The Monthly UnEconomist

Zero Waste Economics: Think Globally, Pay Locally

Recycled & Virgin Material Commodity Markets

The story for the economics of zero waste begins with commodity markets – transactions between material sellers and buying manufacturers that use recycled or virgin raw material commodities to make new products. Figures 1, 2, and 3 show market prices for virgin aluminum ingot vs. recycled cans, unbleached virgin softwood kraft pulp vs. recycled old corrugated cardboard (OCC), and virgin polyethylene terephthalate (PET) pellets vs. recycled PET bottles, respectively. These graphs portray the typical relationship between recycled and virgin materials – recycled materials command a lower price and their value dances to the tune of virgin commodity price cycles.[1]

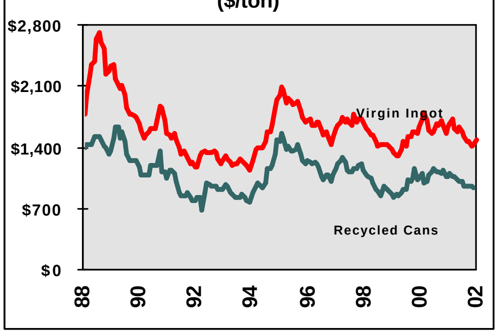


Figure 1: Prices for Virgin Aluminum Ingot Vs. Recycled Aluminum Cans ($/ton)

It should be no surprise that virgin commodities are more valuable. Typically, they have more precisely controlled physical characteristics, have exactly the same characteristics from one truckload supply to the next, and can be readily customized to the precise specifications of each manufacturer. Recycled materials of a given type, by contrast, are composed of a much less controllable and often changing mix of material subtypes, with prohibited and even potentially damaging (to a manufacturer's production equipment) wastes occasionally thrown into the truckload.

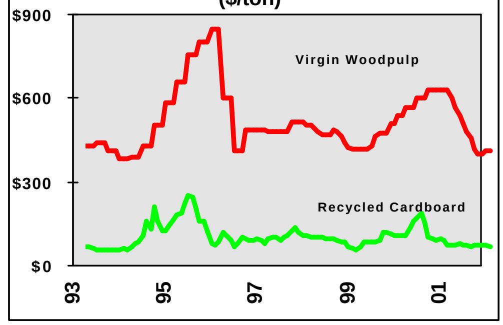


Figure 2: Prices for Virgin Unbleached Softwood Kraft Vs. Recycled OCC ($/ton)

Despite these challenges, manufacturers do manage to mass-produce recycled-content products at a profit. In so doing, manufacturers usually cannot afford to pay a price for recycled material that is sufficient to cover the costs of collecting recyclables from households and businesses, processing collected materials to manufacturers' specifications, and shipping processed recyclables to markets. Thus, some of those costs need to be covered by sources in addition to revenues sellers receive from recycling market transactions.

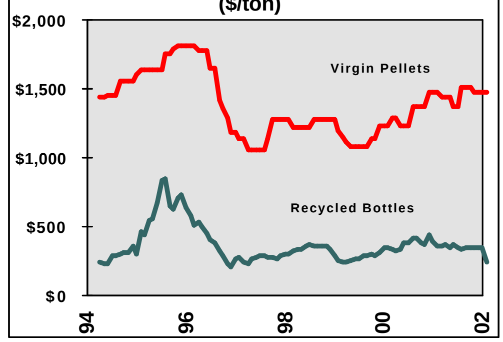


Figure 3: Prices for Virgin PET Pellets Vs. Recycled PET Bottles ($/ton)

Virgin Material Subsidies & Tax Breaks

Given the virgin commodities price cap on recycled materials, it is no surprise that researchers have paid increasing attention to subsidies and tax breaks for extraction and refining of virgin raw materials. Two studies are of note – one a 1994 analysis by the U.S. Environmental Protection Agency (EPA)[2], and the other a 1999 analysis by a consortium of U.S. NGO's.[3] Both studies document extensive U.S. federal taxpayer subsidies for raw material extraction industries, including those that operate indirectly by subsidizing energy production.

