A Case Study on Internalized vs. Externalized Costs & Benefits for Solid Waste Management Methods: Residential Curbside Recycling in Washington State

Part 2

by

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May's *UnEconomist* offered Part 1 of a Washington state case study on the costs versus benefits of curbside recycling. The purpose of that study was to estimate a monetary value for some external environmental impacts of recycling versus landfilling, and then compare those impacts against curbside recycling's internalized costs. Part 1 detailed dollar estimates for externalized environmental impacts.[1]

Part 2 of the case study included herein compares the monetary value of those external impacts against internal costs. Furthermore, Part 2 extends the analysis of impacts from avoided landfill disposal to consider avoided disposal in a waste-to-energy (WTE) incineration facility. Finally, Part 2 provides separate estimates for the monetary value of external environmental impacts from recycling for each of eight recyclable materials -- mixed paper, newspaper, cardboard, glass containers, tin cans, aluminum cans, PET (polyethylene terephthalate) bottles and HDPE (high density polyethylene) bottles.

Estimated Internalized Costs for Curbside Recycling versus Landfill Disposal

Figure 1, Internalized Costs of Recycling & Avoided Landfill Disposal Tipping Fees, shows average internalized costs per month for curbside recycling collection, processing and shipping, including the offset for revenues obtained from selling the collected recyclables after they have been processed to specifications of recycled-content product manufacturers. Cost figures represent monthly amounts per curbside available household. These average costs are based on data gathered from cities, counties, and Washington Utility & Transportation Commission (WUTC) files on customer fees for subscription-based curbside recycling, and on costs for recycling in communities that have curbside recycling bundled into their garbage collection fees.[2]

As shown by Figure 1, average costs for curbside recycling are different in the four regions of Washington state, varying from a high of $2.78 per month in the urban west to a low of $1.66 per household in the rural east. Costs per household are the result of a complex interaction among quantity of materials collected from each household, travel time and distance on the collection route between households, shipping costs to market processed recyclables, and the composition of materials collected. Composition determines average market value for materials picked up at each household. Amount recycled per household is one of the strongest drivers of collection and processing costs for each household.

It should be noted that these curbside recycling cost estimates are based on a subset of the

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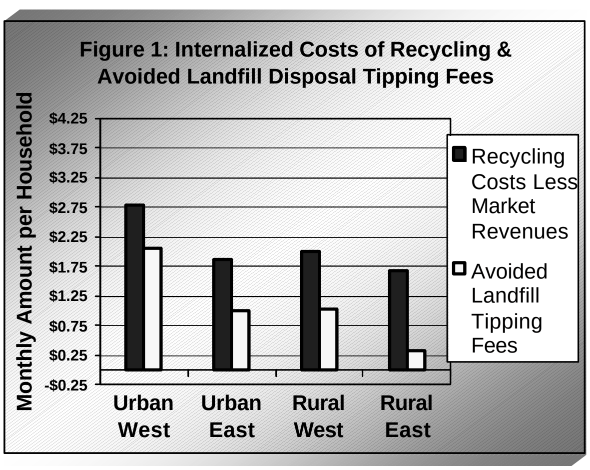
[1] The interested reader should refer to the January and April 2001 issues of *The Monthly UnEconomist* for definition and discussion of "internalized" and "externalized" costs.

[2] Bundling (or embedding) is when the garbage collection service customer gets curbside recycling at no additional charge. This situation is sometimes described as being an "all pay" or "everybody pays" program, because all garbage collection service subscribers pay for curbside recycling whether they choose to use it or not.

households for which SRMG gathered quantity and composition data. In the urban west region, costs for recycling are based on about 407,000 households, or 66% of the households on which SRMG gathered quantity recycled data. Corresponding figures for the other three regions are 104,000 or 97%, 48,500 or 73%, and 1,000 or 22%, of households in the urban east, rural west and rural east, respectively.

