3 Putting the numbers together:

Tools of cost-benefit analysis

Recycling's head start to a better bottom line

Is recycling cost-effective? That core question has been asked and answered by both the pro-recycling and anti-recycling camps. Not surprisingly, they find widely different answers. The Cato Institute, for example, singled out New Jersey's statewide recycling efforts in 1994 as "an inexcusable waste of resources." The Environmental Defense Fund, on the other hand, offers a 14-point analysis documenting recycling's financial benefits.[1] This manual, and this chapter in particular, are not the latest entries into the crowded field of recycling critiques. They will not prove or disprove recycling's cost-effectiveness. Instead, this chapter will discuss useful tools and methods of cost-benefit analysis that can be applied to your program.

Recycling's cost-effectiveness depends on how recyclables, yard waste and garbage are collected and processed, and at what prices they are sold or disposed. It also depends on who is paying which bills in the solid waste management system. In fact, the cost-effectiveness of recycling depends on so many variables that it almost by definition needs to be analyzed individually for each program.

Prices may not measure all the right costs

In New Jersey, the law does not require recycling to be less expensive than garbage collection and disposal. Operating a recycling program that reduces the total cost of solid waste management is a goal to shoot for, but the New Jersey recycling law stands on the premise that recycling provides wider, longer-term environmental and economic benefits (externalities, as economists call them) than burning or burying garbage. And those added benefits may not be accurately reflected in today's costs and revenues.

At the core of this financial question, recycling usually starts with a hefty head start over garbage disposal. The head start is the tipping fee at the disposal site, plus any revenue received from selling the recyclables. You will always have to pay for disposal, and because New Jersey is the most densely populated state in the nation with high land and labor costs, New Jersey's fees will probably always be the highest in the nation. Even with a decline in garbage disposal fees and relatively weak prices for recyclables, that head start in New Jersey remains in the $50 per ton range, and more in some areas of the state.

Three ways to make the numbers work

The key to making the financial numbers work for recycling is three-fold.

1. Increase recycling's head start by finding additional savings created by the recycling program. The basic $50 per ton head start is based on disposal costs alone. Recycling programs should also reduce garbage collection costs, simply because there's less garbage to collect. Be prepared to answer this question: if the current recycling program were disbanded, how much would garbage *collection* costs increase? *Without that answer, it is hard to show that recycling can be cost-effective on disposal savings alone*.
2. Constantly look for ways to drive down recycling collection costs, so that the difference between garbage collection costs and recycling collection costs is in the $50 to $60 per ton range. That's challenging, but possible, especially if you are able to keep recycling collection costs under $100 per ton.
3. Make sure you are getting a fair price for recyclables. You may not be able to affect market prices, but you can definitely be a smart seller who achieves that delicate balance between assuring reliable markets in the long run and receiving competitive prices in the short run.

Doing the math

Why can't we just generalize about the cost-effectiveness of recycling? As a start, simply compare commercial sector recycling with a residential curbside program. Commercial programs often generate relatively large amounts of homogenous waste in a single spot (a factory, warehouse or office building, for instance), so they enjoy relatively low collection costs. On the other hand, most residential curbside programs face high collection costs because small amounts of diverse materials are collected from thousands of locations. Generalizing about the cost-effectiveness of these two programs is a challenge at best and meaningless at worst.

The managers of both programs, however, can use the same tools to find the specific answers for each situation. Those tools include break-even levels, payback periods and total cost comparisons. Managers can use these tools to analyze their overall programs, or specific program changes they are considering.