Manufacture of recycled-content products is significantly less energy intensive than virgin-content products, so subsidization of energy production is a particularly strong benefit to virgin material users. For example, the EPA study estimated that in 1989 the energy-intensive primary aluminum industry received energy subsidies amounting to $331 million, or 23% of the delivered price of aluminum shipments in that year.[4]

The two studies demur from asserting that removal of federal subsidies and tax breaks would significantly increase virgin material prices. The EPA study even goes so far as to assert that, even though virgin materials receive substantial federal subsidization, removing those subsidies likely would have little effect on virgin prices, because virgin commodity prices are primarily determined on international markets and because supply tends to be monopolized in some instances. However, both studies agree that subsidies and tax breaks render virgin industries more attractive to investors, and company failures less likely, than in an unsubsidized world, with the effect being over-production of virgin materials and consequent underutilization of recycled materials.

External Diseconomies in Virgin Material Extraction and Production Activities

Recycling too often takes more money to collect, process, and transport recycled materials to market than markets will pay for the materials once they get there. Does this mean that recycling costs more than it's worth? Two recent analyses of the external environmental costs of virgin materials use[5] suggest just the opposite.

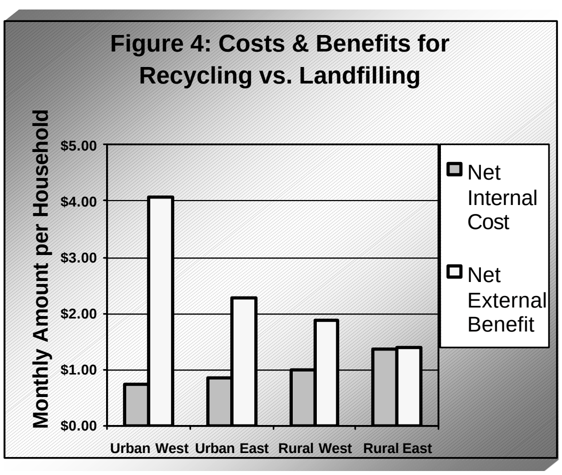
One, a study of curbside recycling in Australia[6] calculated that the dollar value to Australian communities of curbside recycling's external benefits (including avoided external costs of virgin materials use) substantially exceeds its net costs (collection + processing + shipping – market revenues – avoided garbage collection and disposal costs). The study figured that curbside's net cost is just 38% of the dollar value of its overall environmental benefits.

- 75% of this overall environmental benefit is from reductions in air and water pollutant emissions associated with the use of virgin raw materials to manufacture products.
- 21% of the benefit is from land use and future resource access benefits resulting from reduced mining and harvesting of mineral and forestry resources.
- 4% of the benefit is from global warming credits.
- 2% of the benefit is from reduced land use for landfills.
- Environmental costs of increased truck traffic offset just 2% of these overall benefits. (Note that a 2% offset for the environmental costs of increased truck traffic to collect, process, and transport recycled materials is very small compared with 98% for "upstream" benefits of recycling due to reduced virgin materials and energy extraction, refining, and use in manufacturing products.[7] This relationship between upstream environmental benefits and waste management system environmental costs was first illuminated in Tellus Institute's study for The U.S. Council of State Governments on the environmental impacts of packaging materials.[8])

The other, a study by SRMG for the Washington State Department of Ecology also concluded that curbside recycling's environmental benefits outweigh its monetary costs.[9] That study focused on the public health and global warming impacts of 17 waterborne and 10 atmospheric pollutants, including the greenhouse gases carbon dioxide and methane. Lifecycle emissions data for these pollutants were based on a particularly thorough, extensively peer-reviewed U.S. EPA analysis on solid waste management strategies.[10]

Figure 4 shows the study's results for four geographic areas of Washington state – urban and rural regions east and west of the Cascade mountains. As indicated by the bar chart, the estimated dollar value of public health and global warming benefits due to reduced emissions as a result of recycling instead of landfilling recyclable wastes, exceeds the net cost of curbside in all four regions.[11]

Only in the rural east is the net internalized cost of curbside (collection + processing + shipping – market revenues -- avoided landfill tipping fees) at all close to its environmental benefit. That region has the lowest average recycling rate per household, the greatest distance between recycling households, and an average tipping fee that is less than half of average tipping fees in the other three regions.



