

A Vision for Sustainable Organic Materials Recycling in Pennsylvania

By the Pennsylvania Recycles Organics Study Team

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Executive Summary

Since the passage of Act 101 Pennsylvania has made significant progress in advancing recycling throughout the Commonwealth. It is also apparent that further significant advances in recycling must come from recovering and recycling organic residuals in the waste stream. The Pennsylvania Recycles Organics study team, a group of 26 professionals in waste management and recycling, agriculture and education, has devoted considerable time and effort to studying organics recycling issues and systems both in Pennsylvania and in the European Union. This report presents our findings and lays out our vision for what organics recycling could be in Pennsylvania. We present two goals and associated strategies for attaining that vision.

Given the need for more sustainable use of resources, to conserve landfill space, to conserve and capture renewable energy, to build and improve soil quality we believe it is imperative for Pennsylvania to develop and implement an organic residuals management and recycling system that reconnects municipal and agricultural sectors in mutually beneficial and sustainable flows of energy, organic matter, nutrients, and capital. Our vision is described by two goals:

- 1. Reestablish balanced and sustainable carbon cycling at the local level.***
- 2. Reduce disposal of organic residuals by 85% by 2020 and to divert these materials to compost and energy production.***

The first is a philosophical goal articulating the principles that should guide development of organics recycling; cycling of carbon and nutrients should occur within small regional loops, public/private/agricultural partnerships will facilitate such loops, source separated organics collection will result in high quality products with high local value and acceptance. The second is a quantitative goal with associated strategies to attain the goal. These strategies include:

- Expansion and enhanced enforcement of Act 101 mandates;
- Broad state-wide mandates which allow maximum local/regional flexibility for meeting those mandates;
- Disposal bans for certain organic residuals;
- State grant support for public/private partnerships developed to collect, transport, process and market organic residuals;
- A time phased process of infrastructure development and inclusion of various economic/social sectors and types of organics for recycling; and
- A significant effort in public outreach and education.

Forward

In 2006 and 2007, two groups of Pennsylvania professionals, under a USDA sponsored project and assembled by The Pennsylvania State University, traveled to Germany and Austria to investigate the organizational structures, operations, and sustainability of the organics recycling systems that have been developed and implemented in these two countries. Our purpose was to analyze these systems and their applicability to organic residuals management in Pennsylvania. Through a European Union mandate in 1996, Germany and Austria were required to reduce the amount of organic material deposited in landfills by 65% over a 20 year period. These goals have been exceeded with most of the reduction coming from the diversion of organic materials to compost production, sometimes coupled with energy recovery systems. Germany and Austria

enacted even more stringent rules: wastes deposited in landfills can contain no more than 5% fermentable organic matter. This limit has been achieved through balanced programs of source separation, more efficient recycling, and composting of pre- and post-consumer food processing and preparation residuals, and leaf and yard debris. In some cases, source separated organic materials are also anaerobically digested to produce methane used for generation of electricity and heat.

The benefits of such programs have been many-fold in these economies with advanced agricultural production. These benefits include not only the reduction of landfilled waste and a cleaner environment, but also the creation of value added compost and specialty soil products, the production of non-petroleum-based energy from organic materials, increased business opportunities and jobs, soil improvement through compost application, an increase in farm revenues from residuals collection, tipping fees, and energy production. Organics recycling systems that were included on the tour ranged from large, technology intensive facilities that processed organic materials from major cities and often included anaerobic digesters to produce energy, down to very small farm-based, often cooperative compost operations processing material from nearby towns and villages.

However, the political-economic structure of these European countries is in many ways very different from Pennsylvania. We observed more centralized government authority for decision making, more government participation in recycling systems in the form of energy and agricultural subsidies, government backing of organics processing facilities, public-private partnerships, and an existing culture of environmental sustainability and source separation practices which have all facilitated Germany and Austria's transition to high levels of organics recycling. Pennsylvania, by contrast, has relatively more available land, low landfill tipping

fees, strong waste management lobbies for current landfill operations, lower energy costs, very limited government support for private composting operations, no tradition of public-private partnerships, and a decentralized government with strong local authority. Pennsylvanians are also, in general, not as familiar with the benefits of composting and sustainable energy.

The charge placed before the Pennsylvania study group was two-fold. The first task was to investigate organic residuals recycling systems in Germany and Austria. The team attempted to gain an understanding of the policy and regulatory framework under which the systems operated, the financial and economic arrangements used to initiate and operate the systems, relationships between urban and agricultural sectors, product quality and marketing, system sustainability, and public education. The second task was to consider how these European systems could inform our attempts to increase organic residuals recycling in Pennsylvania. The overall mission of the group was to:

Articulate a new vision for organic waste management in Pennsylvania that reconnects municipal and agricultural sectors in mutually beneficial and sustainable flows of energy, organic matter, nutrients, and capital; and to disseminate this vision to a wide audience.

In this report the group first presents its assessment of current organics recycling in Pennsylvania and then, by contrast, presents a synopsis of the organic residuals recycling systems studied in Germany and Austria. This is followed by considerations of economic and environmental sustainability of organics recycling in Pennsylvania. Finally, specific goals and strategies for transforming organics recycling in Pennsylvania are presented.