Figure 1 also shows landfill tipping fees that are avoided when materials are recycled. SRMG calculated monthly tipping fee savings per household based on quantities recycled in each curbside program and the associated tipping fee savings. A Washington State Department of Ecology (Ecology) draft study on average tipping fees for municipal solid waste disposal in each county in the state provided the data for calculating avoided tipping fees.[3]



Amount recycled each month is the main driver of landfill tipping fees, as illustrated in Figure 1 by regions with higher amounts recycled having higher avoided disposal fees.[4] In addition, the rural east region has a much lower average tipping fee, estimated at $32 per ton, than the other three regions where tipping fees average in the $70 to $80 range.

Summary of Results on Internalized Costs and Some Externalized Benefits of Curbside Recycling over Landfill Disposal

Figure 2, Internalized Net Costs vs. Some Low/High Externalized Net Benefits of Recycling over Landfilling, summarizes our case study results for curbside recycling versus landfilling.[5] Figure 1 compares internal net costs against external net benefits of curbside recycling over landfilling in each of the four regions. The internalized net cost for curbside recycling shown in Figure 2 was calculated by subtracting the avoided landfill tipping fee shown in Figure 1 from the internal recycling cost (collection plus processing plus shipping costs minus market revenues) for each region. The result of this subtraction is portrayed by the left most, diagonally shaded bar for each region in Figure 2.

Due to time and budget constraints, no internal costs for curbside garbage collection, transfer and hauling were gathered for this case study. For this reason SRMG assumed that avoided garbage collection, transfer and hauling costs amount to zero when material is collected in the recycling truck instead of the garbage truck. The left most bars for each region in Figure 2, thus, include a credit to recycling only for avoided landfill tipping fees; no credit is shown for avoided garbage collection and hauling system costs.

As indicated in Figure 2, internalized net costs for curbside recycling vary from a low of $0.73 per month for the urban west to a high of $1.35 per household for the rural east. The reasons for this variation were covered in the previous section's discussion regarding amount of

[3] Ecology staff provided the "tipfees4" Excel spreadsheet prepared for the draft study on the statewide median solid waste tipping fee. That spreadsheet listed an estimated average tip fee for solid waste disposal for each county in Washington state.

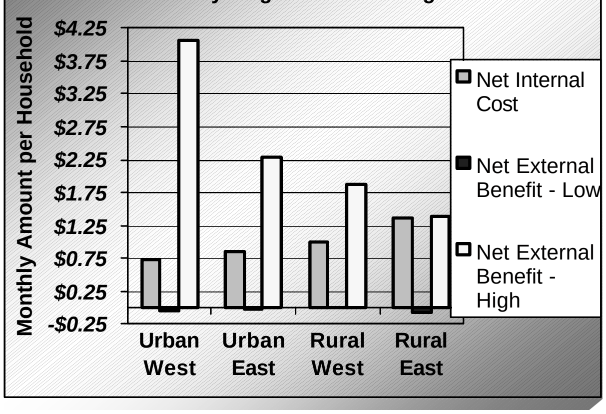
[4] Figure 2 in Part 1 of this study in May's *UnEconomist* illustrates average pounds recycled per household for each region.

[5] As noted in Part 1, the words "some of" or "some" are often used to modify phrases and words such as "externalized costs" in this report. This is an attempt to indicate that this case study is evaluating only the costs of public health and global warming impacts from releases of only 27 pollutants. This is just a small subset of the impacts that should be evaluated in a comprehensive analysis on the sustainability of solid waste management methods.

materials collected, travel time and distance between successive stops on the curbside collection route, and tipping fees in the four regions.

Part 1 of this study in May's *UnEconomist* reported externalized net benefits of curbside recycling over landfill disposal based on high-end cost estimates for public health and global warming impacts from emissions of 10 air and 17 water pollutants. These estimates are repeated in Figure 2 and show that net external benefits exceed net internal costs for recycling versus landfilling in all four regions.