The calculation of recycling's net external benefits shown in Figure 4 includes:

- Reduced releases of pollutants when recycled materials are substituted for virgin materials in manufacturing products, plus
- Reduced releases due to avoidance of certain amounts of garbage collection activity, plus
- Reduced releases due to avoided landfilling of recycled wastes, minus
- Releases due to curbside recycling collection, processing, and shipping activities.

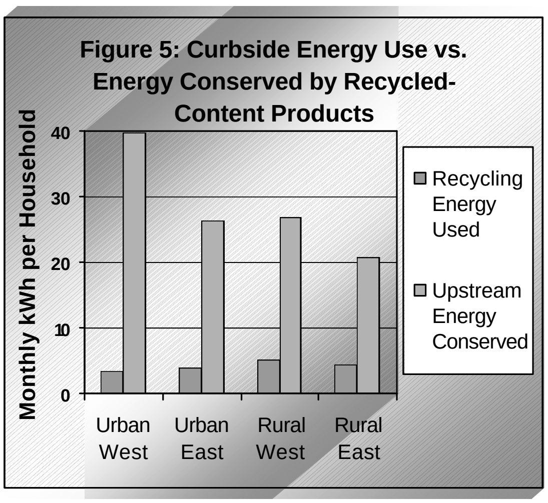
SRMG used dollar values for reduced emissions based on estimates found in the scientific literature on costs to public health and global warming from releases of the 27 pollutants, as well as on trading values on markets for emissions allowances and credits for several of the air pollutants. There is a considerable range in published estimates of environmental costs for releases of each pollutant.[12] Figure 4 shows the result of using high-end cost estimates to calculate recycling's net external benefits.

At the same time, we also note as limitations on our study that:[13]

- Impacts on public health and global warming are calculated for only 10 air and 17 water pollutants.[14] By comparison EPA's annual Toxics Release Inventory currently includes information on releases for 644 toxic chemicals and chemical compounds.[15] In addition, the National Research Council has estimated that more than 70,000 chemicals are used in commerce.[16]
- Inputs and outputs during a product's life cycle have externalized environmental and other sustainability impacts beyond just their impacts on public health and climate change. SRMG's study did not address impacts from the 27 pollutants -- or for that matter from any other outputs or inputs of a product's life cycle -- on habitat, biodiversity, resource conservation, ecosystem productivity or any other sustainability indicators.

On this basis we believe that the high-end external benefit value for curbside recycling in our study of just 27 pollutants is a reasonable representation of the more comprehensive calculation of benefits for curbside recycling that one would obtain by including additional pollutants in the analysis, by considering environmental and sustainability impacts in addition to public health and climate change, and by using the mid-range of estimated environmental and sustainability costs for pollutants reported in the scientific literature on lifecycle analysis.

This view is reinforced by the Australian study's results and by Figure 5, which shows that in all four regions of Washington state, energy used for curbside recycling is a fraction of upstream energy conserved by making recycled-content instead of virgin-content products. A similar relationship holds for most of the 27 pollutants covered by this case study. This illustrates the fact that energy use is often an accurate surrogate for the overall environmental impacts of a solid waste management method, because higher energy use is associated both with greater release of pollutants and with greater ecosystem impacts from acquisition of energy resources.