Organics Recycling in Pennsylvania

Municipal solid waste planning within the Commonwealth of Pennsylvania has historically been the responsibility of each county under the oversight of the Pennsylvania Department of Environmental Protection (DEP) as mandated through Act 101. Collection of residential recyclable materials is the responsibility of municipalities. State mandates for source separation of organic materials from the municipal solid waste stream are weak, poorly enforced and limited to leaf and yard debris. Consequently relatively few communities effectively separate their leaf and yard debris from municipal solid wastes, and almost all leave numerous other organic residuals in the waste stream. While many communities have a separate collection system for Christmas trees, leaf and yard debris, and storm debris, there is essentially no centralized collection of food wastes, which comprises over 10% of the waste stream (PADEP, 2005). Greenhouse gas emissions (methane) from organic materials in landfills, increased need for non-fossil carbon based energy, the need to recycle carbon back to soils for sustainable production all point to the need for much greater capture and recycling of organic residuals in the waste stream. However, the large size of the Commonwealth with varying population densities throughout, and our diversified economic industries and social structures, require the consideration of multiple solutions to improving organic materials recycling rates.

Composting is a controlled biological decomposition and volume reduction method for treating organic materials in order to stabilize the material into a humus-like product for reuse (US EPA, 1995). This process has been utilized for many years, and can be conducted at scales ranging from the individual homeowner, to the farm, to larger municipal or commercial operations. Successful composting operations can be established with relatively small

investments in infrastructure and equipment (compared to energy capture systems) and so has been the system of choice for organics recycling in Pennsylvania.

There are 470 permitted composting facilities throughout the state of Pennsylvania. Most of these facilities compost leaf and yard wastes and storm and land clearing debris, while only a few are capable or permitted to compost biosolids, food wastes, mushroom substrate, paper residues and the many other organic materials. Over 90% of operating composting facilities are municipal facilities that process leaf and yard debris, brush, and branches. Municipal composting operations have been heavily subsidized by equipment grants from the state and because they operate as part of local government have little incentive to produce or market high quality compost. Often the compost produced is given away and undercuts the market for commercial operations. Although a few municipalities haul collected leaves to farms, there is almost no on-farm composting of municipal leaves or other organic residuals such as food waste.

Pennsylvanians landfill approximately 6.3 million tons of organic materials each year (60% of our solid wastes), much of which is food residuals and paper that could be utilized as inputs to compost and energy production (W.R. Beck, 2005). Pennsylvania's municipalities also collect 800,000 tons of leaf and yard debris each year which could be composted with the 2.6 million tons of manure that must be moved off Pennsylvania farms annually.

Pennsylvania's Act 101

Pennsylvania's Act 101 of 1988 directed at municipal waste recycling was intended to accomplish the following goals in the Commonwealth:

- Reduce Pennsylvania's municipal waste generation
- Recycle at least 25% of waste generated by 1998. The subsequent goal of 35% was reached by 2001.
- Procure and use recycled and recyclable materials in state government agencies
- Educate the public as to the benefits of recycling and waste reduction

These goals will be accomplished through the following measures, among others stated in the Act:

- Act 101 mandates recycling in Pennsylvania's larger municipalities and requires counties to develop municipal waste management plans, providing grants to offset expenses.
- Provide grants for the implementation of recycling programs.
- Municipalities with populations of 10,000 or more and more than 300 persons per square mile are required to have curbside recycling programs (grants are legislatively enabled for establishment of a program).
 - Non-organic recycling requirements: mandated municipalities collect at least 3 of the following materials: clear glass; colored glass; plastics; aluminum; steel and bimetallic cans; high grade office paper; corrugated paper and newsprint.

Additional requirements exist for commercial, municipal and institutional establishments within a mandated municipality.

- Organic recycling requirements: leaf debris must be separated from other municipal wastes (in mandated municipalities); no waste disposal facility may accept truckloads primarily composed of leaf waste for processing other than composting.
- Pennsylvania citizens are encouraged to help reduce waste by purchasing products that are durable, repairable, recycled or recyclable and /or have minimal packaging, and to find other uses for surplus goods instead of throwing them away. Manufacturers are encouraged to design their products with recycling in mind and assess their processes to minimize discards.
- Counties are required to develop Municipal Solid Waste Management Plans for managing municipal wastes. The Plans are subject to municipal ratification and DEP approval. Each county must demonstrate 10 years of available disposal capacity. Municipalities may adopt ordinances and regulations for recycling and source separation.
- Act 101 imposed a \$2 per ton fee on municipal waste entering landfills and resource recovery facilities; under current amendments to the Act, the fee will sunset on January 1, 2012.
- The fee is deposited into the Recycling Fund, which may be allocated as follows:
 - Minimum 70% for grants, studies and research to support recycling, market development and waste reduction.
 - Maximum of 30% for public information programs and technical assistance.
 - Maximum 10% for processing and disposal feasibility studies.

- Maximum 3% for fund administration.
- Grants available include: planning grants, recycling grants, county recycling coordinator grants, recycling performance grants, host municipality inspector grants and independent permit application review grants. These grants are only available to municipalities and counties
- A statewide Solid Waste Advisory Committee and a Recycling Fund Advisory Committee have been established to advise PA DEP on the allocation of available funds and other regulatory matters.

Act 101 has been quite successful at stimulating “hard” recycling of glass bottles, steel and aluminum cans, plastics, and newsprint. Act 101 has been much less effective at stimulating recycling of organic residuals. *As will be shown below, organic residuals now constitute the largest fraction of the municipal waste stream and clearly represent the next frontier for overall waste reduction and recycling.*

Current Statistics on Waste and Composting in Pennsylvania

Pennsylvanians dispose of approximately 9,369,083 tons of waste in landfills every year¹. A disproportionate amount of this waste includes organic materials that could potentially be recycled to generate energy and/or compost products. In fact, samples reveal that only 12.7% of landfilled waste can be classified as non-recyclable inorganic, while 34.2% is organic waste of various types (most of which could be composted or digested), and the remaining 53.1% consists of paper products, plastic, glass, and metals, much of which could be recycled if Act 101 goals and guidelines were pursued more aggressively, and with improved recycling techniques. The total composition of landfilled wastes can be seen below in Figure 1.

