United States Business Council For Sustainable Development

By-product synergy networks: reducing waste while creating business opportunities

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The by-product synergy process (BPS) brings clusters of facilities together to create closed-loop systems in which one facility's wastes become raw materials for another. By exchanging materials, energy, water and/or by-products, participants reduce waste, greenhouse gas emissions, and the need for virgin-stream materials. At the same time, they gain opportunities for new products and processes. The US Business Council for Sustainable Development (US BCSD) has developed and facilitated synergy networks throughout the United States and overseas in locations including Chicago, the Gulf Coast, Kansas City, and the Pacific Northwest.

As our world becomes more carbon-constrained, it will become increasingly important to find ways to reduce wastes by reusing by-product streams. And at a time of great financial uncertainty, BPS also presents the potential for important economic development by increasing revenues and creating jobs.

The US BCSD promotes these exchanges by establishing a forum in which companies, regulators and municipalities explore reuse opportunities through collected information and facilitated interactions. Participants sign an agreement that spells out deliverables, confidentiality issues and intellectual property rights. Rather than simply declaring potential exchanges, the BPS process fosters relationships among companies and municipalities, establishing trust and building bridges.

Unlike a waste exchange, which is a static process, by-product synergy is an active process that may involve process changes that allow synergies that would otherwise not be feasible. And while eco-industrial parks rely on co-locating industries, BPS networks take advantage of existing ones in heavily industrialized areas.

Both the US derived BPS process and its European relative, industrial symbiosis, have been cited as a tangible and applied examples of Industrial Ecology, a term defined in 1989 by Frosch and Gallopoulos [1]. As Chertow et al explain it; industrial symbiosis brings together traditionally separate entities in a collective approach to competitive advantage that involves physical exchange of materials, energy, water, and by-products.

BPS Origins

The Business Council for Sustainable Development of Latin America was formed in 1992 following the United Nation Conference on Environment and Development in Rio de Janeiro.

The following year, the Business Council for Sustainable Development for the Gulf of Mexico (BCSD-GM) was formed as a member organization of business leaders. The organization, whose members believe that business success is increasingly measured by contributions to economic, social, and environmental sustainability, evolved to become the US BCSD in 2002.

In 1995, the BCSD-GM received an EPA grant to identify case studies and opportunities in a process the EPA called green twinning, and which the BCSD-GM referred to as by-product synergy. This venture stemmed from the efforts of Gordon Forward, then president of two neighboring companies in Texas: Chaparral Steel and Texas Industries [3].

Chaparral Steel Company was one of the first companies to formulate the BPS concept. The company, based in Midlothian, Texas, is now known as Gerdau Ameristeel. Its parent company, Texas Industries (TXI), produced construction materials from sand, aggregates, cement and concrete. In the early 1990s, Mr. Forward led managers of the two jointly-held businesses in a series of conversations about potential synergies. Several possibilities emerged from these conversations, illustrated in Figure 1, to remove redundancies between the two companies [4].

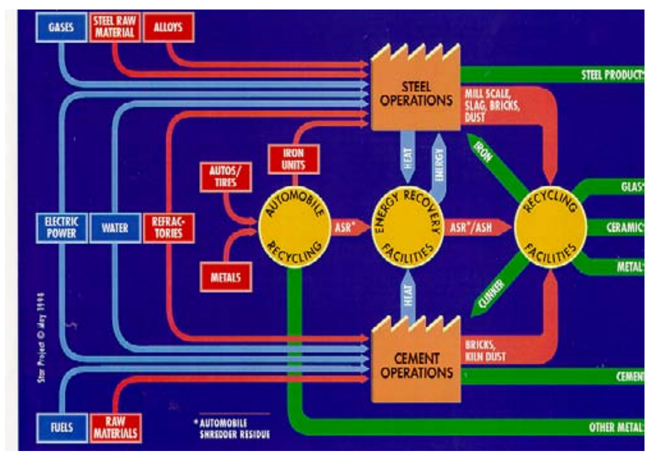


Figure 1: Proposed Flow Diagram at Chaparral steel

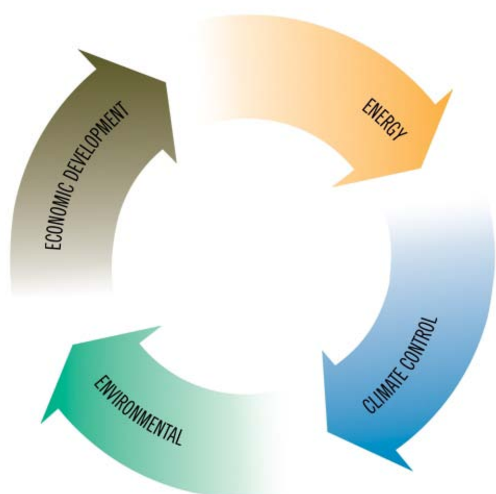
The primary synergy to emerge – the now-patented CemStar process - was based on the premise that steel slag could be converted to a raw material in Portland cement. Steel slag includes dicalcium silicate, which constitutes a building block of Portland cement. By using lime that has already been calcined, cement manufacturers could skip an energy and CO2 intensive step in their process [5].

