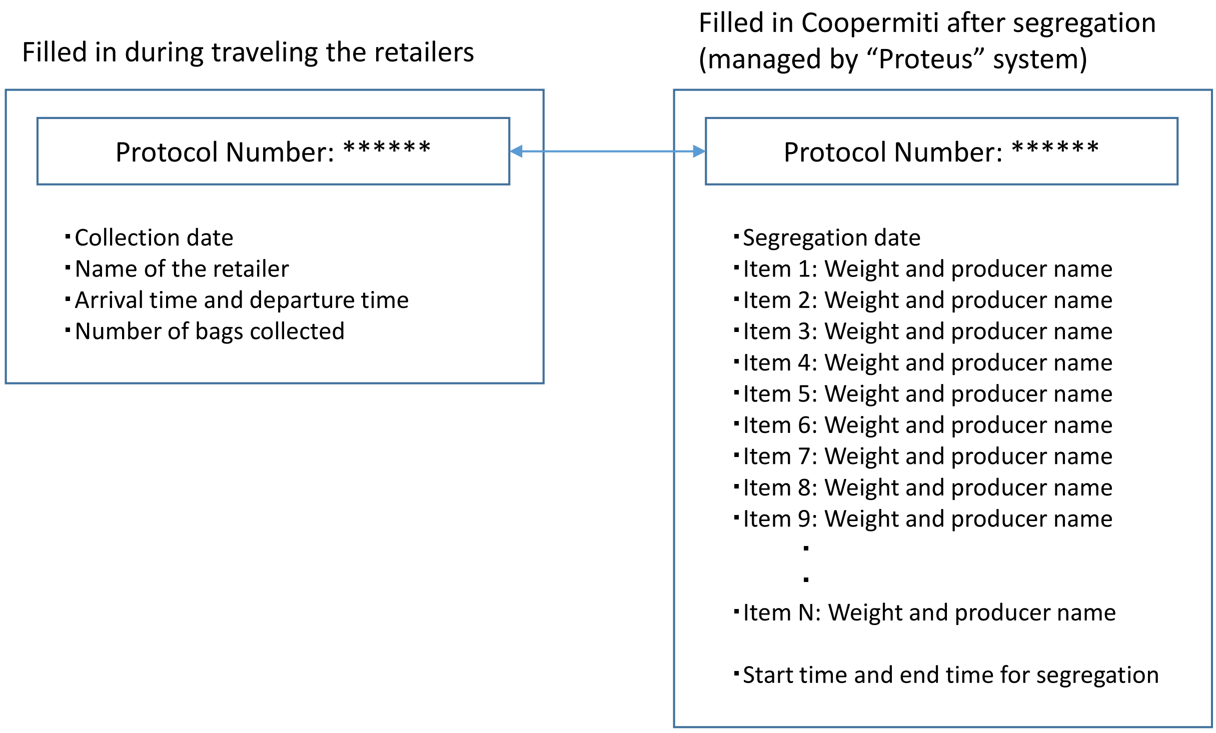
a) Integrated information management system by "Protocol Number"

The data were managed in an integrated way by using "Protocol Number". "Protocol Number" can link the data of collection and the data after segregation.



Source: JICA Expert Team

Figure 2-11 Integration of discarders' properties and e-waste after segregation matched by "Protocol Numbers"



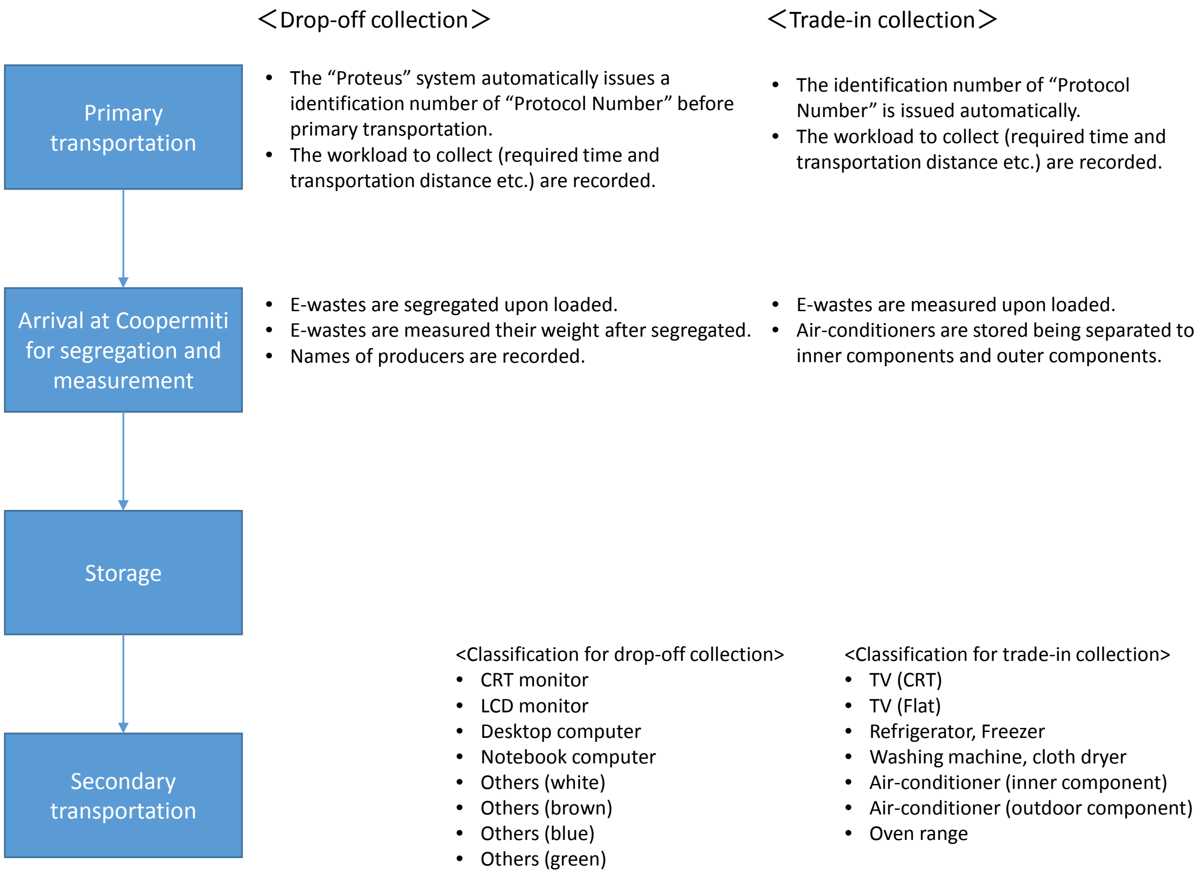
Source: JICA Expert Team

Figure 2-12 Integration with “Proteus” system matched by “Protocol Number” (Output image)

b) Operation procedure in Coopermiti including monitoring

The following figure shows the operation procedure of Coopermiti. The points can be summarized below.

- During the primary transportation, Coopermiti records the required manpower and transportation distance for each retailer identified by a “Protocol Number”.
- E-wastes are unloaded at Coopermiti for segregation. The plastic bags with e-wastes collected by the drop-off collection are teared and the e-wastes inside are to be segregated in accordance with the designated categories. The weigh and number of units with producer’ names are to be recorded.



Source: JICA Expert Team

Figure 2-13 Coopermiti's operation procedure and monitoring system in the Pilot Project

(2) Monitoring system for ABREE for the trade-in collection in GPA retailers

The same monitoring system mentioned above was used for the trade-in collection in GPA retailers managed by ABREE.

(3) Monitoring system in dismantling and sorting factory

1) Operation procedure for dismantling and sorting factory

a) Target work

- Secondary transportation: transportation from the Consolidation Center to the dismantling/sorting facility
- Dismantling and sorting work: dismantling of e-wastes

b) Operation procedure of secondary transportation

- Transportation from the Consolidation Center to the dismantling/sorting facility
- Measuring and recording of the total weight by the segregated e-wastes (do not use the truck scale, weigh each E-waste with a forklift)
- Storage

c) Operation procedure of dismantling/sorting

- Dismantling of e-waste to designated categories (not crushed)
- Fluorocarbons in the heat insulator of refrigerator, Refrigerant Fluorocarbons of refrigerator and air conditioners transported to FOX.

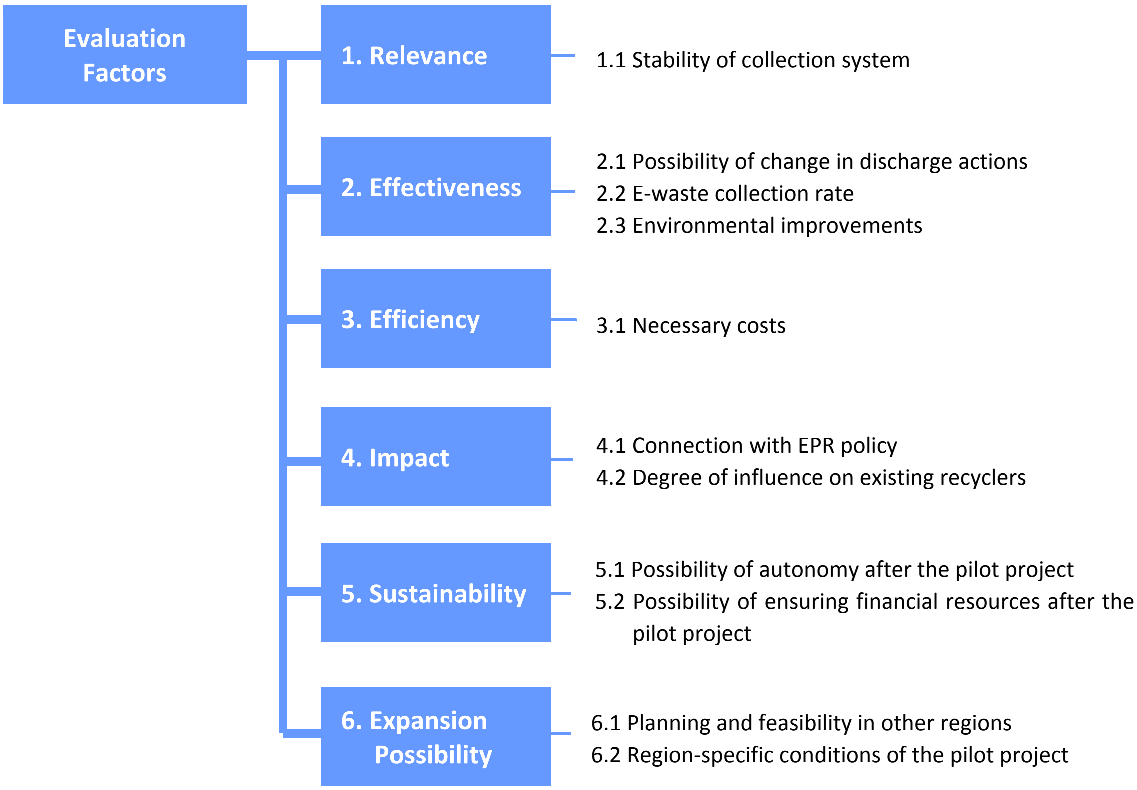
3. Evaluation system and prior evaluation of the Pilot Project

3.1 Evaluation Factors

(1) Evaluation Perspective

"Expansion Possibility" was added to "the five DAC evaluation criteria", totalizing six criteria which will be adopted for evaluating the Pilot Project. Although Expansion Possibility can be understood as part of Sustainability, it was considered as an independent evaluation perspective in order to make a clear distinction between the sustainability of the Pilot Project and the possibility of expanding to other regions.

Evaluation factors representing each evaluation perspective were set as shown in the figure below taking into account the characteristics of the Pilot Project.



Source: JICA Expert Team

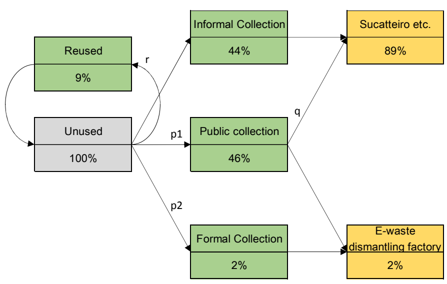
Figure 3-1 Evaluation Factors and Evaluation Perspectives of the Pilot Project

(2) Evaluation Factors

The description and measuring method of each evaluation factor are shown in the next table.

Table3-1 Evaluation Factors of the Pilot Project

Evaluation Perspective	Evaluation Factor	Description of Evaluation Factor	Measuring Method
1. Relevance	1.1 Stability of collection system	Does it work for e-waste collection?	- By means of interviews with stakeholders
2. Effectiveness	2.1 Possibility of change in discharge actions	Is it possible to change discharge actions of dischargers?	<Drop-off system (collection from retailers)> $\mathrm{PRc} = \frac{Wc \times q}{W_L} \times \frac{12}{D}$ - PRc: Participation rate of drop-off system (%)

Evaluation Perspective	Evaluation Factor	Description of Evaluation Factor	Measuring Method
			- Wc: Weight of drop-off system (kg) - W_L: Estimated amount of total discharge at Lapa district (kg/year) - q: Ratio of Lapa district dwellers among total of people who dropped off e-waste for collection from retailers (%) - D: Period covered by the experiment (months) * q is grasped through store exit questionnaires. <Trade-in (door to door collection)> $\mathrm{PRv} = \frac{Nv}{Np \times (1 - r_r)}$ - PRv: Participation rate of trade-in system (%) - Nv: Number of applications for at-home collection (cases) - Np: Number of purchases at retailers (cases) - r_r: E-waste re-utilization rate * Nv, Np, r_r is grasped through store exit questionnaires.
	2.2 E-waste collection rate	What is the performance degree of E-waste collection?	<Definition of E-waste Collection Rate> E-waste Collection Rate = $\frac{Amount\ Collected}{Amount\ of\ Waste}$ - Amount of Waste refers to the amount of waste excluding the amount of Reused in the figure below. <Small- and medium-sized household appliances> Same value as 2.1. <Big-sized household appliances> $\mathrm{CRv} = \frac{M_{vL}}{M_L \times q'} \times \frac{12}{D} = \frac{M_v}{M_L} \times \frac{12}{D}$ - CRv: Collection rate (%) - M_{vL}: Number of items collected from Lapa district (units) - M_v: Number of items collected in the pilot project (units) - q′: Purchase ratio of Lapa district dwellers at Lapa district - M_L: Estimated amount of total discharge at Lapa district (kg/year) - D: Period covered by the experiment (month)  **Figure 3-2 E-waste flow (example)**
	2.3 Environmental improvements	What is the degree of environmental improvement?	- Hazardousness: The amount of hazardous substances (lead) included in e-waste that goes to scrap wholesaler, etc., and the monitoring of which is impossible - Collection of precious metal: The amount of collectable precious metal (gold, silver, platinum, palladium) that are brought to appropriate e-waste dismantling plants

Evaluation Perspective	Evaluation Factor	Description of Evaluation Factor	Measuring Method
			- Traceability: The amount (weight) of e-waste that are brought to appropriate e-waste dismantling plants and can be monitored
3. Efficiency	3.1 Necessary costs	How much cost is needed?	- Primary transportation costs (BRL/kg or BRL/item) - Storage and sorting costs (same as above) - Secondary transportation costs (same as above) - Dismantling and recycling costs (same as above)
4. Impact	4.1 Connection with EPR policy	Is it possible to proceed with discussions with the industry through the pilot project?	- By means of interviews with stakeholders
	4.2 Degree of influence on existing recyclers	Does it have negative impact on existing small- and medium-sized recyclers?	- By means of interviews with stakeholders
5. Sustainability	5.1 Possibility of autonomy after the Pilot Project	After the completion of the pilot project, are the parties concerned in the region able to operate the mechanism by themselves with autonomy?	- Analysis based on the sharing of roles between potential industries (retail industry, manufacturing industry) - By means of interviews with stakeholders
	5.2 Possibility of ensuring financial resources after the pilot project	After the completion of the pilot project, how are the prospects of ensuring financial resources for operating the mechanism?	- Analysis based on the sharing of expected costs - By means of interviews with stakeholders
6. Expansion Possibility	6.1 Planning and feasibility in other regions	Is it possible to launch the mechanism in other regions?	- Capacity of counterparts using the results of capacity assessment
	6.2 Region-specific conditions of the Pilot Project	What are the region-specific conditions that are the premise of the pilot project?	- Clearly state the pilot project-specific conditions by comparing the circumstances of the pilot project at Lapa district in São Paulo city, and other states

3.2 Prior Evaluation of the Pilot Project

The evaluation results of the Pilot Project as of March, 2016 (prior to the commencement of the Pilot Project) are shown in the table below.

Table3-2 Prior Evaluation of the Pilot Project

Evaluation Perspective	Evaluation Factor	Prior evaluation
1. Relevance	1.1 Stability of collection system	Since the Pilot Project e-waste collection system has been designed so as not to place a heavy burden upon part of the actors, it is believed to function in a stable manner. - In order to reduce the burden on consumers, it was decided that at-home collection service would be provided for big-sized household appliances. - In order to reduce the burden on retailers, it was decided that the management of containers for drop-off collection would be done in principle by the Project side and that an emergency collection service would also be provided as a response when the container got full. - In order to realize an efficient primary transportation, it was decided that the collection date for door to door collection would be adjusted directly between the discharger and the primary transportation company. - In order not to cause too much trouble in each work scheduled to be re-commissioned, i.e., storage and sorting, secondary transportation, dismantling and recycling, a realistic TOR was prepared.

<table>
<tr><th>Evaluation Perspective</th><th>Evaluation Factor</th><th>Prior evaluation</th></tr>
<tr><td></td><td></td><td>- Data monitoring was devised so as to minimize additional work in light of existing information management methods.</td></tr>
<tr><td rowspan="2">2. Effectiveness</td><td>2.1 Possibility of change in discharge actions</td><td>
< Drop-off system (collection from retailers)>
The table below shows the cooperation rate to drop-off system obtained by questionnaire survey. With respect to the drop-off system, respondents were asked “1. Is an incentive for taking part necessary?” and “2. How much is the desired incentive?” and the cooperation rate was determined as follows: Cooperation rate = Incentive unnecessary + Incentive necessary x (amount of desired incentive = zero).

Table3-3 Expected participation rate to drop-off system
<table>
<tr><th>E-waste</th><th>Expected Participation Rate (%)</th></tr>
<tr><td>Desktop PC</td><td>58%</td></tr>
<tr><td>Notebook PC</td><td>58%</td></tr>
<tr><td>Mobile telephone</td><td>56%</td></tr>
<tr><td>Small-sized household appliance</td><td>56%</td></tr>
</table>

<Trade-in (at-home collection)>
The figure below shows the probability of willingness-to-pay a fee for at-home collection obtained by questionnaire survey. Since in the Pilot Project the fee was set symbolically in R$10, the table below was obtained considering the probability of willingness-to-pay an amount corresponding to the R$10 of the figure as the participation rate.
Table3-4 Expected participation rate to at-home collection
<table>
<tr><th>E-waste</th><th>Expected Participation Rate (%)</th></tr>
<tr><td>TV set</td><td>18%</td></tr>
<tr><td>Refrigerator</td><td>21%</td></tr>
<tr><td>Washing machine</td><td>21%</td></tr>
<tr><td>Air conditioner</td><td>13%</td></tr>
<tr><td>Microwave oven</td><td>21%</td></tr>
</table>

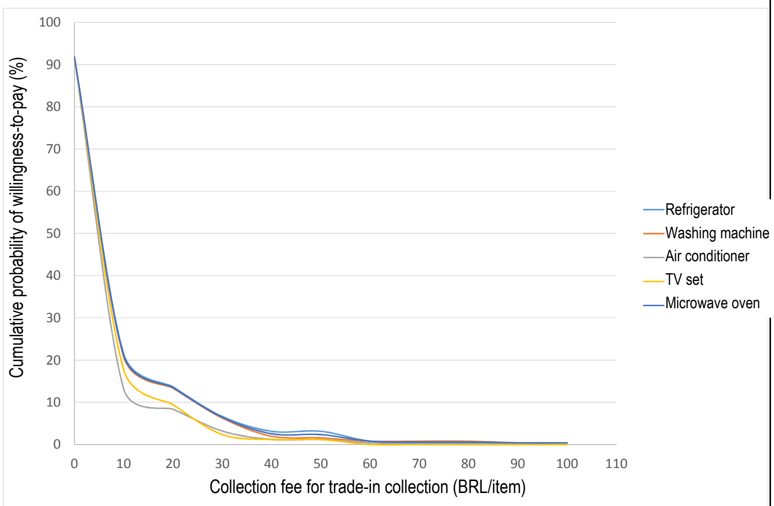


Figure 3-3 Probability of willingness-to-pay regarding a fee for at-home collection of big-sized e-waste
Note) Microwave oven considered the average of refrigerators and washing machines.
</td></tr>
<tr><td>2.2 E-waste collection rate</td><td>Same as 2-1.</td></tr>
</table>

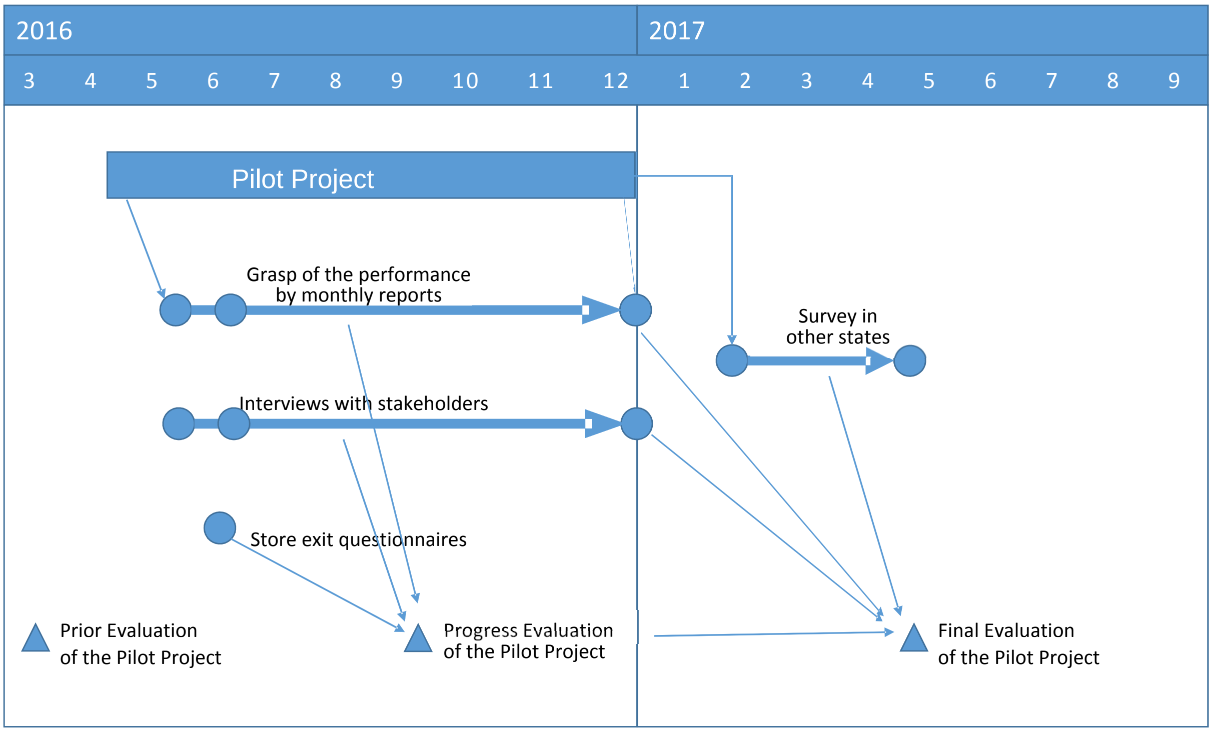
Evaluation Perspective	Evaluation Factor	Prior evaluation
	2.3 Environmental improvements	If the Pilot Project is implemented in the entire city of São Paulo, the three policy indicators of the city of São Paulo would be improved as follows: - Hazardousness: Current situation 68% →53% - Collection of precious metal: Current situation 22% →37% - Traceability: Current situation 8% →23% *Calculation condition: Commercial e-waste flow remains as it is.
3. Efficiency	3.1 Necessary costs	- (These items were not evaluated.)
4. Impact	4.1 Connection with EPR policy	- By implementing the Pilot Project, the necessary costs shall become clear and it is believed that consultations with the industry can be carried out through discussions on matters such as who and how they will be shared, what is the role of the government, etc.
	4.2 Degree of influence on existing recyclers	<Impact on re-use> - E-waste to be re-used are in good conditions and are traded at a fairly more expensive price than recycling collected material, thus impacts such as the re-use rate being lowered by the Pilot Project are considered to be small. <Impact on informal sector> - Although some scrap dealers and waste pickers collect e-waste, the main object is waste paper, scrap, plastic, etc., thus the impact is considered to be small. <Impact on dismantling companies> - If mechanisms to collect e-waste at home such as the Pilot Project are established, the number and types of dismantling companies dealing with e-waste shall increase and new business opportunities shall be created.
5. Sustainability	5.1 Possibility of autonomy after the Pilot Project	- In this Pilot Project, the Project Team became the subject of the contract with Coopermiti and GPA and undertook the management of the Project. After the Pilot Project, if there are actors able to perform these functions, it is believed that the collection system will function autonomously.
	5.2 Possibility of ensuring financial resources after the Pilot Project	- In the Pilot Project, primary transportation costs, storage and sorting costs, secondary transportation costs and dismantling and recycling costs were covered by the Project. After the Pilot Project, the focus of the discussions shall be on who will bear these expenses, but depending on the system, if the full amount is passed on to consumers, financial resources will be ensured.
6. Expansion Possibility	6.1 Planning and feasibility in other regions	- Although planning and feasibility in other regions depend also on the role of counterparts, the capacity to grasp the amount of e-waste, to coordinate with stakeholders (retailers, storage and sorting centers, dismantling and recycling companies, etc.), to manage the system, and to raise awareness on e-waste discharge is considered insufficient at this stage, according to the baseline survey results. Moreover, even if these activities are carried out under the responsibility of the industry, the capacity to smoothly discuss with the industry is insufficient. - These capacities are believed to be developed through the implementation of the Pilot Project.
	6.2 Region-specific conditions of the Pilot Project	- Out of the Pilot Project-specific conditions, the main one that cannot be obtained in other states is believed to be the existence of recycling facilities. As for other conditions, such as the existence of motivated retailers, the existence of pillars of e-waste recycling, like Coopermiti, etc., it is believed that they are resources that can be obtained also in other states. - In states where recycling facilities are not located nearby, secondary transportation costs will increase, but the effects of the rise in secondary transportation costs in other states can be analyzed based on data obtained in the Pilot Project.

3.3 Monitoring Schedule

The monitoring performed pursuant to some data is carried out at the following timing:

- The underlying data, such as amount collected, cost data, etc., were to be grasped from monthly reports from Coopermiti and ABREE.

- Interviews with stakeholders were carried out as the occasion demands during the implementation period of the Pilot Project.
- In June 2016 a questionnaire survey was carried out at the exit of retailers.
- The Pilot Project-specific conditions were extracted through the implementation of the Pilot Project and, in order to verify whether these specific conditions are applicable to other states, other states were investigated (re-commissioned survey).



Source: JICA Expert Team

Figure 3-4 Monitoring Schedule

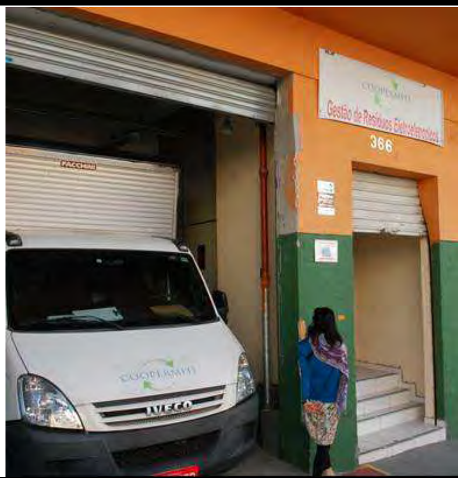
4. Implementation of Pilot Project

4.1 Commencement of Pilot Project

The drop-off collection was commenced in ten retailers in 26th April, 2016 as planned, and the trade-in collection was commenced from July, 2016 only in two retailers of Walmart. In October, 2016, six retailers of GPA participated in the trade-in collection.

4.2 Operation procedure

(1) Operation procedure for drop-off collection by Coopermiti

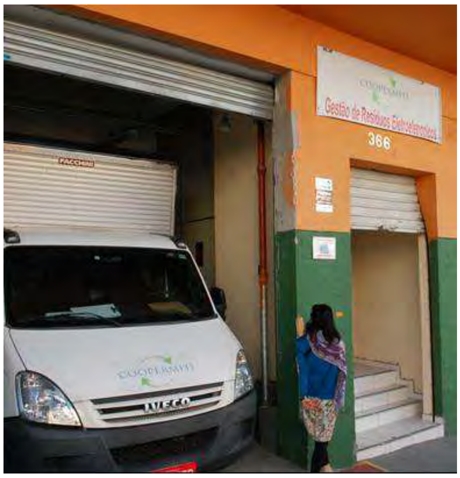
Process	
Start from Coopermiti (with 1. Keys for drop-off boxes, 2. Plastic tags with ID numbers, 3. Monitoring sheets for the project, 4. Order sheet for Coopermiti with Protocol numbers, 5. Empty bags, 6. Carrier)	
Traveling to the first retailer of the day	
Preparation of collection in front of the first retailer of the day (Recording of the arrival time and running transportation)	

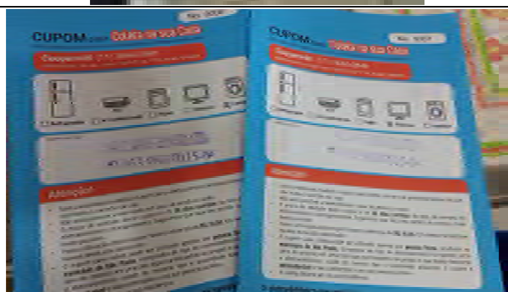
Opening of the drop-off box by the key	
Checking of the inside	
Record of the inside	

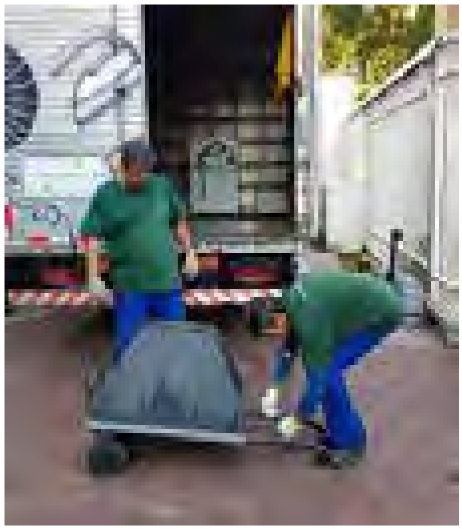
Tying of the bag by the tag with an ID number	
Recording of necessary data	
Signing by both sides for confirmation and leaving of one copy to the responsible person	
Setting of an empty bag	

Bringing out of the bag with e-wastes inside	
Loading of the bag	
Traveling to the next retailer	

(2) Operation procedure for trade-in collection by Coopermiti

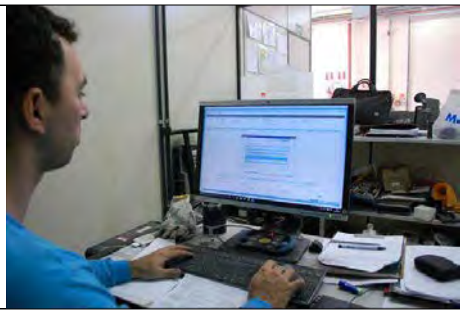
Process	
Start from Coopermiti (with 1. Monitoring sheets for the project, 2. Order sheet for Coopermiti with Protocol numbers, 3. Carrier)	
Traveling to the households scheduled to visit on the day	
Preparation of collection in front of a house (Recording of the arrival time and running transportation)	
Contact to the household	

Entering into the house	
Checking of the e-waste	
Confirmation of the types of the e-waste mentioned on the coupon	
Recording of necessary data and signing by both sides for confirmation and leaving of one copy to the house	

Bringing out of the e-wastes	
Loading of the e-waste	
Transportation to the consolidation center (In the ABREE system for GPA retailers, e-wastes were directly transported to the dismantling factory.)	

(3) Segregation at the Consolidation Center

Unloading of the collected bags	
Checking of the tag number and the order sheet number for identifying the retailer which discarded the bag	
Opening of the bag	
Taking out of an e-waste inside the bag and weighing of the weight	
Recording of the weight, e-waste category and producer's name	
Storage of the e-waste according to the e-waste categories	

Inputting of all data to the database	

4.3 Findings through the implementation of the Pilot Project

(1) Cooperation of the employees in the retailers

Though the Pilot Project was planned through intensive discussions with the headquarters of the retailing companies, however cooperation from employees who talk with customers directly was not enough in some retailers. For example, distributed paper materials were not used in some retailers. Explanation on e-waste trade-in collection was not enough, as the clerks have to explain so many things to customers such as product guarantee. The persons in charge were not found when Coopermiti came to the retailers for drop-off collection.

It is noted that it is difficult to change the culture and nature of retail store clerks. Also, the changes of the persons in charge under the employees' shift change could be pointed out as an obstacle.

(2) Unacceptable waste

In the drop-off boxes, unacceptable wastes such as dry battery and printer ink cartridge were sometimes seen. For these unacceptable wastes, enough notifications to customers have to be provided and another collection boxes designed for collecting these things could be placed beside the e-waste collection boxes.

(3) Durability of the collection containers for drop-off collection

The collection containers for drop-off collection were given lids for preventing the collected e-waste inside from being stolen. However, due to the structure of the lids, the lids were sometimes broken and the Project Team had to replace the broken containers. It is recommendable that enough durability of the collection containers has to be secured.

Source: JICA Expert Team

Figure 4-1 Broken lid of a collection container

(4) Data inconsistency

Data on collected e-wastes were managed basically well, but the data sometimes lacked compatibility. ID numbers of the collection data are sometimes inconsistent to the data on segregation due to data input mistakes.

In the regular e-waste collection system, such mistakes can be prevented if the computer system is designed so.

(5) Material balance in consolidation center

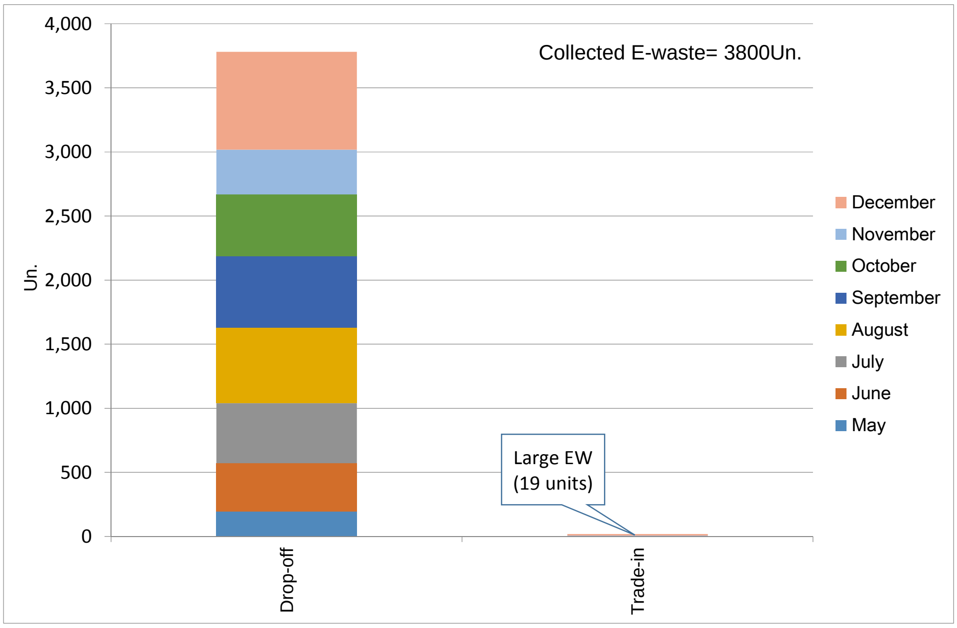
In the Pilot Project, Coopermiti was given the function of the consolidation center. Collected e-waste inside collection bags were opened here and segregated in accordance with the types of e-wastes. Both the weight of the bags and segregated e-wastes were measured, but the total weight are not necessarily match due to the accumulation of data error. In designing a regular data system, such point has to be considered when the material balance is focused.

5. Evaluation on the amount of collected e-wastes and required cost

5.1 Amount of collected e-wastes

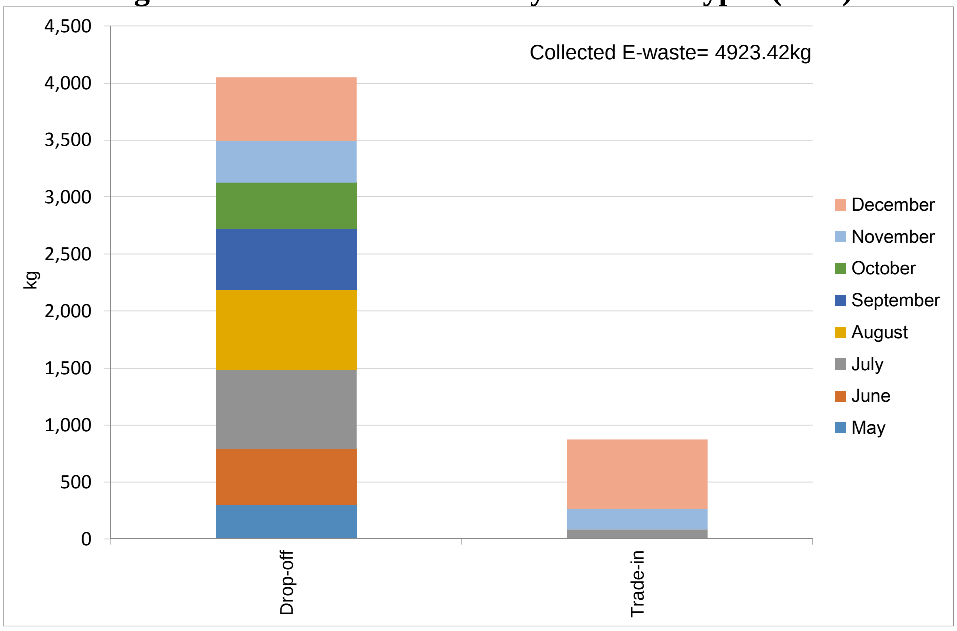
(1) Collected e-waste by collection types

Since the commencement of the drop-off collection, 3,781 units of e-wastes corresponding to 4,050.02 kg were collected in eight months by the end of December, 2016. Also, since the commencement of the trade-in collection, 19 units of e-wastes corresponding to 873.4 kg were collected by the end of December, 2016.



Source: JICA Expert Team

Figure 5-1 Collected e-wastes by collection types (Unit)



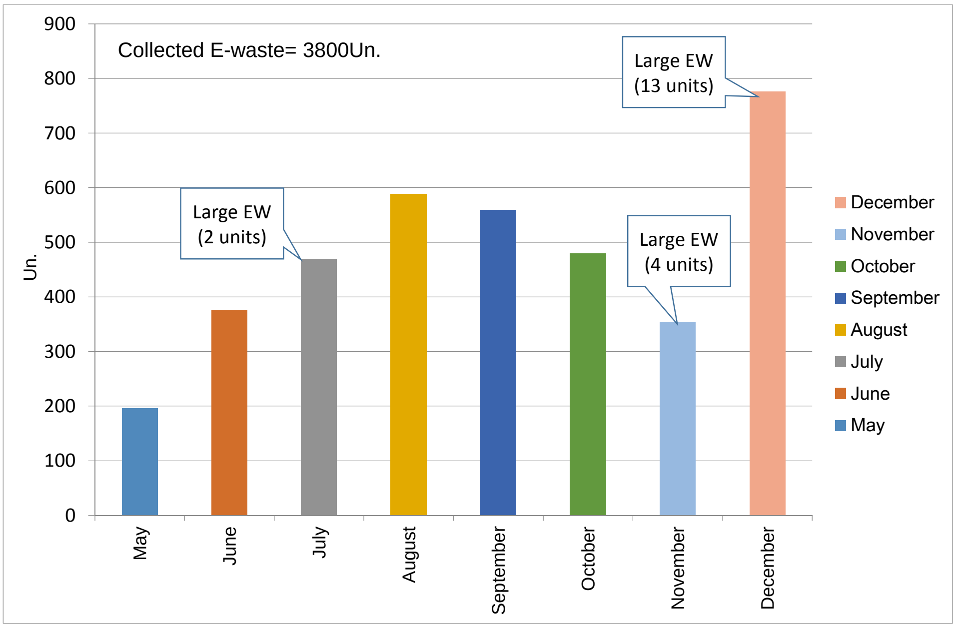
Source: JICA Expert Team

Figure 5-2 Collected e-wastes by collection types (KG)

(2) Collected e-waste by months

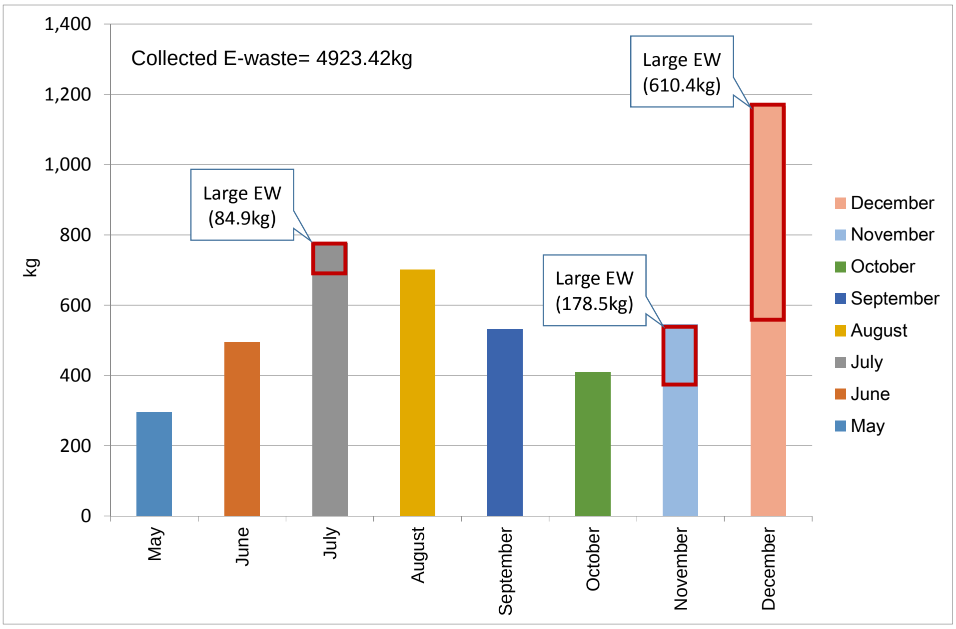
The amount of e-waste collected increased in terms of unit until August, 2016, and it decreased thereafter until November. In December, the largest amount of e-waste were collected.

The monthly amounts in terms of weight also showed almost the same trend as the amount fluctuation in terms of unit.



Source: JICA Expert Team

Figure 5-3 Collected e-wastes by months (Unit)



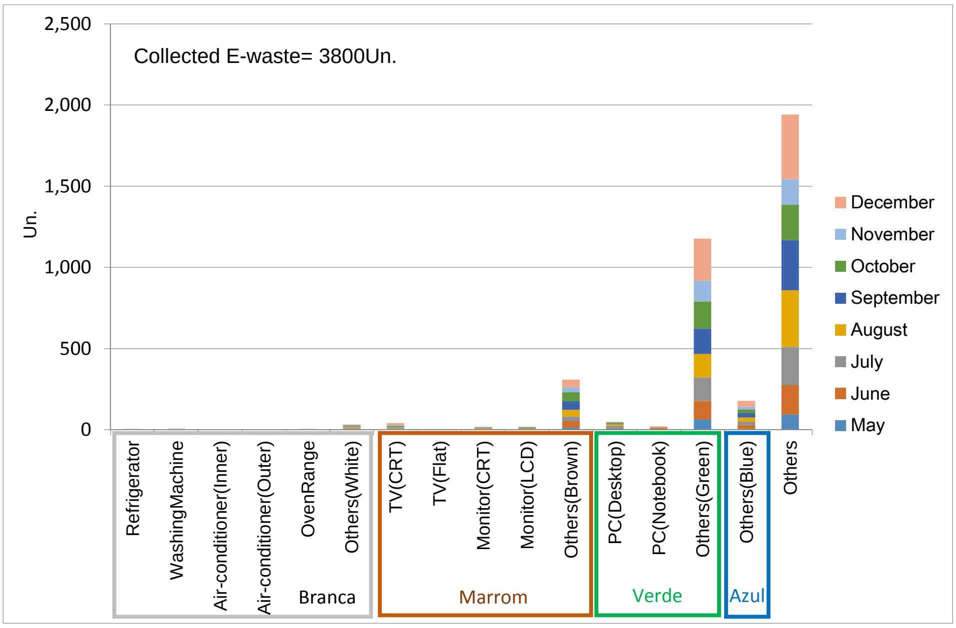
Source: JICA Expert Team

Figure 5-4 Collected e-wastes by months (KG)

(3) Collected e-wastes by types of e-wastes

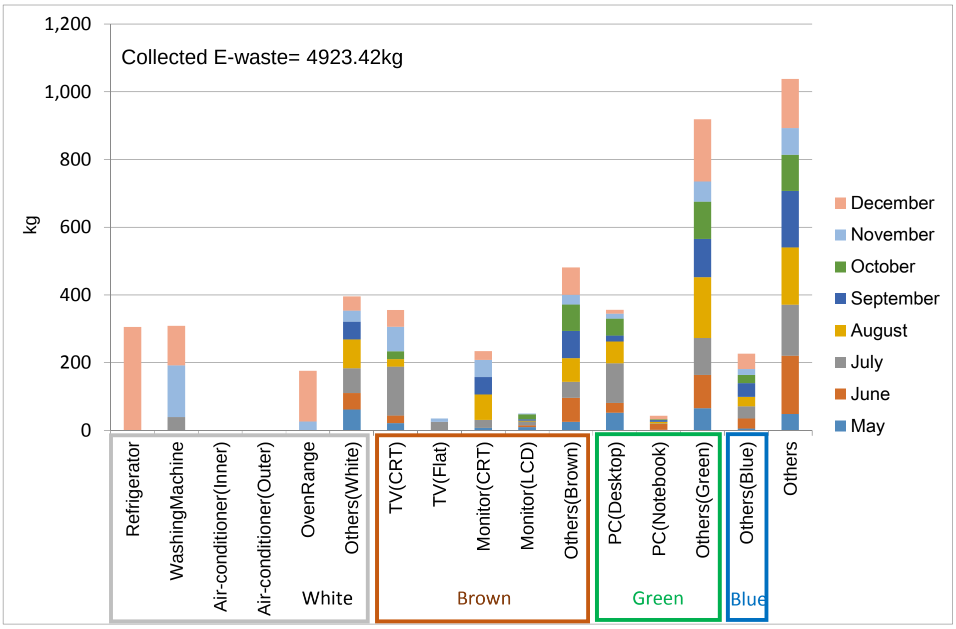
The collected amount of e-wastes by the types can be summarized below.

- “Others” composed of miscellaneous things shares the most in terms of unit and weight.
- “TV (CRT)”, “PC (Desktop)”, “Others (White)” and “Others (Brown)” do not share a lot in terms of unit, but they are not negligible in terms of weight.
- No bulky e-waste was collected by drop-off system.



Source: JICA Expert Team

Figure 5-5 Collected e-wastes by categorized types (Unit)



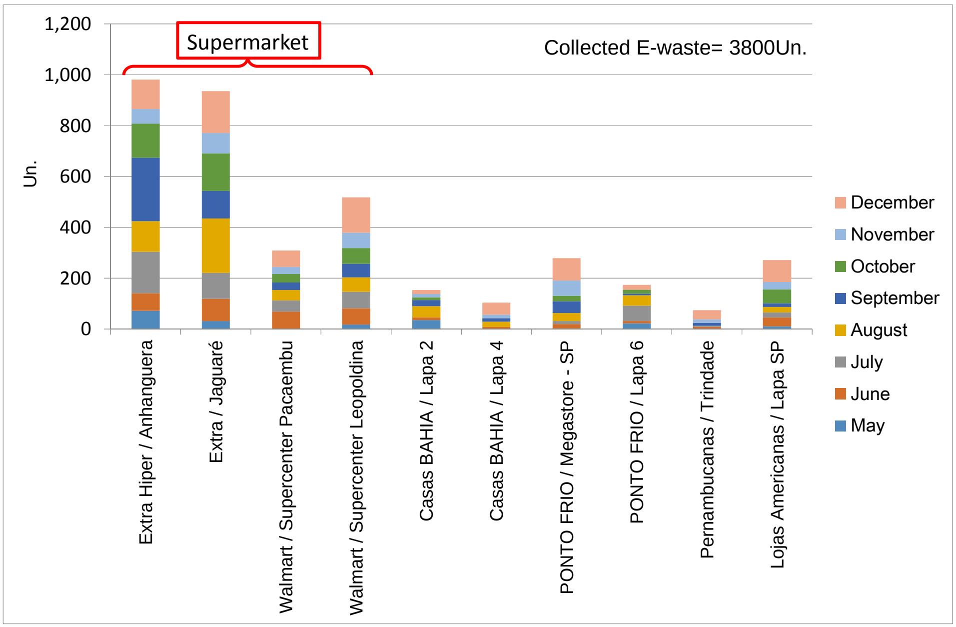
Source: JICA Expert Team

Figure 5-6 Collected e-wastes by categorized types (KG)

(4) Collected e-wastes by retailers

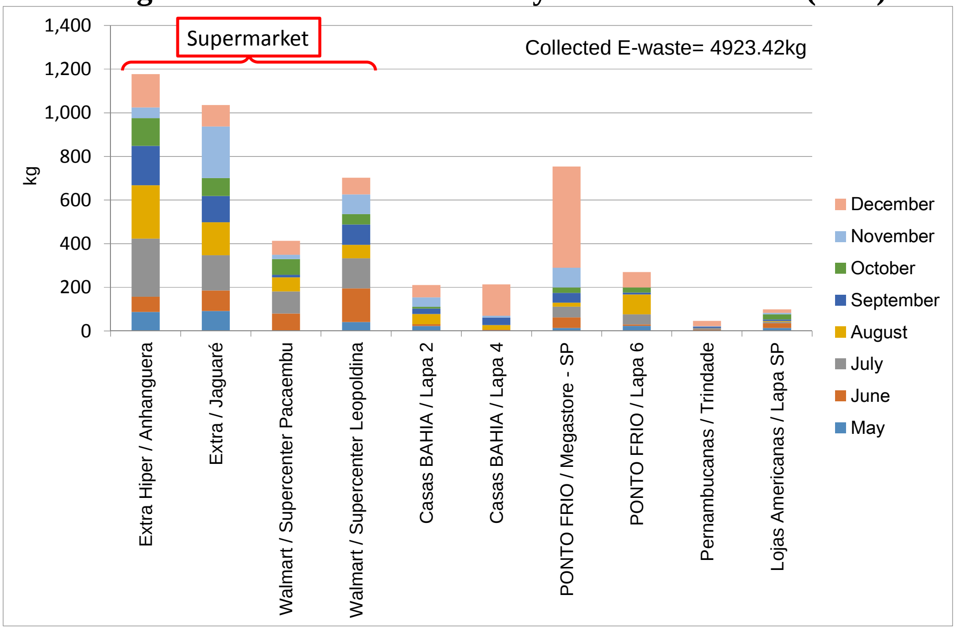
Extra (Jaguare), Extra Hiper (Anhanguera) and Walmart (Leopoldina) collected large amounts of e-wastes. These retailers are the largest supermarkets handling daily goods including foods. The reason why the collection amount of e-waste at these retailers was large is considered as follows.

- Consumers frequently visit these retailers, and there are many opportunities for consumers to bring e-waste and to see collection boxes.
- It is convenient for consumers to bring their e-waste by their cars, as such large supermarkets have enough parking spaces.



Source: JICA Expert Team

Figure 5-7 Collected e-wastes by retailers collected (Unit)



Source: JICA Expert Team

Figure 5-8 Collected e-wastes by retailers collected (KG)

5.2 Questionnaire survey for customers who came to the participating retailers

(1) Two types of questionnaire surveys

Two types of questionnaire surveys were conducted focusing the drop-off collection and the trade-in collection.

(2) Questionnaire survey for drop-off collection

1) Respondents

- Customers who brought their e-wastes to the drop-off collection
- 40 respondents

2) Duration

- Duration: weekends from 16, July to 7 August 2016

3) Target retailers

- Six retailers where e-wastes are expected to be brought by customers

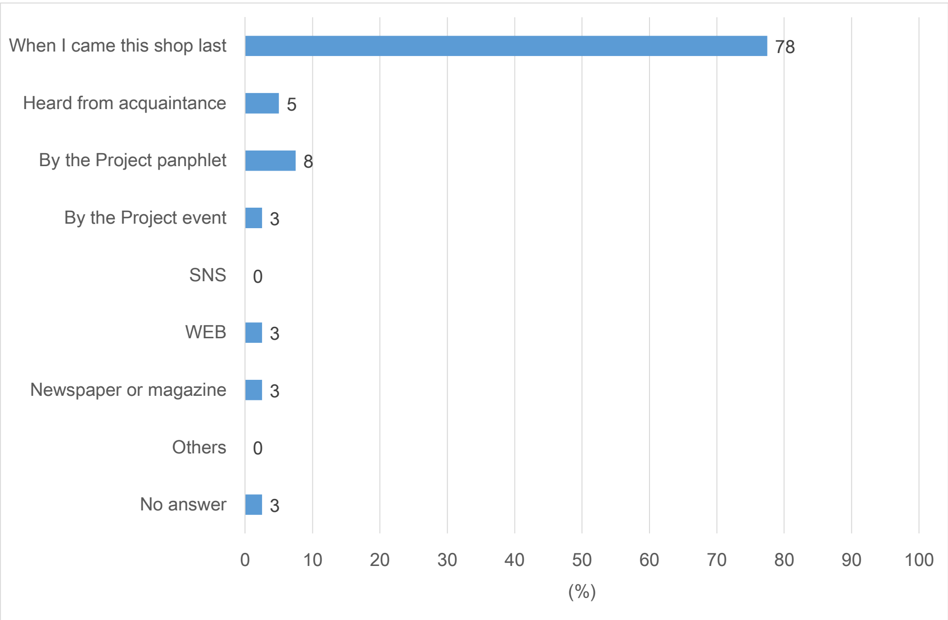
4) Questions

The following questions were asked.

- Area of living
- How to know the information on the drop-off collection
- The reason why the customer brought his/her e-wastes

5) Major results

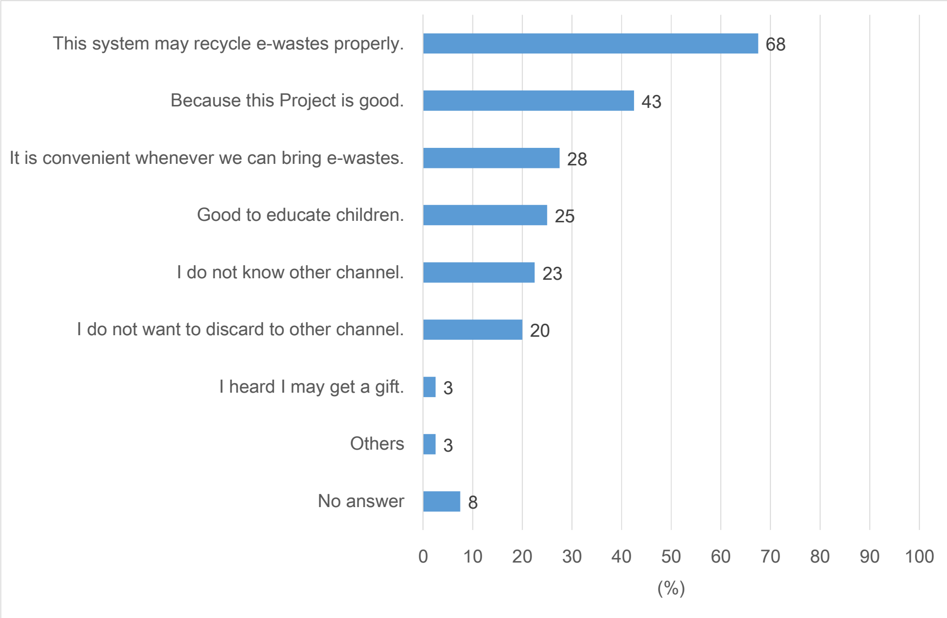
78% of all respondents who brought e-wastes to the drop-off collection replied that they came to know the collection when they came to the retailer last time.



Source: JICA Expert Team

Figure 5-9 How did the participants know the drop-off collection? (N=40)

As the reason of the participation, 68% respondents chose “This system may recycle e-wastes properly” and 43% respondents selected “Because this Project is good”. 28% respondents preferred the convenience of the drop-off collection.



Source: JICA Expert Team

Figure 5-10 Why did you bring your e-wastes to the drop-off collection? (Multiple choice, N=40)

6) Analysis

- It is important to inform the presence of the drop-off collection to the customers who visited the retailers, because 78% respondents came to know it when they came to the retailer last time.
- Convenience is important, because 28% respondents chose the option.

(3) Questionnaire survey for trade-in collection

1) Respondents

- Customers who visited e-product shops or e-product corners in the supermarkets (whether they bought target e-products or not was not considered.)
- 1182 respondents

2) Duration

- Duration 1: 4-7, November 2016 (from 11:00 to 17:00)
- Duration 2: 11-14, November 2016 (ditto)

3) Target retailers

- All retailers participated in the trade-in collection (6 retailers of GPA adnd 2 retailers of Walmart)

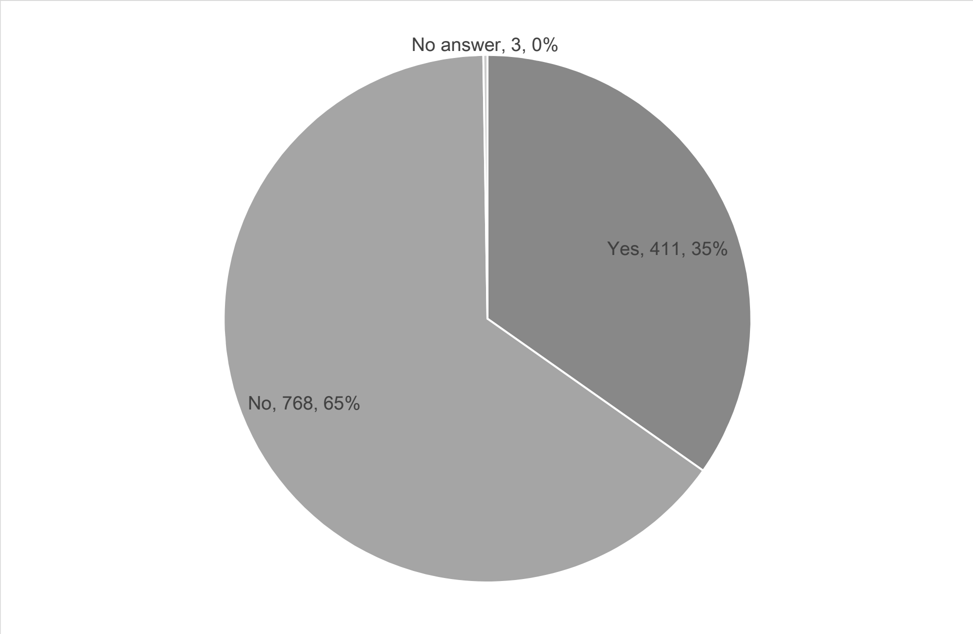
4) Questions

The following questions were asked.

- Area of living
- Whether he/she bought products targeted in the trade-in collection of the Pilot Project
- Needs to discard e-wastes targeted in the trade-in collection of the Pilot Project
- Expected discarding chanel
- Intention to participate in the trade-in collection

5) Major results

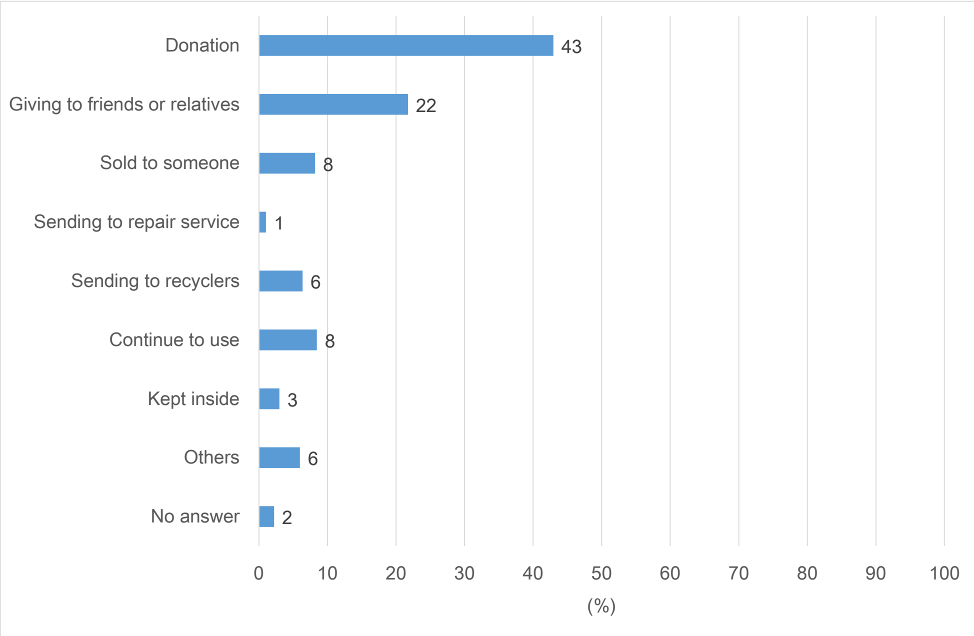
As shown in the following figure, 35% of the total respondents replied that they will dispose e-wastes to channels including the Pilot Project route. Remaining 65% might discard to conventional recycling or reuse routes as shown later.



Source: JICA Expert Team

Figure 5-11 Do you have intention to dispose e-wastes? (not to discard to conventional recycling and reuse channel) (N=1182)

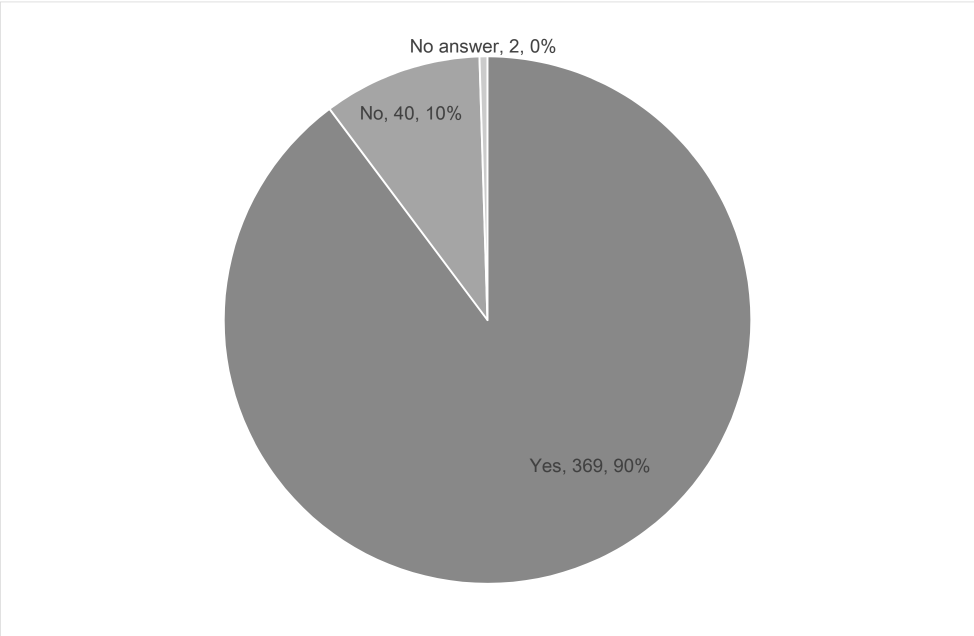
Out of the 768 respondents who replied “No” in the above question, 80% respondents (donation 43%, Giving to friends or relatives 22%, sold to someone 8%, sending to repair service 1%, sending to recyclers (catadores or sucateiros) 6%) replied that they do not dispose e-wastes as shown in the following figure. Also, 11% respondents replied they will keep the possessed e-products inside their houses. See to the following figure.



Source: JICA Expert Team

Figure 5-12 Discarding channel for e-waste recycling (N=768)

Out of the 411 respondents, 90% respondents replied that they have an intention to participate in the Pilot Project by paying R$10. It means they do not mind paying R$10 for recycling cost.



Source: JICA Expert Team

Figure 5-13 Intention to participate in the Pilot Project by payment of R$10 (N=411)

6) Analysis

- According to the questionnaire, potential consumers who have intentions to discard e-wastes to the Pilot Project are 35%, where the conventional discarding channels including giving to donation and giving to friends are the major discarding channel.
- Consumers who have the possibility to discard their e-wastes to the Pilot Project were 31% (35%*90%).

(4) Distributed voucher and e-waste collection

The following table shows the number of voucher distributed, subscribed and the number of e-wastes collected.

- The distributed voucher were quite different depending on the retailers.
- The number of voucher distributed does not necessarily decide the subscribed number.
- There are five cases uncollected, even though subscribed, because R$10 was not paid.

Table 5-1 Number of voucher distributed, subscripted and e-waste collected in the trade-in collection

	Distributed	Subscripted	Collected
Extra Jaguare	7	3	3
Extra Anhanguera	4	0	0
Pontofrio Megastore	45	11	8
Casa Bahia Lapa 2	4	3	2
Casa Bahia Lapa 4	7	2	2
Ponto Frio Lapa 6	4	3	2
Walmart Pacaembu	56	2	2
Walmart Leopoldina	22	0	0
Total	149	24	19

Source: JICA Expert Team

5.3 Estimation of collection rates

It is necessary to normalize the above mentioned collected values for evaluating the collection system performance. Here, the collected amounts of e-wastes were evaluated by converting to the values of collection rates. The method of the conversion is explained in Appendix 1 of this report.

(1) Definition of collection rate

1) Drop-off collection

For estimating the collection rate, the following two factors were considered.

- Collection duration

  The collected amount was converted to annual expected amount by considering the Pilot Project duration.
- Participation from residents of Lapa

  The collected amount was divided to the portion from Lapa and the portion from other areas.

2) Trade-in collection

For estimating the collection rate, the following two factors were considered.

- Collection duration
- Participation from residents of Lapa

- Retailers visited by Lapa residents
  All residents living in Lapa do not necessarily do shopping in retailers located in Lapa.

(2) Estimation of e-waste collection rate

The estimated collection rates are shown in the following table. The estimated collection rates of the drop-off collection are 2-3% at the maximum, and the rates of the trade-in collection are less than 1%. The collection rates of the trade-in collection are lower than those of the drop-off collection.

Table 5-2 Estimated e-waste collection rate

E-waste type	Drop-off collection (%)	Trade-in collection (%)
TV(CRT)	0.0	0.12
TV(Flat)	0.0	0.00
Refrigerator	0.0	0.28
Washing Machine	0.0	0.42
AC(Inner)	0.0	0.00
AC(Outer)	0.0	0.00
Oven Range	0.0	0.16
Monitor(CRT)	0.6	-
Monitor(LCD)	0.1	-
PC(Desktop)	0.2	-
PC(Notebook)	0.1	-
Others(White)	2.7	-
Others(Brown)	3.3	-
Others(Blue)	1.6	-
Others(Green)	1.6	-
Others	1.3	-

Source: JICA Expert Team

5.4 Cost estimation based on the Pilot Project

Future required cost for e-waste recycling was estimated based on the parameters obtained from the Pilot Project, assuming that the collection will be implemented at the maximum efficiency.

Detail calculation method summarized below is shown in the Appendix 2 to Appendix 5.

(1) Important conditions

1) Scope of the estimation

The following items are the major scopes of the cost estimation.

- Area: Whole area of Sao Paulo City
- Target e-waste: 20% of discarded e-waste in 2015

2) Estimated e-waste recycling system

The following recycling systems were estimated.

- Drop-off collection with a consolidation center
- Trade-in collection without a consolidation center
- Trade-in collection with a consolidation center

3) Considered cost items

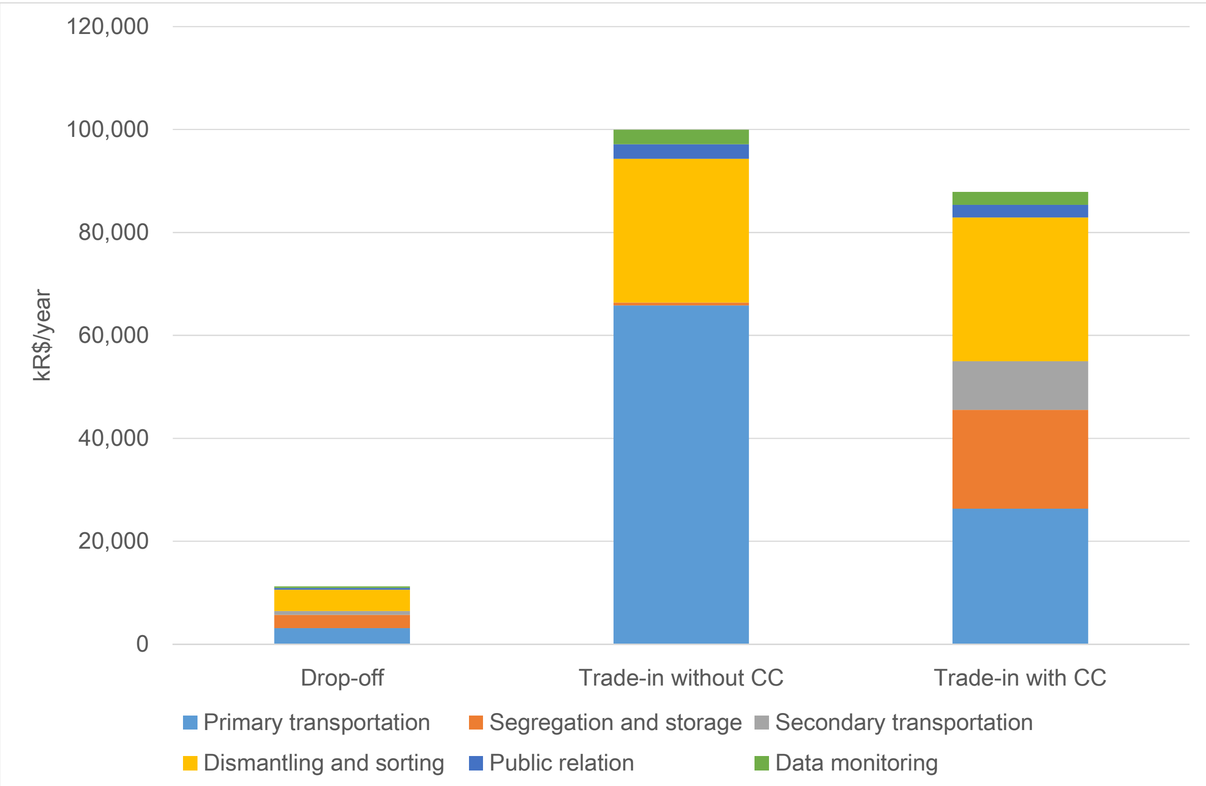
The following cost items were considered depending on the stages in the e-waste recycling stream.

- Labor cost
- Fuel cost
- Cost for vehicles
- Cost for forklift
- Cost for electricity
- Cost for workplace
- Administration cost
- Revenue from recyclables

(2) Result

1) Annual total cost

- The total cost for drop-off collection is much smaller than that for trade-in collection.
- The total cost of the trade-in collection with consolidation centers is smaller than that of the collection without consolidation centers in this case, even though the costs for consolidation centers and secondary transportation are needed.

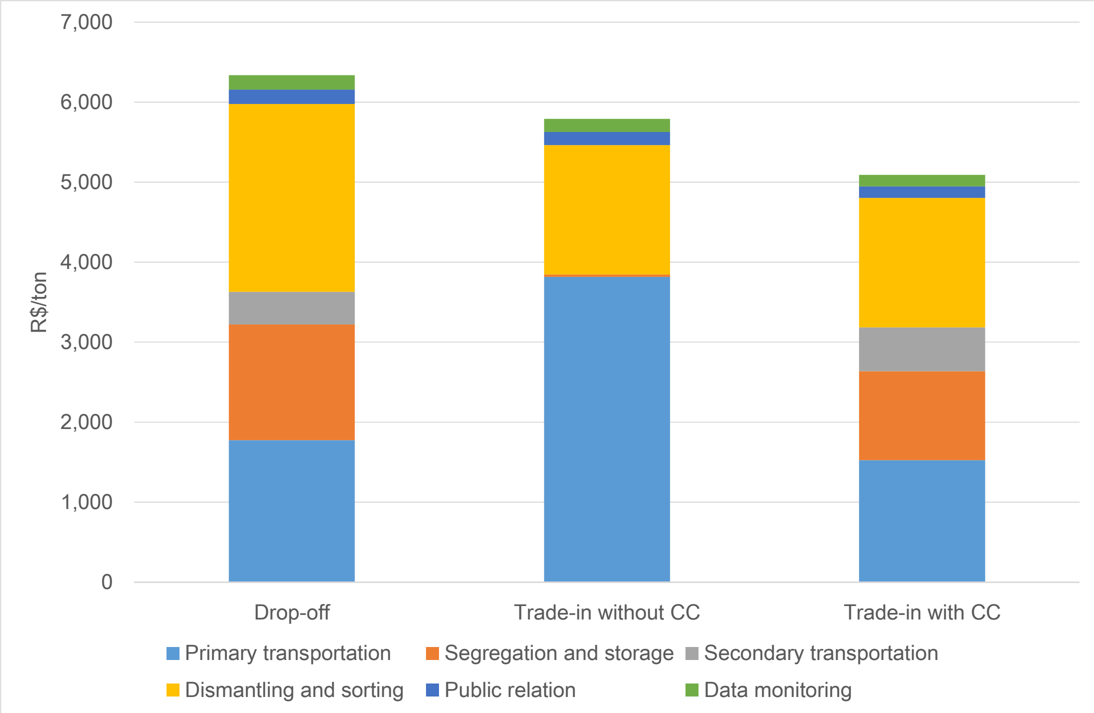


Source: JICA Expert Team

Figure 5-14 Annual required cost for recycling e-waste generated from Sao Paulo City (Year 2016)

2) Unit cost

- The unit cost for drop-off collection is the biggest among three collection types.
- Here, the cost for secondary transportation depends on the distance from the consolidation center (or the collection areas) shown in the following table. For estimating the cost of the collection implemented in other cities, this table can be used.



Source: JICA Expert Team

Figure 5-15 Unit cost required for recycling e-waste generated from Sao Paulo City

Table 5-3 Transportation cost using the transportation distance as the parameter

Types of collection	Estimated cost	Expression (R/ton)
Drop-off collection	Secondary transportation	1.8*X(km) + 227
Trade-in without consolidation centers	Collection and transportation	$\frac{69000H(hr) + 1750X(km)}{60H - 2X - 164}$
Trade-in with consolidation centers	Secondary transportation	1.4*X(km) + 400

Note: X=secondary transportation distance (km)
H=Working hours for collection and transportation (hr)

Source: JICA Expert Team

3) Conversion to the costs per unit and the visible fee

The costs for large-size e-waste recycling can be converted to the costs per unit as shown in the following table. The table also contains the visible fees when these costs are paid by consumers upon purchase (in 2016, the collection rate: 20%).

For estimating these costs, the recyclable sales taken from an e-waste depending on the types of e-waste were considered, keeping the cost per unit.

Table 5-4 Required cost per unit for recycling large-size e-wastes (by trade-in with consolidation center)

E-waste	Recycling cost (R$/Unit)	Visible fee (R$/Unit) (Year: 2016, Collection rate: 20%)
Television set	211	20
Refrigerator	231	17
Washing machine	194	15
Air-conditioner	89	5
Oven range	192	14
Average	201	16

Source: JICA Expert Team

6. Post evaluation of the Pilot Project

The evaluation results of the Pilot Project are shown in the table below.

Table6-1 Post Evaluation of the Pilot Project

<table>
<tr><th>Evaluation Perspective</th><th>Evaluation Factor</th><th>Post evaluation</th></tr>
<tr><td>1. Relevance</td><td>1.1 Stability of collection system</td><td>Although the amount of collected e-wastes was not so much, the collection system itself worked without any fatal faults except following points to be improved.
- Cooperation of the employees in the retailers had to be encouraged more.
- Unacceptable wastes such as dry battery and printer toner had to be considered more.
- Durability of the collection containers for drop-off collection had to be considered more.
- Data management system had to be designed so as to prevent data mismatches.
- Material balance had to be considered more if a consolidation center segregated the e-waste.
(See 4.3)</td></tr>
<tr><td rowspan="3">2. Effectiveness</td><td>2.1 Possibility of change in discharge actions</td><td>The e-waste collection rates were used instead of the cooperation rates.</td></tr>
<tr><td>2.2 E-waste collection rate</td><td>The e-waste collection rates are shown in the following table.
Table 6-2 Estimated e-waste collection rate
<table>
<tr><th>E-waste type</th><th>Drop-off collection (%)</th><th>Trade-in collection (%)</th></tr>
<tr><td>TV(CRT)</td><td>0.0</td><td>0.12</td></tr>
<tr><td>TV(Flat)</td><td>0.0</td><td>0.00</td></tr>
<tr><td>Refrigerator</td><td>0.0</td><td>0.28</td></tr>
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<tr><td>Oven Range</td><td>0.0</td><td>0.16</td></tr>
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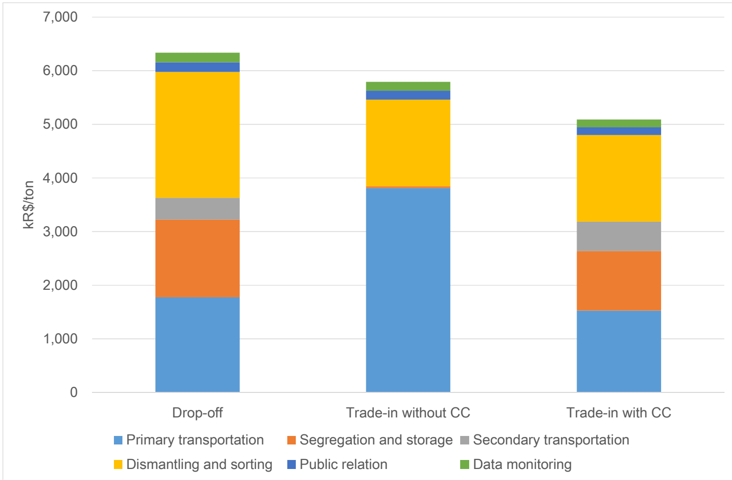
<tr><td>Monitor(LCD)</td><td>0.1</td><td>-</td></tr>
<tr><td>PC(Desktop)</td><td>0.2</td><td>-</td></tr>
<tr><td>PC(Notebook)</td><td>0.1</td><td>-</td></tr>
<tr><td>Others(White)</td><td>2.7</td><td>-</td></tr>
<tr><td>Others(Brown)</td><td>3.3</td><td>-</td></tr>
<tr><td>Others(Blue)</td><td>1.6</td><td>-</td></tr>
<tr><td>Others(Green)</td><td>1.6</td><td>-</td></tr>
<tr><td>Others</td><td>1.3</td><td>-</td></tr>
</table></td></tr>
<tr><td>2.3 Environmental improvements</td><td>The changes of the indexes of hazardousness, precious metal collection and traceability are negligible due to low collection rate of e-waste.</td></tr>
<tr><td>3. Efficiency</td><td>3.1 Necessary costs</td><td>The Required costs are
- Drop-off collection: R$6,300/ton (R$11Mil./year in Sao Paulo City)
- Trade-in collection without any consolidation center: R$5,800/ton (R$100Mil./year in Sao Paulo City)
- Trade-in collection with consolidation centers: R$5,100/ton (R$88Mil./year in Sao Paulo City)
The unit cost for drop-off collection is the highest, but the annual total required cost is lower than that for trade-in collection.
The trade-in collection with consolidation center is slightly more efficient than the trade-in collection without a consolidation center.
The collection and transportation cost shares nearly 60% in the total cost.</td></tr>
</table>

Evaluation Perspective	Evaluation Factor	Post evaluation
		 **Figure 6-1 Unit cost required for recycling e-waste generated from Sao Paulo City** (See 5.4)
4. Impact	4.1 Connection with EPR policy	All related actors worked with each other in the Pilot Project and the Pilot Project generated the required cost mentioned above with expected amount of e-waste to be collected. The numbers are to be used for further discussions on EPR policy in future.
	4.2 Degree of influence on existing recyclers	<Impact on re-use> - The price of an e-product sold in reuse shop can be exemplified as around R$500 per unit, while the price as mix metal is around R$15 per unit (50kg*R$0.3/kg). This great gap would prioritize reuse of e-waste. <Impact on informal sector> - There are several types of "Scateiro" in terms of dealing e-wastes. The most vulnerable "Scateiro" from e-waste removal is metal dealers. Metal dealers are dealing with various metal scraps such as construction material, beverage cans and furniture including e-waste. The rate of e-waste dealt by a metal dealer is around 10%. If e-waste collection under EPR policy collects all e-waste to be discarded, the businesses would be affected at the same rate. <Impact on dismantling companies> - Dismantling companies would have business opportunities from new e-waste collection system under EPR policy, even though some additional investments are necessary.
5. Sustainability	5.1 Possibility of autonomy after the Pilot Project	- Cost issue is the most important issue for autonomous e-waste collection. Once cost bearing policies are committed among related agencies, the e-waste collection system used in the Pilot Project will work for collecting e-wastes.
	5.2 Possibility of ensuring financial resources after the Pilot Project	- The required cost for e-waste recycling of R$88-100 Million per year corresponds to R$200-230 per unit of e-waste. If the visible fee for recycling is charged when purchased, the visible fee would be R$16-18 per unit of sold e-products. The number of e-wastes discarded at the moment is much smaller than the number of e-products currently sold. This can act to reduce the visible fee for recycling.
6. Expansion Possibility	6.1 Planning and feasibility in other regions	- If local governments and industrial sectors are positive, they can play a role to coordinate their Pilot Project. The experiences in the Pilot Project have to be utilized when the system will be copied to other areas.
	6.2 Region-specific conditions of the Pilot Project	- The e-waste collection system used in the Pilot Project does not use any unique conditions to Sao Paulo City. For example, e-products retailers and supermarkets are common in any areas. Any actors working as consolidation centers may be found in any areas. - One uncertain factor is the availability of dismantling factories. Long distance transportation would push up the transportation cost. Here, development of necessary recycling facilities in reasonable locations could be important for realizing e-waste reverse logistic systems covering the whole nation.

7. Lesson learnt

(1) Target e-wastes

It can be pointed out that large-scale e-wastes have to be targeted for achieving the regular e-waste collection rates of the total e-waste. It is reminded that the discarded amount, in terms of weight, of the large-scale e-wastes such as television sets, refrigerators, washing machines and air-conditioners is ten times larger than the amount of small-size e-wastes.

(2) Achieving for the collection rate targets to be set up

The units of e-wastes collected by the trade-in system were found to be very few. As mentioned in the body part of this report, the promotion from the retailer clerks had to be encouraged more.

Also, any incentives for customers had not to be forgot for collection more e-wastes. In the Pilot Project, R$10 was charged for ones who wanted recycling. This means the fee was charged upon discarded. Different from the Pilot Project, the visible fee would be charged upon purchased in future system. The amount of the visible fee would be R$16-18 per unit. The amount is more than the fee used in the Pilot Project. Based on the result of the Pilot Project, this amount would be an obstacle to collect enough numbers of e-wastes, even though the charging points are different. Any incentives to customers or any fee reduction would be very important.

Also, the e-wastes collected from drop-off collection, the collection rate was not enough. Not only intensive public relation but also any incentives for collection are very important.

(3) New business opportunity

Apart from the regulation aspect of the e-waste reverse logistic system, it has the aspect of new business opportunity. A new business market with the size of nearly R$100 million per year covering Sao Paulo City (setting the collection target as 20%) would be emerged. When the system grows up to larger size covering the whole national areas, the market size will be ten times more.

The regular size e-waste recycling system including reverse logistics, reverse manufacturing, public relations and data reporting management has to be designed in an integrated manners so that the system will work the most efficiently.

(4) Pilot Project and future regular collection system

The Pilot Project was implemented under some specific conditions. Especially, the conditions of:

- The Project Team existed and borne the cost, and
- The charge of visible fee was not realistic without enforcement of the “Sectoral Agreement”.

Under these conditions, the Pilot Project was designed as explained in this report. The system would be different from regular collection system to be introduced in future. The following table implies the difference between the Pilot Project and assumed future systems.

Table7-1 Consistency between the pilot project system and the future system

	Pilot Project	Future System (Assumption)	Considerations
Fee collection from consumers	- Collection of a symbolic fee (R$10) from consumers.	- Collection of a more expensive fee	- There is the risk that trade-in participation rate will be low.
Trade-in applicants	- Only consumers who have purchased the same product - Only São Paulo City residents	- Any consumer who wishes	- To act towards increasing trade-in participation rate.
Trade-in collection service beneficiaries	- Service is provided to consumers who have purchased a coupon.	- When recycling fee is collected as Visible Fee at the time of product purchase, its allocation as fund to collect Historical E-waste can also be considered.	- Although payers do not correspond to beneficiaries in the short term, finally this point does not matter. - It will have a completely different system design from this pilot project.
Trade-in collection vehicle	- Apart from the delivery vehicle, collection is done in e-waste collection dedicated vehicle.	- There is also the possibility of delivery vehicle picking up e-waste at the same time.	- By collecting e-waste with delivery vehicles, the collection cost might be efficient.
Primary responsible	- The Waste Management Law stipulates the collection responsibility of retailers and the recycling responsibility of manufacturers and it was based on this idea that the pilot project was designed.	- In case the targeted collection rate is imposed on the producers for considering that primary responsibility lays on the producers, if the collection responsibility is still imposed upon retailers, efforts for improving the collection rate by the producers will become ineffective.	- It is desirable to create a system where producers can easily get motivated to work on their own initiative for the improvement of the system such as to collect e-waste when delivery of sold products.

Source: JICA Expert Team

(5) Availability of other e-waste collection channel

In the Pilot Project, the retailer route was used for collecting e-wastes. There are some other alternative options for collecting e-wastes. The most efficient routes would be selected through assessing by related actors. Here, the availability was assessed for further discussions.

Table 7-2 Advantage and disadvantage of alternative e-waste collection channel

Alternative route	Advantage and availability	Disadvantage
Repair service	- There are two types of repair services. One is private repair services and another one is managed by producers for product warranty.	The repair services would be available, but the contribution to the e-waste collection rate would be not so high, because this service focuses e-wastes to be repaired.
Charity donation	- More than 50% of e-waste are sent to charity donation (questionnaire survey at the retailing shops), because this service does not charge any money to discarders. Also, this is convenient because the NGOs come to the houses to pick up e-wastes. From this aspect, this route seems to have a great possibility to collect a lot of e-wastes. - Not all e-wastes are sellable. Some of them (for example 10% of received e-wastes) cannot be repaired. The potentiality of this rout is 5% (50%*10%). Currently, this unrepaired	- Normally, NGOs for charity repair the donated e-waste and sell them. Dismantling is done in these NGOs. Environmental considerations are to be secured if this actor participates in the e-waste reverse logistics. - The producers do not want e-waste to be repaired for protecting their brand image. For creating good relation between these NGOs and producers, many points have to be discussed.

Alternative route	Advantage and availability	Disadvantage
	e-waste are considered to be sent to "Sucateiro".	
Sucateiro collected by Catadores	- The efficiency of this actor would be high. As their behavior depends on pricing, e-waste stream can be shifted from this conventional route to proper recycling route as far as reverse logistic system can show the attractive price compared with the price shown by the conventional recycler (electrical furnace). - Not small portion of e-waste is flowing to this actor. This route would work depending on the system design.	- For generating good collaboration between "Sucateiro" and producers keeping good brand images, many points have to be discussed.
Cooperativo de Catadores	- In addition to the above mentioned points, this actor kept a good collaboration with the public sector. It is advantage of this actor.	- For ensuring proper e-waste management, this actor has to change their operation. For example, they hae to stop dismantling in their site. The system has to be designed so as to motivate them.
Waste management service managed by the city ("Eco Ponto")	- Sao Paulo City has a positive idea to utilize its "Eco Ponto" for e-waste recycling. The public sector's positive stance is very preferable.	- The e-waste recycling system is to be designed under producers' initiative seeking the most efficient collection route. The public route might be less efficient than the private routes.