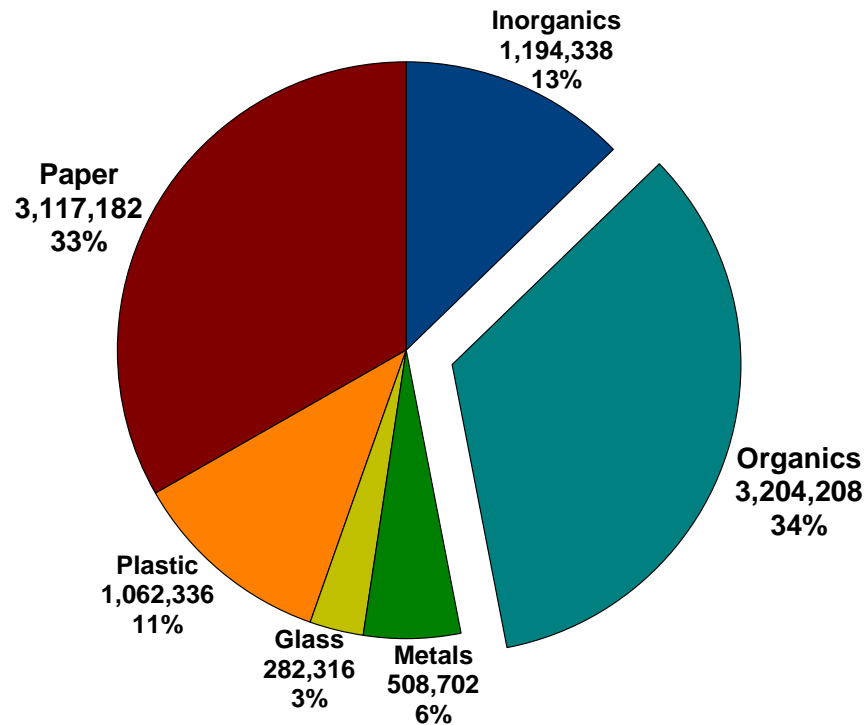


Figure 1. Pennsylvania statewide aggregate composition of landfilled municipal waste (tons/year).

¹ Waste composition statistics in this section taken from: W. R. Beck, Inc. 2005. "Building Financially Sustainable Recycling Programs." *Pennsylvania DEP*, April 2005.

Some wastes are more prevalent in the waste stream than others. Ironically, the top four discarded items in Pennsylvania are organic and include food, paper, cardboard and woody materials, all of which could be composted or used in energy production. The top ten items disposed in landfills in Pennsylvania are given in Figure 2 below.

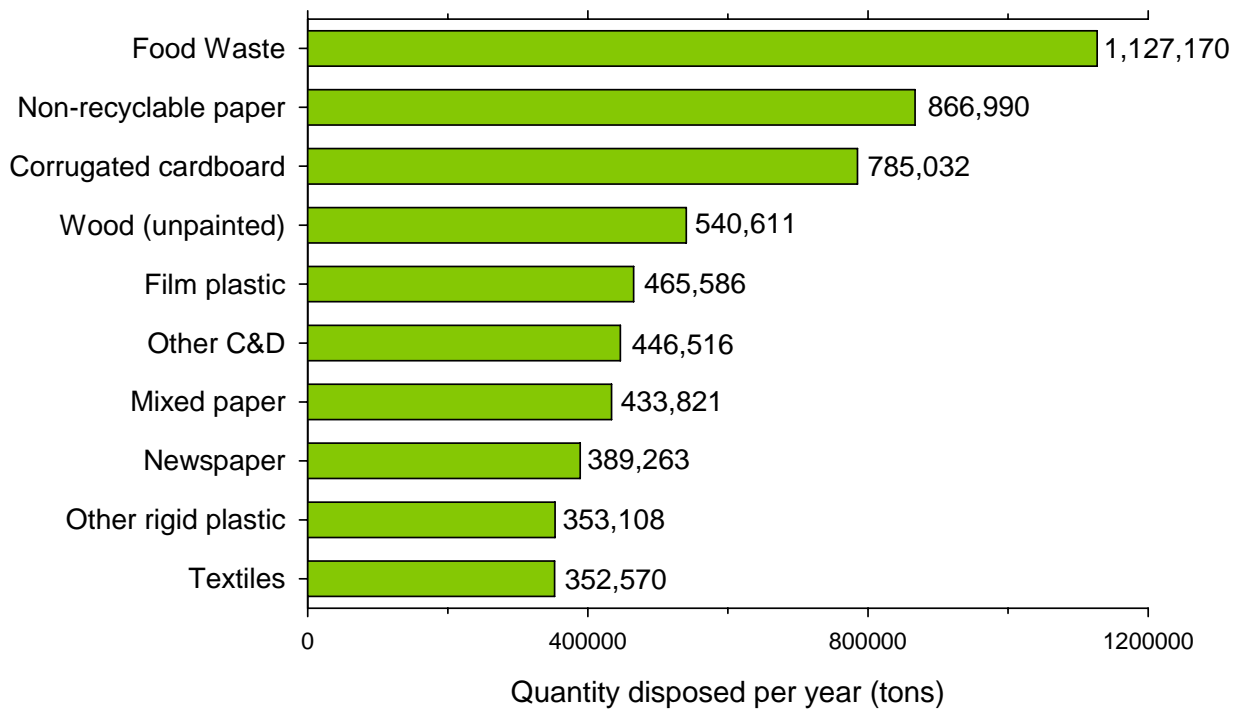


Figure 2. Top 10 most prevalent materials landfilled in Pennsylvania

Clearly a significant reduction in municipal solid waste generation could be achieved by the development and implementation of new systems for organics source separation, collection, and processing. *With innovative government policies that would encourage, rather than hinder, private sector involvement great strides could be made toward achieving sustainable systems for organics recycling that would provide both environmental and economic benefits to the local region and to the Commonwealth.* This process should be facilitated and informed by studying

examples of solid waste management systems that have achieved significant organic residual capture and recycling rates to learn what the successes and problems have been in these systems and apply these lessons here in Pennsylvania. To this end the members of this team studied several examples of organic residuals management in Germany and Austria.