Figure 2: Internalized Net Costs vs. Some Low/High Externalized Net Benefits of Recycling over Landfilling



Only in the rural east does the net internal cost of curbside recycling even approach recycling's high-end net environmental benefit. In the rural east the average monthly amount recycled per household is only 19 pounds, and landfill tipping fees average only $32 per ton, compared with tipping fees averaging between $70 and $80 in the other three regions.

At low-end estimates for the external costs of emissions of the 27 pollutants, curbside recycling has small negative net external benefits. This is mainly because at low-end external costs for pollution, the environmental impacts of curbside recycling's collection and shipping operations outweigh the environmental impacts of additional garbage collection and hauling that would be incurred in the absence of recycling.[6] Furthermore, in the case of low-end environmental costs there are no significant upstream environmental benefits for recycling and no significant environmental costs of landfilling to be avoided, at least as far as the 27 pollutants included in our case study are concerned.

Results for Curbside Recycling vs. WTE Disposal

According to EPA's 1998 study on greenhouse gas emissions from management of solid waste, carbon sequestration "reduces greenhouse gas concentrations by removing carbon dioxide from the atmosphere. Forests are one mechanism for sequestering carbon; if more wood is grown than is removed (through harvest or decay), the amount of carbon stored in trees increases, and thus carbon is sequestered … recycling of paper products, for example, reduce(s) energy consumption, decrease(s) combustion and landfill emissions, and increase(s) forest carbon sequestration."[7]

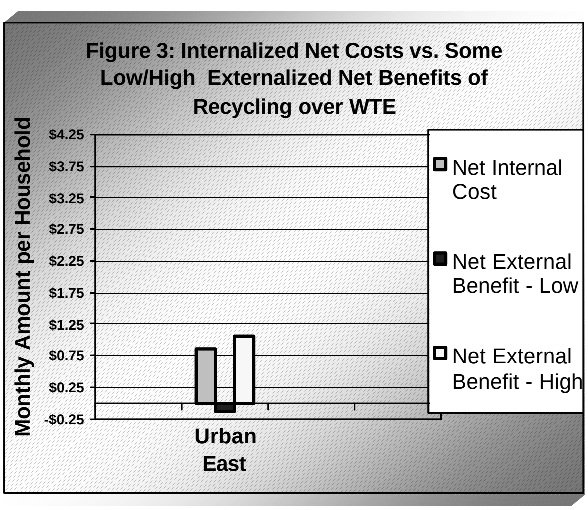
The solid waste decision support tool (DST) model[8] employed to calculate emissions for the 27 pollutants addressed in our case study accounts for fossil fuel carbon dioxide emission reductions when recycled-content products replace virgin-content products as a result of recycling, or when fossil fuel energy generation is reduced by incineration of waste materials in a WTE facility. However, the model does not account for increased carbon sequestration in forests when paper and cardboard are recycled. This appears to be a significant shortcoming of the model, especially for comparisons of recycling with WTE incineration.

To account for increases in carbon sequestration in forests when paper and/or cardboard are recycled, SRMG used EPA's spreadsheet

[6] The reader should recall our assumption given in Part 1 of this report that only 25% of the external costs of garbage collection and transfer are avoided by recycling.
[7] U.S. Environmental Protection Agency, *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, September 1998, p. ES-4.
[8] See Part 1 of this report for a description of this model.

model for calculating greenhouse gas impacts of waste management options to add estimates of carbon sequestration to the greenhouse gas emissions data generated by the DST model.

Other than the addition of estimates for carbon sequestration and the addition of offsets to recycling for WTE energy generation that is lost when materials are recycled, the concept for Figure 3, Internalized Net Costs vs. Some Low/High Externalized Benefits of Recycling over WTE, is the same as for Figure 2. That is, the left most bar shows recycling's net internal cost in the urban east at $0.85 per month for each household, the same figure shown for the urban east in Figure 2.[9] Similarly, the right side graphical bars for externalized net benefits summarize the low- and high-end values for externalized benefits of recycling from avoided garbage collection, transfer and hauling and from upstream avoidance of virgin materials use. These environmental benefits are offset in the summary figures by environmental impacts from recycling collection, processing and shipping operations.