One of the most important charity organization is religious organization. The organizations are registered as one of the business entities with the legal background. The organizations have the following legal obligations.

- Registration to the notary offices by the articles of incorporation.
- Registration to the federal government
- Registration to the cities
- Regular money accounting

The organizations are free from the following taxations.

- Income tax (IRPJ: Imposto de Renda de Pessoas Jurídicas)
- Urban land and terirtorial tax (IPTU: Imposto Predial e Territorial Urbano)
- Real estate transfer tax (ITBI: Imposto de Transmissão de Bens Imóveis)
- Vehicle property tax (IPVA: Imposto de Propriedade de Veículos Automotores)

Appendices

Appendix 1. Estimation of e-waste collection rate

1. Objective

The amount of e-waste collected was recorded. The data can be evaluated by being normalized to the e-waste collection rate, considering that the Pilot Project was conducted for eight months in Lapa Area.

2. Definition of e-waste collection rate

(1) Drop-off collection

The e-waste collection rate can be defined as

- $\text{CRd} = \frac{Estimated\ annual\ amount\ of\ e{-}waste\ collected\ from\ Lapa\ (W_{LC})}{Estimated\ annual\ amount\ of\ e{-}waste\ discarded\ in\ Lapa\ (W_L)}$

  CRd: E-waste collection rate by drop-off collection

Here, W_L can be given by the estimation of discarded e-waste from Sao Paulo City estimated in 2015 by JET, assuming that the amount of e-waste discarded from Lapa Area is proportional to that of Sao Paulo City in terms of population.

When estimating W_{LC}, the following thing has to be considered.

- The amount of e-waste collected in the Pilot Project was contributed from residents living in outside of Lapa Area.

To know the percentage of people living in Lapa Area in the total population sending e-waste to the Pilot Project, a specific survey was conducted.

Here, the e-waste collection rate can defined as (also the duration of the Pilot Project was considered so as to estimate the annual amount.)

- $\text{CRd} = \frac{Wc \times q}{W_L} \times \frac{12}{D}$

  Wc: Total amount of e-waste collected by drop-off collection (kg)

  q: Rate of Lapa residents in the total number of people sending e-waste to the Pilot Project (%)

  D: Duration of the Pilot Project (month)

(2) Trade-in collection

The right to participate in trade-in collection was given to people who bought target products in the participating retailing shops. Considering this, the definition of collection rate by trade-in collection can be expressed by

- $\text{CRt} = \frac{W_{LC}}{W_L \times q} \times \frac{12}{D}$

  CRt: e-waste collection rate by trade-in collection (%)

  W_{LC}: E-waste collected from Lapa residents by the Pilot Project

  W_L: Estimated annual amount of e-waste discarded in Lapa

  q: rate of Lapa residents who bought target products in Lapa retailers

However, it is not easy to know “q” and “W_{LC}”, even though some specific survey was proposed.

Here, it is reasonable to assume

- $W_{LC} = W_C \times \mathrm{q}$
  W_C: E-waste collected by the Pilot Project,

because the rate of participation in the Pilot Project does not depend on living areas. The residents of Lapa and the residents of other areas may have the same willingness to participate. Then the collection rate can be defined as

- $\mathrm{CRt} = \frac{W_C}{W_L} \times \frac{12}{D}$

3. Estimation of e-waste collection rate

(1) Drop-off collection

i) Amount of e-waste discarded in Lapa: “W_L”

The amount of e-waste discarded in 2016 was estimated by JET in 2015 as shown below.

Table Amount of e-waste discarded in Sao Paulo in 2016

E-waste type	Estimated amount of e-waste discarded from Sao Paulo in 2016 (ton)
TV(CRT)	14,155
TV(Flat)	6,246
Refrigerator	22,590
Washing Machine	13,852
Air-Conditioner	6,888
PC(Desktop,CRT)	1,127
PC(Desktop,LCD)	3,738
PC(Notebook)	1,112
MobilePhone	820
SmallEwaste	1,103
Total	71,631

Source: JICA Expert Team, 2017

The rate of population of Lapa in total population of Sao Paulo is 2.9%. Then the e-waste discarded in Lapa can be estimated as shown in the following table.

Table Amount of e-waste discarded in Lapa in 2016

E-waste type	Estimated amount of e-waste discarded from Lapa in 2016 (ton) (W_L)
TV(CRT)	410
TV(Flat)	181
Refrigerator	654
Washing Machine	401
Air-conditioner (Inner)	66
Air-conditioner (Outer)	133
Oven Range	654
Monitor (CRT)	22
Monitor (LCD)	36
PC(Desktop)	83
PC(Notebook)	32
Others(White)	8
Others(Brown)	8

Others(Blue)	8
Others(Green)	32
Others	45
Total	2,773

Source: JICA Expert Team, 2017

Note:
1) Amount of air-conditioner was divided to “inner” and “outer”, assuming that weight of “inner” is one-third.
2) Weight of “Oven Range” was given the same value of “Refrigerator”.
3) “Monitor (CRT)” was estimated by two-third of “PC(Desktop, CRT)”.
4) “Monitor (LCD)” was estimated by one-third of “PC(Desktop, LCD)”.
5) “Others (White)”, “Others (Brown)”and “Others (Blue)” were given the one-fourth of “Small E-waste”.
6) “Others (Green)” was given the one-fourth of “Small E-waste” and “Mobile Phone”.
7) “Others” was estimated by the rate of “Others” (51.3%) in the total of “Others (White)”, “Others (Brown)”, “Others (Blue)” and “Others (Green)” collected by the Pilot Project.

ii) Total amount of e-waste collected by drop-off collection: “Wc”

Total amount of e-waste collected by drop-off collection in the Pilot Project is shown below.

Table. Total amount of e-waste collection by drop-off collection in the Pilot Project

E-waste type	Amount of collected e-waste (kg)
TV(CRT)	272
TV(Flat)	35
Refrigerator	0
Washing Machine	0
AC(Inner)	0
AC(Outer)	0
Oven Range	0
Monitor(CRT)	234
Monitor(LCD)	50
PC(Desktop)	356
PC(Notebook)	43
Others(White)	396
Others(Brown)	481
Others(Blue)	227
Others(Green)	919
Others	1,038
Total	4,050

Source: JICA Expert Team, 2017

iii) Rate of Lapa residents in the total number of people sending e-waste to the Pilot Project: q

According to the specific survey to collect data of “q” conducted from 16 July, 2016 to 8 August 2016, 87 % participants were residents in Sao Paulo and 42 % of the participants from Sao Paulo were residents of Lapa area.

- q=87%*42%=36.5%

iv) Length of the Pilot Project: “D”

The length of the Pilot Project was eight month.

v) E-waste collection rate of drop-off collection: “CRd”

As the result of calculation with above mentioned factors, E-waste collection rate for the drop-off collection is estimated as shown in the following table.

Table E-waste collection rate of drop-off collection

E-waste type	E-waste collection rate of drop-off collection (%)
TV(CRT)	0.0
TV(Flat)	0.0
Refrigerator	0.0
Washing Machine	0.0
AC(Inner)	0.0
AC(Outer)	0.0
Oven Range	0.0
Monitor(CRT)	0.6
Monitor(LCD)	0.1
PC(Desktop)	0.2
PC(Notebook)	0.1
Others(White)	2.7
Others(Brown)	3.3
Others(Blue)	1.6
Others(Green)	1.6
Others	1.3

Source: JICA Expert Team, 2017

(2) Trade-in collection

i) Amount of e-waste discarded in Lapa: “W_L”

Same as the values shown for drop-off collection

ii) Total amount of e-waste collected by trade-in collection: “Wc”

Total amount of e-waste collected by trade-in collection in the Pilot Project is shown below.

Table. Total amount of e-waste collection by trade-in collection in the Pilot Project

E-waste type	Amount of collected e-waste by Walmart (kg)	Amount of collected e-waste by GPA (kg)
TV(CRT)	0	84
TV(Flat)	0	0
Refrigerator	0	305
Washing Machine	39	270
AC(Inner)	0	0
AC(Outer)	0	0
Oven Range	0	176
Total	39	834

Source: JICA Expert Team, 2017

iii) Length of the Pilot Project: “D”

The lengths of the Pilot Project were six months for Walmart and two months for GPA.

iv) E-waste collection rate of trade-in collection: CRt

As the result of calculation with above mentioned factors, E-waste collection rate for the trade-in collection is estimated as shown in the following table.

Table E-waste collection rate of trade-in collection

E-waste type	E-waste collection rate of trade-in collection (%)
TV(CRT)	0.12
TV(Flat)	0.00
Refrigerator	0.28
Washing Machine	0.42
AC(Inner)	0.00

AC(Outer)	0.00
Oven Range	0.16

Source: JICA Expert Team, 2017

Appendix 2. Cost estimation for drop-off collection

1. Cost parameters obtained from the Pilot Project

(1) Primary transportation

i) Monitored data

The data monitored in the primary transportation were as shown in the figure:

- Dp: Total transportation distance in one trip
- Tp: Total required time for one trip
- n: Number of drop-of points visited

ii) Modeling

The primary transportation can be modeled by several ways. Here, it was modeled simply, assuming:

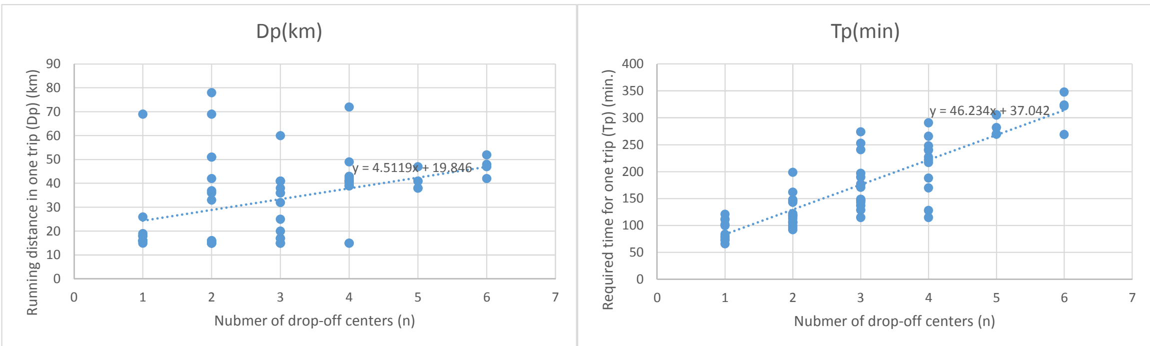
- Dp and Tp can be determined by the number of the retailers visited in one trip.

Then, Dp and Tp can be expressed by:

- Dp = C0(Dp)+C1(Dp)*n
- Tp = C0(Tp)+C1(Tp)*n

Where, the following coefficients can be given by linear regressions of the monitored data.

- Dp = 20+4.5*n (km)
- Tp = 37+46*n (min.)



Source: JICA Expert Team, 2017

Figure Monitoring Data for Primary Collection

(2) Segregation and storage at the Consolidation center

i) Monitored data

In the Consolidation Center, the factors of

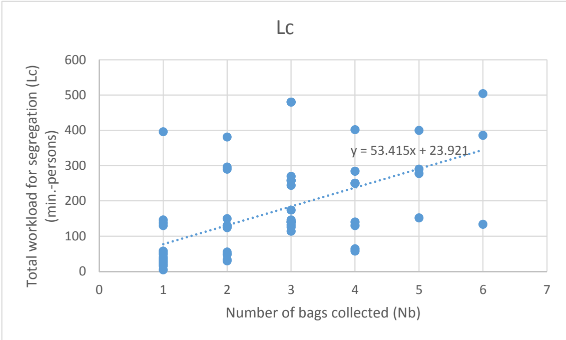
- Lc: Total workload for segregation (min.)
- Nb: Total number of bags collected (nos.)
- W: Total number of e-wastes collected (kg)

were monitored.

ii) Modeling

The segregation can be modeled as

- Lc=C0(Lc)+C1(Lc)*Nb+C2(Lc)*W.
- The parameters were found by a linear regression.
- Lc=24+53*Nb
  (“W” was not significant statistically.)



Source: JICA Expert Team, 2017

Figure Monitoring Data for Segregation at Consolidation Center

(3) Secondary transportation

i) Monitored data

The monitored data are

- Ds: Total transportation distance for the secondary transportation
- Ts: Total required time for the secondary transportation including loading and unloading
- L: Number of e-waste lots carried to the dismantling factory

ii) Modeling

Ds can be given average of Ds.

Ts can be given by

- Ts = C0(Ts)+C1(Ts)*L

But C0 was assumed to be zero due to lack of raw data. C1 was calculated as the average of loading verocity.

- Ds = 2 * X (km) (depending on the location of dismantling factories)
- Ts = 2*X*(1min/km) + 12 * L (min.)
  X: distance between the consolidation center and the dismantling factory (km)

(4) Dismantling and sorting

i) Monitoring data

The monitored data are:

- Ld: Total workload for dismantling of the e-waste
- W: Total units of dismantled e-waste

ii) Modeling

Ld can be expressed by

- Ld=C1(Ld)*W

E-waste	ΣLd/ ΣW (min/kg)
Monitor(CRT)	1.97
Monitor(LCD)	1.98
PC(Desktop)	1.54
PC(Notebook)	4.64
Others(White)	3.37
Others(Brown)	3.56
Others(Blue)	5.27
Others(Green)	2.37
Others	2.19

2. Estimation of material flow covering the whole area of Sao Paulo City

(1) Preconditions

- Small-size and middle-size e-wastes are collected by the drop-off collection system with consolidation centers.
- The consolidation centers work at the full efficiency.
- The expected collection rate of e-waste is 20 % (as the given condition).
- The density of supermarkets is one supermarket per 30000 population (Source: Pilot Project in Lapa).

(2) Drop-of points to be collected in a day

i) Assumptions

- A car works for eight hours a day (or ten hours at maximum).

ii) Important parameters

- Tp=37+46*n

  Tp: required time for collection (min.)

  n: number of supermarkets

iii) Drop-of points to be collected in a day

- 8 (hour)*60>37+46*n
- n=9.6 centers (nearly n=10)

Ten drop-of points can be visited in a day.

iv) Related parameters

- Dp(km)=20+4.5*n=20+4.5*9.6 = 63.3(km)

  Dp: Total transportation distance in one trip (km)

v) Illustration

Number of supermarkets to be travelled in a day in a drop-off collection

(3) Number of supermarkets to be covered by a consolidation center

i) Assumptions

- A consolidation center collects e-waste the most efficiently.
- A consolidation center has enough space for storage.

ii) Important parameters

- Drop-of points to be collected in a day: 9.6 supermarkets
- Amount of e-waste to be collected in a day in one supermarket = 13.8 kg/day
- Capacity of a collection bag = 22.3 kg
- Number of necessary trips to a supermarket = 22.3 (kg)/13.8 (kg) =once in 1.62 days

iii) Number of supermarkets to be covered by a consolidation center

- 9.6 (centers) * 1.62 (days/collection) = 15.6 supermarkets

iv) Related parameters

- Expected amount of e-waste to be collected by a consolidation center
  = Amount of e-waste discarded from 30,000 (persons) * 15.6 (supermarket) = 468,000 persons

E-waste	ton/year
Monitor(CRT)	6.6
Monitor(LCD)	11.0
PC(Desktop)	25.3
PC(Notebook)	9.8
Others(White)	2.4
Others(Brown)	2.4
Others(Blue)	2.4
Others(Green)	9.7
Others	8.7
Total	78.4

v) Illustration

Number of supermarkets to be covered by a consolidation center in a drop-off collection

(4) Number of required consolidation centers to cover Sao Paulo City

i) Assumptions

- None

ii) Important parameters

- A consolidation center covers the area of 468,000 population.

iii) Number of required consolidation centers

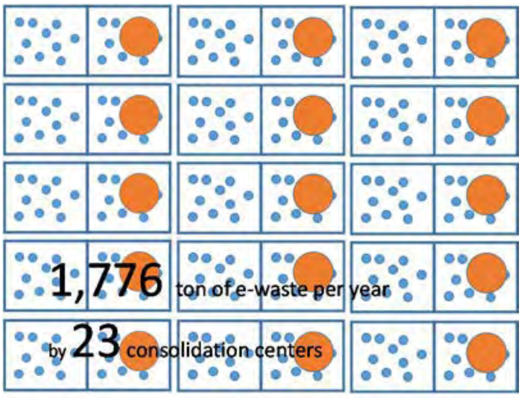
- Population of Sao Paulo City / 468,000 persons = 22.7 consolidation centers

iv) Related parameters

● Expected amount of e-waste to be collected from Sao Paulo City

E-waste	ton/year
Monitor(CRT)	150
Monitor(LCD)	249
PC(Desktop)	574
PC(Notebook)	222
Others(White)	55
Others(Brown)	55
Others(Blue)	55
Others(Green)	219
Others	196
Total	1,776

v) Illustration



Number of consolidation centers to cover the whole Sao Paulo City in a drop-off collection

(5) Number of required secondary transportation for Sao Paulo City

i) Assumptions

● The secondary transportations are done at the full efficiency by loading e-waste fully.

ii) Important parameters

● Number of lots carried by a vehicle: L=30 lots.

● Average weight of a lot = 53 kg/bag (Pilot Project)

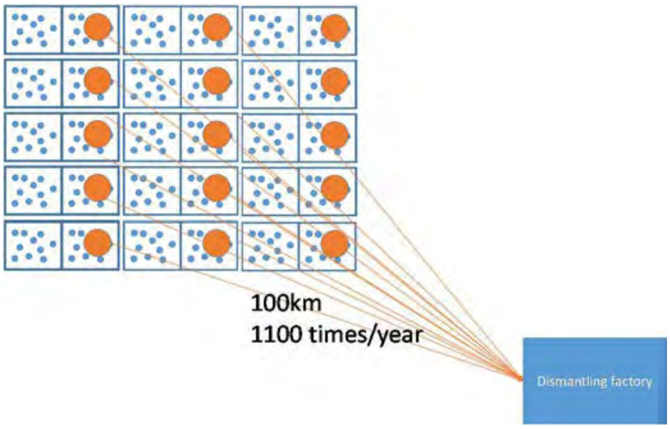
iii) Number of required secondary transportations

● Expected amount of e-waste 1776 (ton/year) *1000 / 53 (kg/bag) / 30 (lots) = 1,117 times/year.

iv) Related parameters

● None

v) Illustration



Number of secondary transportations from Sao Paulo City in a drop-off collection

3. Cost estimation of drop-off collection covering the whole area of Sao Paulo City

(1) Primary transportation

i) Parameters

● Nt: Total number of trips in a year

= (Amount of e-waste collected from Sao Paulo City) / (Amount of e-waste collected by a trip)

= 1776 (ton/year) / [(drop-of points to be collected in a day)*(Amount of e-waste to be collected in a day in one drop-of point)*(Number of necessary trips to a drop-of point)]

= 1776 (ton/year)/ [9.6 (centers)*13.8 (kg/day)*1.62 (days)]=8,300 (times/year)

● ΣDp: Total transportation distance in a year

= (C0(Dp)+C1(Dp)*n) * Nt

= (20+4.5*9.6) (km) * 8,300 (times/year)

= 524,000 km/year

● ΣTp: Total required time in a year

= (C0(Tp)+C1(Tp)*n) * Nt

= (37+45*10) (min) * 8,300 (times/year)

= 66,000 hours/year

ii) Cost items

● Labor cost

● Fuel cost

● Cost for vehicles

● Administration cost

iii) Cost estimation

● Labor cost: ClPT

=[(Salary for drivers)*(Number of drivers)+(Salary of workers)*(Number of workers)]*ΣTp

=[14.2(R$/hour)*1(person)+6.9(R$/hour)*2(person)]*66,000(hours/year)

=1,900 (kR$/year)

● Fuel cost: CfuelPT

=[(Price of fuel)/(fuel efficiency)]*ΣDp

=3.0 (R$/liter) / 6.0(km/liter) * 524,000 (km)
= 260 (kR$/year)

- Cost for vehicles: CvPT
  =[(Price of vehicle per year)+(Price of maintenance cost per year)]* Σ Tp
  = (9.5 (R$/hour)+1.8 (R$/hour))*66,000(hours/year)
  = 750 (kR$/year)
- Administration cost: CaPT
  =(ClPT+CfuelPT+CvPT)*0.1 = 290 (kR$/year)
- Total cost for primary transportation: CtPT
  =ClPT+CfuelPT+CvPT+CaPT = 3,150 (kR$/year)

(2) Segregation and storage at consolidation centers

i) Parameters

- Σ Lc: Total workload for segregation
  = (24+53*9.6 (bags))*Nt
  = 500 (min) * 8,300 (times/year)= 73,700 hours/year

ii) Cost items

- Labor cost
- Cost for forklift
- Cost for electricity
- Cost for workplace
- Administration cost

iii) Cost estimation

- Labor cost: ClSS
  = (Salary of workers)* Σ Lc
  = 6.9 (R$/hour) * 73,700 (hours/year)
  = 510 kR$/year
- Cost for forklift: CfSS
  = [(Price of forklift in a year)+(Forklift maintenance cost in a year)]*(Number of consolidation center)
  = [13,000 (R$/year) + 1,800 (R$/year)] * 22.7 (CC)=340 (kR$/year)
- Cost for electricity: CeSS
  = (Price of electricity consumption per ton in a year) * (Amount of e-waste treated)
  = 40 (R$/ton/year) * 1800 (ton/year) = 70 (kR$/year)
- Cost for workspace: CwpSS
  = (Price for workplace in a year: kR$/ton/year) * (Amount of e-waste: ton/year)
  = 800 (R$/ton/year) * 1776 (ton/year) = 1,400 (kR$/year)
- Administration cost: CaSS
  = (ClSS+CfSS+CeSS+CwpSS)*0.1=230(kR$/year)
- Total cost for segregation and storage: CtSS
  = ClSS+CfSS+CeSS+CwpSS+CaSS = 2,600 (kR$/year)

(3) Secondary transportation

i) Parameters

- Σ Ts: Total required time for secondary transportation including loading and unloading (min.)
  = (1(min/km) * X (km) *2 + 12 * (number of e-waste lots)) * (Number of secondary transportations) (times/year)
  = (1(min/km) * X (km) *2 + 12 * (number of e-waste lots)) * ((Amount of e-wastes)/(30 (lots)* (weight of a bag) (kg))
  = (1 (min/km) * 100 (km) *2 + 12 * 30 (lots)) * (1776 (ton) / (30 (lots) * (53 (kg))
  = (2*X + 360)*18.6
  = 10,400 hours/year
  X: distance between the consolidation center and the dismantling factory (km)
- Σ Tsl: Total required time for secondary transportation for loading and unloading (min.)
  = (12 * (number of e-waste lots)) * (Number of secondary transportations) (times/year)
  = (12 * 30 (lots)) * (1776 (ton) / (30 (lots) * (53 (kg))
  = 6,700 hours/year
- Σ Ds: Running distance for secondary transportation
  = (X (km)*2) * (number of secondary transportations) (times/year)
  = (100 (km) *2) * (1776 (ton) / (30 (lots) * (53 (kg))
  = 223,000 (km/year)

ii) Cost items

- Labor cost
- Fuel cost
- Cost for vehicles
- Administration cost

iii) Cost estimation

- Labor cost: ClST
  = (Salary of drivers)* Σ Ts+(Salary of workers)* Σ Tsl
  = 14.2 (R$/hour) * 10,400(hours/year) + 6.9 (R$/hour) * 6,700 (hour/year)
  = 190 (kR$/year)
- Fuel cost: CfuelST
  = =[(Price of fuel)/(fuel efficiency)]* Σ Ds
  = 3.0 (R$/liter) / 6.0(km/liter) * 223,000 (km)
  = 110 (kR$/year)
- Cost for vehicles: CvST
  =[(Price of vehicle per year)+(Price of maintenance cost per year)]* Σ Ts
  = (28.4 (R$/hour)+5.4 (R$/hour))*10,400(hours/year)
  = 350 (kR$/year)
- Administration cost: CaST
  = (ClST+CfuelST+CvST)*0.1=66 (kR$/year)
- Total cost for secondary transportation: CtST
  = ClST+CfuelST+CvST+CaST = 720 (kR$/year)

(4) Dismantling and sorting

i) Parameters

- ΣLd: Total workload for dismantling of the e-waste

  = Σ(C1(Ld)*W)

  = 72,000 (hours/year)

  W: Total units of dismantled e-waste

E-waste	Amount of target e-waste (ton/year)	Required workload: C1(Ld) (min/kg)	ΣLd (hour/year)
Monitor(CRT)	150	1.97	4,935
Monitor(LCD)	249	1.98	8,223
PC(Desktop)	574	1.54	14,721
PC(Notebook)	222	4.64	17,204
Others(White)	55	3.37	3,096
Others(Brown)	55	3.56	3,271
Others(Blue)	55	5.27	4,842
Others(Green)	219	2.37	8,652
Others	197	2.19	7,156
Total	1,776	-	72,000

- ΣRS: Recyclable sales

  = Σ(P*W)

  = 320 (kR$/year)

E-waste	Amount of target e-waste (ton/year)	Economic value from recyclable sales (R$/kg)	ΣRS (kR$/year)
Monitor(CRT)	150	-1.04	-160
Monitor(LCD)	249	0.26	64
PC(Desktop)	574	0.46	270
PC(Notebook)	222	0.57	130
Others(White)	55	0.14	7.8
Others(Brown)	55	0.22	12
Others(Blue)	55	0.13	7.3
Others(Green)	219	0.12	27
Others	197	-0.16	-32
Total	1776	-	322

ii) Cost items

- Labor cost
- Cost for electricity
- Cost for dismantling factory
- Administration cost
- Revenue from recyclable

iii) Cost estimation

- Labor cost: ClD

  = (Salary of workers) * ΣLd

  = 6.9 (R$/hour) * 72,000 (hours/year) = 500 (kR$/year)

- Cost for electricity: CelecD

  = (Electricity capacity (kW))*(Electricity load (%))*(Price of electricity (R$/kWh)) * (Total operation hours in a year)

  = 100 (kW) * 0.6 * 0.5 (R$/kWh) * 72,000 (hours/year) = 2,160 (kR$/year)

- Cost for dismantling factory: CwpD

  = (Price for dismantling factory: R$/ton/year) * (Amount of e-waste)

  = 800 (R$/ton/year) * 1776 (ton/year) = 1420 (kR$/year)

- Cost for administration cost: CaD
  = (ClD+CelecD+CwpD)*0.1 = 370 (kR$/year)
- Total cost for dismantling and sorting: CtD
  = ClD+CelecD+CwpD+CaD = 4,000 (kR$/year)
- Revenue from recyclable sales: ΣRS
  = 320 (kR$/year)
- Net total cost for dismantling and sorting
  = CtD-ΣRS = 4,000 (kR$/year) – 320 (kR$/year) = 3,700 (kR$/year)

Appendix 3. Cost estimation for trade-in collection (without the consolidation center)

1. Cost parameters obtained from the Pilot Project

(1) Collection and transportation

i) Monitored data

The data monitored in the collection and transportation were as shown in the figure:

- Dp: Total transportation distance in one trip
- Tp: Total required time for one trip
- m: Number of visiting houses

ii) Modeling

The collection and transportation can be modeled by several ways. Here, it was modeled simply, assuming:

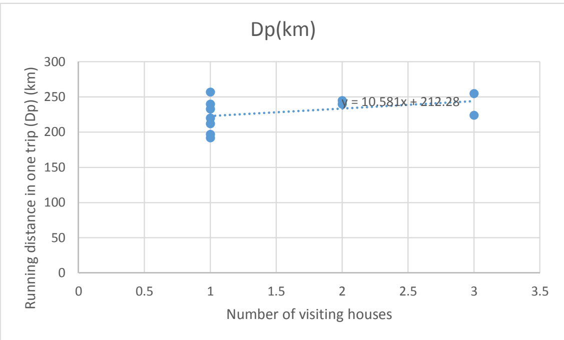
- Dp and Tp can be determined by the number of the houses visited in one trip.

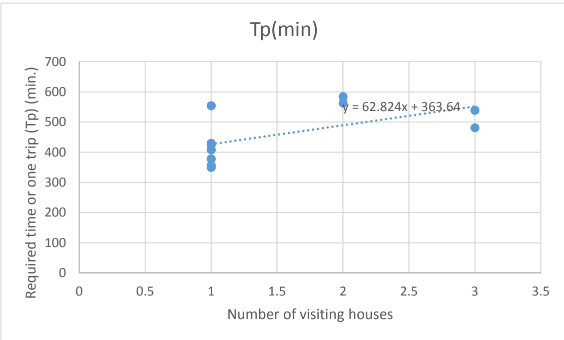
Then, Dp and Tp can be expressed by:

- Dp = C0(Dp)+C1(Dp)*m
- Tp = C0(Tp)+C1(Tp)*m

Where, the following coefficients can be given by linear regressions of the monitored data.

- Dp = 2 * X (km) + 10.6 * m (min.)
- Tp = 364 + 63 * m (min.)





(2) Segregation and storage

i) Monitored data

In the dismantling factory, the factors of

- Lc: Total workload for segregation (min.)
- M: Total units of e-wastes collected (nos.)

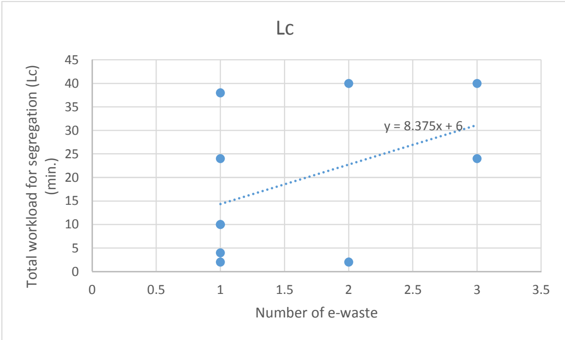
were monitored.

ii) Modeling

The segregation can be modeled as

- Lc=C0(Lc)+C1(Lc)*M
- The parameters were found by a linear regression.

● Lc=6 + 8.4 * M



(3) Dismantling and sorting

i) Monitoring data

The monitored data are:

● Ld: Total workload for dismantling of the e-waste
● M: Total units of dismantled e-waste

ii) Modeling

Ld can be expressed by

● Ld=C1(Ld)*M

E-waste	ΣLd/ ΣM (min/unit)
TV(CRT)	17
TV(Flat)	15
Refrigerator	11
Washing Machine	117
Air-conditioner	43 *
Oven Range	52

(Note) Average of observed dismantling time was used for dismantling time for air-conditioners.

2. Estimation of material flow covering the whole area of Sao Paulo City

(1) Preconditions

● The e-wastes from houses are collected at the full efficiency.
● The expected collection rate of e-waste is 20 % (as the given condition).

(2) Number of houses to be collected in a day

i) Assumptions

● A car works for ten hours a day.

ii) Important parameters

● Tp = 364 + 63 * m
Tp: required time for collection (min.)
m: number of visiting houses

iii) Number of houses to be collected in a day

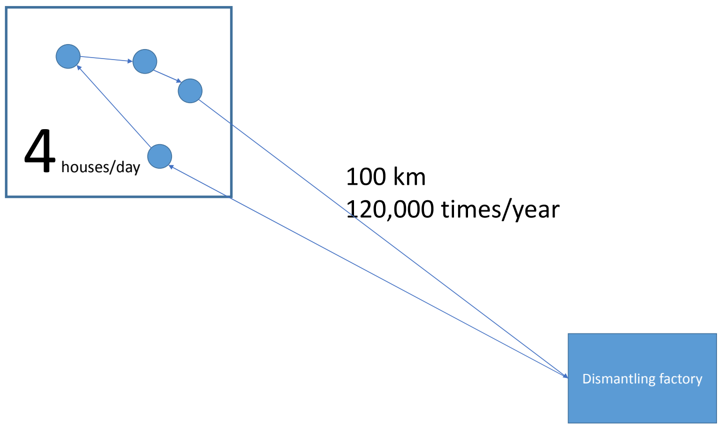
● 10*60>364+63*m
● m=3.7

Three to four houses can be visited in a day.

iv) Related parameters

- Dp (km) = 2 * 100 + 10.6 * m = 200 + 10.6 * 3.7 = 240 (km)
  Dp: Total transportation distance in one trip (km)
- Nt (times/year) = Number of trips in a year
  = (Total unit of e-waste to be collected in a year) / m
  = 437kUnit/year/m
  = 117,000 (times/year)

v) Illustration



Number of houses to be travelled in a day in the system of trade-in without a consolidation center

3. Cost estimation of trade-in collection without consolidation centers covering the whole area of Sao Paulo City

(1) Collection and transportation

i) Parameters

- Σ Dp: Total transportation distance in a year
  = Dp * Nt
  = 240 (km/trip) * 117,000 (times/year)
  = 28,000,000 (km/year)
- Σ Tp: Total required time in a year
  = Tp * Nt
  = (364 + 63*m) * 117,000 (times/year)
  = (364 + 63*3.7) * 117,000 (times/year)
  = 1,170,000 (hours/year)

ii) Cost items

- Labor cost
- Fuel cost
- Cost for vehicle
- Administration cost

iii) Cost estimation

- Labor cost: ClPT
  =[(Salary for drivers)*(Number of drivers)+(Salary of workers)*(Number of workers)]* ΣTp
  = [14.2(R$/hour)*1(person)+6.9(R$/hour)*2(person)] * 1,170,000 (hours/year)
  = 32,700 (kR$/year)
- Fuel cost: CfuelPT
  =[(Price of fuel)/(fuel efficiency)]* ΣDp
  =3.0 (R$/liter) / 6.0(km/liter) * 28,000,000 (km)
  =14,000 (kR$/year)
- Cost for vehicles: CvPT
  =[(Price of vehicle per year)+(Price of maintenance cost per year)]* ΣTp
  = (9.5 (R$/hour)+1.8 (R$/hour)) * 1,170,000 (hours/year)
  = 13,000 (kR$/year)
- Administration cost: CaPT
  =(ClPT+CfuelPT+CvPT)*0.1=6,000 (kR$/year)
- Total cost for primary transportation: CtPT
  =ClPT+CfuelPT+CvPT+CaPT=66,000 (kR$/year)

(2) Segregation and storage

i) Parameters

- Lc: Total workload for segregation
  =6 + 8.4 * M (min.)
  M: Number of e-waste to be segregated

ii) Cost items

- Labor cost
- Administration cost

iii) Cost estimation

- Labor cost: ClSS
  = (Salary for workers) * ΣLc
  = (Salary for workers) * Lc * (Total number of trips in a year)
  = 6.9 (R$/hour) * (6 + 8.4 * 3.7) * 117,000 (times/year)
  = 500 (kR$/year)
- Administration cost: CaSS
  = ClSS * 0.1 = 50 (kR$/year)
- Total cost for segregation: CtSS
  = ClSS+Cass = 550 (kR$/year)

(3) Dismantling and sorting

i) Parameters

- ΣLd: Total workload for dismantling of the e-waste
  = Σ(C1(Ld)*M)
  = 300,000 (hours/year)

E-waste	Unit of target e-waste: M (kUnit/year)	Required workload: C1(Ld) (min/unit)	ΣLd (hour/year)
TV(CRT)	76	17	22,000
TV(Flat)	104	15	26,000
Refrigerator	78	11	14,000
Washing Machine	76	117	150,000
Air-conditioner	25	43	18,000
Oven Range	78	52	67,000
Total	437	-	300,000

- ΣRS: Recyclable sales
  = Σ(P*W)
  = -737 (kR$/year)
  (“Minus” values means that they need disposal cost instead of recyclable sales.)

E-waste	Amount of e-waste: W (ton/year)	Economic value from recyclable sales: P (R$/kg)	RS (kR$/year)
TV(CRT)	2,831	-0.77	-2,188
TV(Flat)	1,249	0.14	178
Refrigerator	4,518	-0.54	-2,446
Washing Machine	2,770	0.14	390
Air-conditioner	1,378	2.00	2,755
Oven Range	4,518	0.13	573
Total	17,264	-	-737

(Note) As for air-conditioner, the data was sourced from JET.

ii) Cost items

- Labor cost
- Cost for electricity
- Cost for dismantling factory
- Administration cost
- Revenue from recyclable sales

iii) Cost estimation

- Labor cost: ClD
  = (Salary of workers) * ΣLd
  = 6.9 (R$/hour) * 300,000 (hours/year) = 2,000 (kR$/year)
- Cost for electricity: CelecD
  = (Electricity capacity (kW))*(Electricity load (%))*(Price of electricity (R$/kWh)) * (Total operation hours in a year)
  = 100 (kW) * 0.6 * 0.5 (R$/kWh) * 300,000 (hours/year) = 8,900 (kR$/year)
- Cost for dismantling factory: CwpD
  = (Price for dismantling factory: R$/ton/year) * (Amount of e-waste)
  = 800 (R$/ton/year) * 17,264 (ton/year) = 14,000 (kR$/year)
- Cost for administration cost: CaD
  = (ClD+CelecD+CwpD)*0.1 = 2,300 (kR$/year)
- Total cost for dismantling and sorting: CtD
  = ClD+CelecD+CwpD+CaD = 25,000 (kR$/year)
- Revenue from recyclable sales: ΣRS
  = -737 (kR$/year)

- Net total cost for dismantling and sorting
  = CtD- Σ RS = 25,000 (kR$/year) – (-737 (kR$/year) = 26,000 (kR$/year)

Appendix 4. Cost estimation for trade-in collection (with consolidation centers)

1. Cost parameters obtained from the Pilot Project

(1) Primary transportation

i) Monitored data

The data monitored in the primary transportation were as shown in the figure:

- Dp: Total transportation distance in one trip
- Tp: Total required time for one trip
- m: Number of visiting houses

ii) Modeling

The primary transportation can be modeled by several ways. Here, it was modeled simply, assuming:

- Dp and Tp can be determined by the number of the houses visited in one trip.

Then, Dp and Tp can be expressed by:

- Dp = C0(Dp)+C1(Dp)*m
- Tp = C0(Tp)+C1(Tp)*m

Where, the following coefficients can be given by linear regressions of the monitored data. However the number of monitored data taken from the Pilot Project was too few. “C1” was taken from the data from trade-in collection without a consolidation center. “C0” was estimated by a data that a drop-off collection for one house needed 137 (min).

- Tp = 74+63*m (min.)
  (C0(Tp) = 137(min)-63(min/house)*1(house)=74(min))
- Dp = 40+10.6*m (km)
  (Supposing that the running velocity of “20(km)/37(min)=0.54(km/min)” is the same as the drop-off collection, C0(Dp) = 74 (min)*0.54 (km/min)=40 (km)

(2) Segregation and storage at the Consolidation center

- (Same as the data for trade-in without a consolidation center)

(3) Secondary transportation

- (Same as the data for drop-off collection regarding one unit of e-waste is one lot.)

(4) Dismantling and sorting

- (Same as the data for trade-in without a consolidation center)

2. Estimation of material flow covering the whole area of Sao Paulo City

(1) Preconditions

- The e-wastes from houses are collected at the full efficiency.
- The expected collection rate of e-waste is 20 % (as the given condition).

(2) Houses to be collected in a day

i) Assumptions

- A car works for ten hours a day.

ii) Important parameters

- Tp = 74+63*m (min.)

  Tp: required time for collection (min.)

  m: number of visiting houses

iii) Number of houses to be collected in a day

- 10*60>74+63*m
- m=8.4

Eight houses can be visited in a day.

iv) Related parameters

- Dp = 40+10.6 * 8.4 (km)=129 (km)

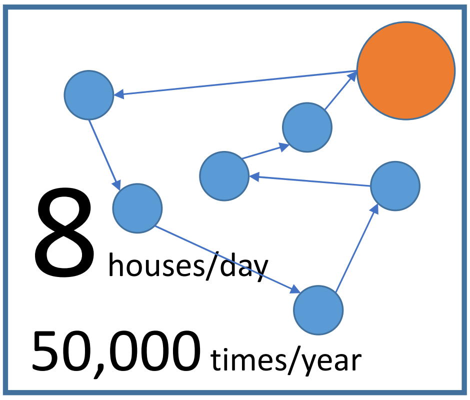
  Dp: Total transportation distance in one trip (km)

- TF: Total number of trips per year (times/year)

  = (Total units of e-waste) / (Number of houses visited in a day)

  = 437 (kUnit/year) / 8.4 (houses) = 52,000 (times/year)

v) Illustration



Number of houses to be travelled in a day in a trade-in collection with consolidation centers

(3) Number of required consolidation center for the whole of Sao Paulo City for trade-in collection with consolidation centers

i) Assumptions

- One collection vehicle has a consolidation center.

ii) Important parameters

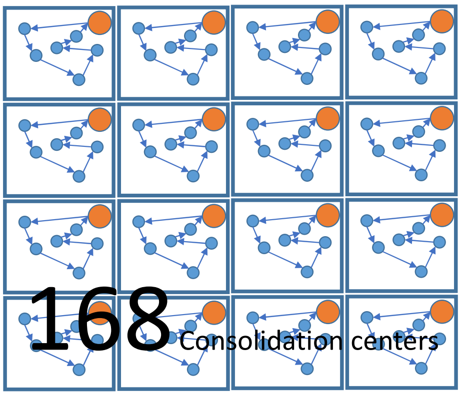
- None

iii) Number of require consolidation centers

- TF: Total number of trips per year (times/year) (TF) / (Operation days per year)

  = 52,000 (trips/year) / 312 (days) = 168 (CC)

iv) Illustration



(4) Number of secondary transportations for the whole of Sao Paulo City for trade-in collection with consolidation centers

i) Assumptions

- A vehicle used for secondary transportation can load 30 units of e-waste.

ii) Important parameters

- Expected number of e-wastes to be collected=437 kUnit/year

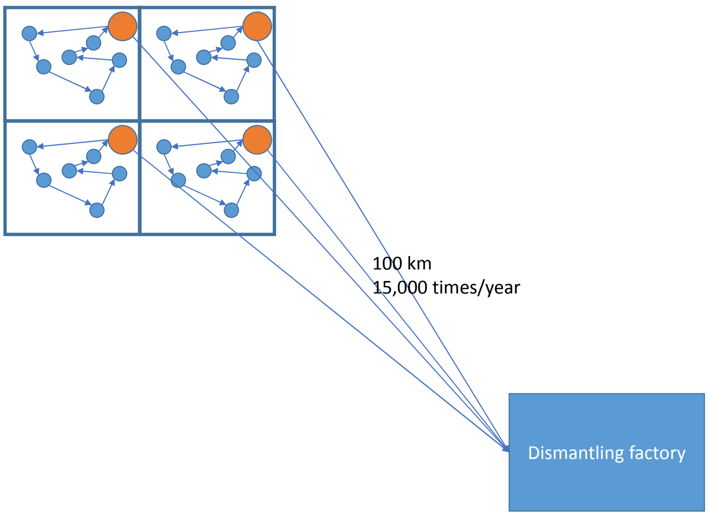
iii) Number of secondary transportations for trade-in with consolidation centers

- 437,000 (units/year) / 30 (units/car) = 15,000 (times/year)

iv) Related parameters

- None

v) Illustration



Number of secondary transportations for the whole Sao Paulo City by trade-in collection with consolidation centers

3. Cost estimation of trade-in collection with consolidation centers covering the whole area of Sao Paulo City

(1) Primary transportation

i) Parameters

- Nt: Number of trips for collection and transportation
  = 437 (kUnit/year) / 8.4 (houses/day) = 52,000 (times/year)
- ΣDp: Total transportation distance in a year
  = (40+10.6*8.4) (km/trip) * 52,000 (times/year)
  = 6,700,000 (km/year)
- ΣTp: Total required time in a year
  = (74+63*8.4) (min) * 52,000 (times/year)
  = 520,000 (hours/year)

ii) Cost items

- Labor cost
- Fuel cost
- Cost for vehicle
- Administration cost

iii) Cost estimation

- Labor cost: ClPT
  =[(Salary for drivers)*(Number of drivers)+(Salary of workers)*(Number of workers)]*ΣTp
  =[14.2(R$/hour)*1(person)+6.9(R$/hour)*2(person)]*520,000(hours/year)
  =15,000 (kR$/year)
- Fuel cost: CfuelPT
  =[(Price of fuel)/(fuel efficiency)]*ΣDp
  =3.0 (R$/liter) / 6.0(km/liter) * 6,700,000 (km)
  = 3,400 (kR$/year)
- Cost for vehicles: CvPT
  =[(Price of vehicle per year)+(Price of maintenance cost per year)]*ΣTp
  = (9.5 (R$/hour)+1.8 (R$/hour))*520,000(hours/year)
  = 5,900 (kR$/year)
- Administration cost: CaPT
  =(ClPT+CfuelPT+CvPT)*0.1 = 2,400 (kR$/year)
- Total cost for primary transportation: CtPT
  =ClPT+CfuelPT+CvPT+CaPT = 26,000 (kR$/year)

(2) Segregation and storage at consolidation centers

i) Parameters

- ΣLc: Total workload for segregation
  = (6+8.4*8.35(units))*Nt
  = 76 (min) * 52,000 (times/year)= 66,000 hours/year

ii) Cost items

- Labor cost
- Cost for forklift
- Cost for electricity
- Cost for workplace
- Administration cost

iii) Cost estimation

- Labor cost: ClSS
  = (Salary of workers)* Σ Lc
  = 6.9 (R$/hour) * 66,000 (hours/year)
  = 460 kR$/year
- Cost for forklift: CfSS
  = [(Price of forklift in a year)+(Forklift maintenance cost in a year)]*(Number of consolidation center)
  = [13,000 (R$/year) + 1,800 (R$/year)] * 168 (CC) = 2,500 (kR$/year)
- Cost for electricity: CeSS
  = (Price of electricity consumption per ton in a year) * (Amount of e-waste treated)
  = 40 (R$/ton/year) * 17,000 (ton/year) = 690 (kR$/year)
- Cost for workspace: CwpSS
  = (Price for workplace in a year: kR$/ton/year) * (Amount of e-waste: ton/year)
  = 800 (R$/ton/year) * 17,000 (ton/year) = 14,000 (kR$/year)
- Administration cost: CaSS
  = (ClSS+CfSS+CeSS+CwpSS)*0.1=1,700(kR$/year)
- Total cost for segregation and storage: CtSS
  = ClSS+CfSS+CeSS+CwpSS+CaSS = 19,000 (kR$/year)

(3) Secondary transportation

i) Parameters

- Σ Ts: Total required time for secondary transportation including loading and unloading (min.)
  = (1(min/km) * X (km) *2 + 12 * (number of e-waste lots)) * (Number of secondary transportations) (times/year)
  = (1(min/km) * X (km) *2 + 12 * (number of e-waste lots)) * ((Number of units of e-wastes)/(30 (units) (kg))
  = (1 (min/km) * 100 (km) *2 + 12 * 30 (units)) * (437 (kUnit) / (30 (units))
  = 136,000 (hours/year)
  X: distance between the consolidation center and the dismantling factory (km)
- Σ Tsl: Total required time for secondary transportation for loading and unloading (min.)
  = (12 * (number of e-waste)) * (Number of secondary transportations) (times/year)
  = (12 * 30 (units)) * (437 (kUnit) / (30 (units))
  = 87,000 hours/year
- Σ Ds: Running distance for secondary transportation
  = (X (km)*2) * (number of secondary transportations) (times/year)
  = (100 (km) *2) * (437 (kUnit) / (30 (units))
  = 2,900,000 (km/year)

ii) Cost items

- Labor cost
- Fuel cost
- Cost for vehicles

- Administration cost

iii) Cost estimation

- Labor cost: ClST
  = (Salary of drivers)* Σ Ts+(Salary of workers)* Σ Tsl
  = 14.2 (R$/hour) * 136,000 (hours/year) + 6.9 (R$/hour) * 87,000 (hour/year)
  = 2,500 (kR$/year)
- Fuel cost: CfuelST
  = =[(Price of fuel)/(fuel efficiency)]* Σ Ds
  = 3.0 (R$/liter) / 6.0(km/liter) * 2,900,000 (km)
  = 1,500 (kR$/year)
- Cost for vehicles: CvST
  =[(Price of vehicle per year)+(Price of maintenance cost per year)]* Σ Ts
  = (28 (R$/hour)+5 (R$/hour))*136,000(hours/year)
  = 4,500 (kR$/year)
- Administration cost: CaST
  = (ClST+CfuelST+CvST)*0.1=900 (kR$/year)
- Total cost for secondary transportation: CtST
  = ClST+CfuelST+CvST+CaST = 9,400 (kR$/year)

(4) Dismantling and sorting

(Same as trade-in collection without a consolidation center)

Appendix 5. Calculation sheets for cost estimations

- The cost calculation models were described in the forms of spreadsheets.
- The spreadsheets also contain the data sources.

(1) Drop-off collection

Parameter		Unit	Symbol	Worst	Standard	Best	Source
E-waste	M(CRT)	ton/year	W1	751	751	751	JET, Progress Report I
	M(LCD)	ton/year	W2	1,246	1,246	1,246	ditto
	PC(DT)	ton/year	W3	2,868	2,868	2,868	ditto
	PC(NB)	ton/year	W4	1,112	1,112	1,112	ditto
	Others(White)	ton/year	W5	276	276	276	ditto
	Others(Brown)	ton/year	W6	276	276	276	ditto
	Others(Blue)	ton/year	W7	276	276	276	ditto
	Others(Green)	ton/year	W8	1,095	1,095	1,095	ditto
	Others	ton/year	W9	980	980	980	ditto
Collection targets	Collection rate	%	CR	20	20	20	Assumption
	Expected amount of e-waste to be collected	ton/year	WT	1,776	1,776	1,776	-
Primary transportation	Coef. C0 for required time for one trip	min	C0Tp	37.0	37.0	37.0	PP
	Coef. C1 for required time for one trip	min/center	C1Tp	46.0	46.0	46.0	PP
	Working hours	hour/day	Hw	8	8	10	Market value aggregated by JET
	Number of drop-off centers to be visited in a day	centers	N	9.6	9.6	12.2	-
	Population of Sao Paulo City	persons	PT	10,600,000	10,600,000	10,600,000	Brazilian Institute of Geographic and Statistic
	Density of drop-off centers	Persons/center	DD	20,000	30,000	30,000	PP
	Daily amount of e-waste collected in a drop-off center	kg/day/center	w	9.2	13.8	13.8	-
	Capacity of a collection bag	kg/bag	wb	19.6	22.3	24.9	PP (Range with 90% significance)
	Capacity of storage at a drop-off center	days	CS	2.1	1.6	1.8	-
	Amount of e-waste collected by a trip	kg/trip	wt	189	215	305	-
	Nubmer of drop-off centers to be covered by a consolidation center	center/CC	NDcc	20.6	15.6	22.1	-
	Annual amount of e-waste collected by a consolidation center	ton/CC	Wcc	68.9	78.4	111.2	-
	Number of consolidation centers	CC	Ncc	25.8	22.7	16.0	-
	Total number of trips in a year	trip/year	Nt	9,409	8,270	5,828	-
	Coef. C0 for running distance in one trip	km	C0Dp	20.0	20.0	20.0	PP
	Coef. C1 for running distance in one trop	km/center	C1Dp	4.5	4.5	4.5	PP
	Running distance in one trip	km/trip	Dp	63	63	75	-
	Required time in one trip	min	Tp	480	480	600	-
	Total running distance in a year	km/year	ΣDp	595,926	523,774	437,511	-
	Total required time in a year	hour/year	ΣTp	75,271	66,157	58,276	-
Segregation and storage	Coef. C0 for total workload for segregation	min	C0Lc	24	24	24	PP
	Coef. C1 for total workload for segregation	min/bag	C1Lc	53	53	53	PP
	Segregation workload for one trip	min/trip	Lc	534	534	673	-
	Segregation workload in a year	hour/year	ΣLc	83,803	73,657	65,334	-
Secondary transportation	Distance to the dismantling factory	km	X	150	100	100	PP
	Coef. C0 for required time for secondary transportation	min/km	C0Ts	1.0	1.0	1.0	PP
	Coef. C1 for required time for secondary transportation	min/lot	C1Ts	12.0	12.0	12.0	PP
	Weight of a lot	kg	wL	53	53	53	PP
	Maximum lots in a secondary transportation	-	L	30	30	45	Assumption
	Number of secondary transportations	times/year	Ns	1,117	1,117	745	-
	Total running distance in a year	km/year	ΣDs	335,090	223,393	148,929	-
	Total required time in a year	hour/year	ΣTs	12,287	10,425	9,184	-
	Total required time in a year for loading and unloading	hour/year	ΣTsl	6,702	6,702	6,702	-
Dismantling and sorting	Unit dismantling workload for M(CRT)	min/kg	C1(Ld)1	2.0	2.0	2.0	PP
	Unit dismantling workload for M(LCD)	min/kg	C1(Ld)2	2.0	2.0	2.0	ditto
	Unit dismantling workload for PC(DT)	min/kg	C1(Ld)3	1.5	1.5	1.5	ditto
	Unit dismantling workload for PC(NB)	min/kg	C1(Ld)4	4.6	4.6	4.6	ditto
	Unit dismantling workload for Others(White)	min/kg	C1(Ld)5	3.4	3.4	3.4	ditto
	Unit dismantling workload for Others(Brown)	min/kg	C1(Ld)6	3.6	3.6	3.6	ditto
	Unit dismantling workload for Others(Blue)	min/kg	C1(Ld)7	5.3	5.3	5.3	ditto
	Unit dismantling workload for Others(Green)	min/kg	C1(Ld)8	2.4	2.4	2.4	ditto
	Unit dismantling workload for Others	min/kg	C1(Ld)9	2.2	2.2	2.2	ditto
	Dismantling workload for M(CRT)	hours/year	Ld1	4,935	4,935	4,935	-
	Dismantling workload for M(LCD)	hours/year	Ld2	8,223	8,223	8,223	-
	Dismantling workload for PC(DT)	hours/year	Ld3	14,721	14,721	14,721	-
	Dismantling workload for PC(NB)	hours/year	Ld4	17,204	17,204	17,204	-
	Dismantling workload for Others(White)	hours/year	Ld5	3,096	3,096	3,096	-
	Dismantling workload for Others(Brown)	hours/year	Ld6	3,271	3,271	3,271	-
	Dismantling workload for Others(Blue)	hours/year	Ld7	4,842	4,842	4,842	-
	Dismantling workload for Others(Green)	hours/year	Ld8	8,652	8,652	8,652	-
	Dismantling workload for Others	hours/year	Ld9	7,156	7,156	7,156	-
	Total required time in a year	hours/year	Ld	72,101	72,101	72,101	-
	Average price of recyclable from M(CRT)	R$/kg	P1	-1.04	-1.04	-1.04	PP
	Average price of recyclable from M(LCD)	R$/kg	P2	0.26	0.26	0.26	ditto
	Average price of recyclable from PC(DT)	R$/kg	P3	0.46	0.46	0.46	ditto
	Average price of recyclable from PC(NB)	R$/kg	P4	0.57	0.57	0.57	ditto
	Average price of recyclable from Others(White)	R$/kg	P5	0.14	0.14	0.14	ditto
	Average price of recyclable from Others(Brown)	R$/kg	P6	0.22	0.22	0.22	ditto
	Average price of recyclable from Others(Blue)	R$/kg	P7	0.13	0.13	0.13	ditto
	Average price of recyclable from Others(Green)	R$/kg	P8	0.12	0.12	0.12	ditto
	Average price of recyclable from Others	R$/kg	P9	-0.16	-0.16	-0.16	ditto
	Recyclable sales	kR$/year	RS	322	322	322	-

Parameter		Unit	Symbol	Worst	Standard	Best	Source
Cost for primary transportation	Salary for drivers	R$/hour	SdPT	14.2	14.2	14.2	Market value aggregated by JET
	Salary for workers	R$/hour	SwPT	6.9	6.9	6.9	ditto
	Number of drivers	Person	PdPT	1	1	1	Market value aggregated by JET
	Number of workers	Person	PwPT	2	2	2	Market value aggregated by JET
	Labor cost	kR$/year	ClPT	2,113	1,857	1,636	-
	Fuel efficiency	km/liter	FePT	6	6	6	Market value aggregated by JET
	Price of fuel	R$/liter	PfuelPT	3	3	3	Market value aggregated by JET
	Fuel cost	kR$/year	CfPT	298	262	219	-
	Price of vehicle per year	R$/year	PvPT	20,000	20,000	20,000	Market value aggregated by JET
	Price of car maintenance cost	R$/year	PmvPT	3,800	3,800	3,800	Market value aggregated by JET
	Cost for vehicle	kR$/year	CvPT	848	746	657	-
	Direct cost for primary transportation	kR$/year	CdPT	3,259	2,864	2,511	-
	Administration cost rate	-	RaPT	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaPT	326	286	502	-
	Cost for primary transportation	kR$/year	CtPT	3,585	3,151	3,013	-
Cost for segregation and storage	Salary for workers	R$/hour	SwSS	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClSS	581	511	453	-
	Price of forklift per year	R$/year	PfSS	13,000	13,000	13,000	Market value aggregated by JET
	Price of forklift maintenance cost	R$/year	PmfSS	1,800	1,800	1,800	Market value aggregated by JET
	Cost for forklift	kR$/year	CfSS	382	335	236	-
	Price for electricity cost	R$/ton/year	PelecSS	40	40	40	Market value aggregated by JET
	Cost for electricity	kR$/year	CeSS	71	71	71	-
	Price for workplace cost	R$/ton/year	PwpSS	1,000	800	800	Market value aggregated by JET
	Cost for workplace	kR$/year	CwpSS	1,776	1,421	1,421	-
	Direct cost for segregation and storage	kR$/year	CdSS	2,809	2,338	2,181	-
	Administration cost rate	-	RaSS	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaSS	281	234	436	-
	Cost for segragation and storage	kR$/year	CtSS	3,090	2,571	2,617	-
Cost for secondary transportation	Salary for drivers	R$/hour	SdST	14.2	14.2	14.2	Market value aggregated by JET
	Salary for workers	R$/hour	SwST	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClST	221	195	177	-
	Fuel efficiency	km/liter	FeST	6	6	6	Market value aggregated by JET
	Price of fuel	R$/liter	PfuelST	3	3	3	Market value aggregated by JET
	Fuel cost	kR$/year	CfST	168	112	74	-
	Price of vehicle per year	R$/year	PvST	60,000	60,000	60,000	Market value aggregated by JET
	Price of car maintenance cost	R$/year	PmvST	11,400	11,400	11,400	Market value aggregated by JET
	Cost for vehicle	kR$/year	CvST	415	352	310	-
	Direct cost for secondary transportation	kR$/year	CdST	804	659	562	-
	Administration cost rate	-	RaST	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaST	80	66	112	-
	Cost for secondary transportation	kR$/year	CtST	884	725	674	-
Cost for dismantling and sorting	Salary for workers	R$/hour	SdD	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClD	500	500	500	-
	Electricity capacity	kW	EcD	100	100	150	Market value aggregated by JET
	Rate of electricity load	-	KelecD	0.6	0.6	0.4	Market value aggregated by JET
	Price of electricity	R$/kWh	PelecD	0.5	0.5	0.5	Market value aggregated by JET
	Cost for electricity	kR$/year	CelecD	2,163	2,163	2,163	-
	Price for dismantling factory	R$/ton/year	PwpD	800	800	500	Market value aggregated by JET
	Cost for dismantling factory	kR$/year	CwpD	1,421	1,421	888	
	Direct cost for dismantring and sorting	kR$/year	CdD	4,084	4,084	3,551	
	Administration cost rate	-	RaD	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaD	408	408	710	-
	Cost for dismantling and sorting	kR$/year	CtD	4,492	4,492	4,261	-
	Revenue from recyclable sales	kR$/year	RevD	322	322	322	-
	Net cost for dismantling and sorting	kR$/year	NetCostD	4,169	4,169	3,939	-
Other cost parameters	PR cost rate	%	CrPR	3	3	1	Market value aggregated by JET
	Data monitoring cost rate	%	CrDM	3	3	1	Market value aggregated by JET
Cost structure	Primary transportation	kR$/year	C1	3,585	3,151	3,013	-
	Segregation and storage	kR$/year	C2	3,090	2,571	2,617	-
	Secondary transportation	kR$/year	C3	884	725	674	-
	Dismantling and sorting	kR$/year	C4	4,169	4,169	3,939	-
	Public relation	kR$/year	C5	352	318	102	-
	Data monitoring	kR$/year	C6	352	318	102	-
Total cost	Total cost in a year	kR$/year	Ct	12,433	11,253	10,448	-
	Cost for recycling	R$/ton	TotalCost	7,000	6,336	5,883	-

(2) Trade-in collection without consolidation centers

Parameter		Unit	Symbol	Worst	Standard	Best	Source
E-waste (weight)	TV(CRT)	ton/year	W1	14,155	14,155	14,155	JET, Progress report I
	TV(Flat)	ton/year	W2	6,246	6,246	6,246	ditto
	Refrigerator	ton/year	W3	22,590	22,590	22,590	ditto
	Washing Machine	ton/year	W4	13,852	13,852	13,852	ditto
	Air-conditioner	ton/year	W5	6,888	6,888	6,888	ditto
	Oven Range	ton/year	W6	22,590	22,590	22,590	ditto
E-waste (unit)	TV(CRT)	kUnit/year	N1	381	381	381	ditto
	TV(Flat)	kUnit/year	N2	520	520	520	ditto
	Refrigerator	kUnit/year	N3	389	389	389	ditto
	Washing Machine	kUnit/year	N4	380	380	380	ditto
	Air-conditioner	kUnit/year	N5	125	125	125	ditto
	Oven Range	kUnit/year	N6	389	389	389	ditto
Collection targets	Collection rate	%	CR	20	20	20	Assumption
	Expected amount of e-waste to be collected	ton/year	WT	17,264	17,264	17,264	-
	Expected amount of e-waste to be collected	kUnit/year	NT	437	437	437	-
Collection and transportation	Coef. C0 for required time for one trip	min	C0Tp	364.0	364.0	364.0	PP
	Coef. C1 for required time for one trip	min/house	C1Tp	63.0	63.0	63.0	PP
	Working hours	hour/day	Hw	8	10	10	Market value aggregated by JET
	Number of houses to be visited in a day	houses	M	1.8	3.7	3.7	-
	Total number of trips in a year	trip/year	Nt	237,228	116,603	116,603	-
	Distance to the dismantling factory	km	X	150	100	100	PP
	Coef. C0 for running distance in one trip	km	C0Dp	200.0	200.0	200.0	PP
	Coef. C1 for running distance in one trop	km/house	C1Dp	10.6	10.6	10.6	PP
	Running distance in one trip	km/trip	Dp	220	240	240	-
	Required time in one trip	min	Tp	480	600	600	-
	Total running distance in a year	km/year	ΣDp	52,075,597	27,950,758	27,950,758	-
	Total required time in a year	hour/year	ΣTp	1,897,821	1,166,034	1,166,034	-
Segregation and storage	Coef. C0 for total workload for segregation	min	C0Lc	6.0	6.0	6.0	PP
	Coef. C1 for total workload for segregation	min/e-waste-unit	C1Lc	8.4	8.4	8.4	PP
	Segregation workload for one trip	min/trip	Lc	21	37	37	-
	Segregation workload in a year	hour/year	ΣLc	84,875	72,812	72,812	-
Dismantling and sorting	Unit dismantling workload for TV(CRT)	min/unit	Ldw1	17	17	17	PP
	Unit dismantling workload for TV(Flat)	min/unit	Ldw2	15	15	15	PP
	Unit dismantling workload for Refrigerator	min/unit	Ldw3	11	11	11	PP
	Unit dismantling workload for Washing Machine	min/unit	Ldw4	117	117	117	PP
	Unit dismantling workload for Air-conditioner	min/unit	Ldw5	43	43	43	PP
	Unit dismantling workload for Oven Range	min/unit	Ldw6	52	52	52	PP
	Dismantling workload for TV(CRT)	hours/year	Ld1	21,590	21,590	21,590	-
	Dismantling workload for TV(Flat)	hours/year	Ld2	26,000	26,000	26,000	-
	Dismantling workload for Refrigerator	hours/year	Ld3	14,263	14,263	14,263	-
	Dismantling workload for Washing Machine	hours/year	Ld4	148,200	148,200	148,200	-
	Dismantling workload for Air-conditioner	hours/year	Ld5	17,917	17,917	17,917	-
	Dismantling workload for Oven Range	hours/year	Ld6	67,427	67,427	67,427	-
	Total required time in a year	hours/year	Ld	295,397	295,397	295,397	-
	Average price of recyclable from TV(CRT)	R$/kg	P1	-0.77	-0.77	-0.77	PP
	Average price of recyclable from TV(Flat)	R$/kg	P2	0.14	0.14	0.14	PP
	Average price of recyclable from Refrigerator	R$/kg	P3	-0.54	-0.54	-0.54	PP
	Average price of recyclable from Washing Machine	R$/kg	P4	0.14	0.14	0.14	PP
	Average price of recyclable from Air-conditioner	R$/kg	P5	2.00	2.00	2.50	PP
	Average price of recyclable from Oven Range	R$/kg	P6	0.13	0.13	0.13	PP
	Recyclable sales	kR$/year	RS	-737	-737	-48	-

Parameter		Unit	Symbol	Worst	Standard	Best	Source
Cost for collection and transportation	Salary for drivers	R$/hour	SdPT	14.2	14.2	14.2	Market value aggregated by JET
	Salary for workers	R$/hour	SwPT	6.9	6.9	6.9	Market value aggregated by JET
	Number of drivers	Person	PdPT	1	1	1	Market value aggregated by JET
	Number of workers	Person	PwPT	2	2	2	Market value aggregated by JET
	Labor cost	kR$/year	ClPT	53,268	32,728	32,728	-
	Fuel efficiency	km/liter	FePT	6	6	6	Market value aggregated by JET
	Price of fuel	R$/liter	PfuelPT	3	3	3	Market value aggregated by JET
	Fuel cost	kR$/year	CfPT	26,038	13,975	13,975	-
	Price of vehicle per year	R$/year	PvPT	20,000	20,000	20,000	Market value aggregated by JET
	Price of car maintenance cost	R$/year	PmvPT	3,800	3,800	3,800	Market value aggregated by JET
	Cost for vehicle	kR$/year	CvPT	21,386	13,140	13,140	-
	Direct cost for primary transportation	kR$/year	CdPT	100,693	59,844	59,844	-
	Administration cost rate	-	RaPT	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaPT	10,069	5,984	11,969	-
	Cost for primary transportation	kR$/year	CtPT	110,762	65,828	71,813	-
Cost for segregation and storage	Salary for workers	R$/hour	SwSS	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClSS	588	505	505	-
	Direct cost for segregation and storage	kR$/year	CdSS	588	505	505	-
	Administration cost rate	-	RaSS	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaSS	59	50	101	-
	Cost for segragation and storage	kR$/year	CtSS	647	555	606	-
Cost for dismantling and sorting	Salary for workers	R$/hour	SdD	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClD	2,048	2,048	2,048	-
	Electricity capacity	kW	EcD	100	100	150	Market value aggregated by JET
	Rate of electricity load	-	KelecD	0.6	0.6	0.4	Market value aggregated by JET
	Price of electricity	R$/kWh	PelecD	0.5	0.5	0.5	Market value aggregated by JET
	Cost for electricity	kR$/year	CelecD	8,862	8,862	8,862	-
	Price for dismantling factory	R$/ton/year	PwpD	800	800	500	Market value aggregated by JET
	Cost for dismantling factory	kR$/year	CwpD	13,811	13,811	8,632	-
	Direct cost for dismantring and sorting	kR$/year	CdD	24,721	24,721	19,542	-
	Administration cost rate	-	RaD	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaD	2,472	2,472	3,908	-
	Cost for dismantling and sorting	kR$/year	CtD	27,193	27,193	23,450	-
	Revenue from recyclable sales	kR$/year	RevD	-737	-737	-48	-
	Net cost for dismantling and sorting	kR$/year	NetCD	27,930	27,930	23,498	-
Other cost parameters	PR cost rate	%	CrPR	3	3	1	Market value aggregated by JET
	Data monitoring cost rate	%	CrDM	3	3	1	Market value aggregated by JET
Cost structure	Primary transportation	kR$/year	C1	110,762	65,828	71,813	-
	Segregation and storage	kR$/year	C2	647	555	606	-
	Secondary transportation	kR$/year	C3	0	0	0	-
	Dismantling and sorting	kR$/year	C4	27,930	27,930	23,498	-
	Public relation	kR$/year	C5	4,180	2,829	959	-
	Data monitoring	kR$/year	C6	4,180	2,829	959	-
Total cost	Total cost in a year	kR$/year	Ct	147,700	99,972	97,835	-
	Cost for recycling	R$/unit	TotalCost	338	229	224	-

(3) Trade-in collection with consolidation centers

Parameter		Unit	Symbol	Worst	Standard	Best	Source
E-waste (weight)	TV(CRT)	ton/year	W1	14,155	14,155	14,155	JET, Progress report I
	TV(Flat)	ton/year	W2	6,246	6,246	6,246	ditto
	Refrigerator	ton/year	W3	22,590	22,590	22,590	ditto
	Washing Machine	ton/year	W4	13,852	13,852	13,852	ditto
	Air-conditioner	ton/year	W5	6,888	6,888	6,888	ditto
	Oven Range	ton/year	W6	22,590	22,590	22,590	ditto
E-waste (unit)	TV(CRT)	kUnit/year	N1	381	381	381	ditto
	TV(Flat)	kUnit/year	N2	520	520	520	ditto
	Refrigerator	kUnit/year	N3	389	389	389	ditto
	Washing Machine	kUnit/year	N4	380	380	380	ditto
	Air-conditioner	kUnit/year	N5	125	125	125	ditto
	Oven Range	kUnit/year	N6	389	389	389	ditto
Collection targets	Collection rate	%	CR	20	20	20	Assumpion
	Expected amount of e-waste to be collected	ton/year	WT	17,264	17,264	17,264	-
	Expected amount of e-waste to be collected	kUnit/year	NT	437	437	437	-
Primary transportation	Coef. C0 for required time for one trip	min	C0Tp	74	74	74	PP
	Coef. C1 for required time for one trip	min/house	C1Tp	63	63	63	PP
	Working hours	hour/day	Hw	8	10	10	Market value aggregated by JET
	Number of houses to be visited in a day	houses	M	6.4	8.3	8.3	-
	Total number of trips in a year	trip/year	Nt	67,779	52,316	52,316	-
	Number of required consolidation center	centers	Ncc	217	168	168	-
	Amount of e-waste collected by a consolidation center	ton/year	Wcc	79	103	103	-
	Coef. C0 for running distance in one trip	km	C0Dp	40.0	40.0	40.0	PP
	Coef. C1 for running distance in one trop	km/house	C1Dp	10.6	10.6	10.6	PP
	Running distance in one trip	km/trip	Dp	108	129	129	-
	Required time in one trip	min	Tp	480	600	600	-
	Total running distance in a year	km/year	ΣDp	7,341,252	6,722,734	6,722,734	-
	Total required time in a year	hour/year	ΣTp	542,234	523,163	523,163	-
Segregation and storage	Coef. C0 for total workload for segregation	min	C0Lc	6.0	6.0	6.0	PP
	Coef. C1 for total workload for segregation	min/e-waste-unit	C1Lc	8.4	8.4	8.4	PP
	Segregation workload for one trip	min/trip	Lc	60	76	76	-
	Segregation workload in a year	hour/year	ΣLc	67,930	66,384	66,384	-
Secondary transportation	Distance to the dismantling factory	km	X	150	100	100	PP
	Coef. C0 for required time for secondary transportatio	min	C0Ts	1.0	1.0	1.0	PP
	Coef. C1 for required time for secondary transportatio	min/e-waste-unit	C1Ts	12.0	12.0	12.0	PP
	Maximum units in a secondary transportation	-	L	30	30	45	-
	Number of secondary transportations	times/year	Ns	14,560	14,560	9,707	-
	Total running distance in a year	km/year	ΣDs	4,368,000	2,912,000	1,941,333	-
	Total required time in a year	hour/year	ΣTs	160,160	135,893	119,716	-
	Total required time in a year for loading and unloading	hour/year	ΣTsl	87,360	87,360	87,360	-
Dismantling and sorting	Unit dismantling workload for TV(CRT)	min/unit	Ldw1	17	17	17	PP
	Unit dismantling workload for TV(Flat)	min/unit	Ldw2	15	15	15	PP
	Unit dismantling workload for Refrigerator	min/unit	Ldw3	11	11	11	PP
	Unit dismantling workload for Washing Machine	min/unit	Ldw4	117	117	117	PP
	Unit dismantling workload for Air-conditioner	min/unit	Ldw5	43	43	43	PP
	Unit dismantling workload for Oven Range	min/unit	Ldw6	52	52	52	PP
	Dismantling workload for TV(CRT)	hours/year	Ld1	21,590	21,590	21,590	-
	Dismantling workload for TV(Flat)	hours/year	Ld2	26,000	26,000	26,000	-
	Dismantling workload for Refrigerator	hours/year	Ld3	14,263	14,263	14,263	-
	Dismantling workload for Washing Machine	hours/year	Ld4	148,200	148,200	148,200	-
	Dismantling workload for Air-conditioner	hours/year	Ld5	17,917	17,917	17,917	-
	Dismantling workload for Oven Range	hours/year	Ld6	67,427	67,427	67,427	-
	Total required time in a year	hours/year	Ld	295,397	295,397	295,397	-
	Average price of recyclable from TV(CRT)	R$/kg	P1	-0.77	-0.77	-0.77	PP
	Average price of recyclable from TV(Flat)	R$/kg	P2	0.14	0.14	0.14	PP
	Average price of recyclable from Refrigerator	R$/kg	P3	-0.54	-0.54	-0.54	PP
	Average price of recyclable from Washing Machine	R$/kg	P4	0.14	0.14	0.14	PP
	Average price of recyclable from Air-conditioner	R$/kg	P5	2.00	2.00	2.50	PP
	Average price of recyclable from Oven Range	R$/kg	P6	0.13	0.13	0.13	PP
	Recyclable sales	R$/year	RS	-737	-737	-48	-

Parameter		Unit	Symbol	Worst	Standard	Best	Source
Cost for primary transportation	Salary for drivers	R$/hour	SdPT	14.2	14.2	14.2	Market value aggregated by JET
	Salary for workers	R$/hour	SwPT	6.9	6.9	6.9	Market value aggregated by JET
	Number of drivers	Person	PdPT	1	1	1	Market value aggregated by JET
	Number of workers	Person	PwPT	2	2	2	Market value aggregated by JET
	Labor cost	kR$/year	ClPT	15,220	14,684	14,684	-
	Fuel efficiency	km/liter	FePT	6	6	6	Market value aggregated by JET
	Price of fuel	R$/liter	PfuelPT	3	3	3	Market value aggregated by JET
	Fuel cost	kR$/year	CfPT	3,671	3,361	3,361	-
	Price of vehicle per year	R$/year	PvPT	20,000	20,000	20,000	Market value aggregated by JET
	Price of car maintenance cost	R$/year	PmvPT	3,800	3,800	3,800	Market value aggregated by JET
	Cost for vehicle	kR$/year	CvPT	6,110	5,895	5,895	-
	Direct cost for primary transportation	kR$/year	CdPT	25,001	23,941	23,941	-
	Administration cost rate	-	RaPT	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaPT	2,500	2,394	4,788	-
	Cost for primary transportation	kR$/year	CtPT	27,501	26,335	28,729	-
Cost for segregation and storage	Salary for workers	R$/hour	SwSS	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClSS	471	460	460	-
	Price of forklift per year	R$/year	PfSS	13,000	13,000	13,000	Market value aggregated by JET
	Price of forklift maintenance cost	R$/year	PmfSS	1,800	1,800	1,800	Market value aggregated by JET
	Cost for forklift	kR$/year	CfSS	3,215	2,482	2,482	-
	Price for electricity cost	R$/ton/year	PelecSS	40	40	40	Market value aggregated by JET
	Cost for electricity	kR$/year	CeSS	691	691	691	-
	Price for workplace cost	R$/ton/year	PwpSS	1,000	800	800	Market value aggregated by JET
	Cost for workplace	kR$/year	CwpSS	17,264	13,811	13,811	-
	Direct cost for segregation and storage	kR$/year	CdSS	21,641	17,444	17,444	-
	Administration cost rate	-	RaSS	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaSS	2,164	1,744	3,489	-
	Cost for segragation and storage	kR$/year	CtSS	23,805	19,188	20,933	-
Cost for secondary transportation	Salary for drivers	R$/hour	SdST	14.2	14.2	14.2	Market value aggregated by JET
	Salary for workers	R$/hour	SwST	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClST	2,881	2,536	2,306	-
	Fuel efficiency	km/liter	FeST	6	6	6	Market value aggregated by JET
	Price of fuel	R$/liter	PfuelST	3	3	3	Market value aggregated by JET
	Fuel cost	kR$/year	CfST	2,184	1,456	971	-
	Price of vehicle per year	R$/year	PvST	60,000	60,000	60,000	Market value aggregated by JET
	Price of car maintenance cost	R$/year	PmvST	11,400	11,400	11,400	Market value aggregated by JET
	Cost for vehicle	kR$/year	CvST	5,415	4,594	4,047	-
	Direct cost for secondary transportation	kR$/year	CdST	10,479	8,586	7,324	-
	Administration cost rate	-	RaST	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaST	1,048	859	1,465	-
	Cost for secondary transportation	kR$/year	CtST	11,527	9,445	8,789	-
Cost for dismantling and sorting	Salary for workers	R$/hour	SdD	6.9	6.9	6.9	Market value aggregated by JET
	Labor cost	kR$/year	ClD	2,048	2,048	2,048	-
	Electricity capacity	kW	EcD	100	100	150	Market value aggregated by JET
	Rate of electricity load	-	KelecD	0.6	0.6	0.4	Market value aggregated by JET
	Price of electricity	R$/kWh	PelecD	0.5	0.5	0.5	Market value aggregated by JET
	Cost for electricity	kR$/year	CeD	8,862	8,862	8,862	-
	Price for dismantling factory	R$/ton/year	PwpD	800	800	500	Market value aggregated by JET
	Cost for dismantling factory	kR$/year	CwpD	13,811	13,811	8,632	-
	Direct cost for dismantring and sorting	kR$/year	CdD	24,721	24,721	19,542	-
	Administration cost rate	-	RaD	0.1	0.1	0.2	Market value aggregated by JET
	Administration cost	kR$/year	CaD	2,472	2,472	3,908	-
	Cost for dismantling and sorting	kR$/year	CtD	27,193	27,193	23,450	-
	Revenue from recyclable sales	kR$/year	RevD	-737	-737	-48	-
	Net cost for dismantling and sorting	kR$/year	NetCD	27,930	27,930	23,498	-
Other cost parameters	PR cost rate	%	CrPR	3	3	1	Market value aggregated by JET
	Data monitoring cost rate	%	CrDM	3	3	1	Market value aggregated by JET
Cost structure	Primary transportation	kR$/year	C1	27,501	26,335	28,729	-
	Segregation and storage	kR$/year	C2	23,805	19,188	20,933	-
	Secondary transportation	kR$/year	C3	11,527	9,445	8,789	-
	Dismantling and sorting	kR$/year	C4	27,930	27,930	23,498	-
	Public relation	kR$/year	C5	2,723	2,487	819	-
	Data monitoring	kR$/year	C6	2,723	2,487	819	-
Total cost	Total cost in a year	kR$/year	Ct	96,208	87,872	83,588	-
	Cost for recycling	R$/unit	TotalCost	220	201	191	-

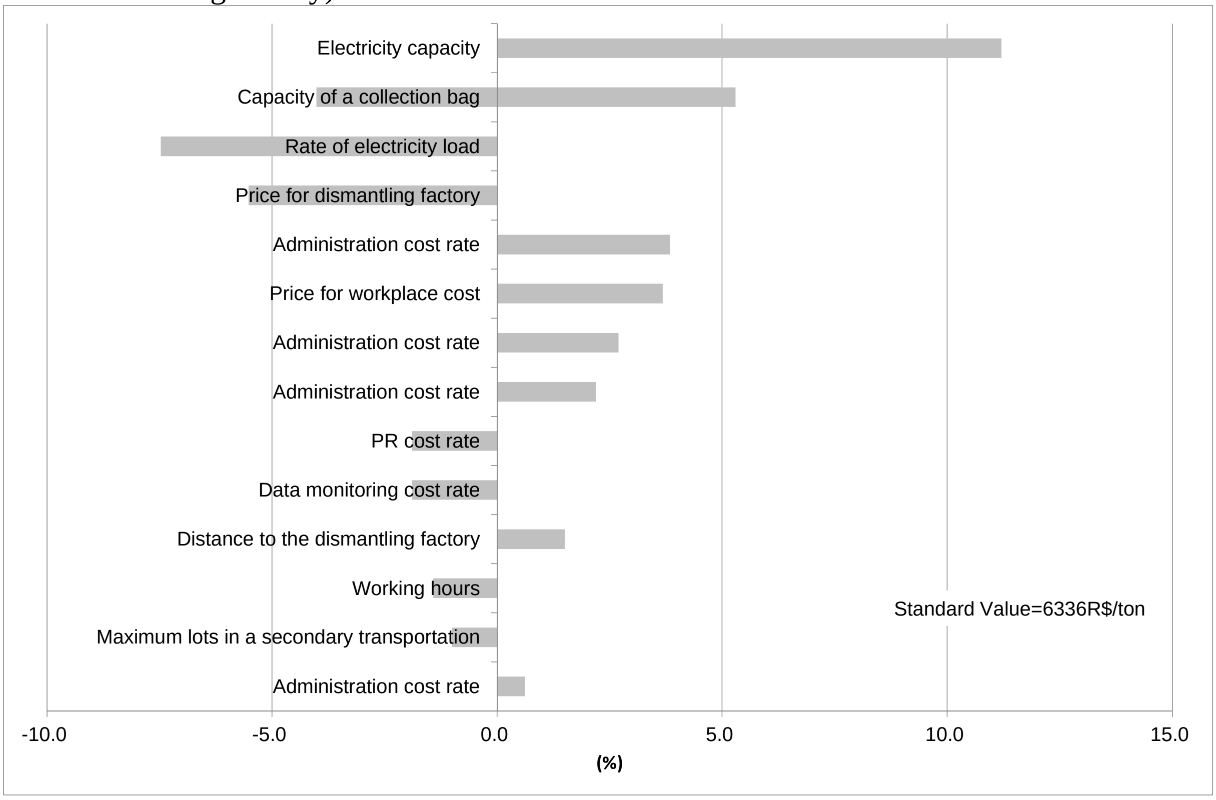
Appendix 6. Ranges of estimated costs

- The parameters were given the ranges shown in the spreadsheets in Appendix 5.
- By considering the ranges given, how the parameters affect the estimated cost can be analyzed in the form of “Tornado chart”.
- By considering the ranges given, the costs were estimated with ranges.

(1) Drop-off collection

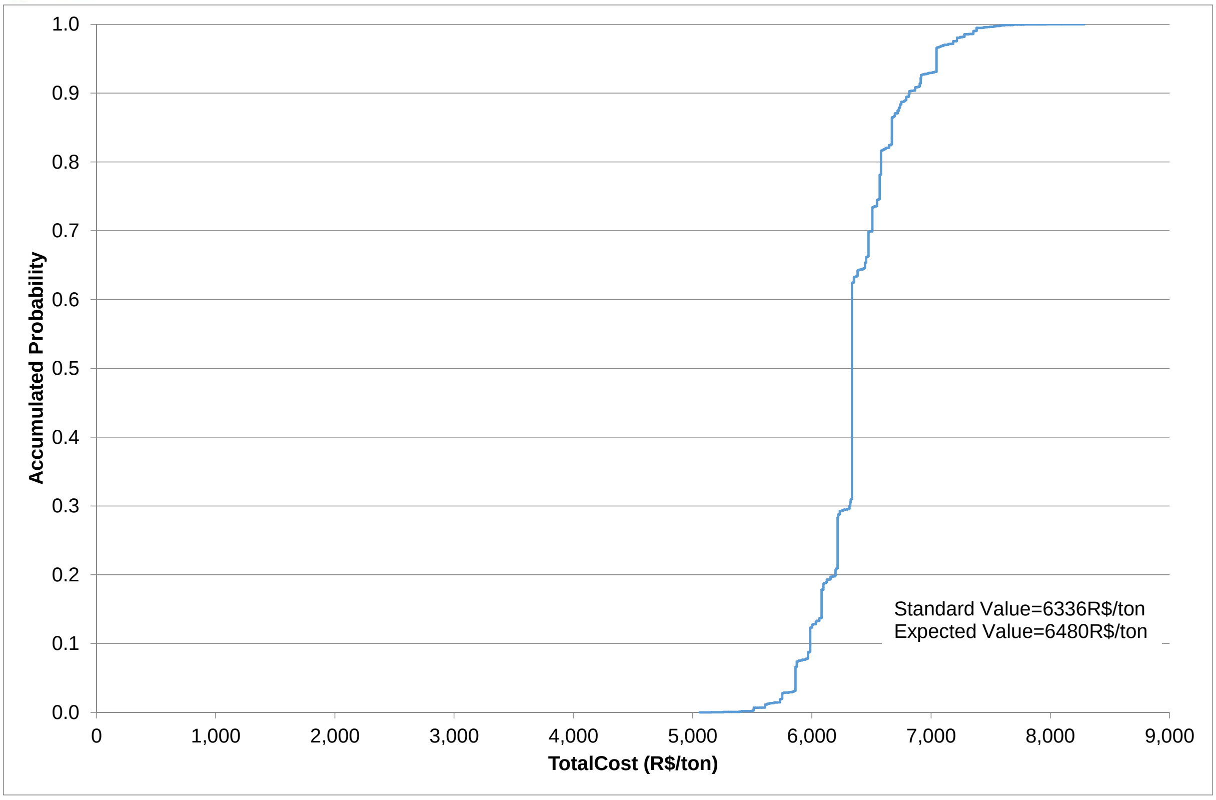
i) Tornado chart

- The following figure shows that the parameter of electricity capacity (of the dismantling factory) affects the total cost the most.



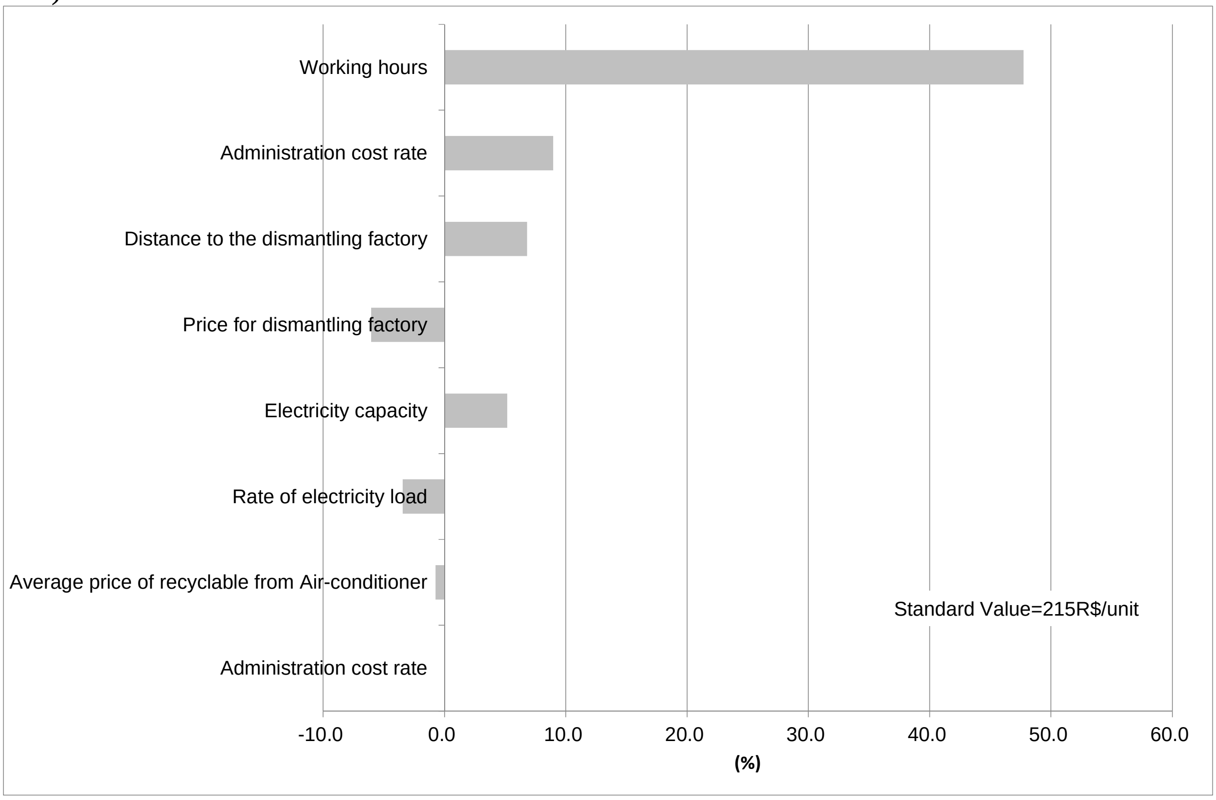
ii) Estimated cost range

- The following figure shows that the estimated cost at the minimum is R$5000/ton and R$8500/ton at the maximum.
- The average cost is R$6500/ton.