Five European Organics Recycling Models

One important observation made by team members relates to a widespread difference between US and EU citizens in their mentality toward wastes. Rather than regarding a wide variety of waste materials as garbage, many Europeans view residual materials as feedstocks for new production. The same holds for organic residuals which are seen as a source of carbon and nutrients that can be returned to the land or converted to energy in the form of methane, ethanol or biodiesel. Many Europeans have engrained the concept of source separation into their daily routines. By separating organic materials from the solid waste stream, not only is the quantity of landfilled waste reduced but a high quality feedstock is produced for digestion or composting. This fundamental cultural difference appears to be a major factor that separates waste management and recycling in Europe from the United States. While the United States remains mostly dependent on landfill deposition and waste to energy (WTE) plants, Europeans are increasingly being taught from a young age that wastes are potential resources, and that the small task of separating organic materials from inorganic wastes is very important to environmental sustainability. During our study tour we saw entire towns gathered at recycling sites, depositing pre-separated yard trimmings, food residuals, (as well as numerous other recyclables) such that the remaining household waste constituted a significantly smaller portion of the original waste stream compared to what is generated by most families in the United States.

The 27 countries comprising the European Union (EU) face issues in solid waste reduction and recycling that are similar to those faced by the United States. Dense populations and limited landfill space in many EU countries make these issues all the more pressing. To conserve landfill space and decrease adverse environmental impacts of landfills, the EU has mandated 65% reductions in the amount of organic wastes that are landfilled. Austria and Germany have

mandated that landfilled wastes may contain no more than 5% organic materials. Both countries now recover and recycle almost 80% of residential and commercial food residuals and leaf and yard debris from the solid waste stream.

Germany and Austria have also mandated that all organic residuals should be source separated. Separate collection and processing is cost competitive when compared to mixed processing, and removal of organics from mixed wastes results in a higher quality material for recycling and composting. Composts and other products from source separated feedstocks contain lower heavy metals concentrations than compost made from organic materials separated from co-mingled feedstocks. Both countries also encourage recycling of organic materials within small geographic areas.

We observed many different approaches and systems for organics recycling during our study tour of Germany and Austria. On the basis of organics collection and processing philosophy and ownership we have categorized these systems into five models. First we have divided the systems into those which use a centralized collection and processing system and those which utilize a decentralized approach. Centralized systems are characterized by collection of organic residuals from over a wide area (waste district or city) and hauling to a single large facility for processing (anaerobic digestion and/or composting). In decentralized systems organic materials are collected by one or more entities from a waste district or city and transported to multiple sites and facilities for processing. Second we divide the systems on the basis of enterprise ownership: entirely public ownership and operation, private-public partnerships for collection and/or processing, public collection and commercial private processing and marketing, public collection and agricultural processing and use/marketing, and finally agricultural collection, processing and use. We will describe five examples that typify these models of operation

The city of Frankfurt, Germany (pop. 667,000) utilizes a *centralized system with municipal-private partnership* for collection, processing and marketing. A company owned 49% by the city and 51% private is contracted by the city to provide source separate collection of organic materials (food and leaf and yard debris) utilizing both curbside collection from bins and neighborhood drop off sites. Similar systems are utilized by many German cities. The private-public partnership company also processes organic materials and markets the products. In the Frankfurt operation food residuals are first anaerobically digested to produce methane. Most of the energy produced is used to supplement the facility's energy needs and the remaining electricity produced is fed into the public utility network. The digestate from this process is composted with leaf and yard debris and several compost-based products are marketed locally. Combining the digestion and composting operations in a single facility, saves money and land area; important considerations in an urban area. The entire digestion and composting facility is enclosed and all exhaust air is scrubbed and passed through a biofilter to entirely eliminate odors; another essential for operation in a densely populated area. This is a large capacity, technology and equipment intensive operation that required a large capital outlay for construction, and requires a large staff, many of them highly trained and specialized, to operate, manage and maintain the facility.

The city of Vienna, Austria (pop. 1.6 million) also utilizes a *centralized system but with 100% municipal collection and processing*. The municipally operated source separate collection system is very similar to that of Frankfurt utilizing both curbside pick up from bins and drop-off centers. The organic materials are brought to a large central processing facility where food residuals and leaf and yard debris are mixed and hauled to a large open-air windrow composting site on the outskirts of the city. The compost produced is marketed to city residents

and to vegetable farms in the area. Though large in scale, the technology used is far simpler than in Frankfurt, requiring a much smaller investment and a smaller and fewer highly skilled staff to operate.

The city of Linz, Austria (pop 190,000) provides an example of ***private collection and decentralized private processing*** and marketing. In this model, the municipality contracts with a company to provide collection services for source separated organic materials. The residuals are delivered to private commercial-scale composting companies contracted by the city for processing the material. The composters receive tipping fees for accepting the material and derive additional income from sales of compost and compost-based products. The private companies assume 100% ownership and responsibility for the materials and the final compost products. The compost products are sold both to urban and agricultural sectors.