Break-even levels

This is defined as the point, or level of operation, where the total cost of a recycling project (or an entire recycling program) equals the money saved in total garbage collection, transfer and disposal costs. Mathematically, the break-even point for a project normally looks like this:

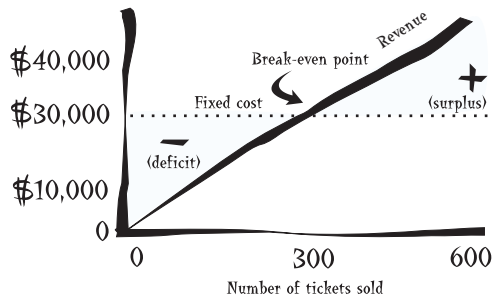
$$\text{Break even} = \frac{\text{Fixed costs}}{\text{Revenue per item} - \text{Variable cost per item}}$$

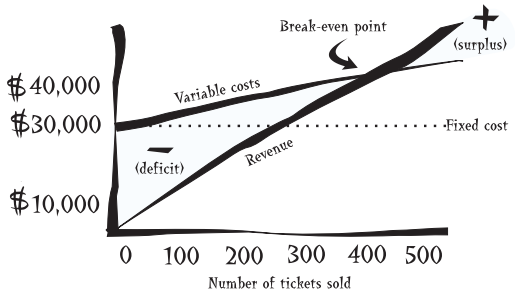
For example, in the fundraising example outlined on page 27 in *The weird world of costs* section of Chapter 2, a recycling committee embarked on a concert with fixed costs of $30,000. They were selling tickets at $100 each. If they had no other costs per person, the break-even level would be:

$$\text{Break even} = \frac{\$30{,}000}{\$100 \text{ per person} - \$0 \text{ cost per person}} = \frac{\$30{,}000}{\$100} = \text{sell } 300 \text{ to break even}$$

If, however, the $100 ticket includes a meal priced at $25 per person (the variable cost), the break-even level for the fundraiser rises to 400.

$$\text{Break even} = \frac{\$30{,}000}{\$100 \text{ per person} - \$25 \text{ cost per person}} = \frac{\$30{,}000}{\$75} = \text{sell } 400 \text{ to break even}$$





Avoided costs as "revenue"

Recycling programs put a unique spin on this classic management calculation. With recycling, the main "revenue" often is the per-ton tipping fee saved at garbage disposal facilities by diverting recyclables out of the garbage can. This break-even calculation works well for programs that contract out collection services at a fixed price. For example, consider a program with a fixed recycling collection contract of $120,000 per year. This program pays a $60-per-ton tipping fee and sells its materials to a private materials recovery facility (MRF) at an average of $5 per ton.

The combination of the $60 tipping fee and $5 in sales revenue is the per ton "head start" for recycling. If you are "saving" $65 for each ton of recyclables, at some number of tons $65 will equal the $120,000 you invested to collect them. That is the break-even point.

Here is how the break-even level translates for a recycling program with a fixed collection contract.

$$\text{Break even level of recycling} = \frac{\text{Fixed costs}}{\text{Revenue per item} - \text{Cost per item}}$$

Which becomes:

$$\text{BREAK EVEN} = \frac{\text{Cost of recycling}}{\text{Avoided cost per ton} \pm \text{Revenue per ton}} = \frac{\$120{,}000}{\$60 + \$5} = \frac{\$120{,}000}{\$65} = 1{,}846 \text{ tons}$$

In this case, the recycling program will reduce the total cost of solid waste management if more than 1,846 tons are collected, and it will increase the total cost of solid waste management if less than 1,846 tons are collected.

Of course, this number has some serious flaws.

- This scenario assumes that none of the recycling tonnage will be disposed of as residue. If the average market price of $5 includes that residue, the assumption is accurate. If the MRF penalizes the program for each ton of residue, the number to work with is the net recycling tonnage after processing. This example also assumes the MRF is privately run. If it is publicly owned and subsidized, the per-ton subsidy needs to be included to calculate a true break-even number.
- This scenario also assumes a fixed collection contract, so collection costs do not increase as recycling levels increase. Many communities operate programs with these kinds of contracts, but that collection price may be fixed in the short run only – until the contract comes up for renewal, for instance. In the long run, costs should be expected to rise as recycling tonnage increases, making the break-even level higher.

