By-Product Synergy Supports Sustainable Development

Case Study

Summary

By-product synergy (BPS) is the practice of matching under-valued waste or by-product streams with potential users. This practice helps to create new revenues or savings for the companies involved while simultaneously generating social and environmental benefits. In 2002, three Dow Chemical Company plants in New Jersey and Pennsylvania joined 12 other companies to take part in a BPS project. The New Jersey Department of Environmental Protection and Andy Mangan of the U.S. Business Council for Sustainable Development are leading this effort with support from CH2M HILL, an engineering consulting firm. Dow Chemical also plans to implement BPS at several of its facilities on the Gulf Coast, including the Texas Operations facility. Concurrently, Dow Chemical will initiate a traditional multi-company BPS project with a diverse set of companies in the Houston/Freeport area. Experience gained from the internal Dow greater synergy program will be leveraged to the benefit of the external project, in which greater diversity is expected to produce a wider range of opportunities for by-product synergies. The two-pronged Gulf Coast BPS effort will be led by Andy Mangan with support from CH2M HILL and the Dow Environmental Technology Center as part of the U.S. DOE-sponsored BestPractices Plant-Wide Assessment program.

By-Product Synergy: A Win-Win Strategy

As defined by the U.S. Business Council for Sustainable Development, BPS is "the synergy among diverse industries, agriculture, and communities, resulting in profitable conversion of by-products and wastes to resources promoting sustainability." BPS transforms wastes or by-products for which companies may have to pay disposal costs into sellable commodities that create a flow of income. The wastes may serve as raw materials for existing products or as the basis for an entirely new product.

Benefits

- New uses for waste/by-product streams.
- Reduced environmental impacts.
- Positive flow of income for producers and users of waste/by-products.
- Potential for new products.

The practice of BPS helps to foster sustainable development and brings companies closer to a synergy between environmental quality and economic growth.

While the economic and environmental benefits of BPS vary from case to case, previous studies have shown significant energy and cost savings in addition to reduced environmental impact.

By-Product Synergy Success Stories

One of the earliest companies to adopt BPS was the Chaparral Steel Company. In the early 1990s, managers of Chaparral Steel began exploring synergies between the company's operations and those of its parent company, Texas Industries, a manufacturer of Portland cement. The most successful synergy discovered was the potential for steel slag to be used as a raw material for cement. As a result of the high temperatures of the steelmaking process, steel slag contains dicalcium silicate, a building block of Portland cement. By using the steel slag instead of purchased lime (that would then have to be heated to calcination), the cement-making operation at Texas Industries reduced energy requirements and related emissions—carbon dioxide (CO_2), oxides of nitrogen (NO_x), and sulfur dioxide (SO_2). Profits for both companies also increased.

The Chaparral Steel Company is one example of a handful of companies that have successfully developed synergies. Other BPS studies, such as the Business Council for Sustainable Development projects—Tampico (Mexico), Alberta (Canada), North Texas, and Montreal (Canada)—have been larger, involving up to 20 companies and organizations that cut across several industries. A sampling of successful synergies is shown in Table 1. As the numbers indicate, BPS presents a large opportunity for reducing raw material consumption, energy use, emissions, and waste generation, while also decreasing costs.

Table 1. Annual Cost and Environmental Benefits of Successful Synergies

Implemented Synergies	Ecological/ Biological	Energy Savings	Residue Reduction	Cost Savings
Steel slag used in place of lime in cement-making	• Reduced SO_2 (acid rain) through coal displacement	• Displacement of 11,800 tons of coal used to calcine lime (3.5 billion Btu)	• 130,000 tons of steel slag kept out of landfills • Emission reductions from coal displacement: 65,000 tons of CO_2, 800 tons of NO_x, 33 tons of hydrocarbons	Steel producer: • Value added to steel slag • Reduced/eliminated steel slag treatment/disposal costs Cement producer: • Less costly raw material • Calcination is not required; reduces energy consumption and associated emissions for cement production
Auto Shredder Residue (ASR) mined for metal reclamation, and used for power generation	• Reduced SO_2 (acid rain) through coal displacement	• 18,000 tons of metals (Al, Cu, Mg, Sn) received through ASR as opposed to mining • 98,000 tons of carbon-based ASR displaces 66,000 tons of coal for power generation (20 billion Btu)	• 120,000 tons of ASR kept out of landfills • Energy savings associated with metal recovery versus mining prevent 151,000 tons of CO_2 emissions • SO_2 emissions reduced by substitution of ASR for coal	ASR producer: • Reduction/elimination of ASR disposal fees • Increased revenue from recovered metals • Revenue from sale of ASR as alternative fuel ASR consumers: • Lower cost, less energy-intensive method of obtaining metals • Lower cost fuel
Copper recovered from graphite/copper sludge	• Landfill biota saved from exposure to toxicity of copper waste	• 18,750 pounds of copper recovered and not mined (5.6 million Btu)	• 37,500 pounds of graphite/ copper sludge not landfilled • 412,500 gallons of graphite/ copper-tainted wastewater kept out of municipal wastewater treatment	Sludge producer: • Reduced/eliminated waste-disposal fees • Revenue from sale of sludge to copper-extraction company Metal recovery company: • Lower cost source of copper

New Jersey Project

The most recent BPS project, launched in 2002, involves 3 Dow Chemical plants in New Jersey and Pennsylvania plus 12 New Jersey companies. These companies represent a range of industries and processes, which is key to expanding synergy opportunities.