The city of Graz, Austria (pop. 250,000) operates a ***municipal collection and decentralized agricultural processing partnership*** system. As in Frankfurt, city of Graz has formed a public-private partnership company that is contracted to provide collection of source separated organic materials (both curbside and drop off centers). This company processes collected material to remove contaminants, and blends a compostable mixture of food residuals and leaf and yard debris. The city has contracted with approximately 20 farms in the region to accept organic materials for composting, with the amount delivered dependent on farm arable land area. The material is hauled to the farms which receive a tipping fee and assume responsibility for the composting process. In most cases the compost produced is used on farm to improve soil quality and help supply the farm's nutrient needs. In some cases compost may be marketed to residents of Graz or to local consumers. The on-farm composters are organized into a cooperative that received state and city support for purchasing shared composting equipment.

In the more rural district of Friestadt, Austria (pop 65,000 in the district) a *decentralized farmer collection and processing* model is used. The district (politically analogous to a Pennsylvania county) contracts with farmers to collect and process organic materials from specific communities within the district. There are 27 municipalities in the district ranging in size from 700 to 8,000 inhabitants. Within each village in the Friestadt District the contracted farmer conducts curbside collection of residential food residuals from 10-L buckets and hauls the material to the farm for composting. The farmer also collects leaf and yard debris from a municipal drop off center. The municipality and its residents may also deliver leaf and yard debris to the farm. Weekly collection minimizes nuisance odors and vectors, and the small buckets ensure easy and inexpensive handling by the farmers. After collection, the farmers own and are responsible for 100% of the organic material. As in the Graz model above, the farmers are organized into an equipment purchasing and sharing cooperative that received some state and district support for initial equipment purchases. The farmers typically use about 90% of the compost they produce directly on their own farms and the remaining 10% is bagged and sold to local residents for profit. This municipal-agricultural arrangement as well as that in the Graz example provides an additional source of income for farmers, helps to maintain their profitability and operational sustainability, and recycles carbon into local soils.

While there is much to be lauded in the organics recycling systems we observed in Germany and Austria, we also noted several problems. In some cases, significant public as well as private investment was expended on very large, technology intensive composting and energy generation facilities. Because these facilities were expensive to operate, prone to production stoppages due to mechanical and control system failures, it appeared they would never be able to operate profitably or without significant government subsidy. Another major issue that appeared

to plague most residentially collected organics, particularly food residuals was contamination with plastics and other inert materials. Processing facilities and compost producers had to expend considerable effort, time and energy to remove these contaminants from the final product. We also observed some, and were told of other cases of poorly operated composting operations where odors, leachate generation, and low quality products were the norm. Pennsylvania would do well to learn from these problems and avoid them or devise solutions as we embark on efforts to substantially increase organics recycling in the Commonwealth.

These models have several features in common. Each model stresses *source separation* as a means of removing organic materials from the waste stream. The models also emphasize the use of the carbon-based material either for energy production or improving soil quality *locally*. Local use of finished compost to improve soil quality is encouraged through advertising slogans such as “from the region, for the region.” While many of these systems enjoyed significant financial support from various government entities, the most successful programs were those in which this support led to public private partnerships or balanced support for public and private aspects of the systems. Emphasis on product quality and product marketing was strong in all systems. Neither compost nor energy was ever given away. All programs invested significant time, effort, and resources on public education.

There are many similarities between these two countries and the state of Pennsylvania, including populations concentrated in several larger urban centers with extensive and sparsely populated rural areas devoted to agriculture, forestry, and mining.

Overall, these models prove that there isn't a singular solution to improving municipal solid waste handling, but that a combination of methods may work best for particular municipalities,

counties, and regions. The various models observed provide ideas for developing systems appropriate for varying regions found in Pennsylvania.

Economic Sustainability of Organic Residuals Recycling in Pennsylvania

As we consider these various European models for organics residuals recycling we should also keep in mind the economic forces that have been brought into play under our present organics recycling system. Pennsylvania Act 101 (Municipal Waste Planning, Recycling and Waste Reduction Act) established in 1988 mandated municipalities with populations over 10,000 people to implement curbside recycling. The Act highly subsidized Pennsylvania's public sector to achieve the collection and technical assistance for recyclables such as bottles, cans, paper and leaf and yard debris (see the previous more detailed summary of Act 101). In the early phase of capturing bottles, cans and paper, markets did not exist and cost recovery was impossible in the short term. Thus such subsidies were essential for establishing recycling programs. Over the past 20 years, many market opportunities have evolved for bottles, cans and paper and created a viable and more sustainable recycling effort. From the outset, hard recyclables were considered a marketable commodity, and most county recycling programs in the state actively seek to generate clean streams with minimum contamination in order to sell their hard recyclables to the highest value market possible. In most, if not all counties, this has not been the case with recycled organic residuals. In most municipal operations, the recycling objective for organics until recently has been to process the materials as inexpensively as possible and to give away the resulting compost with no focus on product quality or market development. The prevailing mindset of most municipalities has been that tax dollars and waste fees support the collection and

processing of yard debris, therefore the product (compost) should be given back to the residents. This mindset stands in stark contrast to hard recyclables whose collection and processing are supported by the very same taxes and waste fees. The unintended consequence has been to decrease the value of compost and to undercut the market for this product. This situation has been a major disincentive to private sector composting, both commercial and on-farm. Thus Act 101 and the impact of the more than \$90 million dollars that was issued by the state government as subsidies to the public sector has resulted in less than optimal outcome. A sustainable focus has not come to be with leaf and yard debris efforts as has been developed for bottles, cans and paper recycling.