- The scenario ignores a third factor, and unlike the first two, this one understates an important advantage for recycling. This break-even problem assumes savings only from garbage disposal costs. Garbage collection costs remain unchanged in this scenario. This is true for many communities, especially where residents contract with haulers directly for garbage collection and disposal. In these communities, residents' garbage bills do not decline as recycling increases. However, as recycling increases, there should be some savings in garbage collection, simply because there is less garbage to collect. That's why an integrated solid waste management system should translate increased recycling into reduced garbage collection costs. If it does not, it's harder to make recycling reach break-even.

Payback periods

Break-even levels tell **how many** units (tons, tickets, households or whatever is being measured) are needed to recover an investment. A payback period tells you **how soon** you will recover it. It is particularly valuable for projects that require an up-front investment of fixed costs and a "stream" of revenue or benefits that will flow over several years.

Backyard composting often produces just that scenario. A program may require investment in promotion and education to attract converts and instruct them in composting. The payback comes over several years as residents divert food and yard waste from the garbage can to the compost pile.

Savings come in two ways: reduced garbage disposal costs and reduced garbage collection costs. The first is easy and obvious: disposal fees are reduced for every ton diverted to the compost pile. For each household each week, the disposal savings from composting food waste may look almost laughably small. An average household might produce three to five pounds per week of compostable food. Using the conservative figure of three pounds and a $60 per ton disposal fee, that translates to less than 10 cents per week in avoided disposal costs. Over the year, however, it totals almost $5 in savings per household. The savings don't end there, of course. Next year, another $5 is saved and then another. As long as that household composts, $5 is saved every year.

Let's say you partner with schools and civic organizations to present composting training sessions. Your partners advertise the class and provide the facilities. You provide the materials and instruction, and estimate it costs about $90 to present a two-hour composting training workshop for 24 people. Based on past workshop results, you can expect to convert about 30% of the class into active, reliable food waste composters. In a workshop with 24 participants,

that's seven new composters. What's the payback period on the composting education project? If each composting household saves $5 per year, that's $35 in the first year ($5 x 7) from one workshop.

$$\frac{\text{Up front investments}}{\text{Savings per year}} = \text{Payback period}$$

$$\frac{\$90}{35} = 2.5 \text{ years}$$

Including the cost of money

The composting education project example is simplified in two important ways. First, by partnering with a civic group or school to promote and host the workshops, the up-front cost is dramatically reduced. Piggybacking onto another organization's promotional efforts eliminates an important cost from the workshop budget. That's not unrealistic; it's simply one design for a low-cost educational program.

Second, this payback period example ignores the time value of money, which is discussed in the *Weird world of costs* section of Chapter 2. To be accurate, a payback period calculation should recognize that any dollar saved next year, or in any future year, is less valuable than a dollar spent today. Money spent today or money received in the future cannot earn interest for you now. When interest rates are relatively low and payback periods are short (say 6% interest over a three-year period), ignoring the time value of money may be inaccurate, but often not catastrophic. At 6% interest, the value **today** of receiving $5 per year for three years is $14.16. When interest rates hit 20% during the high inflation days of 1979-80, the "cost of money" was one of the most critical variables in any cost-benefit analysis.

The composting example has a payback period of less than three years. That's attractive by most financial yardsticks. Also note that this example ignores any cost savings from reduced garbage collection costs, expected to be small, but real. (They may be less than 1% if we're talking about only food waste and a 30% participation rate.) The numbers look even better when both yard waste and food waste are considered.

Comparing the total cost of solid waste management with and without recycling

This is the acid test. Comparing the total cost of solid waste management with and without recycling side-by-side provides a good estimate of the net cost or savings of a recycling program – measured in today's dollars only. It's critical to note again that this cost-benefit calculation is based solely on current costs and current markets. It does not include the wide range of potential social and environmental costs of landfilling or incineration, or the job-creating benefits of recycling compared to garbage disposal. In New Jersey, public policy explicitly prefers recycling for these reasons, even if it increases the total cost of solid waste management in today's markets. Even given that preference, however, we can still aim to design a recycling program that does reduce the total cost of solid waste management. This total cost comparison is a good place to start.