Funding Additional Recycling

These two systematic studies on the environmental and sustainability benefits of recycling strongly suggest that society would benefit from increased recycling, especially because the studies compared society's environmental benefits against costs for curbside residential recycling, one of the most expensive methods of diverting materials from disposal. At the same time, how to pay for local recycling programs that provide environmental benefits beyond the local area, and indeed even beyond the local timeframe, is an issue. Assuming that the local community wants to invest for society's overall, long-term benefit, we devote the remainder of this paper to funding mechanisms for recycling.

There are at least three financial methods that have been used alone or in combination to fund successful recycling programs.

(1) *Avoided garbage collection and disposal fees*: In communities where garbage and recycling are both managed by the same public or private entity, recycling's avoidance of garbage collection and disposal costs is internalized in total waste management system costs. Thus, garbage management cost savings can be counted as an offset to the costs of recycling. If the disposal facility is not internal to the garbage and recycling collection entity, and if disposal fees are reasonably high and levied on the basis of disposal quantities, then avoided disposal fees plus garbage collection savings may be great enough, when taken in combination with recycling market revenues, to entirely pay for recycling programs.

(2) *Incentives for recycling collection, disincentives for garbage generation*: A particularly effective way to motivate recycling and pay for it at the same time is to charge weight- or volume-based user fees for garbage collection, and set those user fees high enough on average to allow recycling collection service to be provided at no additional charge to garbage collection customers. Numerous studies have concluded that volume-based garbage fees result in significant increases in recycling.[17] In addition, a study by SRMG estimated that user fees that increase at least in proportion to the volume of waste improve recycling rates by about four percentage points over less sharply graduated user fees. That same study also estimated that bundling recycling costs into garbage collection fees, i.e., providing recycling at no additional charge, improved recycling rates by over ten percentage points.[18]

(3) *Product deposits, advanced disposal fees, and other producer responsibility measures*: A third general set of methods for generating funds to pay for recycling programs involves deposits, advanced disposal fees, and other measures designed to internalize recycling costs into product prices, preferably at the product manufacturer level so that producers have an incentive to design and otherwise manage their product(s) to minimize waste management costs at the end of their product's life. Deposit systems that refund some or all of the deposit when the targeted ma-

terial is returned for recycling can be particularly effective at diverting materials. Deposit-redemption systems can also be self-supporting, depending on the level of unredeemed deposits, the market value of recycled materials, and the efficiency of the redemption and recycling infrastructure.

For example, beverage container deposit-redemption programs in various states in the U.S. recycle from 69 to 95% of targeted containers, with the level of diversion depending importantly on the magnitude of the deposit and the convenience of redemption locations. Some of these programs are self-supporting. Some obtain additional revenues through such means as processing fees charged to container manufacturers based on the differential between costs to process containers for sale on recycling markets and market value for the particular materials they use to manufacture containers. These U.S. beverage container deposit-redemption systems also differ widely in cost-effectiveness.[19]

Finally, in addition to direct financial methods to fund recycling, there also are regulatory measures -- such as disposal bans, recycled-content product manufacturing requirements, or buy recycled requirements -- that can be effective at pushing or pulling recyclable materials out of the garbage stream. For example, bans on collection in garbage and/or disposal of lawn and garden debris force generators to recycle those materials. With generators motivated to find ways to divert the banned materials from disposal, private sector service providers are able to charge fees that are sufficient to cover their costs of collecting and composting yard debris. At the same time, competition among service providers presumably keeps customer from being overcharged.

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.

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[1] More information on virgin vs. recycled material prices is available online at http://www.zerowaste.com in various issues of *The Monthly UnEconomist* and on various price graphs.

[2] United State Environmental Protection Agency, *Federal Disincentives: A Study of Federal tax Subsidies and Other Programs Affecting Virgin Industries and Recycling*, EPA 230-R-94-005, August 1994.