Pennsylvania Act 101 has mandated municipalities to separate leaf and yard debris from other municipal waste. Funds generated from a \$2 per ton fee on municipal waste entering landfills and resource recovery facilities was allocated to public sector municipalities and county authorities for infrastructure development. However, at the time Act 101 was initiated, little thought was given to forming inter-municipal cooperative partnerships or public/private partnerships nor did the Act encourage sustainable operations or capital recovery of infrastructure development. Revisions to Act 101 mandating sustainability on behalf of the public sector and that would enable public/ private partnerships will yield economic benefits.

Act 101 addressed leaf and yard debris but not the full scope of organics. To compete with subsidized public sector composting, the relatively few successful private sector composters in the state have focused on product quality and composting of high moisture, high nitrogen organic residuals. The narrow focus of Act 101 on leaf and yard debris has had some impact on landfill diversion, but diverted a major high carbon feedstock away from commercial operations. *This*

pattern has tied up valuable carbon sources that are essential to processing other forms of organics in an economically and scientifically sound manner.

Economic factors of organics processing include environmental impacts to land, water and air quality through landfill diversion, and manufacturing a value added product used to improve soil health. Often however, the viability of organics processing is evaluated solely on avoided cost. Although factors such as preservation of land, water and air quality are difficult to quantify and vary from region to region within the state they are nevertheless real factors with real values. Diverting organics from traditional landfill disposal to a resource for manufacturing must also be accounted for in an economic evaluation. Cost benefit analysis is dependent on specific circumstances. Factors impacting the economics of organics processing include business planning, financing, market development, land, site development, permitting, capital equipment purchases, feedstock availability, transportation, processing, labor, and maintenance. In addition, organics processing facilities may foster benevolent neighborhood relations when compared to nuisances of a landfill.

Through legislation, Pennsylvania has attempted to remove a significant portion of the leaf and yard debris from landfills. Infrastructure development has come primarily through grant funding for the public sector and private funding for the private sector (with the exception of some small grant opportunities for private composters). Until very recently, sustainability has not been a primary focus of the public sector. It is time to evaluate organics processing impacts through lifecycle analysis, foster new business and fully utilize current infrastructure development to establish sustainable organics processing facilities. Allocating resources to product development, quality standards and market development will provide the opportunity to create an economically viable industry supporting environmental stewardship. Opportunities

exist in alternative energy initiatives and composting. Recycling carbon resources can become less costly in the long term. The shift will require fully utilizing existing infrastructure, partnerships, market development, new business incentives and changing society's behavior.

Environmental Sustainability of Organics Recycling in Pennsylvania

While recycling organic residuals would provide a significant economic benefit to the Commonwealth, recycling these materials back to the soil also provides environmental and sustainability value. In this section we describe how soil based recycling of organic residuals can serve to:

- Maintain or improve soil quality for agricultural production, and
- Sequester carbon and nutrients in soil.

The main benefit of adding compost to soil is the addition of stabilized forms of organic carbon and the resulting increase in stable soil organic carbon (SOC) or humus. Humus is the end product of decomposition of plant and organic material and is a critical component of soil quality, or the health of a soil. In soils of temperate regions like Pennsylvania, the SOC pool has been depleted by an estimated 60% as a consequence of land being converted to production agriculture (Lal, 2004). Therefore the addition of compost to a soil, especially a soil lacking humus and soil organic carbon, can improve both physical and chemical properties and provide a use for the organic residuals that are so prevalent in Pennsylvania.

The addition of compost to the soil surface has numerous implications for the physical properties of a soil. Overall, there is an increase in soil structural stability, which is marked by

an increase in soil porosity, a decrease in bulk density, an increase in water holding capacity, and consequently in the aeration and drainage of a soil. Soils with high soil porosity and low bulk density are more permeable to water, reducing the likelihood of surface runoff and erosion. The increased water holding capacity means a soil is less likely to be affected by weather extremes such as drought. Additionally, high soil porosity improves the friability of a soil, resulting in less energy input to work the soil.

Chemical properties of soils are also altered by the addition of compost. The SOC associated with compost contributes to a high nutrient sorption capacity, causing an increase in nutrient availability. Increasing SOC w/ compost increases the cation exchange capacity (CEC) of the soil. CEC is a measure of the soils natural ability to hold and slowly release plant essential cations such as calcium, magnesium and potassium (Ca^{2+} , Mg^{2+} , K^{+}).

Compost contains low levels of nutrients relative to inorganic fertilizer, but high levels relative to soil. Most of the nitrogen and phosphorus in compost is in stable organic forms that are not soluble or mobile. Thus with well stabilized composts there is limited risk of nutrient transport out of the soil and into water bodies. The conversion of organic nitrogen and phosphorus in compost occurs slowly, maintaining a pool of reserve nutrients in the soil (Kluge, 2006; Ebertseder and Gutser, 2003). Compost also contributes to the ability of soils to retain added nutrients by increasing soil cation exchange capacity. Compost also helps to buffer soils against changes in pH (Kluge, 2006) and helps to reduce plant toxicity of metals such as iron, aluminum, and manganese in low pH soils.

The process of composting has additional benefits to soil quality. High temperatures in thermophilic aerobic composting systems effectively kill most weed seeds and pathogens, and

potentially toxic compounds, such as residual pesticides, are also decomposed in the composting process (Brady and Weil, 2008). Compost can also suppress soilborne plant diseases by providing an environment for antagonistic organisms to colonize during the final stages of composting (Hartl and Erhart, 2001; Brady and Weil, 2008). The dark color of compost can also help soils warm faster in the spring, greatly facilitating agricultural production. Compost has also proven to increase the amount of earthworms in the soil, providing biological aeration and fertilization (Hartl and Erhart, 2001).