This calculation is relatively straightforward. Compile all the costs incurred and revenues generated by garbage and recycling programs. For a worksheet of costs to be included in the analysis, *Appendix E* can serve as a useful guide. Then compare those costs with the ones that would be incurred if recycling were discontinued and all solid waste were disposed of as garbage.

The cost of more garbage in the can

The numbers get tricky mainly in the collection costs. The core question becomes: how much will garbage collection costs increase if all households suddenly throw out 20% to 35% more garbage every week because they are no

Costs without a change in collection frequency

	SWM costs without recycling	SWM costs with recycling
Garbage collection	$357,000	$321,300
Garbage transfer & disposal @ $60/ton	$683,640	$566,400
Recycling collection	$185,250	
Sales of recyclables	$0	$0
Total cost of SWM	$1,040,640	$1,072,950
Net cost of recycling program		**$32,310**

Note: This SWM scenario with recycling assumes that 9,440 tons of waste are disposed of as garbage at $60 per ton and 1,950 tons are recycled at a private MRF, which accepts the recyclables at no fee. Under this scenario, the net cost of recycling would drop to zero if this program received an average of $16.56 per ton for its recyclables.

longer recycling? No doubt, costs will rise. Collection crews will be lifting more and heavier cans at each stop. Trucks will be making more round trips to the transfer station or disposal facility.

But how much will costs rise? This is a classic marginal cost question, and it's an important reason to understand the nature of marginal costs, which are discussed in *The weird world of costs* in Chapter 2. The answer depends on your collection system and its cost structure, and on the demographics of your community.

But here's a pretty safe prediction: a 25% increase in the amount of garbage set out will not cause a 25% increase in collection costs. Why not? Fixed costs. Fixed costs don't change with volume of collection. (This issue is discussed further in *The paradox of marginal costs* in Chapter 2.) For example, a supervisor's salary does not increase if a community's garbage cans suddenly contain more waste. Costs for administrative offices, maintenance facilities, billing and collection system, payroll department, computer support, telephones – these don't change easily with volume.

One analysis done by the consulting firm Ecodata Inc. using New Jersey labor costs, projects that a 25% increase in the weight of garbage set out per household will cause a 14% increase in garbage collection costs. In some scenarios, the increase might be almost imperceptible. Pick-up time at the curb may not change at all, particularly if an automated collection system is in place, where a mechanical arm can lift a 60-pound garbage can just as quickly as it lifts a 45-pound one. In this case, with no extra time expended at the curb, the

Costs with a change in collection frequency

	SWM costs without recycling	SWM costs with recycling	
Garbage collection	$357,000	$249,900	
Garbage transfer & disposal @ $60/ton	$683,640	$566,400	
Recycling collection	$185,250		
Sales of recyclables	$0	$0	
Total cost of SWM	$1,040,640	$1,001,550	
Net savings with recycling program			**$39,090**

Note: This SWM scenario with recycling assumes that 9,440 tons of waste are disposed of as garbage and 1,950 tons are recycled. A private MRF accepts the recyclables at no fee. In this case, reducing the frequency of garbage collection from twice per week to once per week reduced garbage collection costs by 30%. Under this scenario, recycling remains cost-effective even if the program must pay $20 per ton on average to "sell" its recyclables to the MRF.

only cost increase may come from filling up the garbage truck more quickly. These seemingly small issues can ultimately determine the net cost or savings of recycling.

The best way to compare solid waste management costs with and without recycling is to actually do it side-by-side, as shown in *Costs without a change in collection frequency* and *Costs with a change in collection frequency.*

When garbage disposal fees approach $100 per ton, many recycling programs can actually reduce the total cost of solid waste management, even if they receive no revenue for their recyclables. In these cases, the $100-per-ton disposal savings exceed the additional, or marginal, costs of recycling collection. With garbage disposal fees closer to $50, disposal savings alone are not usually big enough to cover the cost of recycling collection, which can easily exceed $100 per ton in New Jersey.