Previously, slag was cooled, crushed, and sold to the road construction industry. Using the steel slag instead of purchased lime significantly reduced TXI's energy requirements and related emissions. CemStar has resulted in 10 to 15 percent overall energy savings, 10 percent CO2 reductions, 25 to 45 percent NOx reductions, and 5 to 15 percent production increase. In addition, the slag is worth more than 20 times what it was worth as road construction fill [5].

A carrot sorter in Belgium proved an unlikely source of inspiration to Chaparral. The company studied the density separation process used to sort carrots and applied the same concept to its auto shredder. Chaparral was producing about 120,000 tons of residue by shredding one million automobiles per year. Auto shredder residue (ASR), also called fluff, consists of about 25 percent of the automobile by mass [6] and includes materials not removed by standard steps in the shredding process, such as plastics, oxides, fluids and foams. The food industry-imported technology enabled high throughput and inexpensive separation of these materials, including a 15 percent increase in metals over what was obtained in the shredder. This separation also generated a stream of concentrated non-chlorinated plastics, a potential fuel source that would otherwise end up in landfills. This potential ASR-derived fuel source has a calorific value of 14,000 btu/lb, the equivalent of a light bituminous coal. Gerdau Ameristeel and Lafarge Cement are pursuing a version of this synergy as part of the Kansas City BPS project [7]. The regulatory hurdle preventing final implementation involves the 50 ppm of polychlorinated biphenyl (PCB) present in the fluff. The incineration process used in the kilns may, however, prove to be as effective as current methods for destroying PCBs [4], [8].

Methodology

The US BCSD BPS methodology involves establishing a forum where companies, regulators and municipalities explore reuse opportunities through collected information and facilitated interactions. Participants sign an agreement that spells out deliverables, confidentiality issues and intellectual property rights. Rather than simply declaring potential exchanges, the BPS process fosters relationships among companies and municipalities. The process is about information gathering and facilitation, but also about trust and bridge building.



The process begins by cataloging each participating organization's inflows and outflows in a confidential data base that is analyzed for synergies by an experienced project team and through facilitated working sessions with the participants. Participants develop action plans for synergies determined to be commercially viable, and organize strategies for addressing technical, regulatory or other barriers. Synergies typically cut pollution, save energy, reduce material costs, improve internal processes and improve the bottom line. Regulators have demonstrated a willingness to encourage and support the permitting of reuse options that deliver demonstrable environmental benefits.

A key step in a by-product synergy project is to team with a local coordinating body, often a local non-profit such as the Chicago Manufacturing Center in Chicago or Bridging the Gap in Kansas City. Using an independent facilitator eases the difficulties in bringing together disparate companies across traditional sector and industry boundaries [9]. Other key ingredients for a potential synergy network include project champions, a researched and justifiable location, and several interested stakeholders. Adequate funding is also necessary to staff the network, search for synergies, and perform ongoing evaluation and measurement. Broad-based support is needed from local, state, and federal government agencies, as well as network participants. The government's role in developing synergy networks has been to provide technical expertise and funded grants, coordinate learning and resource sharing across regions, and ensure that the appropriate regulations are in place. However, there are limits to what the government can enforce; by-product synergy networks need to evolve synergistically, with the support of agencies, but without mandates [10].

Barriers & Accelerators

Businesses and municipalities stand much to gain from implementing by-product synergy, but first, they must overcome regulatory, technical, and economic barriers.

For one thing, potential synergies may be at odds with local and national environmental ***regulatory*** requirements. Regulators have, however, been willing to consider permitting reuse options when projects produce environmentally beneficial results [3]. When regulation takes the form of landfill bans and disposal fees, it can even provide incentives for by-product synergy development.

The ***technical*** feasibility of exchanges could provide another barrier to execution. From the outset, tracking and characterizing materials flows requires a level of technical expertise within a company. In some cases research and development may be necessary before a particular synergy can be pursued.

Successful synergies may also be hindered by ***economic*** barriers. Companies will do what is in their economic interest and are less likely to pursue synergies if the potential savings are not clearly demonstrated. .

A further economic consideration is the size, scope, and consistency of feedstock supplies if by-products are to be used as feed to another commercial process. A crucial objective in researching potentially useful byproducts is to identify streams that will exist in the future, are of sufficient volume to support process development, and can be effectively blended with existing process without impacting process or product reliability.