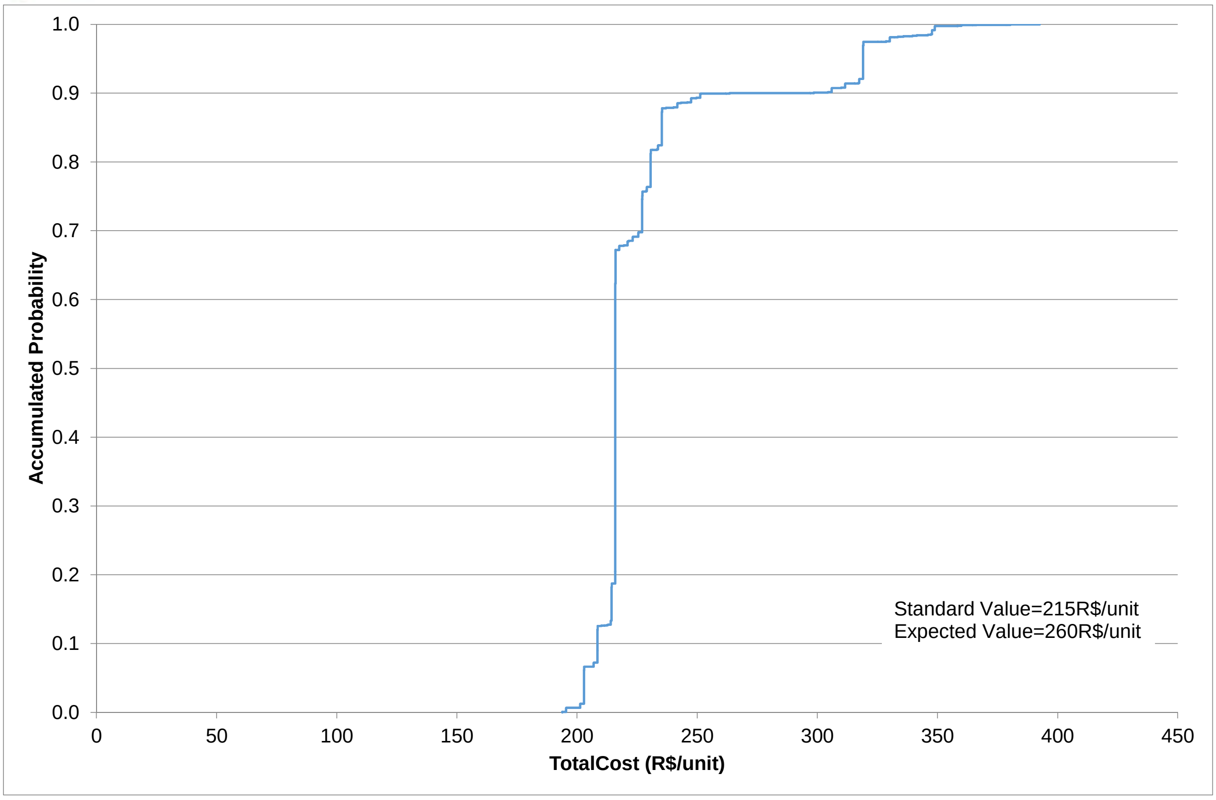


(2) Trade-in collection without consolidation centers

i) Tornado chart

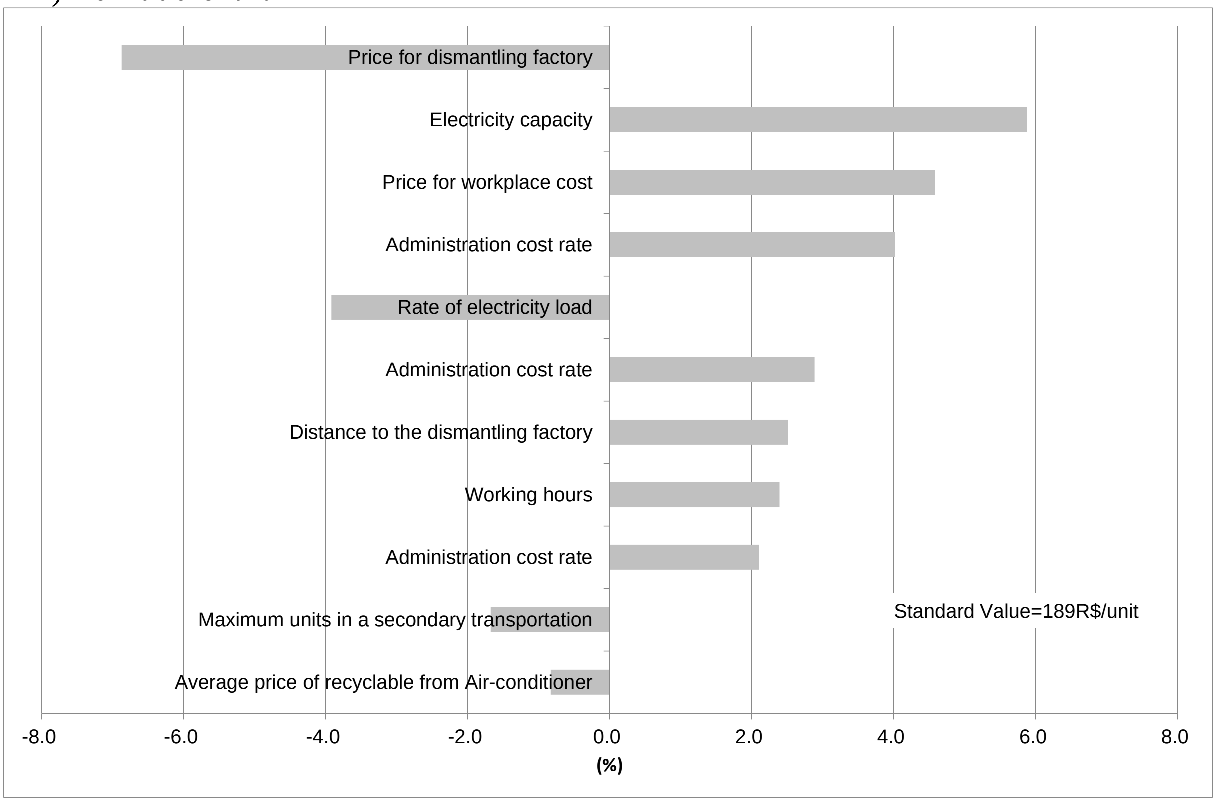


i) Estimated cost range

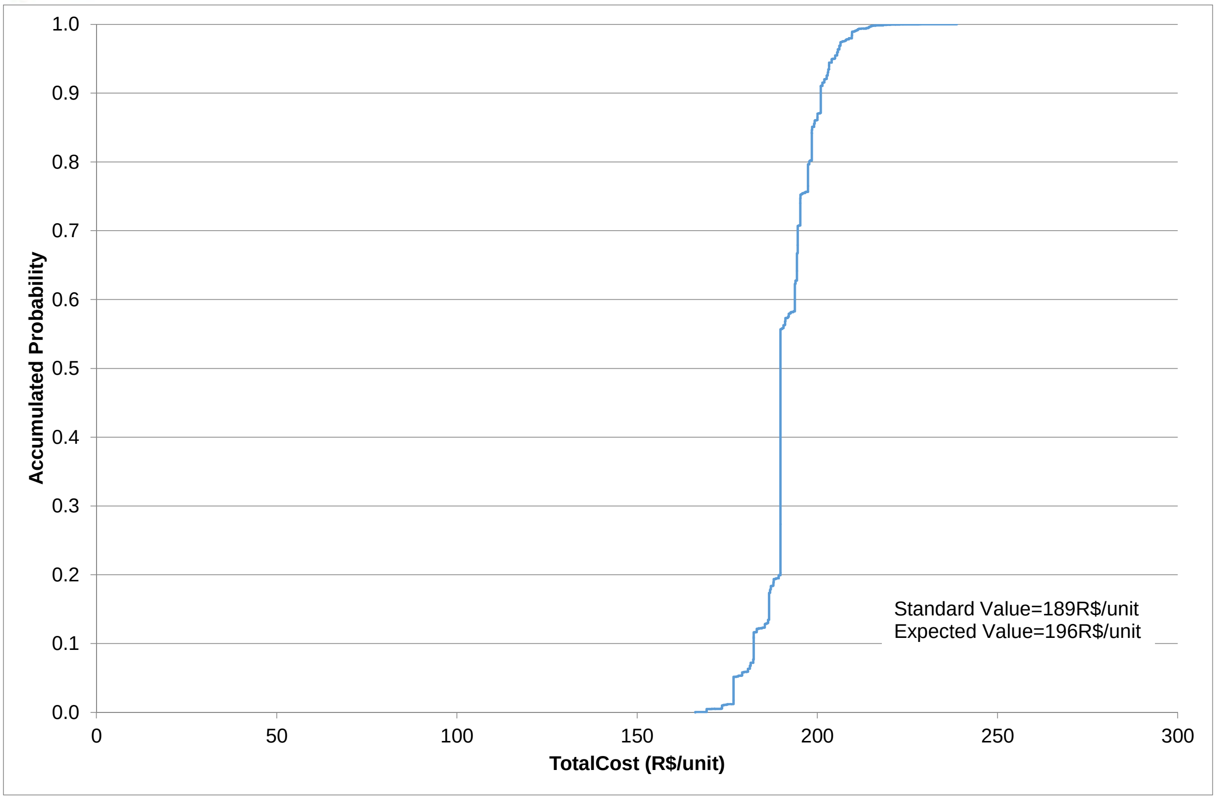


(3) Trade-in collection with consolidation centers

i) Tornado chart



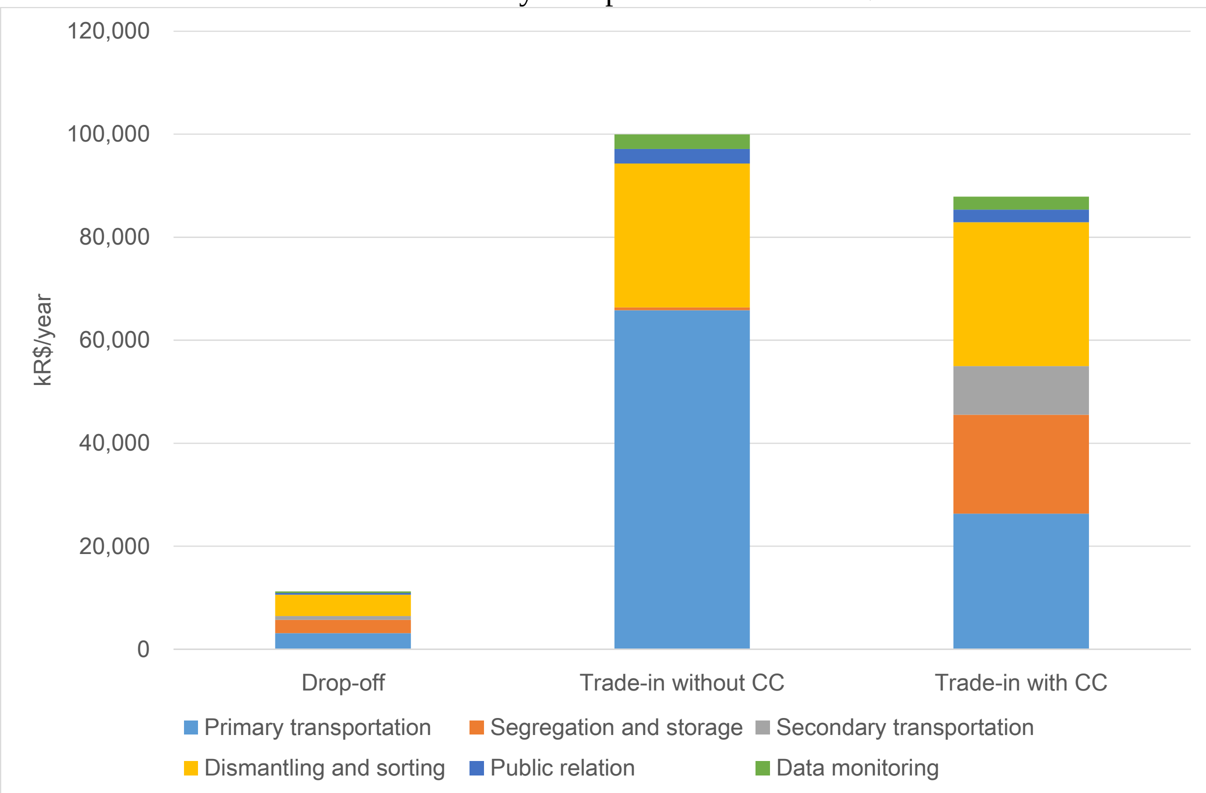
ii) Estimated cost range



(4) Comparison of the standard case

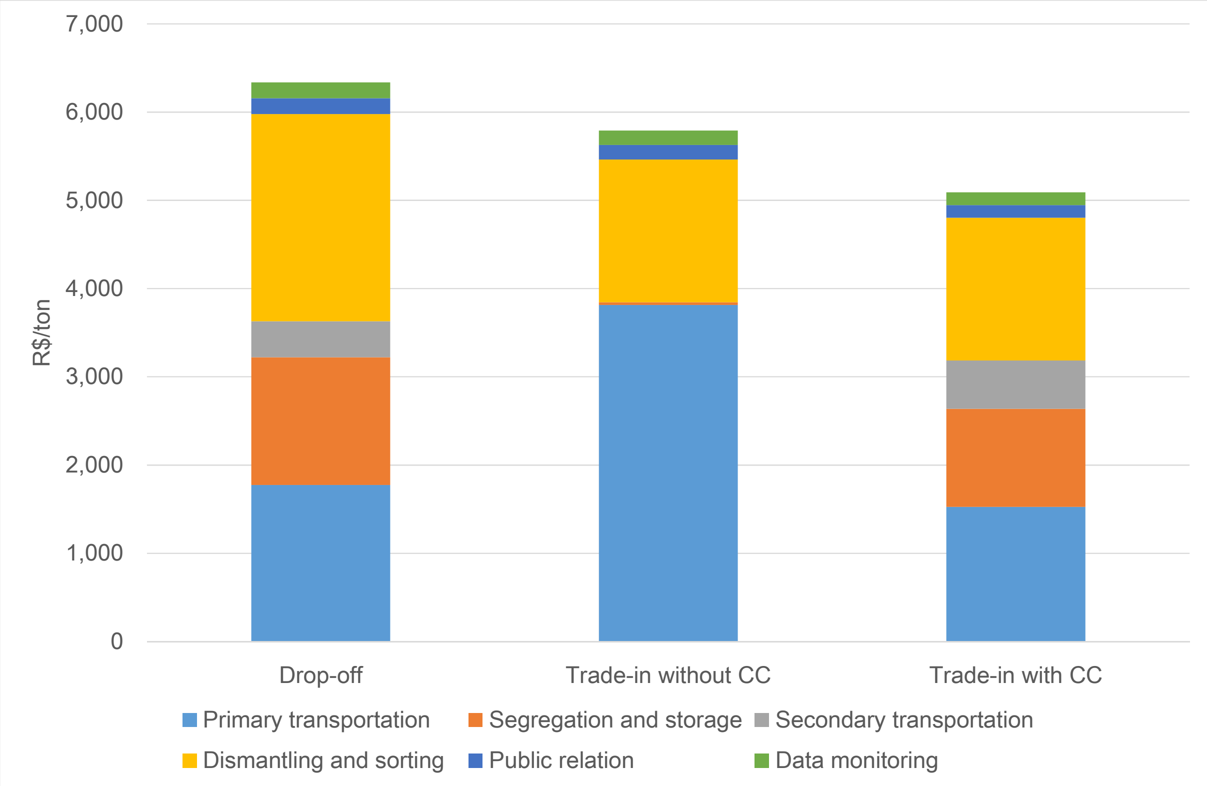
i) Annual total cost

- The total cost for drop-off collection is much smaller than that for trade-in collection.
- The total cost of the trade-in collection with consolidation centers is smaller than that of the collection without consolidation centers in this case, even though the costs for consolidation centers and secondary transportation are needed.



ii) Unit cost

● The unit cost for drop-off collection is the biggest among three collection types.



Appendix 7. Other required cost parameters

(1) Primary transportation

Cost item	Estimation formula
Cost for vehicles	(Price of vehicle per e-waste: R$/ton)*(collected e-waste: ton)
Cost for workers	ΣTp*(salary for drivers+salary for workers)
Cost for fuel	ΣDp/(fuel efficiency)*(fuel price)
Cost for car maintenance	(Car maintenance cost per e-waste: R$/ton)*(collected e-waste: ton)
Cost for administration	(Total of above items)*25%

(2) Segregation and storage at the Consolidation Center

Cost item	Estimation formula
Cost for forklift	(Price of forklift per e-waste: R$/ton)/(usable year)*(collected e-waste: ton)
Cost for factory	(Factory cost per e-waste: R$/ton)*(collected e-waste: ton)
Cost for workers	ΣTc*(salary for workers)
Cost for folk lift maintenance	(Folk lift maintenance cost per e-waste: R$/ton)*(collected e-waste: ton)
Utility cost	(Utility cost per e-waste: R$/ton)*(collected e-waste: ton)
Cost for administration	(Total of above items)*25%

(3) Secondary transportation

Cost item	Estimation formula
Cost for vehicles	(Price of vehicle per e-waste: R$/ton)*(collected e-waste: ton)
Cost for workers	ΣTs*(salary for drivers+salary for workers)
Cost for fuel	ΣDs/(fuel efficiency)*(fuel price)
Cost for car maintenance	(Car maintenance cost per e-waste: R$/ton)*(collected e-waste: ton)
Cost for administration	(Total of above items)*25%

(4) Dismantling and sorting

Cost item	Estimation formula
Cost for forklift	(Price of forklift per e-waste: R$/ton)/(usable year)*(collected e-waste: ton)
Cost for factory	(Factory cost per e-waste: R$/ton)*(collected e-waste: ton)
Cost for workers	ΣTd*(salary for workers)
Cost for forklift maintenance	(Folk lift maintenance cost per e-waste: R$/ton)*(collected e-waste: ton)
Utility cost	(Utility cost per e-waste: R$/ton)*(collected e-waste)
Recyclable sales	(Price of recyclables)*(Recovery materials)
Cost for administration	(Total of above items)*25%

(5) Public relation cost

- Cost for public relation cost was estimated by the public relation cost rate to total cost.

(6) Data monitoring cost

- Cost for data monitoring cost was estimated by the data monitoring cost rate to total cost.

Japan International Cooperation Agency (JICA)

Project for E-waste Reverse Logistics Improvement in the Federative Republic of Brazil

The Survey of the Current Situation of E-waste Reverse Logistics in other cities

Part I – Result of Surveys

August 2017

JICA Expert Team

Preface

This survey has been made by JICA Expert Team under the Project for E-waste Reverse Logistics Improvement to capture a current status of generation, collection, transportation and treatment of post consumer E-waste in the Area of Brasilia and Recife. The results of the survey shall be utilized by the Brazilian counter parts and stake holders for policy formation of E-waste reverse logistics in Brazil.

This report consists of the following two parts, and Part I is sub-contracted to a local consultant: TING AÇÃO AMBIENTAL, while Part II is the result of analysis and estimation by JICA Expert Team.

Part I – Result of Surveys

Methodology and results of survey on the available recycling companies in Brasilia and Recife city

Methodology and results of Interview to related actors in Brasilia and Recife.

Part II – Estimated volume of discarded WEEE and Recommendation

Estimation methodology and results of E-waste generation in Brasilia and Recife city: E-waste amounts and flows

Recommendation on the applicability of the Pilot Project tried in Sao Paulo City

The results described in this report, especially contents of Part II, shall be carefully handled and shall not be disclosed to the public without permission of Brazilian counter parts of the project: Ministry of Development, Industry and Foreign Trade (MDIC), Ministry of Environment (MMA) and Municipal Authority of Urban Cleaning, Sao Paulo city (AMLURB)

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Executive summary

The Project to Improve Reverse Logistics of Electrical and Electronic Waste (WEEE) in the Federative Republic of Brazil (hereinafter, the Project) was started in October 2014, with the objective of promoting the reverse logistics of WEEE in Brazil. The project is implemented by the Ministry of Industry, Foreign Trade and Services (MDIC), Ministry of Environment (MMA) and Municipal Cleaning Service Authority, São Paulo Municipal Government (AMLURB) (hereinafter referred to as Brazilian Partners) with JICA's team of experts (JET). The project consisted of three components: i) to define the generated WEEE quantity, reverse logistics production chains and recycling activities in the State of São Paulo; ii) implement the Reverse Logistics Pilot Project in the State of São Paulo and list the lessons learned from the Pilot Project; iii) to propose the monitoring and communication system for reverse logistics.

The duration of the project is three (3) years, until September 2017. Based on the experiences of components i) and ii) above, "research on the current situation of ERWL in other cities" - Brasília (DF) and Recife (PE), specified as the scope of work presented in this document, was conducted by Ting Environmental Action with the collaboration of JICA's expert team to identify organizations, industries, retailers working with WEEE, recyclers and cooperatives who work with WEEE and are interested in being part of a reverse logistics program within these two municipalities, as well as collecting socioeconomic data from the target areas to estimate the volume of discarded WEEE.

This report is structured in two parts as follows:

Part I – Result of Surveys

i. Survey on available potential consolidation centers

Listing potential recyclers or cooperatives that will function as future consolidation centers, including retailers of electrical appliances that are interested in participating as future consolidation centers.

ii. Survey on available licensed recycling factories

Listing of potential licensed recyclers that function as future re-characterization plants.

iii. Interviews with government related organizations
iv. Interviews with related industrial sectors
v. Interviews with companies in the retail sector

Part II – Estimated volume of discarded WEEE and recommendation

Part I – Result of Surveys

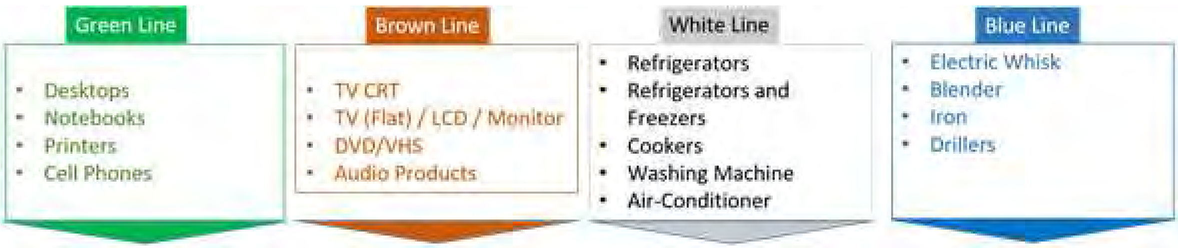
1. Target

To understand the scenario of the targeted electronics recycling market in the cities of Brasília (DF) and Recife (PE) and their environments, specifically:

- Map potential future consolidation centers and recharacterization centers;
- Conduct interviews regarding current work and expectations;
- Map retailers and industries active in the electronics market;
- Conduct interviews to collect data regarding the current work and check availability for partnership;
- Recommendation on the applicability of the Experimental Pilot Project in the City of São Paulo.

In this work, sampling, methodology, elaboration of questionnaire and selection of the organizations of the sectors involved in the research were defined.

The types of target WEEE are:



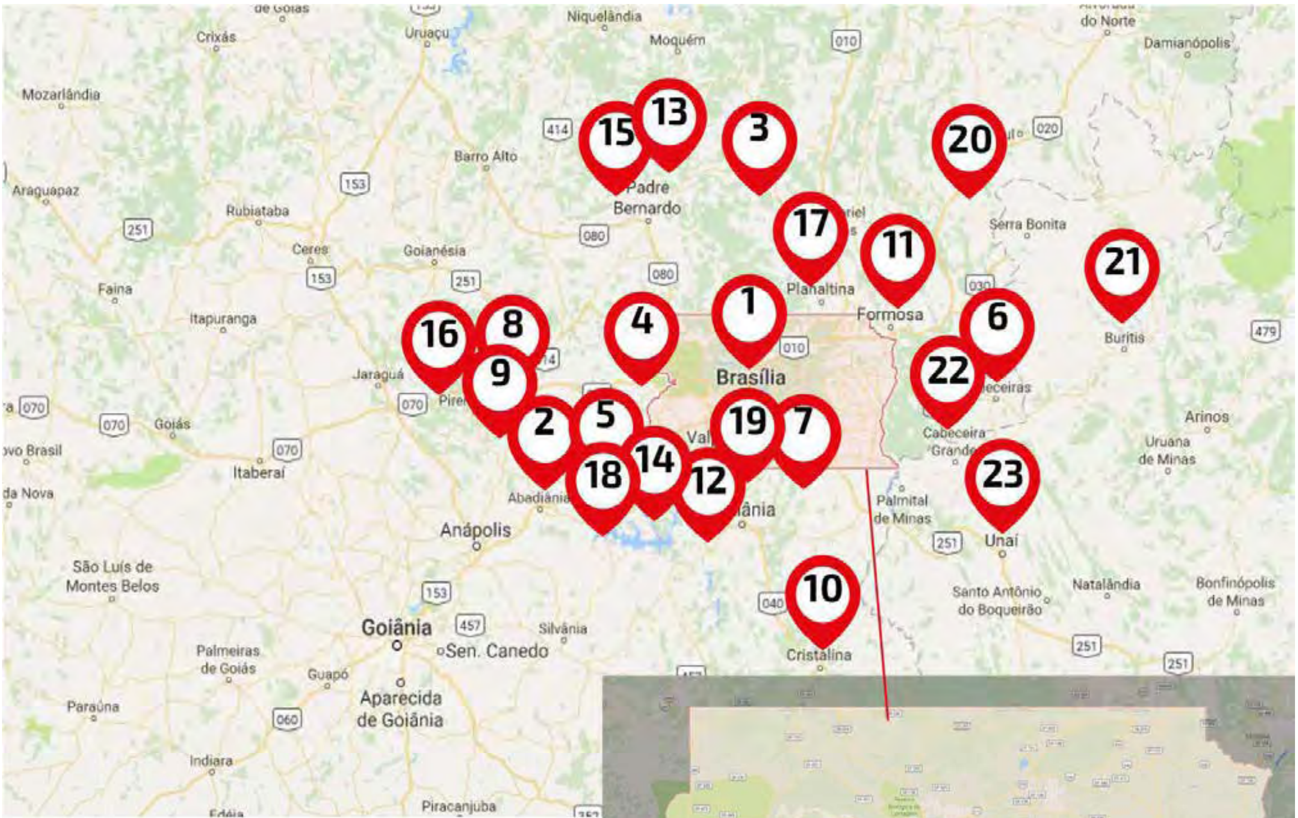
For this purpose, researches were carried out in industrial sectors and retailers to verify the capabilities to start a reverse logistics system of WEEE and verify systems already in place, as well as the screening of high potential recyclers for future consolidation centers and recharacterization centers.

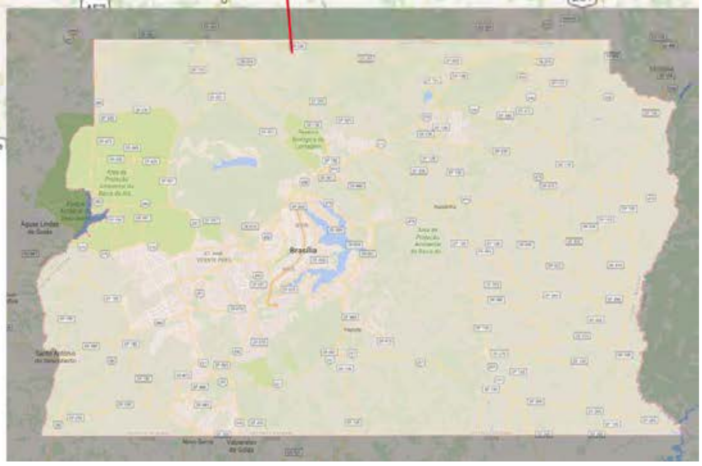
2. Regional Information

Location Map of Recife (PE) and Brasília (DF) in the context of Brazil.

Brasília - Distrito Federal (DF) **Recife - Pernambuco (PE)**

Federal District (DF):





State: Federal District
Number of municipalities: 1
Capital: Brasília

List of RIDE members of the Federal District and Surroundings:

1. *Distrito Federal*
2. *Abadiânia (GO)*
3. *Água Fria de Goiás (GO)*
4. *Águas Lindas de Goiás (GO)*
5. *Alexânia (GO)*
6. *Cabeceiras (GO)*
7. *Cidade Ocidental (GO)*
8. *Cocalzinho de Goiás (GO)*
9. *Corumbá de Goiás (GO)*
10. *Cristalina (GO)*
11. *Formosa (GO)*
12. *Luziânia (GO)*
13. *Mimoso de Goiás (GO)*
14. *Novo Gama (GO)*
15. *Padre Bernardo (GO)*
16. *Pirenópolis (GO)*
17. *Planaltina (GO)*
18. *Santo Antônio do Descoberto (GO)*
19. *Valparaíso de Goiás (GO)*
20. *Vila Boa (GO)*
21. *Buritis (MG)*
22. *Cabeceira Grande (MG)*
23. *Unaí (MG)*

Municipal data	*Year*	*Brasília*	**RIDE*
Demographic Area and Density			
Area of the Municipality (km²)	2015	5,780.00	56,433.60
Demographic density (hab/km²)	2010	444.07	67.10
Resident population			
Total population	2010	2,570,160	3,724,181
Urban Population	2010	2,481,272	3,504,433
Rural Population	2010	88,888	219,748
Estimated Population	2016	2,977,216	-
Population and Income Indicators			
Population growth rate (% pa)	2000/2010	2.38	2.42
Municipal Human Development Index [1]	2010	0.824 - high (PNUD - 2010)	0.792 (High)
Average household income per capita [2]	2010	2,097.83	1,664.94
Gross Domestic Product - GDP			
GDP (Thousand Brazilian Reais - BRL)	2010	149,906,319	160,213,433
GDP per capita (BRLs)	2010	58,326	43,020
Annual growth rate of GDP (%)	2010	12.42%	12.56%
Households and Sanitation			
Total Permanent Private Households	2010	774,037	1,107,077
Urban Homes	2010	750,847	1,044,155
Rural Homes	2010	23,190	62,922

[1] (1) The Municipal Human Development Index (MHDI) is a measure composed of indicators of three dimensions: longevity, education and income. The index ranges from 0 to 1. The closer to 1, the greater the human development.
MHDI: Very high (0.800-1.000) High (0.700-0.799) Medium (0.600-0.699) Low (0.500-0.599) Very Low (0.000-0.499).
[2] Household income per capita is the sum of the monthly income of the residents of the household, in reais, divided by the number of their residents.

Form of water supply (index of attendance of the population %)	2012	99	89.45
Households with Adequate Sanitation [3]	2010	86.04	-
Households with Semi-Adequate Sanitation [4]	2010	12.60	-
Households with Improper Sanitation [5]	2010	1.00	-
´Economias´ [6] *supplied by the Water Network*	2012	981,474	1,248,681
´Economias´ [7] *served by the Sewage Network*	-	788,586 (2016)	543,067 (2013)

**RIDE Integrated Development Region of the Federal District and Environment*

Sources: Integrated Region of Economic Development of the Federal District; IPEA - Institute for Applied Economic Research, 2013.

The Federal District is one of the 27 federative units of Brazil. Located in the Central-West Region, it is the smallest Brazilian federal unit and the only one that has no municipalities, being divided into 31 administrative regions. In its territory, is located the federal capital of Brazil, Brasília, that is also the seat of the government of the Federal District.

The Federal District is practically an enclave in the state of Goiás, were it not for the small borderland less than two kilometers long with Minas Gerais, marked by the passage of the DF-285 highway. Overland, the Federal District connects to Minas Gerais through a small bridge, 130 meters above the Preto River.

The Federal District is a legal entity of internal public law (entity of the political-administrative structure of Brazil) of a sui generis nature, since it is neither a state nor a municipality, but a special entity that accumulates the legislative powers reserved to states and Municipalities, as provided in art. 32, § 1º of the Brazilian Federal Constitution, which gives it a hybrid nature of state / municipality.

In Brazil, by legal definition, "city" is the seat of a "municipality". In the Federal District, however, the various urban centers are called Administrative Regions, the main one being the administrative region of the Pilot Plan, which in turn is also confused with the idea of the Pilot Plan. Strictly speaking, the other nuclei are more to districts far from the capital of the country than to distinct cities, since the Brazilian Constitution expressly forbids the

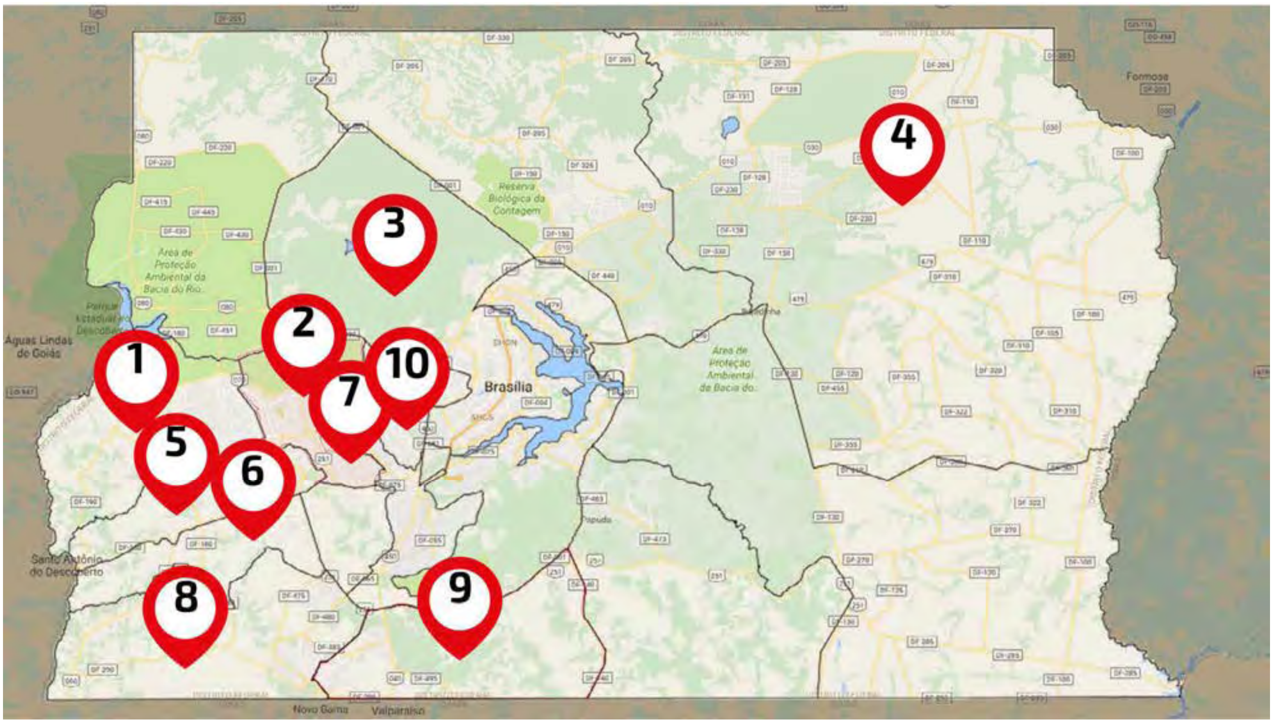
[3] Households with water network, sewage network and waste collection.
[4] Households with at least one adequate form of sanitation.
[5] Households without any form of adequate sanitation
[6] ´Economias´ are residential, commercial, industrial and public units.
[7] ´Economias´ are residential, commercial, industrial and public units.

division of the Federal District into municipalities. Brasília is constituted by the entire urban area of the Federal District and not only the part registered by the United Nations Educational, Scientific and Cultural Organization (UNESCO) or the central administrative region, since the city is polynucleate, constituted by several regions (AR's), so that the peripheral regions are hinged to the central ones.

The urban nuclei of the Federal District, called administrative regions, are known as satellite cities. Some nowadays understand as Brasília only the administrative region of Brasília (formed by part of the Pilot Plan and by the National Park of Brasília), and not the entire Federal District. However, some of these urban centers, like Planaltina and Brazlândia, are older than Brasília itself. Planaltina already existed as a municipality of Goiás, before losing part of its territory to the Federal District.

On the other hand, the law of organization of the Federal District is an organic law, typical of municipalities and not a constitution, as it occurs in the states of the Brazilian federation, although this organic law regulates both matters typical of municipal organic laws and state constitutions. In addition, all the administrative regions of the Federal District have a certain political-administrative autonomy, and their regional administrators are indicated by the local population of each administrative region, through a selective process of the candidates indicated by the representative entities of the various segments of society. However, it is important to clarify that official research institutions, such as IBGE, Dieese and IPEA, do not distinguish Brasília from the Federal District for the purposes of counting and statistics, since their data are always elaborated taking into account the municipality. Since the DF does not have municipalities, it is considered as a single entity.

More populous administrative regions of the Federal District



Position	Administrative Region*
1	Ceilândia
2	Taguatinga
3	Plano Piloto
4	Planaltina
5	Samambaia
6	Recanto das Emas
7	Águas Claras
8	Gama
9	Santa Maria
10	Guará

Source: Central-West Development Authority (SUDECO). Municipalities RIDE-DF.

* DECREE 2,710 from 1998.

The integrated region of development (or RIDE) is the Brazilian metropolitan regions that are located in more than one federative unit. They are created by specific federal legislation, which delimits the municipalities that integrate it and establishes the competencies assumed by the collegiate of the region.

The first RIDE established was the Integrated Development Region of the Federal District and Surroundings.

The Integrated Development Region of the Federal District and Surroundings is an integrated region of economic development, created by Complementary Law No. 94, of February 19, 1998 and regulated by Decree No. 2,710, of August 4, 1998, amended by Decree No. 3,445, of May 4, 2000 and Decree No. 4,700, of May 20, 2003.

Decree No. 7.469 of May 5, 2011 revoked the previous ones and gave new legal interpretations to RIDE of the Federal District and Environment.

It is constituted by the Federal District, some municipalities of Goiás and of Minas Gerais.

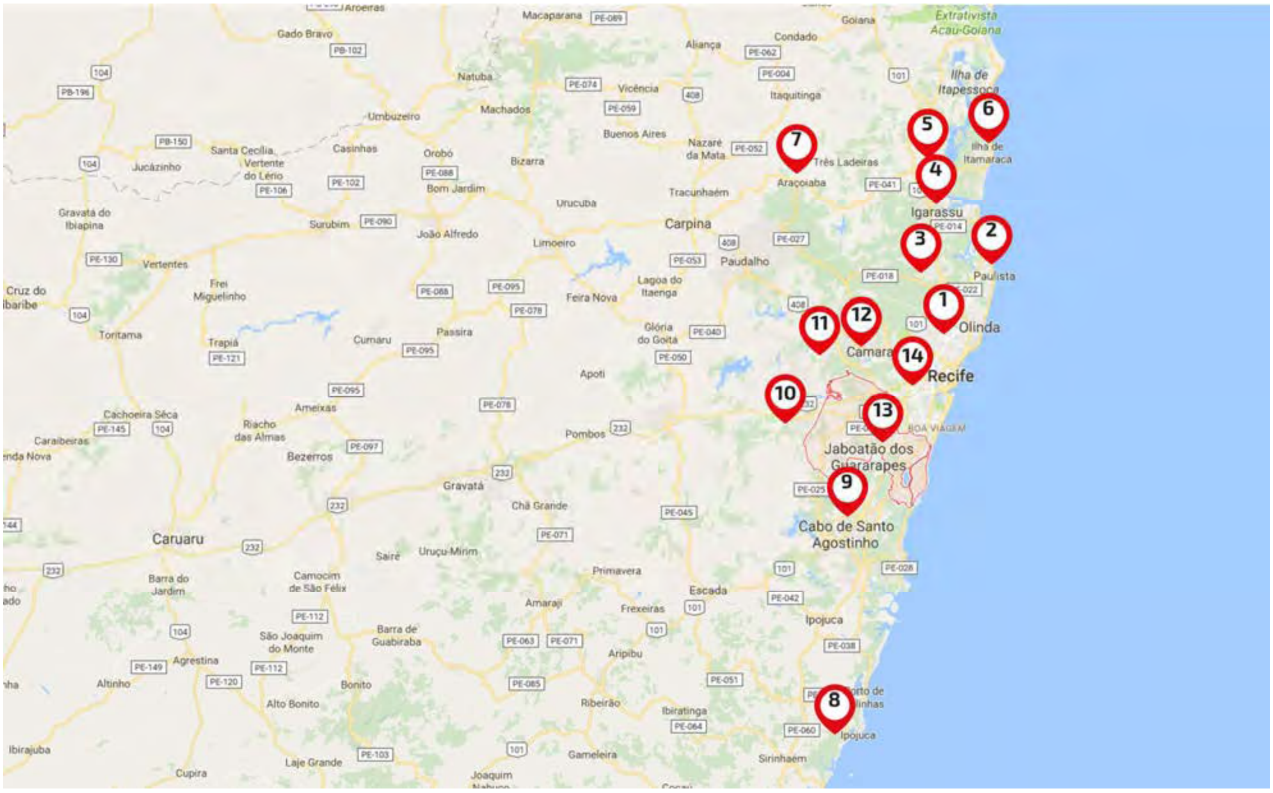
In the center of the territory is the most dense area, composed by the Federal District, which holds 69% of the population within its neighboring municipalities. There is a large troubled area in the south direction BR-040, including in this region the municipalities of Valparaíso de Goiás, Cidade Ocidental, Novo Gama and Luziânia that represent 12.3% of the RIDE population of the Federal District and Surroundings. Other municipalities that can also be considered as densely populated areas are: Águas Lindas de Goiás (BR-070), Formosa (BR-020), Planaltina (BR-010), Santo Antônio do Descoberto (BR-060).

RECIFE (PE):

State: Pernambuco
Number of municipalities: 185
Capital: Recife

Metropolitan Region of Recife - RMR

The Metropolitan Region of Recife - RMR is located in the eastern portion of Brazilian's Northeast and is bordered by the Atlantic Ocean and the Meso-region called Mata. Located in an area of 2,768 km², the Metropolitan Region of Recife-RMR covers 14 municipalities, with a population of 3,693,177 inhabitants (IBGE / 2010). It is the largest urban agglomeration in the Northeast, the fifth in Brazil, and represents 53.4% of the urban population of the state, which gives it a population density of 1,324.92 inhabitants / km².



Municipalities of RMR:

1. *Olinda*
2. *Paulista*
3. *Abreu e Lima*
4. *Igarassu*
5. *Itapissuma*
6. *Ilha de Itamaracá*
7. *Araçoiaba*
8. *Ipojuca*
9. *Cabo de Santo Agostinho*
10. *Moreno*
11. *São Lourenço da Mata*
12. *Camaragibe*
13. *Jaboatão dos Guararapes*
14. *Recife*

The greatest population concentration is in the municipality of Recife, which represents approximately 42% of the RMR, and there is a unification of the urban network between Recife, Jaboatão dos Guararapes, Camaragibe, Olinda and Paulista.

The Metropolitan Region of Recife presents a diversified economy, concentrating Pernambuco’s industry and tertiary sector. It is the central core of an economy that represents 35% of Northeastern GDP.

Municipalities data	*Year*	*Recife*	*Metropolitan*	*Pernambuco*
Demographic Area and Density				
Area of the Municipality (km²)	2013	218,435	2,787,469	98,149,119
Demographic density (hab/km²)	2010	7,039.64	1,324.92	89.62
Resident population				
Total population	2010	1,537,704	3,693,177	8,796,448
Urban Population	2010	1,537,704	3,591,806	7,052,210
Rural Population	2010	-	101,371	1,744,238
Population and Income Indicators				
Population growth rate (% pa)	2000-2010	0.78	1.01	1.06
Municipal Human Development Index [8]	2010	0.772 (High)	0.737 (High)	0.673 (Medium)
Average household income per capita [9]	2010	1,109.01	745.10	508.82
Gross Domestic Product - GDP				
GDP (Thousand Brazilian Reais)	2010	33,195,676	60,888,255	97,187,992
GDP (Thousand Brazilian Reais)	2013	46,445,339	89,802,319	140,727,623
GDP per capita (BRL)	2010	21,599	16,496	11,049
GDP per capita (BRL)	2013	29,037	23,252	15,282
Participation of the Municipality and the RD Region of Development of Pernambuco - in GDP of PE (%)	2010	31.90	64.98	100.00

[8] (1) The Municipal Human Development Index (MHDI is a measure composed of indicators of three dimensions: longevity, education and income. The index ranges from 0 to 1. The closer to 1, the greater the human development.
MHDI: Very high (0.800-1.000) High (0.700-0.799) Medium (0.600-0.699) Low (0.500-0.599) Very Low (0.000-0.499)).

[9] Household income per capita is the sum of the monthly income of the residents of the household, in reais, divided by the number of their residents.

Participation of the Municipality and the Region of Development of Pernambuco - RD in PE GDP (%)	2013	31.74	64.35	100.00
Households and Sanitation				
Total Permanent Private Households	2010	470,754	1,111,213	2,546,872
Urban Homes	2010	470,754	1,085,083	2,091,157
Rural Homes	2010	-	26,130	455,715
Households with Adequate Sanitation [10]	2010	59.75	49.68	47.35
Households with Semi-Adequate Sanitation[11]	2010	39,87	48,34	40.58
Households with Improper Sanitation [12]	2010	0.38	1.98	12.07
´Economias´ [13] *supplied by the Water Network*	2015	275,572	958,619	1,822,728
´Economias´ [14] *served by the Sewage Network*	2015	206,816	340,317	340,317

Sources: BDE-State Database (www.bde.pe.gov.br), TRE; IBGE, Pnud / Ipea / FJP, INEP, Datasus, Compesa, Celpe, MTE, DETRAN-PE, Central Bank, STN and Agência CONDEPE / FIDEM.

Pernambuco is one of the 27 federative units of Brazil, having as geographical limits: to the North, Ceará and Paraíba; to the West, Piauí; to the South, Bahia and Alagoas and to the East, the Atlantic Ocean. It is equidistant from Fortaleza (CE) and Salvador (BA) (approximately 800 km), and within a radius of 300 km with three state capitals under its direct influence: João Pessoa (PB) (122 km), Maceió (Al) (257 km) and Natal (RN) (286 km). Occupying an area of approximately 98,149,119 square kilometers, the State of Pernambuco is divided politically into 184 municipalities and a state district, the Archipelago of Fernando de Noronha, being Recife its capital city.

[10] Households with water network, sewage network and waste collection.
[11] Households with at least one adequate form of sanitation.
[12] Households without any form of adequate sanitation
[13] ´Economias´ are residential, commercial, industrial and public units.
[14] ´Economias´ are residential, commercial, industrial and public units.

Much of the region's economy comes from the provision of services, although industrial activity is also at an outstanding level, accounting for 40.5% of Great Recife's GDP. It houses a large number of regional and national headquarters of public and private institutions and companies, such as the Military Command of the Northeast, SUDENE, Eletrobrás Chesf, TRF of the 5th Region, Cindacta III, II COMAR, Infraero SRNE, SRN of INSS, TV Globo Nordeste, Votorantim Cimentos N / NE, Queiroz Galvão, among others, besides having the largest number of foreign consulates outside the Rio - São Paulo axis, being the only city, except São Paulo and Rio de Janeiro, which has Consulates General from countries such as Germany, China, the United States, France and the United Kingdom. Also worthy of note is Porto Digital, a software center created in July 2000. It is recognized as the largest technology park in Brazil in terms of revenues and number of companies, totaling 173 companies in 2010, among them multinationals such as Motorola, Oracle, Nokia, IBM and Microsoft. It employs about six thousand people, and has a 3.9% share of the state's GDP.

Despite this prosperous situation, it still presents high rates of poverty and social inequality and low social indicators. Concerning the Human Development Index - HDI, a statistical value that evaluates the degree of local human development, taking input data on life expectancy at birth, education and GDP per capita, the State of Pernambuco presents a value of 0.673 (2010), the highest in the Northeast. Although this index is used as a reference for the development of projects in the areas of education, health, basic sanitation and infrastructure, the methodology has been criticized for a number of reasons, such as not including ecological considerations, focusing exclusively on the local performance and not paying much attention to the development of a global perspective.

Development Regions

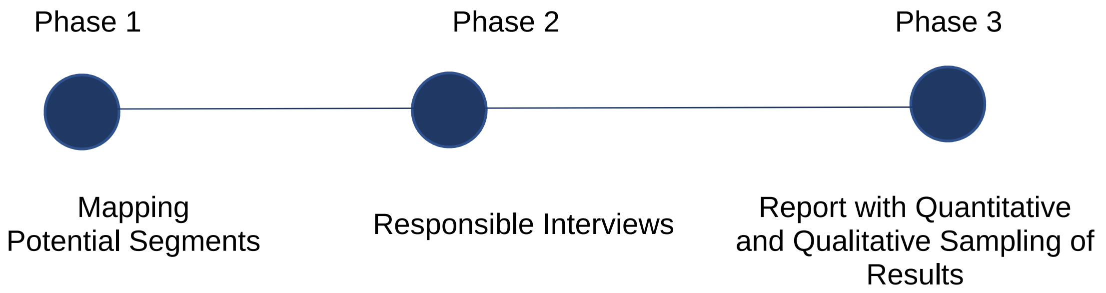
The territory of Pernambuco is divided into 12 Development Regions (RDs), according to its environmental, socioeconomic, cultural and geographic characteristics, facilitating the implementation of public policies of participative and specialized management. From this division, it is possible to carry out regionalized budgets, with the participation of society, meeting mainly the needs, potentialities and peculiarities of each region, allowing government actions to be decentralized, integrated and internalized (State Agency for Planning and Research of Pernambuco - CONDEPE / FIDEM).

3. Methodology

An exploratory study was carried out in order to discover and know the market and its peculiarities through the collection of secondary data through official sources via the web, competent bodies, trade unions, among others.

Primary data were also collected through interviews with discovered sources (during the investigative process itself) and also through technical visits to possible "industry opinion leaders" in order to deepen specific issues arising from findings secondary data.

During interviews, one of the project studies were segmented by the following phases:



The technique used in the collection of primary data was the semi-structured interview where the interviewer had the questions previously prepared, a script to follow, but was allowed both the interviewer and the person interviewed the flexibility to deepen or request clarification, confirm data if necessary, thus making possible the collection of important data and generating quantitative and qualitative information.

The interviews and visits were used to comprehend and understand the operation of the chain related to the E-Waste Reverse Logisics (EWRL) and also how it is the behavior of companies, cooperatives, non-governmental organizations - NGOs and governmental organizations.

A total of 732 actors were identified in the target municipalities and of those, 138 actually answered the questionnaire, including the industrial sector (see tables below).

The interviewed actors are classified into 6 categories: i) Cooperatives and Associations (25); (ii) Governmental Organizations (18); (iii) non-governmental organizations (17); (iiii) Recyclers (13); (iiiii) Retailers (56). Already for the industrial sector were interviewed (9) industries. A survey of secondary data for the industrial sector was also carried out (14), through internet research in what refers to the existing reverse logistics programs - iiiii) Industries (23).

BRASÍLIA (DF) AND SURROUNDINGS

A total of 303 actors were identified in Brasília (DF) and surroundings and in these number, 63 effectively answered the questionnaire (see tables below).

Table - Research Rank.

Status	Cooperatives and Associations	Recyclers	Non-governmental organizations	Government Organizations	Retailers	Grand total
Interviewee	18	5	4	5	31	63
Responsible not found	1	2	7	5	48	63
Exceeded contact attempts	6	2	5	2	37	52
Off target	3	0	17	4	23	47
Did not want to answer the research	0	0	1	1	28	30
Inactive	2	0	4	0	21	27
No contact phone	0	0	5	2	4	11
Changed of activity	0	0	0	0	11	11
Total unqualified	12	4	39	14	172	303

Source: Research Data – Ting Ação Ambiental.

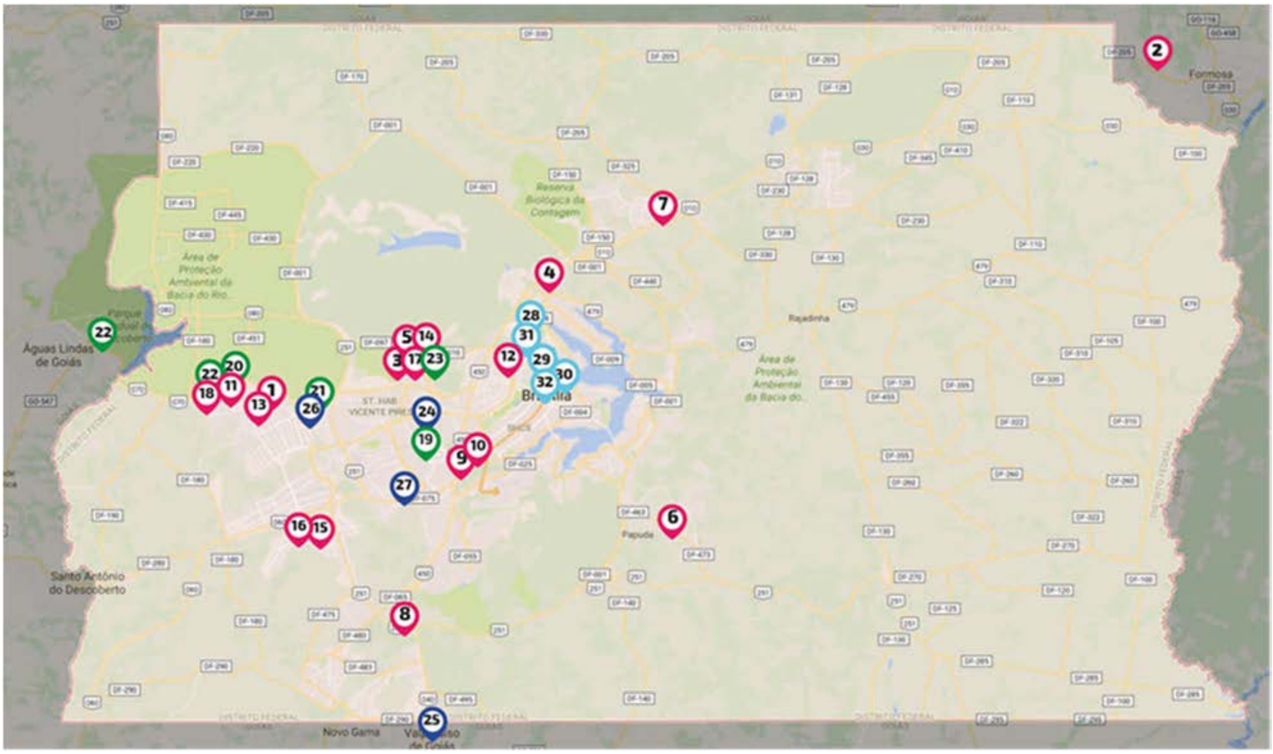
Table - Number of interviews by segments.

Interviewed Segments	Brasília and Surroundings
Cooperatives	18
Recyclers	5
Non-governmental organizations	4
Government Organizations	5
Retailers	31
Total*=	**63**

* Not including those who did not respond.

Source: Research Data – Ting Ação Ambiental.

Organizations working in the recycling chain:



COOPERATIVES:

- 1. Associação Recicle a Vida
  Qnm 28 Módulo B, Área Especial Ceilândia Norte - DF
- 2. Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa
  GO 430, km 5, aterro sanitário, Zona Rural, Formosa – GO
- 3. Cooperativa de Produção Artesanal e Industrial do DF (Sonho de Liberdade)
  Q 04, Conjunto C, Lote 44, Vila Estrutural, Guara, Brasília – DF
- 4. Central de Reciclagem do Varjão (CRV)
  Vila Varjão do Torto, Setor de Habitações Individuais Norte – DF
- 5. Cooperativa COOPERE
  Quadra 7, Setor Oeste, V. Estrutural – DF
- 6. Cooperativa de Trabalho Ecolimpo
  Quadra 1, Conj. 1, Bonsucesso, S. Sebastião, Brasília – DF
- 7. Cooperativa de Reciclagem Ambiental (Cooperdife)
  Área Especial P, Lote 3 a 6, Ste Sobradinho, Distrito Federal – DF
- 8. R3 Cooperativa de Catadores de Santa Maria
  Quadra 517/518, Área Especial, Sta Maria Norte – DF
- 9. Associação de Recicladores Resíduos Sólidos da Candangolândia
  Quadra Qro A, Conjunto VC, Candangolândia – DF
- 10. Associação de Catadores Pre-Cooperativa Recicla Mais Brasil
  Quadra Qro A, Conjunto VC, Candangolândia –DF
- 11. Catamare Cooperativa dos Catadores de Materiais Recicláveis do DF
  Setor de Industrial 01, Quadra 04, Lote 37, A 39 – DF

- 12. Associação dos Catadores de Materiais Recicláveis do DF
  Sgon Q. 05, Lote 23, Dl Norte – DF
- 13. Associação Pré-Cooperativista dos Catadores e Recicladores de Resíduos Sólidos de Cinelândia (APCORC)
  Qnb 28 - Área Especial S/N- Usina de Lixo - DF
- 14. Cooperativa de Trabalho de Reciclagem Ambiental (CONSTRUIR)
  Quadra 4, Conj 02, Casa 18, Setor Oeste, Estrutural - DF
- 15. Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas
  Avenida Monjolo, Quadra 300, Setor de Chácaras, Recanto das Emas – DF
- 16. Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos (Reciclo)
  AE próximo Q. 301, Cidade dos Meninos - DF
- 17. Cooperativa de Reciclagem Ambiental da Cidade Estrutural (COORACE)
  Estrutural, Aterro do Jóquei - DF
- 18. Cooperativa de Coleta Seletiva de Material Reciclável com Formação de Educação Ambiental (FÊNIX)
  Qi5, Setor de Industria, Gama Distrito Federal - DF

RECYCLERS:

- 19. Zero Impacto Organização Logística de Cargas Ltda
  Qe 40, Rua 12, Lote 09, Polo de Modas, Guará II - DF
- 20. DMS Recicláveis Ambientais Ltda - Epp
  Quadra 05, Lote 61 E, 63, Setor de Materiais de Construção, Ceilândia – DF
- 21. Reciclagem Rio Campos Ltda - Me
  Lote 36/37/38, QI 6 Setor Industrial, Taguatinga, Distrito Federal – DF
- 22. Nasa Serviços de Logística Ltda. Me (Nasa Recycle)
  Q Quadra 8, LT 82, Setor Industrial, Ceilândia - DF e BR 070, 2,5 KM, Jardim das Oliveiras, Águas Lindas de Goiás - GO
- 23. Capital Indústria e Comércio de Produtos Recicláveis Ltda
  SCIA, Quadra 09, Conjunto 01, Lote 01, Cidade Automóveis, Brasília - DF

NON-GOVERNMENTAL ORGANIZATIONS:

- 24. Comitê para Democratização da Informática DF e Entorno
  Qe 40, Rua 12, Lote 09, St Diversões Sul, Asa Sul, Brasília - DF
- 25. Programando o Futuro
  Área Especial, Quad 34, Lote 2, Valparaíso I, Valparaíso de Goiás - GO
- 26. Associação de Apoio a Família ao Grupo e a Comunidade de Brasília - DF
  Q QI 06, LOTES 20, 40,60 e 80, Brasília - DF
- 27. Serviço Social da Indústria da Construção Civil do Distrito Federal
  SPLM, Conjunto, 3, Setor Placa da Mercedes, Núcleo Bandeirante - DF

GOVERNMENT ORGANIZATIONS:

- 28. Secretaria de Recursos Hídricos e Ambiente Urbano (Ministério do Meio Ambiente)

SEPN 505, Lote 02, Bloco B, Edifício Marie Prendi Cruz, Brasília - DF

- 29. Agência Brasileira de Desenvolvimento Industrial (ABDI)
  SCN Quadra 1, Bloco D, Ed. Vega Luxury Offices, Asa Norte, Brasília - DF
- 30. Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC)
  Esplanada dos Ministérios Bloco J, Zona Cívico, Administrativa, Brasília - DF
- 31. Secretaria de Estado do Meio Ambiente (Sema) do Distrito Federal
  Sepn Quadra 511, Bloco A, Ed. Bittar, Bairro Asa Norte, Brasília – DF
- 32. Serviço de Limpeza Urbana (SLU) do Distrito Federal
  SCS Quadra 8, Bloco B, Lotes 50/60, Edifício Venâncio 2000, Brasília – DF

• Organizations Visited • Unvisited Organizations

RECIFE (PE) AND SURROUNDINGS

A total of 429 actors were identified in Recife (PE) and surrounding areas, and they effectively answered questionnaire 66 (see tables below).

Table - Research Rank.

Status	Cooperatives and Associations	Recyclers	Non-governmental organizations	Government Organizations	Retailers	Grand total
Interviewee	7	8	13	13	25	66
Responsible not found	3	3	5	3	104	118
Exceeded contact attempts	8	3	13	9	73	106
Did not want to answer the research	2	1	4	0	48	55
Inactive	8	2	6		26	42
Off target	9	3	13	1	0	26
Changed branch of activity	1	0	0	0	16	17
Total unqualified	**31**	**12**	**41**	**13**	**267**	**429**

Source: Research Data – Ting Ação Ambiental.

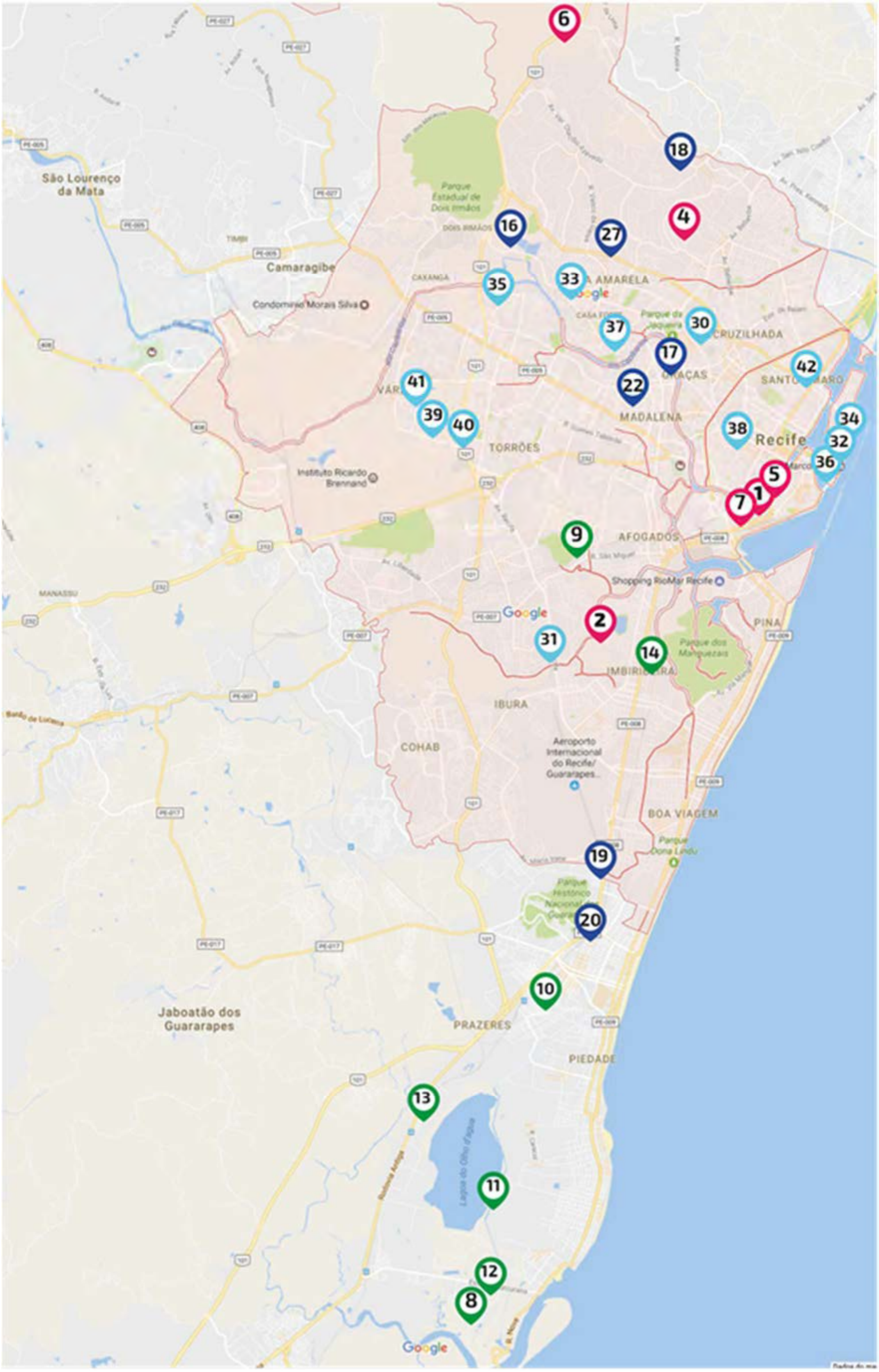
Table - Number of interviews by segments.

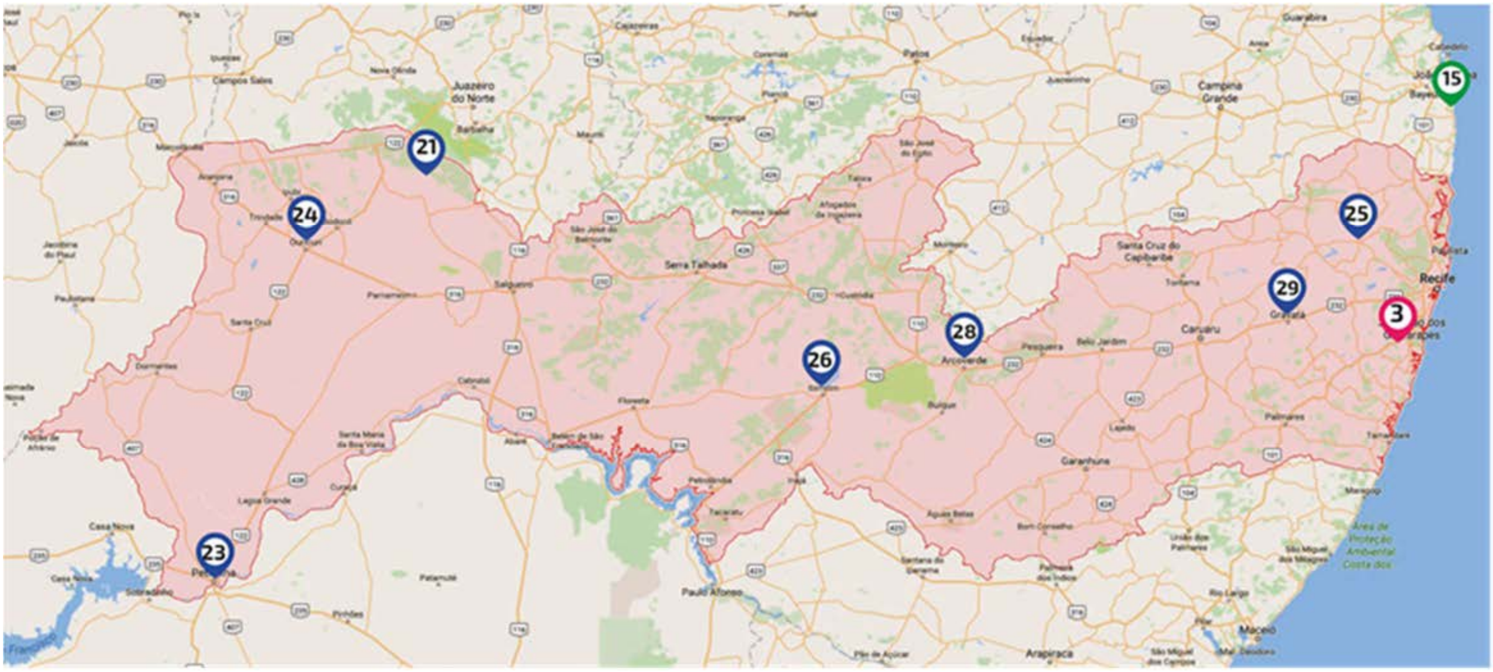
Interviewed Segments	Recife and surroundings
Cooperatives	7
Recyclers	8
Non-governmental organizations	13
Government Organizations	13
Retailers	25
Total*=	**66**

*Not including those who did not want to respond.

Source: Research Data – Ting Ação Ambiental.

Organizations working in the recycling chain:





COOPERATIVES:

1. Núcleo de Triagem de Catadores e Catadoras de Gusmão
   Travessa do Gusmão, 178, São José, Recife – PE
- 2. Pró-Recife Cooperativa de Catadores Profissionais do Recife
   Rua Antônio Cardoso da Fonte, 483, Imbiribeira, Recife – PE
- 3. Cooperativa Mista Serviços de Santo Agostinho (COMSERC)
   Rua Pedro Celso Uchôa Cavalcante, 59, Centro, Cabo de Santo Agostinho – PE
- 4. Associação de Catadores de Materiais Recicláveis (ACMR) Boa Esperança
   Praça Constantino Gomes, S/N, Centro, São José da Coroa Grande, Recife - PE
- 5. Cooperativa Esperança Viva
   Rua do Peixoto, 440, São José, Recife - PE
- 6.Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede
   Av. Padre Mosca de Carvalho (Vl. Confiança), 357, Guabiraba, Recife - PE
- 7. Associação de Catadores O Verde e Nossa Vida
   Avenida Sul, 1148, São José, Centro, Recife - PE

RECYCLERS:

- 8. Fênix Gerenciamento de Resíduos Eireli - Me
   Rua Guepardo, 77, Barra de Jangada, Jaboatão dos Guararapes - PE
- 9. Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda - Epp
   Rua São Miguel, 1895, Jiquiá, Recife - PE
- 10. DDX TECNOLOGIA (Descarte Já)
   Travessa 13 de Maio, 981, Cajueiro Seco, Jaboatão dos Guararapes - PE
- 11. Só Reciclagem do Nordeste Ltda - Epp
   Rua Lagoa do Náutico, 101, Prazeres, Jaboatão Dos Guararapes - PE
- 12. Jaidete Gomes dos Santos Reciclagem – Me (JG Reciclagem)

Rua Registro, Barra da Jangada, Jaboatão dos Guararapes - PE

- 13. Icarau Costa Serafim e Reciclagem - Me (Bumerangue Sucateiro)
  Rua Itaituba Prazeres, S/N, Lote 78, Jaboatão Guararapes, Recife - PE
- 14. Lorene Recife Comércio de Sucatas Ltda.
  Rua Artur Moura, 88, galpão CO3, Imbiribeira, Recife - PE
- 15. Ecobras Reciclagem e Resíduos Ltda.
  Alameda dos Beija Flores, 218, Conde - PB

NON-GOVERNMENTAL ORGANIZATIONS:

- 16. União Norte Brasileira de Educação e Cultura (UNBEC - CRC Marista)
  Rua Jorge Tasso Neto, 318, Apipucos, Recife - PE
- 17. Assistência e Promoção Social Exército de Salvação
  Rua Conde de Irajá, 108, Torre, Recife - PE
- 18. Associação dos Trapeiros de Emaús Recife
  Rua Mamede Coelho, 53, Dois Unidos, Recife - PE
- 19. Grupo de Apoio à Criança e Adolescente Rua Linha e Massangana
  Rua Santa Flora, 171, Prazeres, Jaboatão dos Guararapes - PE
- 20. Associação dos Moradores de Cariri-Mirim
  Rua Luiz Gonzaga, 246, Distrito Cariri Mirim, Centro, Moreilândia – PE
- 21. Lar do Neném
  Rua Menezes Drummond, 284, Madalena, Recife - PE
- 22. Associação dos Amigos do Petrape
  Av. da Integração, S/N, Gercino Coelho, Petrolina - PE
- 23. Caatinga
  Ouricuri - PE
- 24. Centro Social Paula Frassinetti
  Rua José Nasario Coutinho, 100, Bairro Novo, Carpina - PE
- 25. Serviço de Tecnologia Alternativa (SERTA)
  Açude Engenheiro Francisco Saboya, S/N, Zona Rural, Ibimirim - PE
- 26. Centro de Reabilitação e Valorização da Criança (CERVAC)
  Pça. do Morro da Conceição, 211, Casa Amarela, Recife - PE
- 27. Fundação Terra
  Rua Alfredo Souza Padilha, S/N, São Cristóvão, Arcoverde - PE
- 28. Obra e Defesa da Infância Pobre
  Faz Sampaio, S/N, Fazenda Sampaio, Gravata - PE

GOVERNMENT ORGANIZATIONS:

- 29. Secretaria de Meio Ambiente e Sustentabilidade (SEMAS)
  Avenida Conselheiro Rosa e Silva, 1339, Jaqueira, Recife - PE
- 30. Empresa de Manutenção e Limpeza Urbana (EMLURB) do Recife
  Avenida Recife, 3587, Areias, Recife - PE
- 31. Secretaria de Meio Ambiente e Sustentabilidade (SMAS) do Recife
  Avenida Marquês de Olinda, 222, Recife - PE

- 32. Fundação Joaquim Nabuco (FUNDAJ)
  Av. Dezessete de Agosto, 2187, Casa Forte, Recife - PE
- 33. Parque Tecnológico de Eletroeletrônicos e Tecnologia Associada (PARQTEL)
  Rua Vital de Oliveira, 32, Bairro do Recife, Recife - PE
- 34. Secretaria das Cidades (SECID)
  Rua Estradas do Barbalho, 889-A, Iputinga, Recife - PE
- 35. Núcleo de Gestão do Porto Digital
  Avenida Cais do Apolo, 222, Bairro do Recife, Recife - PE
- 36. Agência Estadual do Meio Ambiente (CPRH)
  Rua Santana, 367, Casa Forte Recife - PE
- 37. Agência Estadual de Planejamento e Pesquisa de PE (Condepe/Fidem)
  Rua das Ninfas, 65, Boa Vista, Recife – PE
- 38. Instituto de Tecnologia de Pernambuco (ITEP)
  Avenida Professor Luiz Freire, 700, Cidade Universitária, Recife - PE
- 39. Centro de Tecnologias Estratégicas do Nordeste (CETENE)
  Avenida Professor Luiz Freire, 01, Cidade Universitária, Recife - PE
- 40. Grupo de Resíduos Sólidos (GRS) da Universidade Federal de Pernambuco (UFPE)
  Avenida Acadêmico Hélio Ramos, S/N, Cidade Universitária, Recife - PE
- 41. Federação das Indústrias do Estado de Pernambuco
  Avenida Cruz Cabugá, 767, Santo Amaro, Recife - PE

• Organizations Visited • Unvisited Organizations

INDUSTRIAL SECTOR

Interviewed Segment	National Level
Industry	23
Total*=	**23**

*(9) interviewed and (14) Secondary data - internet search.

Source: Research Data – Ting Ação Ambiental.

The list of actors for conducting telephone interviews was initially elaborated on online search sites. In addition, indications were drawn from some of the interviewees when contacted and also through the acquisition of databases of qualified companies, involving the category of economic activity and having as reference the National Classification of Economic Activities (CNAE).

4. Summary of statistical data collected, including graphical representations and tables

4.1 Results of the Brasília Region and Surroundings

The sampling of the Brasília region totaled 63 interviews, segmented by the selected institutions:

• Cooperatives and Associations
• Recyclers
• Non-Governmental Organizations
• Government Organizations
• Retailers

When mapping the manufacturers in the regions of Brasília, it was verified the presence of branches and / or distributors of electrical and electronic equipment. The orientation of the heads of these subsidiaries was to contact the headquarters, since the procedures are standardized for the whole national territory and they have the data and strict control of all the regions.

4.1.1 Cooperatives and Associations

The data collection of the Cooperatives and Associations was carried out through telephone interviews and selected to be understood as having the potential to function as a center for the consolidation and / or re-characterization of WEEE.

Sampling included 18 cooperatives and associations interviewed:

COOPERATIVES AND ASSOCIATIONS[15]	ADDRESS	RESPONSIBLE
1.Associação Recicle a Vida	Qnm 28 Módulo B - Área Especial Ceilândia Norte - DF	Ana Carolina Martins
2.Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa	Go 430, km 5, Aterro Sanitário - Zona Rural, Formosa - GO	Flavisneide Rocha

[15] Infoplex. Available at: https://www.infoplex.com.br/. Accessed on April 28, 2017.

3.Cooperativa de Produção Artesanal e Industrial do DF - Sonho de Liberdade	Q 04 Conjunto C Lote, 44, Vila Estrutural, Guara, Brasília - DF	Fernando Figueiredo
4.Central de Reciclagem Do Varjão (CRV)	Vila Varjão do Torto Setor de Habitações Individuais Norte – DF	Ana Carla Rodrigues
5.Cooperativa Coopere	Quadra 7 Setor Oeste (V. Estrutural) – DF	Adriana Alves Soares
6.Cooperativa de Trabalho Ecolimpo	Quadra 1 Conj. 1 Bonsucesso (S. Sebastião), Brasília - DF	Joao Hildebrando Santana Gomes e Gabriela Paes Landim Da Silva
7.Cooperativa de Reciclagem Ambiental - Cooperdife	Área Especial P - Lote 3a6 -Ste Sobradinho, Distrito Federal – DF	Gilmar Clementino da Silva
8. R3 Cooperativa de Catadores de Santa Maria	Quadra 517/518 - Área Especial - Sta Maria Norte – DF	Vilany Freitas de Sousa Filha
9.Associação de Recicladores Resíduos Sólidos da Candangolândia	Quadra Qro A Conjunto VC - Candangolândia – DF	Moyzeis Silva de Carvalho
10.Associação de Catadores Pré Cooperativa Recicla Mais Brasil	Quadra Qro A Conjunto VC Candangolândia – DF	Cristiane Pereira de Brito
11.Catamare Cooperativa dos Catadores de Materiais Recicláveis do Distrito Federal	Setor de Industrial 01 - Quadra 04 - Lote 37 - A 39 – DF	Antônia Cardoso Abreu
12.Associação dos Catadores de Materiais Recicláveis do Distrito Federal	Sgon Q. 05 Lote 23 Dl Norte – DF	Roque Moreira de Almeida Filho
13.Associação Pré-cooperativista dos catadores e recicladores de resíduos sólidos de Cinelândia/DF (APCORC) Ltda.	Qnb 28 - Área Especial S/N- Usina de Lixo – DF	Cleia Regina Lopes Conde
14.Cooperativa de Trabalho de Reciclagem Ambiental - CONSTRUIR	Quadra 4 Conj 02 - Casa 18 - Setor Oeste - Estrutural - DF	Zilda Fernandes de Souza
15.Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas	Avenida Monjolo- Quadra 300 - Setor De Chácaras - Recanto das Emas – DF	Assis Linhares
16.Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	AE Próximo Q. 301 Cidade dos Meninos – DF	Nivea Sousa da Trindade
17.Cooperativa de Reciclagem Ambiental da Cidade Estrutural - Coorace	Estrutural, Aterrro do Jóquei – DF	Lucia Fernandes do Nascimento

18.Cooperativa de Coleta Seletiva de Material Reciclável com Formação de Educação Ambiental – Fênix.	Qi5- Setor de Industria - Gama Distrito Federal – DF	Raimunda Alves Ribeiro

Source: Research Data – Ting Ação Ambiental.

During the interviews, information was collected on the work of cooperatives and associations in a broad way.

Of the 18 institutions interviewed, it was observed that 11 act with at least ten of the target items of this research. The 7 cooperatives that do not work with any type of WEEE were not considered, that is, 11 institutions were qualified.

We applied questions with focus on the performance of each instution regarding to the electro-electronic residues and it was identified what types of WEEE these cooperatives and associations act:

COOPERATIVES AND ASSOCIATIONS	Brown Line		White Line		
	TV (CRT)	TV (Flat)	Refrigerator and Freezer	Washing Machine	Air-Conditioner
1.Associação Recicle a Vida	No	No	Yes	Yes	Yes
2.Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa	Yes	Yes	Yes	Yes	Yes
3.Cooperativa de Produção Artesanal e Industrial do DF - Sonho de Liberdade	Yes	Yes	Yes	Yes	Yes
4.Central de Reciclagem Do Varjão (CRV)	No	Yes	Yes	Yes	Yes
5.Cooperativa de Reciclagem Ambiental - Cooperdife	No	Yes	No	Yes	Yes
6. R3 Cooperativa de Catadores de Santa Maria	No	Yes	Yes	Yes	Yes
7.Catamare Cooperativa dos Catadores de Materiais Recicláveis do Distrito Federal	Yes	Yes	Yes	Yes	Yes
8.Associação dos Catadores de Materiais Recicláveis do Distrito Federal	Yes	Yes	Yes	Yes	Yes
9.Cooperativa de Trabalho de Reciclagem Ambiental - CONSTRUIR	Yes	Yes	Yes	Yes	Yes
10.Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas	Yes	No	Yes	Yes	Yes
11.Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	Yes	Yes	Yes	Yes	Yes

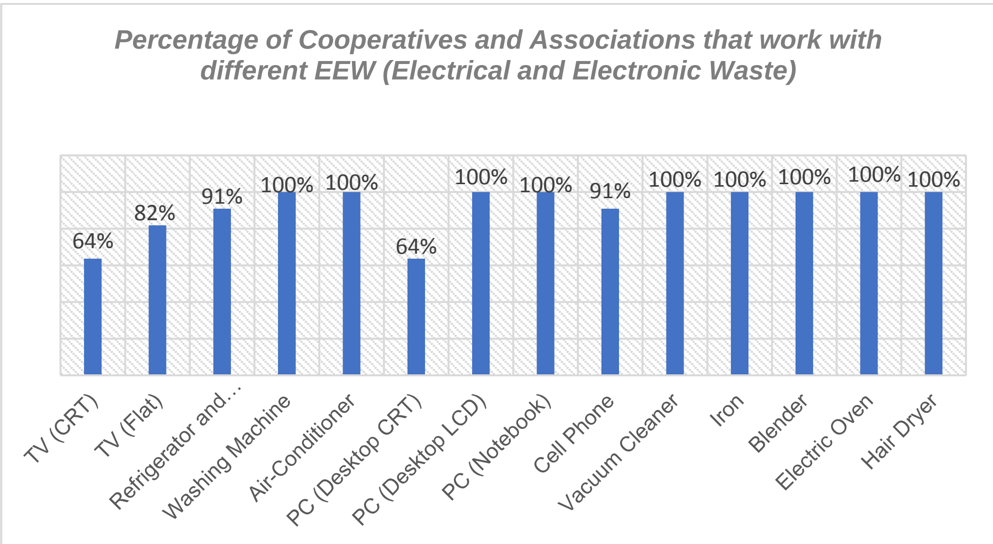
	Green Line	Blue Line

COOPERATIVES AND ASSOCIATIONS	PC (Desktop CRT)	PC (Desktop LCD)	PC (Notebook)	Cell Phone	Vacuum Cleaner	Iron	Blender	Electric Oven	Hair Dryer
1.Associação Recicle a Vida	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
2.Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3.Cooperativa de Produção Artesanal e Industrial do DF - Sonho de Liberdade	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4.Central de Reciclagem Do Varjão (CRV)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5.Cooperativa de Reciclagem Ambiental – Cooperdife	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. R3 Cooperativa de Catadores de Santa Maria	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7.Catamare Cooperativa dos Catadores de Materiais Recicláveis do Distrito Federal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8.Associação dos Catadores de Materiais Recicláveis do Distrito Federal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9.Cooperativa de Trabalho de Reciclagem Ambiental – CONSTRUIR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10.Cooperativa de Coleta Seletiva e	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas									
11.Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	Yes	Yes	Yes	Yes	Yes	Ye s	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental.

It is observed the percentage of cooperatives and associations that work with the different WEEE:



Source: Research Data – Ting Ação Ambiental.

They show full performance in the blue line (100%); Followed by the white line (97%); The green line (90.9%); And the brown line (72.7%). Percentage of these cooperatives that work with each line of electronics:

COOPERATIVES AND ASSOCIATIONS	Percentage of Cooperatives and Associations that work with each line of electronics
Brown Line	72,7%
White Line	97,0%
Green Line	90,9%
Blue Line	100,0%

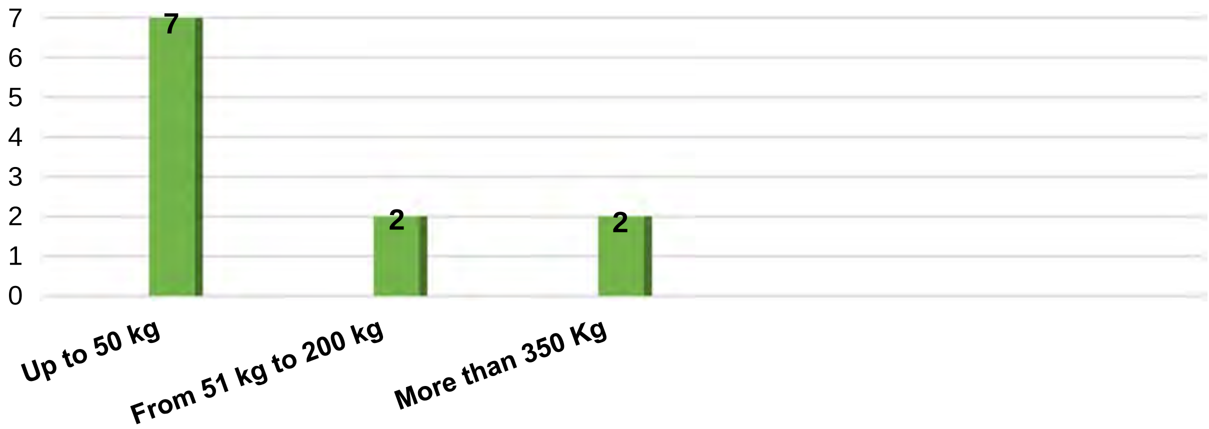
Source: Research Data – Ting Ação Ambiental.

These cooperatives are part of the raw materials for recycling market and their activities involve the receipt of products that are no longer useable, disassemble and separation of the products into raw materials that are marketed until they reach the industries that will reuse such waste in the recycling process. The waste used in this market comes from the sources of recyclable materials collected by these institutions, including schools, public bodies, individuals, private companies, associations and cooperative partners or informal disposal.

It was identified, through the research, that there is a lack of adequate infrastructure for the collection, dismantling, de-characterization and storage of the electro-electronic waste in most of the cooperatives located in Brasília (DF) and surroundings.

Regarding to the monthly quantity collected, an exact amount was not quoted, the data indicate that there is no regular collection of electro-electronic waste carried out by these cooperatives and in some months they receive a larger amount and in others not so much.

Approximate monthly quantities collected and most frequent



Source: Research Data – Ting Ação Ambiental

After screening, WEEE are generally sold to recyclers, but there is also sale to middlemen, who buy the waste directly from the collectors, for a lower price, in order to collect a greater amount to be sold, for a higher price, for recycling companies. This is not interesting for associations, since they do not have adequate capacity and infrastructure, they do not collect enough WEEE and other waste to sell directly to recycling companies, thus earning a higher profit.

The activities of harvesting and commercialization, developed by these organizations, are carried out, in most cases, in precarious and unhealthy conditions. Scavengers are still faced with a work environment fraught with difficulties. These are coupled with the difficulty of working in group, managing and controlling production on a large scale, technical inability to process and add value to materials and the expansion and diversification of their products. This group ends up restricting their performance and restraining the increase of income, which impels them to the informal market, having their sales restricted to the middlemen.

