RENEWABLE ENERGY PLUS

OPTIMIZING MANAGEMENT OPTIONS FOR SOLID WASTES

Biomass materials represent the basis for current success in recycling — and the greatest potential for future landfill diversion.

Part I

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ORGANICS RECYCLING has long been recognized as the "natural" path to disposal avoidance and beneficial reuse. Go to virtually any urban community in the United States today, and it's likely you'll find a separate collection and processing infrastructure for yard debris and commercial landscaping wastes. Indeed, thanks to codification of the "integrated waste management hierarchy" into state laws, the composting of "green" materials and other degradable fractions of the municipal solid waste stream has become an integral part of most local diversion programs.

That's the good news. The bad news is that, despite all of these efforts, Americans on average still recover less than one-third of the waste stream through recycling and composting combined. According to the latest figures from USEPA and the BioCycle "State of Garbage In America" figures, about 70 percent of what we throw away every day still ends up in a landfill or incinerator. Moreover, per capita generation rates appear to be on the rise.

A closer look at these statistics yields some interesting insights. For example, the bulk of discards we've managed to recover and reutilize to date consists of organic materials and products made from plant matter — in other words, various forms of biomass. Specifically, paper, paperboard and yard trimmings top the USEPA's list of materials recovered nationwide. Similarly, when we examine the remaining nonrecycled or unrecovered fractions of the waste stream, we find that biomass — paper, cardboard, green and wood wastes, food residuals, and other organics — also compose well over half of the materials going to disposal.

In other words, biomass materials represent not only the locus of current success for recycling, but also the greatest potential for future landfill diversion. Clearly, increased efficiencies in the recovery, conversion, and return of these materials to the economic mainstream is where we need to go. But getting there will require new ideas, new policies, and new tools.

At least three things need to happen if this challenge is to be met in the next decade. First, our current vision of organics recycling must be expanded to include all biomass materials that find their way into the solid waste stream. This means looking beyond marketable paper fractions and yard trimmings to the potential resource value of low-grade cellulose and other plant-derived materials. Second, our management strategies must become more varied and more sophisticated. We will need to become conversant in a much broader range of technologies and explore new, sustainable markets for these materials. And third, front-line solid waste managers must become the agents for change. Municipal officials can take the lead in developing innovative policies and creative partnerships to catalyze a new generation of biomass industries at the local level.

ENLARGING THE SCOPE OF BIOMASS RECYCLING

The first step in expanding the productive utilization of waste biomass is a basic receptivity to new ideas. While simple enough in concept, the journey of discovery often labors under the weight of existing policy and vested interests. A case in point is USEPA's "integrated waste management hierarchy," a 1980s policy model that has become pervasive in state statute. Historically, it represents both an enabling and a limiting factor for biomass recycling.

The positive side of this equation is well known. Over the past decade, an unprecedented transformation of local waste management systems has taken place nationwide. Hundreds of billions of dollars have
The need for renewable and environmentally friendly fuels, chemicals and electricity could fundamentally transform the management of municipal wastes.

To reach significantly higher levels of recycling, new technologies and markets must be utilized and gained for such biomass feedstocks as the mixed paper shown above.

been invested in specialized collection, transfer, and processing infrastructures to recover recyclable commodities for the scrap and compost markets. These programs have had both tangible and intangible environmental benefits. The hierarchy has also served as a political, educational, and regulatory platform for the advancement of pollution prevention, resource conservation, and environmental stewardship goals.

This same hierarchy, however, is conservative by nature. It relies upon the prescriptive ranking of known management strategies, elevating, as it does, source reduction, recycling, and composting over all others. No anticipation is given nor accommodation made for new technologies and market opportunities. In such static schemes, the formula for greater diversion relies upon a heightened intensity of existing strategies and programs, often without regard to efficiencies, cost, or economic sustainability. Such inflexibility in public policy always carries with it the danger of dynamic obsolescence, or of simply beating a dead horse.

Some would argue that present technologies and end markets for recovered biomass have already been optimized — that the benefits of more intensive separation and processing of landfill-bound biomass via the existing infrastructure are effectively checkmated by the limits and volatilities of today’s paper and compost markets. In other words, significant new biomass diversion cannot be accomplished through markets that are already unstable or in oversupply. Instead, a new menu of biobased products capable of penetrating more diversified and more lucrative market niches is needed. This will require new technologies, a new infrastructure, and commodity concepts that were not envisioned by the architects of the current waste management hierarchy.

BIOMASS FUTURES AND THE ENERGY CONNECTION

Some barriers to significant new biomass diversion are systemic to the modern industrial economy itself, and therefore largely outside the waste manager’s span of control. Factors such as excess packaging and increased consumerism present major challenges in stemming the flow of these materials to local waste management systems. Moreover, municipal officials are often poorly positioned to influence strategic macroeconomic policies, or to take the entrepreneurial risks necessary to catalyze the commercialization of new technologies and secondary markets.

But significant developments are occurring outside the field of solid waste management that could change all that. A national policy platform promoting bioenergy and biobased products is fostering the emergence of new, clean industries that rely upon both purpose-grown and waste biomass feedstocks for the production of renewable and environmentally friendly fuels, chemicals and electricity. These innovative technologies and products have the potential to displace a broad spectrum of petroleum and petrochemical markets. And, in so doing, they could fundamentally transform both the nature and management of municipal wastes.