Garbage collection is the natural place to look for additional savings, and reducing the frequency of garbage collection is one strategy to capture those savings. Reducing the frequency of collection, even without reducing the amount set out, can save about 30% in collection costs for some programs.[2] And recycling's success creates the rationale for reducing the frequency of garbage collection. Garbage justifiably can be collected less frequently because strong recycling and waste reduction can reduce the weight of household garbage by as much as 25% to 35%. Unless recycling prices head far into the negative, a cost-efficient recycling program (collection costs near or under $100 per ton), combined with a reduction in garbage collection from twice per week to once per week, should reduce total solid waste management costs.

Financial sense may not mean political popularity

The system outlined above makes good financial sense. This recycling program has reduced both garbage collection and disposal costs, so it succeeds in reducing the total cost of solid waste management. It would still reduce costs if the community were forced to pay $20 per ton to "sell" its recyclables.

Don't confuse good financial sense with political popularity, however. This system may never make it from a spreadsheet to Main Street because residents, or their elected officials, may not accept reduced garbage service in the name of economic efficiency. That's fine. In fact, it's good. That's what democracies do; they let people choose. Recycling coordinators and solid waste managers have the responsibility of identifying the least cost options that meet New Jersey's environmental objectives. If residents, or their elected representatives, choose a higher-cost path because they want a higher level of service, that's their right. However, they can make better decisions with better information. They may never know a lesser-cost option exists unless you find it first. Designing a system that incorporates recycling and reduces overall costs is the kind of win-win scenario that may carry the day.

Designing a system for financial success

In the examples *Costs without a change in collection frequency* and *Costs with a change in collection frequency*, communities reduced their garbage disposal costs every time a ton of material was recycled. In New Jersey, that is no guarantee. In fact, New Jersey doesn't really have one solid waste management system. Solid waste collection methods often change once a municipal border is crossed, complicating an already confusing financial story.

Take the fairly common case of a community where the municipality or county operates the recycling program and residents contract directly with haulers for solid waste collection and disposal. Then try doing the simple side-by-side comparison of total solid waste management costs in these communities. Suppose that, for a decade, residents in these communities have watched their taxes pay for a publicly-funded recycling program, but most have seen no decrease in the fees they pay to their garbage haulers. In these communities, there is no direct mechanism for recovering garbage collection or disposal costs. To residents, recycling may simply appear as an additional cost to the system that generates no identifiable financial benefit. To the consumer, the side-by-side comparison of solid waste management costs may look something like *Residents contract directly with haulers*.

Residents contract directly with haulers

	SWM costs without recycling	SWM costs with recycling
Garbage collection and disposal cost per household @ $25/month	$300 per year	$300 per year
Per household recycling costs less sale of recyclables (paid through tax bill)	$0	$25 per year
Total cost of SWM	$300 per year	$325 per year
Net cost of recycling program per year		**$25 per household**

In a world of perfect competition, recycling should reduce residents' garbage bills in the long run. If a publicly-funded recycling program indeed does reduce a hauler's collection and disposal costs, and that hauler does not pass the savings on to the consumer, a competitor can easily underbid that firm. That's how competition is supposed to drive prices down.

However, there is no time limit on when the "long run" will actually kick in with savings for consumers. The next section of this chapter outlines strategies to consider.

Strategies for recovering avoided costs

The only sure way to recover avoided costs is to first know where to find them. That means fully understanding marginal costs and how they change for different program options. For example, will reduced garbage set-outs allow you to run fewer garbage collection routes? If so, will equipment sit idle after the changes, and what is the cost of allowing it to sit idle? Could dumpster sizes and collection routes be reduced more easily if you contract for garbage and recycling collection?

Identifying garbage collection savings is crucial to making recycling cost-effective, but those savings are frequently difficult to identify. It requires knowing which costs are fixed and variable, and which are controllable over the time period you are analyzing. That's why every important cost decision should be examined through the lens of marginal costs.

Here are some suggestions for recovering avoided costs.

1. Use collection-only contracts

Rather than contracting for garbage collection and disposal, contract for the collection portion only. If you are paying the tipping fee, you capture the savings each time you divert a ton away from disposal. If the hauler pays the tipping fee, how are you capturing the savings from your recycling investment?