- Burlington County Resource Recovery Complex
- The Dow Chemical Company (3 facilities)
- Ferro Corporation
- Hercules
- Mannington Mills
- Merck
- Motiva Enterprises
- NJ American Water
- OTC-Burlington County
- Public Service Enterprise Group
- Shield Alloy
- US Pipe
- Winzinger Corporation

The U.S. Environmental Protection Agency (EPA) is working in conjunction with the New Jersey project to understand the BPS process and verify BPS benefits for the environment. The EPA is funding the Center for Clean Air Policy, a non-governmental organization, to select and analyze a representative sample of the synergies to determine the environmental benefits versus current methods for handling and disposal.

In the past, regulatory issues such as the definition of "waste" and subsequent rules on the storage, transportation, and disposal of the waste material have limited the potential for reuse. One benefit of EPA's involvement is that the agency will be in a position to address these issues. Results of the case studies may also strengthen the case for BPS and provide a firm foundation upon which to promote its use.

The facilities have explored more than 50 promising synergies and are now evaluating the characteristics of the waste streams to determine their composition and day-to-day consistency. The companies are actively pursuing approximately 12 of the synergies identified. Dow Chemical plants are pursuing the use of a latex emulsion stream (from paint production), off-grade polyethylene or polyethylene scraps, and rigid polyurethane foam scraps.

The production of latexes used in paints generates a wastewater stream containing latex. Ultrafiltration is used to recover much of the polymer, but a small amount remains in the wastewater sent to a treatment plant. Also referred to as "white water" because the oil-based latex is insoluble in water, the latex adds a "stickiness" that can be used in road construction and agricultural operations to control dust. The Public Service Enterprise Group, an electric company participating in the New Jersey project, has expressed interest in using the "sticky" water.

One of the Dow Chemical facilities has a polyethylene (PE) compounding plant that makes insulation and jacketing for the wire cabling industry. PE compounds that do not meet material specifications, as well as scraps, are often landfilled, but Dow Chemical is hoping to match these waste materials with a potential consumer. In the past, such material has been used in countries such as China to manufacture shoe soles. Because shipping costs can be prohibitive, the key to implementing this synergy is the identification of local customers.

The third promising synergy is the use of waste cuttings generated in the production of rigid polyurethane foam boards for building insulation. Approximately 5% of the foam board is lost when cut down to size. The foam scraps can be shredded and added to potting soil to increase aeration.

Gulf Coast By-Product Synergy Project

The New Jersey project has enabled Dow Chemical to become familiar with the BPS process and to gauge the success of BPS firsthand. Through its participation in the project, the company has recognized the potential cost savings and environmental benefits associated with by-product synergy. The company will build on the experience gained through the New Jersey project in sponsoring its Gulf Coast BPS project.

The Gulf Coast project will consist of two phases to be carried out simultaneously: an internal Dow Chemical BPS project between the Texas Operations facility and other nearby Dow Chemical facilities, and a traditional multi-company BPS project. The two-phase project will be carried out as part of the DOE-sponsored BestPractices Plant-Wide Assessment program. The multi-company BPS project will involve 10 to 15 companies within a 100-mile

radius of the Freeport/Houston area. Andy Mangan, Executive Director of the U.S. Business Council for Sustainable Development, will lead the teams, with support from cross-functional experts at CH2M HILL and the Dow Environmental Technology Center.

Figure 1: Aerial View of Plant B, Texas Operations Facility

The Texas Operations facility is Dow Chemical's largest integrated site, composed of three major complexes: Plant A, Plant B, and Oyster Creek. Together, the three complexes serve all eight of Dow Chemical's Global Business Groups. The Texas Operations facility manufactures approximately 40 billion pounds of chemicals and other products annually, ranging from performance chemicals and plastics to fuels and agricultural products. Of the products manufactured at the Freeport site, 23 billion pounds are consumed internally, and the remaining 17 billion pounds are sold to customers. The facility runs 75 individual production processes. Several opportunities may exist for creating synergies between these processes and other Dow facilities in the area.

The Houston area is home to many chemical, petroleum refining, and electronics companies, with manufacturing processes that offer potential synergies among facilities. Dow Chemical hopes to take advantage of the breadth of industries concentrated in the Houston area to create exchanges of waste and by-product streams that will be economically and environmentally beneficial to both parties.

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For more information, please visit our Web site: www.eere.energy.gov

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