For some, the notion of producing energy from waste conjures up negative images of mass burn incinerators. But the new bioenergy equation does not involve combustion. It relies upon a limited number of elegant processes for harnessing the energy of the sun. Living cells capture solar energy as they develop and grow. This stored energy can be liberated in the form of gases and sugars that, in turn, may be converted into “green” products.
Literally anything that can be made out of petroleum can be produced from renewable biomass. This includes not only fuels for power generation and the transportation sector, but a broad spectrum of everyday commodities, such as plastics, solvents, fertilizers, pesticides, cosmetics, fragrances, pharmaceuticals, food additives and flavorings, and adhesives, to name just a few. Because these products are made from plant-based chemicals, they are also biodegradable and nontoxic to the environment.

The National Bioenergy Initiative, led by the U.S. Department of Energy, has as its goal the creation of an integrated industrial economy that places principal reliance on various forms of biomass for the production of heat, energy, fuels and chemicals. This new industrial platform would help to close the carbon cycle because the biobased materials that feed industry absorb carbon dioxide during their growth and development in proportion to that released to the atmosphere from the production of goods and services. In addition to mitigating global warming effects, displacement of petroleum with renewable biomass reduces air pollution, water pollution, and release of toxins into the environment and food chain. Moving away from a petroleum dependent economy also helps to restore America’s balance of trade, and to address increasing national security concerns.

URBAN BIOMASS AS PREMIER FEEDSTOCK

While most attention to date has focused on the utilization of agricultural crops and residues for bio-based products, there are several reasons why urban biomass wastes could ultimately emerge as the premier feedstock for these new industries. First, the supply is constant, and not subject to the seasonality, storage requirements, and potential carbohydrate loss of crop-based sources. Second, urban sources of biomass are more “resource friendly.” Since they already exist as a residual of the industrial process that must be managed, they compare favorably to crop alternatives whose production requires the consumption of land and water, and the potential release of chemicals, such as agricultural pesticides, to the environment. Third, urban biomass has an existing collection and processing infrastructure, which is separately funded as a public utility. And finally, urban sources of biomass do not compete with existing food and feed markets, and often can be delivered at a negative cost to bioindustries, i.e. they can charge a tip fee for receipt of their feedstock materials.

Bioindustries already have begun to make their presence felt in local solid waste management systems. The most primitive form of bioenergy technology commercially available today is the recovery of landfill gas as a renewable fuel for power generation and heavy equipment or vehicle use. Due to the substantial biomass content of materials going to disposal, landfill management units function as natural bioreac-
lies in the commercialization of more sophisticated upstream solutions. As noted in the November 2001 issue of BioCycle ("Commercial Infrastructure Takes Shape for Anaerobic Digestion"), one of the fastest growing technologies for biomass conversion takes advantage of the same natural degradation process, but under more controlled conditions. Anaerobic digestion technologies manage biomass wastes in a containerized environment, where specific feedstocks can be earmarked and preprocessed, and where temperature, moisture, microbes, and other essential biological conditions can be manipulated and optimized. Commercial anaerobic digestion technologies are currently available to produce biogas and high-value agricultural amendment products from a variety of biomass wastes, including urban yard debris, agricultural crop residues, manures and biosolids.

A second category of bioconversion technologies that has begun to eye the commercial potential of urban biomass wastes is gasification/pyrolysis. These processes also utilize a containerized environment in which biomass materials are heated to high temperatures in the absence of oxygen to produce biogas (sometimes referred to as synthesis gas or "syngas"). The gas is typically utilized to fire on-site generators for the production of electricity. Plants currently in operation are tailored to receive a variety of separated biomass streams, including manures, tires, and the post-recycled residual stream from solid waste material recovery facilities. Unlike the large and technically troubled gasification/pyrolysis plants of 20 years ago, these new facilities are small, modular, and highly efficient units that hold great potential for the development of local distributed energy systems.

Technologies that hold perhaps the greatest potential for displacing broad-based petroleum markets are those that utilize acid or enzymes to break down cellulosic biomass. These hydrolysis processes convert plant material into basic sugar compounds, which are then processed into a variety of industrial chemicals and products. Hydrolysis facilities, also known as "biorefineries," are the most technically complex and capital intensive of the new technologies, and hence the slowest to commercialize. A number of showcase facilities are in various stages of development in New York, Louisiana and California. These first plants will utilize acid hydrolysis to produce industrial alcohol and fuel ethanol from agricultural and forestry wastes, as well as urban biomass wastes. Currently, the greatest obstacle to development of biorefineries is financing, due both to the size of required investments and the absence of strong national policy commitments to renewable fuels. The future of biochemical conversion facilities may well lie in technological advances in enzymatic hydrolysis processes, which have the potential for higher efficiencies and lower costs.

In summary, the national focus on renewable sources of energy and on biobased products provides both a policy framework and an opportunity to open up new end uses for major fractions of the solid waste stream that are currently disposed. Evolving bioindustries have the potential to add value and to incrementally expand the range of markets available to post-recycled or residual biomass. If such technologies are commercially available today, how can solid waste managers facilitate the development of these options in their own communities?

(Part II of this report will discuss how the next phase of biomass recycling can be achieved through the work of local change agents who know the feedstocks, the technologies, regulatory barriers, and can help establish synergistic partnerships in a bioindustrial economy that uses renewable inputs and recyclable outputs.)

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