Collection-only contracts also reduce bonding costs for your contract. Performance bonds (discussed in Chapter 5) are insurance policies. Contractors buy them to ensure services will be provided even if the contractor is unable to perform required duties. The cost of these insurance policies is tied to the total cost of the contract, so excluding disposal fees reduces the cost of the performance bond.

2. Evaluate contractor rebates

The garbage hauler pays a specified amount for each ton of material a community recycles, so the more a program recycles, the more it receives. The rebate reflects the fact that garbage haulers' collection costs should be reduced whenever a recycling program diverts material from the garbage can to the recycling bin. This is especially applicable in communities where tax dollars pay for recycling education and collection (a county program, for example) and a private hauler has a multi-year contract with a municipality to collect garbage. In these cases,

the success of the publicly funded recycling program (when a new material is added to the program, or through an extensive home-composting educational campaign, for example) helps reduce garbage collection costs. The rebate seeks to recover some of those savings.

Be careful with rebates, however. In reality, you should expect this provision to increase the base price of contractors' bids. Why? Contractors will add these rebates to the core cost of service, so the total price of their bids should rise. The net cost or savings of the rebates, then, truly will depend on the success of the recycling program.

3. Consider Pay-As-You-Throw pricing

The EPA reports that as many as 4,000 communities around the country use some form of Pay-As-You-Throw (PAYT). Residents pay a direct charge for each bag or can of garbage they set out. This system rewards the individual rather than the community as a whole for waste prevention and recycling. PAYT pricing has proven popular in many areas because it gives customers the power to reduce their garbage bill. It sends a direct dollar signal to the consumer: generating more garbage costs more money. Because the same dollar signal that encourages source reduction and recycling also can encourage illegal dumping, successful PAYT programs usually include a credible enforcement program.

PAYT may not work in all communities; it is especially difficult to implement in large multi-family units, for example. However, it has been an economic and environmental success story in rural, suburban and urban settings. New Jersey has more than 40 municipalities with some form of PAYT pricing. The USEPA maintains a toll-free hotline (1-888-EPA-PAYT) and website (www.epa.gov/payt) that provide a wealth of valuable technical assistance for anyone considering PAYT.[3]

4. Encourage competition, cooperation and negotiation

Unusually high profits should attract competition, which should increase the number of service providers and drive prices downward. But how competitive is the market, and can you encourage more competition? Contractors facing little or no competition may not work as hard to find savings for you.

If you are contracting for garbage or recycling collection, follow the recommendations in Chapter 5 to ensure your bid specifications are clear, complete and supported with the information contractors need to submit accurate bids, and give them at least a month to prepare. Overly complicated bid specifications will discourage new bidders, as will excessive insurance requirements and punitive damage provisions. Also, consider coordinating collection bids with neighboring towns to create a larger, contiguous service area that may be big enough to attract new, hungry bidders.

5. Work with your current vendors to identify cost savings

A vendor's front-line collection workers may know more about route inefficiencies than any consultant might find. Remember, lower prices need not mean lower profits for vendors if you provide an incentive for vendors to reduce costs.

6. Go for easy weight first

New Jersey has mandated recycling for more than a decade, and some of the state's mature programs are facing a new challenge. As manufacturers reduce the weight of packaging (called "light weighting") and plastic containers continue to replace glass and aluminum, some programs are starting to see recycling tonnages decline. With many fixed recycling costs in place, this translates to higher per-ton recycling collection and processing costs.

To reach the state's ambitious recycling goals and reduce average costs, the best counter strategy to light weighting may be to re-examine the waste each household produces. Where are the biggest opportunities today to reduce garbage tonnage and increase recycling? For most mature programs with high participation among the basic recycling commodities, that answer may be in yard waste, food waste and mixed paper. Although percentages will vary for different communities, paper, cardboard, yard waste and food can exceed 50% of the average household's weight. With the demographic shift toward home-based offices, mixed paper may grow as a percentage of the waste stream, adding material that will counter the trend toward light weighting.

Notes: