ACTION TEAM PROGRESS REPORT

Recovering the Value of Waste for Environmental and Energy Sustainability

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Environmental Problem:

There are several drivers for exploring the environmental benefits of using waste as a source of energy, fuels, or chemicals for further processing and manufacturing of products:

> First, it is critical to significantly reduce greenhouse gas (GHG) emissions from every practice and technology in all sectors and consumer behaviors. Depending on the scenario, using wastes as sources of energy may have a favorable GHG profile, compared to conventional energy sources.
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> Second, consumers and industries strive to increase the availability and reduce the cost of energy for electricity, transportation fuels, and heating. Additionally, our increased demand for primary energy has led to the degradation of natural resources (e.g., water and land) and ecosystems, and generation of significant amounts of solid waste, water and air pollution. The Energy Information Agency predicts that the U.S. domestic supply of natural gas will be exhausted in 50 years while the coal supply will be spent in 250 years. World-wide, technologies able to

use alternative materials, such as wastes, to replace natural gas, oil, and coal are beginning to be developed and evaluated for their economic and technical feasibility, and comparative environmental benefits.

Third, in a world with high prices for dwindling material resources, it is increasingly desirable to derive the highest value for discarded materials, and use them in ways that extend their lifetime use and encourage reuse. This resource conservation is critical for environmental, economic, and resource sustainability.

Fourth, waste generation per capita has increased and is expected to continue to climb with growing population, wealth, and consumerism throughout the world. Communities are challenged to develop systems for managing discarded materials that are cost-effective, have minimal impact on air, water, land, ecosystems and human health, and do not contribute to GHG emissions.

These four trends, combined, present both challenges and opportunities. Converting wastes to energy products hold the promise of:

1) providing more sustainable waste management options
2) providing alternative energy solutions
3) providing increased value of discarded materials
4) decreased environmental and GHG impacts
5) reducing dependence on foreign energy sources and increasing national security
6) development of technologies that aid in transitioning to a hydrogen economy
7) introduction of technologies that can respond to future legislation constraining carbon dioxide emissions
8) enhancing rural power production

The conversion of wastes as a potential source of energy may have value as a supplemental feedstock for the rapidly developing biofuels sector. This sector currently relies on conversion of corn crops to ethanol, and the conversion of soybeans, rapeseed, food wastes, and greases to biodiesel. Reliance on agricultural crops for biofuel feedstock has resulted in an increase in crop acreage, water demand, nutrient and pesticide applications, competition of land-use for growing food, fiber, and energy crops, water quality impacts, and an increase in food prices and shortage of some food crops. There is considerable skepticism as to whether agriculturally derived biofuels is sustainable. Life cycle analyses have demonstrated that both net energy and GHG emissions can be lower or higher than conventional energy sources, depending on agricultural production system inputs and outputs for the type of feedstock grown, and the energy source and operating efficiencies of the conversion technology used to produce the fuel.

As this industry evolves, it will rely more heavily on cellulosic biomass, including agricultural plant residues, woody biomass, and perennial energy crops, such as switchgrass. Biochemical and thermochemical conversion technologies being developed for producing biofuels, today and in the future, may also be capable of converting various forms of wastes. Although the U. S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA) are intensely investigating the feasibility of agricultural crops and residues, and woody biomass, there is very little exploration of waste as a feedstock, or characterizing inputs and outputs using this feedstock compared to other bio-based feedstocks.

In addition, there may benefits to using waste as a source of energy for power at the biorefineries. Life cycle GHG emissions are considerably lowered when biomass is used as an energy source for power, compared with coal and natural gas. Characterizing the environmental performance of using waste as an energy source at biorefineries compared to both conventional and biomass energy sources may provide one more economically feasible energy source for this industry.

Technology Challenges: A variety of new technologies are being developed for the production of biofuels that may also be capable of converting wastes into heat, power, fuels, or chemical feedstock. Although there are many concepts and pilots being developed, relatively few technologies are commercially available to date in such proportion as to effect long-term economic, structural and behavioral changes. It is important to understand the technical and economic feasibility of these technologies, along with their environmental performance to move them towards commercialization.

The technical and economic feasibility, as well as the environmental performance of using various wastes as a feedstock for energy products will be dependent on the characteristics of the waste, conversion technologies, the type of energy product produced, and the geospatial relationship between feedstock, conversion, and use. Discarded materials with potential for conversion to energy products include: municipal solid wastes, construction and demolition wastes, manures, woody biomass wastes, food wastes, biosolids from waste water treatment plants, and animal renderings.

Besides characterizing the technical and economic feasibility and environmental performance of conversion technologies, the feedstock supply must also be evaluated (including availability, energy content, collection, separation, and processing) as part of a life cycle analysis of costs, net energy, GHG and environmental emissions.

Economic and environmental aspects of a waste conversion system need to be compared to other biomass feedstocks used for biofuels and to other waste management options, including landfilling the waste, reusing/recycling the waste, or other management options.

In addition, identification of regulatory barriers to using waste as a feedstock need to be identified and further analyzed.

This team will develop an analytic framework that systematically compares use of waste as a biofuel feedstock and as a source of energy for power, compared with other biomass sources and conventional energy. It will also compare using waste as an energy feedstock compared to other waste management options.

Key challenges are to:

- compare full life cycle environmental and GHG emissions of waste as an energy source for power compared to other biomass sources and conventional energy sources at biorefineries

- compare full life cycle environmental and GHG emissions of waste as an energy source for power compared to other waste management options for that waste.

- Compare full life cycle inputs and outputs of waste as a feedstock in technologies capable of converting wastes into fuels to other agriculturally based or other biomass feedstocks. Inputs would include water, land, and chemical use; outputs would include water effluents, air emissions, wastes, fuels, and co-products.

FY'07 Team Accomplishments:

- Environmental and Sustainable Technology Evaluations (ESTE) program – Verification of co-firing of solid biomass with coal in boilers.
- Published *Biomass Conversion: Emerging Technologies, Feedstocks, and Products* , posted at www.epa.gov/sustainability
- Region 6 developed GIS Decision Tool to help identify available feedstocks and infrastructure for WTE conversions.

FY'08 Team Accomplishments:

- Presented abstract exploring feasibility and benefits of considering waste as an alternative biofuel feedstock at the Ecological Society of America Conference, March, 2008
- Forged partnerships with USDA's Office of Technology Transfer, Agricultural Research Service, and DOE's Biomass Program in the Office of Energy Efficiency and Renewable Energy to explore collaborative opportunities in research and pilot demonstrations using waste as a feedstock

FY'09 Objectives:

- Develop MOU between USDA and EPA to collaborate on waste to energy systems.
- Inventory waste to energy technologies, including:

    - Number of conversion technology types, location, kinds of wastes for which technical feasibility has been verified, etc.
- Identify wastes that have potential to be used as fuel, and potential GIS mapping of geographic predominance, annual generation rates, and collection infrastructures
- Secure funding to perform Life-cycle analyses on predominant, emergining waste to energy technologies
- Identify environmental performance (e.g., emissions to air, water, waste residuals, etc.) of these technologies and compare them with similar technologies using non-waste fuels, as well as comparing them with other waste treatment technologies
- Identify industries/sectors that could benefits from waste to energy technologies
- Quantify potential energy savings/conservation by employing waste to energy technologies.
- Identify EPA's unique and collaborative roles in mitigating barriers for waste conversion technologies
- Identify specific state, industry, regional interest in waste to energy.

Issues/Lessons Learned:

- **Staffing & extramural funds –** The Team Leader leverages opportunities, staff and funding as it arises, but there is no strategic plan or commitment of funds to carry out objectives.
- **No formal recognition of this as part of job role**
- **No detailed reporting back to management on accomplishments or followup actions that are needed.**
- **Lesson learned –** need staffing and funding and upper management interest