

Composition of Solid Waste - Cost Effectiveness of Recycling





Example Problem - Plastic Recycling Efficiency

A community of **500,000** people generates **6** lbs per person per day of waste. Using Table 1, we see that plastic consists of **5.6%** of total disposed (collected) waste and that **20%** of total **generated** plastic is recycled. Plastic recycling is only profitable if **100,000** lb/day are collected.



Table 1. Distribution of Collected Items, Recycling Efficiency

Item	Collected Waste % by Weight	Recycling Efficiency % of Generated
Food Waste	11.6	0
Paper	26.2	30
Cardboard	13.3	5
Yard Waste	21	0
Rubber	5.7	0
Plastic	5.6	20
Metal	6.1	35
Miscellaneous	10.5	0
Total	100	NA





Problem Statement

- Determine the composition of the generated waste.
- Determine whether plastic recycling is profitable in this community.
- If not profitable now, how much more plastic would this community have to separately collect in order for recycling to be profitable?





Approach

The equation you would use to solve this problem is:

Generated waste = Recycled waste + Collected waste

or

$$G = R + C$$

It is recommended that you use an electronic spread sheet for this problem.





Approach – Cont'd

If we allow X to be the decimal recycling efficiency, then the amount recycled (R) equals the recycling efficiency times the generated amount (G). Then by simple algebra, the following can be stated.



Approach – Cont'd

$$G = R + C$$



$$G = (X * G) + C$$



$$G/G = (XG)/G + C/G$$



$$1 = X + C/G$$



$$1 - X = C/G$$



$$G = C / (1 - X)$$



Step 1: Calculate Generated Waste

- Let's assume that 100 lb of waste are collected for disposal.
- Use the equation $G = C/(1-X)$ to calculate the amount of generated waste from Table 1.
- 26.2 lb (out of 100 lb) of disposed waste is paper (we skip food waste because no food waste is recycled)



Step 1: Continued

- The recycling efficiency of paper is 30%, therefore the total amount of paper waste generated = $26.2 / (1 - 0.30) = 37.4$ pounds
- Use this same calculation for the remaining items to determine the total amount (in pounds) of generated solid waste

Table 2: Generated waste

Item	Collected Waste, lb	Recycling Efficiency, % of Generated	Generated Waste, lb
Food Waste	11.6	0	
Paper	26.2	30	37.4
Cardboard	13.3	5	
Yard Waste	21	0	
Rubber	5.7	0	
Plastic	5.6	20	
Metal	6.1	35	
Miscellaneous	10.5	0	
Total	100	NA	

Table 2: Generated waste

Item	Collected Waste, lb	Recycling Efficiency, % of Generated	Generated Waste, lb
Food Waste	11.6	0	11.6
Paper	26.2	30	37.4
Cardboard	13.3	5	14.0
Yard Waste	21	0	21.0
Rubber	5.7	0	5.7
Plastic	5.6	20	7.0
Metal	6.1	35	9.4
Miscellaneous	10.5	0	10.5
Total	100	NA	116.6



Summary

Table 2 shows that for every 100 lb of collected waste, there are 116.6 lb of generated waste, therefore 16.6 lb are recycled per 100 lb of collected waste.

We can now calculate the generated waste composition (% by weight) of the sample.





Step 2: Determine Percent Composition of Generated Waste

Divide each waste component's lb/100lb of disposed waste by the total amount of generated waste, for example for food waste:

$$\frac{11.6 \text{ lb food waste}/100 \text{ lb Disposed}}{116.6 \text{ lb Generated}/100 \text{ lb Disposed}} = 0.099 \text{ lb food waste}/\text{lb Generated}$$

Then multiply by 100



Table 3: Percent Generated Waste Composition

Item	Generated Waste lb	Recycled Waste, lb	Generated Waste % by weight
Food Waste	11.6	0	9.9
Paper	37.4	11.2	
Cardboard	14.0	0.7	
Yard Waste	21.0	0	
Rubber	5.7	0	
Plastic	7.0	1.4	
Metal	9.4	3.3	
Miscellaneous	10.5	0	
Total	116.6	16.6	100

Table 3: Percent Generated Waste Composition

Item	Generated Waste lb	Recycled Waste, lb	Generated Waste % by weight
Food Waste	11.6	0	9.9
Paper	37.4	11.2	32.1
Cardboard	14.0	0.7	12.0
Yard Waste	21.0	0	18.0
Rubber	5.7	0	4.9
Plastic	7.0	1.4	6.0
Metal	9.4	3.3	8.1
Miscellaneous	10.5	0	9.0
Total	116.6	16.6	100



Step 3: Determine the Amount of Recycled Plastic

- Total waste generated = 6 lbs/person/day
- Number of people = 500,000
- Total amount of waste generated = 3,000,000 lbs/day
- Amount of plastic waste generated = $3,000,000 * 0.06$
= 180,000 lb/day
- Amount recycled plastic = Recycling Efficiency*
daily generation
= $0.20 * 180,000$
= 36,000 lbs/day

Therefore, since 36,000 lb < 100,000 lb;
recycling plastics is not currently profitable.





Step 4: Determine the Profitable Recycling Efficiency

- Let us now find out what percentage of disposed plastic would need to be recycled in order for recycling of plastics to be profitable in this community.
- If plastic recycling is only profitable when 100,000 pounds per day are recycled, and we only produced 36,000 lb of recyclable plastic, then it is evident that plastic recycling is not profitable in this community.



Step 4: Cont'd

The total amount of plastic waste generated is:

**3,000,000 lb waste generated (6 lb
plastics/100 lb generated) = 180,000 lb**

Profitable plastic recycling divided
by the total plastic generated:

$$100,000/180,000 = 0.556$$

The necessary recycling
percentage would be:

$$(0.556) * 100 = 55.6 \%$$





Solution

The present recycling efficiency for plastic waste is 20% of the total amount of disposed waste. In order for plastic recycling to be profitable, we would need to increase the efficiency to 55.6 % of disposed plastic waste.





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