These conditions contribute to the failure of taking advantage of the full potential contained in recyclables. Today, the work done by the scavengers is restricted to sorting the materials. This situation impedes the evolution of the sector, but it can also provide an opportunity for the creation of promising solidary economic enterprises such as the activity itself with the WEEE.

It was mentioned by some interviewees the pioneering initiative of the GEA Institute, in partnership with Lassu - Laboratory of Sustainability of Poli-USP, and sponsorship of Caixa Econômica, the Legal Disposal Project that aims to include collectors' cooperatives into the reverse chain logistics of electronic waste, creating opportunities and solving the problem of city halls and companies. In this project, cooperatives of waste pickers are trained in the correct treatment of waste electrical and electronic equipment (a course developed with a technical partnership of CEDIR-USP), and there is a follow-up of the implementation of the techniques in the partner cooperatives: from withdrawal of donations to commercialization to certified companies.

The project operates in 11 Brazilian capitals, including Brasília. At the current stage, Legal Disposal Project has been promoting partnerships among cooperatives, companies and public agencies.

Regarding the licensing, the body responsible is the IBRAM - Brasília Environmental Institute and today no cooperative of the Federal District has an environmental license, but the Cooperative of recyclers Recicle a Vida and the Cooperative Sonho de Liberdade, both interviewed, are in the licensing process. The licensing fee increased from R$ 900.00 to R$ 18,000.00, and there is a lot of bureaucracy and the documentation takes years to analyze, a fact that is mentioned by most of the interviewees. Cooperative Recicle a Vida has already filed an application and the cooperative has a business license.

Of the cooperatives interviewed, 16.7% expressed an interest in functioning as a future center for the consolidation of WEEE (receiving and storing for future shipment for the removal and appropriate processing) of a Project to Improve the ERWL in Brazil.

4.1.2 Recyclers

The data collection of the recycling companies was carried out through telephone interviews and selected those that were considered to have the potential to function in the future as a center for consolidation and / or re-characterization of WEEE.

The sample included 5 interviewed recycling companies:

RECYCLER	ADDRESS	RESPONSIBLE
1.Zero Impacto Organização Logística de Cargas Ltda	Qe 40, Rua 12, Lote 09 – Polo de Modas, Guará II - DF	Gustavo Noleto e Silva Bertolino
2.DMS Recicláveis e Serviços Ambientais Ltda - Epp	Quadra 05 Lote 61 E, 63, Setor de Mat. de Construção, Ceilândia – DF	Gilvander Oliveira
3.Reciclagem Rio Campos Ltda - Me	Lote 36/37/38, QI 6 Setor Industrial, Taguatinga, Distrito Federal – DF	João Geraldo de Campos

4.Nasa Serviços de Logística Ltda - Me	Q Quadra 8, LT 82, Setor Industrial, Ceilândia - DF e BR 070, 2,5 KM - Jardim das Oliveiras, Águas Lindas de Goiás - GO	Fernando J. de Morais e Antônio Crisóstomo Filho
5.Capital Indústria e Comércio de Produtos Recicláveis Ltda	SCIA, Quadra 09 Conjunto 01, Lote 01, Cidade Automóveis, Brasília - DF	Jorge Ribeiro

Source: Reseach Data – Ting Ação Ambiental.

It was observed that the 5 companies interviewed act with at least three of the target items of this research. We applied questions with focus on the performance of each instuition in regards to the electro-electronic residues. It was identified the types of WEEE that recycling companies act on:

RECYCLER	Brown Line		White Line		
	TV (CRT)	**TV (Flat)**	**Refrigerator and Freezer**	**Washing Machine**	**Air-Conditioner**
1.Zero Impacto Organização Logística de Cargas Ltda	Yes	Yes	No	Yes	No
2.DMS Recicláveis e Serviços Ambientais Ltda – Epp	No	No	No	No	No
3.Reciclagem Rio Campos Ltda – Me	Yes	Yes	Yes	Yes	Yes
4.Nasa Serviços de Logística Ltda – Me	Yes	Yes	Yes	Yes	Yes
5.Capital Indústria e Comércio de Produtos Recicláveis Ltda	Yes	Yes	Yes	Yes	Yes

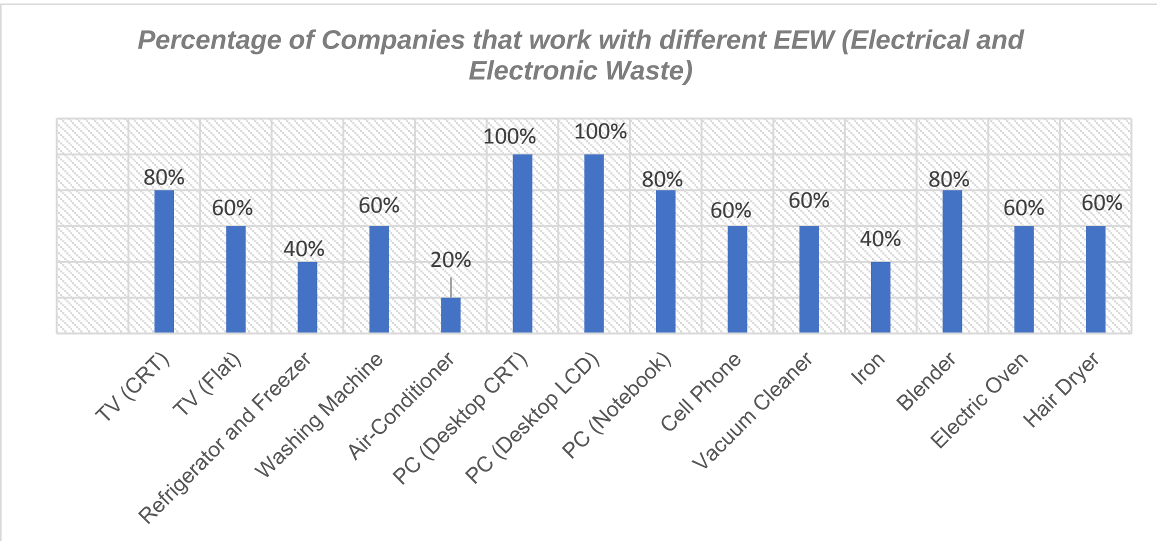
Source: Research Data – Ting Ação Ambiental

RECYCLER	Green Line					Blue Line			
	PC (Desktop CRT)	**PC (Desktop LCD)**	**PC (Notebook)**	**Cell Phone**	**Vacuum Cleaner**	**Iron**	**Blender**	**Electric Oven**	**Hair Dryer**
1.Zero Impacto Organização Logística de Cargas Ltda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.DMS Recicláveis e Serviços	Yes	Yes	Yes	No	No	No	No	No	No

Ambientais Ltda - Epp									
3.Reciclagem Rio Campos Ltda - Me	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
4.Nasa Serviços de Logística Ltda - Me	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
5.Capital Indústria e Comércio de Produtos Recicláveis Ltda	Yes	Yes	No	No	No	No	Yes	No	No

Source: Research Data – Ting Ação Ambiental

It is observed the percentage of recycling companies that work with the different WEEE:



Source: Research Data – Ting Ação Ambiental

They present greater performance in the green line (80%); Followed by the brown line (70%); Then the blue line (60%); And the white line (40%). Percentage of these recycling companies that work with each line of electronics:

RECYCLER	Percentage of Recycling Companies that work with each line of electronics
Brown Line	70,0%
White Line	40,0%
Green Line	80,0%
Blue Line	60,0%

Source: Research Data – Ting Ação Ambiental

Most of these companies are part of the raw materials for recycling market and their activities involve the collection and reception of products that are no longer in use, the disassembly and separation of products in raw materials that are marketed until they reach the Industries to reuse these waste in the recycling process.

And a smaller percentage presents as main activities the:

- ✓ COLLECTION AND TRANSPORT of Electric and Electronic residues*;
- ✓ DESMANUFATURE of Electric and Electronic Equipment;
- ✓ RE-CHARACTERIZATION of hard disks and any equipment capable of storing information, with the issuance of a verifying report;
- ✓ FINAL DESTINATION with duly licensed partners;
- ✓ TRACEABILITY of all treated material;
- ✓ DESTINATION CERTIFICATE for collected waste;
- ✓ CONSULTING IN THE MANAGEMENT OF ELECTRO-ELECTRONIC RESIDUES.

The number of employees in these companies ranges from 4 to 250 employees. Using as a criteria the number of employees it can be said that in terms of the size of the company, two companies are microenterprises, two are small companies and one is a large company.

Company	Company´s Size	Number of Employees
Capital Indústria e Comércio de Produtos Recicláveis Ltda	Large	100+
-	Medium	From 50 to 99
DMS Reciclaveis e Serviços Ambientais Ltda - Epp e Nasa Serviços de Logística Ltda – Me	Small	From 10 to 49
Zero Impacto Organização Logística de Cargas Ltda e Reciclagem Rio Campos Ltda - Me	Micro	Up to 9

Source: Adapted from SEBRAE

The companies have vehicles for the collection of WEEE, such as trucks and small trucks.
It was presented by the interviewees that the waste used in this market comes from the sources of recyclable materials collected by these institutions or from the collection of informal waste pickers in homes, technical assistance, city hall, junk yard / scrapper and organizations. The sale of these materials is made for NGO's (reconditioning), recycling industry and for remanufacturing companies.
It was identified through the research that all the companies involved in this interview have adequate infrastructure for the collection, dismantling, de-characterization and temporary storage of electrical and electronic waste.
In regards to the monthly quantity collected, this varies between 1 and 10 tons, an exact quantity was not quoted, but in the majority (60%), there are accounting records of the incoming operations of WEEE and exit of materials and tailings.
The interviewees affirmed to have licenses, including the Environmental License of Instituto Brasíla Ambiental - IBRAM; Registration IBAMA, registration in the Regional Council of Engineering - CREA; Registration in the Regional Council of Chemistry - CRQ. One of the companies included in this research, based in Águas Lindas de Góias (GO), is in the process of licensing in the municipal environmental agency of the municipality (see Resolution nº 26/2013), of projects whose activities are included in the Sole Annex to Resolution CEMAM No. 2 from July 29, 2016, among them, the storage, commercialization and / or recycling of metallic scrap; Storage and commercialization of machinery and equipment, assembly, repair or maintenance of industrial and commercial machines, equipment and electrical and electronic equipment; Sorting and storage of recyclable waste for commercialization; among others.
They presented as difficulties for the business expansion the interference of the informal market, lack of receivers, absence of skilled labor, knowledge and investment of the public power.
The interviewees are interested in functioning as a future center for the consolidation of WEEE (receiving and storing for future disposal and appropriate processing) and as a future WEEE re-characterization plant (re-characterization of household appliances including refrigerators and air conditioning containing CFC gases) of a Project to Improve the EWRL in Brazil.

4.1.3 Non-Governmental Organizations

As far as government organizations were concerned, 3 NGOs were interviewed. The data collection of these institutions was carried out through telephone interviews and selected to be understood as having the potential to function in the future as a center for the consolidation and / or re-characterization of WEEE.

During the interviews, information was collected on the work of non-governmental organizations and social assistance in a broad way, and also more specific questions related to the reverse logistics of WEEE were applied.

Respondents reported acknowledging the great responsibility in correct disposal and social responsibility, moreover, would like to have financial recognition of the public power as service providers.

Sampling included 4 non-governmental organizations interviewed:

NON-GOVERNMENTAL ORGANIZATIONS	ADDRESS	RESPONSIBLE
1.Comitê para Democratização da Informática no DF e Entorno	Qe 40, Rua 12, Lote 09 – St Diversões Sul, Asa Sul, Brasília –DF	Afrísio Pereira de Sousa
2.Programando o Futuro	Área Especial, Quad 34, Lote 2 - Valparaíso I - Valparaíso de Goiás – GO	Vilmar Simion e Adalberto R. do Vale
3.Associação de Apoio a Família ao Grupo e a Comunidade de Brasília / DF (equipment donation)	Q QI 06 LOTES 20, 40,60 E 80 - Brasília – DF	Zélia Victorino
4. Serviço Social da Indústria da Construção Civil do Distrito Federal	SPLM, Conjunto, 3, Setor Placa da Mercedes, Núcleo Bandeirante - DF	Geraldo Henrique Gomes

Source: Research Data – Ting Ação Ambiental.

It was observed that only 3 institutions work with at least 03 of the items targeted by this research, but the Associação de Apoio a Família ao Grupo e a Comunidade de Brasília (DF), which acts with the receipt and donation of PC (desktop - CRT and LCD) and PC (notebook) was disregarded, as it responded to having no interest in being a center of consolidation or re-characterization. The organization Serviço Social da Indústria da Construção Civil of the Federal District was disqualified because it does not act with any type of electronic waste.

We applied questions with focus on the performance of each instuition in regards to the electro-electronic residues. It was identified which types of WEEE that non-governmental organizations act on:

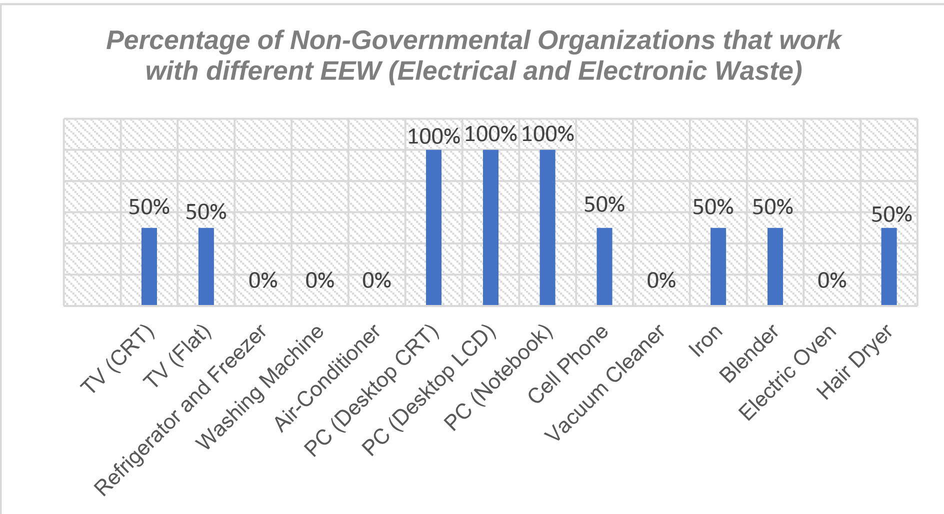
NON-GOVERNMENTAL ORGANIZATIONS	Brown Line		White Line		
	TV (CRT)	TV (Flat)	Refrigerator and Freezer	Washing Machine	Air-Conditioner
1.Comitê para Democratização da Informática no DF e Entorno	No	No	No	No	No
2.Programando o Futuro	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental.

NON-GORVERNMENTAL ORGANIZATIONS	Brown Line					Blue Line			
	PC (Desktop CRT)	PC (Desktop LCD)	PC (Notebook)	Cell Phone	Vacuum Cleaner	Iron	Blender	Electric Oven	Hair Dryer
1.Comitê para Democratização da Informática no DF e Entorno	Yes	Yes	Yes	No	No	No	No	No	No
2.Programando o Futuro	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes

Source: Research Data – Ting Ação Ambiental.

The percentage of non-governmental organizations working with different WEEE:



Source: Research Data – Ting Ação Ambiental.

They show greater performance in the green line (70%); Followed by the brown line (50%); The blue line (37.5%); And the white line with zero performance (0.0%). Percentage of these non-governmental organizations working with each line of electronics:

NON-GOVERNMENTAL ORGANIZATIONS	Percentage of Non-Governmental Organizations working with each line of electronics
Brown Line	50,0%
White Line	0,0%
Green Line	70,0%
Blue Line	37,5%

Source: Research Data – Ting Ação Ambiental

Most of the non-governmental organizations interviewed are working to strengthen civil society initiatives by encouraging the appropriate use of information and communication technologies. They use Informatics for the social transformation of communities and stimulate entrepreneurship, education and citizenship, aimed at the digital empowerment of young people.

The number of employees of these institutions is between 10 and 49, using as a criteria the number of employees can be said that regarding the size they fit into a small company.

It was informed by the interviewees that there is record and knowledge of the origin of the equipment being all material weighed and cataloged.

They work with the reuse of computers, computer equipment, segregation of parts and materials, recycling and correct disposal of electronic waste.

Parts and materials that are recoverable are either reused on site or sent to donation and tailings are sent for specific collection.

The WEEE processing capacity of these organizations is currently between 10 and 50 tons / month and can be expanded.

As for licensing the institutions are in compliance.

Two of the interviewees showed interest in functioning as a future WEEE consolidation center (receiving and storing for future shipment for dismantling and appropriate processing) and as a future WEEE re-characterization plant (re-characterization of household appliances including refrigerators and air conditioning containing CFC gases) of a Project to Improve the EWRL in Brazil.

4.1.4 Governmental Organizations

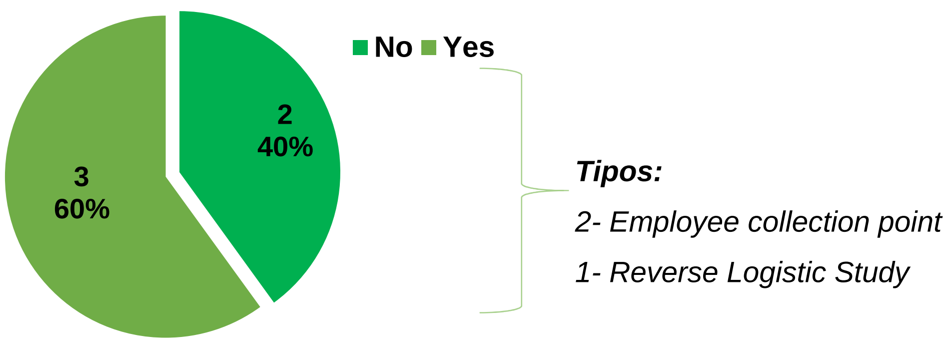
In the Federal District, 5 Government Organizations were interviewed:

GOVERNMENTAL ORGANIZATION	ADDRESS	RESPONSIBLE
1.Secretaria de Recursos Hídricos e Ambiente Urbano - Ministério do Meio Ambiente	SEPN 505 - Lote 02 - Bloco B - Edifício Marie Prendi Cruz, Brasília – DF	Ismael Pavani, Sabrina Andrade e Marília Viotti
2.Agência Brasileira de Desenvolvimento (ABDI)	SCN Quadra 1, Bloco D, Ed. Vega Luxury Offices, Asa Norte, Brasília – DF	Ricardo Martins
3.Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC)	Esplanada dos Ministérios Bloco J-Zona Cívico-Administrativa, Brasília – DF	Demétrio Fiorentino
4.Secretaria de Estado do Meio Ambiente do Distrito Federal (SEMA)	SEPN Quadra 511 Bloco A, C Ed. Bittar, Bairro Asa Norte, Brasília – DF	Leider Oliveira
5.Serviço de Limpeza Urbana do Distrito Federal (SLU)	SCS Quadra 8 Bloco B Lotes 50/60-Edifício Venâncio 2000, Brasília – DF	Francisco Jorge

Source: Research Data

We interviewed Government Organizations that are related to the WEEE theme, but when asked if they had a reverse logistics program, only 3 answered yes. Two of them presented WEEE collection points for employees and one is involved in studies related to the theme.

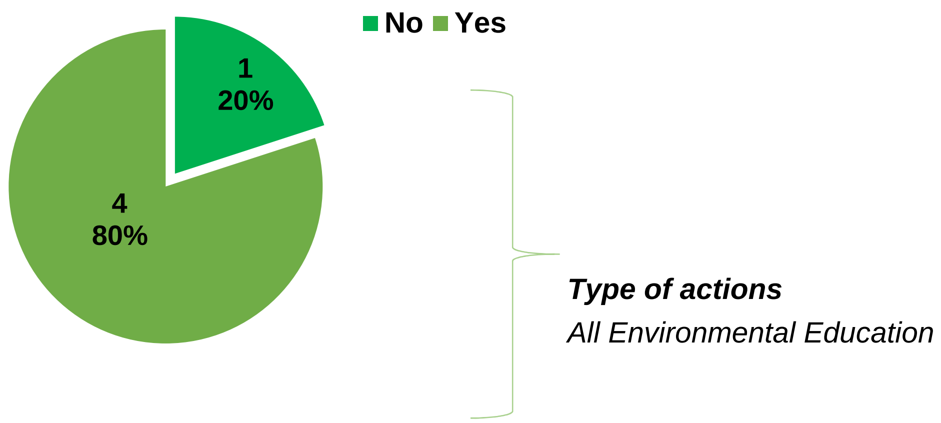
The Organization has a Reserve Logistics Program:



Source: Research Data – Ting Ação Ambiental

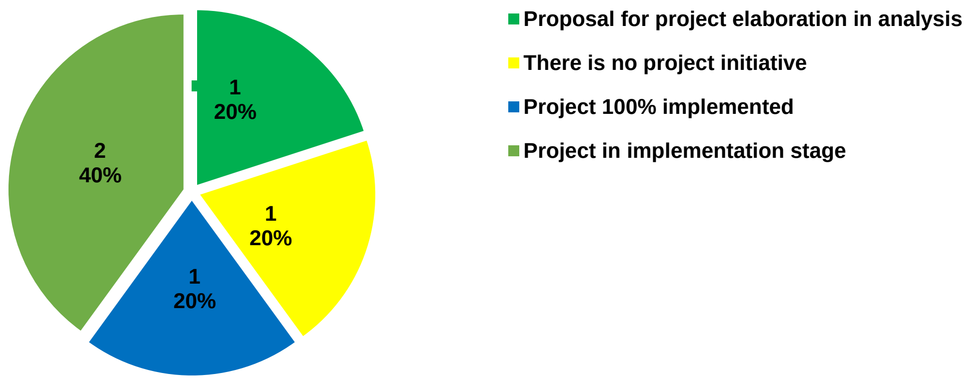
Regarding the development of socio-environmental actions, 80% practice environmental education actions and in regards to solid waste management, 40% answered that there is a socio-environmental education program / campaign related to non-generation, reduction, reuse, recycling, waste treatment and disposal and 60% said there were programs specifically involving WEEE.

The organization develops socio-environmental actions:



Source: Research Data – Ting Ação Ambiental.

Is there a program/campaign of Socio-environmental Education related to the management of solid waste, non-generation, reduction, reuse, recycling,treatment and final disposal environmentally adequate? Specifically programs involving WEEE:



Source: Research Data – Ting Ação Ambiental

Regarding possible partnerships with companies and / or institutions related to electro-electronic waste, 60% reported having a partnership, some of them with the National Confederation of Commerce of Goods, Services and Tourism (CNC), the Brazilian Association of the Electrical and Electronic Industry (ABINEE), the Brazilian Association for the Recycling of Electric Appliances and Appliances (ABREE) and International Organizations (JICA).

4.1.5 Retailers

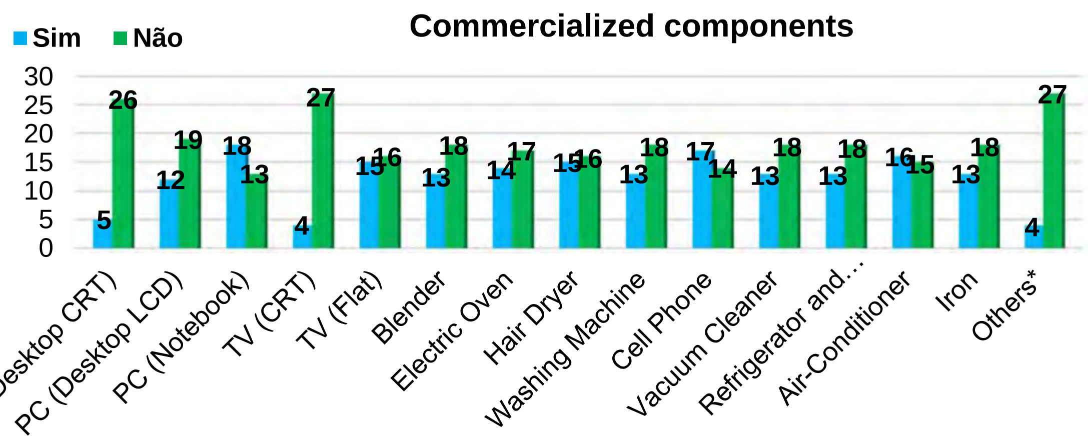
The surveys with retailers were conducted through telephone interviews. Sampling generated 31 interviews:

RETAILERS
1. Extra Companhia Brasileira De Distribuicao
2. Fast Shop S.A (Fast Shop - Shopping Iguatemi Brasília)
3. Pananorte Tecnologia Eletronica Ltda - Epp
4. Me Componentes E Equipamentos Eletrônicos Ltda (Me Componentes E Equipamentos Eletrônicos)
5. Nacional Tv Video Materiais Eletronicos Ltda - Me (Nacional Tv Video)
6. Walmart Brasil Ltda (Wal-Mart) – Loja 1
7. Companhia Brasileira De Distribuicao (Pão De Açúcar)
8. Fast Shop S.A (Fast Shop Comercial)
9. Polimport - Comercio E Exportacao Ltda (Polishop)
10. Oi Movel S.A. - Em Recuperacao Judicial (Oi)
11. LF Comercio De Celulares Ltda - Me (Vivo -World Cell)
12. LF Comercio De Celulares Ltda - Me (Vivo -World Cell/ Terraço Shopping)
13. Brasília Celulares Comercio De Celulares Ltda - Me (Tim - Brasília Celulares)
14. G&A Comercio De Informatica Eireli - Me (Netshop Informatica)
15. Condominio Vitrinni Shopping (Vitrinni Shopping)
16. CTIS Tecnologia S.A (Ctis)
17. Fujioka Eletro Imagem S.A (Fujioka)
18. Nova Casa Bahia S/A (Casas Bahia)
19. Mrf Comércio De Celulares E Serviços Ltda-Me (Samsung)
20. Universo Dos Cartuchos Empresas Ltda - Me (Universo Dos Cartuchos)
21. Ar Netto Comercio De Ar Condicionado Ltda - Epp (Ar Netto Refrigeracao)
22. Super Maia Supermercado Ltda (Super Maia -Loja Sudoeste)
23. Fast Shop S.A (Fast Shop - Park Shopping)
24. Silzeny Christiane Rodrigues Vieira 03894578173 (Informatica Do Junior)
25. Carlos Saraiva Importacao E Comercio S/A (Ricardo Eletro)
26. Eletronica Rpm Ltda - Me
27. Tronica Comercio De Eletronicos Eireli - Me (Tronica)

28.	Wal Mart Brasil Ltda (Wal-Mart) – Loja 2
29.	Silzeny Christiane Rodrigues Vieira 03894578173 (Informatica Do Junior)
30.	Panacopy Comercio De Equipamentos Reprograficos Ltda (Panacopy)
31.	Ag Eletronica Ltda – Me

Source: Research Data – Ting Ação Ambiental

The components marketed by the retailers involved in the interviews are indicated in the chart below:



Source: Research Data – Ting Ação Ambiental

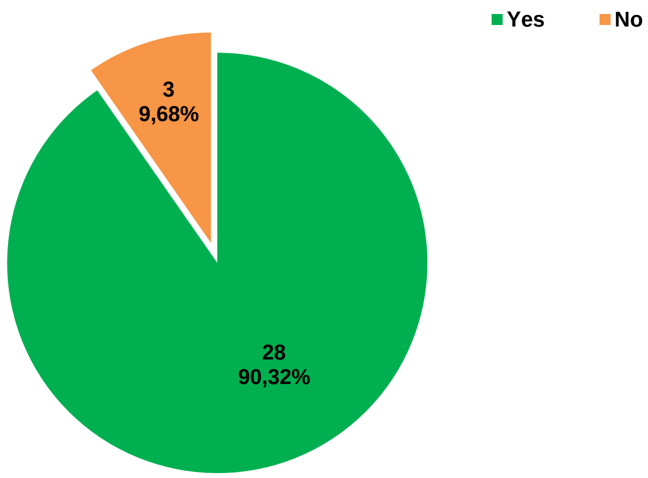
The products commercialized by these retailers related to the chain of electronic equipment by line of products are:

RETAILERS	Percentage of Retailers that commercialize each line of electronics
Brown Line	48,39%
White Line	51,61%
Green Line	58,06%
Blue Line	48,39%

Source: Research Data – Ting Ação Ambiental

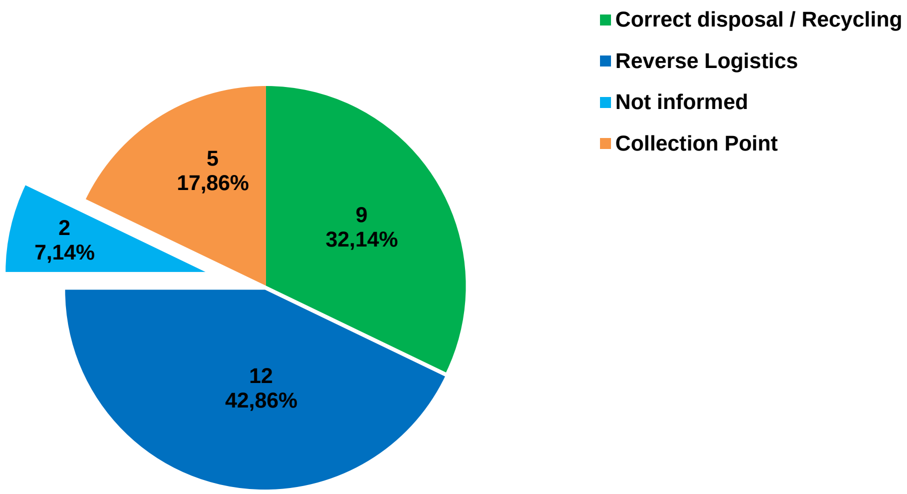
From the retailers interviewed, 90.32% developed environmental actions, among the actions are the operation as collection points, incentive to reverse logistics and correct discarding campaign for recycling, and 54.84% of the retailers that participated in this research carried out programs of other sectoral agreements (batteries) acting as collection point through collection box.

The company develops socio-environmental actions:



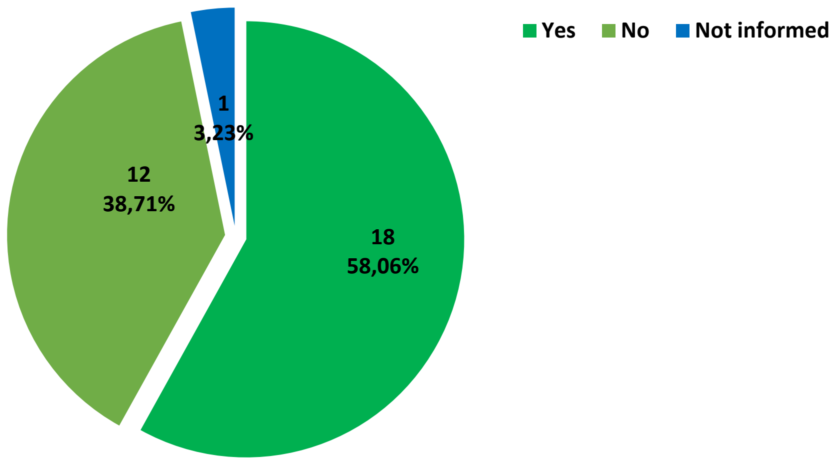
Source: Research Data – Ting Ação Ambiental

Actions:



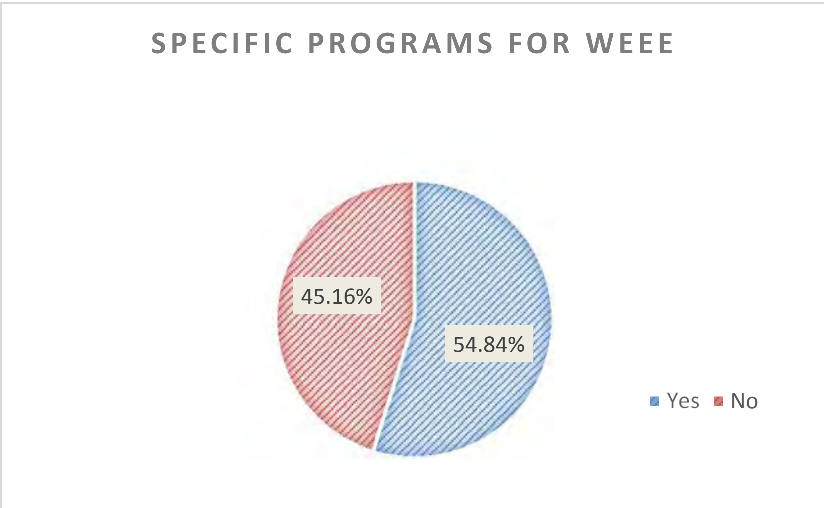
Source: Research Data – Ting Ação Ambiental

Run programs of other sectorial agreements (ie: batteries):



Source: Research Data – Ting Ação Ambiental

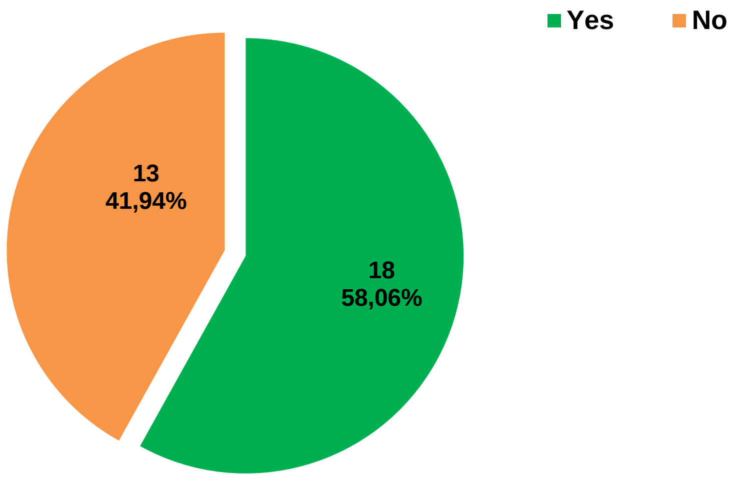
Regarding the specific programs related to reverse logistics, 54.84% said they had it.



Source: Research Data – Ting Ação Ambiental

When questioned about having a partnership, related to electro-electronic waste, with other companies, associations, cooperatives or if they participate in any state, municipal reverse logistics program, 58.06% answered yes.

Have partnerships with other companies related to WEEE, associations, cooperatives or take part on any municipal program of reverse logistics:



Source: Research Data – Ting Ação Ambiental

From the 18 retailers who answered affirmatively, 9 have industry partners - mobile telephony – (Ex: Motorola, Samsung, etc.) for these actions and 9 partnerships with recyclers.

The partnerships:

Institution	Type of partnership
Zero Impacto	COLLECTION AND TRANSPORT of electrical and electronic waste; DEMANUFATURE of electrical and electronic equipment; DE-CHARACTERIZATION of hard disks and any equipment capable of storing information, with issuance of a verifiable report; FINAL DESTINATION with duly licensed partners. What you get: computer, notebook, server, mouse, keyboard, sound box, cables and wires, HD, ram, processor, motherboard / other source boards, charger, printer, modem, router, hub, scanner, nobreak Telephone, video cassette, DVD player, video game, stereo, mp3 player, camera, small appliances: blender / mixer / coffee machine / toaster / electric oven / Etc., power tools: drill / screwdriver / sander / saw / monitor / TV, etc.
Empresa Leão de Judá	Not found, therefore, without further information.

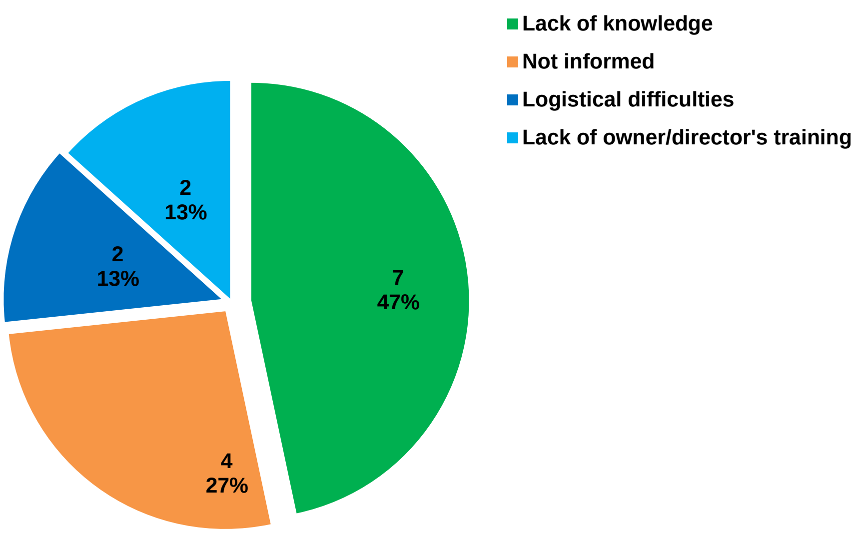
Novo Rio Papéis	Recyclable collection
Logística Reversa da Fast Shop	Back-to-cycle Sunscreen Program - FastShop (Proper Disposal of Computer Products). Program, where consumers can discard their old products such as notebooks, netbooks, desktops, monitors, keyboards and mice - regardless of the brand, model or store where they were purchased.
Mauro San - Sucatas de Eletrônicos	Collection of WEEE. Details not informed.
Programa da Panasonic e Abinee	The operation includes all portable batteries sold in the country, but with different treatments. Batteries received from brands that participate in the Abinee Receives Batteries (Alfacell, Bic, BRW, Carrefour, Duracell, Elgin, Energizer, Eveready, Kodak, Panasonic, Philips, Qualita, Rayovac, Pleomax, Sieger and SJC Ceras brands). There is no indication of how to make the collection available on the website.
Samsung	The brand has a partnership with Trocafone. Together, the companies act to give a new destination to used equipment, implementing a pioneering model in the Brazilian market. Consumers who want to switch old smartphones and tablets to more modern models can sell the old handsets - from any brand -, to the Trocafone, which offers a bonus on switching to new Samsung handsets. This can be done at one of all Samsung Stores or brand kiosks in the country. Https://www.oficinadanet.com.br/redirect.php?urlout=https://www.trocafone.com/
Tim	The TIM operator has a specific program to collect handsets at its service stations and mobile handsets. Programs Programs Reload the Planet and Potato Piles - http://www.tim.com.br/sp/sobre-a-tim/sustentabilidade/ambiental/sistema-de-colleta-de-celulares,-baterias-e-acessorios
Sony	The company's conscious disposal initiative refers only to batteries, which can be taken to authorized service stations or to the brand's own stores, but there is no indication of how to do the collection on the site. https://www.sony.com.br/electronics/eco/development-sustainable
LG	LG Reverse Logistics Program - It is possible to dispose of batteries, cell phones, electronic items and any type of junk that is not used by LG or any other brand. http://www.lg.com/br/suporte/coleta-seletiva Federal District: To find out more details call: 4004 5400 (capitals and metropolitan regions). Ar Netto Comércio de Ar Condicionado LTDA EEP Endereço: ST SHCGN CLR Quadra 709 Bloco B Loja - 46, Asa Norte Brasília CEP: 70750-512 Telefone: (61) 3340-1407

	E-mail: arnetto@arnetto.com.br Endereço: CND 02 - Lote 07, Loja 02, Taguatinga Norte Brasília CEP: 72120-025 Telefone: (61) 3021-8822 E-mail: nacionaltvvideo@uol.com.br Endereço: CLS 312 Bloco D LJ 24, Asa Sul Brasília CEP: 70365-540 Telefone: (61) 3245-2424 E-mail: eletronicarpm@terra.com.br
Nokia	There is no indication of how to collect on the site. And the website http://www.nokiatrocacomtroco.com.br does not load.

Source: Research Data – Ting Ação Ambiental.

When questioned about the reasons for not using these campaigns and services provided by manufacturers and / or recycling companies, respondents claimed lack of knowledge, information, training of employees and difficulty in logistics.

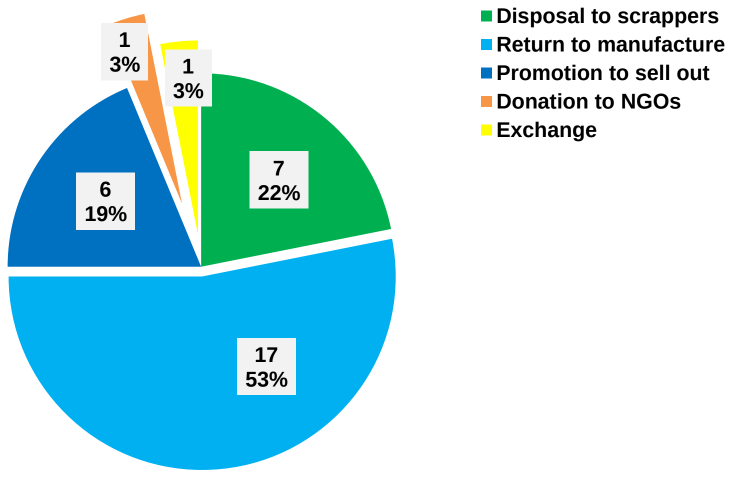
The reasons why not take advantage of the programs/campaigns' services:



Source: Research Data – Ting Ação Ambiental

Regarding the products offline and stored in the store through the warranty service and that the consumer did not return to fetch the product 53% is returned to the manufacturer.

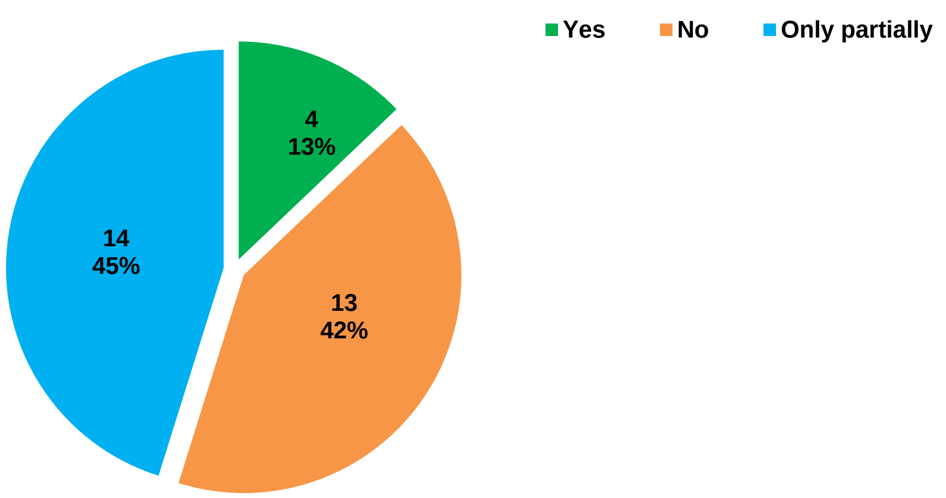
What is done to the out of date products and those left in the warranty service:



Source: Research Data – Ting Ação Ambiental.

And in regards to the knowledge about the National Solid Waste Policy 42% of respondents said they did not know, so they did not know about the requirement of reverse logistics for WEEE.

Know the Waste National Policy - Federal Law 12.305/2010:



Source: Research Data – Ting Ação Ambiental.

Proper disposal of WEEE at the end of its useful life presents a great challenge to organizations, and its impact on society and the environment makes the issue a case of extreme relevance. We can see the growing interest in the subject of reverse logistics and the movement of some actors, but there are still many challenges to be overcome in Brazil, such as gathering the thousands of products marketed and returning it to the same manufacturer. As a result, companies are being forced to rethink their business strategies and their products and how to make it possible to return goods or their constituent materials to the production or business cycle, adding economic, ecological, legal and location value (Milk, 2003), including recycling, reprocessing and proper disposal.

4.2 Results of the Recife and Surrounding Region

The sampling of the region of Recife totaled 66 interviews, segmented by the selected Institutions:

- Cooperatives and Associations
- Recyclers
- Non-Governmetnal Organizations
- Governmental Organizations
- Retailers

4.2.1 Cooperatives and Associations

Cooperative and Associate surveys were conducted through telephone interviews. Sampling generated 7 interviews:

COOPERATIVES AND ASSOCIATIONS[16]	ADDRESS	RESPONSIBLE
1.Núcleo de Triagem de Catadores e Catadoras de Gusmão	Travessa do Gusmão, 178, São José, Recife - PE	Lucicleide Borges, Djalma Borges, Maria Ramos, e Luciano Santana
2.Pró-Recife Cooperativa de Catadores Profissionais de Recife	Rua Antônio Cardoso da Fonte, 483, Imbiribeira, Recife - PE	José Cardoso, Roberta de Santana e André Cardoso.
3.Cooperativa Esperança Viva	Rua do Peixoto, 440, São José, Recife - PE	Laudineide Santos Roberto
4.Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede	Av. Padre Mosca de Carvalho (Vl. Confiança), 357, Guabiraba, Recife - PE	Luís Cláudio Pires
5. Associação de Catadores O Verde e Nossa Vida	Avenida Sul, 1148, São José, Centro, Recife - PE	Edoaldo Francisco de Souza Edson
6. Cooperativa Mista Serviços de Santo Agostinho (COMSERC)	Rua Pedro Celso Uchôa Cavalcante, 59, Centro, Cabo de Santo Agostinho – PE	Nivaldo Batista da Silva Ronaldo

[16] Infoplex. Available at: https://www.infoplex.com.br/. Accessed on April 28, 2017.

7. Associação de Catadores de Materiais Recicláveis (ACMR) Boa Esperança	Praça Constantino Gomes, S/N Centro, São José da Coroa Grande, Recife - PE	Jose Carlos da Silva Lins

Source: Research Data

From the 07 institutions interviewed, it was noted that 04 work with all the items targeted by this research. The 03 cooperatives that do not act with any type of WEEE were not considered, that is, 04 institutions were qualified.

During the interviews, information regarding the work of the cooperatives and associations was collected in a broad way and soon thereafter questions were applied with a greater focus on EWRL. The types of WEEE that cooperatives and associations work with:

COOPERATIVES AND ASSOCIATIONS	Brown Line		White Line		
	TV (CRT)	TV (Flat)	Refrigerator and Freezer	Washing Machine	Air-Conditioner
1.Núcleo de Triagem de Catadores e Catadoras de Gusmão	Yes	Yes	Yes	Yes	Yes
2.Cooperativa Esperança Viva	Yes	Yes	Yes	Yes	Yes
3.Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede	Yes	Yes	Yes	Yes	Yes
4. Associação de Catadores O Verde e Nossa Vida	Yes	Yes	Yes	Yes	Yes

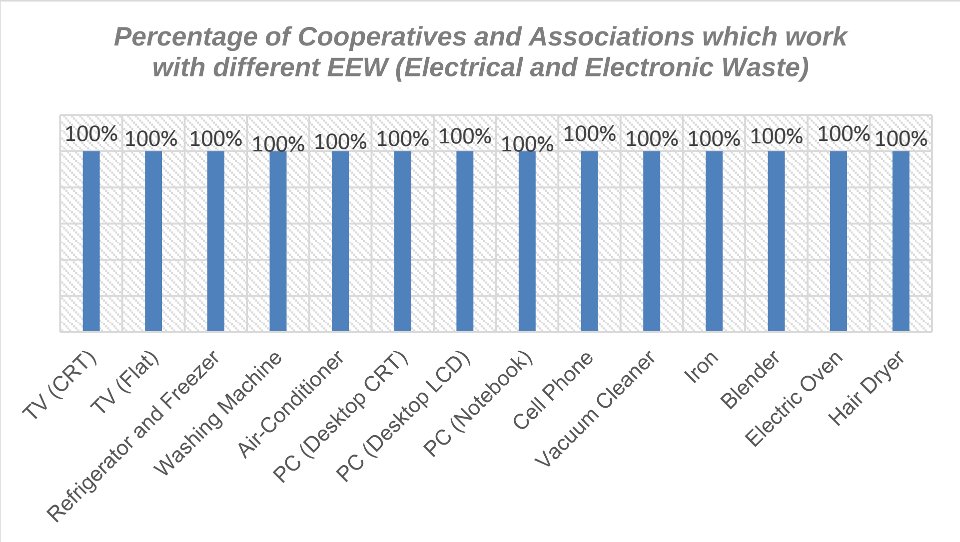
Source: Research Data – Ting Ação Ambiental

COOPERATIVES AND ASSOCIATIONS	Green Line					Blue Line			
	PC (Desktop CRT)	PC (Desktop LCD)	PC (Notebook)	Cell Phone	Vacuum Cleaner	Iron	Blender	Electric Oven	Hair Dryer
1.Núcleo de Triagem de Catadores e Catadoras de Gusmão	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.Cooperativa Esperança Viva	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3.Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4.A Associação de Catadores O Verde e Nossa Vida	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental

It is observed the percentage of cooperatives and associations that work with the different WEEE:



Source: Research Data – Ting Ação Ambiental

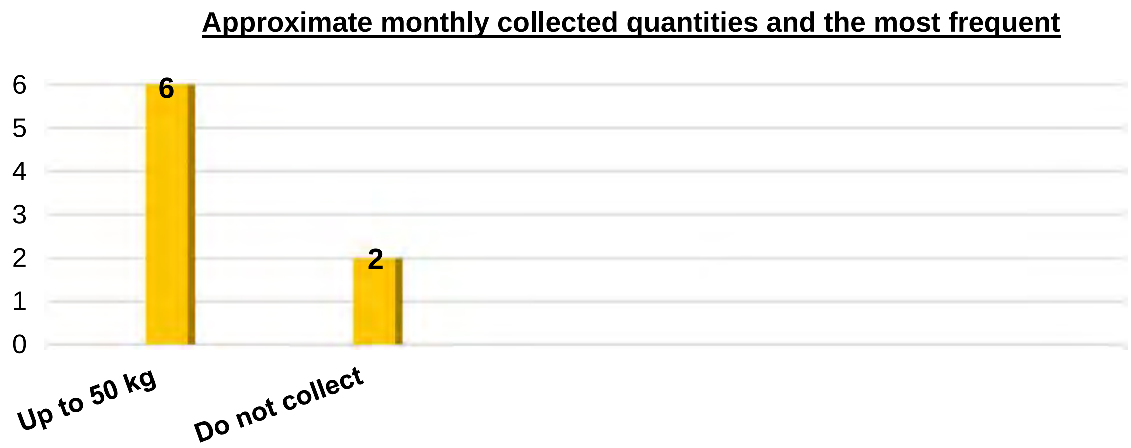
All the qualified institutions present full performance in the brown lines; white; green; blue (100%). Percentage of these cooperatives that work with each line of electronics:

COOPERATIVES AND ASSOCIATIONS	Percentage of Cooperatives and Associations working with each line of electronics
Brown Line	100.00%
White Line	100.00%
Green Line	100.00%
Blue Line	100.00%

As in Brasília (DF), cooperatives based in Recife (PE) are part of the market for raw materials for recycling and their activities involve the reception of products that are no longer in use, disassembly and separation of products in raw materials which are marketed until they reach the industries that will use these waste in the recycling process.

The waste used in this market comes from the sources of recyclable materials collected by these institutions including individuals and legal entities.

It was identified through the research that it lacks adequate infrastructure for the collection, disassembling, discharacterization and storage of the electro-electronic residues in the majority of the cooperatives located in Recife and surroundings.
In regards to the monthly quantity collected, an exact amount was not quoted, the data indicate that there is no regular collection of electro-electronic waste carried out by these cooperatives, in some months they receive a larger quantity and others not so much being declared the monthly average of 50 kg for all interviewees.



Source: Research Data – Ting Ação Ambiental

After screening, WEEE is sold to different partners (industries, recyclers, technical assistance and others), this varies according to the material. Only one of the interviewees reported one of the partnerships, the cooperative Pró Recife, the institution presented that it dismantles the equipment and sells them to Ecobras, a company located in the city of Conde - Paraíba, which is 111 km away from Recife. This company buys board, cell phones, monitor, and plastic at the time of purchase choose the products they want to purchase at, but the respondent does not have the information on the fate of these materials.
In order to work / manage WEEE, the cooperatives of Pró Recife also participated in the course promoted by the Gea Institute developed with a technical partnership between CEDIR-USP and Caixa Econômica Federal, with the support of Professor Lúcia Xavier of the Joaquim Nabuco Foundation.
In regards to commercialization, there is also the sale to middlemen, who buy the waste directly from the collectors, at a lower price, in order to collect a good amount to be sold, at a higher price for recycling companies.
The interviewees showed little knowledge about the fate of the materials sorted after being marketed.

Regarding the licensing of the participants, only Cooperativa Pró Recife affirmed having an environmental license issued by the State Agency of Environment and Water Resources - CPRH and Certificate of Regularity - AR (Fire Brigade). The other interviewees did not comment on environmental licensing.

All interviewees who work with WEEE stated that they had a truck and / or a pickup truck.

Two cooperatives were interested in functioning as a future WEEE consolidation center (receiving and storing for future shipment to the chopper and appropriate processing) and as a future WEEE re-characterization plant (re-characterization of household appliances including refrigerators and air conditioning containing CFC gases) of a Project to Improve the EWRL in Brazil.

4.2.2 Recyclers

The data collection of the recycling companies was carried out through telephone interviews and selected those that were considered to have the potential to function in the future as a center for consolidation and / or re-characterization of WEEE.

The sampling included 8 recycling companies interviewed:

RECYCLERS	ADDRESS	RESPONSIBLE
1.Fênix Gerenciamento de Resíduos Eireli - Me	Rua Guepardo, 77, Barra de Jangada, Jaboatão dos Guararapes - PE	Marlon Souza Pinheiro
2.Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda – Epp	Rua São Miguel, 1895, Jiquiá, Recife – PE	Renato Vila Nova
3.DDX Tecnologia - Descarte Já	Travessa 13 de Maio, 981, Cajueiro Seco, Jaboatão dos Guararapes - PE	Paulo Dimas
4.Só Reciclável do Nordeste Ltda - Epp	Rua Lagoa do Náutico, 101, Prazeres, Jaboatão dos Guararapes - PE	Paulo / Marcos Begoto
5.Jaidete Gomes Dos Santos Reciclagem - Me (JG Reciclagem)	Rua Registro, Barra da Jangada, Jaboatão dos Guararapes - PE	Clairton Santos
6.Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Rua Itaituba Prazeres, S/N, Lote 78, Jaboatão Guararapes, Recife - PE	Ícaro Serafim
7.Lorene Recife Comércio de Sucatas Ltda	Rua Artur Moura, 88, Galpão CO3, Imbiribeira, Recife - PE	Evânia Maria de Medeiros

8. Ecobras Reciclagem de Resíduos Ltda	Alameda dos Beija Flores, 218, Cidade do CONDE - PE	Saulo Silva

Source: Research Data – Ting Ação Ambiental.

During the interviews, information was collected on the work of recyclers in a wide way including quantities and forms of execution, and also more specific questions related to EWRL were applied.

It was observed that the 8 companies interviewed act, if not all, with at least five of the target items of this research.

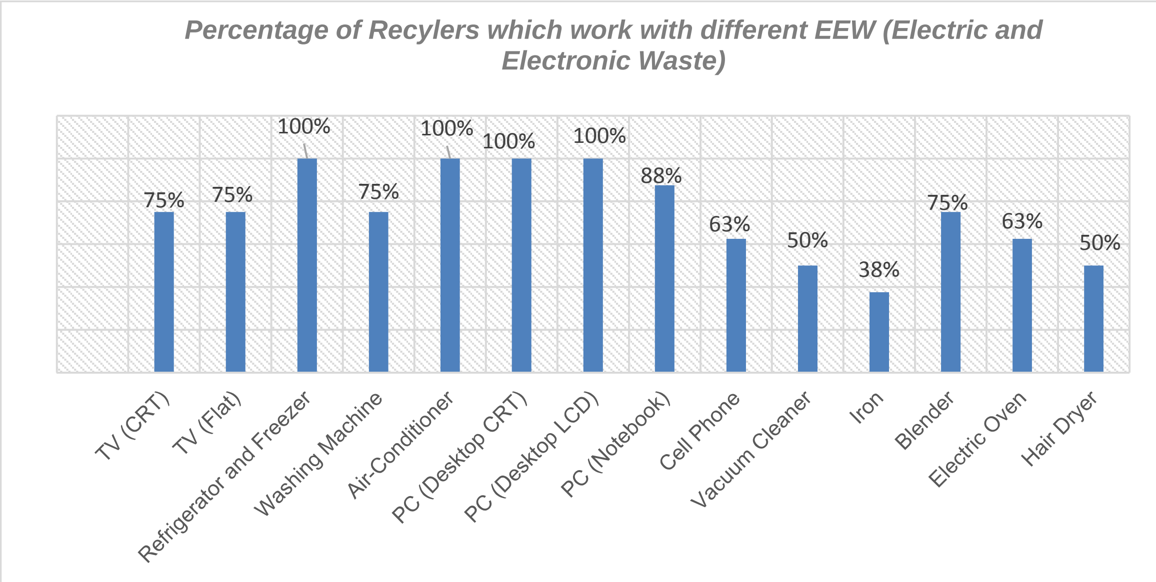
RECYCLERS	Brown Line		White Line		
	TV (CRT)	TV (Flat)	Refrigerator and Freezer	Washing Machine	Air-Conditioner
1.Fênix Gerenciamento de Resíduos Eireli – Me	No	No	Yes	Yes	Yes
2.Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda – Epp	Yes	Yes	Yes	Yes	Yes
3.DDX Tecnologia - Descarte Já	Yes	Yes	Yes	Yes	Yes
4.Só Reciclável do Nordeste Ltda – Epp	Yes	Yes	Yes	No	Yes
5.Jaidete Gomes Dos Santos Reciclagem - Me (JG Reciclagem)	No	No	Yes	No	Yes
6.Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Yes	Yes	Yes	Yes	Yes
7.Lorene Recife Comércio de Sucatas Ltda	Yes	Yes	Yes	Yes	Yes
8. Ecobras Reciclagem de Resíduos Ltda	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental

RECYCLERS	Green Line						Blue Line		
	PC (Desktop CRT)	PC (Desktop LCD)	PC (Notebook)	Cell Phone	Vacuum Cleaner	Iron	Blender	Electric Oven	Hair Dryer
1.Fênix Gerenciamento de Resíduos Eireli - Me	Yes	Yes	Yes	No	No	No	Yes	No	No
2.Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda - Epp	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
3.DDX Tecnologia - Descarte Já	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4.Só Reciclável do Nordeste Ltda – Epp	Yes	Yes	Yes	Yes	No	No	No	No	No
5.Jaidete Gomes Dos Santos Reciclagem - Me (JG Reciclagem)	Yes	Yes	Yes	No	No	No	No	No	No
6.Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Yes	Yes	Yes	No	No	No	Yes	Yes	No
7.Lorene Recife Comércio de Sucatas Ltda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8. Ecobras Reciclagem de Resíduos Ltda	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental

It is observed the percentage of recycling companies that work with the different WEEE:



Source: Research Data – Ting Ação Ambiental.

They show greater performance in the white line (91.7%); Followed by the green line (80.0%); the brown line (75.0%); and the blue line (56.3%). Percentage of these recicreation companies that work with each line of electronics:

RECYCLERS	Percentage of Recycling Companies that work with each line of electronics
Brown Line	75.0%
White Line	91.7%
Green Line	80.0%
Blue Line	56.3%

Source: Research Data – Ting Ação Ambiental

Most of the interviewees are part of the market for raw materials for recycling and their activities involve the collection and reception of products that are no longer in use, the dismantling and separation of products in raw materials that are marketed until they reach the Industries to reuse such waste in the recycling process.

The number of employees in these companies ranges from 4 to 100 employees. Using as a criteria the number of employees it can be said that in regards to the size of two, they are microenterprises, 3 are small companies, one is medium size and one is a large company.

Company	Company Size	Number of Employees
Jaidete Gomes dos Santos Reciclagem - Me (JG Reciclagem)	Large	100 or more
Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda – Epp Ecobras Reciclagem de Resíduos Ltda	Medium	From 50 to 99
Fênix Gerenciamento de Resíduos Eireli - Me Só Reciclável do Nordeste Ltda – Epp Lorene Recife Comércio de Sucatas Ltda	Small	From 10 to 49
DDX Tecnologia (Descarte Já) Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Micro	Up to 9

Source: Adapted from SEBRAE

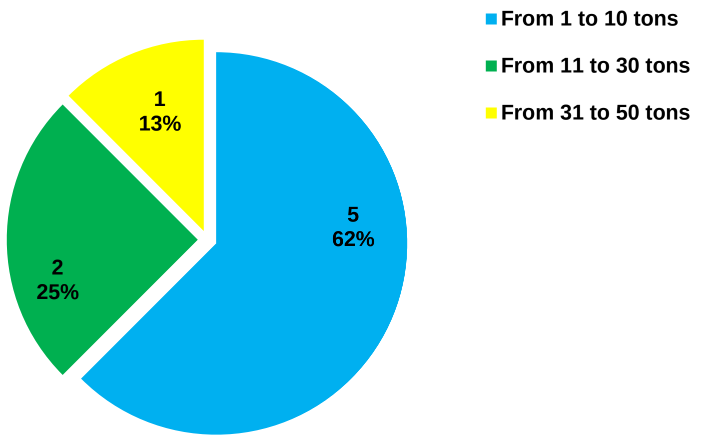
The companies have vehicles for collecting of WEEE, trucks, towing truck and utilities.

It was presented by the interviewees that the waste used in this market comes from the sources of recyclable materials collected by these companies from individuals, legal entities, from the collection of informal waste pickers, technical assistance, public organizations. The sale of these materials is made to partner buyers (these uninformed), recycling industry and to remanufacturing companies.

It was identified through the research that all the companies involved in this interview have adequate infrastructure for the collection, dismantling, de-characterization and temporary storage of electrical and electronic waste.

In regards to the monthly quantity collected, this varies between 1 and 50 tons and there are accounting records of the incoming operations of WEEE and the exit of materials and tailings.

Monthly quantity:



Source: Research Data – Ting Ação Ambiental.

The companies reported presenting an environmental license issued by CPRH - State Agency for the Environment, Secretariat for Sustainable Development and Environment, CTF - IBAMA, among others.

They presented as difficulties for the expansion of the business the capture of material, difficulty in logistics, compliance with legislation, public investment (government), buyers, skilled labor, difficulty obtaining necessary licenses (bureaucracy), lack of receivers.

The interviewees are interested in functioning as a future center for the consolidation of WEEE (receiving and storing for future disposal and appropriate processing) and as a future WEEE re-characterization plant (re-characterization of household appliances including refrigerators and air conditioning containing CFC gases) of a Project to Improve the EWRL in Brazil.

4.2.3 Non-Governmental Organizations

With regard to non-governmental organizations, 13 NGOs were interviewed. The data collection of these institutions was carried out through telephone interviews and selected those that were understood to have the potential to function in the future as a center for the consolidation and / or re-characterization of WEEE for an on-site visit .

During the interviews, information was collected on the work of non-governmental organizations and social assistance in a broad way, and also more specific questions related to the reverse logistics of WEEE were applied.

List of the 13 NGOs interviewed:

NON-GOVERNMENTAL ORGANIZATIONS	ADDRESS	RESPONSIBLE
1.União Norte Brasileira de Educação e Cultura (CRC Marista)	Jorge Tasso Neto, 318, Apipucos, Recife - PE	Domingos Sávio França
2.Assistência e Promoção Social Exército de Salvação	Rua Conde de Irajá, 108, Torre, Recife - PE	Israel Franca
3.Associação dos Trapeiros de Emaús Recife	Rua Mamede Coelho, nº 53 - Dois Unidos, Recife - PE	Ronaldo Rebouças
4. Grupo de Apoio à Criança e Adolescente Rua Linha e Massangana	Rua Santa Flora, 171, Prazeres, Jaboatão dos Guararapes - PE	Cláudia Valeria de Queiroz Rodrigues
5.Associação dos Moradores de Cariri-Mirim	Rua Luiz Gonzaga, 246, Distrito Cariri Mirim, Centro, Moreilandia - PE	Willis Laurence
6. Lar do Nenen	Rua Menezes Drumond, 284, Madalena, Recife - PE	Daniela Xavier

7.Associação dos Amigos do Petrape	Av. da Integração, S/N, Gercino Coelho, Petrolina - PE	Fransilene Amorim
8.Caatinga	Ouricuri – PE	Cristina Nascimento
9.Centro Social Paula Frassinetti	Rua Jose Nasario Coutinho, 100, Bairro Novo, Carpina - PE	Eliana Oliveira
10.Serviço de Tecnologia Alternativa (SERTA)	Açude Engenheiro Francisco Saboya, S/N, Zona Rural - Ibimirim – PE	Luciana Luiza Silva
11.Centro de Reabilitação e Valorização da Criança (CERVAC)	Pça do Morro da Conceição, 211, Casa Amarela, Recife – PE	Michele Cristina Santos
12.Fundação Terra	Rua Alfredo Souza Padilha, S/N, São Cristovao, Arcoverde – PE	Lisiane Mossmann
13.Obra de Defesa da Infância Pobre	Faz Sampaio, S/N, Fazenda Sampaio, Gravata - PE	Maria Auxiliadora Araújo

Source: Research Data – Ting Ação Ambiental

From the 13 institutions interviewed, it was observed that only 03 work with at least eight of the target items of this research. The other governmental organizations were not considered, that is, 03 institutions were qualified.

We applied questions with focus on the performance of each instuition regarding the electro-electronic residues. It was identified which types of WEEE that non-governmental organizations act upon:

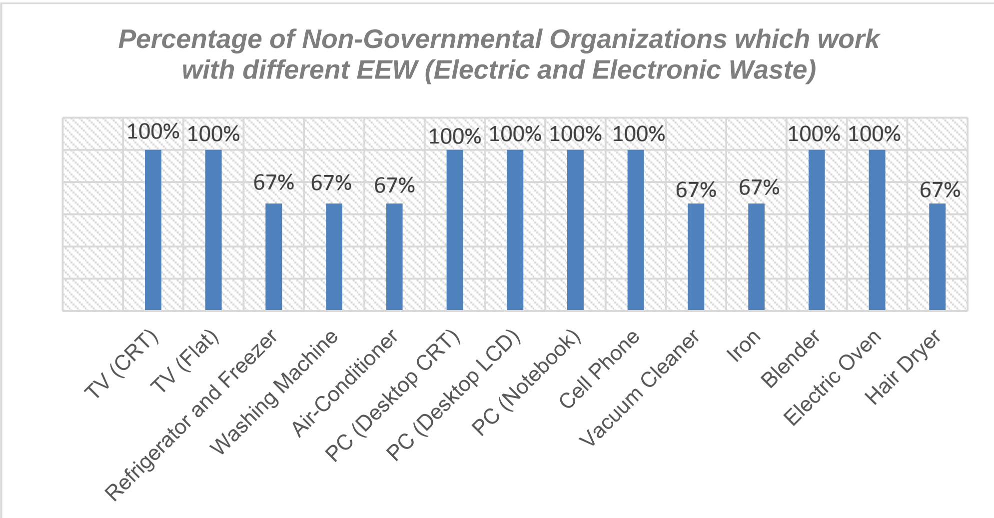
NON-GOVERNMENTAL ORGANIZATIONS	Brown Line		White Line		
	TV (CRT)	**TV (Flat)**	**Refrigerator and Freezer**	**Washing Machine**	**Air-Conditioner**
1.União Norte Brasileira De Educação e Cultura (CRC Marista)	Yes	Yes	No	No	No
2.Assistência E Promoção Social Exército de Salvação	Yes	Yes	Yes	Yes	Yes
3.Associação dos Trapeiros de Emaús Recife	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental

NON-GOVERNMENTAL ORGANIZATIONS	Green Line					Blue Line			
	PC (Desktop CRT)	PC (Desktop LCD)	PC (Notebook)	Cell Phone	Vacuum Cleaner	Iron	Blender	Electric Oven	Hair Dryer
1.União Norte Brasileira de Educação e Cultura (CRC Marista)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No
2.Assistência e Promoção Social Exército de Salvação	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3.Associação dos Trapeiros de Emaús Recife	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research Data – Ting Ação Ambiental

The percentage of non-governmental organizations working with different WEEE:



Source: Research Data – Ting Ação Ambiental

They show full performance in the brown line (100%); Followed by the green line (93.3%); Then the blue line (83.3%); And the white line (66.7%). Percentage of these non-governmental companies that work with each line of electronics:

NON-GOVERNMENTAL ORGANIZATIONS	Percentage of non-governmental organizations that work with each line of electronics
Brown Line	100.0%
White Line	66.7%
Green Line	93.3%
Blue Line	83.3%

Source: Research Data – Ting Ação Ambiental

Respondents reported recognizing the great responsibility in correct disposal and social responsibility in regards to the subject, and would like to have financial recognition of the public power as service providers.

Regarding the perspective of these institutions as a service provider in the reverse logistics of WEEE, they informed the importance of the financial recognition of the government, they consider it to be a promising future, and there is a need to increase the collection, since the paper is large.

It is understood the great relevance of NGOs linked to the collection of recyclable and "waste" materials, including WEEE, in addition to the aforementioned collectors and cooperatives. NGOs are also key players in the reverse logistics processes carried out in Brazil (Guarnieri, 2013 and Pereira and Pereira, 2011), there is still, perhaps because it is recent or due to lack of efficient information or even due to limitations of the Law itself, gaps in which refers to the relationship of such organizations of private initiatives with their effective role in the reverse logistics process of solid waste, especially the waste characterized as electronics (Brazil, 2010).

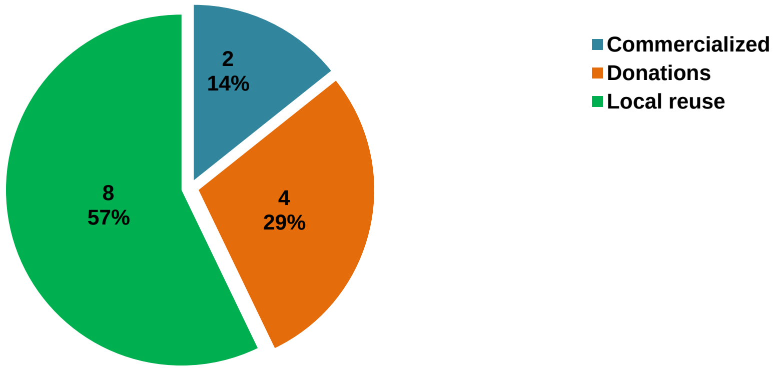
The work carried out by these organizations can be seen as a strategic factor for the implementation of environmental management, as well as being characterized as viable alternatives for proper disposal in regards to reverse logistics processes, and it is also possible to highlight other benefits such as social inclusion, income, formal jobs, digital inclusion, reduction of environmental impacts and reconditioning of electronic equipment, resulting in the extension of their useful lives (GUARNIERI, 2013).

After the WEEE is received at these institutions, the equipment is screened for recovery, involving the test to verify its operation, the next stage is the repair, some WEEE being reused in digital inclusion projects and the "unserviceable" are sent to Disassembly.

Some of the non-governmental organizations interviewed are working to strengthen civil society initiatives by encouraging the appropriate use of information and communication technologies. They use computers for social transformation of communities and stimulate entrepreneurship, education and citizenship, aimed at the digital empowerment of young people.

Of the interviewees only one commercializes the materials collected and most of them act with donations or for reuse in the organization's projects, and the tailings are sent for specific collection.

Destination of recoverable parts and materials:



Source: Research Data – Ting Ação Ambiental

Using as a criteria the number of employees it can be said that regarding the size they fit into the types of companies informed below:

Company	Company Size	Number of Employees
-	Large	100 or more
-	Medium	From 50 to 99
União Norte Brasileira de Educação e Cultura (CRC Marista) Assistência e Promoção Social - Exército de Salvação Associação Trapeiros De Emaús	Small	From 10 to 49
-	Micro	Up to 9

Source: Adapted from SEBRAE

It was informed by the interviewees that there is registration and knowledge of the origin of the equipment through the completion of a material delivery form or a donation receipt.

The capacity of processing of WEEE, was only reported by two of these organizations, CRC MARISTA, today about 5 tons / month, but with the investment to implement appropriate spaces, as well as the operational cost, estimates that they can, in the future, process a quantity of 80 to 100 tonnes / month. The idea is to make this expansion under the logic of circular economy, what is still possible to be reused, reconditioned, repaired will thus be processed to return to solidary use. And the Trapeiros de Emmaus that processes between 1 and 10 tons.

As for the licensing, information has also been obtained from the CRC MARISTA and TRAPEIRO DE EMAÚS that is in compliance.

Of the respondents, only 6 NGOs were interested in functioning as a future center for the consolidation of WEEE (receiving and storing for future disposal and appropriate processing) and as a future WEEE re-characterization plant (re-characterization of household appliances including refrigerators and air-conditioning system containing CFC gases) of a Project to Improve the EWRL in Brazil.

4.2.4 Governmental Organizations

Surveys with governmental organizations were conducted through telephone interviews and in 6 of them an on-site visit was conducted.

Sampling generated 13 interviews:

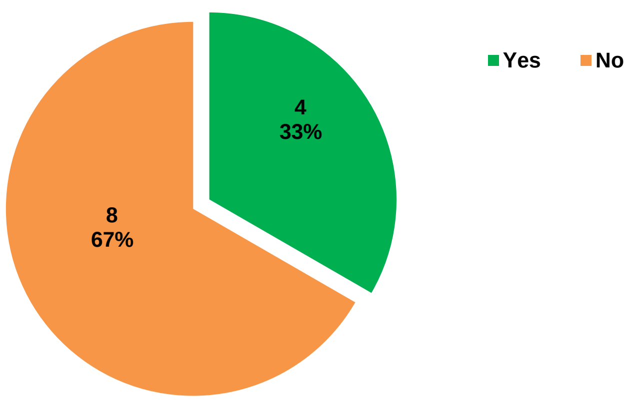
GOVERNMENTAL ORGANIZATIONS	ADDRESS	RESPONSIBLE
1.Secretaria do Meio Ambiente e Sustentabilidade (SEMAS)	Avenida Conselheiro Rosa e Silva, 1339, Jaqueira, Recife - PE	Joana Aureluiano e Adriana Dorneles
2.Empresa de Manutenção e Limpeza Urbana (EMLURB)	Avenida Recife, 3587, Areias, Recife - PE	Címtia Santana
3.Secretaria de Meio Ambiente e Sustentabilidade (SEMAS) do Recife	Avenida Marquês de Olinda, 222, Recife - PE	Érica Vidal de Negreiros
4.Fundação Joaquim Nabuco (FUNDAJ)	Endereço: Av. Dezessete de Agosto, 2187, Casa Forte, Recife - PE	Adriana Martins e Alexandre Muniz
5.Associacao do Parque Tecnológico de Eletroeletrônica de Pernambuco – PARQTEL	Rua Vital de Oliveira, 32, Bairro do Recife, Recife - PE	Fernanda Muniz

6. Secretaria das Cidades – SECID	Rua Estradas do Barbalho, 889-A, Iputinga, Recife - PE	Ana Gama
7.Nucleo de Gestão do Porto Digital	Avenida Cais do Apolo, 222 - Bairro do Recife, Recife - PE	Carla Modena
8.Agência Estadual do Meio Ambiente (CPRH)	Rua Santana, 367, Casa Forte, Recife - PE	Erica Monte
9.CONDEPE/FIDEM - Agência Estadual de Planejamento e Pesquisa de Pernambuco	Rua Das Ninfas, 65, Boa Vista, Recife - PE	Alda Magalhães
10.Instituto de Tecnologia de Pernambuco (ITEP)	Avenida Professor Luiz Freire, 700, Cidade Universitária, Recife - PE	Alexandre Queiroz
11.Centro de Tecnologias Estratégicas do Nordeste (CETENE)	Avenida Professor Luiz Freire, 01, Cidade Universitária, Recife - PE	Erica Azevedo
12.Grupo de Resíduos Sólidos (GRS) da Universidade Federal de Pernambuco (UFPE)	Avenida Acadêmico Hélio Ramos, S/N, Cidade Universitária, Recife - PE	Ericka Rocha
13.Federação das Indústrias do Estado de Pernambuco	Avenida Cruz Cabugá, 767, Santo Amaro, Recife - PE	Abrão Rodrigues

Source: Research Data – Ting Ação Ambiental

Governmental Organizations were interviewed that are related to the WEEE theme, but when asked if they had any reverse logistics program, only 4 answered yes. They claimed to function as WEEE collection points, to carry out a proper disposal program and correct disposal for employees, and to collaborate with the Joaquim Nabuco Foundation.

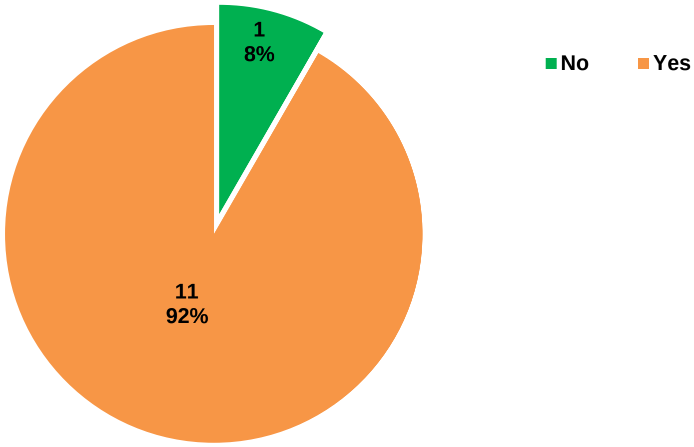
The Organization has a Reserve Logistics Program:



Source: Research Data – Ting Ação Ambiental.

Concerning the development of socio-environmental actions, 92% said they are developing programs / actions, among them: Correct disposal; Environmental Education and Research Projects.

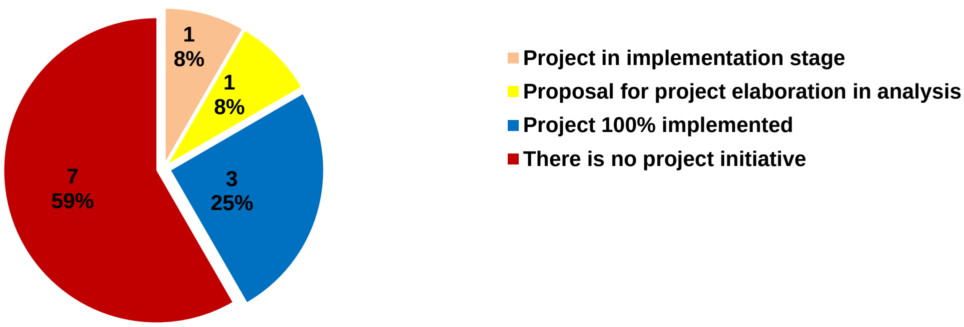
The organization develops socio-environmental actions:



Source: Research Data – Ting Ação Ambiental

Regarding the management of solid waste, a question was raised about the existence of any Socio-environmental Education program / campaign related to non-generation, reduction, reuse, recycling, waste treatment and environmentally appropriate final disposal, programs specifically involving WEEE, 59% reported not existing and 8% reported having project in the deployment phase; 8% analysis of proposal for project design and 25% project implemented.

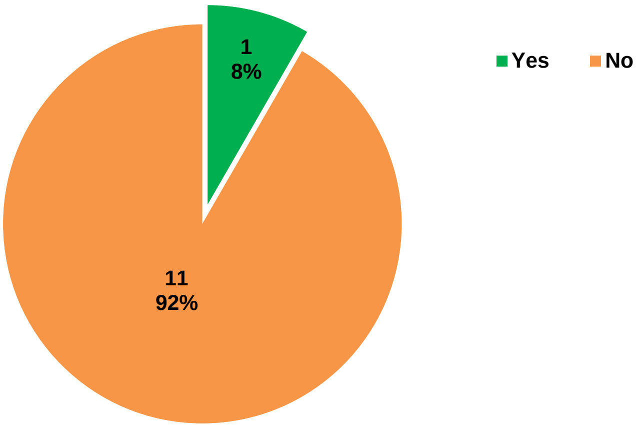
Is there a program/campaign of Socio-environmental Education related to the management of solid waste, non-generation, reduction, reuse, recycling,treatment and final disposal environmentally adequate? Specifically programs involving WEEE:



Source: Research Data – Ting Ação Ambiental.

Regarding the possible partnerships with companies and / or institutions related to electrical and electronic waste, only one institution, CETENE - Centro de Tecnologias Estratégicas do Nordeste, reported having a partnership, among them: Fundação Joaquim Nabuco, ONG Cáritas and Pro Recife Cooperative.

Have partnerships with WEEE companies:



Source: Research Data – Ting Ação Ambiental

Regarding the governmental organizations, it is concluded that the actions are timely and most of the institutions are of communication, the Porto Digital (Digital Port), since 2011, annually holds the International Seminar on Electrical and Electronic Equipment Waste (SIREE). In 2013, the event received scientific papers related to the theme (SIREE, 2013), coordinated in partnership with the Joaquim Nabuco Foundation. Also in 2013, Porto Digital concluded a research regarding the identification of the best practices in the management of technological waste (Porto Digital, 2013).

Other research groups have also deepened on the subject, such as the Joaquim Nabuco Foundation, which published a book on Electronic Waste Management in partnership with the University of São Paulo involving researcher Lúcia Helena Xavier (Xavier and Carvalho, 2014). All work of the foundation is based on the work of the aforementioned Professor Lúcia Helena Xavier[17], chief researcher of REE, but the project is stopped by the teacher's licensing. Also by the educational institution was launched the E-book "Electronic Residues in the Metropolitan Region of Recife - practical guide to a Sustainable Environment"[18] which serves as a reference to guide the correct disposal of electronic waste.

[17] Researcher. Available at: http://www.fundaj.gov.br/index.php?option=com_content&view=article&id=3846:sustentabilidade-e-tecnologia-unidas-pela-inclusao-social&catid=44:sala-de-impressa&Itemid=183. Accessed on 22 March 2017.
[18] Resíduos Eletroeletrônicos na Região Metropolitana do Recife - guia prático para um Ambiente Sustentável. Available at: https://dl.dropboxusercontent.com/u/883454/ebookREEE_2014_pt-final.pdf. Accessed on 22 March 2017.

Semas is also responsible, through the State Agency for the Environment (CPRH), for carrying out activities related to environmental licensing and inspection, as well as promoting environmental education, regulation, control, regularization, protection, conservation and recovery of natural resources. Semas has done some activities related to WEEE, participated in the format of state legislation - LAW Nº 15.084, OF SEPTEMBER 6, 2013, which provides for the mandatory installation of electronic waste collectors by companies that sell batteries and electronic devices of small size in the State of Pernambuco, and take other measures about this.

The city of Recife and Emlurb have launched the project EcoRecife that provides points of receipt of waste, but does not receive WEEE.

4.2.5 Retailers

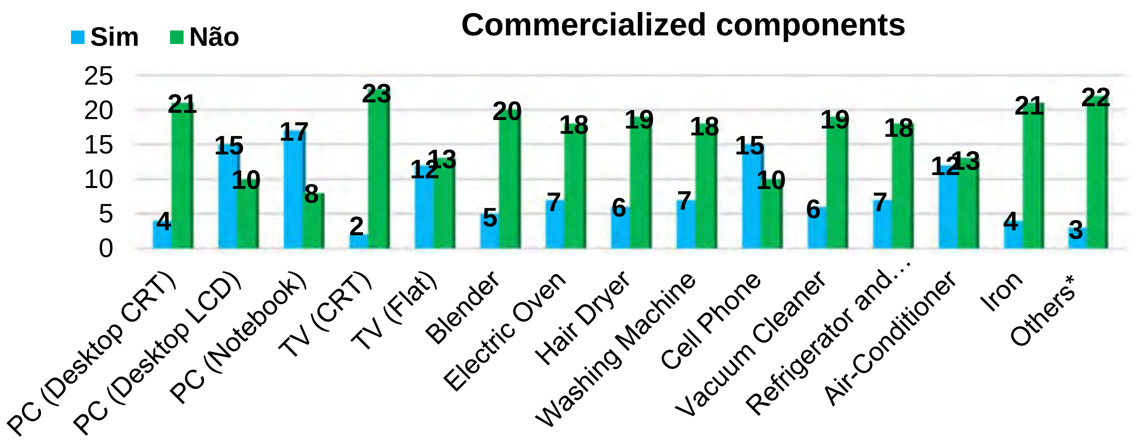
The surveys with retailers were conducted through telephone interviews. Sampling generated 25 interviews:

RETAILERS
1. E & F Comércio e Serviços de Informática Ltda. (Infohouse)
2. Thermo Brasil Comércio e Isolamentos Térmicos Ltda. (Thermo Brasil)
3. TIM Nordeste Telecomunicações S/A (Telpe Celular)
4. Telefônica Brasil S.A (VIVO)
5. Notebook City Comercio de Informática Ltda. - Me (Notebook City)
6. Supermercado da Família Ltda. (Supermercado Da Família)
7. Lognet Comércio e Tecnologia Ltda. - Me (Lognet)
8. Me Componentes e Equipamentos Eletrônicos Ltda. (Me Componentes e Equipamentos Eletrônicos) Comércio Ltda. - Me (Mundo Digital)
9. Nordap Comércio de Equipamentos e Pecas para Climatização Ltda.
10. Tecno Indústria e Comércio de Computadores Ltda. (Ibyte)
11. Tecno Indústria e Comércio de Computadores Ltda. (Ibyte Computadores)
12. N3 Computadores, Periféricos e Eletrônica Ltda. (N3 Computadores)
13. J. S. Refrigeração Elétrica Ltda. - Epp (J. S. Refrigeração)
14. Engefrio Industrial Ltda.
15. Nova Casa Bahia S/A (Casas Bahia)
16. Bartô Eletrônica Ltda.
17. Estoks Pernambuco Logística Reversa Integrada Ltda. (Estocks)
18. Ciclar Ciclo de Ar Assistência Técnica Ltda. - Epp (Ciclar Ar Condicionado)
19. Tron Controles Elétricos Ltda. (Tron)

20.	Lojas Americanas S.A. (Lojas Americanas)
21.	Master Eletrônica de Brinquedos Ltda. (Laser Eletro)
22.	Sony Brasil Ltda. (Sony Brasil)
23.	Fast Shop S.A (Fast Shop)
24.	Magazine Luiza S/A (Magazine Luiza -Shopping Riomar)
25.	Saraiva e Siciliano S/A (Itown)

Source: Research Data – Ting Ação Ambiental

The components marketed by the retailers involved in the interviews are indicated in the chart below:



Source: Research Data – Ting Ação Ambiental

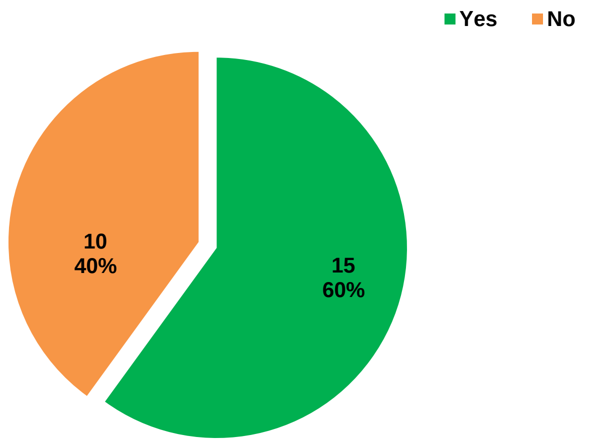
The products marketed by these retailers related to the chain of electronic equipment composed by line are:

RETAILERS	Percentage of Retailers that market each line of electronics
Brown Line	48.00%
White Line	48.00%
Green Line	68.00%
Blue Line	28.00%

Source: Research Data – Ting Ação Ambiental

From the retailers interviewed, 60% develop environmental actions, among them the incentive to correct disposal / recycling, reverse logistics, gas regeneration and collection points.

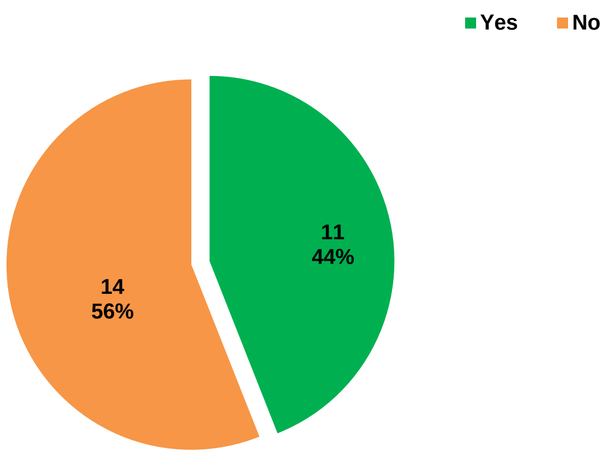
The company develops socio-environmental actions:



Source: Research Data – Ting Ação Ambiental.