Adding compost to the soil also has the potential to sequester C and N, helping to offset the impact of fossil fuel emissions and enhancing food security. Globally, C sequestration in soil has the potential to offset an estimated 5 – 15% of fossil fuel emissions; compost is listed as one of the recommended management practices that lead to SOC sequestration in soils (Lal, 2004; Smith, 2004). In Europe, composting is estimated to have a C sequestration potential of 0.38 tons C per hectare per year (Smith, 2004). Fortuna et al. (2003) showed that compost addition to agricultural systems had significantly higher C sequestration than systems using only fertilizer. As previously stated, the increase in C leads to an increased ability to sequester N; in compost, this N is largely in the form of stable organic N, which will remain in the soil (Lynch et al., 2004.)

Both C and N sequestration in soils through compost application can also give access to C and nutrient trading markets. The C trading market has been established to help offset carbon dioxide emissions that are contributing to global warming. Nutrient trading markets were recently established in Pennsylvania, Maryland, and Virginia to help address water quality in streams and the Chesapeake Bay.

Overall, compost is environmentally beneficial, both from a soil quality and production standpoint. The production of compost is considered carbon neutral because the organic material used to make compost is primarily composed of atmospheric carbon recently taken up as carbon dioxide via photosynthesis (Brady and Weil, 2008). Compost is also an easy way to safely store organic materials for later use while minimizing odors and pests commonly associated with manures and other organics. Thus compost is easy to transport and handle due to its stable nature and reduced volume.

Goals and Strategy

Given that disposal of organic materials results in

- Loss of potential economic development from production of value added products.
- Loss of potential energy production from the carbon contained in these materials.
- Failure to recycle the carbon and nutrients contained in these materials back to soils to enhance soil quality and productivity.
- Methane generation in the landfill and fugitive emissions of this potent greenhouse gas (and even with gas collection is an inefficient way to produce energy).
- Increased need for landfill space that should be reserved for truly non-recyclable materials.

Given Pennsylvania's need for sustainable energy systems and sustainable soils, organic carbon materials

- Should be recognized as valuable resources and not as wastes.
- Must be utilized as inputs to energy production.
- Must be utilized to build soil quality and productivity needed for sustainable food, feed and biofuel production.

Given that

- Animal based agricultural production systems need alternative manure and nutrient management systems to maintain and sustain operation,
- The profitability and economic sustainability of Pennsylvania agriculture is increasingly threatened,
- Demand for organic inputs to agriculture, horticulture, and landscaping is increasing,

We believe Pennsylvania must develop a truly integrated and sustainable system of organic residuals management and recycling. This transformed system requires a state-wide policy that encourages and supports:

- Partnerships between private, agricultural and public sectors. Organics recycling should be done regionally to attain maximum efficiency of operations, and to create jobs through the development of new enterprises for collection, processing, and marketing.

- Production of energy, compost, and other value added products. Organic resources must be directed to their highest value use, recognizing a balance between energy production and soil quality.
- Recycling of organic matter and nutrients into soils. Carbon and nutrient cycling through soils should be restored in as small a loop as possible. Soil quality protection should be elevated to the same level as air and water quality protection.
- Source separated collection of organic residuals. Source separate collections systems will generate the highest quality feedstocks which in turn will yield high value products.

In addition to its environmental benefits, such a system would have significant local economic impacts in the commercial, public/municipal, and agricultural sectors.

- Diversion of 75% of presently landfilled food residuals and non-recyclable paper (2.5 million tons annually) could produce 34,400 million ft³ of methane with a value of \$200 million or 2.5 million yards of compost with a value in excess of \$50 million, and stimulate construction of digesters, expansion of composting operations, and add Pennsylvania jobs.
- Much of this new economic activity could occur on farms providing significant income, organic matter and nutrients thereby improving sustainability of Pennsylvania agriculture.
- Diversion of 50% of leaf and yard debris to farms for composting with manure could utilize up to 400,000 tons of manure annually converting it into compost with a market value in excess of \$20 million.
- Farms on the urban/farm interface would have an economic and social value to themselves and the community.

We believe the following two overarching goals should guide the development of this transformed system. The first of these goals expresses our overarching philosophy for how organics recycling programs should be developed and structured, while the second more quantitative goal lists specific objectives for organics recycling and strategies to achieve them.

1. ***Reestablish balanced and sustainable carbon cycling at the local (county or municipal) level.***
2. ***Reduce disposal of organic residuals by 85% by 2020 and to divert these materials to compost and energy production.***

We believe this can be done by a combination of policy changes that will

- Phase in and enforce bans on landfilling of various types of organic materials,
- Provide for source separate collection of organic residuals,
- Recognize organic residuals as resources for sustainable soil management and raise soil quality protection to the same level as air and water quality protection,
- Recognize organic residuals as resources for renewable energy production, and
- Expand opportunities and support for private enterprises (commercial and agricultural) to partner with the public sector in collection, processing and marketing of organic residuals and products.

We believe no single system for organic residuals recycling will work throughout the Commonwealth. Rather, the state should establish minimum requirements for recycling while allowing maximum flexibility for county and municipal level planning to meet those requirements.

Attaining these goals will require changes in policy and regulation at the state and local level; changes in economic support systems; infrastructure development; and changes in mindset of state and local government officials, regulatory and service agencies, the solid waste and recycling industry, and perhaps most importantly the general public. In the following section we more fully articulate these two goals and outline strategies to attain them.

Goal 1: Reestablish balanced and sustainable carbon and nutrient cycling at the local (regional) level.

This refers to the pathway by which carbon and nutrients (essential components of soil and all living cells) leave the farm and eventually make their way back. In our current system, carbon and other nutrients are constantly being extracted from our farms as we harvest crops. In our current production and consumption systems, much of the carbon and nutrients leaving farms as

produce never returns, and increasingly manures are also exported from farms. Following consumption, we transport organic residuals hundreds of miles to be landfilled, by-passing farms whose soils could benefit from that carbon. We expend significant energy to transport organic residuals, by-passing the opportunity to capture the significant energy contained in those residuals. We envision an organics recycling system that returns a much greater proportion of this carbon and the associated nutrients to soil, possibly capturing energy along the way, thus restoring the carbon and nutrient cycle. A crucial component of this goal will be educating Pennsylvania citizens about the importance of carbon cycling at the local level and its various benefits including renewable energy, richer soils, new business opportunities for farmers, and reduced reliance on chemical fertilizers.

- a) Recognize soil and soil quality as a resource to be protected and sustained.
 - i) Raise soil quality protection to same level as air and water quality protection.
 - ii) Promote soil quality measures.
 - iii) Balance carbon and nutrient inputs into the soil
 - iv) Optimum manure management/odor reduction
 - v) Recognize the linkage between quality soils and water quality.
- b) Recognize carbon as a resource essential for renewable energy production and sustaining soil quality
 - i) Renewable/alternative energy use should be optimized for economic and environmental benefits
 - ii) Transition into anaerobic digestion (AD), gasification, and other processes as viable energy recovery sources

- c) Flows of carbon to energy or to soil needs to be balanced on a local level. Maximum efficiency can be attained by developing and maintaining carbon and nutrient cycling loops that are as small and local as possible.
 - i) Local loops can be established by reconnecting urban and municipal sectors with agriculture to create value-added products and economic opportunities
 - ii) Reconnecting these sectors will be best facilitated by building creative public/private partnerships for collection, transport, and processing of organic residuals. Such partnerships need to be supported by state and local policy at levels equal to support for the public/municipal sector.
- d) Launch education programs on the importance of capturing and recycling all sources of carbon for sustainable energy, sustainable soils, and sustainable society. Educational audiences would include all those identified in point e under Goal 2 below.

Goal 2: To reduce the disposal of organic residuals in Pennsylvania by 85% by 2020.

- a) Step 1: Begin by increasing enforcement of mandates contained in Act 101.
 - i) Move to enforce limits on disposal of leaf and yard waste. When waste hauling trucks and drivers are inspected for licenses and mechanical integrity add inspection of load composition.
 - ii) Move to more closely link leaf and yard waste composting performance with receipt of performance grants.

- b) Step 2: Modify Pennsylvania Act 101 to recycle a minimum of 50% of total waste generated by 2020. Target is attainable by recycling organic materials currently disposed in the waste stream. Organics recycling mandates (as well as sources and types of organic materials to be recycled) should be gradually phased in as described in the following items, allowing for maximum flexibility at local and regional levels.
 - i) Requirements for increased organics recycling should begin with those communities currently mandated under Act 101
 - ii) Develop more strict enforcement at municipal level
 - iii) Expand Act 101 mandated communities to include all communities in Pennsylvania.
- c) Step 3: Create a hierarchy of organic residuals currently in the waste stream and develop a sequence and timetable from now until 2020 for inclusion of these residuals in recycling programs.
 - i) Maintain source separate the collection of all organic resources to insure highest quality feedstocks and products, and entry to the highest value markets
 - ii) Begin with Leaf, Yard, Wood (unpainted) wastes: 30% of organics
 - iii) Expand to include organic residuals from processing, distribution, and sale of food.
Begin with grocery stores, restaurants, educational institutions and commercial generators. Final step would be to add collection of food residuals from households.
 - iv) Expand to include non-putrescible organics such as non-recyclable paper again beginning with commercial and institutional generators and later adding households: 30% of organics.
 - v) Establish mutually beneficial connections between municipal high carbon (leaf and yard trimmings, paper) and agricultural high nitrogen (manure) organic materials.

- d) Implement and enforce disposal bans for organic residuals
 - i) Implement and enforce a real leaf and yard waste landfill ban by 2012 or sooner, as has been done in many other states across the US.
 - ii) Establish ban on disposal of all organic materials generated from food processing and non-recyclable paper products by grocery stores, restaurants, educational institutions and commercial generators by 2016.
 - iii) A policy and infrastructure development plan must precede disposal bans. Collection and processing of these materials should be phased in as capacity is developed. State should continue supporting such infrastructure development with equal opportunity for private and municipal sectors.
 - iv) Final step is to ban disposal of food residuals by households. State will need to provide incentives to facilitate development of infrastructure for collection and processing of household organic residuals.
- e) Accomplishment of the mandates listed under point b above will best be attained by affording counties or multi-county partnerships maximum flexibility in developing plans that suit the local situation.
 - i) Local planning should determine the exact sequence by which organic residuals are added to recycling programs
 - ii) Organics collection, processing and marketing could be done by municipalities, private facilities, private farmers, cooperatives, public-private partnerships, or any combination of the above.
 - iii) There should be *equal* opportunity for all entities listed above to obtain state support for development of organics recycling infrastructure and equipment.

- iv) Organics recycling should be done on as local a level as possible, seeking to restore local cycles of carbon and nutrients back to soil.
- f) Educate at all levels about the “whys” and “hows” of organics recycling and production of compost and energy will be key to attaining all of the goals and objectives listed above.
 - i) Education and outreach efforts must target K-12, general public, municipal officials, legislators.
 - ii) Education efforts should emphasize the value of the organic materials (resource not waste) and of carbon and nutrient recycling to encourage participation, clean source separated material, and support for recycling programs.
 - iii) The educational effort should precede expansion of organics recycling efforts and be an ongoing component of all recycling programs.
- g) Organic residuals should be recycled to highest value energy and compost products.
 - i) Require source separate collection of organic residuals
 - ii) Establish compost quality standards and compost testing requirements to ensure high quality products and highest value markets.

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