In addition, in the case of WTE disposal one needs to take into account an additional offset to recycling's benefits. This offset is to reflect the loss of energy generation when materials are recycled rather than being incinerated to generate energy. Whereas in Figure 2 avoided environmental impacts of landfill disposal were a benefit for recycling, in Figure 3 lost energy generation is an offset to recycling's benefits. This is because with respect to the 27 pollutants tracked in our case study, releases of the 27 pollutants from WTE incineration are not as great as the emissions of those 27 pollutants from conventional energy generation facilities that are avoided when recyclables are incinerated in a WTE disposal facility to generate energy.

Figure 3 compares curbside recycling with WTE incineration for the 90% of waste disposal in the urban east region that is managed at Spokane's WTE facility. As indicated in Figure 3, at high-end costs for public health and global warming impacts of pollutants, curbside recycling's monthly internalized net costs of $0.85 per household are more than offset by recycling's externalized net benefits of $1.06, even after taking into account the energy not being generated in the WTE facility when materials are recycled.

At low-end externalized costs, curbside recycling has negative externalized benefits due to lost energy generation at Spokane's WTE facility and to the extremely low valuation on carbon dioxide emissions. At the low-end cost of $0.0002 per pound for the global warming impacts of carbon dioxide emissions, carbon sequestration in forests from paper recycling is almost valueless.[10,11]

[9] Ecology's study on average tipping fees in each county did not distinguish between disposal in a landfill and disposal at a WTE incineration facility. Thus, the avoided costs of disposal in Spokane County are the same for landfilling and WTE incineration.

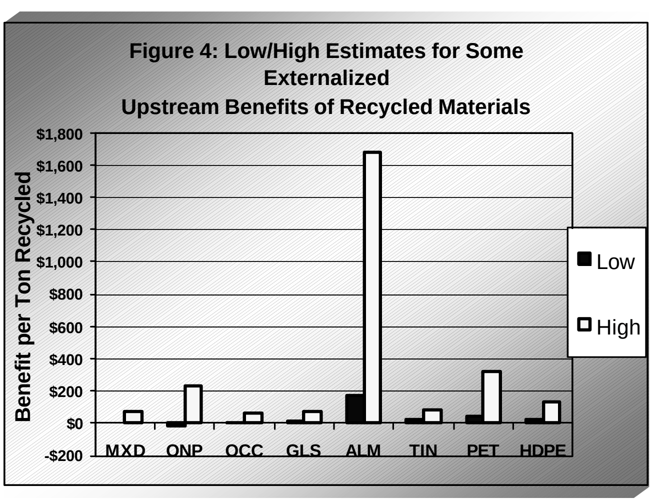
[10] The $0.0002 per pound cost for carbon dioxide emissions is based on a trading price early in 2001 on nascent markets for voluntary trading in carbon dioxide emissions credits.

[11] The reader is cautioned to review the Limitations on Conclusions and Case Study Results for Energy Used by Curbside Recycling vs. Upstream Energy Conserved by Recycling sections in Part 1 of this report before making any conclusions based on low-end environmental costs for pollution releases.

Case Study Results for Each Type of Recycled Material

As a final aspect of our case study on costs and benefits for curbside recycling, SRMG also examined external benefits from recycling eight different materials -- mixed paper, newspapers, cardboard, glass containers, tin-plated steel cans, aluminum cans, PET bottles, and HDPE bottles. This analysis was confined to upstream benefits, both because it is extremely difficult to allocate collection and processing system impacts to specific types of materials, and because RTI had neither time nor budget to use the DST model for this purpose.

Figure 4, Low/High Estimates for Some Externalized Upstream Benefits of Recycled Materials, shows the dollar value for estimated public health and global warming benefits from reduced emissions of 10 air and 17 water pollutants as a result of recycling eight different materials. In order to include the climate change benefits of carbon sequestration in forests due to paper recycling, SRMG employed EPA's global warming model to augment the carbon dioxide and methane greenhouse gases emissions data generated by the DST model.