And still 44% of the retailers that were part of this research carry out programs of other sectorial agreements (batteries) acting as a point of collection through a collection box.

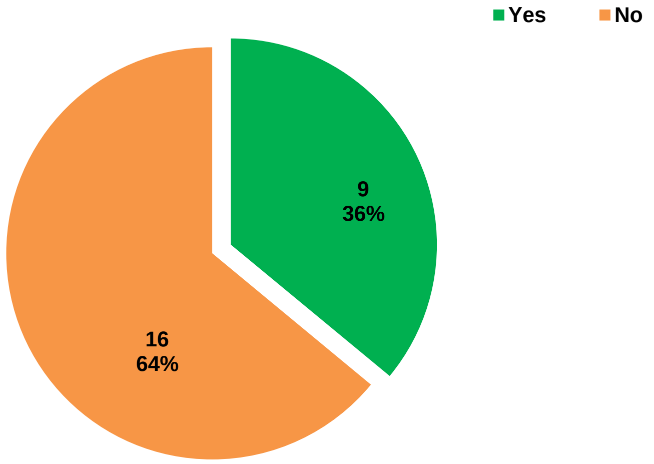
Run programs of other sectorial agreements (ie: batteries):



Source: Research Data – Ting Ação Ambiental.

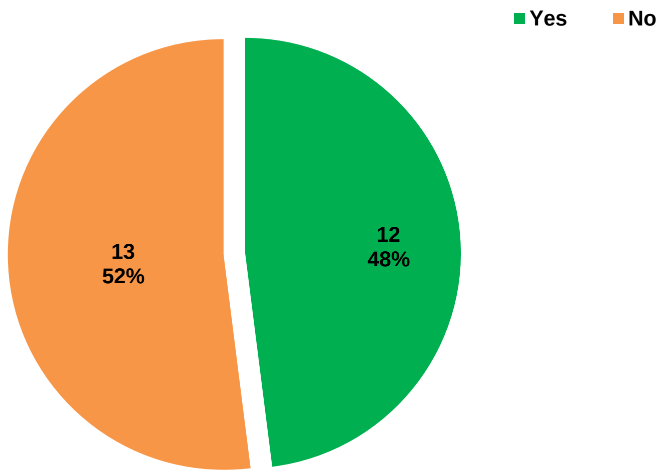
Regarding the specific programs related to reverse logistics, only 36% said they exist, of which 48% have industrial sector partners, chart follows:

Are there specific WEEE programs:



Source: Research Data – Ting Ação Ambiental.

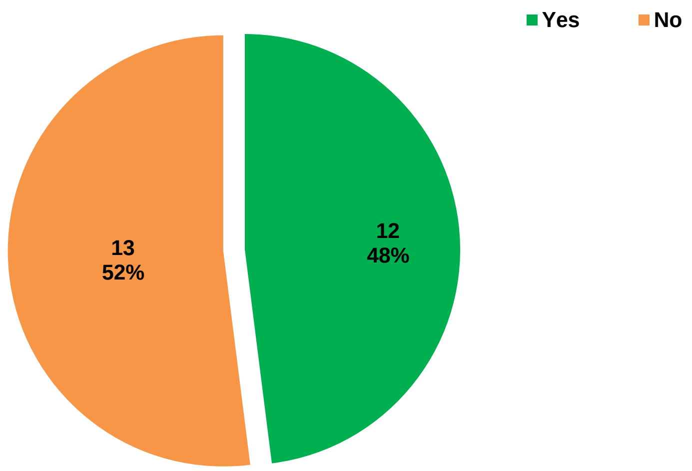
Have partnerships with the industrial sector - telecom operators, ie: Motorola, Samsung, etc for environmental actions:



Source: Research Data – Ting Ação Ambiental.

When questioned about having a partnership, related to electrical and electronic waste, with other companies, associations, cooperatives or if they participate in any state, municipal reverse logistics program, 48% said yes.

Have partnerships with other companies related to WEEE, associations, cooperatives or take part on municipal programs for reverse logistics:



Source: Research Data – Ting Ação Ambiental.

From the 12 retailers who answered affirmatively, 10 have industry partners - mobile telephony - Ex: Motorola, Samsung, etc. For these actions and 9 partnerships with recyclers.

The partnerships:

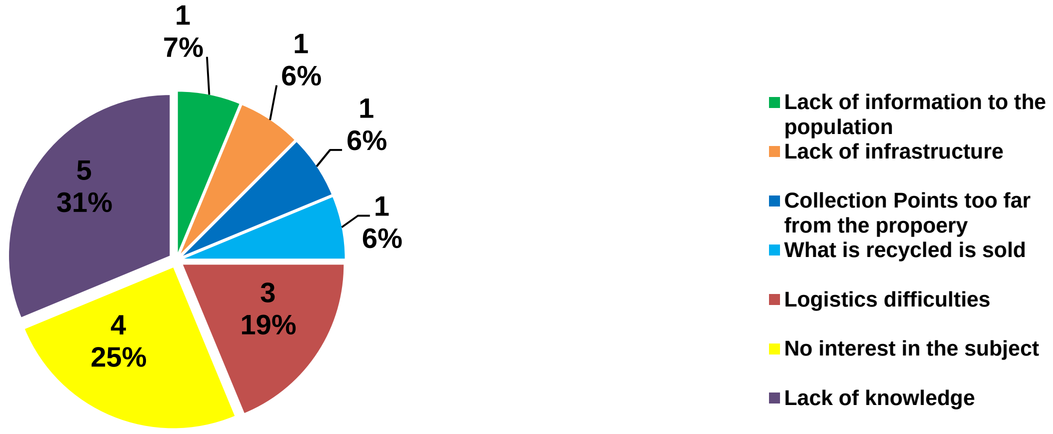
ORGANIZATION	TYPE OF PARTNERSHIP
GM&CLOG	GM & CLOG was founded on May 1st, 2002 and is currently located in São José dos Campos, strategic point of business and growth of our Brazil. GM & CLOG Logistics specializes in reverse logistics due to the high volume of products placed on the market that need to return to the manufacturer or have their final disposal environmentally correct. GM & CLOG complies with applicable environmental laws in Brazil and the transportation, handling, storage, treatment and final disposal of waste. GM & CLOG as well as its final destination partners have licenses authorized by the state environmental agencies. In transportation we have a well trained team, we use appropriate packaging and homologated according to Resolution ANTT 420 and our drivers have special clearance for dangerous cargo (MOPP). For an effective control of the logistics management of these goods, we use our GM & CLOG system, the only one in Brazil that has a serial number and IMEI database of equipment, as well as statistical reports on inventory control, collection lead time, history of recyclers waste and recycling and processing certificate. Http://www.gmclog.com.br/site/index.php/servicos/logistica-reversa

Claro	Claro Recicla - A program that aims to contribute to raising public awareness about the importance of properly targeting cell phones, rechargeable batteries, obsolete or out-of-use chips and accessories. In this way, Claro helps combat water and soil contamination, properly treat toxic materials, reduce the amount of waste and reduce the extraction of heavy metals. Simply deposit obsolete or out of use material from any operator and manufacturer at the collecting ballot boxes, available at more than 2,000 Clear Shops and Authorized Agents. It is not necessary to be a Claro customer or fill out forms. http://www.claro.com.br/institucional/claro-recicla/regiao/ddd11/SP-11/cidade/
Braslimp	Company of collection, transportation and final destination of solid waste generated. No EWRL system found. http://www.braslimp.com.br/solucoes.php
Apple	No specific program in Brazil. https://www.apple.com/br/environment/reports/

Source: Research Data – Ting Ação Ambiental

When questioned about the reasons for not using these campaigns and services provided by manufacturers and / or recycling companies, respondents claimed lack of knowledge, information, structure, difficulty in logistics and lack of interest in the subject.

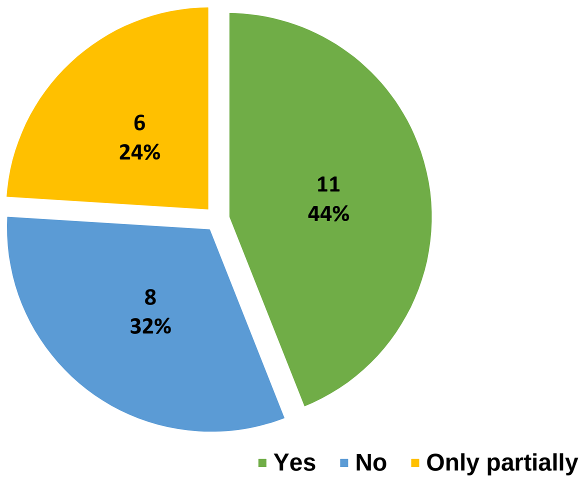
The reason why not take advantage of the programs/campaigns and services:



Source: Research Data – Ting Ação Ambiental

And in regards to the knowledge about the National Policy on Solid Waste, 32% of respondents said they did not have knowledge, therefore without knowledge about the obligation of reverse logistics for WEEE.

Know the Waste National Policy - Federal Law 12.305/2010:



Source: Research Data – Ting Ação Ambiental.

It can be seen that in the Brazilian formal private sector, with respect to the practices of return of the WEEE made by the merchants, there is a violation of federal legislation (PNRS) by a large part of the sector, since most of the large retail stores do not have programs to return and / or recycle their electronics.

4.3 Industrial Sector

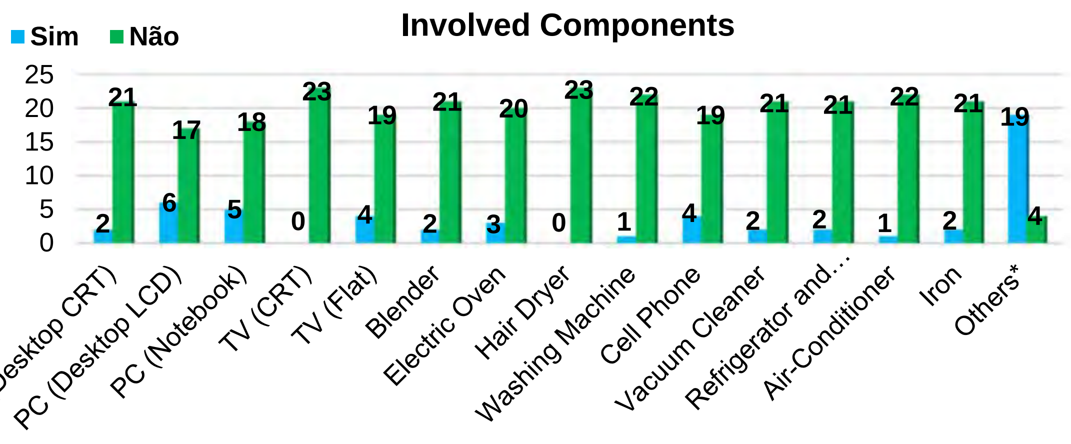
In regards to the industrial sector, 25 manufacturers were investigated, among them:

COMPANIES	
1.	Lenovo Tecnologia Brasil Ltda. (Lenovo)
2.	AOC do Brasil Monitores Ltda. (AOC)
3.	Tramontina Teec S/A (Tramontina)
4.	Hewlett-Packard Brasil Ltda. (HP - Hewlett Packard)
5.	Digibras Indústria do Brasil S/A (CCE)
6.	Apple Computer Brasil Ltda. (Apple)
7.	Motorola Solutions Ltda. (Motorola)
8.	Whirlpool S/A (Unidade de Eletrodomésticos)

9. Dell Computadores do Brasil Ltda. (Dell)
10. Flextronics International Tecnologia Ltda. (Microsoft - Flextronics International Tecnologia Ltda.)
11. Cellcom Brasil Indústria e Comércio de Baterias para Celulares Ltda.
12. OKI Brasil Indústria e Comércio de Produtos e Tecnologia em Automação S.A. (OKI Brasil)
13. Orkli Do Brasil Indústria De Controles Para Eletrodomésticos Ltda. (Orkli Do Brasil)
14. Industrias Rossi Eletromecânica Ltda. (Industrias Rossi)
15. Karitec Sistemas Ltda. (Karitec)
16. Cromax Eletrônica Ltda. (Cromatek)
17. Semp TCL Indústria e Comércio de Eletroeletrônicos S/A
18. Sonabyte Eletrônica Ltda.
19. Hohner do Brasil Indústria e Comércio Ltda. Me
20. CM Comandos Lineares Ltda.
21. Foxconn Brasil Indústria e Comércio Ltda.
22. Quanta Tecnologia Eletrônica Indústria e Comércio Eireli
23. CIS Eletrônica Indústria e Comércio Ltda.

Source: Research Data – Ting Ação Ambiental

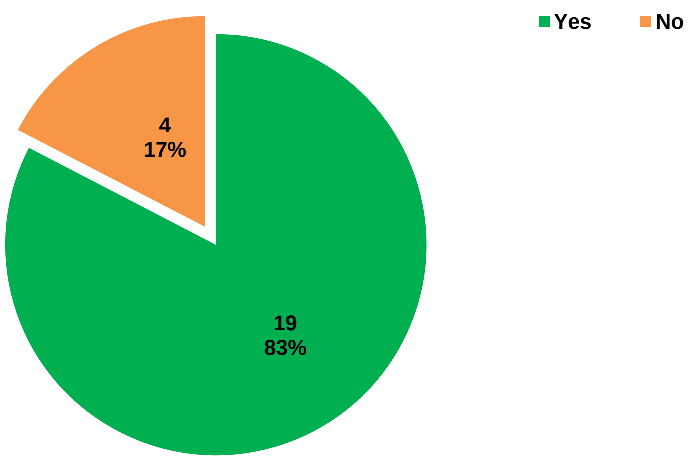
These electrical and electronic components are indicated in the following graph:



Source: Research Data – Ting Ação Ambiental

Regarding the development of environmental actions, 19 (83%) manufacturers said to develop this line of action.

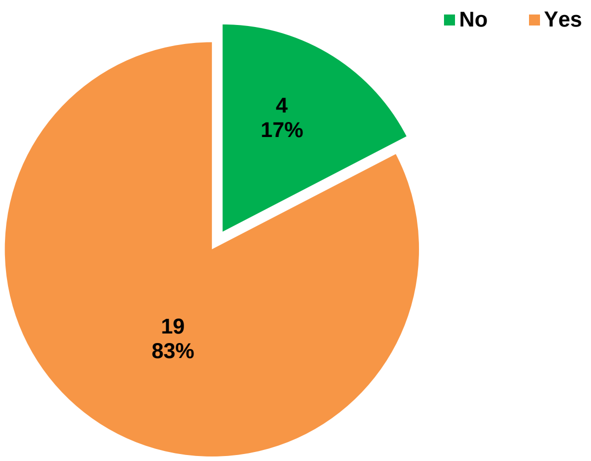
The company develops socio-environmental actions:



Source: Research Data – Ting Ação Ambiental.

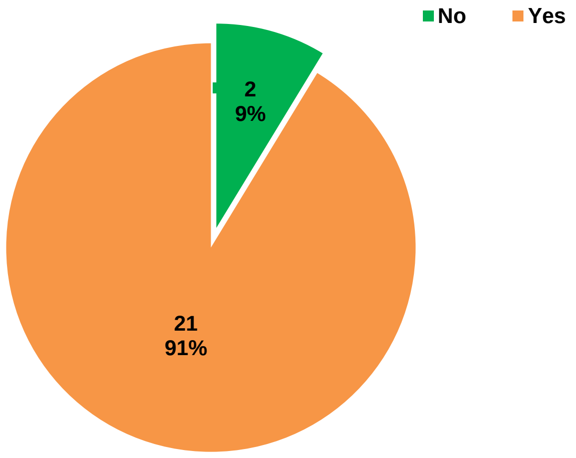
Most respondents (83%) said they were concerned about the design of their products with regard to ease of dismantling and recycling and 91% regarding durability.

The product design is aimed at easy dismantling/recycling:



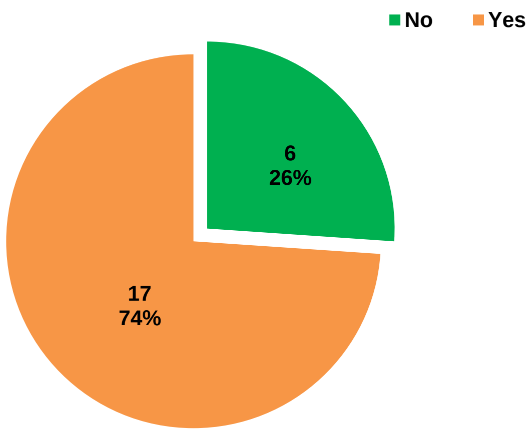
Source: Research Data – Ting Ação Ambiental.

The product design aims for long life-functioning:



Source: Research Data – Ting Ação Ambiental.

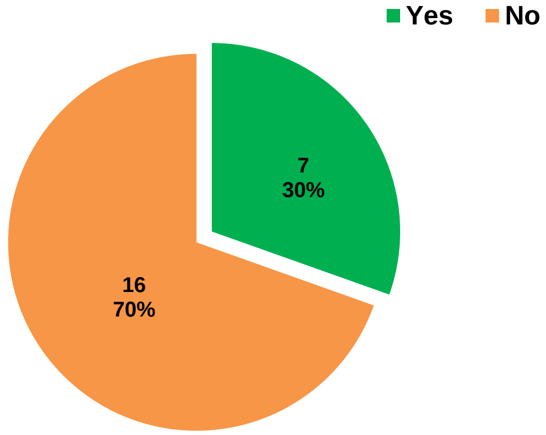
Develops dismantling / recyling process:



Source: Research Data – Ting Ação Ambiental.

From the interviewees, 74% reported developing a process of dismantling and recycling, but when asked if they had partnerships with companies that recycle WEEE only 30% said yes, partnerships with cooperatives / associations and private companies.

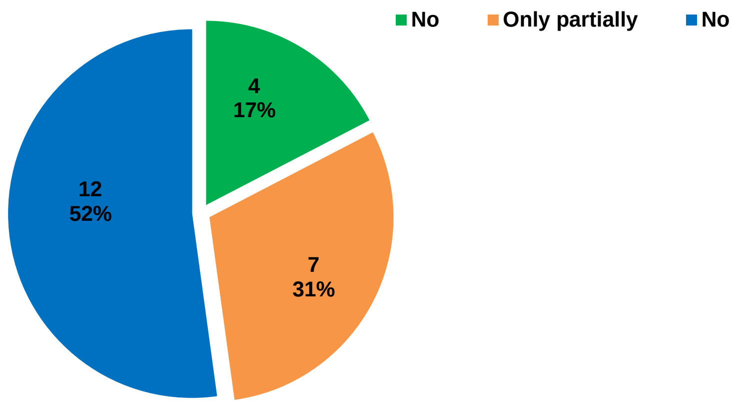
Have partnership with other WEEE companies:



Source: Research Data – Ting Ação Ambiental.

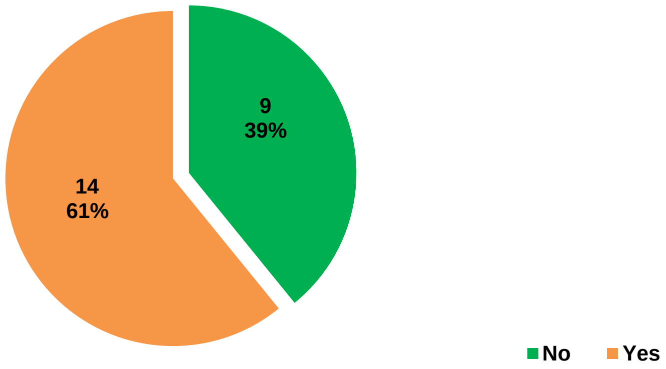
From the 23 interviewees, 52% stated that they had knowledge of the National Policy on Solid Waste (Federal Law 12,305 / 2010). It is worth remembering that the reverse logistics system is one of the most important aspects of the National Solid Waste Policy. It is directly linked to the principle of shared responsibility for the product life cycle between manufacturers, traders, consumers and public authorities.

Know the Waste National Policy – Federal Law 12.305/2010:



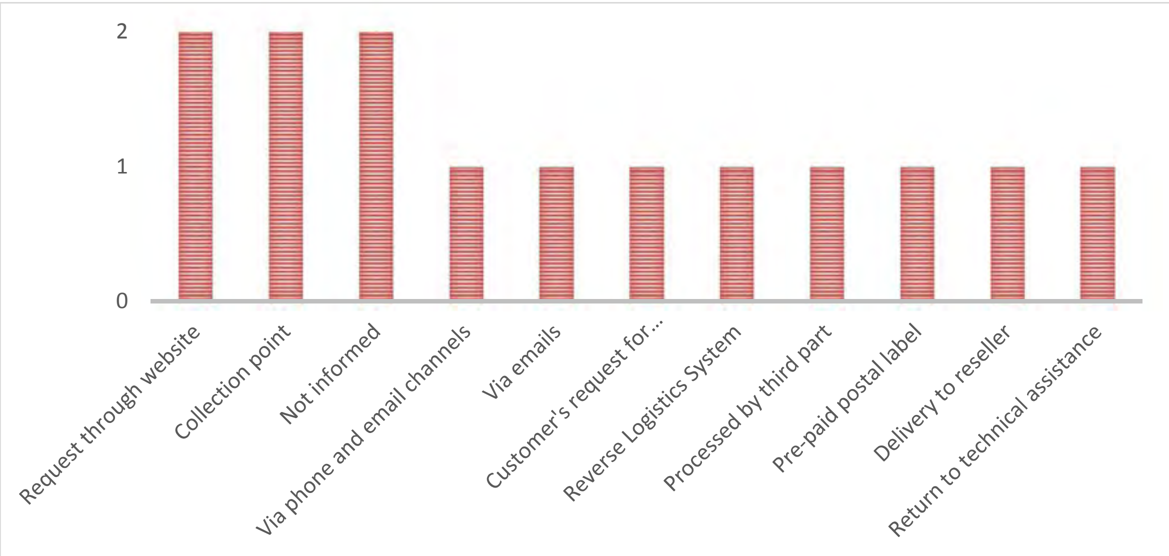
Source: Research Data – Ting Ação Ambiental.

This company collects the material for reverse logistics:



Source: Research Data – Ting Ação Ambiental.

From the companies involved in the survey, 61% said to collect WEEE for reverse logistics and the forms of collection are:



Source: Research Data – Ting Ação Ambiental

It can be seen that return policies, as well as the aggression of products to the environment, are still not seen as priority areas by a significant part of the industrial sector. As these are closely related to the solidification of reverse logistics, it is possible to affirm that the possible benefits, which can be achieved with the reverse flow operation, are still not being fully practiced by national companies. Part of the industry develops eco-design actions and perhaps evaluation of the product life cycle and although the partnership between this sector and the electrical and electronic waste sector has been evidenced, it is timid and needs to be stimulated in order to expand and strengthen collection and reduction of this waste at national level.

The PNRS establishes that every institution and organization is responsible for correctly separating and disposing of the waste they produce, which includes industry, commerce, municipalities and consumers. Following this principle some companies are investing in reverse logistics operations in order to collect their products at the end of the life cycle. Consumers should participate in this process by separating the waste properly and leading to authorized delivery points and the products collected usually undergo the process of re-characterization, reuse and are routed to the correct destination.

We have listed some companies that have invested in reverse logistics operations[19].

COMPANY	PROGRAM	TAGET	MATERIAL
DELL	Reciclagem Dell	Responsibility to recover used electronics and to recycle them properly.	Notebook, desktop PC without monitor, desktop PC with monitor, CRT monitor, flat panel monitor, Printers / Scanner among other Dell products.
MOTOROLA	Motorola Solutions	Recycling of WEEE.	Motorola Products.
PHILIPS	Ciclo Sustentável Philips	Promote the recycling of Philips electronics and household appliances.	TVs, audio and video devise, portable electronics, among other Philips products.
HP	Reciclagem de Produtos HP - HARDWARE	Dispose of obsolete equipment, batteries, cartridges and toners of your products and reintegrate the recycled materials into your own production chain, managing the entire life cycle and ensuring sustainable solutions.	Notebooks and tablets. Desktops, printers, toner, monitors and accessories, among other HP products.
Claro	Claro Recicla	Contribute to the public's awareness of the importance of properly disposing of obsolete or out-of-use cell phones, rechargeable batteries, chips and accessories.	Unused cell phones, batteries and accessories.
Positivo	Ti Verde – Positivo Informática	Prevent unused electronic equipment from being dumped in the regular trash, thereby polluting the environment.	Cellphones, notebooks, all in one, computers and accessories out of use.
Itautec	Itautec	In the pursuit of its activities it seeks environmental, social and economic sustainability, ensuring quality, productivity and competitiveness in the market. Contributing to the	Computers, printers, cell phones, refrigerators, TVs, among other Itautec products.

[19] A complementary description is given in Annex I.

		improvement of the quality of life of the population.	
AOC Brasil	AOC do Brasil Monitores LTDA	Return AOC products to the production chain and avoid incorrect disposal.	Monitors, among other AOC Brasil products.
CCE	DIGIBRAS Indústria do Brasil S/A	Dispose of an unused CCE product correctly.	Computers, notebooks, and batteries, among other CCE products.
LENOVO	LENOVO	Dispose of an Lenovo product that is not in use.	Notebooks and ultrabooks, desktops and all-in-ones and accessories, among other Lenovo products.
Apple	Apple Renew	The consumer sends for recycling any device at any Apple Store or by mail.	Mac, iPad, iPhone, Watch, TV, among other Apple products.
Brastemp, Consul and KitchenAid	"Resíduo Zero" da Whirlpool S/A	Collection points for products that are no longer being used in the State of São Paulo.	All brands Acros, Brastemp, Consul, Kitchenaid, Whirlpool, Maytag, Luxury Link and Jenn-air.
SEMP, TCL and TOSHIBA	SEMP TCL Indústria e Comércio de Eletroeletrônicos S/A	Reverse logistics service for the return of products and / or accessories marketed at the end of its useful life, in accordance with current legislation.	All products of brands SEMP, TCL and TOSHIBA
Sonobyte	Sonobyte Eletrônica LTDA.	To become more sustainable and contribute effectively to the preservation of natural resources, helping to prevent pollution of the environment, reduce waste generation and smart reuse, integrate with the consumer, strengthen the environmental responsibility of the company, The commitment of its employees to care for the environment, encouraging the use of clean technologies, among many other benefits for the company and Brazilian society.	Electronic products.

Source: Research Data – Ting Ação Ambiental

It is noticed that some manufacturers in Brazil are already investing in reverse logistics programs. The products collected usually undergo the process of decharacterization, reuse and are routed to the correct destination after the end of their life cycle.

However, there are still disagreements regarding the responsibility that each one has in this process, which causes obstacles to the implementation of reverse logistics programs in the country.

The industries of the reverse logistics chain for product reuse in Brazil are concentrated in the southeast region, and are mostly made up of micro and small companies, which use low technology in recycling. The country still does not have enough capacity to process the waste electrical and electronic equipment generated and its components, and most of the recycling procedures are not yet available, for example, we have the processing of printed circuit boards and tube glass of televisions that goes through a special process and the plates are formed by isolated and integrated units and its scrap contains copper, lead, cadmium, zinc, tin, as well as precious metals, gold, silver and platinum.

5 Potential coopperatives and recyclers to function as a consolidation and/or de-characterization center

The management priority for all solid waste established by the PNRS was to prioritize its reuse and recycling after all efforts have been made to avoid its generation.

The reuse and recycling of WEEE involves operations for the reverse manufacture and recycling of WEEE. Reverse manufacturing includes steps such as disassembly, separation, de-characterization, crushing, compaction and packaging of WEEE for reuse or subsequent recycling that must be carried out observing operating standards and current legislation.

Regarding the operational criteria that an organization must present to be considered an appropriate destination for intermediate treatment of WEEE and indicators, it was adopted:

a) OPERATIONAL CRITERIA [20]

The technical standard ABNT NBR 16156: 2013 - Electrical and Electronic Waste - which presents requirements for reverse manufacturing activity was structured as a certifiable management system; There are therefore identifiable and measurable aspects for the reverse manufacturing stage, a stage of the recycling activity that includes the processes of transforming WEEE into parts or parts, inputs or raw material without obtaining new products.

The requirements are:

[20] Source of part a): Elaboration of technical standards for the reverse chain of electronics: the case of ABNT NBR 16156: 2013 - Waste electrical and electronic equipment - Requirements for reverse manufacturing activity
Marcia Regina Ewald - Information Technology Center Renato Archer - CTI (marcia.ewald@cti.gov.br)
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- **Protection of the environment**

Define the organization's environmental policy with a focus on pollution prevention and compliance with environmental legislation; Ensuring the environmentally sound disposal of tailings; Establish, document, implement, maintain and continuously improve a management system for hazardous WEEE; Protect against spills or accidental breaks, exposure to the weather and security against access to WEEE from unauthorized persons; Disposal of WEEE only to licensed recycling facilities.

- **Health and safety at work**

Define health and safety at work policy with focus on pollution prevention and compliance with environmental legislation; Establishment, implementation and maintenance of plans and procedures to eliminate exposure to hazardous materials or substances at the workplace, both from electrical and electronic waste and from operations inputs; Conducting safety inspections; Implementation of work accident prevention program, regardless of the number of workers in the organization; Establishing procedures to clean the workplace to minimize exposures, both for employees and their families; Establishment of plans for responding to emergency situations; Use of accredited laboratories for all biological analyzes.

- **Traceability of WEEE**

Ability to recover the history, application or location of what is being considered until the transformation into raw material or final disposal.

- **De-characterization of user data and manufacture´s brand protection**

Process to protect the trademark and information of the contracting company or user that may be contained in the electronic waste, such as patrimony stamps, logos and electronic data.

b) INDICATORS

Measurement instruments adopted capable of providing information that facilitates the evaluation of the suitability of a WEEE disposal unit.

- **Protection to the environment**

- ✓ The organization is licensed by environmental agencies;
- ✓ Has an environmental policy;
- ✓ Comply with environmental legislation;
- ✓ Tailings are properly destined;
- ✓ It has a management system for hazardous WEEE;
- ✓ Disposal of its WEEE only to licensed recycling facilities.

- **Health and safety at work**

- ✓ The organization has a health and safety at work policy focused on pollution prevention and compliance with environmental legislation;
- ✓ The organization has established, implemented and maintains plans and procedures to eliminate exposure to hazardous materials or substances at the workplace, both from electrical and electronic waste and from operations inputs;
- ✓ The organization conducts safety inspections;
- ✓ The organization has a work accident prevention program;
- ✓ The organization has procedures for cleaning the workplace;
- ✓ The organization has plans for emergency situations;
- ✓ The organization uses accredited laboratories.

- **Traceability of WEEE**

- ✓ The organization has the capacity and procedures in place that can recover the history, application or location of WEEE until its transformation into raw material or final disposal;
- ✓ User re-characterization and protection of the manufacturer's brand;
- ✓ The organization has the capacity and procedures in place to protect the brand and the information of the company or contracting user that may be contained in the WEEE, such as patrimony stamps, logos and electronic data.

The importance of identifying and presenting institutions that are structured or formalized is known. However, throughout the survey, we identified that some of the institutions have great potential, but with the need for adjustments and regularization of operations / certification licenses. In addition, regarding cooperatives of collectors we understand that we must comply with the established in the National Electronic Waste Plan, Law 12,305 / 201: Central support for the productive inclusion of collectors of reusable and recyclable materials, prioritizing the participation of cooperatives or other forms of association of recyclers of reusable and recyclable materials made up of low-income individuals.

Decree 7404 defines that:
The selective collection and reverse logistics systems will prioritize the participation of the collectors of recyclable materials, in the same way that the municipal plans must define programs and actions for their inclusion in the processes. The waiver of bidding for the contracting of cooperatives or associations of collectors should be observed; The encouragement of the institutional strengthening of cooperatives, as well as research aimed at integrating them into actions involving shared responsibility for the product life cycle and the improvement of their working conditions. The priority in the participation of the collectors is reflected in the prioritization of access to federal resources for municipalities that implement selective collection with the participation of cooperatives or other forms of organization.

A relevant and very important aspect addressed in the National Plan that points out the significant advances that have taken place in favour of the collecetors. An important inclusion to define strategies to induce social programs or measures that promote the organization of collectors / cooperatives.

Below we list the evaluation criteria used to evaluate the institutions that are qualified to become Consolidation Centers - CC and (or) Disability Center - CD.
The established order of institutions has as criteria the Institution that has the greatest potential to be a Consolidation Centers - CC / Discrimination Center - CD for the Institution of least potential.

5.1 BRASÍLIA

BRASÍLIA – DF										
EVALUATION CRITERIA - CONSOLIDATION AND RE-CHARACTERIZATION CENTERS										
INSTITUTIONS	Category	Licenses / Certifications				Environmental Licensing IBRAM - DF		Environmental licensing SECIMA - GO		Municipality
		AR	ANVISA	ISO	IBAMA (Federal Technical Registry - Registration Certificate)	Licensed	With the capacity to receive it	Licensed	With the capacity to receive it	License
Zero Impacto Organização Logística de Cargas Ltda	Recycler	YES	-	-	YES	YES	-	-	-	YES
DMS Recicláveis e Serviços Ambientais Ltda - Epp	Recycler	YES	YES	YES	YES	YES	YES	-	-	YES
Capital Indústria e Comércio de Produtos Recicláveis Ltda	Recycler	YES	-	-	-	YES	-	-	-	YES
Comitê para Democratização da Informática no DF e Entorno	Non-Governmental Organizations	YES	-	YES	-	YES	YES	-	-	YES
Programando o Futuro	Non-Governmental Organizations	YES	-	YES	YES	-	-	Presents license waiver	-	YES
Reciclagem Rio Campos Ltda - Me	Recycler	YES	-	-	-	YES	-	-	-	YES
Associação Recicle a Vida	Cooperatives and Associations	YES	-	-	-	In licensing process	-	-	-	YES

Cooperativa de Produção Artesanal e Industrial do DF - Sonho de Liberdade	Cooperatives and Associations	YES	-	-	-	In licensing process	-	-	-	YES
Nasa Serviços de Logística Ltda - Me	Recycler	YES	-	-	-	-	-	In licensing process	-	YES
Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa	Cooperatives and Associations	YES	-	-		-	-	NO	YES	YES
Central de Reciclagem do Varjão	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Cooperativa de Reciclagem Ambiental - Cooperdife	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
R3 Cooperativa de Catadores de Santa Maria	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Catamare Cooperativa dos Catadores de Materiais Recicláveis do Distrito Federal	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Associação dos Catadores de Materiais Recicláveis do Distrito Federal	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Cooperativa de Trabalho de Reciclagem Ambiental – CONSTRUIR	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES

Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES
Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	Cooperatives and Associations	YES	-	-	-	NO	YES	-	-	YES

BRASÍLIA – DF

EVALUATION CRITERIA - CONSOLIDATION AND RE-CHARACTERIZATION CENTERS

INSTITUTIONS	Category	Protection to the environment	Health and Safety at work	Traceability of WEEE	Re-characterization of user data and protection of the manufacturer's brand	Infrastructure		Management Capacity		Potential to:		
						Adequate	To be adapted	With capacity	Needs training	Start work immediately	Start works, but need adjustments	Do not act upon, but have potential and interest
Zero Impacto Organização Logística de Cargas Ltda	Recyclers	YES	YES	Not informed	YES	X				(CC and RC)	-	-
DMS Recicláveis e Serviços Ambientais Ltda - Epp	Recyclers	YES	YES	Not informed	YES	X				(CC and RC)	-	-
Capital Indústria e Comércio de Produtos Recicláveis Ltda	Recyclers	YES	YES	Not informed	YES	X				(CC and RC)	-	-

Comitê para Democratização da Informática no DF e Entorno	Non-Governmental Organizations	YES	YES	Not informed	YES	X				(CC and RC)	-	-
Programando o Futuro	Non-Governmental Organizations	YES	YES	Not informed	YES	X				(CC and RC)	-	-
Reciclagem Rio Campos Ltda - Me	Recyclers	No defined environmental policy	YES	Not informed	NO	X				(CC)	-	-
Associação Recicle a Vida	Cooperatives and Associations	YES	YES	NO	YES		X			-	(CC and RC)	-
Cooperativa de Produção Artesanal e Industrial do DF - Sonho de Liberdade	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X			-	(CC)	-
Nasa Serviços de Logística Ltda - Me	Recyclers	No defined environmental policy	No informed	Not informed	NO	X		X		-	(CC)	-
Cooperativa de Reciclagem e Desenvolvimento Sustentável de Formosa	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X			-	(CC)	-
Central de Reciclagem do Varjão	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X			-	(CC)	-
Cooperativa de Reciclagem Ambiental - Cooperdife	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	-
R3 Cooperativa de Catadores de Santa Maria	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	-

Catamare Cooperativa dos Catadores de Materiais Recicláveis do Distrito Federal	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	-
Associação dos Catadores de Materiais Recicláveis do Distrito Federal	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	-
Cooperativa de Trabalho de Reciclagem Ambiental – CONSTRUIR	Cooperatives and Associations	No defined environmental policy	NO	NO	NO		X		X		(CC)	-
Cooperativa de Coleta Seletiva e Reciclagem de Resíduos Sólidos com Formação em Educação Ambiental do Recanto das Emas	Cooperatives and Associations	No defined environmental policy	NO	NO	NO	-	X	-	X	-	(CC)	-
Cooperativa de Coleta Seletiva de Materiais Recicláveis e Resíduos Sólidos - Reciclo/DF	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	-

AR - Attestation of Regularity (Fire Department). Source: Attestation of Regularity (Fire Department). Available at: http://www.portais.pe.gov.br/web/cbmpe/atestado-de-regularidade. Accessed on: 10 March 2017.
ANVISA - National Agency of Sanitary Surveillance (Federal Agency). Source: ANVISA. Available at: http://portal.anvisa.gov.br/registros-e-autorizacoes/empresas/cbpda/solicitacao-de-certificado. Accessed on: 10 March 2017.
ISO - International Certification. Source: ISO certification. Available at: http://certificacaoiso.com.br/iso-9001/guia-de-implementacao-requisitos/. Accessed on: 10 March 2017.
IBAMA (Ministry of the Environment, Federal Technical Registry - CTF). Source: IBAMA. Ministry of the Environment. Federal Technical Registry. Available at: http://www.ibama.gov.br/index.php?option=com_ content & view = article & id = 1000 & Itemid = 1004. Accessed on 10 March 2017.
LA - Environmental Licensing (Instituto Brasília Ambiental - IBRAM). Source: IBRAM. Available at: http://www.ibram.df.gov.br/. Accessed on Mar 10. 2017.
SECIMA - Secretary of Environment, Water Resources, Infrastructure, Cities and Metropolitan Affairs. Source: SECIMA. Available at: http://www.secima.go.gov.br/. Accessed on 10 March 2017.
City Hall - Location and operating permit issued by responsible municipalities). Source: Brasília. Available at: http://www.brasilia.df.gov.br/index.php/servicos/?cat_ID=36. Accessed on 10 March 2017.

5.2 RECIFE

RECIFE – PE								
EVALUATION CRITERIA - CONSOLIDATION AND RE-CHARACTERIZATION CENTERS								
INSTITUTIONS	Category	Licensing / Certifications				Environmental Licensing CPRH		Municipality
		AR	ANVISA	ISO	IBAMA (Federal Technical Registry - Certificate of Registration)	Licensed	With the capacity to receive it	License
Fênix Gerenciamento de Resíduos Eireli - Me	Recyclers	YES			YES	YES	NA	YES
Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda – Epp	Recyclers	YES			YES	YES	NA	YES
DDX Tecnologia - Descarte Já	Recyclers	YES			YES	YES	NA	YES
Jaidete Gomes Dos Santos Reciclagem - Me (JG Reciclagem)	Recyclers	YES			YES	YES	NA	YES
Lorene Recife Comércio de Sucatas Ltda	Recyclers	YES	YES	YES	YES	YES	NA	YES
Ecobras Reciclagem de Resíduos Ltda.	Recyclers	YES	YES	YES	YES	YES	NA	YES
União Norte Brasileira de Educação e Cultura (CRC Marista)	Non-Governmental Organizations	YES				YES	YES	YES
Assistência e Promoção Social Exército de Salvação	Non-Governmental Organizations	YES				NO	YES	YES

Associação dos Trapeiros de Emaús Recife	Non-Governmental Organizations	YES				YES	NA	YES
Pró-Recife Cooperativa de Catadores Profissionais de Recife	Cooperatives and Associations	YES				YES	NA	YES
Só Reciclável do Nordeste Ltda - Epp	Recyclers	YES			YES	YES		YES
Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Recyclers	YES	YES		YES	YES	NA	
Núcleo de Triagem de Catadores e Catadoras de Gusmão	Cooperatives and Associations	NO			NO	NO	YES	YES
Cooperativa Esperança Viva	Cooperatives and Associations	NO				NO	YES	
Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede	Cooperatives and Associations	NO				NO	YES	
Associação de Catadores O Verde e Nossa Vida	Cooperatives and Associations	NO				NO	YES	

RECIFE – PE												
EVALUATION CRITERIA - CONSOLIDATION AND RE-CHARACTERIZATION CENTERS												
INSTITUTIONS	**Category**	**Protection to the environment**	**Health and Safety at work**	**Traceability of WEEE**	**Re-characterization of user data and protection of the manufacturer's brand**	**Infrastructure**		**Management Capacity**		**Potential to:**		
						Adequate	**To be adapted**	**With capacity**	**Needs training**	**Start work immediately**	**Start works, but need adjustments**	**Do not act upon, but have potential and interest**
Fênix Gerenciamento de Resíduos Eireli - Me	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
Natureza Viva Reciclagem, Empreendimentos e Soluções Ambientais Ltda – Epp	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
DDX Tecnologia - Descarte Já	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
Jaidete Gomes Dos Santos Reciclagem - Me (JG Reciclagem)	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
Lorene Recife Comércio de Sucatas Ltda	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
Ecobras Reciclagem de Resíduos Ltda.	Recyclers	YES	YES	Not informed	YES	X		X		(CC and RC)		
União Norte Brasileira de Educação e Cultura (CRC Marista)	Non-Governmental Organizations	YES		YES	YES	X		X		(CC and RC)		

Assistência e Promoção Social Exército de Salvação	Non-Governmental Organizations	YES		NO	Not informed	X		X		(CC)		
Associação dos Trapeiros de Emaús Recife	Non-Governmental Organizations	No defined environmental policy		NO	Not informed		X	X			(CC)	
Pró-Recife Cooperativa de Catadores Profissionais de Recife	Cooperatives and Associations	No defined environmental policy	YES	NO	YES		X		X		X	
Só Reciclável do Nordeste Ltda - Epp	Recyclers	No defined environmental policy	YES	Not informed	YES	X		X		(CC and RC)		
Icaru Costa Serafim - Comércio e Reciclagem - Me (Bumerangue Sucateiro)	Recyclers	No defined environmental policy	YES	Not informed	YES	X		X				(CC and RC)
Núcleo de Triagem de Catadores e Catadoras de Gusmão	Cooperatives and Associations	No defined environmental policy	NO	NO	NO		X		X		(CC)	
Cooperativa Esperança Viva	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	
Cooperativa de Trabalho dos Catadores de Resíduos Sólidos Bola na Rede	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	
Associação de Catadores O Verde e Nossa Vida	Cooperatives and Associations	No defined environmental policy	YES	NO	NO		X		X		(CC)	

AR - Attestation of Regularity (Fire Department). Source: Attestation of Regularity (Fire Department). Available at: http://www.portais.pe.gov.br/web/cbmpe/atestado-de-regularidade. Accessed on: 10 March 2017.

ANVISA - National Agency of Sanitary Surveillance (Federal Agency). Source: ANVISA. Available at: http://portal.anvisa.gov.br/registros-e-autorizacoes/empresas/cbpda/solicitacao-de-certificado. Accessed on: 10 March 2017.
ISO - International Certification. Source: ISO certification. Available at: http://certificacaoiso.com.br/iso-9001/guia-de-implementacao-requisitos/. Accessed on: 10 March 2017.
IBAMA (Ministry of the Environment, Federal Technical Registry - CTF). Source: IBAMA. Ministry of the Environment. Federal Technical Registry. Available at: http://www.ibama.gov.br/index.php?option=com_content&view=article&id=1000&Itemid=1004. Accessed on 10 March 2017.
CPRH - State Agency for the Environment and Water Resources (Government of the State of Pernambuco, Secretariat of Environment and Sustainability). Source: Government of the State of Pernambuco. Secretariat of Environment and Sustainability. Available at: http://www.cprh.pe.gov.br/home/42821%3B61212%3B10%3B0%3B0.asp. Accessed on 10 March 2017.
City Hall - Location and operating permit issued by responsible municipalities). Source: Permit of location and operation. Available at: http://www2.recife.pe.gov.br/servico/emissao-de-alvara-de-localizacao-e-funcionamiento. Accessed on 2 April 2017.

6 Considerations

The inadequate management of electronic waste is a major environmental problem in the regions involved in this research, as well as in all of Brazil. According to ABDI - Brazilian Agency for Industrial Development and Inventta Consultoria Ltda, the estimated generation of WEEE for 2017 in Brazil is 1,367.69 thousand tons. In developed countries, this situation has been approached through the promulgation of regulations and incentives that promote the existence of companies to recover and recycle electronic equipment or act in the commercialization of these materials as new raw materials. In Brazil, despite Law No. 12,305 / 10, which establishes the National Solid Waste Policy (PNRS), which contains important instruments to enable the country to advance in addressing the main environmental, social and economic problems arising from the inadequate management of solid wastes and especially the approach regarding shared responsibility between waste generators, manufacturers, importers, distributors, traders, citizens and owners of urban solid waste management services in reverse logistics, including in these the waste of electrical and electronic equipment and its components, management is still limited. It is basically oriented towards equipment recovery (remanufacturing) to extend its use in social projects, recycling, mainly based on the disassembly and export of parts for recovery in industries outside the country.

If you recover or recycle a minimum percentage of WEEE, another part is disposed of as hazardous waste. And much of it is being sent to landfills, controlled landfills, and even dumps. The sector currently includes a wide range of actors: manufacturers, importers, distributors, reclaimers and recyclers, both formal and informal, waste pickers and public managers.

There are still some barriers related to an incipient market for recoverable electronic waste components in the country, which should be strengthened to determine their potential for development as well as the diffusion of management alternatives.

Included in the conditions and difficulties inherent in post-consumer reverse logistics:

- The long time elapsed between the acquisition of the product and the return of the product used;
- Diffuse responsibility between the manufacturer, the distributors and the retailers regarding the evaluation of the various elements related to the EWRL - conflict of interest;
- Organization of the remuneration of the participants of the reverse chains;

- How to deal with products that do not have added value or that there is no technology for recycling and reintegration into the production chain;
- The diversity of electronic products (types, volumes, components, periculosities, among others), being necessary the determination of suitable solutions for each case;
- Lack of information for the consumer public who is not informed about the reverse logistics, actors involved, resolutions and the main objectives of the National Policy on Solid Waste;
- Transport Challenges (high cost);
- Challenges in reuse, since the reuse is carried out by a small number of micro or small companies that need expressive labor, use low technology and have low productivity;
- Immediately, the number of recyclers in the country is unlikely to be sufficient for the treatment of planned generation quantities;
- Small percentage of companies acting with processes of reuse with high technology, labor standards, certifications and environmental licensing;
- General Reverse Logistics Costs - Who will pay for this account?
- Lack of clear definition of roles among the actors involved;
- Efficient organization of the network of reverse logistics activities: forms of collection, transportation, location of these activities, processing;
- Allocation of resources to qualify skilled labor and resources to acquire equipment;
- Delays in the definition of sector agreements, among others.

According to the National Information System on Solid Waste Management (SINIR), "Reverse logistics is an instrument of economic and social development characterized by a set of actions, procedures and means to enable the collection and restitution of solid waste to the business sector, for reuse, in its cycle or in other productive cycles, or other environmentally adequate final destination. "

Law 12,305 / 2010 devoted special attention to reverse logistics and defined three different instruments that could be used for its implementation: regulation, sectoral agreement and term of commitment. The instrument defined for the reverse logistics of electrical and electronic waste was the sector agreement. Ten sectoral agreement proposals were received until June 2013, four of which are considered valid for negotiation. The unified proposal was received in January 2014. And it is still under negotiation, with the next stage being the Public Consultation.

The sectoral agreement is an "act of a contractual nature entered into between the public authority and manufacturers, importers, distributors or traders, in view of the implementation of shared responsibility for the product life cycle."

Green Eletron, Manager for Reverse Logistics of Electronic Products, created by Abinee, is the new entity to meet the obligations set forth in the National Policy on Solid Waste (Law 12,305/2010), regulated by Decree 7,404 / 2010, and in the Sectorial Agreement, which will still be signed, and which will set targets for collection and disposal of discarded products. According to Abinee, compliance with the Settlement Agreement was done collectively, the association considered this to be the most appropriate option after a detailed analysis of risks, opportunities and costs elaborated by the entity, the focus was to create a manager to harmonize all activities and sectors by a path that would be more technically and economically feasible for companies. The performance of the future manager covers all products and electronic by-products that are discarded at the points of collection after used by consumers. Their responsibility, however, does not directly address the management, disposal and final disposal environmentally adequate of these wastes, which will be made by companies contracted. The Management's membership is not limited to Abinee members. According to established criteria, it may be composed of legal entities, unlimited, with or without profit, based in the country, representing the electrical and electronic sector or that act in the production and commercialization, including the integration of systems and development of dedicated software.

There is also the Brazilian Association for the Recycling of Electrical and Electronic Appliances -ABREE, a non-profit entity, which aims to define and organize the solid waste management (post-consumption) of its Associates, contracting inspection and auditing of the services provided by third parties, for the implementation of large-scale reverse logistics collective systems, promoting the apportionment of costs through participation in the chain.

On the other hand, in regards to the investigations, it should be mentioned that when looking for information on variables of composition of integrated solid waste management, specifically involving electronic waste, in both Brasília (DF) and Recife (PE) appeared difficulties of different orders: Few technical studies, failure to update data in some areas, failure of district / municipal / state entities to generate information, disarticulation of the district / municipal / state secretariat network, lack of reports by public and private companies related to Management of solid waste.

It was evidenced the lack of an administrative transversality that could dynamize and optimize specific processes that involve several actors in the issue of solid waste generated in these cities. These negative particularities, suppose a first failure in the search of a systemic and effective work. It is considered that an adequate WEEE logistics program will promote, in addition to its environmental ambitions, a series of paradigms of civility along with the introduction of economic alternatives that encourage social equity and harmony among citizens and support the insertion of the collectors in the chain of reverse logistics by improving the status of the category by supporting collector cooperatives as an instrument to combat inequality and other issues related to the National Solid Waste Policy (PNRS). However, a change so essential in the community leads to an initial breakthrough manifested through different political positions and social confusion that can be overcome only with the first concrete achievements of the program.

Japan International Cooperation Agency
(JICA)

Project for E-waste Reverse Logistics Improvement in the Federative Republic of Brazil

The Survey of the Current Situation of E-waste Reverse Logistics in other cities

Part II - Estimated volume of discarded WEEE and Recommendation

August 2017

JICA Expert Team

Preface

This survey has been made by JICA Expert Team under the Project for E-waste Reverse Logistics Improvement to capture a current status of generation, collection, transportation and treatment of post consumer E-waste in the Area of Brasilia and Recife. The results of the survey shall be utilized by the Brazilian counter parts and stake holders for policy formation of E-waste reverse logistics in Brazil.

This report consists of the following two parts, and Part I is sub-contracted to a local consultant: TING AÇÃO AMBIENTAL, while Part II is the result of analysis and estimation by JICA Expert Team.

Part I – Result of Surveys

Methodology and results of survey on the available recycling companies in Brasilia and Recife city

Methodology and results of Interview to related actors in Brasilia and Recife.

Part II – Estimated volume of discarded WEEE and Recommendation

Estimation methodology and results of E-waste generation in Brasilia and Recife city: E-waste amounts and flows

Recommendation on the applicability of the Pilot Project tried in Sao Paulo City

The results described in this report, especially contents of Part II, shall be carefully handled and shall not be disclosed to the public without permission of Brazilian counter parts of the project: Ministry of Development, Industry and Foreign Trade (MDIC), Ministry of Environment (MMA) and Municipal Authority of Urban Cleaning, Sao Paulo city (AMLURB)

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Abbreviations

TV	Television
CRT	Cathode Ray Tube
LCD	Liquid Crystal Display
PC	Personal Computer
IBGE	Instituto Brasileiro de Geografia e Estatística
IDC	International Data Corporation

1 Preconditions and estimation method

1.1 Preconditions for estimating the e-waste disposal and recycling flow

1.1.1 Target e-wastes

The following ten e-wastes were targeted, considering the shares in the total amount of e-wastes, hazardousness and resource recovery.

- Television sets (CRT)
- Television sets (FLAT)
- Refrigerator
- Washing machine
- Air conditioner
- Personal computer (Desktop, CRT)
- Personal computer (Desktop, LCD)
- Personal computer (Notebook)
- Mobile phone
- Small electrical and electronic equipment[1]

1.1.2 Target area

- Brasilia
- Recife

1.1.3 Target duration

The latest data up to 2013 were used for estimating the amount of e-waste after year 2014. The past data were regressed back to 1990 by considering the lifetimes of the target e-wastes. The future data were regressed up to 2030 so as to provide the enough information for discussions on future policies.

[1] Small e-wastes were represented by some highly penetrated products such as cleaners, irons, mixers, ovens and hair-dryers.

1.2 Procedure for estimation of e-waste disposal and recycling flow

1.2.1 Procedure for estimation of e-waste disposal and recycling flow

Step 1. Estimation of the supply of E-products

The future numbers of the supplied e-waste in the City of Brasilia and Recife are estimated based on the past number of the supplied e-waste.

Step 2. Estimation of the amount of generated e-wastes

The numbers of the reused, discarded and stocked e-wastes are estimated by applying the supply rates to households, average used years and reused rates to the past supplies.

Step 3. Estimation of e-waste flow

The e-waste flow can be estimated by applying the flow parameters to the numbers estimated in Step 2. The flow parameters are obtained from the questionnaire surveys on households/businesses and the e-waste flow survey.

1.2.2 Sub-contracted work for e-waste flow

As part of this project, the following two surveys were conducted in Sao Paulo city in the first year. The generating characteristics in this other cities survey will refer to the results of this investigation in Sao Paulo City.

Questionnaire survey on households and businesses

The questionnaire surveys were conducted in April and May, 2015. The samples of the surveys are shown below.

- Household 715 households
- Business 325 businesses
- (Office 66）
- (Retailer 68)
- (Restaurant 67)
- (Hotel 63)
- (School 61)

As for the household survey, the households selected by the sampling by household income levels were visited and asked the questions. As for the businesses, the questionnaire survey was conducted by means of the automatic answering system of the telephones.

E-waste flow survey

The e-waste flow survey was conducted in 89 facilities related to e-waste recycling. The visited companies are shown below.

- Licensed e-waste factory 38 facilities
- Licensed hazardous waste treatment factory 4
- Non-licensed e-waste recycling factory 16

- Repair shop 10
- E-waste collector/Junkshop/dealer 13
- Secondhand shop 6
- Take-back to retailers 2

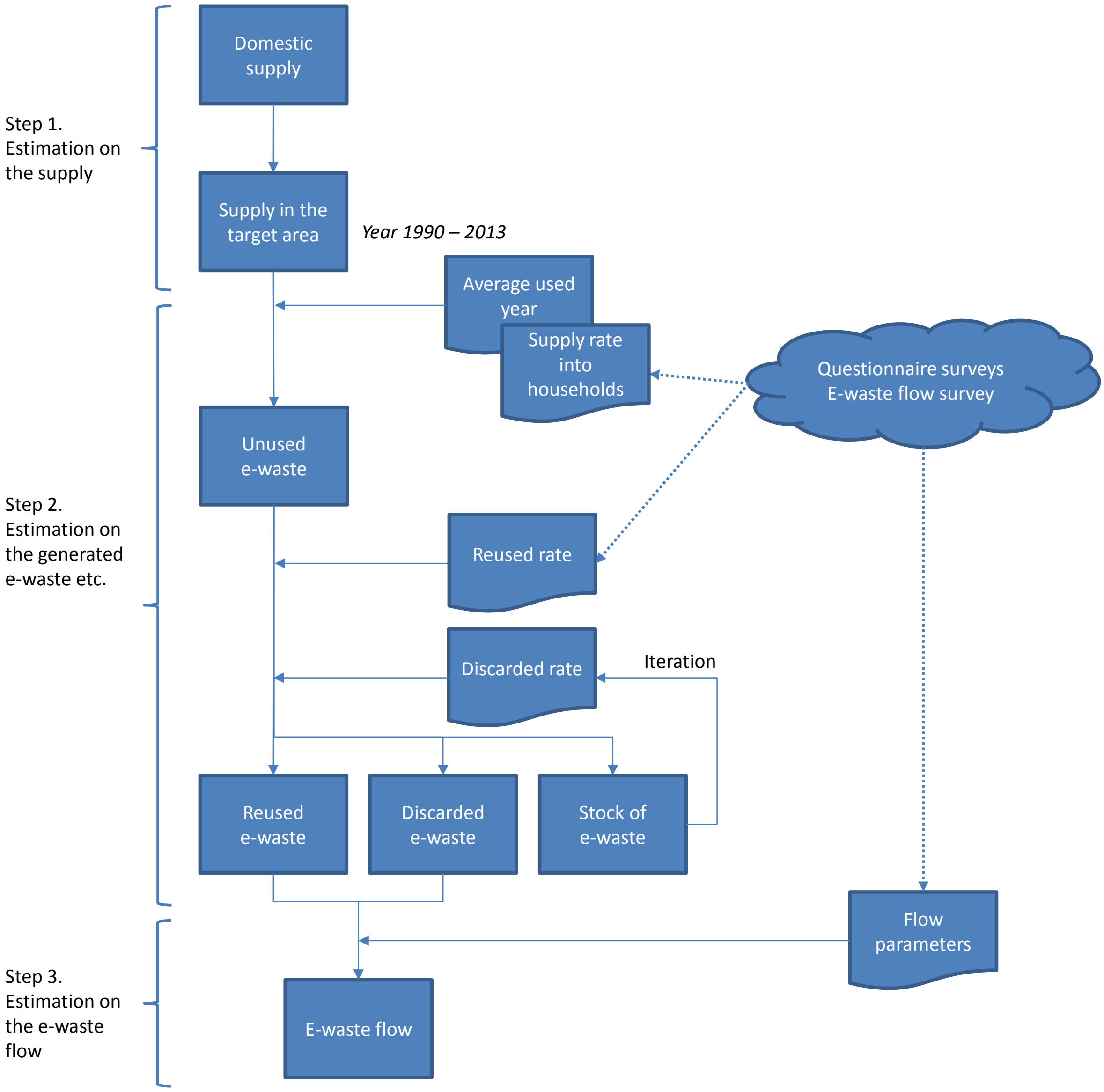


Figure 1 Procedure for estimating generated and recycled e-waste flow
Source: JICA Expert Team

2 E-waste flow estimation in detail

2.1 Step 1. Estimation of electrical and electronic products supply

2.1.1 Estimation Procedure

The supply of electrical and electronic products are estimated by the following steps.

- Data collection of numbers of electrical and electronic products sold in Brazil in the past
- Estimation of the numbers of electrical and electronic products sold in Brasilia and Recife

2.1.2 Supply in Brazil

Figure 2 shows the trend of the domestic supply of electrical and electronic products in Brazil. The fauture numbers were regressed by using the data between 2005 and 2012 provided by "Instituto Brasileiro de Geografia e Estatística" (IBGE) based on the considerations contained in, and the past trends were also regressed smoothly. The data of television sets and personal computers were split to CRT TV and FLAT TV and to CRT Desktop type, LCD Desktop type and notebook type respectively by using the procedure described below.

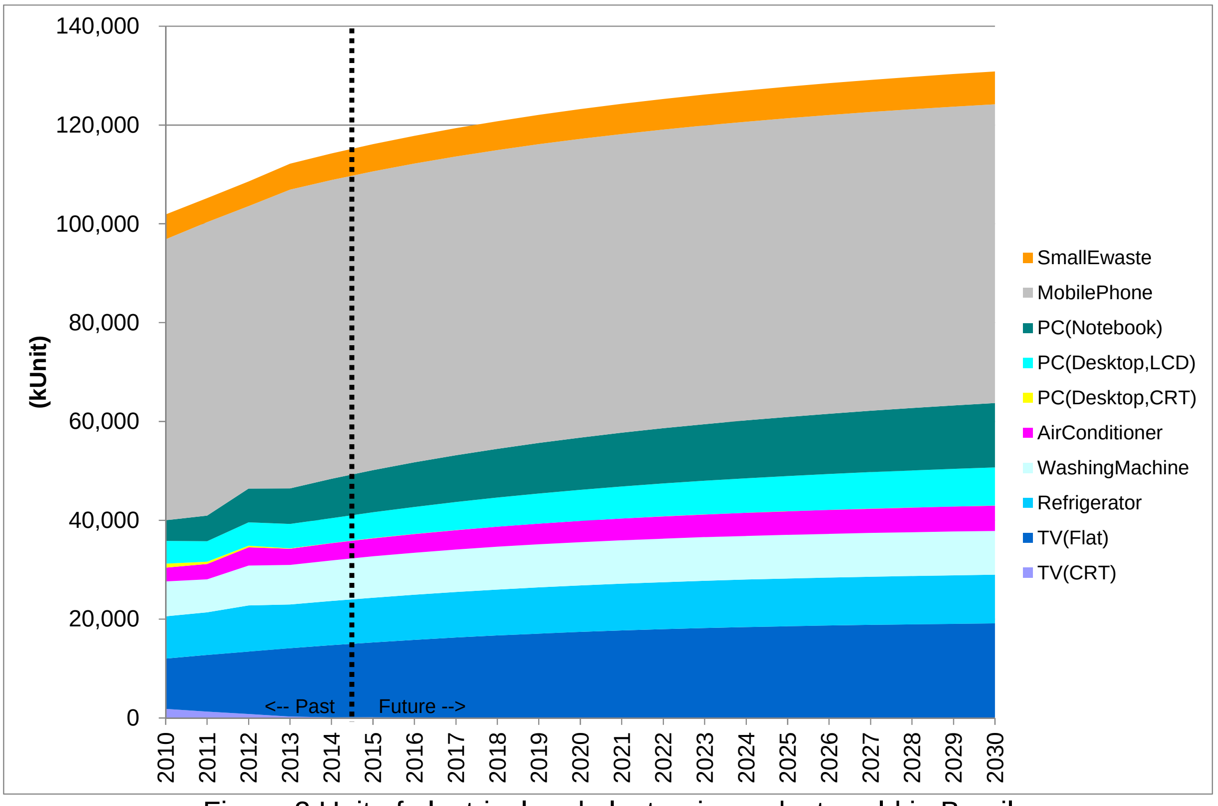


Figure 2 Unit of electrical and electronic products sold in Brazil

Source： JICA Expert Team

Table 1 Future trend of sales of electrical and electronic products in Brazil

	Penetration rate in Sao Paulo	Analysis on the penetration rate	Future trend considered in the regression

	City (Household questionnaire)		
Television sets	192%	Saturated already. However, big demands of replacement towards 2016 when the digital broadcasting was started.	Rising slowly up to 20 million units.
Refrigerator	100%	Saturated already.	10 million units in 2030, keeping the present sales
Washing Machine	89%	To be penetrated a little more	Rising up to 9 million units
Air-conditioner	7%	To be penetrated more	Growing up to 5 million units in 2030
Personal computer	81%	The penetration rate is not 100%, but the shift from personal computers to tablets is expected after the present.	Growing at the present growing speed to reach at 20 million units in 2030
Mobile phone	215%	Saturated already. Replacement by smartphones is expected after the present	Keeping the present sales.
Small e-waste	70%	To be penetrated a little more.	Growing slowly to reach at 7 million units in 2030

Source: JICA Expert Team

Splitting of television sets

IBGE does not prepare the data of television sets with the categories of CRT TV and FLAT TV. Here, the IBGE data were split by the production rate shown in the following figure.

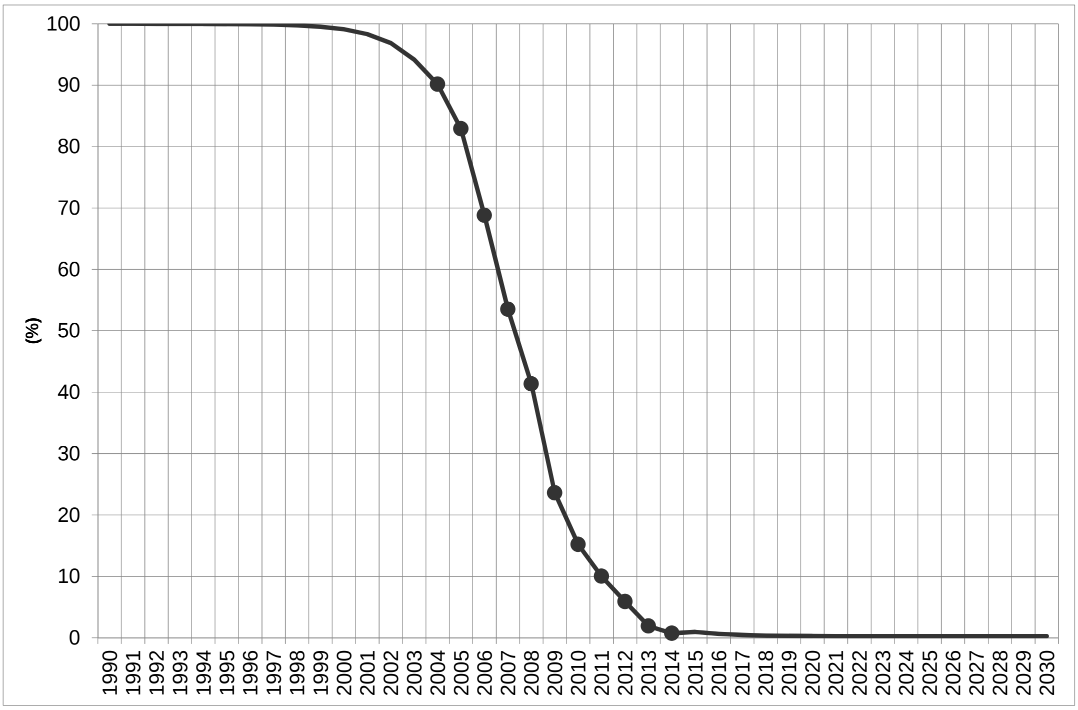


Figure 3 The rate of CRT television in the total production of televisions

Source: Display Search NPD DisplaySearch Advanced Quarterly Global TV Shipment and Forecast Report

URL:http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/120103_lcd_tv_shipment_growth_to_improve_in_2012_driven_by_40_and_larger_sizes.asp (confirmed on 2 June 2015)

Splitting of personal computers

IBGE does not prepare the data of personal computers with the categories of CRT desktop type, LCD desktop type and notebook type. Here, the IBGE data were split by the production rate of desktop computers prepared by International Data Corporation (IDC). The data for desktop computers were split to CRT type and LCD type by using the data of Figure 3 .

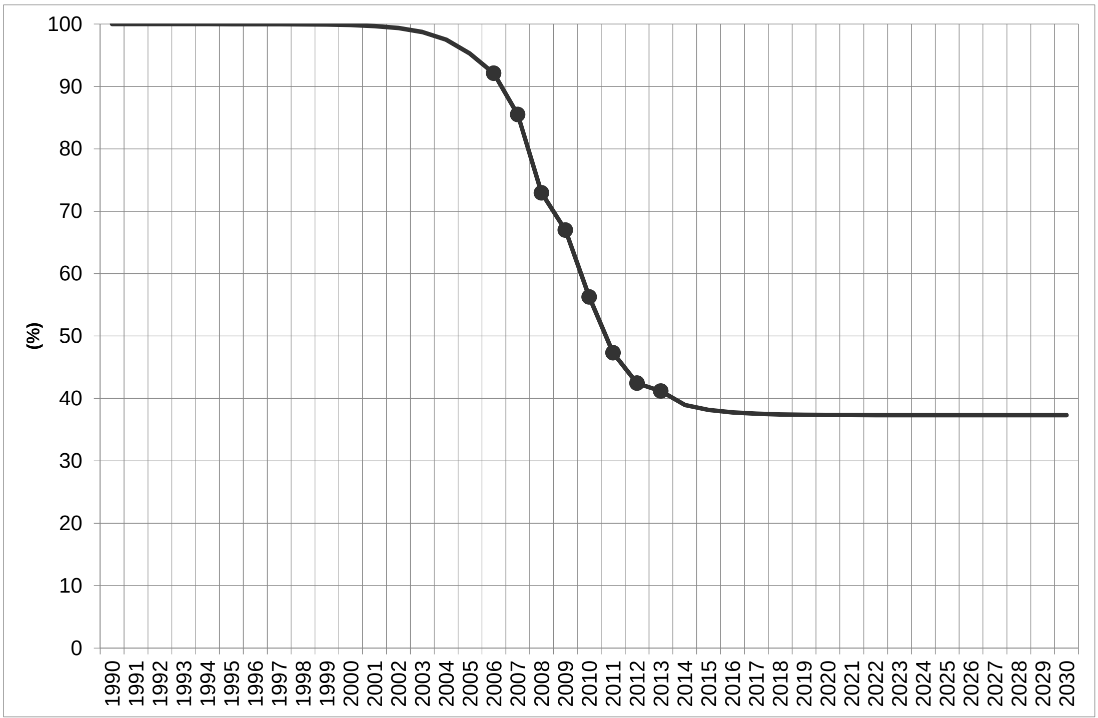


Figure 4 Rate of sales of desktop computers in the total personal computer sales

Source: IDC

Sales of small appliances

The category of small appliances were represented by the products of

- Vacuum cleaner
- Iron
- Mixer
- Electrical oven
- Hair-dryer,

considering their penetration rates in Brazil. The number of units of small appliances were calculated by the following formula.

- Supplied units of small appliances $= \frac{w_1 * N_1 + w_2 * N_2 + \cdots + w_n * N_n}{w_1 + w_2 + \cdots + w_n}$

Where,

- w_i: weight of each product
- N_i: supplied unit of each product。

2.1.3 Conversion to the supply to Brasilia and Recife

The domestic supply in Brazil is converted to the supply to Brasilia and Recife City by the following formula, assuming that the supplies are determined according to the population and the GDP per capita.

$$DS_{DF\ or\ Re} = \frac{DS_{BR}}{POP_{BR}} * POP_{DF\ or\ Re} * \frac{GC_{DF\ or\ Re}}{GC_{BR}}$$

$$= \frac{DS_{BR}}{POP_{BR}} * POP_{DF\ or\ Re} * \frac{GDP_{DF\ or\ Re}/POP_{DF\ or\ Re}}{GDP_{BR}/POP_{BR}} = DS_{BR} * \frac{GDP_{DF\ or\ Re}}{GDP_{BR}}$$

Where

- DS: $Domestic\ supply$
- GC: $GDP\ per\ capita$
- GDP: $Gross\ Domestic\ Products$
- POP: $Population$
- Suffix DF: $Brasilia$
- Suffix Re: $Recife$
- Suffix BR: $Brazil$

The data of GDP in Brazil, Brasilia and Recife were prepared as shown in Figure 5 and Figure 6 . The supplies of e-products in Brasilia and Recife were calculated as shown in Figure 7 and Figure 8.

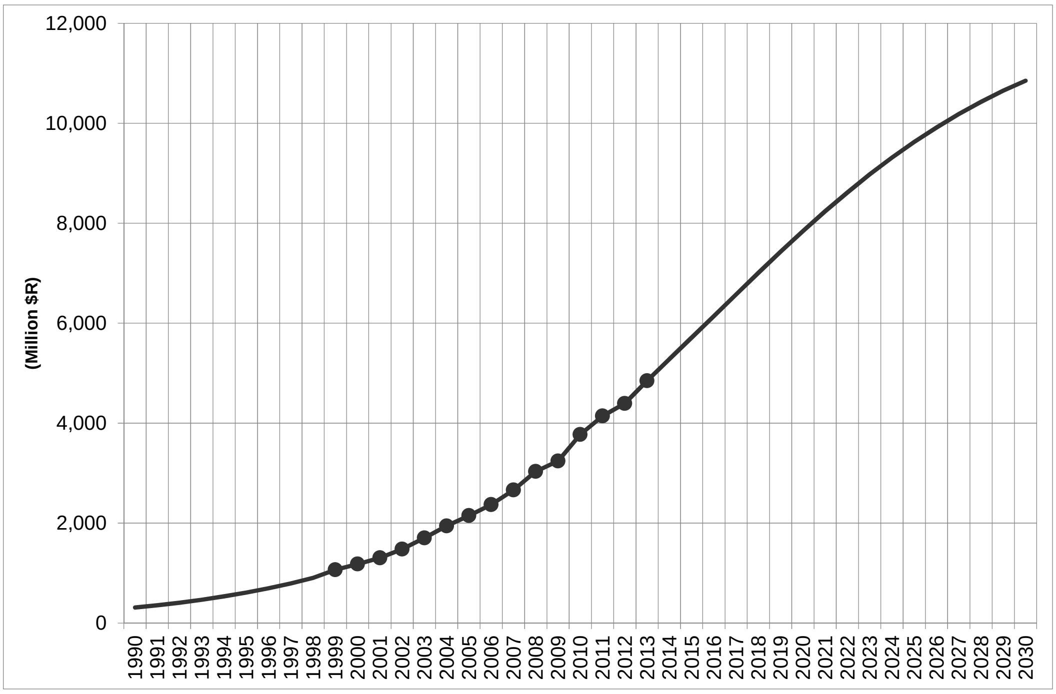


Figure 5 Trend of GDP of Brazil

Source: Brazilian Institute of Geographic and Statistic

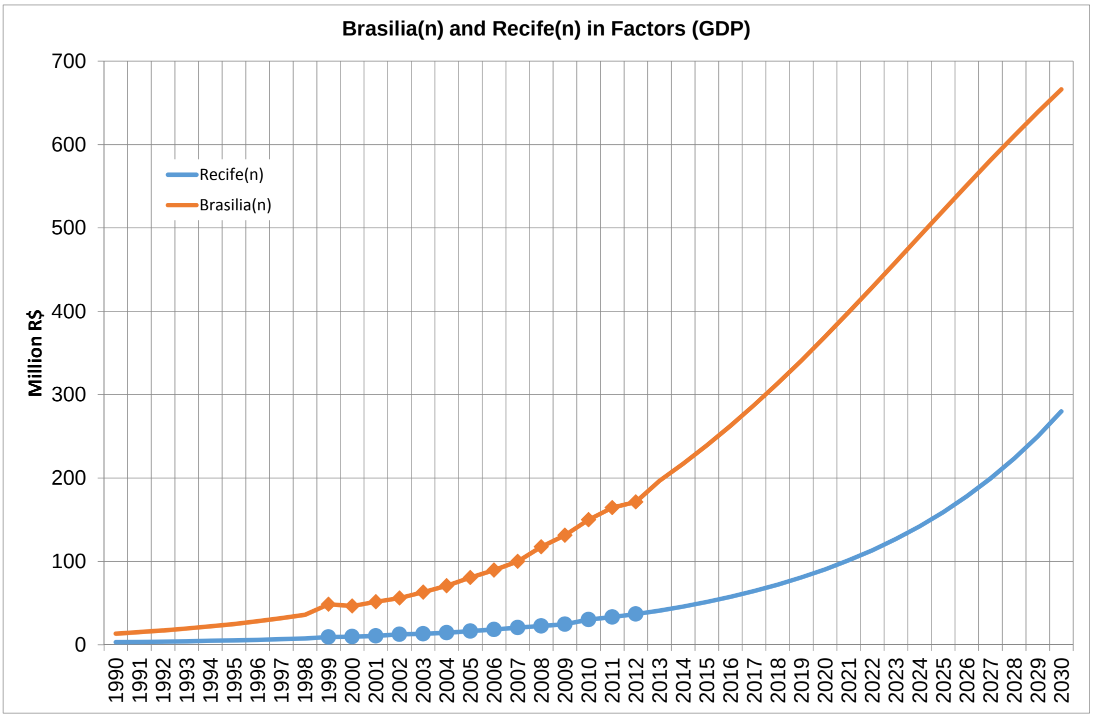


Figure 6 Trend of GDP in Brasilia and Recife

Source: Brazilian Institute of Geographic and Statistic

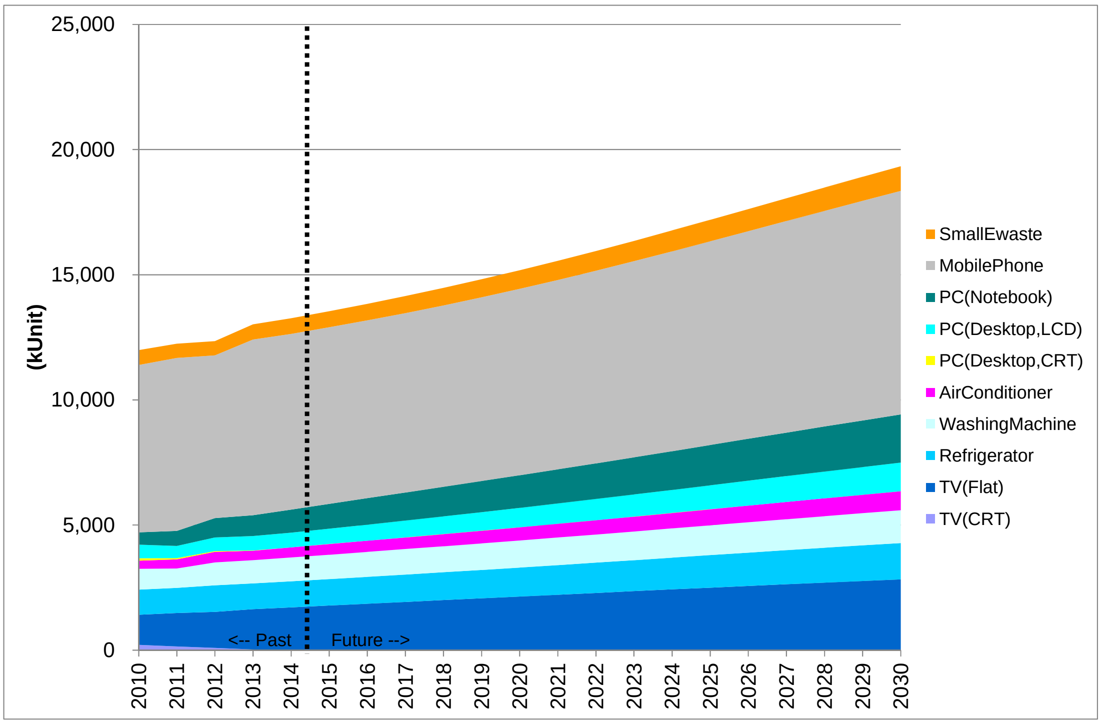


Figure 7 Supply of electrical and electronic products in Brasilia

Source： JICA Expert Team

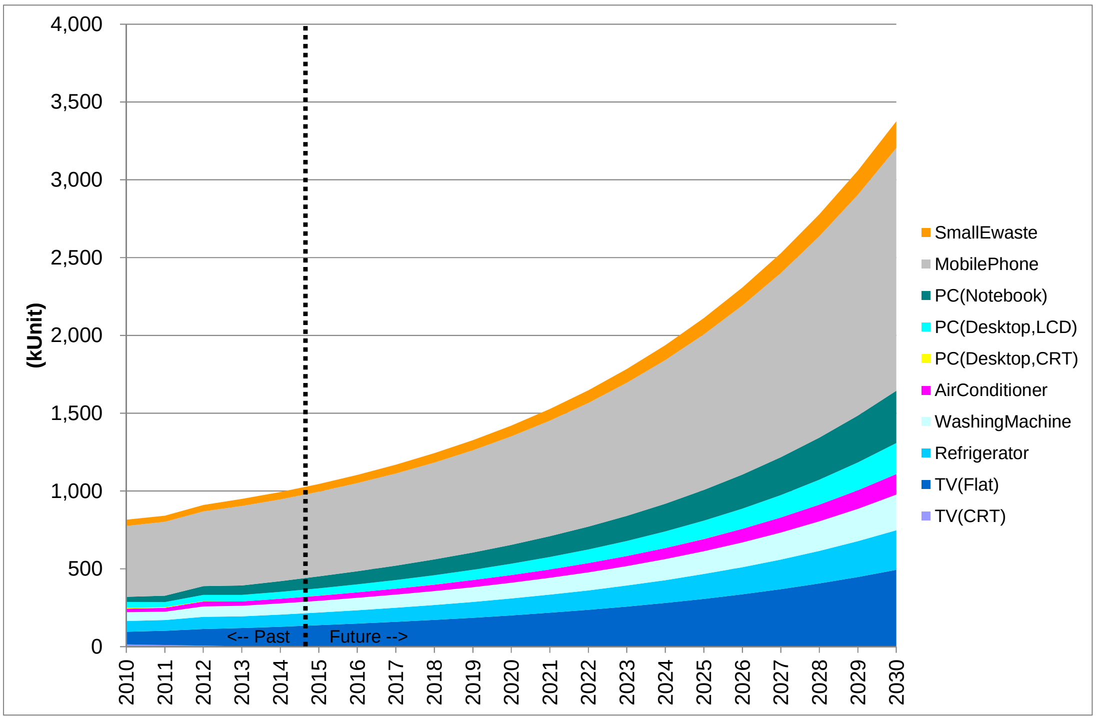


Figure 8 Supply of electrical and electronic products in Recife

Source： JICA Expert Team

2.1.4 Unit weight of each kind of e-wastes for converting to weight

The table below contains the unit weight of e-wastes for converting the values into weight.

Table 2 Unit weight of e-wastes

	TV (CRT)	TV(FLAT)	Refrigerator	Washing machine	Air-conditioner	PC(Desktop, CRT)	PC(Desktop, LCD)	PC(Notebook)	Moble phone*	Small e-waste*
Unit weight(kg/unit)	37.2	12.0	58.0	36.5	50-60	37.2	12.0	2.4	0.2	2.4

Source: Inventta 2012 report (Inventta Consultoria / MDIC / ABDI, 2013) (Small e-wastes was set by aggregating vacuum cleaner, iron, mixer, electrical oven and hair-dryer)

The weight of air-conditioners was taken from the catalogue of a product.

2.2 Step 2. Estimation of generated e-wastes

2.2.1 Procedure for estimation

The procedure for estimation of generated e-waste is shown in the following figure.

- The supplies of electrical and electronic products are divided to the supplies to households and the supplies to businesses by setting the supply rates to households by types of e-wastes.
- The amount of unused e-wastes, discarded e-wastes and stocked e-wastes are calculated based on the discarded probability distribution and reused rates. The rates of dead stocks in generators are set as zero in this estimation.

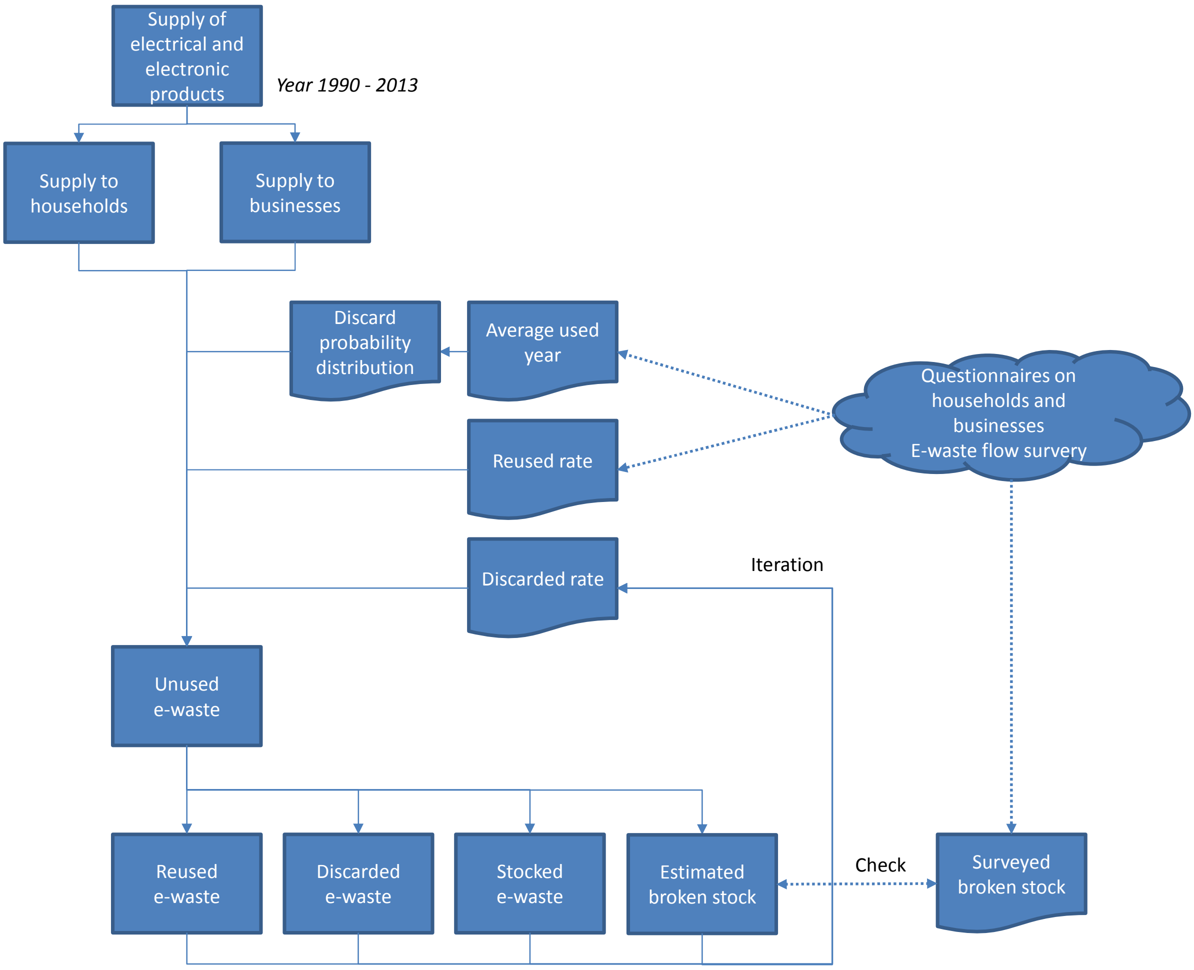


Figure 9 Procedure for estimation on generated e-wastes etc.

Source： JICA Expert Team

2.2.2 Model for estimation

Discard probability distribution

The discard probability distribution rises from zero and reach at the peak in the year of average used year. The Weibull distribution is commonly used as the function form. The accumulated probability distribution of the Weibull distribution can be expressed as:

- $W_t(y) = 1 - exp[-\left(\frac{y}{\bar{y}_t}\right)^b * \{\Gamma(1 + \frac{1}{b})\}^b]$
- Where
- $W_t(y)$: the accumulated discard probability until year-y
- y_t: average used year
- Γ: Gamma function,

and according to Yoshida et. al.[2], the parameters of b can be set as 3.0 – 4.0. Here, b was set as 3.5.

The discarded probability in each year can be given as

- $W'_t(y) = W_t(y) - W_t(y-1)$
- Where $W_t(0) = 0$.

Unused e-waste

The amount of unused e-wastes in year-i can be estimated by the step 2. The unused e-wastes include the amount of e-wastes returning to the consumption stage as reused e-wastes.

- $D_i = \sum_{j=1}^{i} DS_j * W'_t(i-j)$

Where

- D_i: The amount of unused e-wastes in year-*i*
- DS_j: The amount of inputted e-products in year-*j*

Reused rate and stock

The relation among unused e-waste, reused e-waste (Ri) and discarded e-waste (Wi) can be expressed as:

- $R_i = r * D_i$
- $W_i = (1 - r) * D_i$

Where

- r: Reused rate (shown in Table 8),

and the stock S_i can be expressed by

- $S_i = S_{i-1} + P_i - W_i$.

