

# Recycling Fee Rate Calculation and Sample Exercises

## Overview

Under the 4-in-1 Recycling Program, recycling fees charged to manufacturers and importers of new regulated recyclable waste (RRW) products feed into the Recycling Fund that subsidizes licensed collectors and recyclers. For each RRW item, the Recycling Fund Management Board (RFMB) of Environmental Protection Administration Taiwan (EPAT) calculates a recycling fee rate based on the cost of recycling and collecting that item. The fees are distributed by EPAT into trust funds and special income funds. There are eight trust funds, organized by categories of RRW. These are used to subsidize private collectors and recycling enterprises that meet EPAT standards. Special income funds are dedicated to education, research and development, auditing, grants for municipalities and citizen groups, and administration of the 4-in-1 Recycling Program. RFMB also determines the appropriate collection and recycling subsidy rate for each type of RRW.

The recycling fee and subsidy rates have a direct impact on collectors' and recyclers' costs and competitiveness, so it is important to ensure these rates accurately reflect the costs of managing RRW. The Recycling Rate Review Committee (RRRC), a multi-stakeholder group appointed by EPAT, is responsible for final decisions on the fee and subsidy rates based on the following factors:

- a. RRW component materials
- b. Per unit weight or volume of RRW
- c. Collection and recycling rates (verified through auditing)
- d. Cost of private collection, recycling and disposal (of non-recyclable components)
- e. The value of recycled or reused RRW products
- f. Annual cost of municipal RRW collection
- g. Cost of auditing
- h. The financial condition of the Recycling Fund (based on RFMB reports)

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### i. Other relevant factors

RFMB regularly reports to the RRRC on the condition of the fund and also makes recommendations to the RRRC on how the fee and subsidy rates should be modified, if at all. After the RRRC reviews fee and subsidy rates and the RFMB's recommendations, its final decisions are sent to the EPAT for approval.

## Recycling Fee Rate Calculation Formula

The following formula is used to calculate the recycling fee rate for each RRW item:

*Recycling fee rate = [ total cost of collection, transportation, and recycling (H) + cost of auditing and verification (L) – total revenue generated by recyclers<sup>1</sup> and collectors from processing RRW (V) – prorated trust fund surplus (F)] / quantities of new RRW products put on the market in Taiwan (S)*

The subsidy rate, auditing and other administrative costs that are supported by the Recycling Fund must equal the recycling fees brought in from manufacturers and importers. Table 1 gives an example of the factors that go into the calculation of the fee rate for manufacturers and importers of EEE.

**Table 1.**

Recycling Fee Rate Calculation Formula
H : Total Cost of collection, transportation, and recycling (NTD)=D+T+E
D (Cost of collection, transportation, and recycling)(NTD)= (C1+C2) × g
T (Additional Municipal Collection Costs) (NTD) = 0
E (Environmental External Cost, including cost of environmental effects) (dollar)
C1 : Unit cost of collection (NTD/unit)

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<sup>1</sup> In the case of WEEE, recyclers are subsidized under the 4-in-1 Recycling Program but collectors aren't, so only recyclers' revenues are considered in the rate formula.

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<p><b>C2</b> : Unit cost of recycling (NTD/unit)</p> <p><b>g</b> : Certified quantities from processing RRW (number of units)</p>
<p><b>L</b> : Cost of auditing (NTD)</p>
<p><b>V</b> : Revenue generated by recyclers from processing RRW (NTD) = <math>r \times g</math> :</p> <p><b>r</b> : Average unit profit for recyclers and collectors (NTD/unit)</p> <p><b>g</b> : Certified quantities from processing RRW (units)</p>
<p><b>F</b> : Prorated trust fund surplus (NTD) = <math>(f - q) / y</math> :</p> <p><b>f</b> : Accumulated trust fund surplus (NTD)</p> <p><b>q</b> : Amount set aside from surplus for future fund management (NTD)</p> <p><b>y</b> : RRW life span (years)</p>
<p><b>S</b> : Quantities of new RRW products put on the market in Taiwan (total units)</p>

Additional detail on the input factors in Table 1 is given below.

**H**: Total cost of collection, transportation, and recycling

Costs associated with recycling RRW including collection, transportation, and recycling.

**D**: Cost of collection, transportation, and recycling

This variable accounts for the costs of RRW collection by collectors or municipal collection teams, transportation to subsidized recyclers, and recycling and dismantling by subsidized enterprises. These costs are determined based on surveys of subsidized recyclers and registered collectors.

**C1**: Unit cost of collection

This variable reflects the purchase price paid by collectors for RRW.

**C2**: Unit cost of recycling

In general, this variable represents the cost of processing RRW to a point

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where component resources can be resold as commodities. In the case of WEEE, this variable reflects the cost of disassembling, shredding, recovering material from WEEE, and waste disposal by the recycling plant.

### T: Additional municipal collection costs

This variable is meant to represent the cost of collecting RRW which is incorrectly or illegally disposed of through municipal waste collection. Since residents are currently required to cover municipal waste collection through a garbage bag fee, this cost is estimated to have a value of 0.

### E: Environmental external cost

This variable is the cost of the environmental impacts of improper disposal. Currently, the cost is estimated by the amount of subsidies given to local governments' municipal collection teams, which come from grants financed by the special income fund.

### L: Cost of auditing

These costs include funding the work of the ACG, supporting the online reporting and auditing systems, and other administrative costs associated with auditing.

### V: Revenue generated by recyclers from processing RRW

This revenue is generated by selling recovered materials or derivative commodities from recycled RRW such as dismantled WEEE. The average unit profit for recyclers and collectors is based on a market survey of derivative material prices.

### F: Prorated trust fund surplus

This item approximates the amount of money available in the Recycling Fund for the RRW item in question.

*Prorated trust fund surplus = (Cumulative trust fund surplus – Amount set aside from the previous year's surplus for future fund management of the*

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*fund<sup>2</sup>)/ RRW life span*

f: Cumulative trust fund surplus

The cumulative annual surplus of the RRW's trust fund since 1998

q: Amount set aside from surplus for future fund management

This item approximates the monetary amount that is reserved for the normal operation of the trust fund. Currently the amount set aside from surplus for future fund management is twice the annual expenditure of previous three years in average.

y: RRW life span

The length of a product's useful life

S: Quantities of new RRW products

This variable is the total number of new RRW products put on the market from manufacturing and imports.

## Market Surveys

In order to determine unit costs and revenues associated with recycling and collection, EPAT surveys licensed recyclers and collectors annually on their costs related to purchasing RRW, facility equipment, management and marketing, labor, and waste disposal, as well as the revenue generated by selling derivative materials generated from recycling. The results of this survey are used to calculate the following terms in the recycling fee rate formula:

(1) C1: Unit cost of collection

(2) C2: Unit cost of recycling

(3) r : Average unit profit for recyclers and collectors

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<sup>2</sup> Currently, funds are set aside for two years of future fund management.

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### Rate Calculation Sample Exercises

(1) Exercise 1: Labor costs

Operations overview of a recycling plant

a. Operations overview

	Percentage
WEEE operation cost / total operation cost	60.0%
Other operation cost / total operation cost	40.0%

b. Labor costs

Item	Head count	Personnel expense (dollar/year)
Executives (manager and above)	5	6,000,000
Administration staff/specialist	10	4,800,000
WEEE-specific front line workers	20	9,600,000

Question A: What is the total labor cost of this WEEE recycling plant?

Solution:

	Percentage of WEEE operating cost	Administration labor costs (dollar)	AppORTIONED Administration labor costs (dollar)	Specific front line labor costs (dollar)	Total labor cost of WEEE recycling (dollar)
Total labor cost of WEEE recycling	60.0%	10,800,000	6,480,000	8,000,000	14,480,000

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**Question B:** Based on cost derived from Problem 1 and the volume of recycling shown below, what is the unit labor cost for a television?

	Volume (piece)	Total processing time (min)
Waste televisions	100,000	1,000,000
Waste air conditioners	50,000	400,000
Waste refrigerators	50,000	400,000
Waste washing machines	100,000	1,000,000

Solution:

	Volume (piece)	Total processing time (min)	Percentage of processing time	Total labor cost (dollar)	AppORTIONED labor cost (dollar)	Unit labor cost (dollar/piece)
Waste televisions	100,000	1,000,000	35.7%	14,480,000	5,171,429	51.7

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### (2) Exercise 2: Cost of equipment

The cost of equipment of a recycling plant is as follows:

Common equipment				
Items	Total cost (dollar)	Unit cost (dollar)	Useful life (year)	Equipment cost after amortization (dollar)
Truck scales (set)	1,000,000	1,000,000	20	50,000
Forklift (unit)	3,000,000	230,769	8	375,000
Freight vehicles (unit)	1,200,000	1,200,000	8	150,000
Office air conditioners (unit)	80,000	80,000	8	10,000
Office computers (unit)	400,000	28,571	5	80,000
Plant renovation	40,000,000	40,000,000	20	2,000,000

Special equipment				
Item	Total cost (dollar)	Unit cost (dollar)	Useful life (year)	Equipment cost after amortization (dollar)
Cost of waste television recycling equipment	5,000,000	74,627	10	500,000

**Question:** According to the recycling volume and the time it takes to recycle each category of WEEE, as shown in table below, what is the unit cost of equipment for recycling televisions?



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	Volume (piece)	Total processing time (min)
Waste televisions	100,000	1,000,000
Waste air conditioners	50,000	400,000
Waste refrigerators	50,000	400,000
Waste washing machines	100,000	1,000,000

Solution:

a. Common equipment

	Percentage of processing time	Cost of common equipment after amortization (dollar)	Recycling volume (piece)	Unit cost of common equipment (dollar/piece)
Waste televisions	35.7%	2,665,000	100,000	9.5

b. Special Equipment

	Cost of special equipment after amortization (dollar)	Recycling volume (piece)	Unit cost of special equipment (dollar/piece)
Waste televisions	500,000	100,000	5.0

- c. Unit cost of equipment for recycling televisions =  $9.5 + 5.0 = 14.5$  dollars/piece

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### (3) Exercise 3: Management and marketing costs

The result of management and marketing costs survey is as follows:

Items	Annual cost (dollar)
Land and plant leases	9,600,000
Water bill	240,000
Electricity bill	3,600,000
Fuel cost	600,000
Tax	500,000
Common equipment maintenance	3,600,000
Special equipment (for television recycling) maintenance	60,000

Operation overview	Percentage
Waste home appliances operation cost / total operation cost	60.0%
Other operation cost/ total operation cost	40.0%

Question: Given the recycling volumes and processing times shown below, what is the unit cost of management and marketing for recycling televisions?

	Volume (piece)	Total processing time (min)
Waste televisions	100,000	1,000,000
Waste air conditioners	50,000	400,000
Waste refrigerators	50,000	400,000
Waste washing machines	100,000	1,000,000

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Solution:

- a. Total costs of common management and marketing for waste household appliances

	Percentage of operation cost	Total costs of common management and marketing (dollar)
Waste home appliances	60.0%	10,914,000

- b. Unit cost of common management and marketing

	Percentage of processing time	Common cost of management and marketing (dollar)	Recycling volume (piece)	Unit common cost of management and marketing (dollar/piece)
Waste televisions	35.7%	10,914,000	100,000	39.0