[3] GrassRoots Recycling Network, Friends of the Earth, Taxpayers for Common Sense, & Materials Efficiency

Project, *Welfare for Waste: How Federal Taxpayer Subsidies Waste Resources and Discourage Recycling*, GrassRoots Recycling Network, April 1999.
[4] U.S. EPA, *op. cit*., p. iv.
[5] The phrase "external costs of virgin materials use" is used herein to indicate those costs that are caused by virgin materials extraction, refining, and production activities, but that are not directly paid by extractors, refiners, and producers and, thus, do not get internalized in prices for virgin commodities. As with subsidies and tax breaks, externalized costs typically result in excess employment of virgin materials.
[6] Nolan-ITU, SKM Economics, and ENVIROS/RIS, *Independent Assessment of Kerbside Recycling in Australia*, Australian National Packaging Covenant Council, January 2001. To download the report, go to Home Page from http://www.packcoun.com.au.
[7] "Upstream" is typically used to refer to that part of a product's life cycle that is upstream from its use/consumption and waste disposition stages – i.e., "upstream" refers to the raw materials and energy extraction, refining, and manufacturing stages.
[8] Tellus Institute, *CSG/Tellus Packaging Study: Assessing the impacts of production and disposal of packaging and public policy measures to alter its mix*, The Council of State Governments, U.S. EPA, and New Jersey Department of Environmental Protection and Energy, May 1992.
[9] See *The Monthly UnEconomist* for January through June 2001 for detailed reports on the various aspects of this study.
[10] Research Triangle Institute, Franklin Associates, Roy F. Weston, North Carolina State University, and University of Wisconsin-Madison, *A Decision Support Tool for Assessing the Cost and Environmental Burdens of Integrated Municipal Solid Waste Management Strategies*, U.S. EPA National Risk Management Research Laboratory, forthcoming.
[11] A similar conclusion holds for curbside recycling versus waste-to-energy (WTE) incineration at Spokane's WTE facility in the urban east region, except that the environmental benefits of recycling do not exceed curbside's net cost by as much as in the landfill disposal case, because some of curbside's benefits are offset by the loss of avoided pollutant releases when materials are not incinerated to generate energy. With respect to the 27 pollutants tracked by SRMG's study, releases of those specific pollutants from WTE incineration are not as great as releases of the 27 from conventional energy generation facilities. These latter releases can be avoided by incinerating recyclables to generate energy.
[12] See Table 3, Economic Valuation of Atmospheric and Waterborne Emissions ($ per pound), in Jeffrey Morris, "Evaluating Externalized Costs in the Management of Discards," *The Monthly UnEconomist*, April 2001.
[13] Jeffrey Morris, "A Case Study on Internalized vs. Externalized Costs & Benefits for Solid Waste Management Methods: Residential Curbside Recycling in Washington State, Part 1," *The Monthly UnEconomist*, May 2001, p.3.
[14] Air emissions of mercury plus air and waterborne emissions of dioxins are three important examples of pollutant emissions not included in this case study.
[15] See http://www.epa.gov/tri.
[16] National Research Council, *Environmental Neurotoxicology*, National Academy Press, 1992, p. 2.
[17] See for example, Lisa Skumatz, "Nationwide Diversion Rate Study – Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies," October 1996.
[18] Jeffrey Morris, "Incentives to recycle – an end to the Seattle Stomp!" *Warmer Bulletin*, January 2000, No. 70; Jeffrey Morris, "What works best to increase waste diversion?" *Resource Recycling*, January 2000, Vol. XIX, No.1; and *The Monthly UnEconomist*, September and October, 1999, Vol. 1, Nos. 3 and 4.
[19] R. W. Beck, Franklin Associates, Sound Resource Management, and Tellus Institute, *Understanding Beverage Container Recycling: A Value Chain Assessment prepared for the Multi-Stakeholder Recovery Project, Stage 1*, prepared under the direction of Businesses and Environmentalists Allied for Recycling (BEAR), A project of Global Green USA, forthcoming 2001.