Where

- S_i: Stock in year *i*
- P_i: Domestic Supply in year *i*

[2] Tomohiro Tasaki, Masahiro Oguchi, Takashi Kmeya and Kohei Urano: A prediction method for the number of waste durable goods, Journal of the Japan Society of Waste Management Experts, Vol. 12, No. 2, pp. 49 – 58, 2001

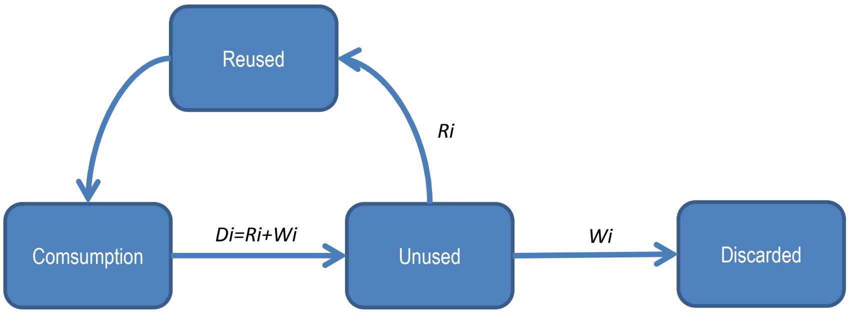


Figure 10 The relation among unused e-waste, reused e-waste and discarded e-waste

Source： JICA Expert Team

2.2.3 Supply to households and businesses

Here, the supplies of e-products are split to the supplies to households and the supplies to businesses. The rates of supplies to households was obtained from the rate of stocks in households in 2015, assuming that the rates of supplies to households do not change. The remaining portions were allocated to the supplies to business uses.

The supply rates were considered for whole television sets and personal computers due to the limitation of available data. After setting the supply rates, television sets and personal computers were split to the types of products by the method shown in 2.1.2.

The stocks in 2015 was estimated by using the data obtained from the questionnaire survey on households. The penetration rates are available from POF survey and the PNAD survey by IBGE, but the latest POF survey is 2008/2009 and the definition of the penetration rate of PNAD has the ceiling at the rate of 100%, so those data were not used here.

Table 3 Estimation of the supply rates of electrical and electronic products for households

	TV(whole)	Refrigerator	Washing machine	Air-conditioner	PC(whole)	Mobile phone	Small e-waste
Penetration rate in households in 2015 (unit/household)	1.916	1.000	0.887	0.069	0.397	2.151	0.698
Stock calculated from the penetration rates (thousand UNIT) (Penetration rate X number of households)	13,693	7,147	6,339	493	2,837	15,373	4,988
Estimated stock in 2015 (thousand UNIT)	14,785	11,193	8,397	3,270	7,158	83,786	4,943
Stock in businesses	1,092	4,046	2,058	2,777	4,321	68,413	-45
Supply rate to households	0.926	0.639	0.755	0.151	0.396	0.183	1.009

Source： JICA Expert Team

Note 1: the number of households in Sao Paulo City was estimated as 7,146 million households based on the number of households obtained from PNAD survey.

Note 2: The penetration rates were obtained from the questionnaire survey on households.

2.2.4 Average used year

The average used years obtained from some different sources were compared and selected, because they are very important parameters for estimating the amount of discarded e-wastes.

Method 1: The average used years obtained from the question of "when do you suppose the e-products possesses may be broken?"

The following table contains the average used years obtained from the questions of "When did you buy?" and "When do you expect it breaks?" asked in the questionnaire survey on households (the years to be broken).

Table 4 The years to be broken (estimated from the expected discard timings obtained from the questionnaire on households)

	TV(CRT)	TV(Flat)	Refrigerator	Washing machine	Air-conditioner	PC (Desktop, CRT)	PC (Desktop, LCD)	PC (Notebook)	Mobile phone	Small e-waste
Number of samples (NOS.)	152	588	658	597	35	21	268	122	658	-
Average used year (year)	10.3	9.5	12.1	11.9	11.1	11.4	10.1	8.7	6.1	10.1
Sample standard deviation (year)	3.4	3.3	4.0	4.1	4.6	3.5	3.5	3.3	3.3	-
Upper 5% significance interval (year)	10.8	9.7	12.4	12.3	12.6	12.9	10.5	9.3	6.3	-
Lower 5% significance interval (year)	9.7	9.2	11.8	11.6	9.5	9.9	9.6	8.1	5.8	-

Source: JICA Expert Team

Note: As for the small e-wastes, the average used years of electrical oven, mixer, iron, vacuum cleaner and hair dryer were averaged, considering that they are almost same.

Method 2: The average used years obtained from the question of "How many years did you use the e-waste until discard?"

Table 5 shows the average used years estimated by the question of "How did you used the e-waste when you discarded it?" These years are generally shorter than the years obtained as Table 4.

Table 5 The years until broken (estimated from the discarded years for respondents" past e-waste obtained from the questionnaire on households)

	TV (CRT)	TV (FLAT)	Refrigerator	Washing machine	PC (Desktop, CRT)	Mobile phone	Small e-waste
Number of samples (NOS.)	80	10	42	19	6	98	-
Average used year (year)	7.3	4.8	7.3	8.4	5.8	2.0	4.0
Sample standard deviation (year)	3.6	2.7	3.7	4.1	2.6	1.2	-
Upper 5% significance interval (year)	8.0	6.5	8.4	10.3	7.9	2.6	-
Lower 5% significance interval (year)	6.5	3.1	6.2	6.6	3.7	2.1	-

Source: JICA Expert Team

Note: As for the small e-wastes, the average used years of electrical oven, mixer, iron, vacuum cleaner and hair dryer were averaged, considering that they are almost same.

Only reliable average used years with enough number of samples are contained in the table.

Method 3. Estimation from stocks and domestic supplies

The time-series stocks in cities can be known in Brazil. By using these data, the average used years can be estimated roughly by the following equation.

$$\text{Average used year} = \frac{Difference\ of\ Stock\ between\ year-i\ and\ year-j}{Average\ annual\ supply\ between\ the\ years}$$

The results of the calculations were shown in the following table.

Table 6 Estimated average used year (Estimated by the official data of the past stocks and average annual supply

	TV	Refrigerator	Washing machine	PC	,Mobile phone	Small e-waste
Average used year (years)	10.3–11.8	11.3-13.5	8.3-9.0	7.5-12.5	2.4	8.4-8.7

Source: JICA Expert Team

Evaluations and selection of the average used years

The average used years estimated above three methods were evaluated as below.

- The average used years estimated by the question of "How long do you expect the possessing e-products (Method 1) will be broken?" tend to be longer.
- The average used years estimated by the past experience to discard e-wastes (Method 2) tend to be shorter by the discarders' unclear memories.
- The average used years estimated by the stock data (Method 3) give nice values in spite of the rough estimation model.

Based on the evaluation, the average used years were set based on the following thoughts.

- The average used years obtained from the stock data (Method 3) were used as the reference data.
- The values obtained by Method 1 were used for the bulky e-wastes such as television sets, refrigerators, washing machines, air-conditioners and small e-wastes, considering that they are discarded when broken, because they are less likely to be dead stocks.
- The values obtained by Method 2 were used for personal computers and mobile phones, considering that they are likely to be unused before broken.

Due to the data reliability and limitations, the average used years used for the calculation are considered to be checked their sensitivities as shown Chapter 2.6.

The same values were used for the e-wastes derived from business entities, checking the ranges of the values were almost same as the values of households.

Table 7 Selected average used years

	TV (CRT)	TV (Flat)	Refrigerator	Washing machine	Air-conditioner	PC (Desktop, CRT)	PC (Desktop, LCD)	PC (Notebook)	Mobile phone	Small e-waste
Selected average used years	10.3	9.5	12.1	11.9	11.1	5.8	5.1	4.4	2.0	10.1

Source：JICA Expert Team

Note: As for PCs, the average used year of Method 2 was expanded by the values of Method 1.

Consideration on the digitalization of television broadcasting

It is likely happening that the CRT television sets are replaced with the LCD types. In order to consider this tendency in the estimation model, the average used years for CRT television sets for the products after 2007 were calibrated as the number of years by the year of 2016. For example, the average used year for the product of 2007 was set as 9 years of the difference between 2007 and 2015.

2.2.5 Disposal flow (here only reused rates are referred.)

The disposal flows were estimated by the results of the questionnaire surveys.

By the questionnaire surveys, the disposal rates are obtained by the following channels.

- Public collection service
- Containers on streets
- Garbage boxes on streets
- Eco-pont
- Bulky waste collection
- Illegal dumping
- Takeback by retailers
- Private recyclers
- Junk shops
- Second-hand market
- Repair shops
- Giving to acquaintance
- Recycling factories
- others

These disposal options were classified below by considering the characteristics of the options.

- Reused route (Second-hand market, Repair shops, Giving to acquaintance)
- Routes to Sucateiro etc. (Private recyclers, Junk shops)

- Public collection route (Public collection service, Containers on streets, Garbage boxes on streets, Eco-pont, Bulky waste collection, Illegal dumping)
- Proper recycling route (Takeback by retailers, Recycling factories)
- Others

Secondly, the category of "Others" were deleted by distributing the rate to other categories.

The categories of e-wastes were modified so that the disposal rates can be estimated.

- TV=TV(CRT)+TV(FLAT)
- PC=PC(Desktop)+PC(Desktop,CRT)+PC(Desktop,LCD)+PC(Notebook)
- Small e-waste=Electric oven+Mixer+Iron+Vacuum cleaner+Hair dryer

Here, the symbol of "+" means that the data of the categories were analyzed jointly.

Table 8 Disposal flow of e-wastes derived from households

	TV	Refrigerator	Washing machine	Air-conditioner	PC	Mobile phone	Small e-wastes
Number of samples (NOS)	90	42	19	151	20	98	56
Reused route (%): r	37	43	21	36	4	49	9
Public collection route (%): p1	17	7	21	14	20	42	46
Sucateiro etc. route (%): 1-r-p1-p2	47	50	58	47	65	9	44
Proper recycling (%): p2	2	2	0	2	13	0	2

Source: Questionnaire survey on households
Note 1: The data for air-conditioner were estimated by aggregating three categories of TV, Refrigerator and Washing machine, as the data were not obtained from the survey.
Note 2: The symbols in the left columns shows the symbols used in the flowcharts shown later.

Table 9 Disposal flow of e-waste derived from business entities

	TV	Refrigerator	Washing machine	Air-conditioner	PC	Mobile phone	Small e-wast
Number of samples (NOS)	50	20	4	12	92	27	44
Reused route (%): r	66	65	75	42	51	35	50
Public collection route (%): p1	16	10	25	0	12	27	24
Sucateiro etc. route (%): 1-r-p1-p2	16	20	0	33	29	15	24
Proper recycling (%): p2	2	5	0	25	8	23	2

Source: Questionnaire survey on business entitties
Note: The symbols in the left columns shows the symbols used in the flowcharts shown later.

2.2.6 Discarded rate

By using above parameters, the unused e-waste, discarded e-waste and stocked e-waste can be calculated. However, some types of e-waste is not suitable the estimation model due to their stock behavior. People continue to keep e-wastes even after they are broken. Here, the following e-wastes were considered to have such characteristics and they are given the parameter of discarded rate. Other types of e-waste were given 100% as the discarded rate.

- Personal computers
- Mobile phone

The discarded rate was explored by repeating the procedure of step 2 until the calculated number of broken e-waste in the stock is equal to the estimated number of broken e-waste by the survey.

The estimated number of broken e-waste surveyed and the discarded rates calculated are shown in the following table.

Table 10 Broken e-waste in stock and estimated discarded rate

	PC (Desktop)	PC (Notebook)	Mobile phone
Rate of broken e-waste in stock (surveyed) (%)	30%	18%	29%
Discarded rate (estimated) (%)	73%	72%	54%

Source：JICA Expert Team

2.3 Step 3. Flow estimation

2.3.1 E-waste flow

Among various types of e-waste flows, the following flow was proposed by considering the actual situations of Sao Paulo so as to discuss the contents of the pilot project. The points of this flow can be summarized below.

- All e-wastes collected by catadores etc. and dismantled by sucateiros etc. would be brought to scrap dealers and finally utilized by steel industries as mix metals.
- The path from public collection services to e-waste recycling factories were remained for the future consideration, although all e-waste collected by catadores unions done as one of the public collection services may flow to scrap dealers.
- E-waste to be discarded to the proper recycling route to be formed in the future will be designed so that all of them will flow to the proper dismantling factory.
- The flow can be described by four parameters of r, p1, p2, q (q=1 at present).

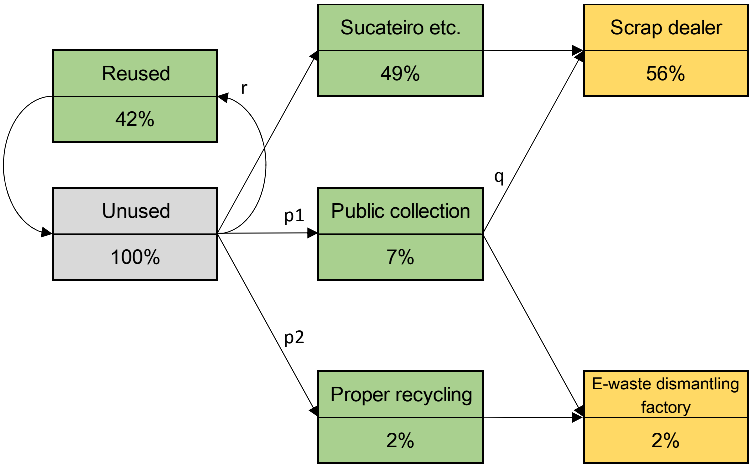


Figure 11 The e-waste flow used in this Project (the numbers are just examples.)
Source： JICA Expert Team

2.4 Results of estimations (Brasilia)

2.4.1 Domestic supply to Brasilia

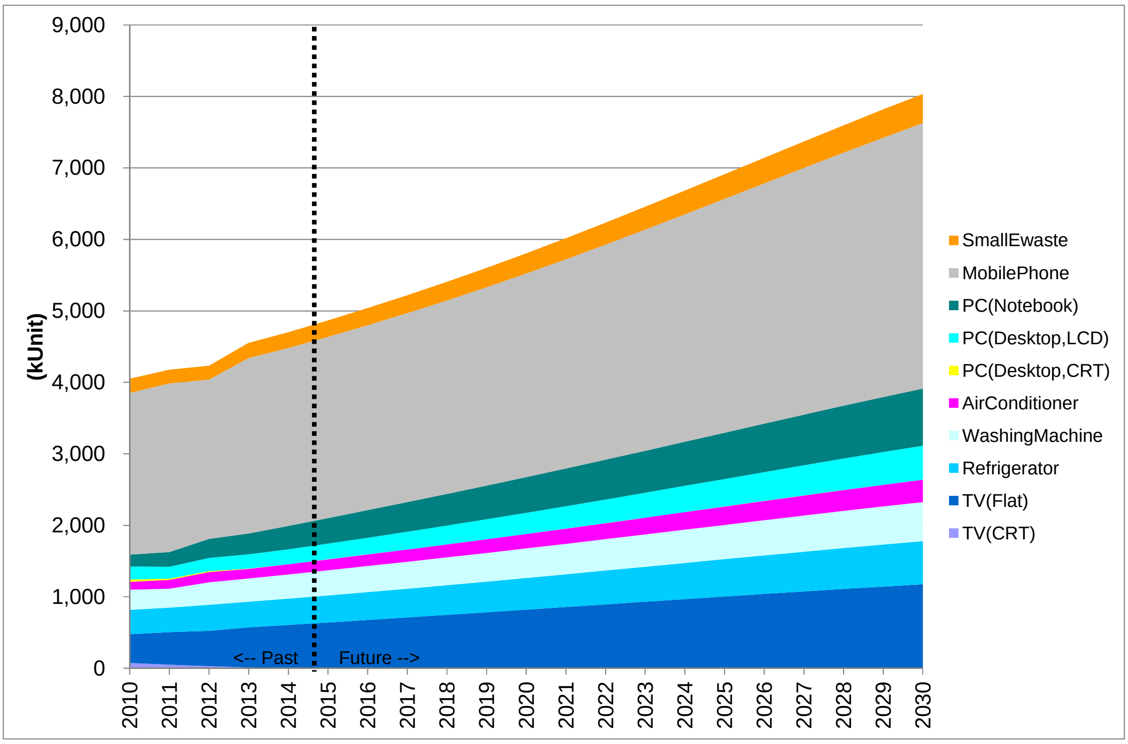


Figure 12 Supplied units to households and businesses (Brasilia)

Source: JICA Expert Team

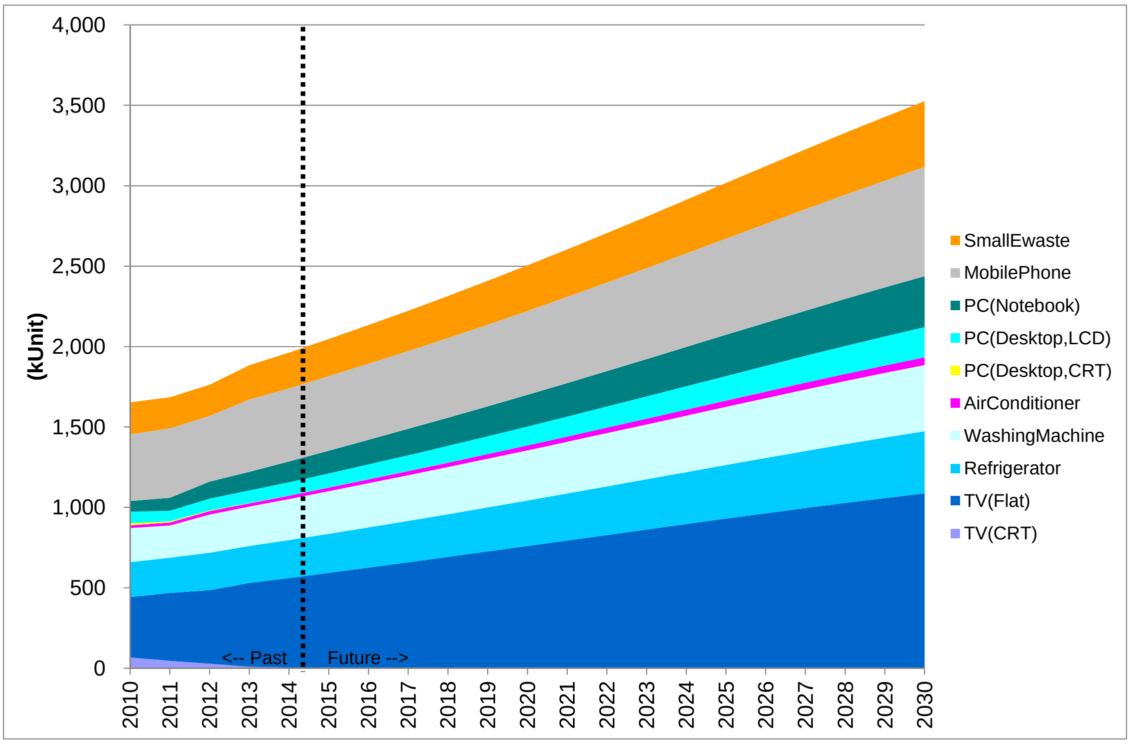


Figure 13 Supplied units to households (Brasilia)

Source: JICA Expert Team

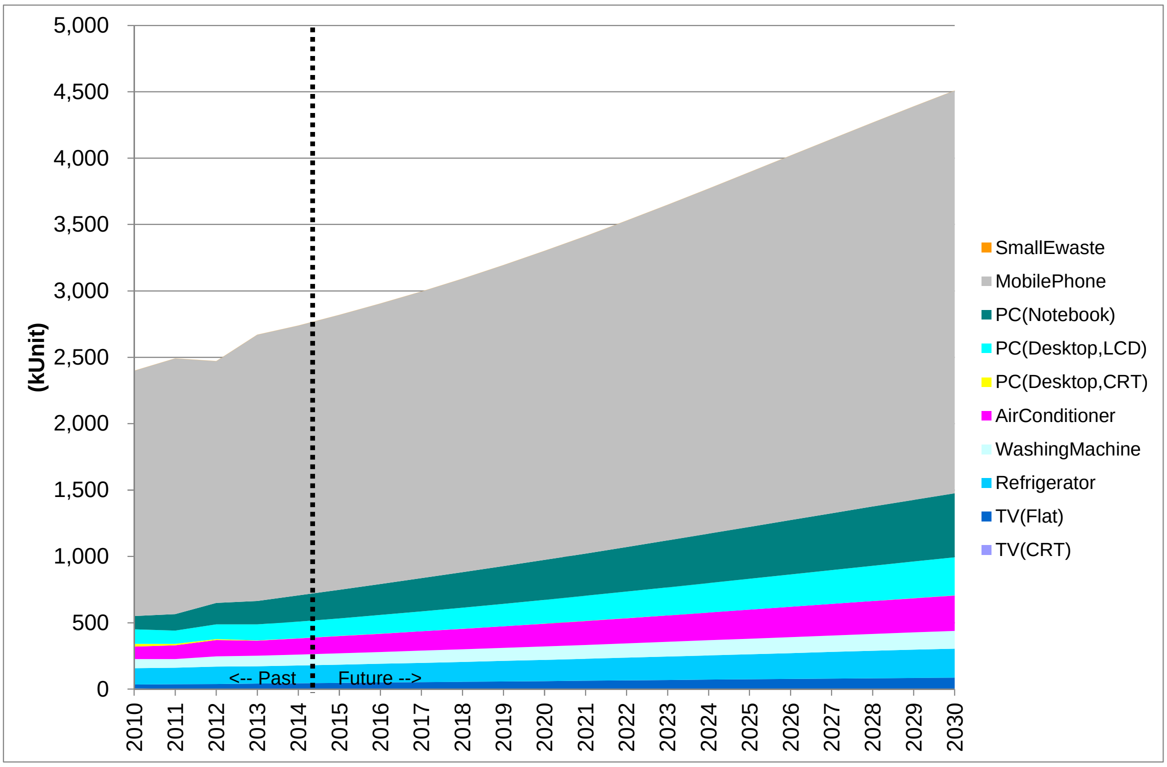


Figure 14 Supplied units to businesses (Brasilia)

Source: JICA Expert Team

2.4.2 Stocked units in Brasilia

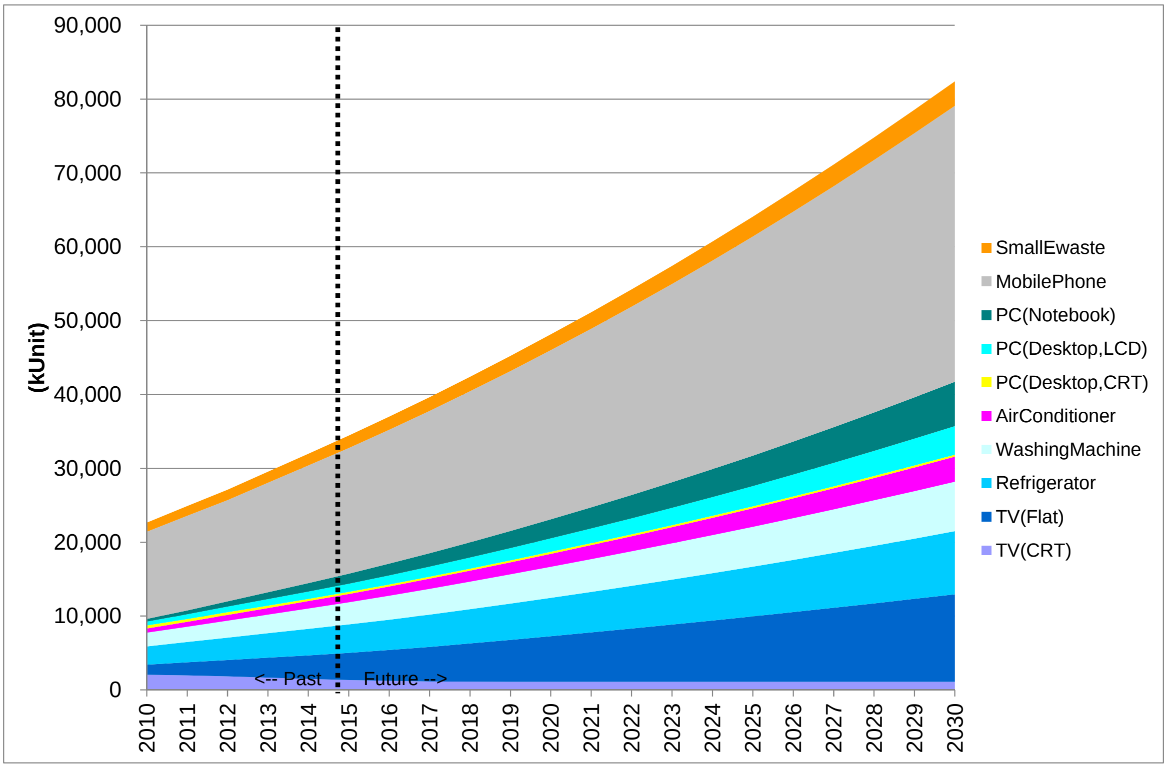


Figure 15 Stocked units in households and businesses (Brasilia)

Source: JICA Expert Team

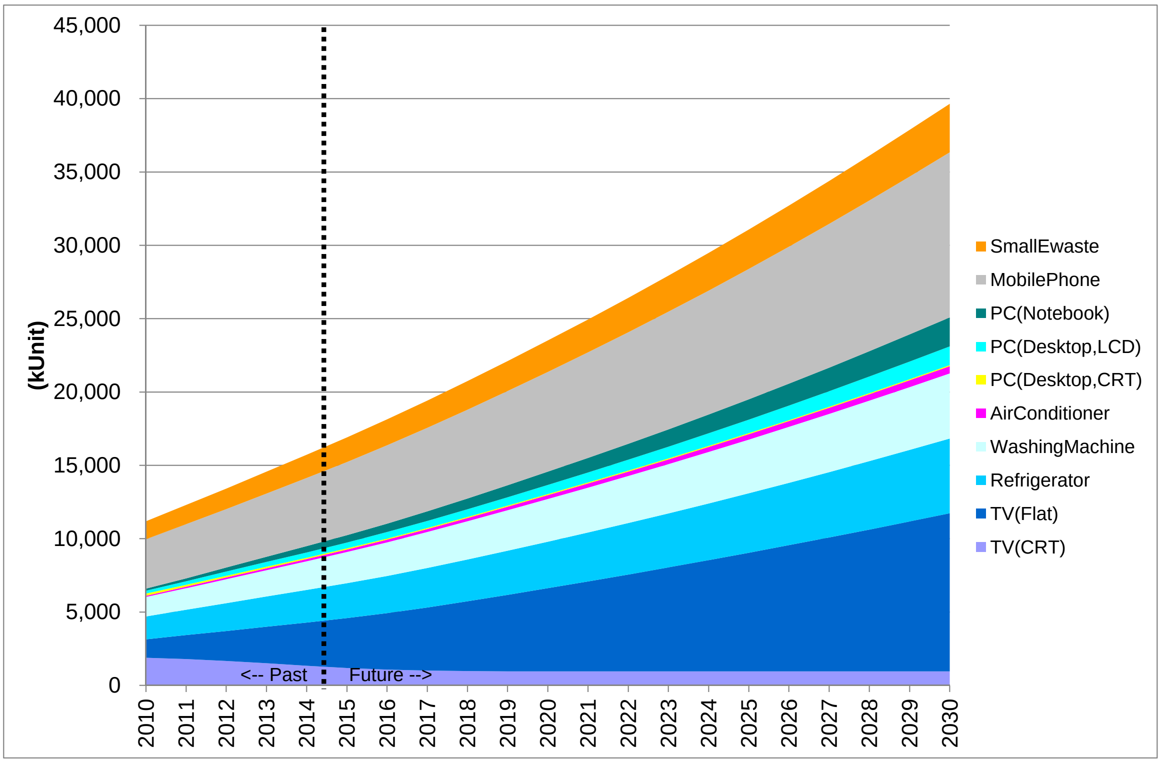


Figure 16 Stocked units in households (Brasilia)

Source: JICA Expert Team

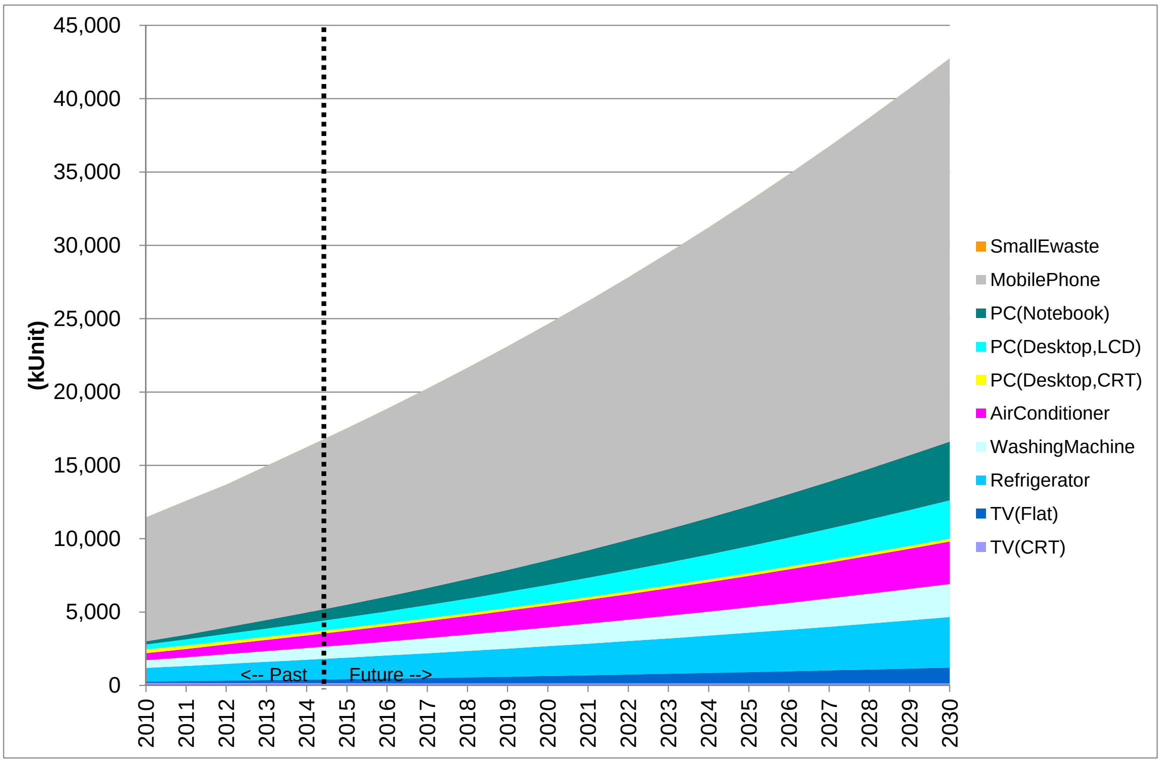


Figure 17 Stocked units in businesses (Brasilia)

Source： JICA Expert Team

2.4.3 Discarded weight including reused in Brasilia

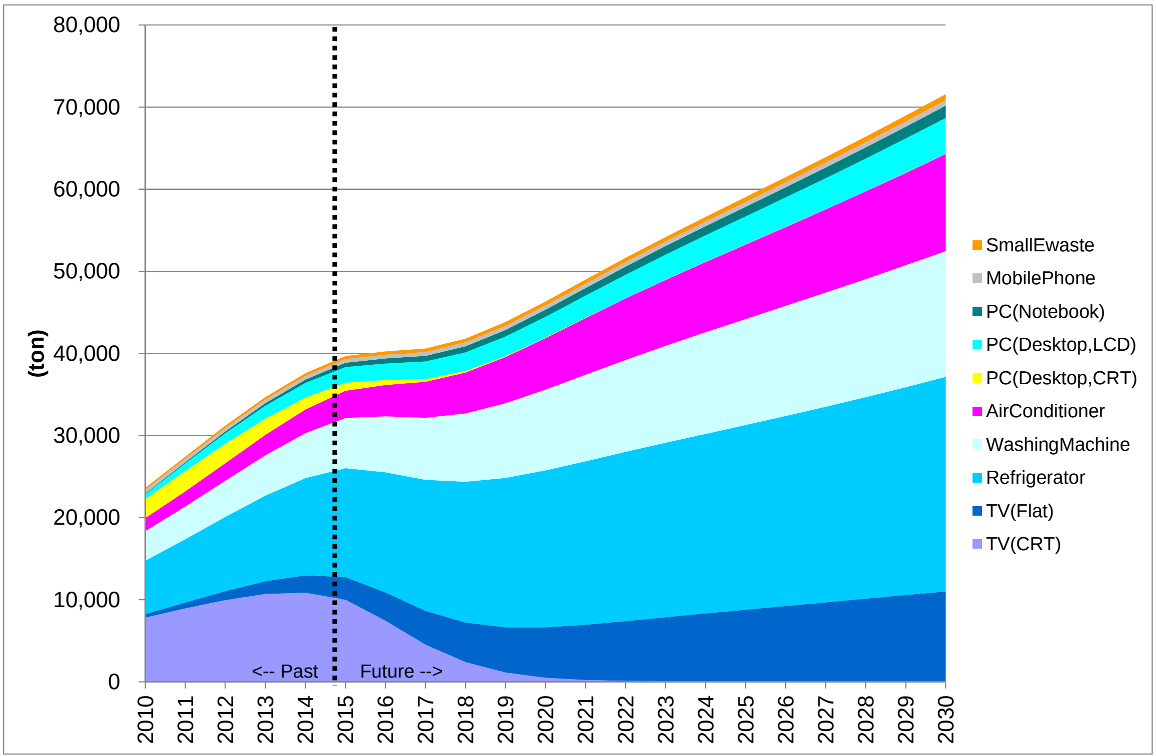


Figure 18 Discarded weight including reused from households and businesses (Brasilia)

Source: JICA Expert Team

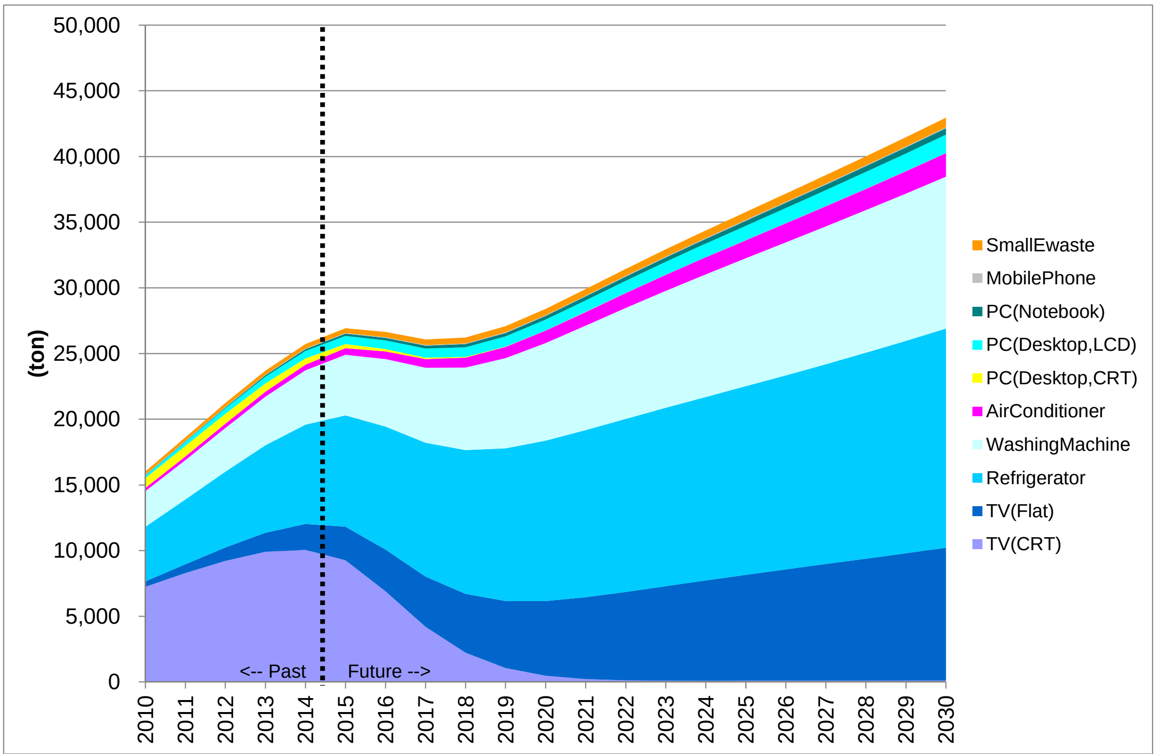


Figure 19 Discarded weight including reused from households (Brasilia)

Source: JICA Expert Team

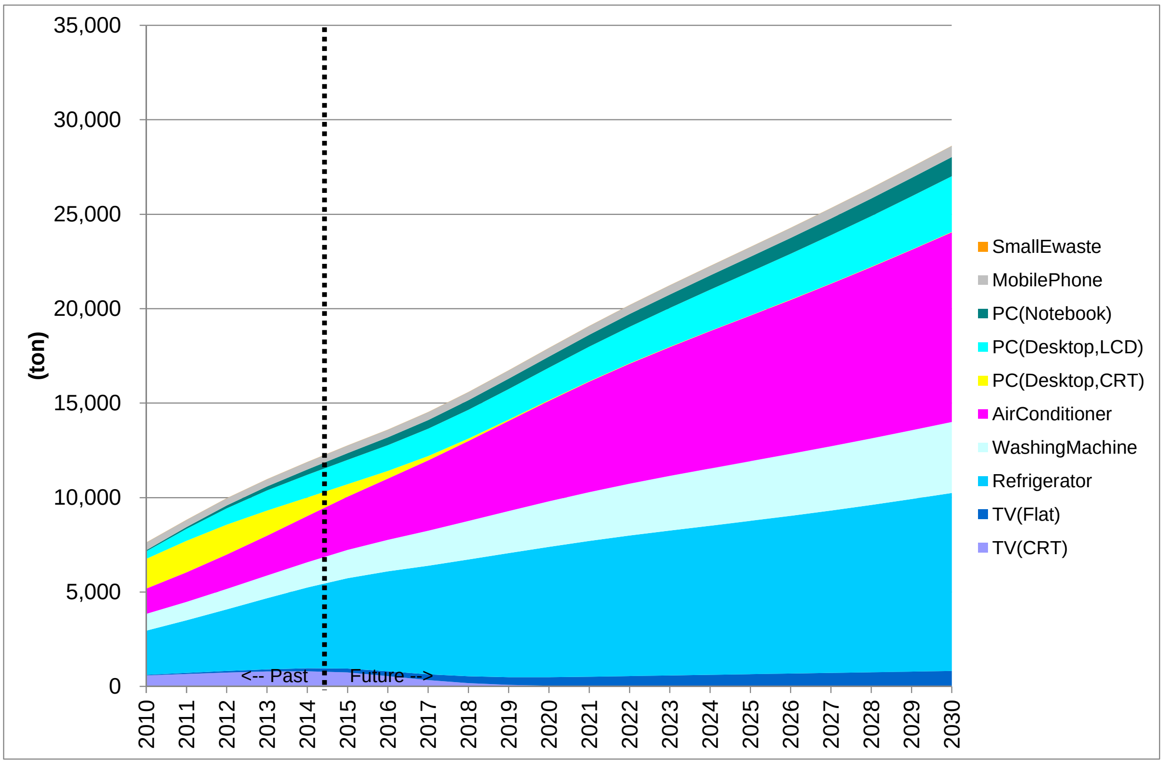


Figure 20 Discarded weight including reused from businesses (Brasilia)

Source: JICA Expert Team

2.4.4 Discarded weight excluding reused in Brasilia

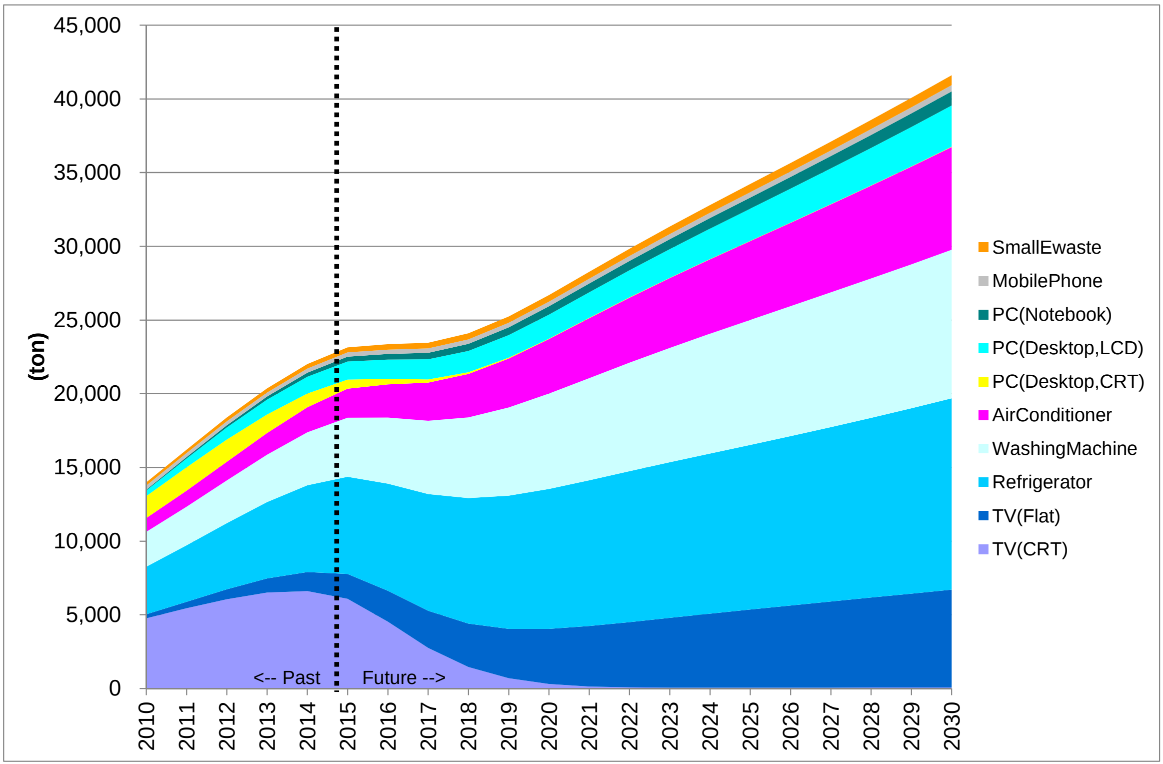


Figure 21 Discarded weight excluding reused from households and businesses (Brasilia)
Source: JICA Expert Team

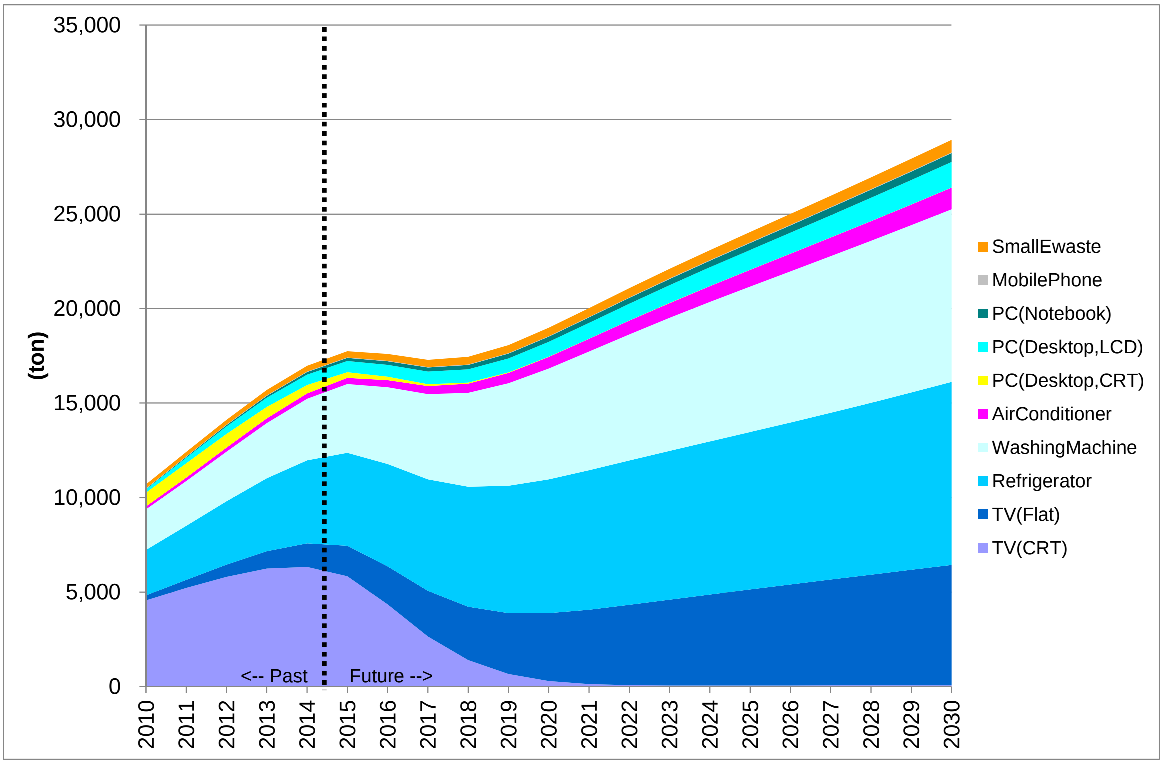


Figure 22 Discarded weight excluding reused from households (Brasilia)
Source: JICA Expert Team

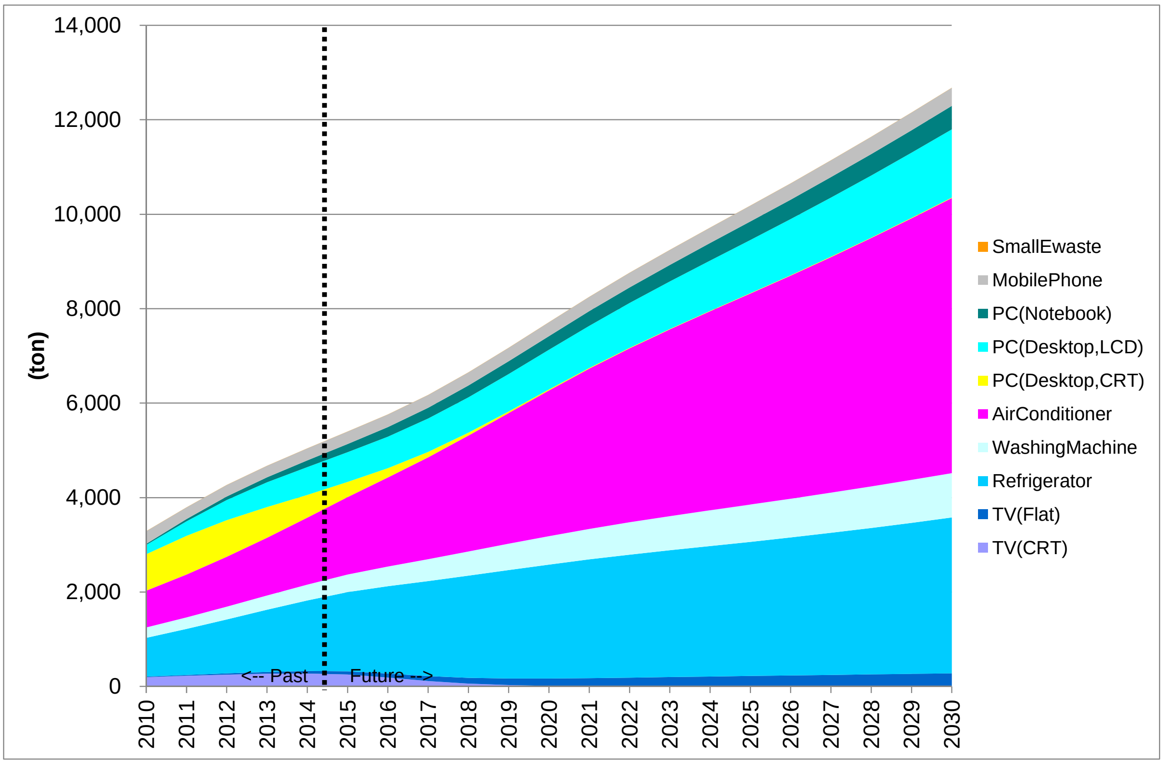


Figure 23 Discarded weight excluding reused from businesses (Brasilia)

Source： JICA Expert Team

2.4.5 Disposal rate in Brasilia

Disposal rate from households

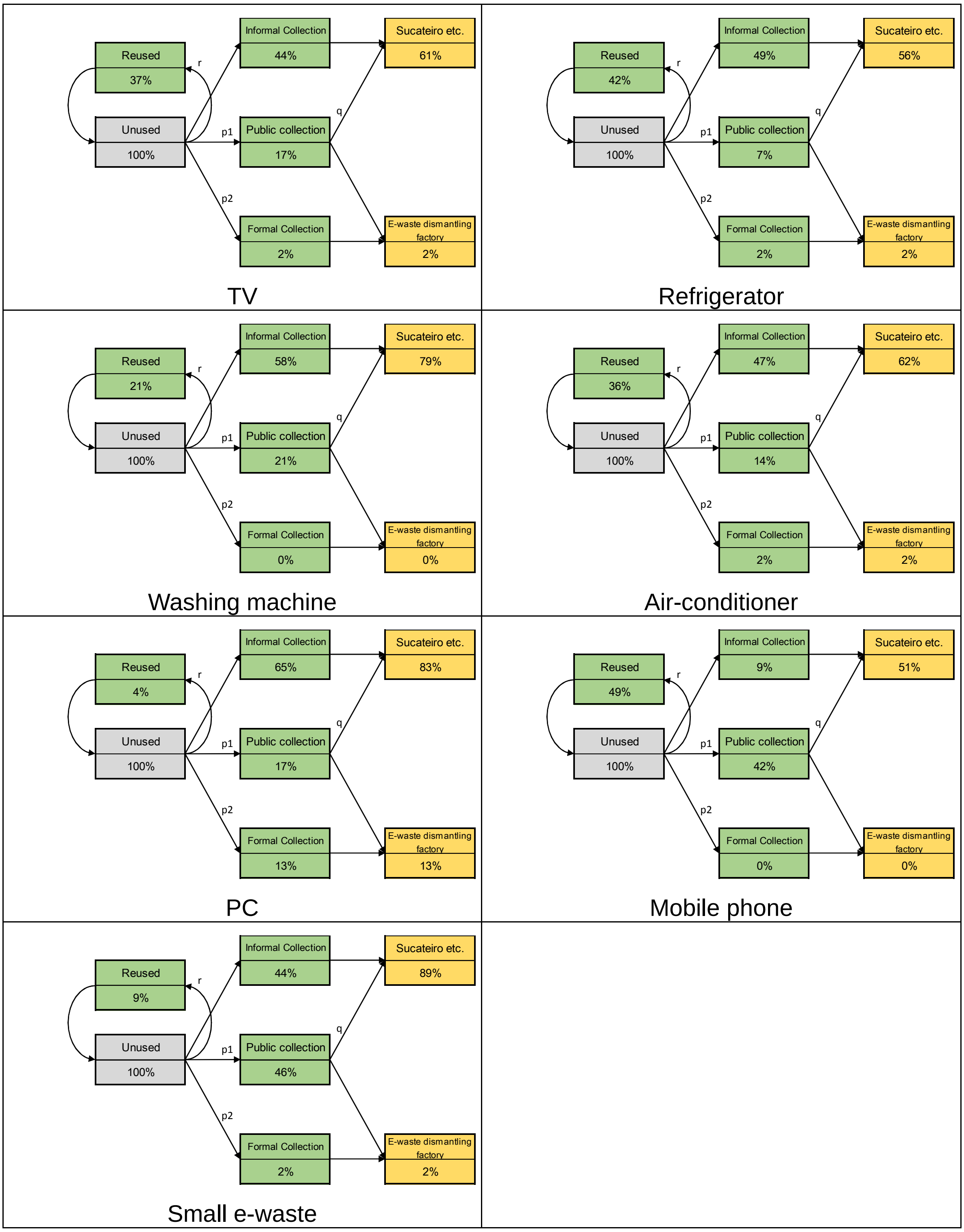


Figure 24 Disposal rate of e-waste from households

Source： JICA Expert Team

Disposal rate from businesses

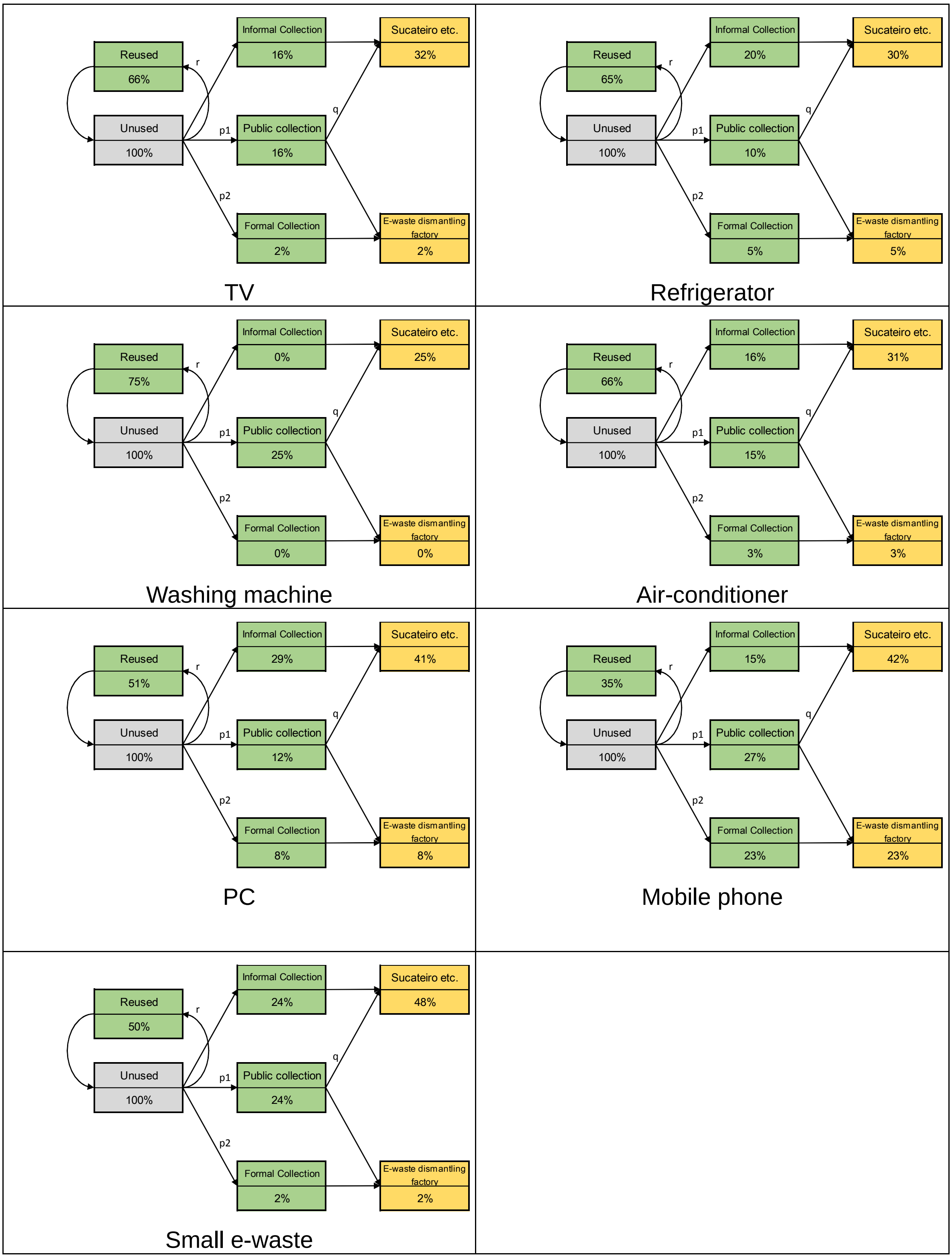
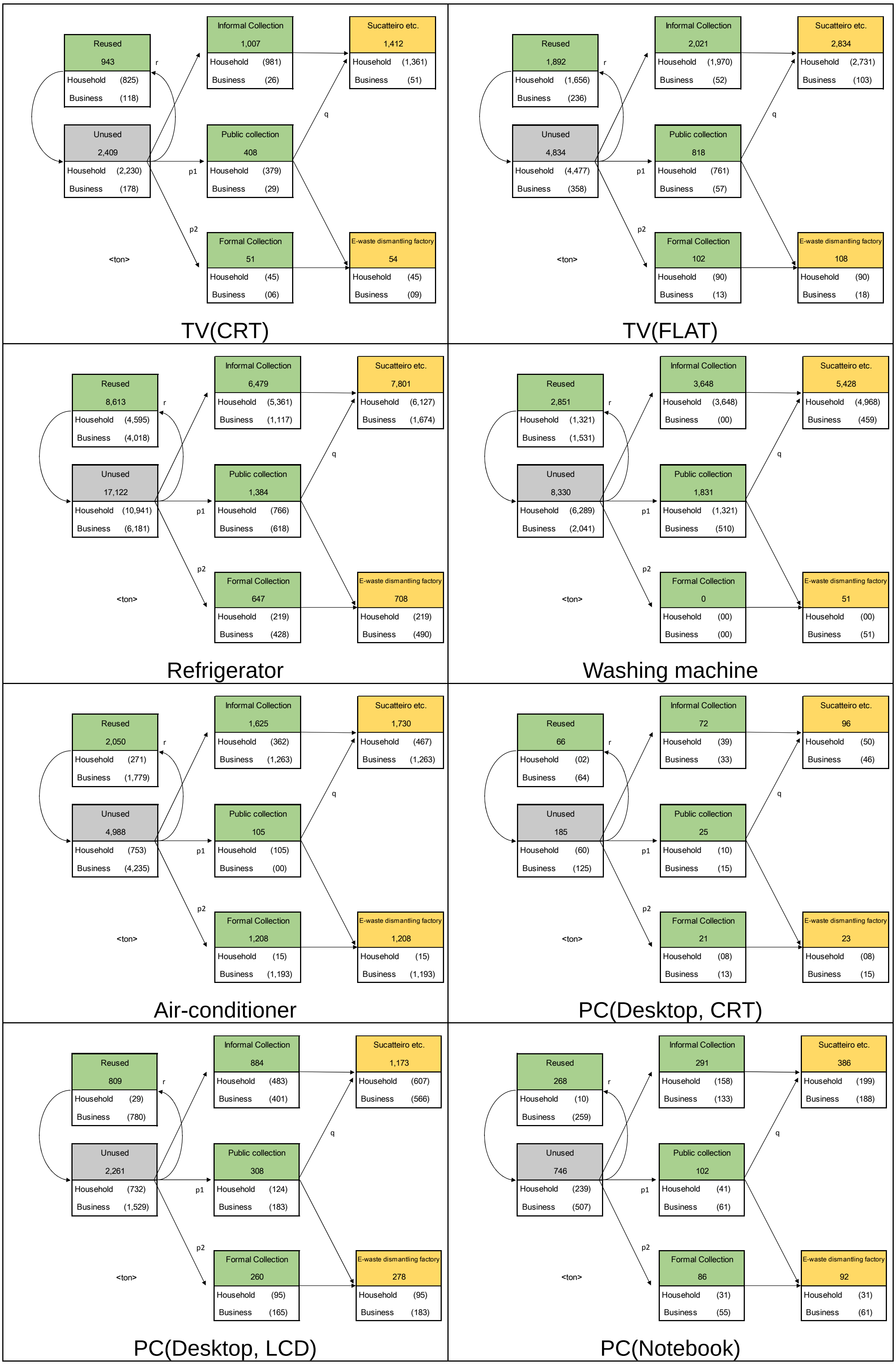


Figure 25 Disposal rate of e-waste from businesses

Source: JICA Expert Team

2.4.6 E-waste flow in Brasilia



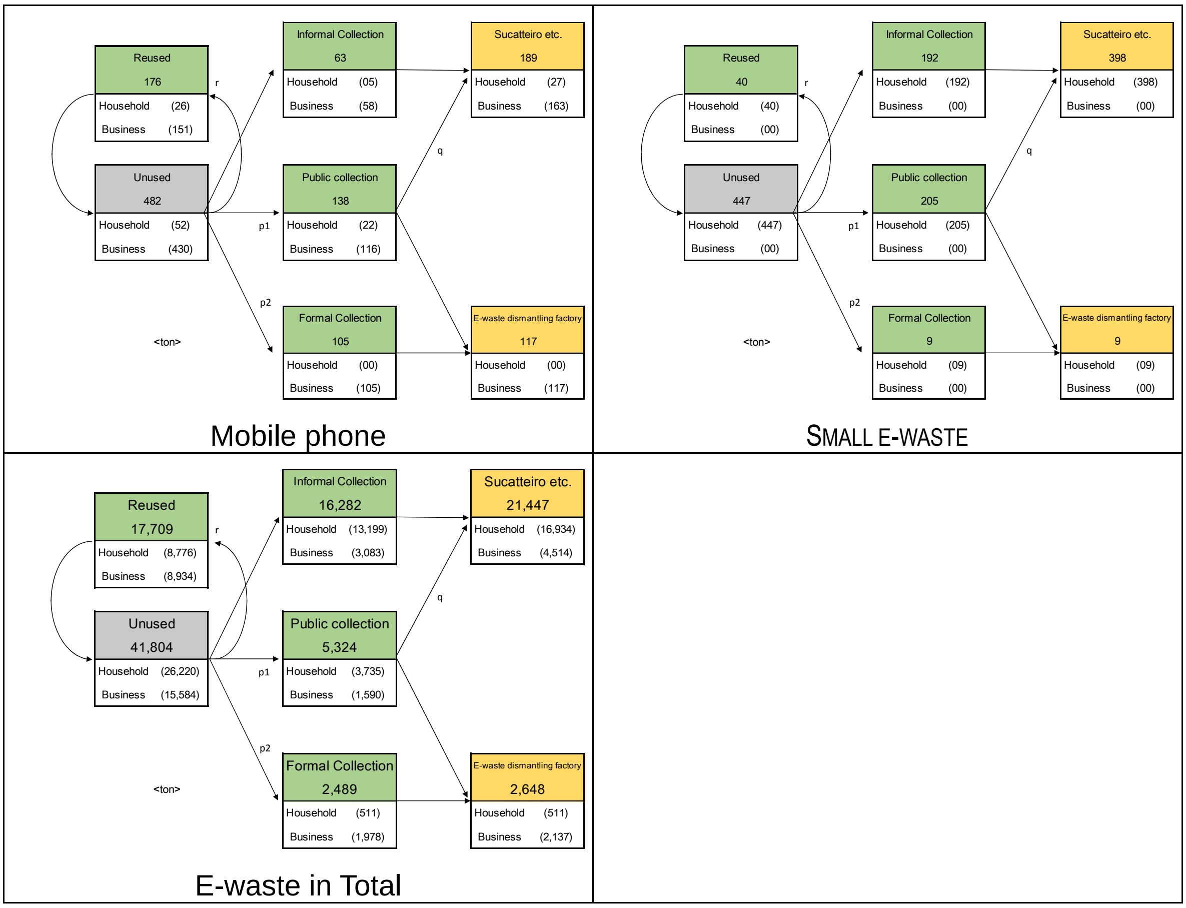


Figure 26 E-waste flow from households and businesses in 2018 (Brasilia)

Source: JICA Expert Team

2.5 Results of estimations (Recife)

2.5.1 Domestic supply to Recife

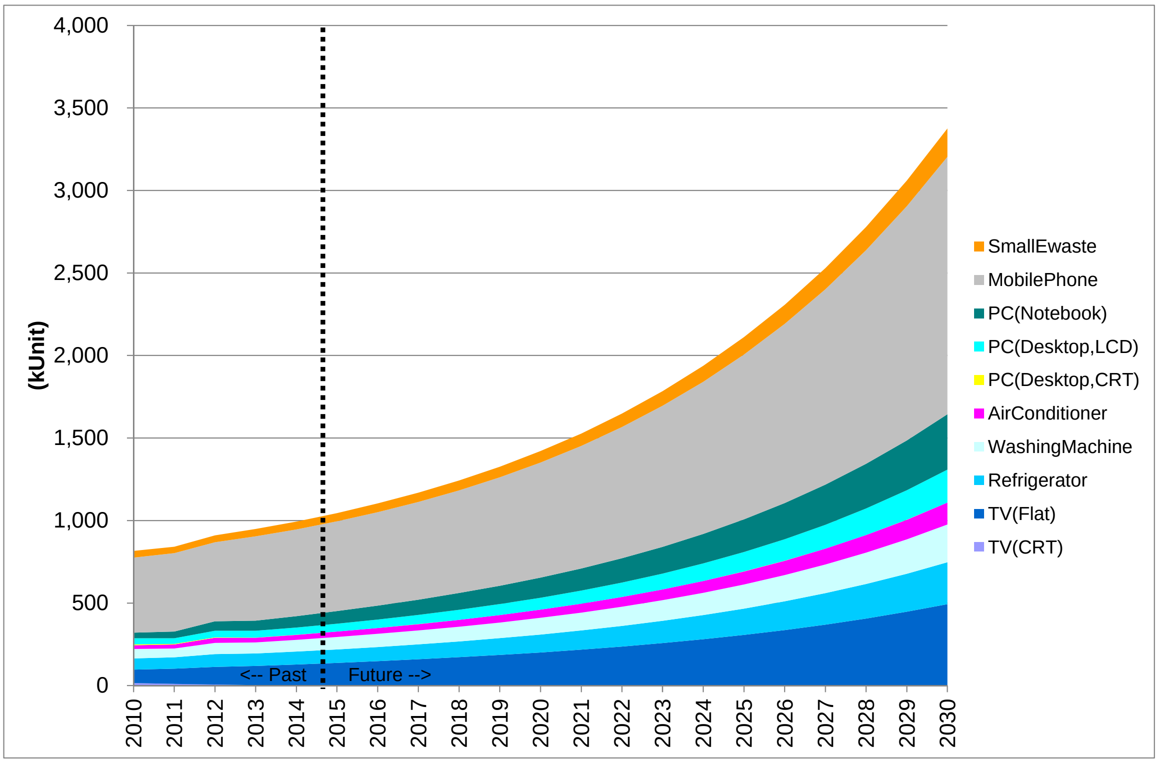


Figure 27 Supplied units to households and businesses (Recife)

Source: JICA Expert Team

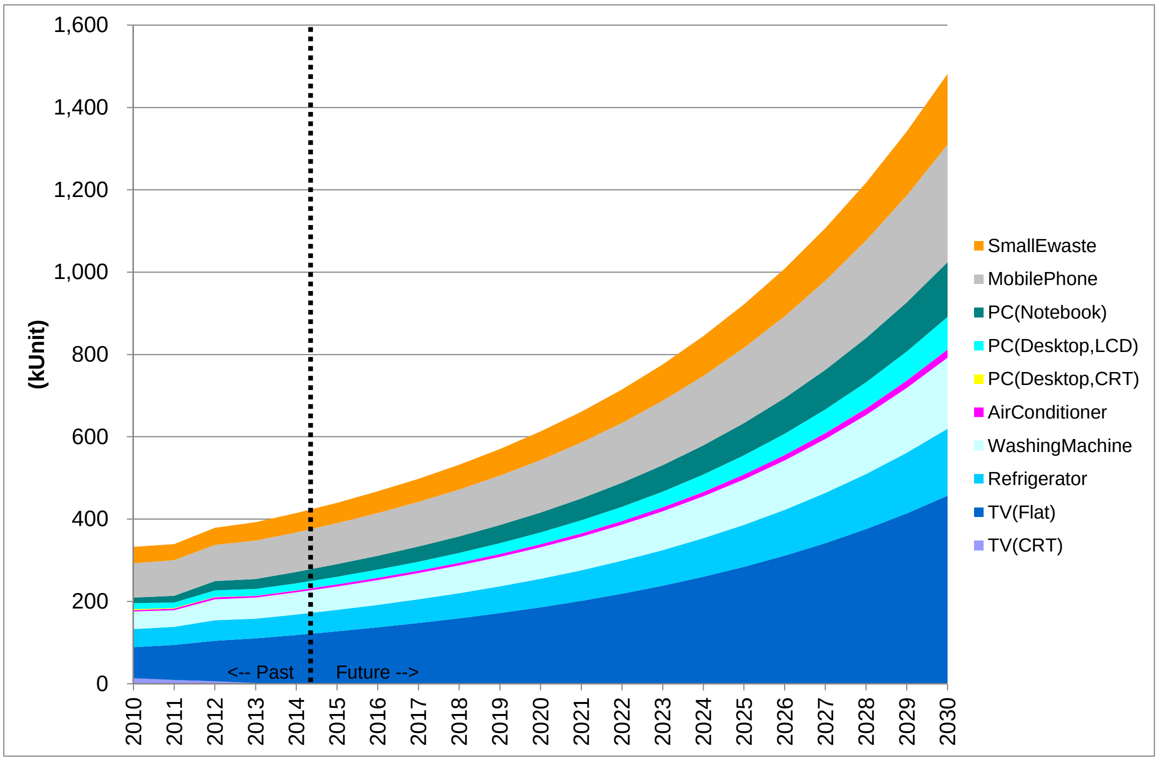


Figure 28 Supplied units to households (Recife)

Source: JICA Expert Team

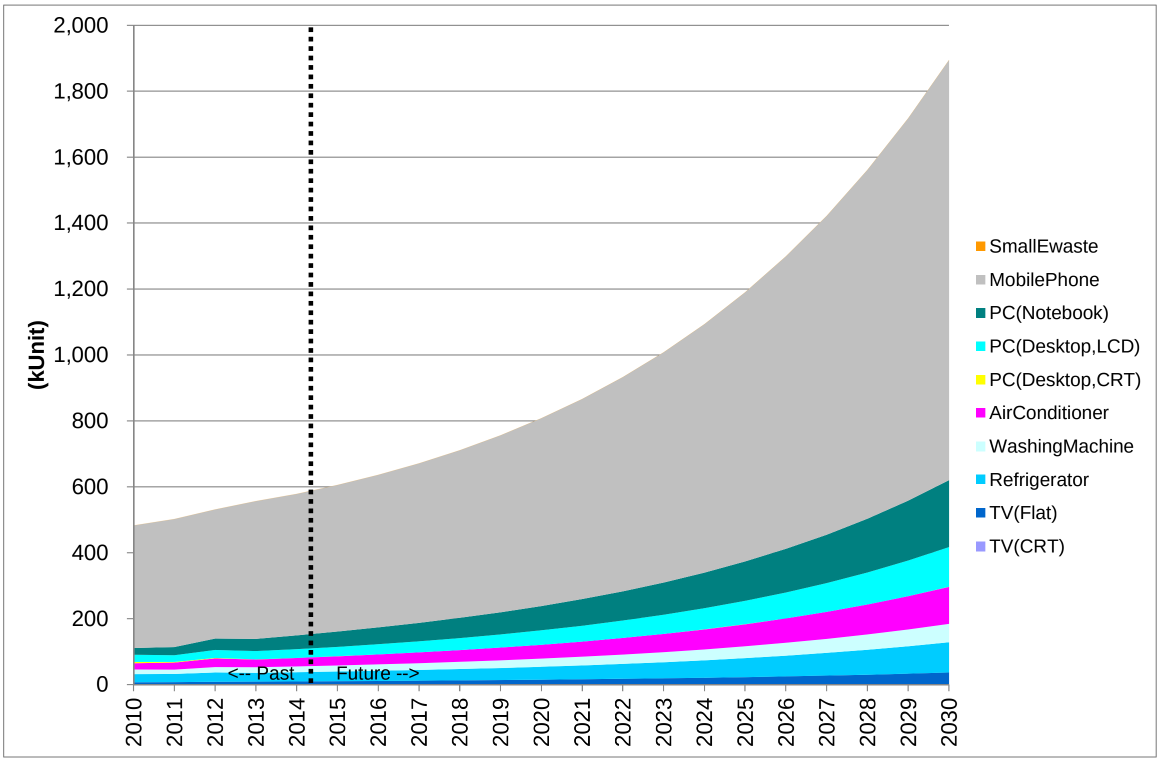


Figure 29 Supplied units to businesses (Recife)

Source：JICA Expert Team

2.5.2 Stocked units in Recife

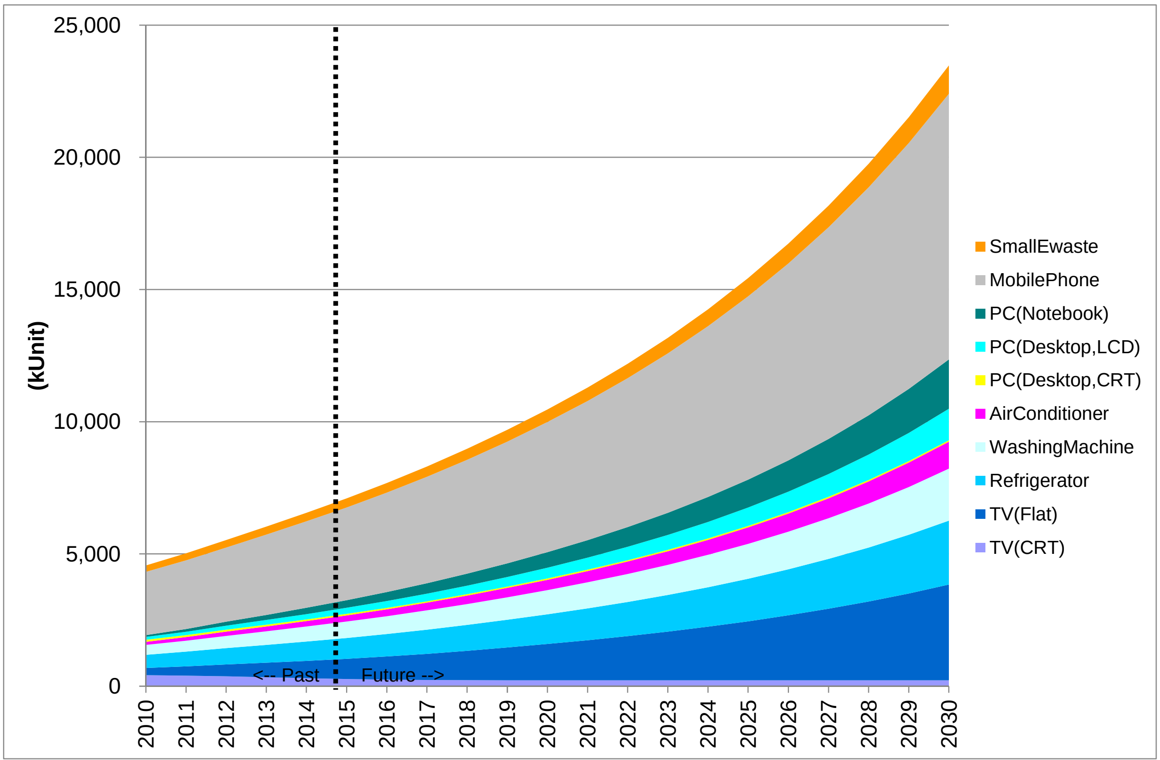


Figure 30 Stocked units in households and businesses (Recife)

Source: JICA Expert Team

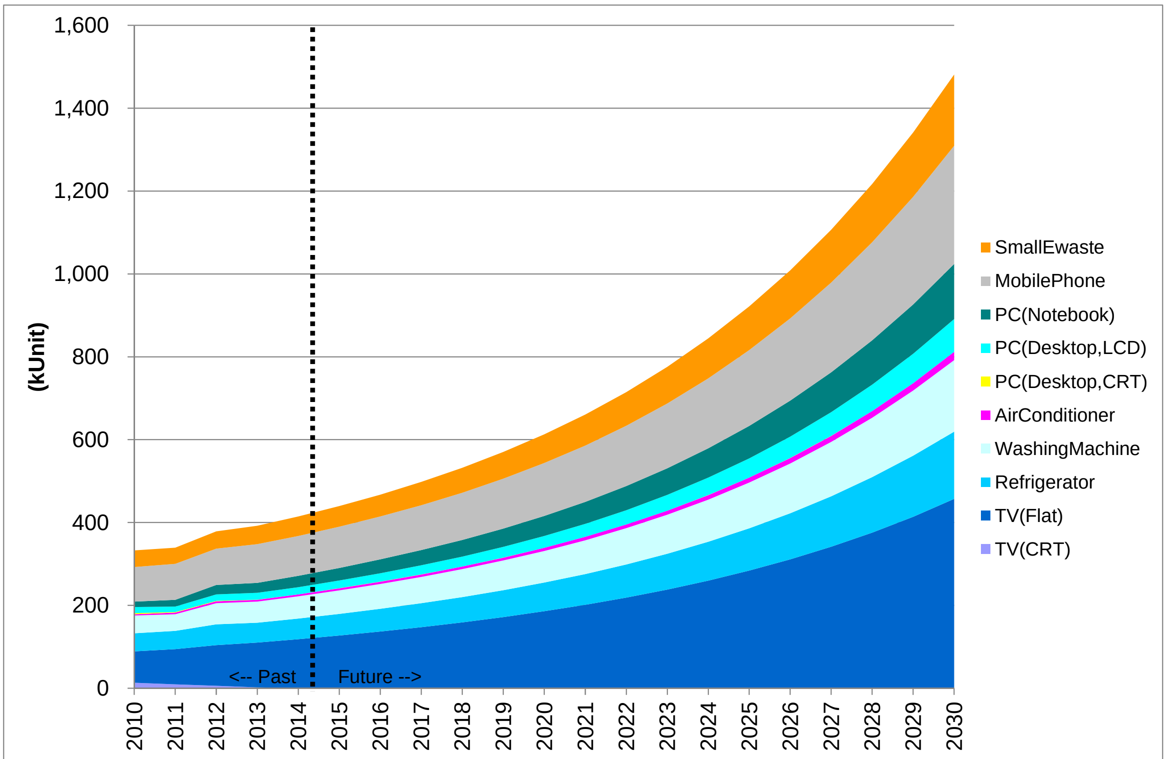


Figure 31 Stocked units in households (Recife)

Source: JICA Expert Team

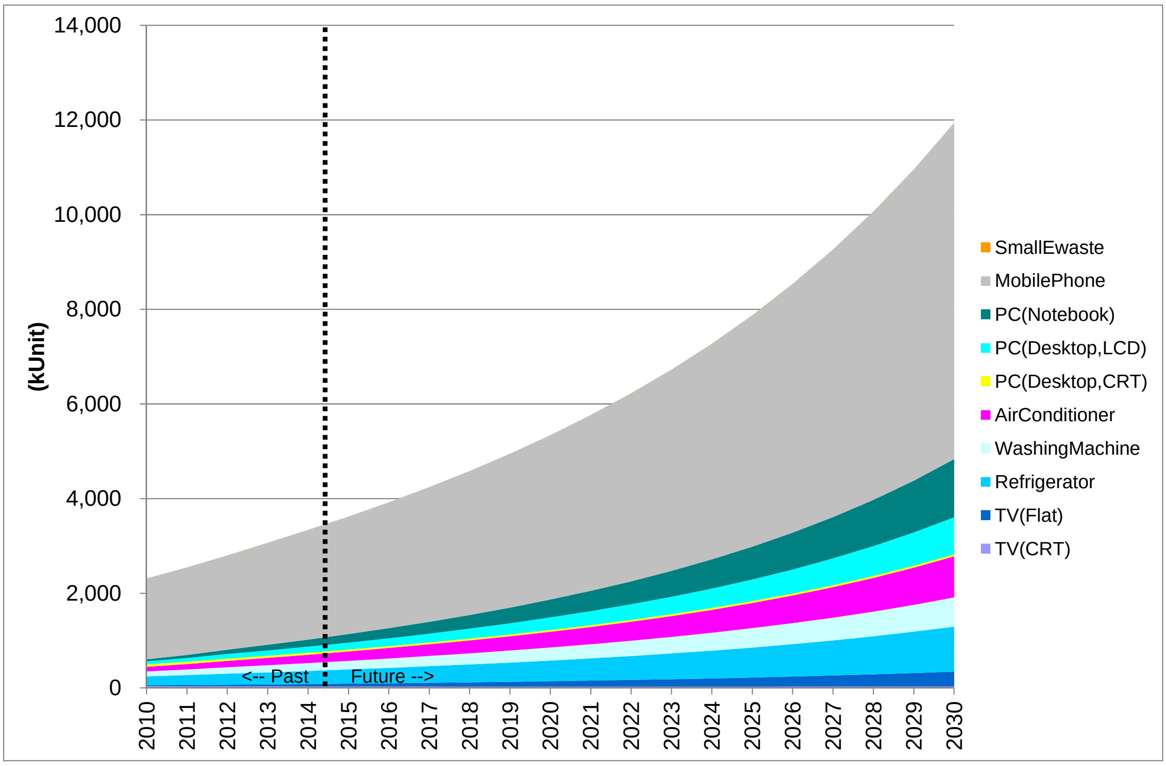


Figure 32 Stocked units in businesses (Recife)

Source: JICA Expert Team

2.5.3 Discarded weight including reused in Recife

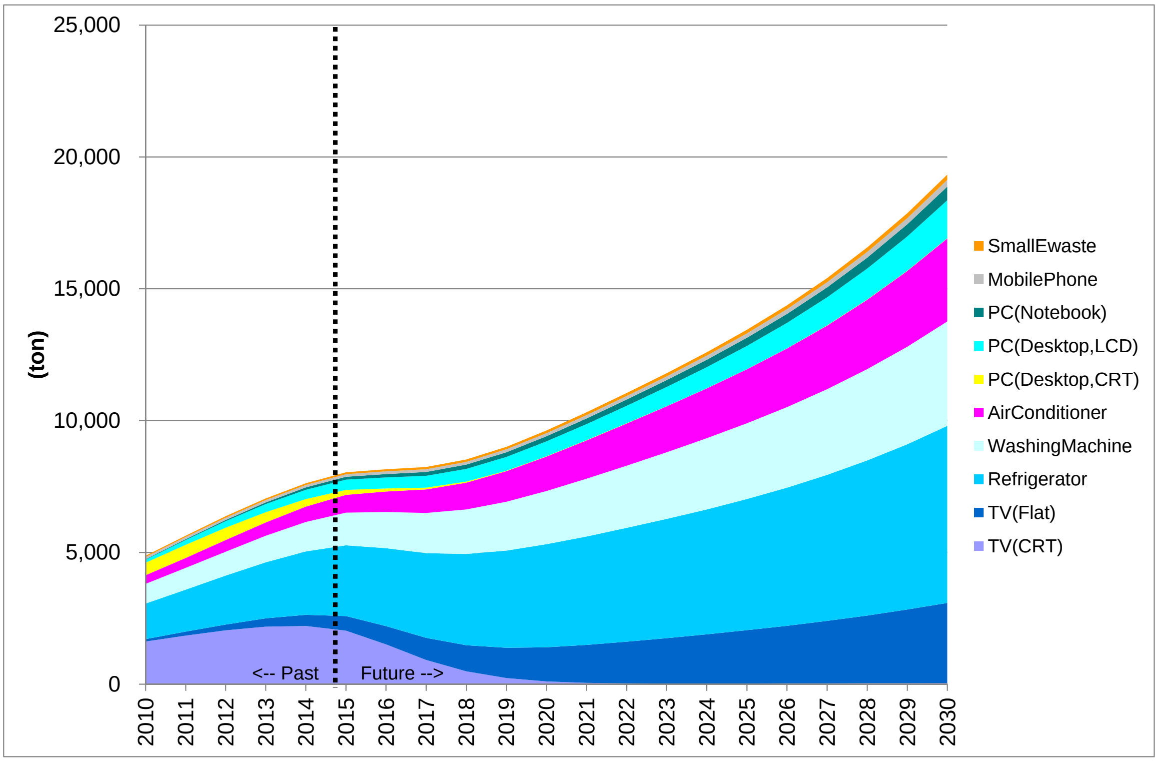


Figure 33 Discarded weight including reused from households and businesses (Recife)

Source： JICA Expert Team

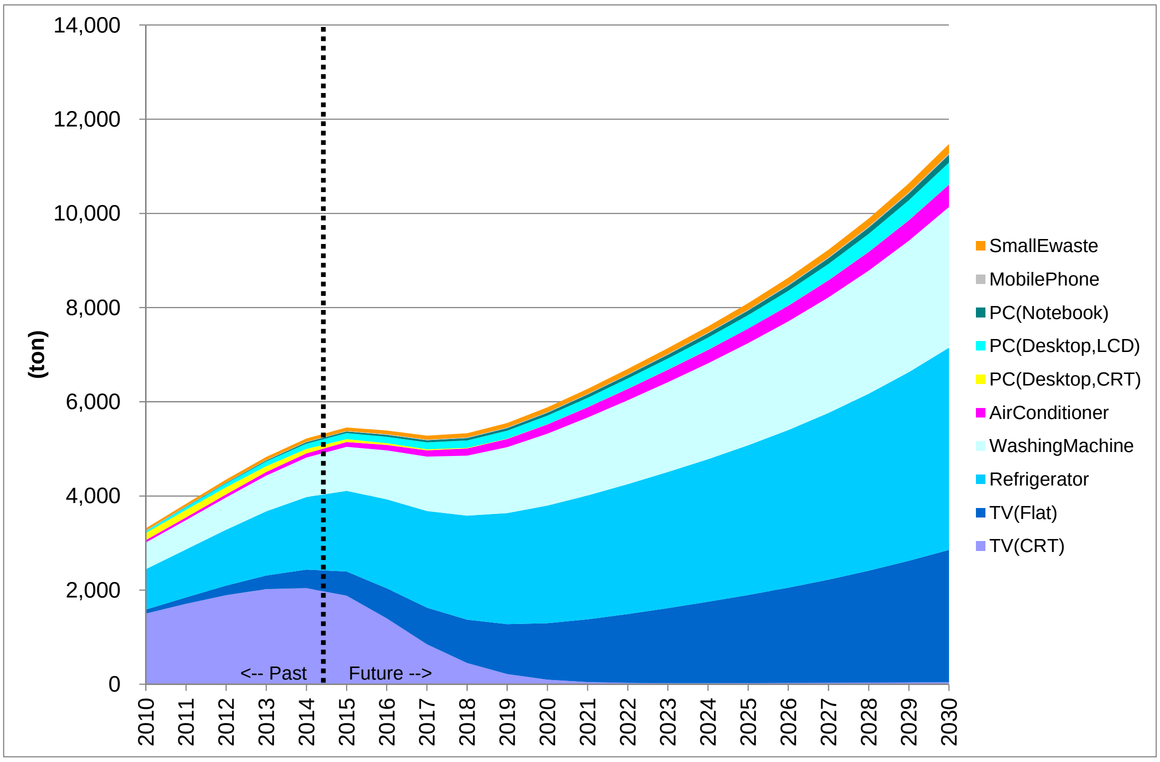


Figure 34 Discarded weight including reused from households (Recife)

Source： JICA Expert Team

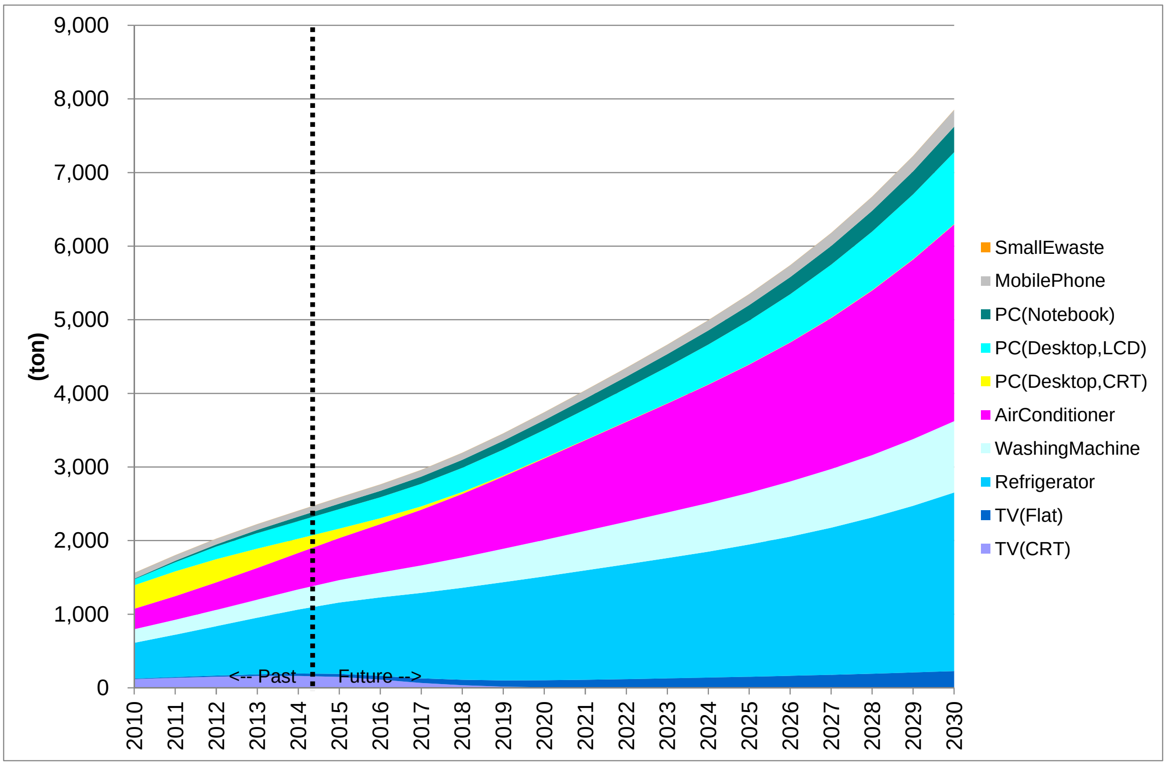


Figure 35 Discarded weight including reused from businesses (Recife)