- c. Unit cost of dedicated management and marketing

	Annual cost of management and marketing	Recycling volume (piece)	Unit cost of dedicated management and marketing (dollar/piece)
Waste televisions	60,000	100,000	0.6

- d. Unit cost of utility and maintenance for recycling televisions =  $39.0 + 0.6 = 39.6$  dollars/piece

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(4) Exercise 4: Revenue generated by recyclers from processing RRW and cost of waste disposal

Derivative materials and corresponding weight and price from dismantling televisions are shown below:

Average weight (kg/piece)	33.0		
Derivative material	Weight percentage	Weight (kg)	Saleprice (dollar/kg)
Iron	9.20%	3.04	11.5
Copper	0.86%	0.28	165.0
Plastic	14.69%	4.85	12.0
IC board	6.18%	2.04	14.0
Wire	0.17%	0.06	45.0
Panel	42.12%	13.90	-3.0
Funnel	20.00%	6.60	-6.0
Fluorescent powder	0.03%	0.01	-170.0
Waste	6.75%	2.23	-4.1

Question: What is the revenue generated by recyclers from processing televisions and the cost of waste disposal?

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Solution:

a. Revenue generated by recyclers from processing televisions

Item	Total revenue (dollar/piece)
Iron	34.9
Copper	46.8
Plastic	58.2
IC board	28.6
Wire	2.5
Total	171

b. Cost of waste disposal

Item	Total cost (dollar/piece)
Panel	41.7
Funnel	39.6
Fluorescent powder	1.7
Waste	9.1
Total	92.1

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### (5) Exercise 5: Unit cost of recycling

**Question:** According to surveys, the purchase cost of a television is NT\$200/piece. Please summarize exercise 1-4 and calculate unit cost of recycling televisions.

**Solution:**

Item	Cost of collection (purchase) (dollar/piece)	Cost of processing and recycling (dollar/piece)				Revenue of recycling (dollar/piece)	Net cost of recycling (dollar/piece)
		Labor cost	Equipment cost	Management and marketing expenses	Cost of waste disposal		
Waste televisions	200.00	51.71	14.52	39.58	92.11	170.99	226.94

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### (6) Exercise 6: Suggested Fee rate for television recycling

**Question:** Based on Table 1 and conditions listed below, please calculate a suggested fee rate for television recycling.

Item	Waste televisions	
Unit cost of collection(C1)	200	
Unit cost of recycling (C2)	Unit direct labor cost	51.7
	Unit cost of equipment	14.5
	Unit cost of management and marketing	39.6
	Unit cost of waste disposal	92.1
	Total	197.9
Unit cost of collection and recycling ( C ) = (C1+C2)	397.9	
Certified quantities from processing RRW (g)	100,000	
Cost of recycling (D)=C*g	Please calculate	
Cost of Municipalities (T)	0	
Environmental External Cost (environ. effect) (E)	20,000,000	
Total cost of collection and recycling (H) =D+T+E	Please calculate	
Cost of auditing (L)	5,000,000	
Average unit profit for recycler (r)	170.9895	
Certified quantities from processing RRW (g)	100,000	
Total revenue generated by recyclers from processing RRW (V)=r*g	Please calculate	
Accumulated trust fund surplus (f)	50,000,000	
Amount set aside from surplus for future fund management (q)	60,000,000	
RRW life span (y)	10	
Trust fund surplus amendment (F)= (f-q)/y	Please calculate	
Quantities of new RRW products (S)	500,000	

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Item	Waste televisions
Fee rate calculation formula $M = (H + L - V - F) / S$	Please calculate fee rate

Solution:

Item	Waste televisions
Cost of recycling (D) = C * g	39,792,526
Total cost of collection and recycling (H) = D + T + E	59,792,526
Total revenue generated by recyclers from processing RRW (V) = r * g	17,098,950
Trust fund surplus amendment (F) = (f - q) / y	-1,000,000
Fee rate calculation formula $M = (H + L - V - F) / S$	97.39