Synergies require sufficient ***communication*** among interested parties. Companies must freely exchange waste and by-product characteristics, resource requirements, conversion technologies, economic information, and other factors that affect project feasibility. Communication and trust are important when materials are being exchanged or infrastructure is being shared because of potential liabilities. Participating industries may use different terms to describe their processes, which can create confusion and inhibit collaboration. Strong social networks can facilitate the discovery and implementation of synergies [11].

The keys to BPS are collaboration, motivation, innovation and participation. All levels of an organization should be involved in identifying, evaluating and implementing the project to ensure that all potential barriers to success are identified and overcome. Including a diverse range of industries and organizations broadens markets and creates more opportunities.

BPS creates economic, environmental and social benefits. Manufacturing innovations may improve efficiency and productivity, boosting revenue. BPS can eliminate or reduce disposal and treatment costs, and cut the costs of energy, transportation and materials while improving internal processes. Under ideal conditions, the waste produces new revenue through connection to new markets.

These reductions in pollution, emission and waste streams benefit the network and the region as a whole. Carbon emissions are also reduced when existing materials are reused rather than using new materials with carbon-intensive extraction or production impacts.

BPS participants can demonstrate regional and national leadership in sustainability. The relationships established by these networks lead to improved community perception and connections, enhance networking and partnership and opportunities to showcase sustainable practices and processes. Companies interested in clustering around synergistic opportunities may be drawn to the region, and the process can help create new jobs and businesses.

The strength of a BPS network stems from the development of accurate measuring protocols and diagnostic metrics. The need for quantifiable results in showing environmental benefits has increased in recent years due to concerns about CO_2 emissions and climate change [12]. Benefits are quantified by measuring the changes in consumption of natural resources and in emissions to air and water through increased cycling of materials and energy. Economic benefits are quantified by determining the extent to which companies cycling by-products can capture revenue streams or avoid disposal costs.

Example

In the fall of 2005, the Department of Environment for the City of Chicago was looking for a proven, but exciting process for developing eco-industrial activities in the Chicago region. Coincidentally, the Chicago Manufacturing Center (CMC) had begun collaborating with the US BCSD to create a BPS process toward business resiliency. Through this partnership, with assistance from EPA Region V, the City of Chicago could leverage both groups' expertise to develop the type of network that the city had hoped to develop. In October of 2006, Mayor Richard M. Daley launched the Chicago Waste to Profit network (CWTPN). As many as 80 companies have become a part of this network and have discussed more than 100 synergies. Fifty of the projects have been implemented in this partnership mentored by the city of Chicago, US BCSD and the CMC [13].

Through City of Chicago leadership, additional investments were provided through the State of Illinois' Dept of Commerce and Economic Opportunity Recycling Expansion and Modernization Program, and the National Institute of Standards and Technology's Manufacturing Extension Partnership. Company participants paid fees to be part of the network. Using the hybrid approach of innovative networks between fee-paying companies as well as smaller community networks, the CWTPN has enabled involvement by smaller companies and entrepreneurial firms. The innovation network, based on the US BCSD BPS model, forms the core of the CWTPN, and is coordinated by a team providing communication, technical expertise, and facilitation. This network is designed for 10-to-25 organizations that have signed an agreement spelling out deliverables, confidentiality, intellectual property issues [14]. The great variety of companies involved in this network has allowed for a diversity of potential materials streams, increasing the probability of synergistic exchanges including food waste, plastics, solvents, chemicals, paper, construction materials, soils, and metal.

Like other BPS projects, the Chicago network includes a series of working groups divided along types of potential synergies. These subcommittees focus on individual opportunities within one type of by-product stream. For example, the organics group involves 12 companies and two city departments collaborating on 11 synergies with a current estimated total waste diversion from landfill of 4,400 tons. This group focuses on long-term projects involving alternative fuels, composting, anaerobic digestion, and changing regulations to reflect changing resources. Another affinity group focusing on transforming hazardous waste into revenue streams involves 10 companies and five city departments. The group is collaborating on 14 synergies, with a current estimated total waste diversion from landfill of 1117.5 tons. In the future, these affinity groups will expand to include water and energy sections [14].

The CWTPN has framed itself as a metrics-driven network from the beginning and focused on Chicago area manufacturing sectors in a ratio proportionately aligned with its prominence in the area. In its pilot year, CWTPN diverted approximately 22,118 tons of landfill-bound waste, saved $4.5 million in costs and new revenue creation, and reduced almost 50,000 tons of CO_2 emissions [15]. This network continues to expand and implement more synergies.

As BPS networks develop, industry goals may shift from reducing waste generation towards producing zero waste and finally to producing 100 percent product. This can be accomplished while lowering emissions and reducing energy use. Among the ultimate benefits will be sustained networks that engage and benefit their communities.

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