Source: JICA Expert Team

2.5.4 Discarded weight excluding reused in Recife

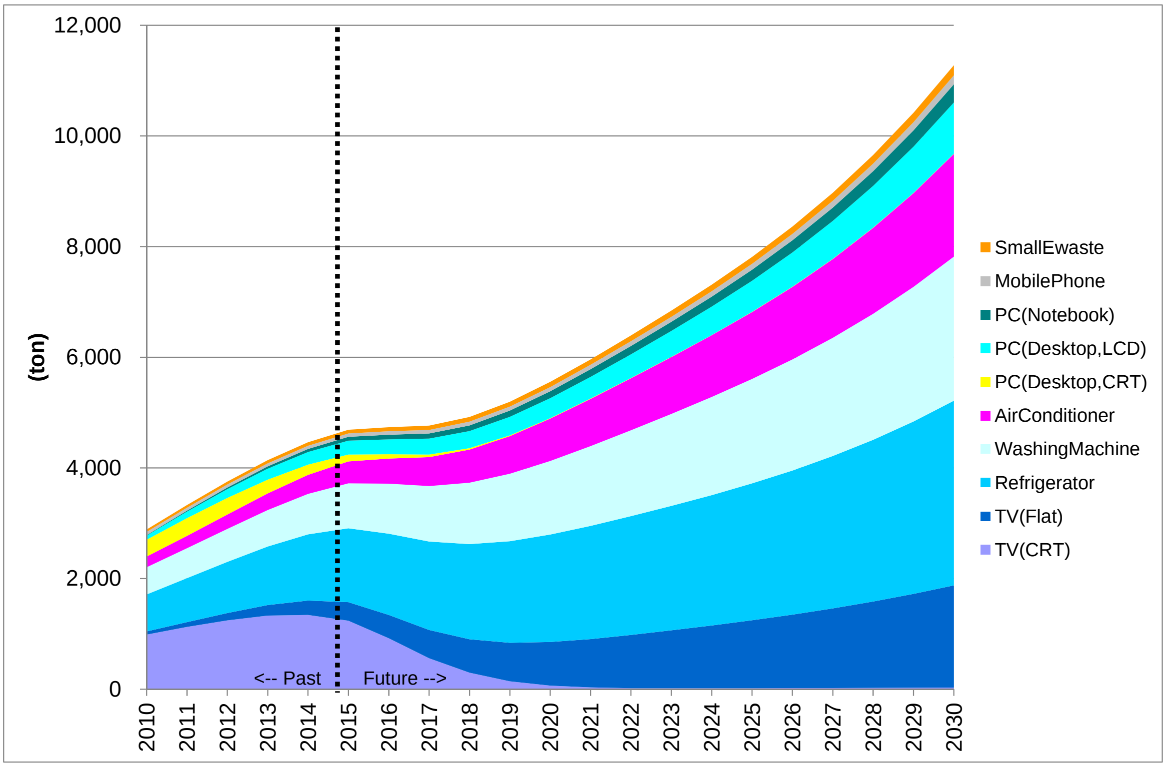


Figure 36 Discarded weight excluding reused from households and businesses (Recife)
Source: JICA Expert Team

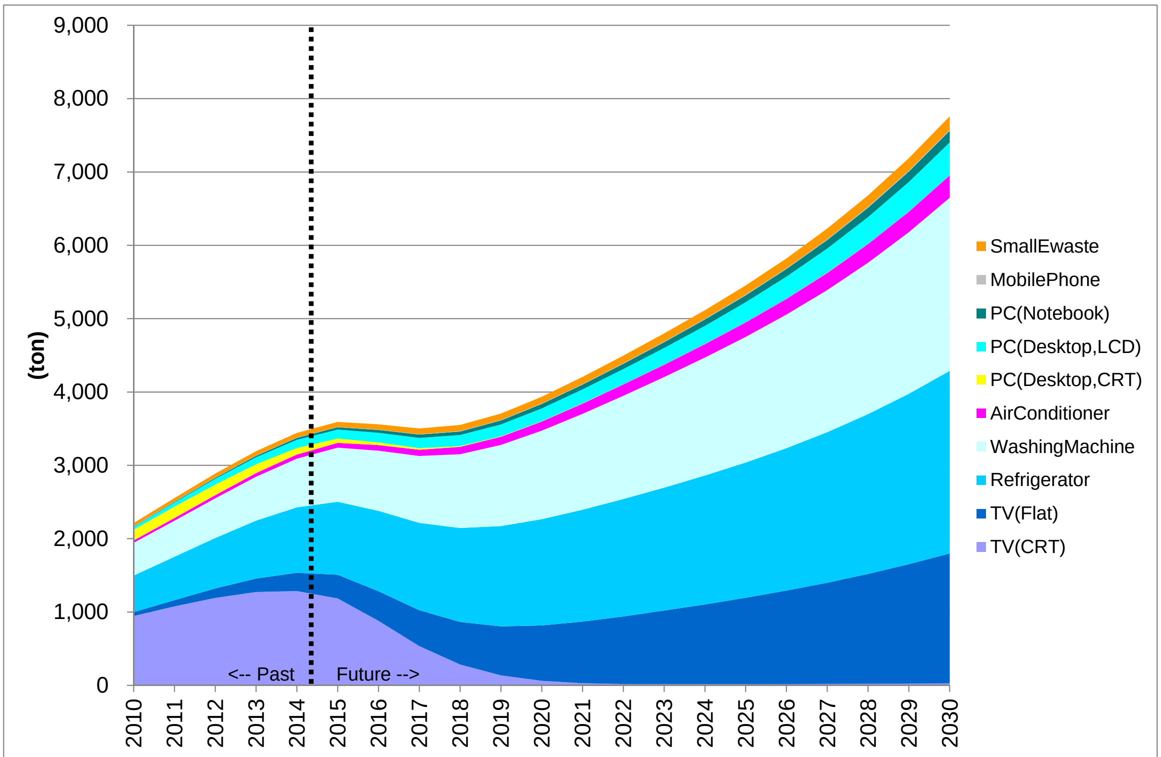


Figure 37 Discarded weight excluding reused from households (Recife)
Source: JICA Expert Team

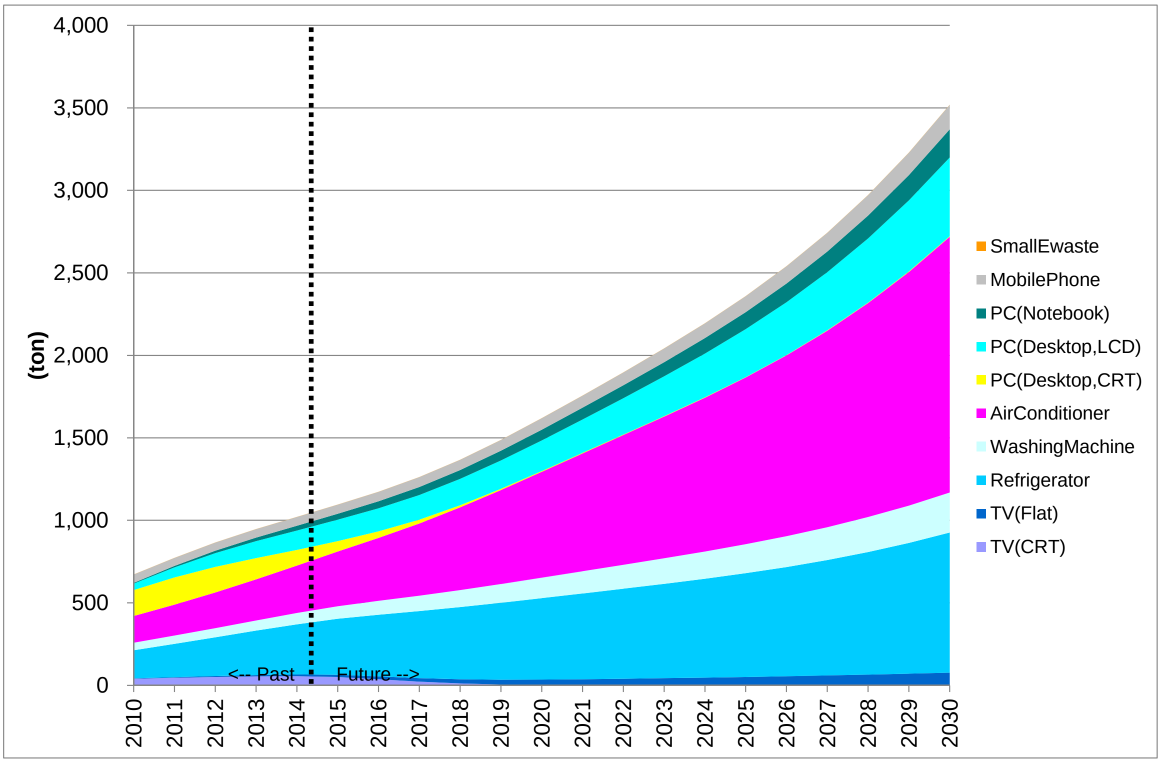
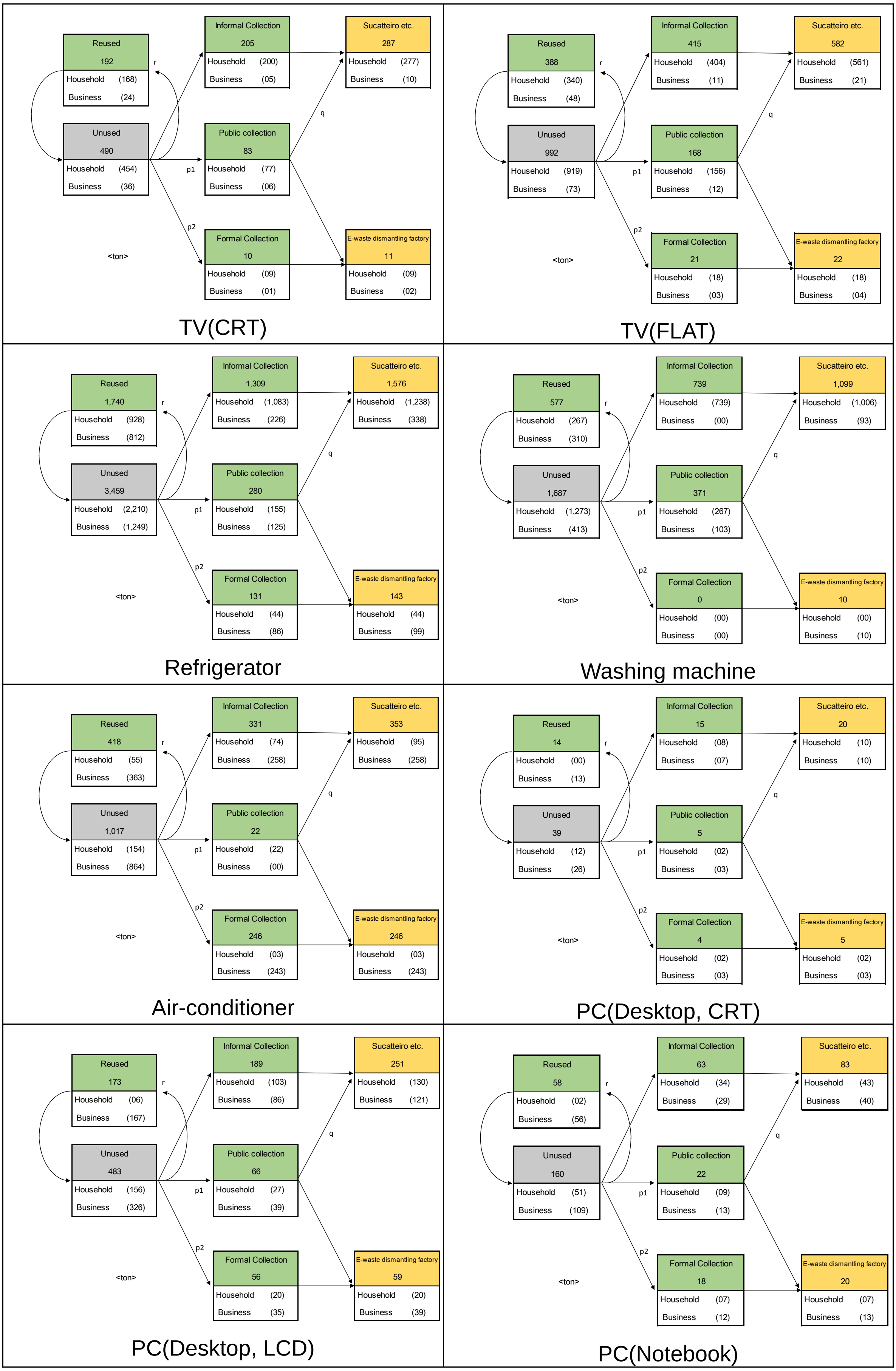


Figure 38 Discarded weight excluding reused from businesses (Recife)
Source： JICA Expert Team

2.5.5 Disposal rate

In the same way as Brasilia, the disposal rate (household, business) in Recife is the same as the result of Sao Paulo's survey.

2.5.6 E-waste flow



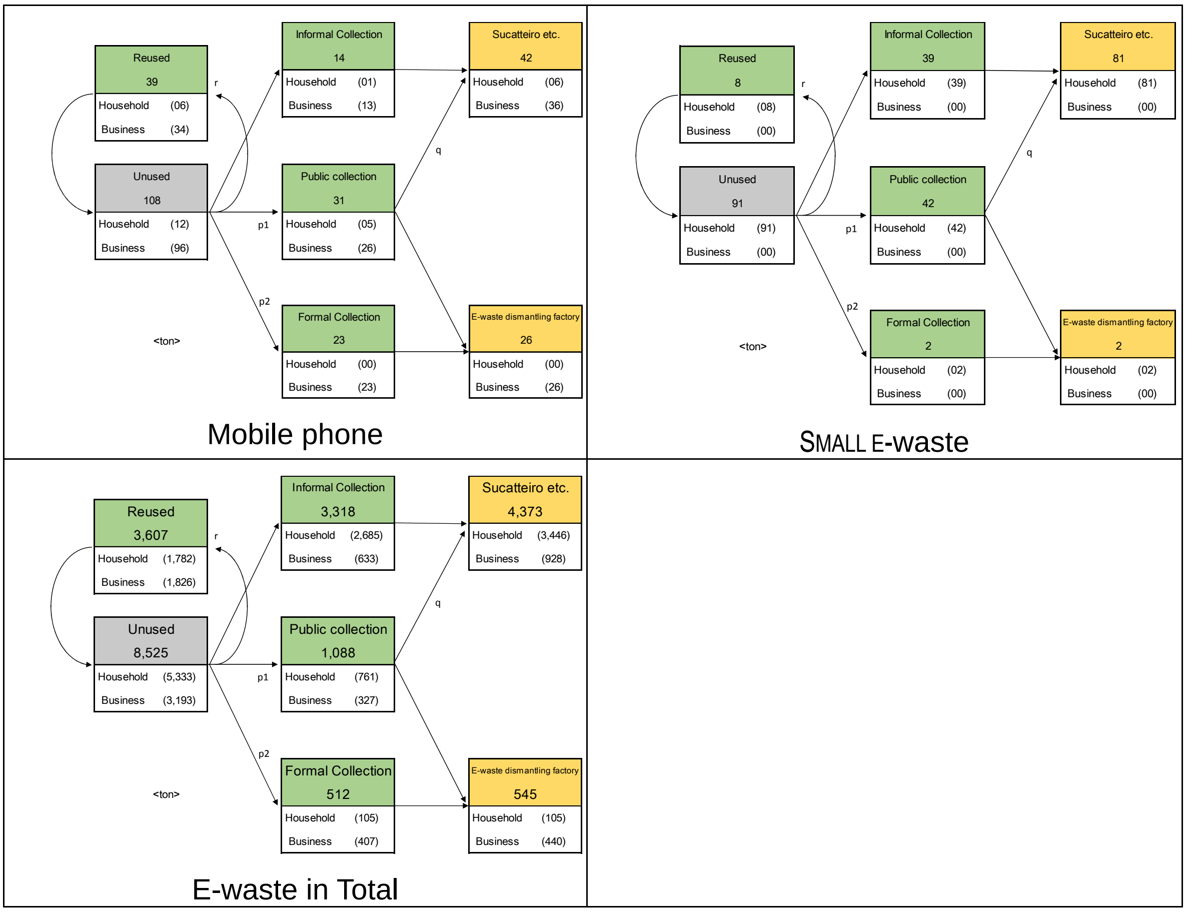


Figure 39 E-waste flow from households and businesses in 2018 (Recife)

Source：JICA Expert Team

2.6 Sensitivity analysis

2.6.1 Ranges of the parameters

The unreliable parameters used in the e-waste inventory analysis were checked their sensitivities. The sensitivities was checked in the household inventory. The target parameters and the range of each parameter are shown in the following table.

Table 11 Targeted parameters and their ranges

Parameter	E-waste	Standard value	Range (upper and lower)
Average used year	TV(CRT)	10.5	7.3
	TV(FLAT)	9.5	4.8
	Refrigerator	12.1	7.3
	Washing machine	11.9	8.4
	Air-conditioner	11.1	6.7
	PC(Desktop, CRT)	5.8	11.4
	PC(Desktop, LCD)	5.1	10.1
	PC(Notebook)	4.4	8.7
	Mobile phone	2.0	6.1
	Small e-waste	10.1	4.0
Average weight per unit	Air-conditioner	55	50-60
Domestic input	PC(Desktop, CRT)	-	30% plus to the standard value (Orphan products and illegal import)
	PC(Desktop, LCD)	-	Ditto
	PC(Notebook)	-	Ditto

Source：JICA Expert Team

2.6.2 Sensitivity to the target parameters

The change in the amount of discarded e-waste in 2015 was evaluated in accordance to the change in the parameters with the ranges.

The change is basically inside 10% to the total e-wastes discarded in 2015.

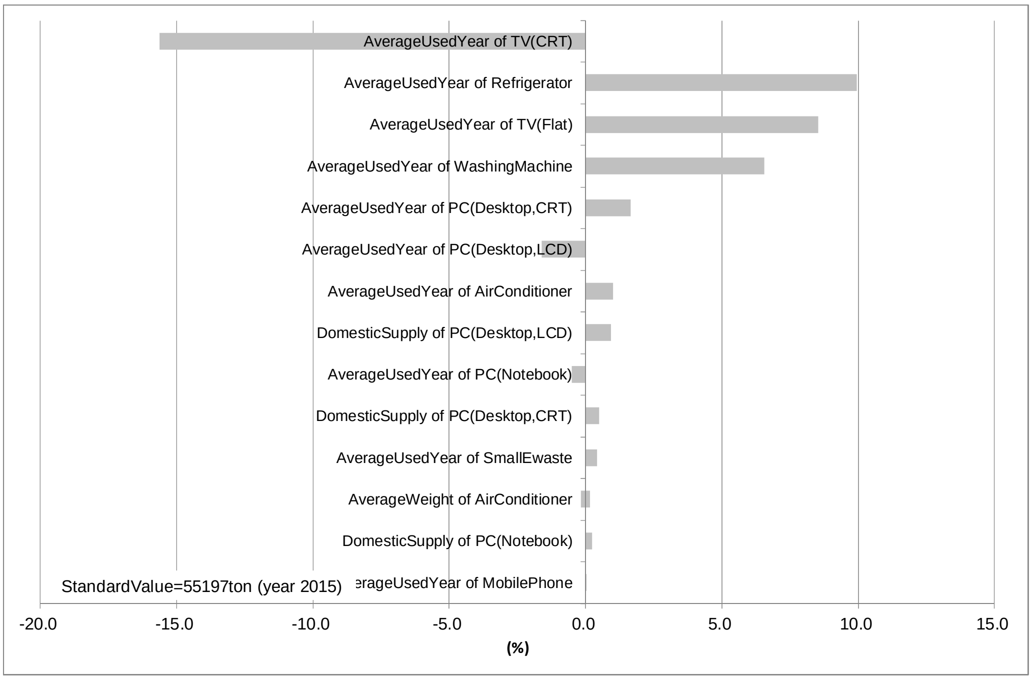


Figure 40 Change of the amount of e-wastes to be discarded from households affected by the parameter changes with the ranges

Source：JICA Expert Team

3 Recommendation on the applicability of the Pilot Project tried in Sao Paulo City

3.1 Characteristics of pilot project tried in Sao Paulo city

3.1.1 Outline of Sao Paulo City

The outline of Sao Paulo City that carried out the pilot project is as follows.

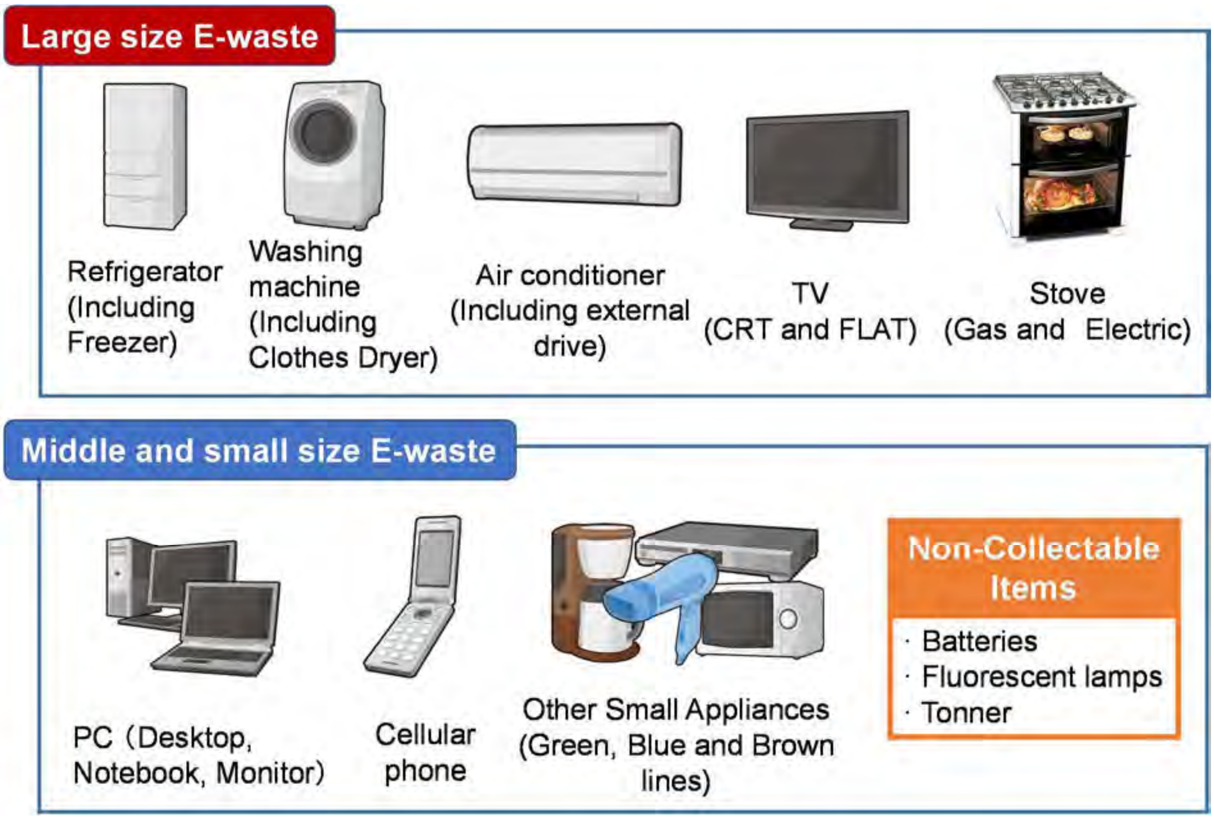
Table 12 Outline of Sao Paulo City

Item	Contents
State	State of Sao Paulo
Population	11,253,503 (2010 census)
Area	1521.11 km2
Density	7,398.3 / km2
Regional GDP	R$ 499 million (2012)
Eestimation of generated e-waste (excluding reused)	71,763 ton/year (2015)

Source: JICA Expert team

3.1.2 Target E-waste

Target E-wastes to be handled in the pilot project were identified as follows. Basically all E-wastes used at home are targeted. On the other hand, batteries and fluorescent lamps targeted by other reverse logistics are excluded from collection.



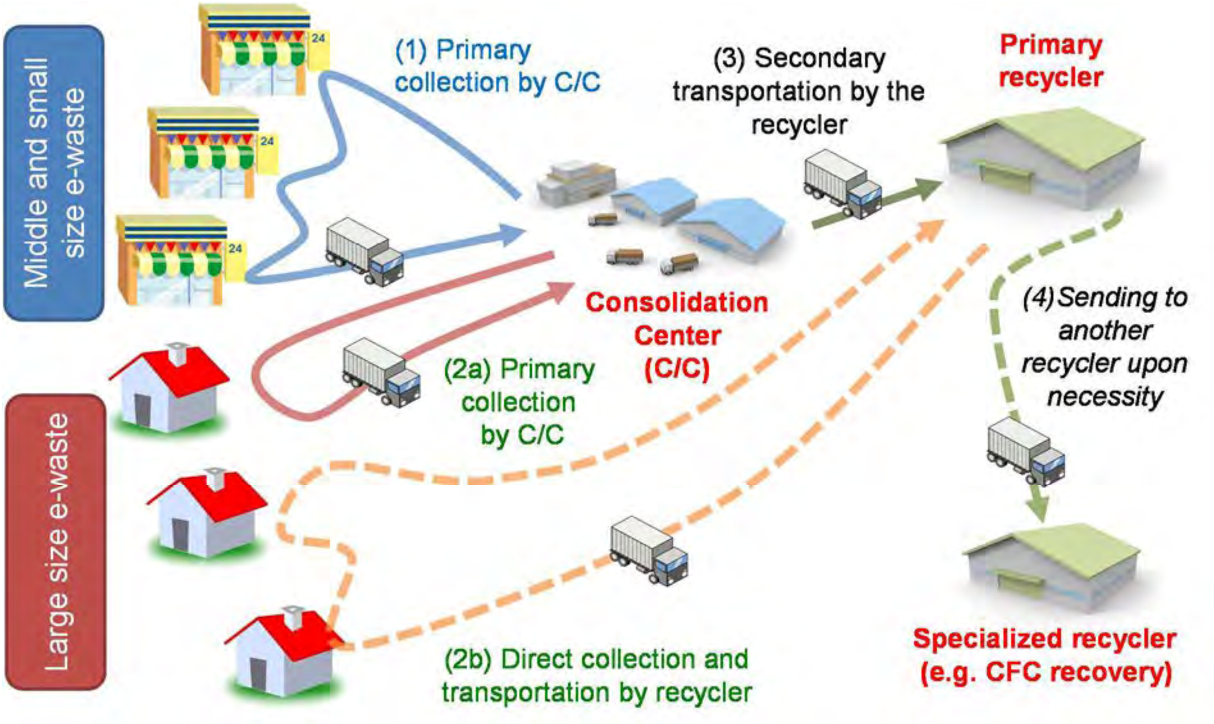
Source: JICA Expert team

Figure 41 Target E-waste in the Pilot Project

3.1.3 Collection flow

In the pilot project, we examined the collection method of medium and small size e-waste and the collection method of large size e-waste respectively. For medium and small size e-waste, "Drop-off collection" was tried by installing collection boxes in supermarkets that sells home electronics dealers and home appliances. For large size e-waste, "trade-in collection" was tried to collect the e-waste separately for new purchasers.

Figure 42 shows the overall image of the e-waste collection system in the pilot project. For the medium and small size e-waste, the operator of the consolidation center (temporary storage facility) visits the retailer directly and collects the e-waste discarded in the collection box. For large size e-waste, the operator of consolidation center or recycler collects e-waste from consumer's home when consumers who purchase new products wish to pick up home appliances that are no longer needed. This consolidation center was proposed by Brazilian side based on cases of Japan in order to achieve efficient e-waste collection, and it was adopted and tried.



Source: JICA Expert team

Figure 42 Overall image of E-WASTE collection system in pilot project

3.1.4 Stakeholders relating to RL

Table 13 shows the stakeholders who participated in the pilot project (PP) and their roles. For the future operation of the E-waste RL system, it is necessary to engage not only the collection of E-waste but also stakeholders such as recycling companies that disassemble and recycle, fund manager, data management organization and PR company. In this P/P, participation of these stakeholders has been realized.

Table 13 Stakeholders and roles that participated in the pilot project

	Stakeholders	Roles
1	MMA, MDIC	Advice and support based on sector agreements and federal government policy Support for coordination with project stakeholders Confirmation of monitoring result and data
2	Sao Paulo city (AMLURB)	Public information, enlightenment to residents (PR material provided by JET) Coordination with project stakeholders Media correspondence, holding briefing sessions (jointly with JICA expert team)
3	Customer (Residents buying home appliances in PP target area)	Carry medium / small E-Waste to collection points. Apply the Trade-in service, hand over the large E-Waste to the shipping company in a manner determined at the designated place, date and time.
4	Retailers (Home electronics dealers and supermarkets participating in PP) (Extra, Extra Hyper, Pont frio, CasasBahia, Walmart, Lojas Americanas, Pernambucanas)	Provide installation space for collection box (collection box provided by JICA) Trial of Trade-in service (takeover of large E-Waste from residents, transportation / storage to C / C (case where retailers try themselves, cost partly by JICA)) Cooperation of PR campaign (material provided by JICA)
5	Retailing association （FECOMERCIO、ABRAS、APAS）	Coordination with participating retail stores to the pilot project Advice to project public relations
6	Consolidation center（Coopermiti）	Operation as Consolidation Center (C / C) (cost is borne by JICA) Loading E-waste from collection points and residents, primary transportation (cost is borne by JICA)
7	Recycler (OXIL、GM&C)	Carry E-waste loading at C / C, secondary transportation, proper treatment / disposal, data reporting. However, loading of some large E - Waste will be done at household. (The cost is borne by the JET)
8	Producer (ABREE、ABNIEE、ELETROS)	Monitoring of recycling companies · Implementation of visit inspection (joint implementation with JET) Cooperation of Public Information Campaign (Public Relations Magazine, Website, etc.)
9	State gov. (SMA･CETESB, SEFAZ)	Issuance of permission required for implementation of pilot project Advice and support based on sector agreements and state government policy

Source: JICA Expert team

3.1.5 Target area

(1) Location area of stores that collect E-waste

Stores located in the Lapa district of Sao Paulo city were targeted (Trade-in: 8 stores, Drop-off: 10 stores).

(2) Target area for collecting E-waste

The area covered by Trade-in was the whole area of Sao Paulo City.

(3) Area to dismantle and recycle E-waste

The recycling company who participated in the pilot project is located in the suburb of Sao Paulo city (Sorocaba City, Sao José dos Campos city) and was about 100 km from the center of Sao Paulo city.

3.1.6 Equipment etc. used for the pilot project

For the implementation of the pilot project, the equipment and materials provided by the JICA Project Team are as follows.

Table 14 Equipment etc. used for the pilot project

Item	Contents
Collection box	Use at collection points
PR goods	Costs of events and campaigns for pilot projects, expenses for publication materials such as distributed items, expenses for public relations activities using the Internet
Operation cost	Cost for collection and transportation, Operating cost for consolidation center, recycling fee, etc.
Information management	Management of E-waste data collected in the pilot project

Source: JICA Expert team

3.2 Characteristics in Brasilia and Recife

3.2.1 Outline of both area

The outline of Brasilia and Recife are as follows.

Table 15 Outline of Brasilia and Recife

Item	Brasilia	Recife
State	District federal	Pernambuco
Popuration	2,570,160 (census in 2010)	1,537,704 (census in 2010)
Area	5,780 km2	217 km2
Density	444.6 / km2	7,053.7 / km2
Regional GDP	R$ 171 million (2012)	R$ 37million (2012)

Source: JICA Expert team

3.2.2 Estimated generating E-waste

Estimated generating E-waste in Brasilia and Recife are as follows.

Table 16 Estimated generating E-waste in Brasilia and Recife (2018)

Item	Brasilia	Recife
E-waste in household	17,444 ton/year	3,551 ton/year
E-waste in business	6,650 ton/year	1,367 ton/year
Total	24,095 ton/year	4,918 ton/year

※excluding reused e-waste

Source: JICA Expert team

3.2.3 Status of existence of stakeholders related to RL

The status of existence of stakeholders related to E-waste reverse logistics in Brasilia, Recife is as follows.

Table 17 Stakeholders in Brasilia and Recife

Item	Brasilia	Recife
Federal Government	Yes (MMA, MDIC)	Yes (MMA, MDIC)
State Government	Yes	Yes (SEMAS, SMAS)
Municipality Government	Yes	Yes (EMLURB)
Customer	Yes	Yes
Retailers	Yes	Yes
Retailing association	No	No
Consolidation center	No	No
Recycler	Few	Few
Producer	No	No

Source: JICA Expert team

3.3 Recommendation on the applicability

Characteristics of the aforementioned pilot project in Sao Paulo City are summarized as follows.

- Trial of collection method with consolidation center installed

- Change method of collection with large size e-waste, and medium and small size e-waste
- Participation by dismantling / sorting company in the relatively near area (in Sao Paulo state)
- We held a technical committee that various stakeholders participated, and agreed to consensus formation.

Based on these characteristics, the recommendation for deploying to other cities are summarized below.

1) Formation of cooperative recycling area among states

In the pilot project of Sao Paulo City, e-wastes discharged from Sao Paulo City was processed at recycling companies located in the suburb of Sao Paulo city. These recycling companies are located at a distance of about 100 km from the center of Sao Paulo City and a recycling economic zone is formed at a distance that allows e-waste to be transported around Sao Paulo City (in Sao Paulo State) .

On the other hand, Brasilia and Recife, which were the subject of this survey, are the capital city of Brazil and the core city in the northeastern part, do not have enough facilities to collect and recycle e-wastes of more than a certain amount in each state or federal jurisdiction. It is also assumed that the recycling economic zone is formed beyond the state.

The issues in the pilot project of Sao Paulo City include: (1) exemption from licenses for the movement of E-waste as hazardous waste, and (2) tax exemption due to the movement of e-waste. Among these issues, (1) was resolved by CETESB issuing a state order that "E-waste that is not dismantled is not a hazardous waste". The tax exemption for (2) was not disclosed, but SEFAZ also considered exempting tax relief for the movement within the state.

However, these solutions are measures only within Sao Paulo state, and when crossing the state, restrictions are imposed in accordance with the laws of each state.

In Brasilia and Recife, it is difficult to conclude recycling activities within each state (or directly under the jurisdiction), so it is desirable to develop a legal system that does not interfere with R/L activities in cooperation with neighboring states that form economic zones.

2) Establishment of the consolidation center

In the case of constructing R/L system similar to PP of Sao Paulo City in other cities, it is possible to participate in dismantling/sorting company, consolidation centers and retailer involved in the collection of e-waste.

Regarding retailers, the situation of Recife and Brasilia is considered to be almost the same level as Sao Paulo, and it is not a big task in collecting e-waste.

The consolidation center is an effective facility when considering efficient transportation. In other words, if there are not enough recycling companies in the vicinity that can properly process E-waste that will occur in the future in Brasilia or Recife, transport the e-waste to a remote recycling company by using the consolidation center is possible.

As a function of the consolidation center, it is necessary to maintain the following functions. Candidates that satisfy these functions exist in Recife and Brasilia, so installation can be done by diverting existing facilities.

＜Function required for Consolidation Center＞

- Building to store the E-waste (roof, concrete floor)
- Experience of the service for allocation of cars (including call center)
- Forklift (for e-waste to move inside the hall)
- Weighing equipment (such as truck scale)

Although dismantling / sorting companies are also present in Recife and Brasilia, their capacities are assumed to be poorer than the companies located in the area around Sao Paulo City. In the case of collecting e-waste in Recife or Brasilia, it will be necessary to identify the capacity of these companies and to support it as necessary.

3) Promotion for recycling companies

Even if a consolidation center is installed, if the recycling company of the destination is in the distance, the cost will increase.

Although it is effective to utilize consolidation centers as a short-term measure, it is desirable to appropriately arrange a recycling factory of a certain size or more in the vicinity of the core city of each region in the long term.

4) Expectation of creating new business by sector agreement

Some existing recycling-related companies in Recife and Brasilia have a movement to consider constructing a structure from now so that it can become a receiver of reverse logistic assuming the conclusion of a sector agreement. For example, compared to the high transportation cost to the city of Sao Paulo in the large-scale economic zone, the completion of recycling within the area is a comparative advantage. In view of this point, it is a comprehensive E-waste recycling service that combines repair / resale / recycling, and cooperation among multiple companies to broaden the service. Creating a new mechanism based on the intention of these recycling companies is greatly expected to lead to the formation of an efficient E-waste reverse logistic. When collecting E-waste in Recife or Brasilia, it is desirable to form an efficient and effective mechanism while seeking cooperation with these recycling companies.

5) Expansion of stakeholder organization

In Sao Paulo City, where the pilot project was implemented, it was easy to consult and coordinate PP trials because there were sufficient stakeholders relating to E-waste's reverse logistics (Industry sector, management institution, retailer, government office, etc.).

On the other hand, in the case of local cities, it may be assumed that these stakeholders are absent and that adjustment concerning RL construction can not be carried out sufficiently. Therefore, it is necessary to take measures such as setting up a branch office of an industry organization and establishing a structure that makes it easy to communicate with headquarters.

6) Approach by type of home appliances

One of the lessons of the pilot project is that large size e-waste and medium / small size e-waste have different characteristics, collection methods and related stakeholders, and the approach to constructing the R/L system was different. For this reason, it is considered that it is realistic to construct R/L in the same way in Brasilia and Recife as well. Regarding the collection of large size e-waste in particular, it is necessary to carefully consider it based on the difficulty in the pilot project.

Japan International Cooperation Agency (JICA)

Project for E-waste Reverse Logistics Improvement in the Federative Republic of Brazil

Report on Required Facilities and Investment Promotion (Draft)

August 2017

JICA Expert Team

Table of Contents

Abbreviations

ABS	Acrylonitrile Butadiene Styrene
AC	Alternating Current
CAPEX	Capital Expenditure
CFC	Chlorofluorocarbon
CRT	Cathode-Ray Tube
IRR	Internal Rate of Return
METI, Japan	Ministry of Economy, Trade and Industry, Japan
OPEX	Operating Expenditure
PCB	Print Circuit Board
PP	Polypropylene
PS	Polystyrene
RDF	Refuse Derived Fuel
RL	Reverse Logistics
TV	Television sets

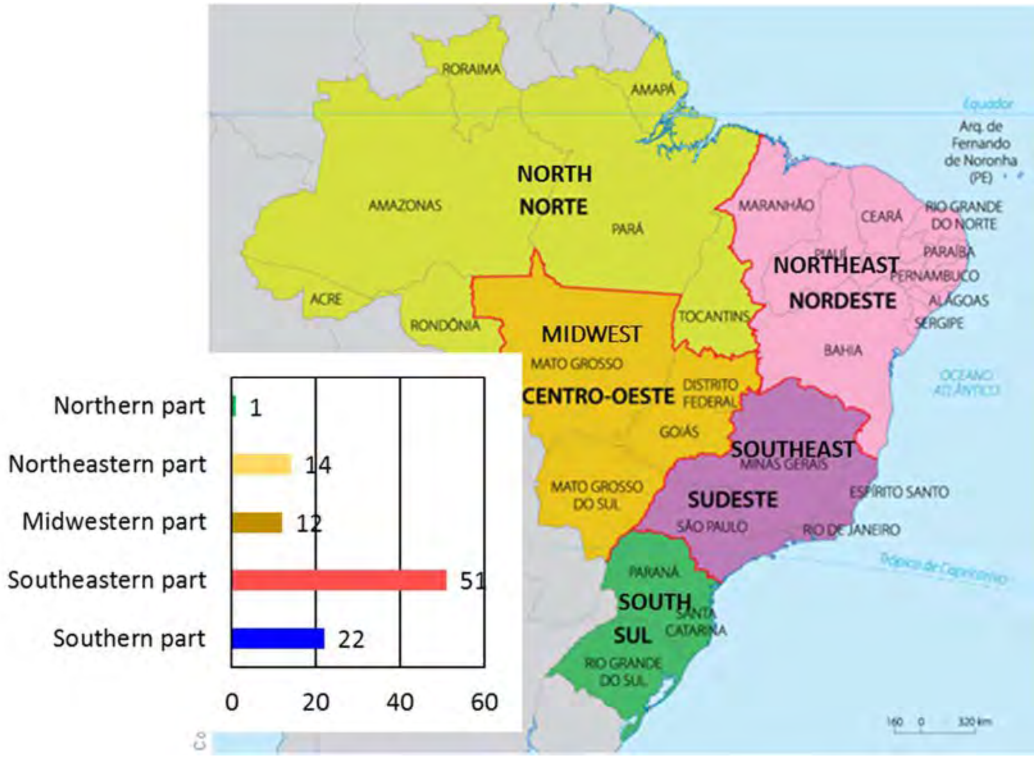
1. Background and objective

1.1 Present facility preparation for recycling facilities for the reverse logistics System

(1) Existing e-waste recycling firms in Brazil

There are one hundred firms, cooperatives and organizations involved in e-waste recycling in Brazil. Major target of e-wastes are small and middle size equipment including personal computers, their accessories and cellular phones.

Out of the 100 firms, 51 firms are located in the Southeastern part, 22 firms are located in Southern part, 14 firms are located in the Northeastern part, 12 firms are located in the Midwestern part and only one firm is located in the Northern part. Half of the firms are located in the Southeastern part where Sao Paulo and Rio de Janeiro are included. Thus, the locations of the firms have a regional bias.



Source of Map: Conexão Editorial

Figure 1-1 Number of recycling firms for e-waste recycling

(2) Advantage and shortage of the recycling facilities

1) Advantage of existing recycling firms

In Brazil, there are 100 firms for e-waste recycling in Brazil. This can be pointed as a potentiality to generate necessary infrastructure for e-waste reverse logistics. Once a demand for e-waste recycling is created, they will be motivated in investing in establishing required e-waste recycling factories. Furthermore, any economic incentive might enhance their motivation. The effects of some economic incentive were evaluated stated in the later chapters.

2) Shortage of functions for bulky e-waste recycling

Although there are 100 recycling firms in Brazil, most of them are dealing with small and middle size of e-wastes such as personal computers. They do not have the functions to crush big-size e-wastes such as television sets, refrigerators, washing machines and air-conditioners. Especially, one of the most important functions is to recover CFC gases which are used as insulation material in refrigerators.

In fact, only two firms are currently functioned to recover insulation CFC from refrigerators so as to achieve the related industrial standard. One of them is located in Cabreúva City, about 90km far São Paulo City. This factory has a capacity to recycle around 360 thousand refrigerators per year. Another one is located in Careaçu City, Minas Gerais State, about 230km from São Paulo City. This factory has a capacity to recycle 450 thousand refrigerator per year.

3) Current trend for generating necessary recycling factories

There are some movements to generate required recycling factories in Brazil. A new firm as a subsidiary of a major compressor manufacturer, located in Joinville City, Santa Catarina State, has recently announced its operation in recycling refrigerators. Also, above mentioned factory in Cabreúva has a plan to establish a factory in Ceará State in the beginning of the coming year.

Thus, there are some trials to generate regular recycling factories. This trend is very favorable for e-waste reverse logistics and any possible economic incentives might enhance the trend. This report evaluated the effects of the possible economic incentives.

1.2 Objective of this report

As mentioned above, recycling factories for large-size e-wastes including refrigerator recycling have to be developed for generating the reverse logistics system. The facilities has to be securely prepared in time for the introduction of new policies for the reverse logistics system.

For smooth development of these facilities, in this report,

- What recycling facilities and how many facilities are required?
- How much is supposed to be necessary?
- How are the investment for the facilities promoted?

will be proposed.

2. Required recycling facilities to be generated

2.1 Target e-wastes

1) Types of the target e-wastes

This report targets the following large-size e-wastes, because the recycling facilities for these e-wastes are not common so far in Brazil.

- Television sets
- Refrigerators
- Washing machines
- Air-conditioners

2) Amount of the target e-wastes

① Trend of the amount of the target e-wastes to be discarded

One of the report of this project: "The survey of current situation of e-waste reverse logistics in Sao Paulo, Part II – E-waste Inventory" issued in August 2015 estimates the expected amount of e-waste.

The amount of the target e-wastes will be increasing in terms of both the units and weights as shown in the following two figures.

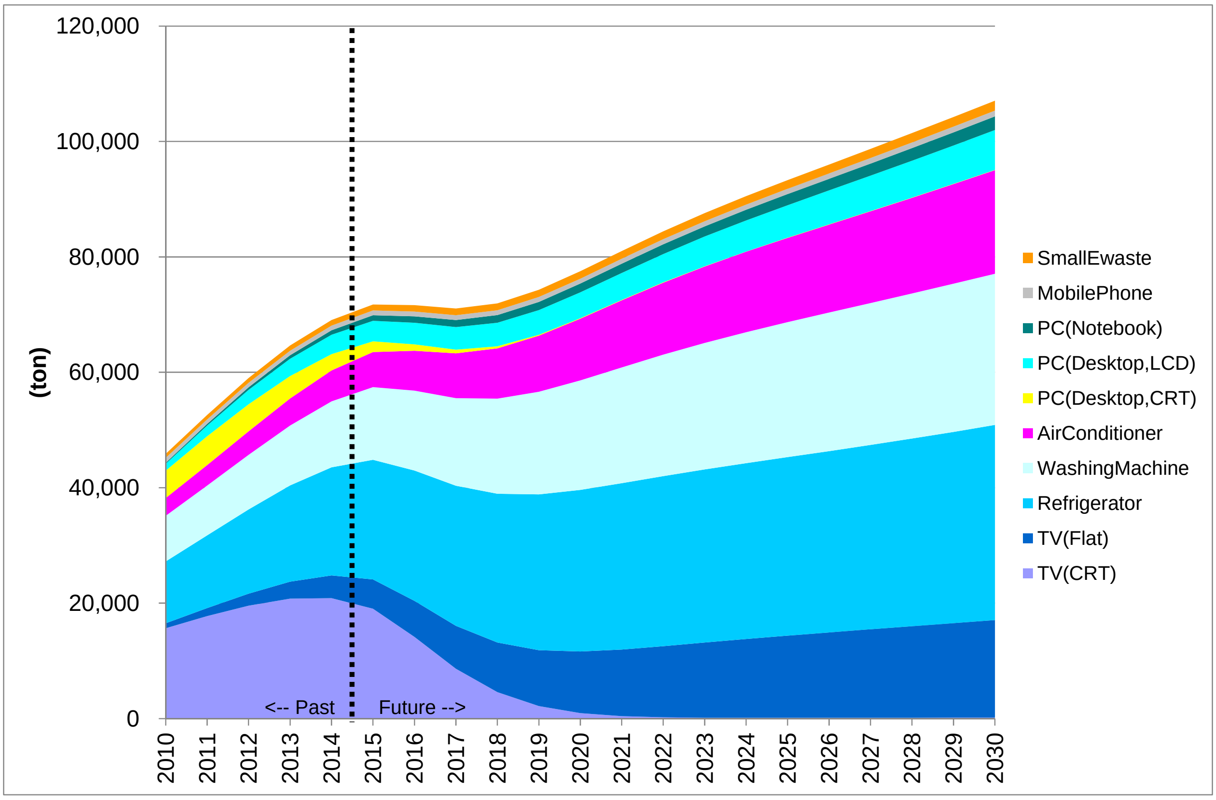


Figure 2-1 Discarded weight excluding reused from households and businesses from Sao Paulo City

Source: JICA Expert Team

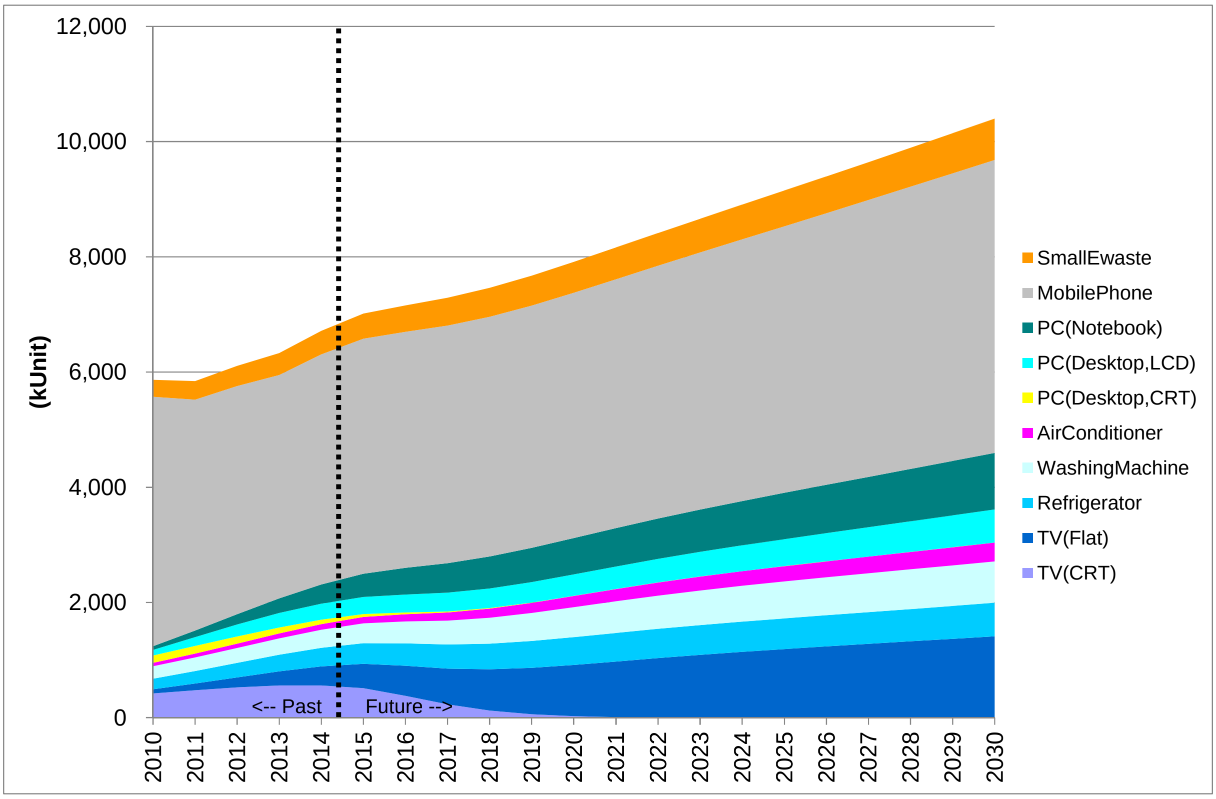


Figure 2-2 <u>Discarded units</u> excluding reused from households and businesses from Sao Paulo City

Source： JICA Expert Team

② Amount of the target e-wastes

The above figures contain the following numbers. This table gives the number of target e-wastes. Assuming that all discarded e-wastes are to be recycled, the number of e-wastes to be discarded can be estimated as shown below.

- Television sets: 900,000 – 1,400,000 units per year
- Refrigerator: 400,000 – 600,000 units per year
- Washing machine: 400,000 – 700,000 units per year
- Air-conditioner: 100,000 – 300,000 units per year

Table 2-1 Number of large-size e-wastes to be discarded from Sao Paulo City (1000 units)

Year \ E-waste	Television Sets	Refrigerator	Washing Machine	Air-Conditioner
2017	851	419	415	141
2018	839	444	451	159
2019	865	466	487	177
2020	915	483	520	194
2021	975	497	550	211
2022	1,035	508	577	227
2023	1,090	517	601	241
2024	1,142	525	622	253
2025	1,190	533	641	265
2026	1,237	541	658	277
2027	1,281	550	674	289
2028	1,326	560	689	301
2029	1,369	571	704	314
2030	1,412	583	718	327

Source： JICA Expert Team

2.2 Required facility

(1) Basic functions of the facility

The following functions are necessary for the recycling facilities.

- Separation of panel glasses and funnel glasses used for CRT television
- Refrigerant CFC gas recovery and storage functions from refrigerators and air-conditioners
- Insulation CFC gas recovery and storage functions from refrigerators
- Crushing and sorting functions for television sets, washing machine and air-conditioners after manual dismantling

(2) Unit process

1) Television sets with CRT

The process flow for CRT TVs is shown in the following figure. The function to separate panel glasses and funnel glasses has to be equipped with, because funnel glasses contain lead.

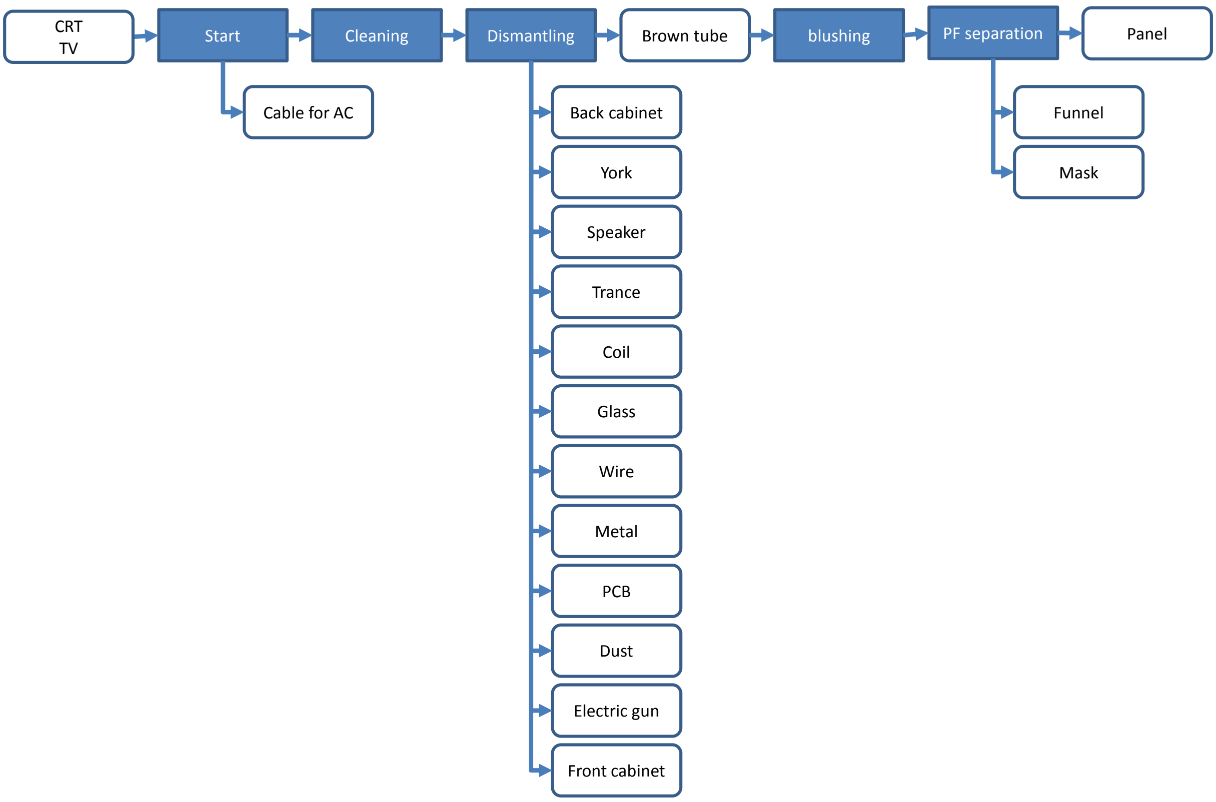


Figure 2-3 Recycling process for CRT TVs

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

2) Flat TVs

The process flow for flat TVs is shown in the following figure. Flat TVs need to be properly dismantled, because they contain mercury in thin fluorescent lumps used for backlight.

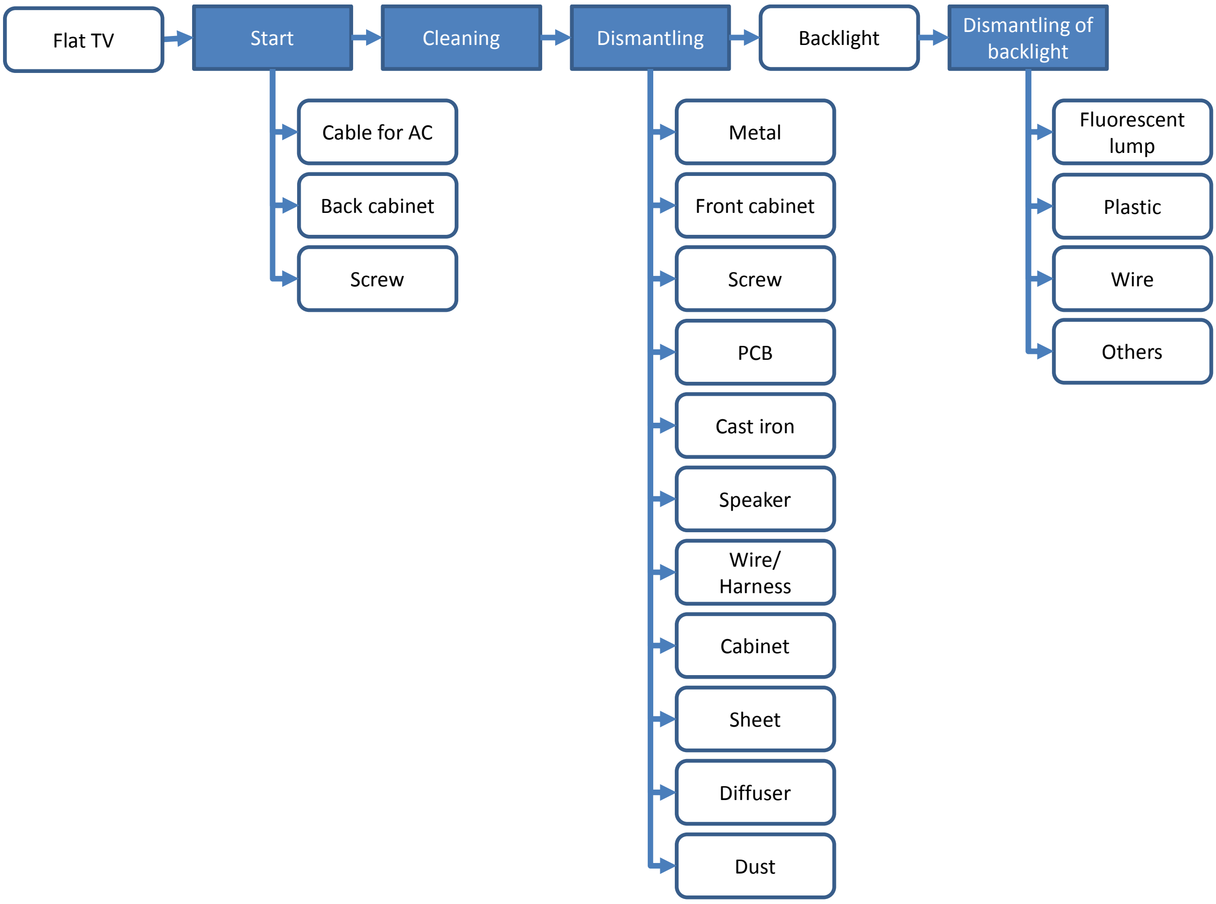


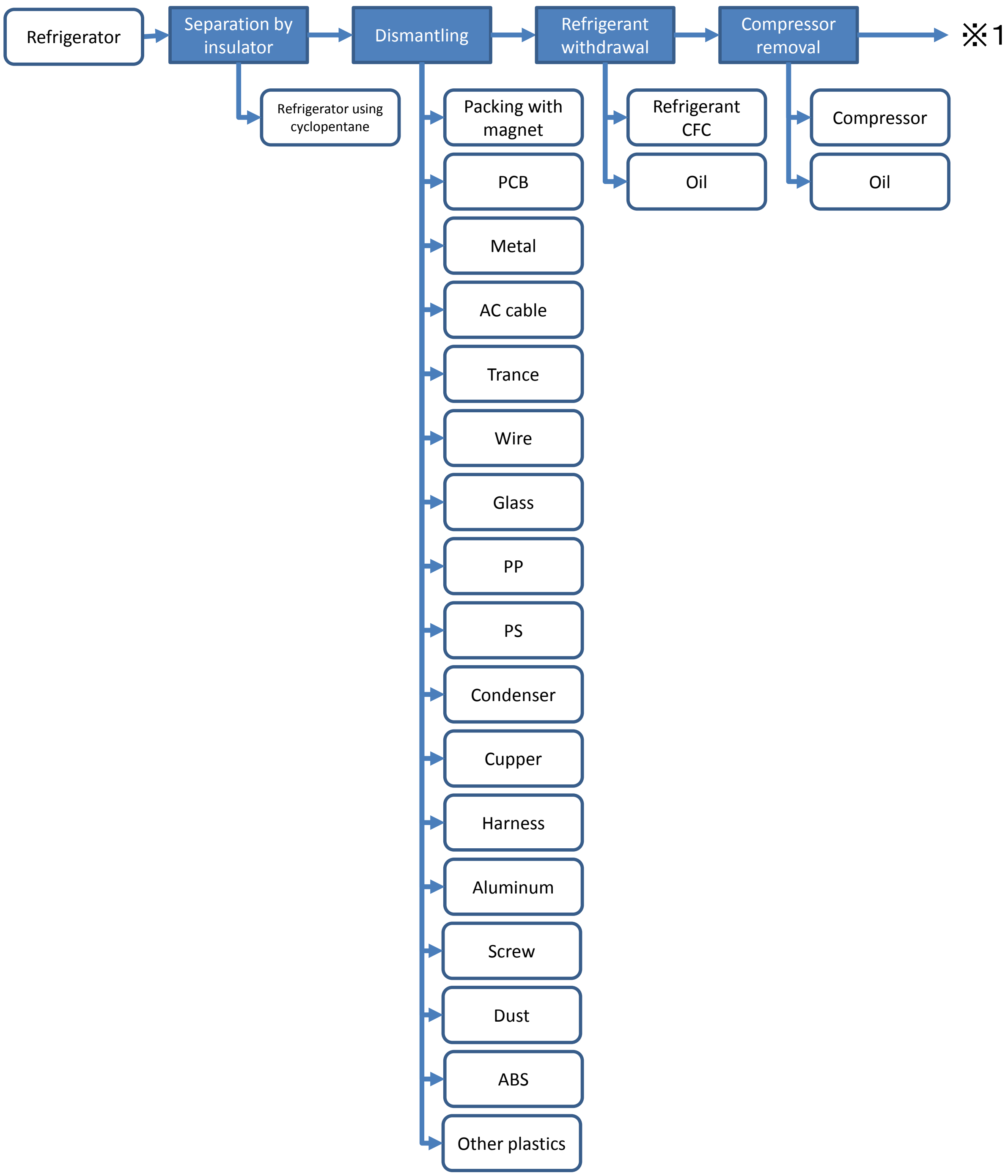
Figure 2-4 Recycling process for flat TVs

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

3) Refrigerator

The process flow for refrigerators is shown in the following figure. The futures can be summarized below.

- Refrigerators are one of the most difficult e-waste to recycle due to CFC gasses used in insulation. The CFC gasses have to be recovered and stored properly.
- There are some refrigerators using cyclopentane as insulation gasses. These refrigerators have to be crushed separately. When crushing, anti-explosion has to be considered.


Refrigerator
Separation by insulator
Dismantling
Refrigerant withdrawal
Compressor removal
※1
Refrigerator using cyclopentane
Packing with magnet
PCB
Metal
AC cable
Trance
Wire
Glass
PP
PS
Condenser
Cupper
Harness
Aluminum
Screw
Dust
ABS
Other plastics
Refrigerant CFC
Oil
Compressor
Oil

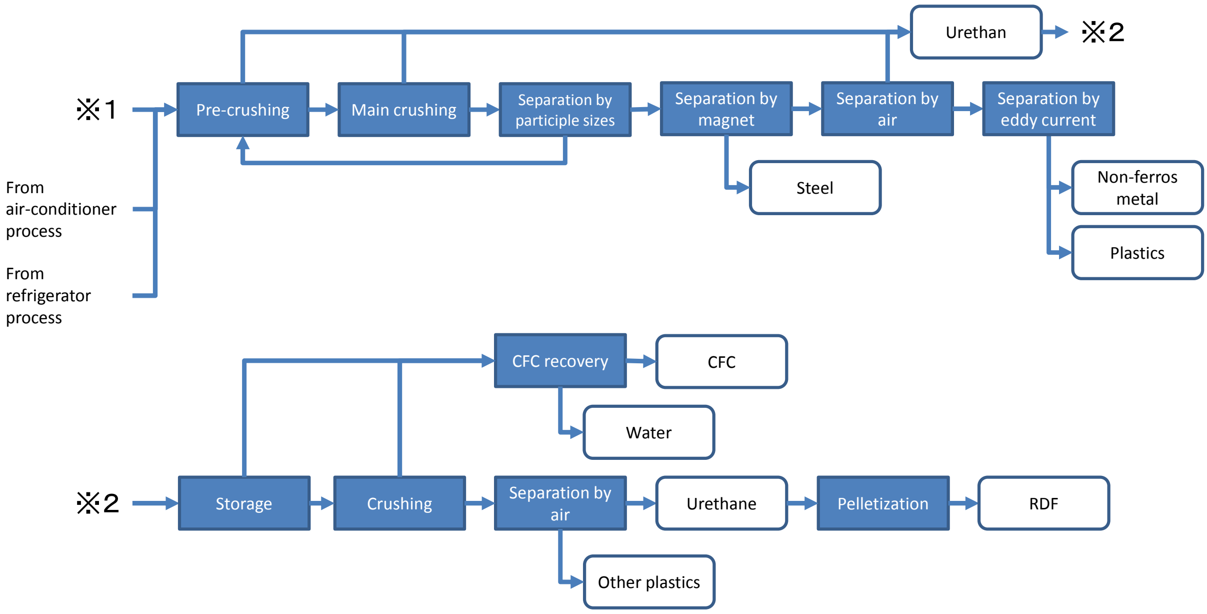


Figure 2-5 Recycling process for refrigerators

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

4) Washing machine

The process flow for washing machines is shown in the following figure. A crusher for crushing the bulky cases is needed.

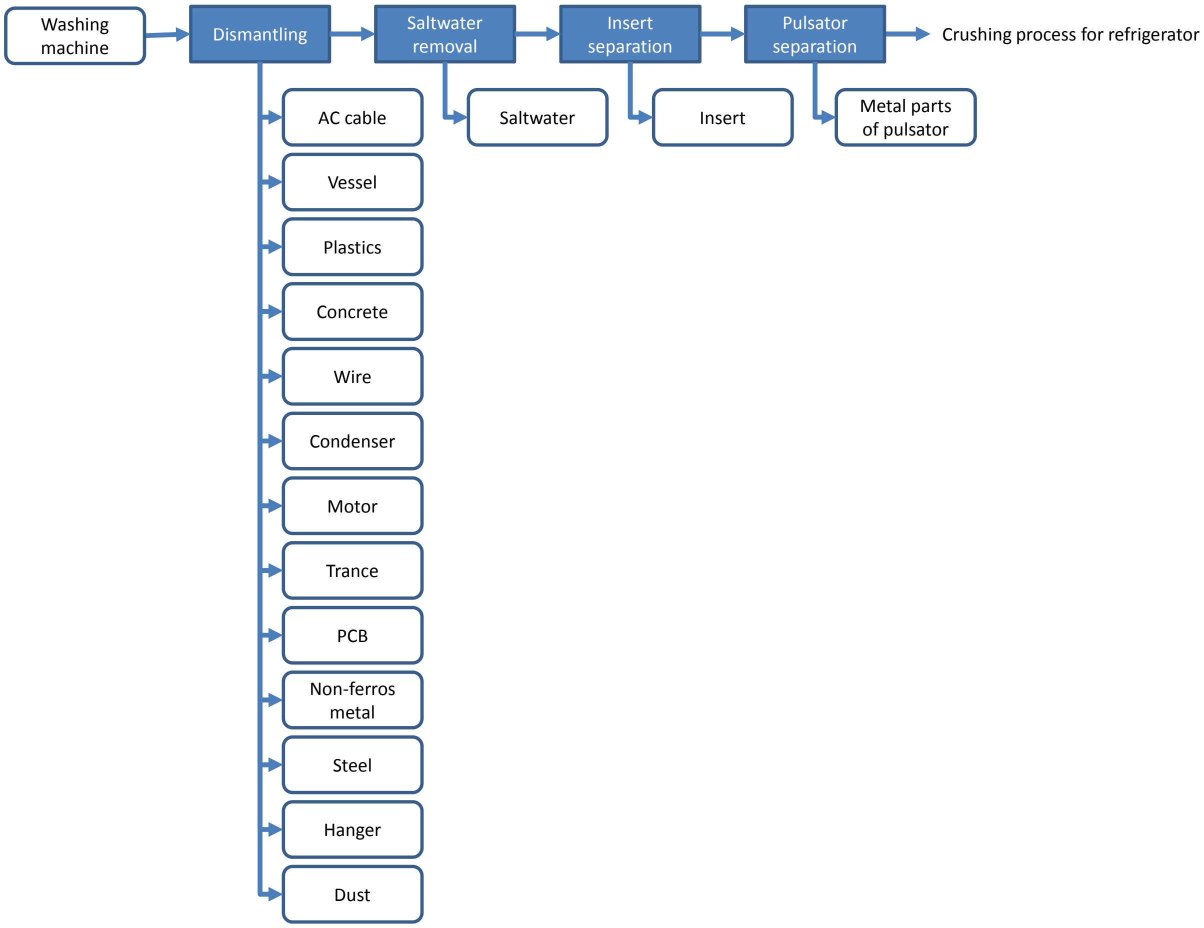


Figure 2-6 Recycling process for washing machines

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

5) Air-conditioners

The process flow for air-conditioners is shown in the following figure. As same as refrigerator recycling, recovery of refrigerant CFC gasses is necessary.

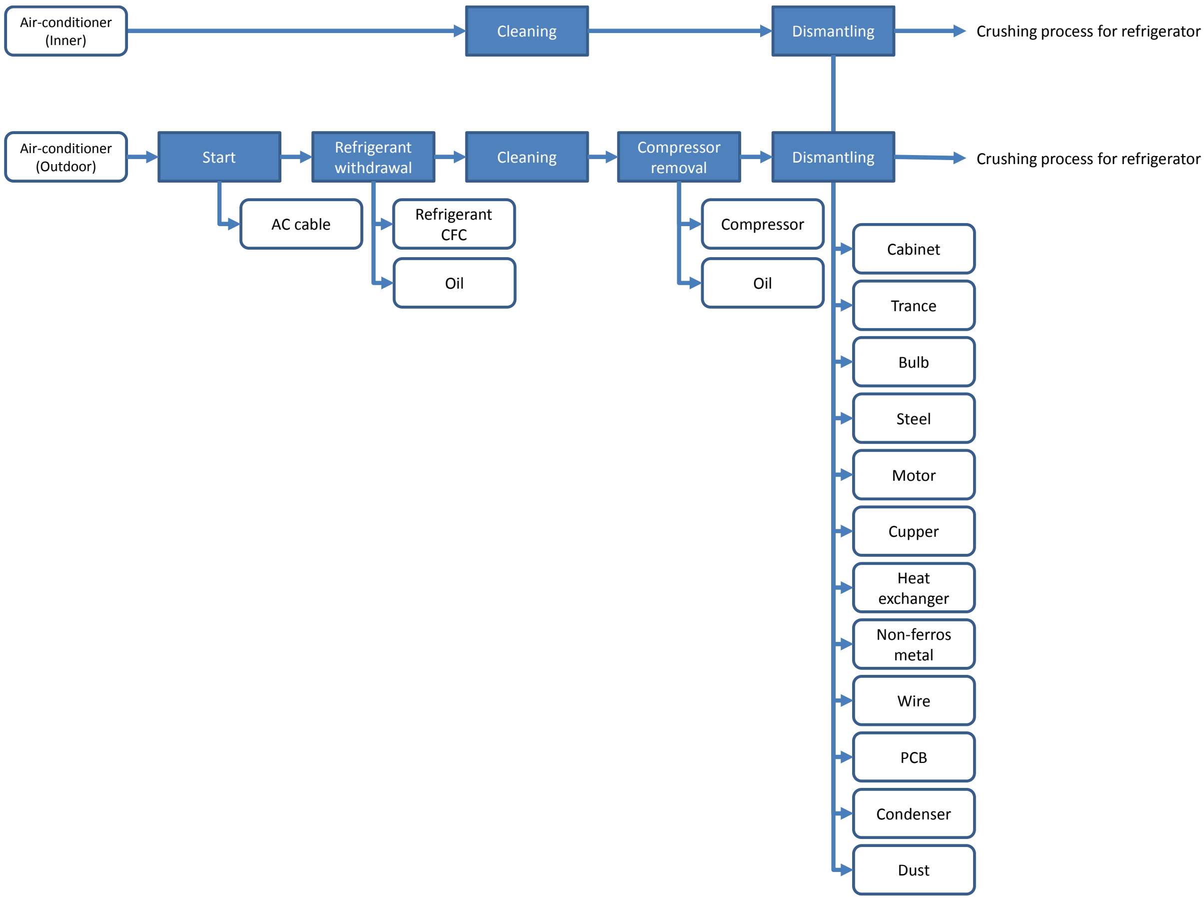


Figure 2-7 Recycling process for air-conditioners

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

(3) Example of process flow

The process flow can be exemplified as shown in the following figure.

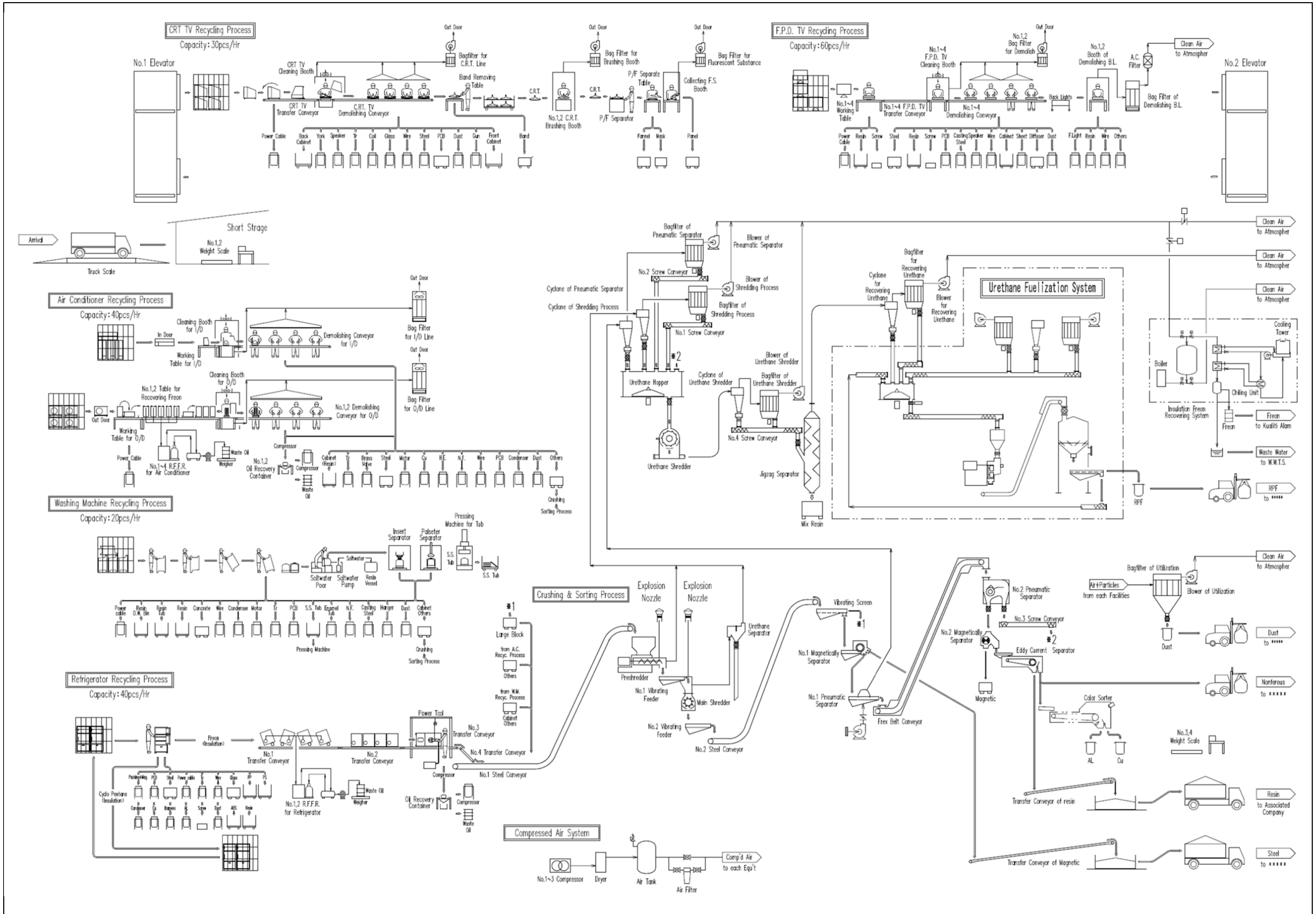


Figure 2-8 Example of basic process flow

Source: Sustainable System Design Institute: “Feasibility study on e-waste recycling project in Malaysia”, March 2014 (for Ministry of Economy, Trade and Industry, Japan)

(4) Material balance

Figure 2-9 contains the rates of recyclables taken from e-wastes.

- The rates of recyclables are 10 – 30 %. By the recycling processes, high reduction rates are expected. As for CRT Tvs, the lead glasses have to be recovered for achieving high recycling rate, while the demand of lead glasses is limited.

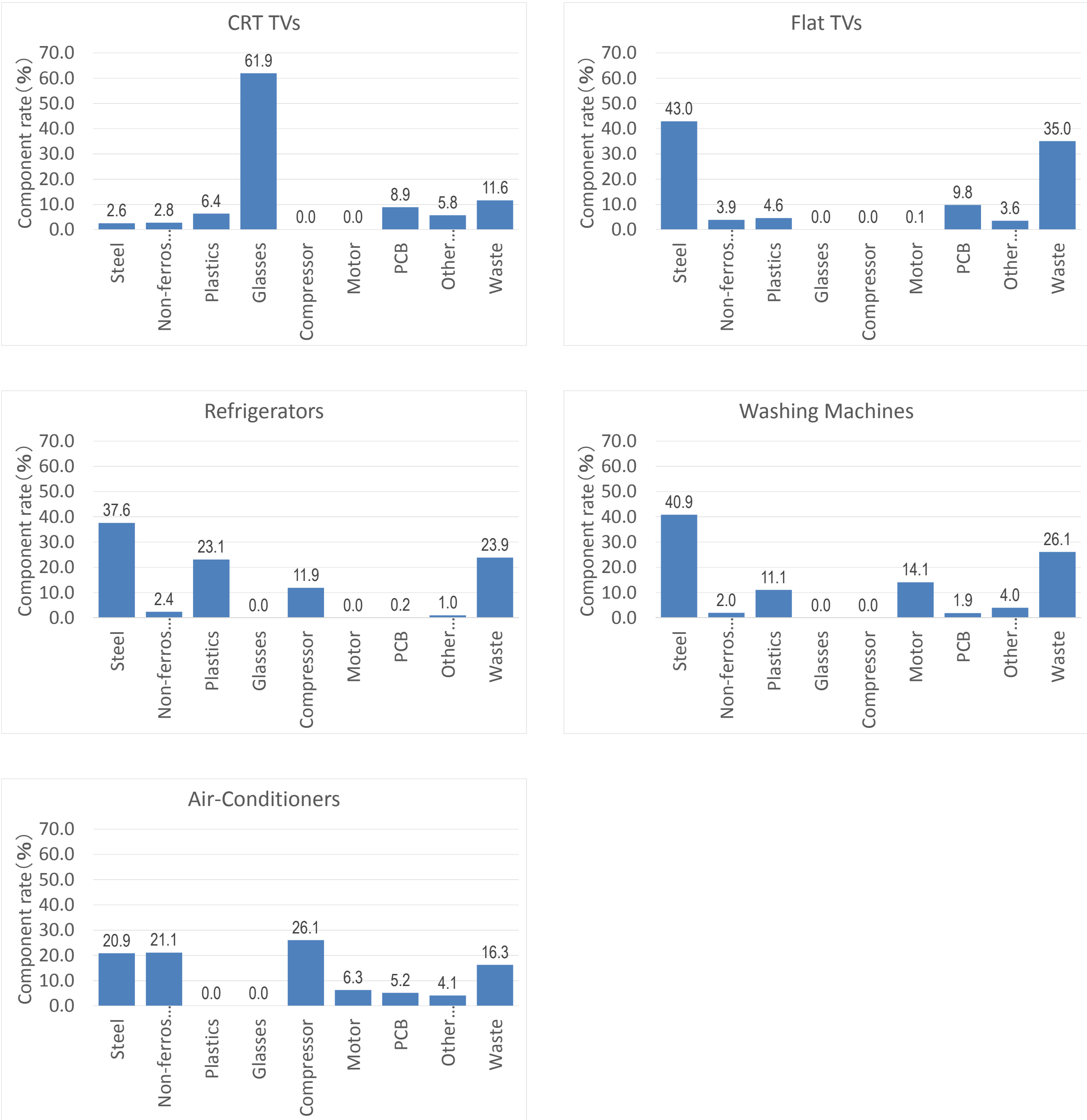


Figure 2-9 Material balance

Source: Sustainable System Design Institute: "Feasibility study on e-waste recycling project in Malaysia", March 2014 (for Ministry of Economy, Trade and Industry, Japan)

2.3 Standard scale facility and initial cost

(1) Standard scale facility and its cost

The standard scale of the recycling plant can be set as 500 thousand unit.

The initial cost for this facility with the functions explained in 2.2 is roughly 10 – 15 million USD.

(2) Number of the required recycling facilities and required total initial cost

The target e-wastes in year 2027 discarded from Sao Paulo City with the target collection rate 80% are:

- TV 1025 kUnit per year
- Refrigerator 440
- Washing machine 539
- Air-conditioner 231

The number of the required recycling facilities covering the e-wastes discarded from Sao Paulo City is considered to be five. The total required initial cost is 50 – 75 million USD.

3. Economic incentives Discussed in the Past

(1) Proposals by ELETROS

In order to promote the e-waste reverse logistics (RL), some ideas for the economic incentives were already studied and proposed by concerned agencies in the past.

In 2014, CNI (National Industrial Confederation) published the report titled "Proposal for the Implementation of the Economic Tools Envisaged in Law 12.305/2010 through Incentives to the Recycling Chain and Support to Productive Sectors Obliged to Reverse Logistics (Proposta de Implementação dos Instrumentos Econômicos Previstos na Lei 12.305/2010 por meio de Estímulos à Cadeia de Reciclagem e Apoio aos Setores Produtivos Obrigados à Logística Reversa)".

This report discussed about the possibility of introduction of some economic incentives for the RL system not only for e-waste, but also for other solid waste stipulated in Law 12.305/2010.

Referring to this report, ELETROS (*Associação Nacional de Fabricantes de Produtos Eletroeletrônicos – National Association of Electric-electronic Products Manufacturers*) submitted the following two proposals related to the economic incentives for e-waste RL.

1) Exemption of ICMS Tax for collecting/handling of e-waste under RL system

In December 2015, ELETROS submitted a proposal to CONFAZ (National Council of Fiscal Policy), through the Ministry of Finance with the following ideas for the exemption of ICMS Tax for collecting/handling of e-waste under the RL system formulated by the sector agreement. It can be expected to reduce the e-waste reverse logistic cost by this exemption. Operations for ICMS taxpayer of the exemption are described as follows:

- As far as the collected e-wastes have no commercial value, any ICMS taxpayer who collect and handle the e-waste from the sender who is not a taxpayer obliged to issue a tax document shall be requested to issue the "Incoming Invoice" (Nota Fiscal de Entrada) with the additional information which mentions "These used products received from the final consumers are exempt from ICMS". This invoice shall be issued only once a day covering all e-waste collected in that day, means not item by item;
- As well as the "Incoming Invoice" in case the e-wastes have no economic values, the "Outgoing Invoices" (Nota Fiscal de Saída) shall be issued for the respective manufacturer, importer or other handlers to which the e-wastes are sent, with the additional information which mentions "These used products are exempt from ICMS".

This proposal also mentions about the operations for non-ICMS taxpayers such as recyclers associations with the same policy for above mentioned ICMS taxpayer, but issuing the "non-commercial and/or fiscal value incoming document (Documento de Entrada)" or "non-commercial and/or fiscal value outgoing document (Documento de Saída)", not invoices (Nota Fiscal).

2) Exemption of ICMS Tax for transportation of the wastes for disposal.

In 2015, ELETROS also submitted another proposal to the Ministry of Finance the exemption of ICMS Tax for transportation of various wastes generated from the dismantling the e-wastes. According to Law 12.305/2010, wastes are defined as "rejected wastes (rejeitos)" and "solid wastes (resíduos sólidos)". "Rejected waste" is the waste only to be disposed of at the landfill because it can not be utilized in any ways. "Solid Waste" is, on the other side, the waste which is discharged from the consumers as the result of their economic activities when it loses its original functions as the product.

That proposal is summarized as follows with the expectations for the reduction of the administration cost of the e-waste R/L:

- In transportation of rejected wastes or solid wastes for disposal such as landfill or incineration, in or between States, it would be required issuance of the Declaration of Movement (Declaração de Movimento). ICMS Tax is not subject to charge due to absence of commercial value;
- This measure will not be applied to goods considered scrap (sucata), new, used or obsolete products because these are still valuable materials in the market.

(2) Other Incentives Discussed or Implemented

1) Tax Incentives for the Use or Sale of Recycled Material and Others

There is another report titled "Reverse Logistic of Electric-electronic Equipment (Logística Reversa de Equipamentos Eletroeletrônicos) issued by ABDI (Agência Brasileira de Desenvolvimento Industrial – Brazil Industrial Development Agency) in 2013. This report proposed to encourage the recycling market through tax incentives for the usage of recycled materials and sale of products with recyclable content.

Referring this proposal, above mentioned report issued by CNI (2014) is proposing the tax exemption of the waste used as raw materials by the industry to increase the demand of recycled materials derived from e-wastes through stimulating activities of recycling firms.

- This will exempt solid wastes from the indirect taxes with a set of additional measures such as the creation of a presumed credit mechanism of ICMS and PIS/COFINS and IPI on the value of the wastes acquired by the recycling industry.

2) Arrangement of enough Funds for Investments in Facilities of RL of E-waste

ABDI report (2013) is also proposing to provide credit lines for investments in infrastructure of regional recyclers through incentive lines of credit. This is because why the current capacity was lower than expected for recycling demand when the RL system is fully operational. Therefore, in addition to allowing for necessary expansion investments, the credit lines will allow for an improvement in the distribution of recyclers throughout the Brazilian territory, minimizing the transportation costs of the e-waste.

Considering this proposal, one of the currently available credit lines of BNDES (National Bank for Economic and Social Development) as "BNDES FINEM" aimed at "Investment of the reduction of the usage of natural resources and materials" can be applied for financing the establishment of new recycling plants, or the expansion of existing ones. This credit line is focused on a minimum amount of R$ 10 million, with a limit of 80% for financing under TJLP (Long term interest rate) conditions.

Although this is an attractive credit line, it should be necessary to provide enough funds for the potential progressive demand of the RL system of e-waste. A timely provision of attractive funds for investing in e-waste recycling plants, especially for acquisition and assembling of machinery and equipment, will be crucial to attract entrepreneurs to invest in this activity.

In addition, it would be necessary to make funds available at an attractive interest rate for the operation expenditures.

3) Exemption or Reduction of ISS (Tax on Services) for RL of E-waste

The ISS (tax on services) is a municipality tax, and it usually vary from 0% to 5%. On the other side, recent Federal Law (Lei Complementar 157/2016) stipulated the ISS should be higher than 2% (except for some activities such as civil works and infrastructure rehabilitation, and passenger transportation) up to 5%. Therefore, municipalities can determine attractive ISS rates for RL of E-waste to stimulate the local recycling industry by reducing ISS, but subject to the limit determined by Federal Law”.

Related to ISS, CNI report (2014) states that “the incidence on services provided by third parties along the chain of collection, sorting, processing and transportation of waste is not high, but mainly affects costly reverse logistics structures, in which it is common to contract third party services for processing or destination of waste or for transportation.

Considering these, it is better for municipalities to foster local recycling facilities through measures as exemption or reduction of ISS. It may reduce the cost of recycled material and attract new industries and firms for E-waste activities. As the primary transportation being one of the most expensive item in the RL of E-waste, municipalities may also reduce ISS tax for local transportation (transportation out of municipality is subject to ICMS tax), and stimulate establishment of recycling plants near where E-waste is generated, with attractive transportation cost.

4) Exemption or Reduction of IPTU (Urban Land and Property Tax) for RL of E-waste Facilities

Municipalities can also adopt additional incentive to the establishment of facilities for RL of E-waste, as well as improve economic, social and environmental aspects in the municipality, through exemption or reduction of IPTU (Urban Land and Property Tax) for the E-waste related facilities. There are some experiences of this incentives implemented in Jundiai City to the assembly industry of electronics.

This measure will allow to attract establishment of new plants for the e-waste activities, by reducing fixed costs to the facilities.

4. Evaluation on the effect of economic incentives for generating e-waste recycling facilities as a new infrastructure

4.1 Objective and analysis method

(1) Objective

Any public policies for promoting the development of the required e-waste recycling facilities explained in the previous chapter are necessary. Especially, economic incentive policies from the government might be effective for promoting the facility development. In this chapter, what incentives are effective was analyzed.

(2) Analysis method

An analytical tool for estimating recycling cost in a dismantling factory was developed. By using this tool, the cash flow covering the whole project life was estimated considering the several economic incentive.

4.2 Estimation conditions

The estimation was conducted under the following conditions.

(1) Target economic incentives

- Subsidization to investment cost (0%→50%)
- Soft loan (15%→10%)
- Business tax exemption (21%→0%)

(2) Evaluation indexes

- Accumulative profit in ten years (from year 2018 to 2027)
- IRR in ten years

(3) Target e-wastes

1) Types of target e-wastes

- Television sets
- Refrigerator
- Washing machine
- Air-conditioner

2) Amount of target e-wastes

- E-wastes processed in a recycling factory out of five factories covering the e-waste discarded from Sao Paulo City
- The e-waste collection rate in year-i was set linearly by setting 20% in year 2018 and 80% in year 2027.
- The evaluation indexes were calculated by changing the operation rate of the facility from 10% to 100% for analyzing how the collection rates affect the indexes.

3) Considered costs and revenues

The cost estimation tool was developed considering the following costs and revenues. The estimation tool in detail can be referred to in Appendix 1.

① Cost

- Investment cost = Given based on the design
- Repayment cost = Calculated from (Investment-Equity-Subsidization)
- Labor cost = k1*Ewaste
- Electricity cost = k2*Ewaste

- Maintenance cost = k3*Ewaste
- Administration cost = k4*(Labor cost + Electricity cost + Maintenance cost)
- Contingency = k5*(Labor cost + Electricity cost + Maintenance cost + Administration cost)

② Revenue
- Ewaste purchase = p1*Ewaste
- Recyclable sales = p2*Ewaste

③ Tax
- r*(Revenue – Cost), if (Revenue - Cost)>0

4.3 Analysis result

(1) Accumulative profit

The result of accumulative profit is shown in the following figure which can be summarized below.

- The business can gain some profits if the operation rate is more than 40%.
- 50% subsidization to the investment cost can push up the accumulation profit effectively.
- The tax exemption will be effective, especially the factory is operated fully as planned.
- The soft loan provision with 10% interest rate is not effective.

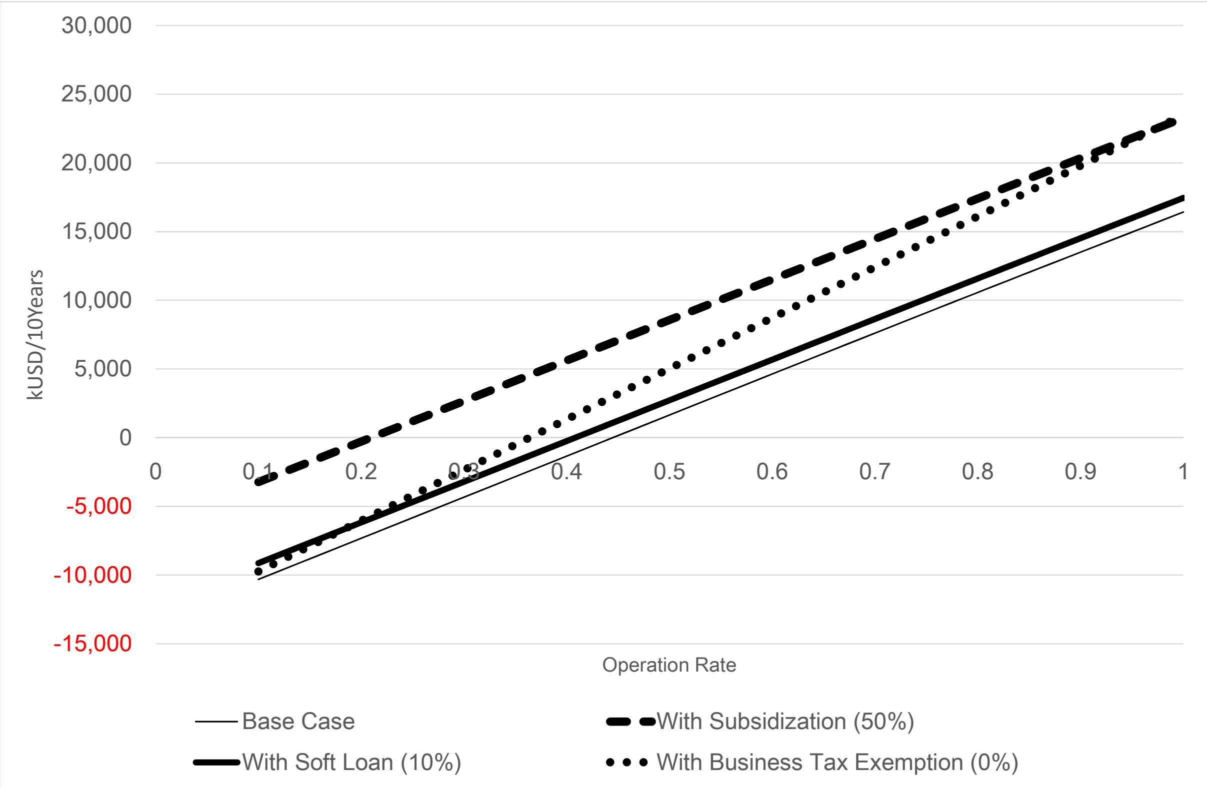


Figure 4-1 Effectiveness of some economic incentives for realizing e-waste recycling factories (accumulative profit)

Source: JICA Expert Team

(2) Internal rate of return

The accumulative profit does not evaluate the profitability. Here, the IRR was estimated for evaluating the profitability of the recycling factory.

The IRR is shown in the following figure which can be summarized below. The IRR was compared with the general interest rate of 15%.

- Without any economic incentive, the business is not attractive unless the operation rate is more than 90%.
- 50% subsidization to the investment cost inputted in the first year can improve the IRR very much.
- The tax exemption and soft loan with 10% do not work so much in terms of IRR improvement. The soft loan with 10% interest rate might not work well.

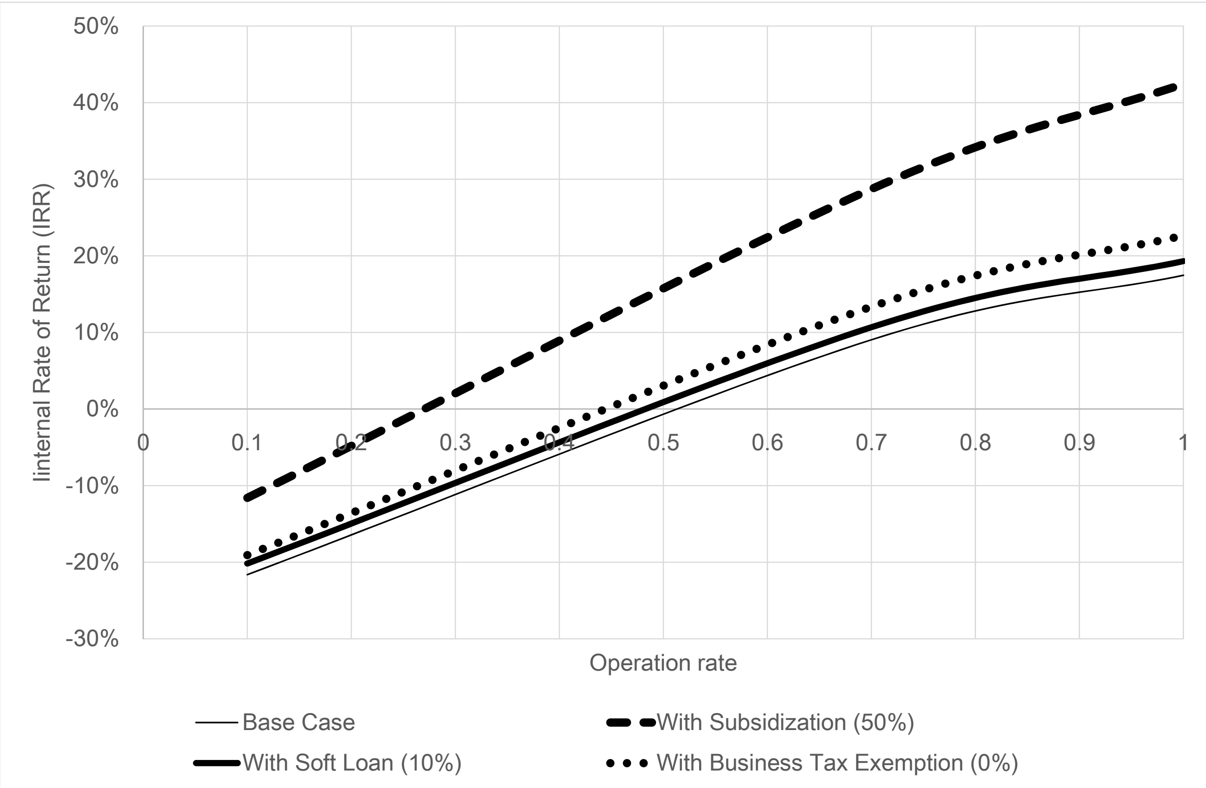


Figure 4-2 Effectiveness of some economic incentives for realizing e-waste recycling factories (Internal rate of return)

Source： JICA Expert Team

5. Implication and recommendation

(1) Recycling factories have to be developed.

For realizing the e-waste reverse logistics, recycling factories with the function to recover insulation CFC gases of refrigerators are necessary. The factories have to be equipped with a large-size crusher to be used for crushing bulky e-wastes such as television sets, refrigerators, washing machines and air-conditioners.

Only two factories with such functions exist in Brazil. E-waste recycling factories have to be developed newly.

It is recommended to the government to promote such facility development by using some economic incentives.

(2) Economic incentives to be used.

In this report, three economic incentive policies were studied. Though the effectiveness depends on the strength of the incentive, subsidization to the facility investment improved the IRR the most among the studies three incentive policies. Application of economic incentives have to be discussed realistically, considering the policies in other various sectors.

(3) For achieving profitable recycling businesses

The profitability of the recycling businesses is not determined by the strength of the economic incentive policy from the government. The effort to pursuit the cost efficiency by the businesses is the basic. Also, it is noted that the recycling fees given to the businesses affect the profitability very much. High recycling fees making the business profitable would affect the price of the visible fees.

This means the price of the visible fees and the economic incentives from the government has a close relation. If any strong economic incentives were provided by the government, the price of the visible fees would be reduced, and vice versa. The economic incentives have to be discussed from the viewpoint of total recycling cost management.

Appendices

Appendix 1. Cost estimation tool

1. Considered costs and revenues

(1) CAPEX/ OPEX

- Initial investment cost
- Interest cost
- Labor cost
- Electricity cost
- Maintenance cost
- Administration cost
- Contingency

(2) Revenue

- E-waste recycling fee
- Recyclable sales

(3) Tax

- Business tax

2. Calculation model

(1) Preconditions

The cost for full scale operation in year 2028 was estimated first. The cost of year-i and the case of lower operation rates was estimated proportionally to the cost of the case of the full scale operation.

(2) CAPEX/ OPEX

i) Initial investment cost

- Given as 10 Million USD based on the study for Malaysia funded by METI, Japan

ii) Interest cost:

- Interest cost in year-i was calculated derived from the repayment cost (= $\frac{A \times r}{1-(1+r)^{-n}}$ (constant repayment method))
- Interest cost in year-i = Remaining debt in year-i * Interest rate
- Also, the interest cost in year-i was converted to the value of the first year by using the discount rate of 6% referring to the long-term prime rate of Brazil.

iii) Other costs

- Labor cost=(Salary of director)*(Number of directors) + (Salary of office worker)*(Number of office worker) + (Salary of operator)*(Number of operator)

- Electricity cost=(Electricity capacity: kW)*(Rate of average electricity load: %)*(Annual operation hours: hr)*(Price of electricity: R$/kWh)
- Maintenance cost=(Total investment cost)*(Annual maintenance cost rate: %)
- Administration cost={(Labor cost)+(Electricity cost)+(Maintenance cost)}*(Administration cost rate: %)
- Contingency={(Labor cost)+(Electricity cost)+(Maintenance cost)+(Administration cost)}*(Contingency rate: %)

(3) Revenue

- E-waste recycling fee: Fee per unit was given as R$15 per unit referring to some market prices
- Recyclable sales: Price of recyclable sale from a unit was given from the Pilot Project data depending on the types of e-wastes.

(4) Tax

- Business tax: Given as 21%

3. Used values

Parameters		Unit	Symbol	Operation Rate=10%	Operation rate=70%	Operation rate=100%
Precondition	Project duration	year	n	10	10	10
	Discount rate	-	dr	0.06	0.06	0.06
	Operation hour	hour/day	Ho	10.5	10.5	10.5
	Operation day	day/year	Do	300	300	300
	Operation rate	-	ro	0.1	0.7	1.0
Target e-waste	Recycled unit (CRT TV)	kUnit/10year	N1	1	10	14
	Recycled unit (Flat TV)	kUnit/10year	N2	110	770	1,100
	Recycled unit (Refrigerator)	kUnit/10year	N3	52	363	519
	Recycled unit (Washing Machine)	kUnit/10year	N4	61	424	605
	Recycled unit (Air-conditioner)	kUnit/10year	N5	25	172	245
	Unit Weight (CRT TV)	kg/Unit	UP1	37.2	37.2	37.2
	Unit Weight (Flat TV)	kg/Unit	UP2	12.0	12.0	12.0
	Unit Weight (Refrigerator)	kg/Unit	UP3	58.0	58.0	58.0
	Unit Weight (Washing Machine)	kg/Unit	UP4	36.5	36.5	36.5
	Unit Weight (Air-conditioner)	kg/Unit	UP5	55.0	55.0	55.0
Investment	Total investment cost	Mil. USD	CC	10	10	10
	Equity	Mil. USD	OC	2	2	2
	Grant	Mil. USD	CP	0	0	0
	Debt	Mil. USD	LA	8	8	8
	Repayment years	years	Ln	5	5	5
	Annual interest rate	-	Ri	0.15	0.15	0.15
Operation cost	Administration (Director)	Persons	Nw1	1	1	1
	Administration (Office)	Persons	Nw2	2	2	2
	Operator (TV)	Persons	Nw5	5	5	5
	Operator (Refrigerator)	Persons	Nw6	5	5	5
	Operator (Washing Machine)	Persons	Nw7	5	5	5
	Operator (Airconditioner)	Persons	Nw8	5	5	5
	Monthly salary (Administration)	USD/m	Pw1	5,000	5,000	5,000
	Monthly salary (Office)	USD/m	Pw2	600	600	600
	Monthly salary (Operation)	USD/m	Pw3	600	600	600
	Labor cost	kUSD/y	Cw	22	153	218
	Electricity capacity	kW	Uel	1,000	1,000	1,000
	Rate of average electricity consumption	-	Rel	0.5	0.5	0.5
	Annual electricity consumption	kWh/y	Ael	157,500	1,102,500	1,575,000
	Price of electricity	USD/kWh	Pel	0.16	0.16	0.16
	Rate of maintenance cost	-	Rmt	0.030	0.030	0.030
	Expense for maintenance	kUSD/y	Cmt	30	210	300
Other costs	Rate for administration cost	-	ka	0.1	0.1	0.1
	Contingency	-	kc	0.1	0.1	0.1
Sales and residue disposal	Price of e-waste (CRT TV)	USD/Unit	VP1	15	15	15
	Price of e-waste (Flat TV)	USD/Unit	VP2	15	15	15
	Price of e-waste (Refrigerator)	USD/Unit	VP3	15	15	15
	Price of e-waste (Washing Machine)	USD/Unit	VP4	15	15	15
	Price of e-waste (Air-conditioner)	USD/Unit	VP5	15	15	15
	Average price of recyclables (CRT TV)	USD/kg	Pr1	-0.245	-0.245	-0.245
	Average price of recyclables (Flat TV)	USD/kg	Pr2	0.045	0.045	0.045
	Average price of recyclables (Refrigerator)	USD/kg	Pr3	-0.171	-0.171	-0.171
	Average price of recyclables (Washing Machin	USD/kg	Pr4	0.045	0.045	0.045
	Average price of recyclables (Air-conditioner)	USD/kg	Pr5	0.633	0.633	0.633
	E-waste purchase	kUSD/10year	Cp1	3,724	26,067	37,238
	Recyclable sales	kUSD/10year	Rr1	483	3,384	4,834
CAPEX/ OPEX	Initial investment cost	kUSD/10year	C1	10,000	10,000	10,000
	Interest cost	kUSD/10year	C2	3,422	3,422	3,422
	Labor cost	kUSD/10year	C3	121	849	1,212
	Electricity cost	kUSD/10year	C4	140	979	1,399
	Maintenance cost	kUSD/10year	C5	167	1,166	1,665
	Administration cost	kUSD/10year	C6	43	299	428
	Contingency	kUSD/10year	C7	47	329	470
	Subtotal	kUSD/10year	Cst	13,939	17,044	18,596
Recycling fee/ Sales	E-waste recycling fee	kUSD/10year	S1	3,724	26,067	37,238
	Recyclable sales	kUSD/10year	S2	483	3,384	4,834
	Subtotal	kUSD/10year	Sst	4,207	29,451	42,073
Balance		kUSD/10year	B	-9,732	12,407	23,476
Business tax rate		%	TR	21	21	21
Profit		kUSD/10year	Profit	-10,308	7,614	16,423

Japan International Cooperation Agency (JICA)

Project for E-waste Reverse Logistics Improvement in the Federative Republic of Brazil

Report on Monitoring/Reporting Guideline (Trial Draft)

August 2017

JICA Expert Team

Table of Contents

1. Legal background in Brazil

1.1 National Policy on Solid Waste (Law 12305, of 2 August 2010)

This law is the fundamental law for solid waste management. It stipulates the compulsory responsibility of manufactures, importers, distributors and sellers to construct and implement the reverse logistic system.

This law stipulates the roles of related actors in the reverse logistic system. It stipulates that consumers have the responsibility to return the waste to distributors or sellers after consumed; distributers and sellers shall hand over the waste returned from consumers to manufactures or importers; and manufactures and importers shall treat the waste in an environmentally-friendly way and dispose the residues from the waste appropriately as stipulated by other regulations.

Also, the law stipulates manufactures, importers, distributers and sellers to manage all information regarding the reverse logistic system so that the competent agencies can utilize it.

1.2 Sectoral Agreement

The sectoral agreement of e-waste reverse logistic has not been concluded yet. Here, the sectoral agreement of fluorescent lumps was referred to. The contents of the agreement are:

- 1. Definitions
- 2. Objective
- 3. Cooperative participation and associations of collectors
- 4. Management authority of creation, industry settlement disclosure and compliance assessment
- 5. Operation of reverse logistics of lamps
- 6. Nature and characteristics of responsibilities of the signatures of a company or aligned companies
- 7. Responsibilities of manufactures and importers
- 8. Participation of entities' managers
- 9. responsibilities of distributors and merchants
- 10. the union's responsibilities
- 11. Responsibilities of domestic generators
- 12. Responsibilities of generators other than domestic generators
- 13. Public urban cleaning services and solid waste management
- 14. Participation of national confederation trade in goods, services and tourism
- 15. Participation of contractors company by management entity for implementation of logistics reverse lamps
- 16. Communication plan
- 17. Goals
- 18. Control and supervision
- 19. Monitoring implementation of the logistics reverse lamps
- 20. Penalty

- 21. Deadline
- 22. Agreement termination of the sector
- 23. Final dispositions
- 24. Jurisdiction

1.3 Terms of Commitment

The contents of the "Terms of Comittement" for mobile phones in the State of Sao Paulo are:

- 1. Objectives
- 2. Definitions
- 3. Outline of the system
- 4. Roles and responsibilities of the related actors
- 5. Target
- 6. Monitoring condition and implementation
- 7. Final dispositions
- 8. Conclusion conditions
- 9. Jurisdiction

1.4 Technical Standards

(1) Requirements to reverse manufacturing of e-wastes (ABNT NBR 16156/2013)

This technical standards stipulates the requirements to ensure the proper management for e-wastes. The contents can be summarized below.

- Planning of e-waste handling containing targets and programs, and its implementation
- Formation arrangement functioning for e-waste handling with necessary training
- Ensuring of e-waste traceability without any missing mass-balance up to final disposal of residues
- Verification of the e-waste handling performance
- Self-audit and feedback to the adjustment of the planning
- Evaluation by top management

(2) Reverse manufacturing for refrigeration machines (ABNT NBR 16156/2010)

This guideline stipulates how to handle e-wastes of 1) end-of-life refrigerator, freezer, refrigerator with freezer and air conditioner with capacity less than 17.6 kW. The requirements can be summarized below.

- Refrigeration machines have to be transported to any recycling factories without any damage in refrigeration system and heat insulation system.
- Refrigeration machines have to be transported keeping them upright so as to avoid leakage of any refrigerant and lubricant.
- Refrigeration machines have to be stored in proper environment so as to avoid leakage of any refrigerant and lubricant.

- Types and amount of refrigerant used in a refrigeration machine has to be identified and recorded (types and amount of refrigerant depending on the sizes of refrigeration machines are given by this standards).
- Refrigerant retrievers and separators have to be equipped. Recovered refrigerant has to be stored, monitored and recorded carefully so as not to be leaked and lost.
- Recovered refrigerants have to be recycled, destroyed or stored properly.
- Insulation gasses contained in heat insulators shall be recovered efficiently by using any specific process so that the released amount to outside become less than the specified amount. Recovered insulation gasses have to be recycled, destroyed and disposed. Foam used as insulator has to be managed properly confirming the remaining gasses are less than the specified amount.
- The material balance including the amount of refrigerant and insulation gasses has to be monitored.

1.5 Points to consider for generating the monitoring/reporting guidelines

- The monitoring/reporting guidelines can be justified by the "National Policy on Solid Waste" (Law 12305, of 2 August 2010).
- "Requirements to reverse manufacturing of e-wastes" (ABNT NBR 16156/2013) stipulates the Plan-Do-SEE procedures to be taken by industries which are involved in e-waste recycling. The requirement of e-waste traceability with material balance can be highlighted from the viewpoint of monitoring guideline development.
- Controls on specific gasses used for refrigerant and insulation can be ensured by "Reverse manufacturing for refrigeration machines" (ABNT NBR 16156/2010).

2. Existing e-waste recycling systems in other countries

2.1 Focal points to compare the existing e-waste recycling systems

There are some trials to compare the existing reverse logistic systems, but the following factors were used in this report considering the focal points of the discussions on the sectoral agreement.

- Dose the system cover all types of e-wastes or part of e-wastes?
- What targets to be achieved are set?
- Is recycling fee shown independently or not shown to consumers?
- Is recycling fee charged upon discarded or when purchased?
- Who can decide the recycling fee? Producers or government?
- Is the recycling fee calculation basis published?
- Who manages the fund of recycling fee? Producers or government?
- Is the recycling fee used for all types of e-wastes? Does it cover the historical waste and/or orphan e-wastes?
- How is payment by beneficiaries justified, if the recycling cost collected upon purchase is used for recycling historical waste?
- How are the strategies for redirecting from conventional recycling channels to designated route?
- Who pays the cost for primary transportation?
- Do the governmental roles not distort the market mechanisms?
- Is any cost reduction mechanism for recycling fee considered?
- How are feedbacks to DfE (“Design for Environment”) considered and monitored?
- How are recycling technologies promoted for innovation?

2.2 Comparison of the existing e-waste recycling systems in other countries

1) Summary of existing e-waste recycling systems

The summary of existing e-waste recycling systems in the world can be summarized below.

The target countries were selected from the countries which have typical reverse logistic systems, and geographical factor was considered for Colombia.

- United States of America (California)
- Germany
- Australia
- Canada (State of British Columbia)
- Colombia

Table 2-1 Summary of e-waste recycling systems in other countries

Factor	United State of America (California)	Germany	Australia	Canada (Example: state of British Columbia)	Colombia
Law, Organization	Electronic Waste Recycling Act (2003～)	Waste Electrical and Electronic Equipment Act (2005 ~)	Product Stewardship Act 2011- Product Stewardship (Televisions and Computers) Regulations 2011 (2011-) (Amended in 2017)	Environmental Management Act - Recycling Regulation (2004-)	Guidelines for the adaption of a public policy of WEEE (WEEE Law) (2013-)
Objective	1) To provide sufficient funding for the safe, cost-free, and convenient collection and recycling of the covered electronic waste, 2) To eliminate electronic waste stockpiles and legacy devices 3) To end the illegal disposal of covered electronic devices, 4) To establish manufacturer responsibility for reporting to the board on the manufacturer's efforts to phase out hazardous materials in electronic devices and increase the use of recycled materials.	1) To prevent waste from electrical and electronic equipment 2) To promote reuse, recycling and other forms of recovery to reduce both the volume of waste for disposal and the inclusion in waste of harmful substances from WEEE.	To reduce the impact: (a) that products have on the environment, throughout their lives (b) that substances contained in products have on the environment, and on the health and safety of human beings, throughout the lives of those products.	To call for the electronics industry to take responsibility for the lifecycle management of their products.	The law stiplates the national policy and framework for regulating WEEE based on extended producers' responsibility.
Target Products	Electronic device with a screen size greater than 4 inches Example: CRT, CRT device, flat panel screen, or similar video display device with a screen	1. Large household appliances, 2. Small household appliances, 3. IT and telecommunications equipment, 4. Consumer equipment, 5. Lighting equipment, 6. Electrical and electronic tools with the exception of large-scale stationary industrial tools, 7. Toys, leisure and sports equipment, 8. Medical products (with the exception of implanted and infectious products), 9. Monitoring and control instruments, 10. Automatic dispensers.	TV, computers, computer parts and peripherals, printers	Computers, Large ride-ons, IT devices, medical & monitoring devices, display products, printing/copying, audio video & gaming products & musical instruments, telephones and etc	Office Automation equipment, televisions and other products.
Collection timing of Recycling fee, Display of recycling fee	- Consumers pay recycling fees upon purchase at retailers. - The recycling fee is visible and set from 5 USD to 7 USD per product in 2017. The recycling fee per product is supposed to be reconsidered based on actual cost required for e-waste recycling in the last 2 years.	- There is no payment from consumers. - Producers pay recycling fee to the management organization according to the quantity of sold products.	Producers and importers of target products bear all cost for from collection to recycling.	- Consumers pay recycling fees upon purchase at retailers. The recycling fees range USD 0.05 to USD 35 depending on types, sizes or weights of products. - There is no regulation on indication of recycling fee at retailers.	The producers bear all cost of collection, transportation and recycling of the producers' products.
Recycling fee management organization / Recycling fee-determining person	Two agencies of the government of the state of California: 1) California Department of Resources Recycling and Recovery 2) Department of Toxic Substances Control	Waste electronic equipment management organization which was established by IT products Industrial association, electronic product manifactarer association and private companies	Co-regulatory arrangement composed of major importers and producers of target products	Electronic Products Recycling Association British Columbia (EPRA BC). The over 1700 stewards in the EPRA BC program are comprised of major producers and retailers of electronics in British Columbia	Producers or the third parties to conduct collection, transportation and recycling of the producers' products on behalf of the producers.
E-waste to be processed by the recycling fee	E-waste recycling including historical wastes and orphan e-wastes	E-waste recycling including historical wastes and orphan e-wastes	E-waste recycling including historical wste and orphen e-wastes	- E-wastes including historical wastes and orphan wastes	E-waste recycling including historical wste and orphen e-wastes
How to redirect the existing recycling routes	- Producers, retailers, collectors and recyclers do not need to pay the cost for recycling. All cost are funded by recycling fee collected from consumers. - Induced by free collection	- Induced by free collection - Public relations from the government to producers and importers - Penalty to producers and importers which do not comply with the regulation	- Induced by free collection - Regulated penalties to producers and importers that do not comply with the law	- Induced by free collection and disposal costs	- Induced by free collection and disposal costs - Promotion activity and environmental education to Public conducted by the government
Collection cost	- Free collection (the cost of collection is covered by the recycling fee paid upon purchase.)	- Consumers have to bring their e-wastes to collection points - Producers are responsible for recycling after the collection points.	- Producers and importers of target products bear all cost for from collection to recycling.	- Transportation by consumers up to collection points	- Free collection - Consumers have to bring their e-wasts to temporary collection points set only once in a month.
Target value (collection rate, recycling rate)	The law targets 100% of collction rate.	Based on the collection target and the collection percentage of the revised European WEEE Instruction, there is the possibility of being considered also in Germany. - Until December 2018: Collection rate=45% (defined as collected e-wastes over average of weights of sold e-products in the last 3 years). - From January 2019: collection rate: 65% to 85% per year	1) Goal of collection rate: that has been set year by year so as to reach 80%. - 62% of the waste from the products generated (2017/2018) - 80% of the waste from the products generated (2026/2027 or later) 2) Goal of Material recovery rate: 90% of recycled e-waste in terms of weight	- Products such as TV and PC and others: average annual collection amounts : 18,000 tons. (2011 to 2013) - Large household appliances: target for collection rate (= estimated weight of collected products devided by estimated weight of recoverable products): 75% (2012, 2013)	- Increase rate for an annual collction amounts and an intermediate target are set for specific items. - The recycling rate has not been set.
Standard of environment-related requirements	(Not sure)	There are standards such as product design and prohibited materials in the act.	Producers, importers and recyclers of target products have to comply with the environmental guidance of the government.	Environmental Recycling Standard (ERS) has established by Electronic Product Stewardship Canada (EPSC).	- Producers have to reduce materials contain hazardous substances for their products. - Recyclers have to minimize contamination of the environment during recycling process of e-wastes.
Difficulties in the system operations	- Recyclers once reported the incorrect amount of e-wastes to the management organization for the payment. For preventing this, the management board started to monitor the situations by on-site inspection. - Lack of lead glass demand: A large amount of untreated CRT is left due to a sharp decline in CRT glass demand. - Shortage of recycling funds: Increase of the amount of collected e-waste and also the recycling cost caused shortage of the recycling fund based on collected fee upon purchase. As a result, in 2008, payment based on handled e-waste to producers, retailers, collectors and recyclers was reduced and the recycling fee was increased.	- Inproper exports of e-wastes - Possibility that incentives for producers of DfE (Design for Environment) do not work well.	- Some consumers have to travel more than 100km to collection points. - There is a lack of clarity over the role of stakeholders including consumers, retailers, and local governments	(Not sure)	(Not sure)

2) Major e-waste stream

The major e-waste streams are shown in the following figure.

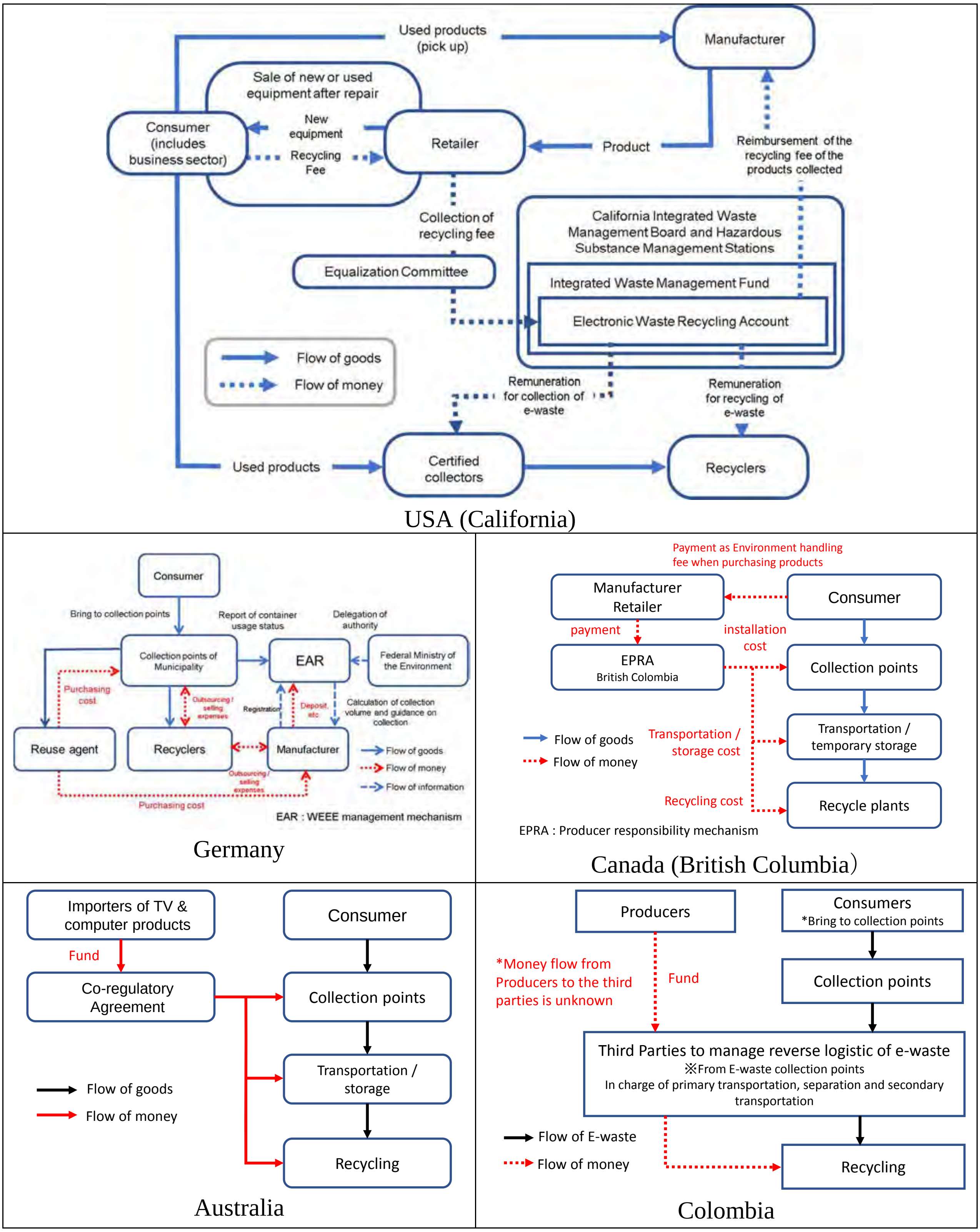


Figure 2-1 Major e-waste stream in other countries

Source： JICA Expert Team

3) Roles of related sectors

Roles of sectors related to e-waste reverse logistic system are shown in the following table.

Table 2-2 Roles of related sectors in other countries

Name of Sectors	USA (California)	Germany	Australia	Canada (State of British Columbia)	Colombia
Producers	- Consideration of DfE	- Consideration of DfE - Payment of recycling cost - Establishment of information center - Registration to the Ministry of the Environment - Achievement of recovery and recycling rate	- Consideration of DfE - Payment of recycling cost - Participation in industrial associations for e-waste management	- Consideration of DfE - Establishment of e-waste collection system including setting up of collection points - Payment of recycling cost	- Consideration of DfE - Payment of recycling cost - Establishment of e-waste collection system including setting up of collection points - Provision of information to consumers on how to collect e-wastes
Consumers	- Payment of recycling fee	- Transportation of e-waste to collection points	- Transportation of e-waste to collection points	- Transportation of e-waste to collection points - Payment of recycling fee	- Transportation of e-wastes to collection points
Retailers	- Collection of recycling fee upon selling - Display of recycling fee at retailers	- Collection of e-waste at retailers and transportation of collected e-waste to municipalities	- No requirement	- Collection of recycling fee upon selling	- Supporting to producers for e-waste collection
Central Gov.	- No requirement	- Setting of goals for collection amount - Registration of producers	- Setting of goals for collection rate - Setting of goals for material recovery rate - Regulation on producers' obligations	- Development and readjustment of national principles for e-waste management - Regulation on provincial obligation to develop laws and regulations regarding e-waste recycling	- Review and approval of collection system proposed by producers - Setting goals - Promotion of comprehensive e-waste management - Establishment of inspection and monitoring mechanism for e-waste recycling
Municipalities	- Establishment of laws for e-waste management	- Setting up of collection points	- No requirement	- Establishment of laws for e-waste management	- No requirement

Source：JICA Expert Team

4) Interpretation of the e-waste recycling systems in other countries

Based on the focal points mentioned in the beginning of this chapter, the e-waste recycling systems in some countries can be interpreted as shown in the following table.

Table 2-1 Interpretation of e-waste recycling systems in the world

Focal point	Consumers pay to a governmental fund <USA (California)>	Producers pay to a private fund <Germany> <Australia> <Colombia>	Consumers pay to private fund. <British Columbia>
Visible fee?	Yes	No	Yes
Charging upon purchased or discarded?	Upon purchased	Producers pay. (Recycling fee is internalized in e-product prices.)	Upon purchased.
Who decides the fee?	Governmental organization (The fee is changing almost every year.)	Producers' organization	Producers' organization
Is the fee calculation basis published?	Should be published because it is the visible fee charged to consumers.	Not necessary to be published, because it is determined through negotiation between the government and industries.	Should be published because it is the visible fee charged to consumers.
Who manages the fund?	Governmental organization	Producers' organization	Producers' organization
What is the fee used for?	E-wastes including historical e-wastes and orphan e-wastes	E-wastes including historical e-wastes and orphan e-wastes	E-wastes including historical e-wastes and orphan e-wastes
How is the fee usage justified?	It is not practical to keep the money for future e-waste.	It is not practical to keep the money for future e-waste.	It is not practical to keep the money for future e-waste.
How to redirect the discarding channel?	Might be motivated by free collection services	Might be motivated by free collection services	Might be motivated by free collection services
Who pays for primary transportation cost?	Consumers who bought new e-products pay.	Consumers have to bring e-wastes to collection points.	Consumers have to bring e-wastes to collection points.
Fund allocation mechanism	The government can contribute in fund allocation.	Fund could be allocated optimally by market mechanism.	Fund could be allocated optimally by market mechanism.
The government roles distort the market mechanism?	Distorted, because the recycling fees and their usage are managed by the governmental organization.	Not so strong, because the contribution from the government is thought to be weak.	Not so strong, because the contribution from the government is thought to be weak.
Is any cost reduction motivated?	Not so high, because the recycling cost can be reimbursed from the visible fees.	Highly motivated, because the producers want to reduce the recycling cost to pay.	Not so high, because the recycling cost can be reimbursed from the visible fees.
How are feedbacks to DfE?	Ditto	Ditto	Ditto
How are technical innovation motivated?	Ditto	Ditto	Ditto

Source：JICA Expert Team

2.3 Implications from the existing reverse logistic systems

Based on the above analysis, the following implications were identified.

1) Classification factors for e-waste recycling systems

The e-waste recycling systems can be classified by the following points.

- Recycling fees are covered by visible fees or internalized in product prices.
- Existing of governmental contribution in recycling fund allocation or not.

In the studied countries, USA (California) and Canada (British Columbia) are using visible fee system, and recycling costs are internalized in product prices and borne by producers in Germany, Australia and Colombia.

Governments contribute the recycling fee fund in USA (California) and producers manage the fund in other studied countries.

2) Target e-wastes

Except for USA (California) and Australia, all types of e-wastes are targeted. USA regulates CRTs and Australia also started to regulate television sets and CRT.

3) Policy targets

As for policy targets, the following three points were found.

- E-waste collection rates are basically set in all studied countries. E-waste collection rate is one of the most important targets for achieving the lower environmental impacts from e-wastes.
- In Germany, collection rates are defined as collected products divided by using latest product sales, while estimated values are used in Canada.
- Target values are set flexibly depending on the target products.

4) Charging timing of recycling fee

Recycling fees are charged to consumers when the products were bought or charged to producers internalized in product prices. In the studied cases, there was no country which charges recycling cost when customers discard e-wastes.

5) Usage of fund

In all studied countries, the recycling fund is used for e-wastes including historical wastes. This is maybe because it is not practical to keep the recycling fee for future e-wastes.

6) Shift of recycling flow from conventional route to regulated route

In all studied countries, consumers are not charged for recycling when they discard e-wastes. This could minimize improper dumping.

7) Feedbacks to DfE (“Design for Environment”)

In the studied counties, DfE is expected to be considered by producers.

3. Implications from experiences of Japan

3.1 Reverse logistic systems in Japan

(1) Large-size e-waste of four items

1) Regulation

- Home appliance recycling law

2) Objective of the regulation

- To reduce the burden of municipalities in disposing large-size e-wastes in their facilities and to promote material recovery rate from the e-wastes

3) Numerical targets

- Recycling rate (=recovered materials/total weight of e-waste)

4) Roles of related sectors

- Consumers
  - Handing over their e-waste to retailers
  - Payment of the recycling fee
- Retailers
  - Taking back of e-wastes at the request of consumers
  - Sending of e-wastes collected to designated stockyards
  - Display of the recycling fee
- Producers
  - Taking back of e-wastes from the stockyards
  - Recycling e-wastes in an appropriate way
  - Publishing the recycling fee

5) Major e-waste stream

The major e-waste stream is shown in the following figure.

- Consumers can subscribe e-waste collection when they buy new products.
- Retailers will collect the e-wastes upon delivery of new products and send them to the stockyard.
- Producers transport the e-wastes from the stockyards and send to the dismantling/sorting facilities.
- E-wastes are dismantled and sorted in the dismantling/sorting facilities and the recovered materials are send to recyclers depending on the types of materials.

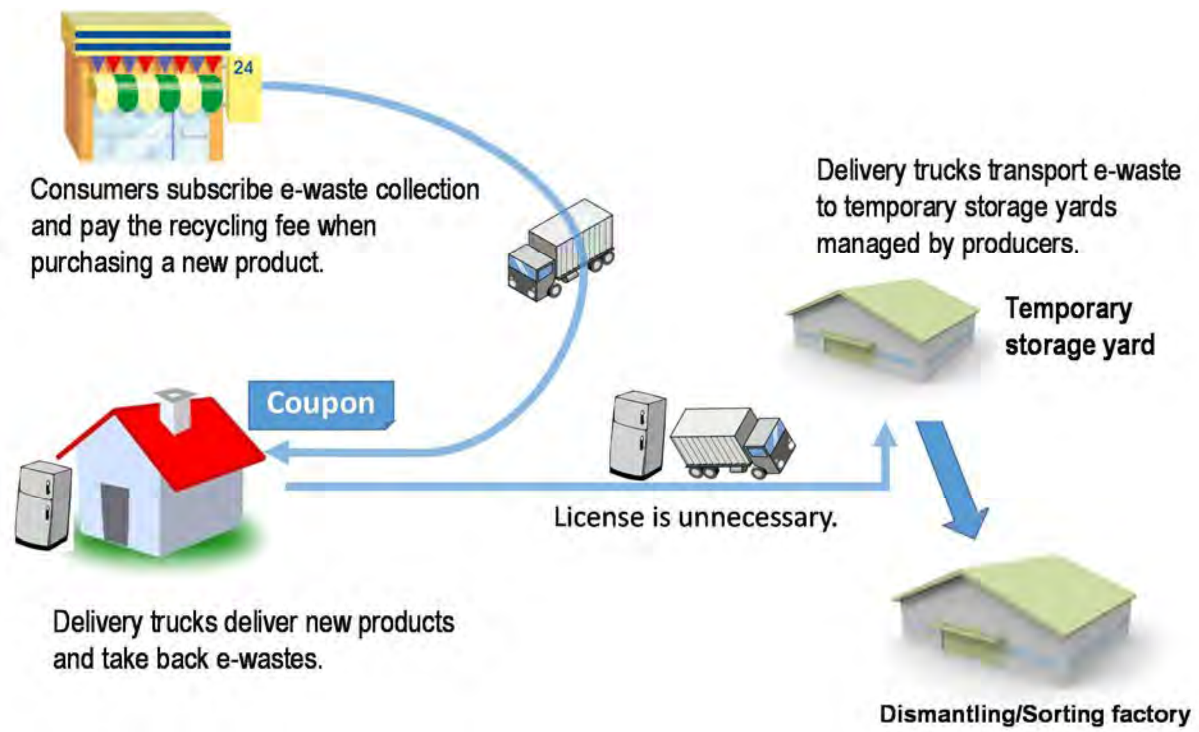


Figure 3-1 Major e-waste stream of large-size e-waste of four items

Source： JICA Expert Team

6) Points of the law

The points of the law to be highlighted can be summarized below.

- The first law designed under the promotion of EPR (Extended Producers Responsibility) for e-wastes.
- The recycling fee shown by the producers was paid by consumers.
- This law gave the authority to the conventional trade-in system which was used to be conducted by retailers as consumer service.
- This law guided producers to join in recycling activities and the investment in recycling factories by producers was encouraged.
- Any collection targets are not set. This can be justified by the objective of this law that reduces the burden of municipalities which disposed of the target e-wastes until the enforcement of this law.

7) Legal effect

After the enactment of the law, the e-waste stream was affected. The affection can be summarized below.

- At the event of enactment, municipalities stopped collection of target e-wastes, what could reduce the burden and cost of municipalities. At the same time, the material recovery from these e-waste went up.
- This law stimulated the investment from producers. Nearly fifty factories opened newly coordinated and invested by producers.
- Small businesses for collecting e-wastes directly from households were very much encouraged. This was justified by consumers as cost avoidance, because consumers were charged when they discard e-waste under this law. Many of the e-waste collected

by small businesses were sent to some secondhand dealers which export e-wastes to Asian countries. Some of the exportation in which unusable e-wastes were exported were considered undesirable and check of such exportation was regulated more strictly.

- Illegal dumping aiming at cost avoidance was seen. Some of them were conducted intentionally by the e-product retailers which received the e-wastes from consumers.

(2) Personal computers

1) Regulation

- Law for Promotion of Effective Utilization of Resources
- Small e-waste recycling law

2) Objective of the regulation

- To ensure proper solid waste management and to promote material recovery rate from the e-wastes

3) Numerical targets

- Material recovery rate
- Amount of recovered materials from e-waste (this can be covered to collection rate)

4) Roles of related sectors

- Consumers
  - Cooperation of PC collection
- Producers
  - Effort to collect end-of-life PCs from consumers

5) Major e-waste stream

The major e-waste stream is shown in the following figure.

- Consumers send of PCs to producers by post mail service (box and fee are borne by producers)
- Post office deliver the PCs to a recycling factory managed by producers
- Producers recycle the PCs sent from consumes

6) Points of the law

The points of these laws for PC recycling can be summarized below.

- This law stipulates voluntary contribution of PC producers for promoting recycling. However, through practical discussions between the government and the industries, effective e-waste stream was newly generated.
- Charging of recycling fee is prohibited by the law. The cost is internalized in the price of PCs.
- Conventional postal system was utilized for collecting end-of-life PCs.

7) Legal effect

The legal effect of these laws can be summarized below.

- This law stipulating the voluntary collection by PC producers generated a very sophisticated PC recycling system.

- Though the collection rate was not regulated, the law collection rate due to unwillingness of consumers to send out-of-use computers was discussed. This point was also disputed about the law collection rate of mobile phones.

(3) Small-size e-waste

1) Regulation

- Small e-waste recycling law

2) Objective of the regulation

- To ensure proper solid waste management and to promote material recovery rate from the e-wastes

3) Numerical targets

- Amount of recovered materials from e-waste (this can be covered to collection rate)

4) Roles of related sectors

- Consumers
  - Carry of e-wastes to designated places
- Municipalities
  - Collection of e-wastes
  - Sending of the collected e-wastes to the designated recyclers
- Manufactures and importers
  - Utilization of recovered materials in the production

5) Major e-waste stream

The major e-waste stream is shown in the following figure.

- Municipalities provide e-waste collection programs.
- Consumers discard e-wastes to the collection programs.
- Municipalities collect the e-waste and storage them.
- Registered recyclers collect the e-waste from municipalities and recycle them.

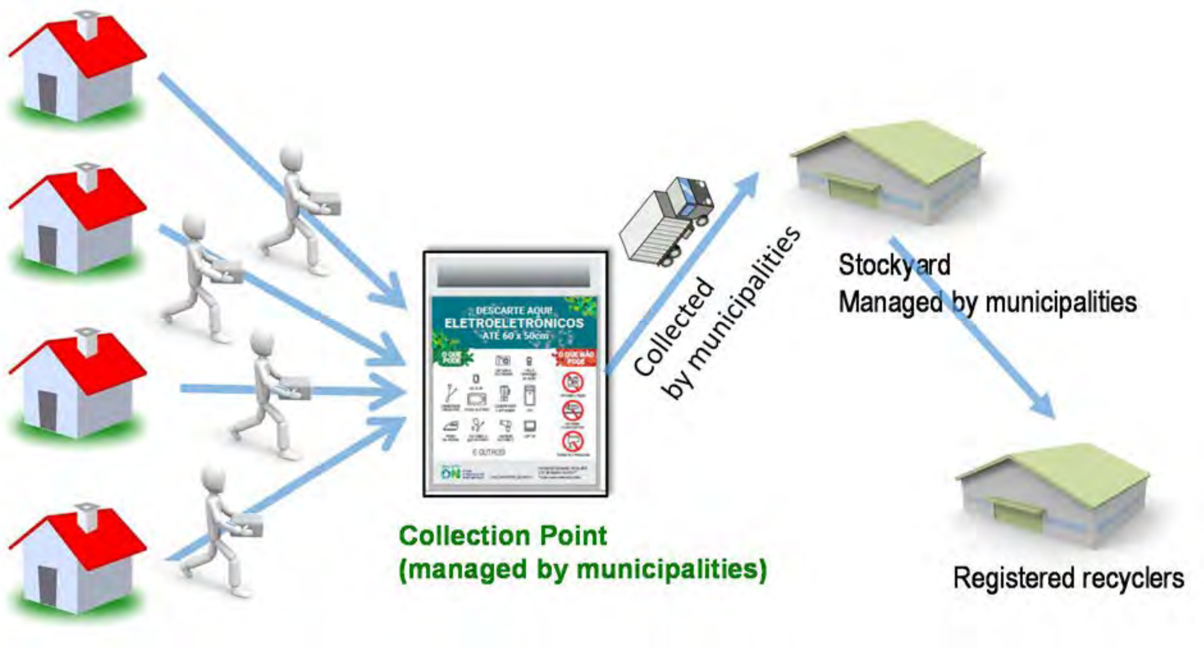


Figure 3-2 Major e-waste stream of small-size e-wastes

Source: JICA Expert Team

6) Points of the law

The points of this law can be summarized below.

- This law can cover all types of e-wastes by introducing the concept of "designated small e-wastes" which have comparatively high economic values.
- This law first tried to access to collection targets (about 20% by year 2015).
- This law stimulated recycling businesses in investing recycling factories.
- This law first stipulated the requirements of recyclers so as to promote recovery of precious metals and rare metals.
- This law does not stipulate cost sharing policy as well as mandatory recycling obligation on producers.

7) Legal effect

This law was just enacted. The effect will be discussed in the future. So far, the following points can be mentioned as the legal effects.

- This law encourages private business activities for small e-waste recycling. Many recycling companies were so far registered as designated recycling factories.
- Cost sharing policies would be discussed among stakeholders in future.

3.2 Discussions after the ten-year operation of "Home appliances recycling law"

Discussion meetings for any necessary amendment were scheduled in the law. The following points were focused.

(1) Recycling fee charging system

As mentioned above, this law stipulates consumers to pay the recycling fee upon discarded. An idea of advance payment upon purchase instead of payment upon discarded was discussed. The aims of the newly proposed charging system was to reduce illegal dumps and to promote EPR more. However, this was not adopted this time by considering that the number of illegal dumping is decreasing and any fatal errors of current payment system are found.

(2) Cost transparence

In the course of the discussion on the change in charging system, the amount of the recycling fee shown by the producers were focused, as the prices for three items of television set, refrigerators and washing machines have not changed for ten years. Even the price for air-conditioners was reduced by 500 JPY from 3500 JPY.

For improving this situation, producers were obliged to report their recycling costs with cost breakdowns periodically. Such transparency on recycling cost is expected to act as fee reduction mechanism.

(3) Efficient collection system

Under the law, two company groups were formulated as Group A and Group B for ensuring competitiveness, but this was pointed out as one of the inefficient factor of the system. Collection vehicles of retailers collected e-wastes of both groups had to travel at least two stockyards of Group A and Group B. For generating more efficient collection system, any possibility to share all stockyards was discussed. In this system, retailers can unload all collected e-wastes in one place.

3.3 Implications for generating the monitoring/reporting guidelines

The outlines and histories regarding e-waste regulations in Japan imply the following points for generating the monitoring/reporting guidelines.

(1) Basic figures regarding e-wastes

One of the most important indexes used in Japan is the material recovery rate which is calculated by the amount of recovered material divided by the amount of collected e-wastes. The reporting of these indexes is well organized and the Japanese government can monitor the index securely. By using these indexes, the government revised the targets to be achieved some time in nearly ten years since the enforcement of the law.

Besides, the amount of CFC gases is also monitored and reported carefully. Lead contained in CRTs and fluorescent lumps are reported as ones of the recovered materials.

(2) Collection rate targets

To set any collection rate targets are discussed carefully in Japan because of some reasons. The first point is the difficulty to monitor the collection rate. The amount of e-wastes discarded in a year is necessary for calculating the collection rate, and this potential discarded amount of e-wastes cannot be monitored but estimated. This results in the uncertainty of the index.

However, even in Japan, the collection rate targets are being discussed. In fact, in the small e-waste recycling law, addressing to the collection rate targets was tried.

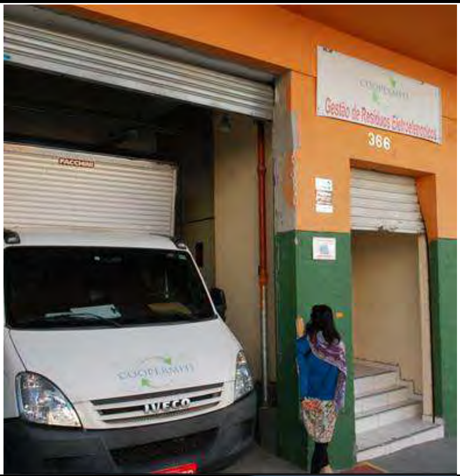
By considering the importance of this target, the effort in the EU countries can be reminded, where recently sold units of e-products is used as the alternative index for the potentially discarded e-waste. This index can be used alternatively in the world where the demands of e-products are saturated enough longer than their usable years.

4. Implications from the Pilot Project

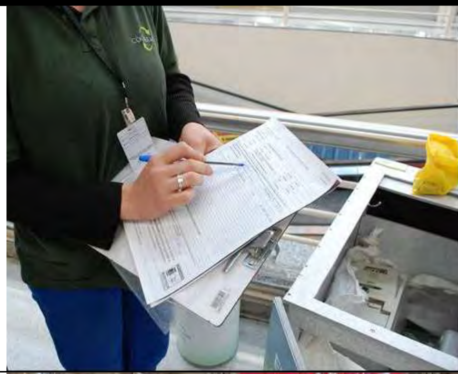
(1) Physical e-waste stream and data monitoring

The operation procedure with data recording in the Pilot Project can be seen in the following table.

Table 4-1 Operation procedure and data recording of the primary transportation

Process	Photo
Start from Coopermiti (with 1. Keys for drop-off boxes, 2. Plastic tags with ID numbers, 3. Monitoring sheets for the project, 4. Order sheet for Coopermiti with Protocol numbers, 5. Empty bags, 6. Carrier)	
Traveling to the first retailer of the day	
Preparation of collection in front of the first retailer of the day (Recording of the arrival time and running transportation)	
Opening of the drop-off box by the key	

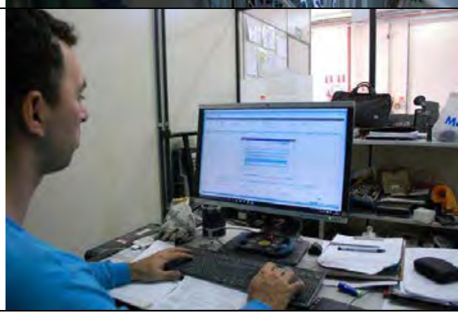
Process	Photo
Checking of the inside	
Record of the inside	
Tying of the bag by the tag with an ID number	

Process	Photo
Recording of necessary data	
Signing by both sides for confirmation and leaving of one copy to the responsible person	
Setting of an empty bag	

Process	Photo
Bringing out of the bag with e-wastes inside	
Loading of the bag	
Traveling to the next retailer	

Table 4-2 Operation procedure and data recording of segregation at the Consolidation Center

Process	Photo
Unloading of the collected bags	

Process	Photo
Checking of the tag number and the order sheet number for identifying the retailer which discarded the bag	
Opening of the bag	
Taking out of an e-waste inside the bag and weighing of the weight	
Recording of the weight, e-waste category and producer's name	
Storage of the e-waste according to the e-waste categories	
Inputting of all data to the database	

4.2 Monitoring system used in the Pilot Project

(1) Monitoring system for the primary collection and segregation/storage at the Consolidation Center

The following figure shows the operation procedure of Coopermiti. The points can be summarized below.

- During the primary transportation, Coopermiti records the required manpower and transportation distance for each retailer identified by a “Protocol Number”.
- E-wastes are unloaded at Coopermiti for segregation. The plastic bags with e-wastes collected by the drop-off collection are teared and the e-wastes inside are to be segregated in accordance with the designated categories. The weigh and number of units with producer’ names are to be recorded.

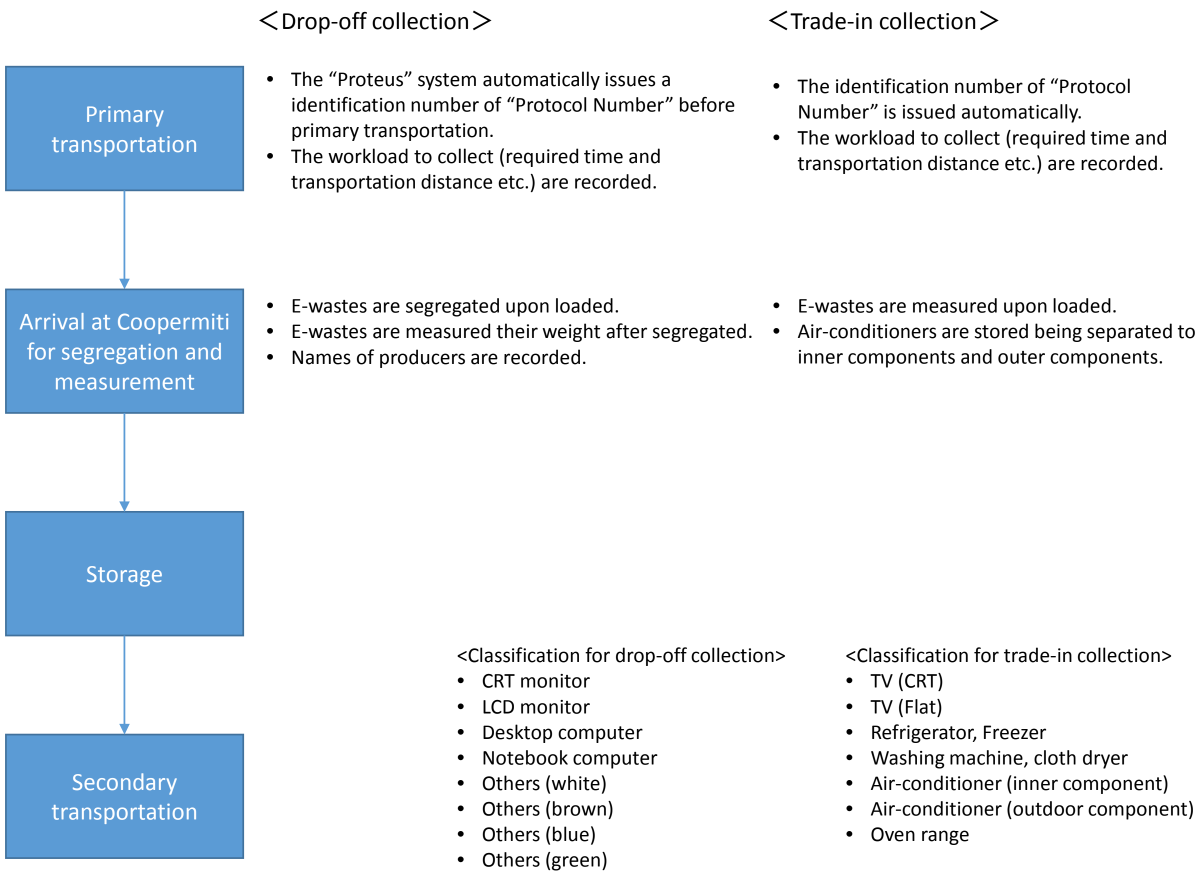


Figure 4-1 Operation procedure and monitoring system in the stage of primary transportation and segregation/storage

Source： JICA Expert Team

(2) Monitoring system for the secondary transportation and dismantling/sorting

- Transportation from the Consolidation Center to the dismantling/sorting facility
- Measuring of the segregated e-waste by the categories when the transportation vehicle reach at the dismantling/sorting factory
- Storage of the e-waste

- Dismantling of e-waste to designated categories (not crushed)
- Measuring of each sorted material (refrigeration and insulation systems of refrigerators and air-conditioners will not be broken and sent to the specific factory)

4.3 Implications for the future monitoring system

(1) Differences between the monitoring data in the Pilot Project and the regular monitoring system

1) Differences in the objective

In the Pilot Project, the major objectives of the monitoring were:

- Identification of expected amount of e-wastes to be collected and
- Estimation of required recycling cost,

while the demands of the future regular monitoring system are wider and are:

- Monitoring of the achievement of collection rate and recycled rate and
- Monitoring of e-waste leakage (completeness in material balance).

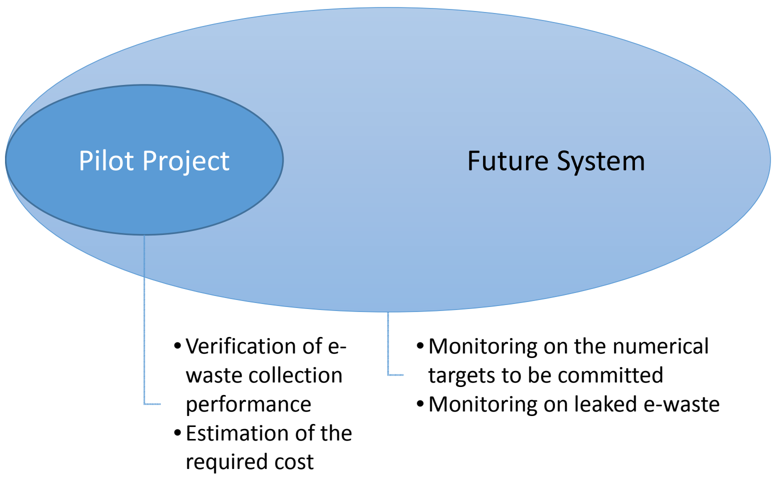


Figure 4-2 Functions needed in the Pilot Project and the future regular system

Source: JICA Expert Team

2) Differences in the size and formation

The differences between the Pilot Project and the future regular system in terms of the size and formation are as shown in the following figure. The formations have basically the same structure but the differences can be summarized below.

- The number of the retailers and related recycling companies are much more than ones in the Pilot Project.
- The Project Team worked for the monitoring activity, while this function will be managed by the related private companies.
- The monitored data were reported to the Technical Committee of the Project, while the data will be reported to specific governmental bodies in the regular formation.

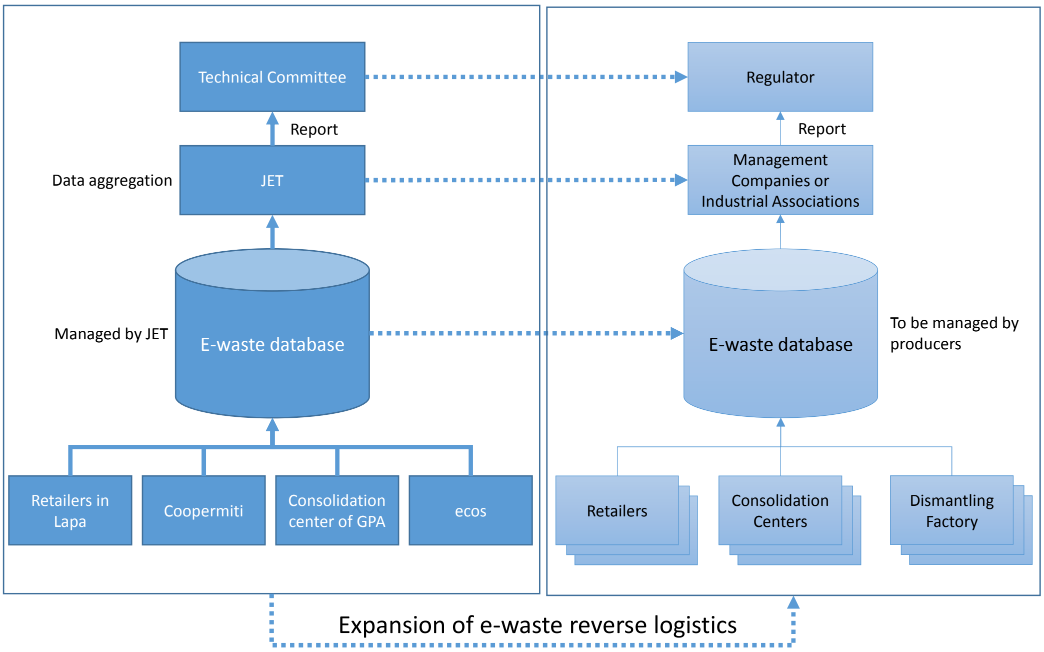


Figure 4-3 Comparison of the data monitoring formation

Source： JICA Expert Team

5. Focal points of a Reverse-Logistics system for considering proper monitoring/ reporting system

5.1 Who will design a reverse-logistics system under producers' primary responsibility for e-waste recycling?

(1) Options

- Option 1: Producers' initiative for designing a reverse logistics system
- Option 2: Cooperation among related business actors including producers and retailers under the Shared Responsibility Concept
- Option 3: Governmental contribution for designing a reverse logistics system

(2) Comparison

Figure 5-1 Comparison on the options for reverse-logistics system designers

Option / Comparison Factor	Option 1: Producers	Option 2: Related business actors including producers and retailers	Option 3: Government
Efficiency of the system to be generated	(High) The most efficient systems will be generated under producers' initiatives.	(A little bit low) Some contributions from the political community might be obstacles in generating the most efficient systems.	(Low) Efficient systems cannot be expected.
Performance for achieving numerical targets	(High) The systems to be generated will concentrate in achieving the targets with strong commitments of producers.	(A little bit low) Some contributions from the political community might interfere the achievement.	(Low) It might be difficult for producers to commit the targets if the system design are specified by the political community.
Motivation of producers	(High) Producers have to commit the achievement of the targets.	(A little bit low) Producers may complain some intervention from the political community.	(Low) It is difficult for producers to commit the targets.
Flexibility of the system to be generated	(High) Flexible systems exploring the ways for achieving the targets will be generated.	(A little bit low) The systems to be generated will be deterministic depending on interventions from the political community.	(Low) Flexible system cannot be expected.

Source: JICA Expert Team

5.2 How is a recycling fee system designed?

(1) Options

- Option 1: Recycling fee charged to consumers when purchased
- Option 2: Recycling fee charged to consumers when discarded
- Option 3: Included in product prices and paid by producers

(2) Comparison

Figure 5-2 Comparison on the options for fee recovery system for e-waste reverse logistics systems

Option / Comparison Factor	Option 1: Recycling fee charged when purchased	Option 2: Recycling fee charged when discarded	Option 3: Included in product prices and paid by producers
Coincidence of the payer and the beneficiaries	<Low> The fee will be used for historical wastes, while	<High> The fee will be used for the payer.	<Low> Same as the option charged when purchased.

Comparison Factor \ Option	Option 1: Recycling fee charged when purchased	Option 2: Recycling fee charged when discarded	Option 3: Included in product prices and paid by producers
	the fee is collected from purchasers.		
Continuous fee minimizing force (efficiency)	<Not high> The fee would be protected officially, what might result in no incentive to reduce the recycling cost.	<Not high> Same as the option charged when purchased.	<High> Producers try to minimize the fee continuously.
Feedback to "DfE" (Design for Environment)	<Weak> Because of above mentioned reason.	<Weak> Because of above mentioned reason.	<Strong> Because of above mentioned reason.
Technological innovation	<Not so strong> Technological innovation for cost reduction cannot be motivated due to the above mentioned reason, but it might be encouraged depending on the recycling rate target setting.	<Not so strong> Technological innovation for cost reduction cannot be motivated due to the above mentioned reason, but it might be encouraged depending on the recycling rate target setting.	<Strong> Because of above mentioned reason.
Justification of the fee amount	<Low> The fee is determined based on the current technical standards, while the target e-waste will be discarded in more than several years.	<High> Current recycling cost can be counted.	<Low> Same as the option charged when purchased.
Possibility of free riders (fairness)	<High> The cost for e-wastes from non-existing producers will be borne by the existing producers.	<Low> The system can be designed so as to cover e-wastes from non-existing producers.	<High> Same as the option charged when purchased.
Cause of illegal dumping	<Low> Illegal dumping will not be induced.	<High> Illegal dumping might be done by ones who want to avoid to be charged.	<Low> Same as the option charged when purchased.
Fund flexibility	<High> The fund can cover several years depending on the design.	<Low> The recycling fee has to be used for the e-wastes discarded.	<High> Same as the option charged when purchased.
Fairness among producers	<Unfair> It might be unfair due to the gap between the present and past market shares among producers. The fee paid for brand A can be used for e-waste of brand B.	<Fair> The fee paid for a brand will be used for e-waste of the brand.	<Unfair> Same as the option charged when purchased.

Source: JICA Expert Team

5.3 How are the strategies for shifting from conventional recycling channels to designated route?

(1) Options

- Option 1: Economic incentive for consumers
- Option 2: Guiding by public relations
- Option 3: Compulsion by laws

(2) Comparison

Even though the combinations for three options are the realistic solutions, the characteristics of three options can be summarized in the following table.

Figure 5-3 Comparison on the options for how to shift the present e-waste stream

Option / Comparison Factor	Option 1: Economic incentive for consumers	Option 2: Guiding by public relations	Option 3: Compulsion by laws
Effectiveness for collecting e-waste	<High> Economic incentive could work for shifting people's behavior if the system is designed well.	<Low> The effectiveness is limited. It needs enough long time to change people's behavior.	<Middle> Compulsion by laws could work as far as enough inspection cost is spared.
Efficiency	<High> The system will be efficient if the budgetary sources for incentive are prepared well.	<Low> The cost marginality is not high and it is difficult to estimate the effectiveness of cost input for public relations.	<Middle> Efficiency depends on how strong inspection system is established.

Source: JICA Expert Team

5.4 What index can be used as the collection rate for target setting?

(1) Options

- Option 1: $\frac{Collected\ e{-}waste}{Estimated\ e{-}waste\ amount\ based\ on\ the\ past\ domestic\ input}$
- Option 2: $\frac{Collected\ e{-}waste}{Past\ product\ sales * (1 - Reuse\ rate)}$
- Option 3: $\frac{Collected\ e{-}waste}{Recent\ product\ sales * (1 - Reuse\ rate)}$

(2) Comparison

Figure 5-4 Comparison on the options for target setting for e-waste reverse logistics systems

Option / Comparison Factor	Option 1: Based on the discarded e-waste amount	Option 2: Based on the past product sales	Option 3: Based on the recent product sales
Consensus making in the business sectors	<Low> It is difficult to make consensus in business sectors due to the complexity of the calculation method.	<Low> Whether the past product sales represent the e-waste discarded is not sure.	<Very low> The recent product sales cannot represent the e-waste amount.
Data availability to calculate the index	<Not low> It is possible to calculate the e-waste amount by using past product sales.	<Not low> Whether the past product sales data is available or not is sure.	<High> The present sales are available.
Data stability	<High> Estimated values are distributed smoothly.	<Low> The past product sales can fluctuate widely every year. (* Average of data for several years for weakening this fluctuation is possible.)	<Low> The present product sales can fluctuate widely every year. (* Average of data for several years for weakening this fluctuation is possible.) The collection rates by this definition may be lower for penetrating products
Setting of reused rate of "r"	<Disputable> Values which can be committed by both industrial sector and political sector have to be set, because it is difficult to set accurate values for "r".		

Source: JICA Expert Team

5.5 Are e-waste collection rate targets to be set for each type of e-waste?

(1) Options

- Option 1: E-waste collection targets set for each type of e-waste
- Option 2: One target set for the whole of e-wastes

(2) Comparison

Figure 5-5 Comparison on the options for the scope of collection target setting

Option / Comparison Factor	Option 1: E-waste collection targets set for each type of e-waste	Option 2: One target set for the whole of e-waste
Ease to achieve the targets	<Low> It is difficult to achieve all targets set for each e-waste.	<Higher> Depending on the target value, the achievement is easier than the option 1, because low achievement can be compensated by higher achievement.
Setting of realistic targets	<High> The target can be set considering the present situations on e-wastes. For example, the targets can be set differently to large-size e-wastes and small-size e-wastes.	<Low> Present situation of each type of e-waste cannot be reflected to the targets.
Policy induction in the e-waste reverse logistic policy	<High> Policy inductions can be expressed by setting different targets depending on the types of e-waste.	<Low> Policy induction such as setting of higher targets on some important e-wastes cannot be expressed on target settings.
E-waste classification	<Necessary> The targets should be set on e-waste groups defined by an e-waste classification.	<Unnecessary> One target will be put on the whole of e-wastes.

Source： JICA Expert Team

5.6 Are e-waste collection rate targets to be set for each state?

(1) Options

- Option 1: E-waste collection targets set for each state
- Option 2: One target set for the whole of Brazil

Option 1 does not mean that the collection will be started differently depending on the states. As far as the visible fees are charged to purchases of e-products, the fee system should be started at the same time.

(2) Comparison

Figure 5-6 Comparison on the options for the geographical scope of collection target setting

Option / Comparison Factor	Option 1: E-waste collection targets set for each state	Option 2: One target set for the whole of Brazil
Setting of realistic targets	<High> The target can be set considering the present situations of a state.	<Low> Present situations cannot be reflected to the targets.
Policy induction in the e-waste reverse logistic policy	<High> Policy inductions can be expressed by setting different targets depending on the characteristics of states.	<Low> Policy induction such as setting of higher targets for some important states cannot be expressed on target settings.
Fairness	<High> Everyone living in any states can be given the same services.	<Low> The accessibility to proper e-waste collection services will be different by states.

Source： JICA Expert Team

5.7 How are recycling fees paid for orphan products? (for the case of visible fee paid upon purchase and the case of internalized to product prices)

(1) Options

- Option 1: Recycling for all e-wastes including recycling of orphan products[1]
- Option 2: Recycling for all e-wastes excluding recycling of orphan products

Note: The case of payment upon discarded was excluded from this focal point, because the fee will be exactly used for the discarded e-wastes even they are orphan products.

(2) Comparison

Figure 5-7 Comparison on the options for uses of recycling fees

Option / Comparison Factor	Option 1: Recycling for all e-wastes including recycling of orphan products	Option 2: Recycling for all e-wastes excluding recycling of orphan products
Fairness among producers	<Unfair> It is unfair, if only brand holders are charged. The products of brand holders have to compete with non-brand producers with price weakness.	<Fair> It is fair, if non-brand producers are not charged.
Contribution to target achievement	<Yes> Recycling of orphan products can be counted, even though they will not be counted as the amount of discarded e-waste (denominator of the collection rate).	<No> The orphan products are not counted in the collection target, even if they are discarded.
Transaction cost	<Low> The orphan products do not contribute to push up the recycling cost.	<High> Segregation of orphan products may push up the transaction cost of e-waste recycling.
Fund design	<No problem> As far as the visible fees are to be used for recycling of historical wastes, the fees do not have any physical meanings. From this sense, the fund can be designed so as to cover the orphan products (even though the amount of orphan products will not affect the fund size so much.)	<No problem> Same as the Option 1.

Source: JICA Expert Team

[1] "Orphan products" means the products whose brands are unsure or which were produced by nonexistent producers at present.

6. Proposal of the Guideline framework

6.1 Legal basis

The monitoring/reporting activities can be justified by the Article 33 of the National Policy on Solid Waste: "Except for consumers, all participants of reverse logistics shall keep updated, complete information of projects under their responsibility available to the competent municipal body and other authorities".

6.2 Items to consider in the guidelines

(1) Objective

The objectives of the reverse logistics have to be discussed carefully, because the target indexes will be set so as to monitor the achievement of the objectives. The home appliance recycling law of Japan has no target index regarding collection rate. This is because the objective of the law is to reduce the burden of municipalities from large-size e-wastes and the leakage to the environment from conventional recycling channels were not focal very much.

As stated in the Article 7 of the National Policy on Solid Waste, the objectives of this law are very wide. The objectives of the e-waste reverse logistics have to be set precisely so as to set the target indexes precisely.

(2) Target indexes

If the objectives of the e-waste reverse logistics are 1) minimization of the leakage of hazardous substances to the environment and 2) maximization of the material utilization, keeping the policy priorities prioritized the reuse prior to the material recovery, the target indexes can be considered as:

- Collection rate of e-waste in the regular reverse logistics (= $\frac{Amount\ of\ e\text{-}waste\ collected\ by\ the\ reverse\ logistic\ system}{Amount\ of\ discarded\ e\text{-}waste\ with\ no\ reusable\ values}$) and
- Material recovery rate of (= $\frac{Amount\ of\ recovered\ materials\ for\ recycling\ from\ collected\ e\text{-}waste}{Amount\ of\ e\text{-}waste\ collected\ by\ the\ reverse\ logistic\ system}$).

Here, for endorsing the minimum leakage of CFC gases, the technical guideline of "Reverse manufacturing for refrigeration machines" (ABNT NBR 16156/2010) can be applied.

In those two indexes, two things have to be considered. One is how to estimate "Amount of discarded e-waste with no reusable values), and another is the definition of "Recycling". In the Pilot Project, the amount of discarded e-waste was estimated based on the survey composed of the survey on the macroeconomic indexes and the questionnaire survey to consumers. The number of sales of e-products in the past and the average used years were analyzed for the future amount of e-waste to be discarded. By multiplying the reuse rates identified by the questionnaire survey, the amount of e-wastes to be discarded and not to be returned to consumers through the reuse market was estimated.

(3) Traceability of e-wastes

Traceability of e-wastes is one of the important issues when the monitoring guideline is discussed. For securing no leakage, e-waste recycling stream has to be traced.

It is easy to trace the stream of e-wastes collected by the trade-in system up to the dismantled stage. However, the e-wastes collected from the drop-off centers cannot be traced after the Consolidation Center, because e-wastes inside a bag are to be segregated in accordance with the e-waste segregation categories, but the total weight sent to the dismantling factory was monitored so as to check there is no leakage.

(4) Recycling cost

As discussed in Japan, the required cost for recycling has to be monitored for keeping continuous effort to minimize the cost.

6.3 Focal points and options to consider

(1) Estimation of amount of discarded e-wastes

For calculating the collection rate, potential amount of e-waste discarded in a year have to be given, but this values cannot be obtained physically. Any estimation method such as one used in the study is applicable. However, it requires the past domestic input data of e-products covering for enough long intervals compared with the average used years, and the e-waste reuse rates have to be identified. In spite of the scientific approach as possible, this estimation method may contain some subjective factors in projection of the future e-product sales, and it is difficult to know the real value of the reused rates. Even such estimation method need commitment between the regulators and regulates.

Another way to estimate the amount of discarded e-wastes commonly used worldwide is simpler. Instead of the past domestic input, the recent domestic input can be used if both sides can commit this simplified way.

(2) Consideration of reuse

Reuse rates of e-wastes have to consider in the definition of expected amount of e-waste to be discarded, but it is not easy to know the values. In the Project, those values were grasped by a questionnaire survey as shown below and used for estimating the amount of e-waste to be recycled. In the regular implementation of e-waste reverse logistic system, such values have to be prepared for practical uses.

- Television set: 37%
- Refrigerator: 42%
- Washing machine: 21%
- Air-conditioner: 36%
- Personal computer: 4%
- Mobile phone: 39%
- Others: 9%

(3) Definition of recycling

Whether thermal recovery can be counted for recycling or not has to be discussed and committed between the regulators and regulates.

Appendix

Appendix 1. Monitoring/Reporting Guidelines (trial draft)

Clause 1 - Definitions of terms

I - Recycling: To utilize the materials taken from the e-wastes as industrial raw materials including heat recovery in any good conditioned incinerators.

II - Management Organizations: Organizations of the private sides including manufactures, importers, distributers and sellers in charge of data monitoring.

Clause 2 - Objective of the guideline

This guideline aims at stipulating the roles/responsibilities of the related actors for monitoring the e-waste reverse logistic systems. By using the monitored data, the sound management of the e-waste reverse logistics can be secured and the future strategies can be discussed.

Clause 3 - Data to be monitored

Para. 1 - Target indexes

I - Target indexes
The target indexes to be monitored are:

- Collection rate of e-waste in the regular reverse logistics
  (=$\frac{Amount\ of\ e{-}waste\ collected\ by\ the\ reverse\ logistic\ system}{Amount\ of\ discarded\ e{-}waste\ with\ no\ reusable\ values}$) and
- Material recovery rate of
  (=$\frac{Amount\ of\ recovered\ materials\ for\ recycling\ from\ collected\ e{-}waste}{Amount\ of\ e{-}waste\ collected\ by\ the\ reverse\ logistic\ system}$).

II - The estimation of the target indexes requires
a) Amount of e-waste collected by the reverse logistic system,
b) Amount of discarded e-waste with no reusable values, and
c) Amount of recovered materials for recycling from collected e-waste.

III - Estimation on the required data to be monitored
a) Amount of e-waste collected by the reverse logistic system
This data are monitored and reported by the Management Organizations.
b) Amount of discarded e-waste with no reusable values
This data requires 1) the amount of end-of-life e-waste and 2) the amount of reused e-waste.
The amount of end-of-life e-waste can be estimated by
Option A: the average of sold e-products in the past three years
Option B: estimation by using past time-serial data and the average used years
The amount of reused e-waste taken by any scientific and reasonable methods can be proposed by the Management Organizations for acceptance of the MMA, or the following values can be used practically.

Table Reused rates
Television set: 37%
Refrigerator: 42%
Washing machine: 21%

Air-conditioner: 36%
Personal computer: 4%
Mobile phone: 39%
Others: 9%

IV - Amount of recovered materials for recycling from collected e-waste.
This data are to be monitored and reported by the Management Organizations.

V - Reporting form
The Management Organizations have to report the above mentioned data to MMA by using the attached "Data Reporting Form A".

VI - Frequency of submission
The Management Organizations have to submit the data once a year by the end of June.

Para. 2 - Environmental aspect to be monitored

I - Target environmental media
The amount of contained and recovered CFC gases have to be monitored and reported to MMA

II - CFC gases to be monitored
The amount of CFC gases contained in the collected e-waste and the amount of recovered CFC gases have to be monitored and reported to MMA by the Management Organizations. If the amount of CFC gases is unsure, the values which are contained in "Reverse manufacturing for refrigeration machines (ABNT NBR 16156/2010)" can be used.

III - Reporting form
The Management Organizations have to report the above mentioned data to MMA by using the attached "CFC Reporting Form B".

IV - Frequency of submission
The Management Organizations have to submit the data once a year by the end of June.

Para. 3 - Recycling cost

I - Target cost data
The required cost covering the primary transportation, segregation/storage at the Consolidation Center, secondary transportation and dismantling/sorting at dismantling factories have to be monitored and reported to MMA.

II - Cost items
The required costs with breakdowns composed of revenue from recycling fee, transportation cost, segregation/dismantling cost, other management cost have to be monitored and reported to MMA.

III - Reporting form
The Management Organizations have to report the above mentioned data to MMA by using the attached "Recycling Cost Reporting Form C".

IV - Frequency of submission
The Management Organizations have to submit the data once a year by the end of June.

Para. 4 - Tracking data of e-wastes

I - Target e-wastes to be tracked

a) Five types of e-wastes have to be traced by the ID numbers put on each e-waste up to dismantling.
b) Other e-wastes have to be checked by the material balance so as not to be leaked.

II - Monitoring of the tracking data
The Management Organizations have to report the e-waste tracking upon requested from the competent agencies.

Clause 4 - Responsibilities of related actors

Para. 1 - Responsibilities of manufactures and importers
a) Manufactures and importers have the first responsibility to monitor and report the e-waste logistics system.
b) Manufactures and importers can entrust data monitoring and reporting to the Management Organizations.

Para. 2 - Responsibilities of distributors and sellers
Distributors and sellers have to cooperate with the manufactures and importers in monitoring and reporting the required data.

Para. 3 - Participation of recycling companies
Recycling companies have to cooperate with the manufactures and importers in monitoring and reporting the required data.

Para. 4 - Responsibilities of the federal government
The federal government has to aggregate the reported data and publish to the public once a year so that the public can know the progress of the reverse logistic systems.

Clause 5 - Consultation meeting

I - The manufactures and importers and the competent agencies have to consult with each other the progress of the reverse logistic systems by sharing the aggregated data.

II - In the consultation meeting, the achievement of collection rate target and material recovered rate have to be checked and the future targets have to be discussed.

Clause 6 - Control and supervision

The manufactures and importers have the duty to report any data correctly.

Clause 7 - Confidentiality

I - The competent agencies have to deal with the reported data confidentially so that any personal data are not identified.

II - When the competent agencies publish the aggregated data, the data have to be published so that any personal data are not identified.

Data Reporting Form A

	Sales (unit)			Sales (kg)			Reuse rate (%)
	One year previous	Two years previous	Three years previous	One year previous	Two years previous	Three years previous	
TV(CRT)							
TV(Flat)							
Refrigerator/Freezer							
Air-conditioner							
Monitor(CRT)							
Monitor(LCD)							
PC(Desktop)							
PC(Notebook)							
Others (White)	-	-	-				
Others (Brown)	-	-	-				
Others (Blue)	-	-	-				
Others (Green)	-	-	-				

(Note) Estimation methods have to be mentioned.

CFC Reporting Form B

	Contained (kg) (A)	Recovered (kg) (B)	Recovery rate (%) (B/A*100)
Refrigerant CFC from air-conditioners			
Refrigerant CFC from refrigerators			
Insulation CFC from refrigerators			

Recycling Cost Reporting Form C

Type of e-waste				Amount (R$/year)
Revenue	Recycling fee			
	Subtotal			
Cost	Direct cost	Primary transportation		
		Consolidation center		
		Secondary transportation		
		Dismantling factory	Recyclable sales	
			Residue disposal	
			Dismantling/sorting	
	Indirect cost	Management organization		
		Others		
	Subtotal			
Balance				

(Note) Estimation methods have to be mentioned.