At high-end estimates for public health and global warming costs of pollutants, external benefits of recycling the various materials range from a low of $65 per ton for cardboard up to $1,684 per ton for aluminum cans. At low-end environmental costs, newspapers have a negative external benefit, mixed paper has zero benefit, and cardboard has only a $3 per ton positive external benefit. Non-paper-fiber materials have higher benefits, ranging from $18 per ton for glass containers up to $175 for aluminum.

The low values for paper reflect increased waterborne emissions of suspended solids and higher biological oxygen demand (BOD) for recycled-content versus virgin-content paper production, especially for mechanical pulp based paper products such as newspapers. Mechanically pulped paper generates a significantly greater amount of short fibers during hydra pulping and deinking. These short fibers have a greater tendency to be released in the wastewater effluent from a recycled paper mill.

The low-end values for paper may also reflect the fact the fact that costs for suspended solids and BOD are the same in both low-end and high-end valuations for environmental costs. This is due to having an estimate of costs for these pollutants in only one of the four studies that were used to determine the cost range for pollutant releases used in this case study.

The relative lack of data on environmental costs for waterborne pollutants compared with atmospheric pollutants is indicative of the need for further research. Further research also is needed on the environmental impacts of using mixed paper in manufacturing, and perhaps as well for other types of recycled paper. The DST model assumed that all mixed paper was recycled into magazines and or paper products used in junk mail. By contrast, it is increasingly common for mixed paper to be used in the manufacture of newsprint.

Concluding Comment

Our report on this case study of the internal and external costs and benefits for curbside recycling has hopefully illuminated the need to consider a broader range of costs when evaluating solid waste management choices. The traditional internalized costs of waste management systems reflect only part of the impacts caused by our choices for managing solid wastes. Although it is difficult to get precise estimates for the monetary costs of external impacts, we believe that the effort is critical to choosing more sustainable practices for handling solid wastes.

At a minimum state and local solid waste planning activities should catalog the impacts of current practices on pollutant and greenhouse gas emissions and energy usage. Different stakeholders may have different ideas about how much they would be willing to spend to reduce emissions or energy usage. But at least everyone should be aware of the impacts that different choices have on emissions and energy consumption, so that here and now cash costs are not the only criteria used to make choices whose impacts ripple out across the globe and over time.

About The Monthly UnEconomist

This monthly online newsletter available at www.ZeroWaste.com (or www.SoundResource.com) intends to provide insight and analysis on the everyday economics of recycling and the unpriced or underpriced environmental benefits of reducing waste disposal and replacing virgin-content products with products manufactured from recycled materials. In addition to *The Monthly UnEconomist*, Sound Resource Management's website ZeroWaste.com also offers recycling markets price history graphs, reports on a variety of topics including the economic and environmental benefits of recycling, and GarboMetrics - elegant, yet not mysterious, tools and spreadsheet models for solid waste and recycling.

These materials are all available for no charge at www.ZeroWaste.com. User feedback is encouraged via info@ZeroWaste.com, and substantive comments will be published in our newsletter whenever they add to our understanding of recycling.

As an example of newsletter content, some issues of the *UnEconomist* analyze northwestern and northeastern U.S recycling market prices for nine recycled materials (mixed paper, ONP, OCC, glass containers, tin cans, UBC, PET bottles, HDPE natural bottles, and HDPE colored bottles). These prices are tracked by online graphs updated quarterly.

In addition, some issues of the *UnEconomist* are devoted to GarboMetrics, economic models for managing and analyzing solid waste and recycling. These newsletter issues explain the structure and use of GarboMetric models provided at ZeroWaste.com for such purposes as designing garbage customer rate structures and correctly comparing garbage rates in different communities. GarboMetric models and corresponding issues of *The Monthly UnEconomist* can be downloaded at no charge from www.ZeroWaste.com.