Case Study

HARBEC PLASTICS INC
TECHNICAL INNOVATION WITH ENVIRONMENTAL RESPONSIBILITY

CLEAN AIR COOL PLANET

Power & Productivity Through Energy Innovation

"Plastics," intones Murray Hamilton's Mr. Robinson in the 1967 movie *The Graduate*, woozily advising Dustin Hoffman's hapless Benjamin. "There's a big future in plastics."

About that, at least, he was right. It is today hard to find a place, from the home, to the highway, to the heart, where plastics aren't an important part of our lives. The fact that plastic is *plastic* makes it possible to use parts intricately designed for a unique purpose. Behind the scenes, plastic injection-molding is a multi-billion dollar, highly-competitive industry that relies on engineering, chemistry and precise production to make those essential widgets. And the industry is as energy-intensive as it is essential.

Harbec Plastics, Inc., a small New York custom-injection molder, has seen the future and taken a unique approach, radically altering the usual manufacturing practices, to emerge as a beacon for others to follow. Harbec has developed a solid reputation for turning out an array of parts, from basic items to engineering prototypes - components made from resins created to resist extreme temperatures or stress, sometimes mimicking substances like aluminum. In an era where just-in-time manufacturing rules the game, Harbec's work ranges from low volume prototypes to large production runs with tight delivery schedules.

Harbec faced soaring electric rates, (15.5 cents per kWh, among the highest in the U. S.), sporadic power surges or outages, and the need to meet the requirements of demanding customers in the automotive, medical equipment, and office products industries, coupled with increasing reliance on power-sensitive computerized controls. Management realized as early as the mid-1990s that they could either work to adequately address these issues, or plan on adding the Harbec name to the list of closed factories in the area around Rochester, NY.

They went to work.

CASE STUDY SNAPSHOT

Technologies:

- Manufacturing equipment & plant energy efficiency upgrades, including combined heat & power system, with gas micro turbines
- Sustainable LEED certified building techniques
- Fuhrlaender wind turbine; up to 350,000 kWh/ year.
- Alternative-fuel vehicles
- Holding pond with plastic-waste filtration system

Investment funding:

- Efficiency paybacks
- Multiple bank lenders for large long-term projects (e.g. wind turbine)

Lessons Learned:

- Investing in energy reliability & independence increases profitability
- Addressing energy concerns allows for simultaneous improvement to working environment & employee morale
- Systemic focus on efficiency and environmental impact encourages multi-problem-solving, spurs innovation and enhances corporate competitiveness

CO_2 Emissions reductions:

1,807.94 tons annually

Using Energy Efficiently

The art of molding intricate parts from plastic is a complex process relying on expertise from diverse disciplines. Permanent molds, or tooling of a particular product, are first formed from blocks of metal, based on engineering diagrams. After testing, the mold is installed onto machinery that injects heated plastic resins to cast each part. Following a cooling period, the piece is ejected, the mold refilled, and the process begun again. In many facilities, the production line involves hydraulic equipment, introducing heated petroleum products to the shop floor. Until recently, that was the case at Harbec Plastics, where during the warm summer months the heat and humidity levels were taking their toll on workers, machinery and product. Making matters worse, electric dryers were used to speed up cycle time, contributing to the discomfort levels and ratcheting up fuel costs. One option, to simply air condition the entire production area, was quickly eliminated due to the high cost. Instead, the challenge for management was clear: reduce energy consumption, find a way to eliminate the waste heat, and determine energy sources for future growth.

In truth, the process began almost 10 years ago, when Harbec's President, Bob Bechtold, explored the concept of bringing a wind turbine on-line to provide affordable, dependable power. After running into a number of obstacles, he began investigating alternatives, including a hybrid wind/Diesel generation system, and gas-fired micro turbines. But before choosing one or the other, his management team needed to complete a comprehensive review of the manufacturing operation, in effect reverse-engineering the entire process looking for cost effective solutions. A key step was identifying an independent consultant to provide guidance, and for that they turned to Bruce Keeley of Energy Concepts Engineering, a firm with previous experience with on-site power generated via reciprocating engines—and a willingness to help develop new answers to old problems.

After completing an energy audit, the company turned its focus towards low-hanging fruit like replacing lights around the shop floor and purchasing more efficient motors, soft starts, and inverter drives. Next came a decision to replace two-dozen hydraulic-powered injection-molding machines, long-time standards of the industry, with something that used less energy. This purchase required a thorough financial analysis since the new electric machines cost 50 percent more than the old hydraulic ones, a significant obstacle for a small privately held company.

Electric-powered injection molder

Harbec convinced the bank that the higher purchase price was a prudent investment risk, since the replacements would recover the cost differential in roughly three years from savings due to the reduced energy consumption. By converting over to all-electric molding equipment, which draws power only when needed, Harbec alleviated two problems: excess waste heat and excess moisture. As an additional benefit, the hydraulic oil residue from leaking fittings disappeared from the shop floor, as did much of the noise, allowing workers to have normal conversations from just a few feet away. Most importantly, the company effectively cut its greenhouse gas emissions from the molding operation in half.

Combined Heat, Cooling and Power

But the engineer in him continued to drive Bob Bechtold to deal with the core issue –dependable power, from a clean, affordable source. Each year, American businesses loose billions of dollars due to blackouts, brownouts or minor fluctuations in power to electronic devices. For Harbec, that translates into lost production time, wasted materials and the inability to meet the needs of large customers, who could shift their orders to less expensive offshore manufacturers. Of the many solutions considered, the one that held the most promise was the use of micro turbines, in effect, miniature jet engines that can run on a variety of fuels. By using this highly efficient form of on-site electric generation, Harbec would cut down on transmission inefficiencies, and be able to supply its own power from natural gas, methane, kerosene,

or waste gases, without oil, oil filters, or coolants, which was very important to this ISO 14001 certified company.

Four Capstone micro-turbines coupled with a heat exchanger at Harbec.

This is where the consultant's expertise paid off. Bruce Keeley was able to design a small power plant consisting of 25 Compressed Natural Gas (CNG) fired Capstone© turbines in matched banks of four linked to five heat exchangers. Each turbine is capable of producing 30kW of electricity for a theoretical potential of 750 kW, roughly twice the plant's average requirements. "Waste" heat from the exchangers would be connected to a 100-ton absorption chiller linked to the ventilation system, providing efficient air conditioning for the entire molding and production facility. The technology offered increased reliability, had only one moving part to wear out, and the entire system could be monitored and controlled electronically by existing staff. What's more, because they are only about the size of a house-hold refrigerator, the Capstone units could be safely sited within the factory floor. By making the transition to generating its own electricity, Harbec would no longer suffer intermittent power outages capable of ruining significant production quantities. A final benefit: the choice would satisfy owner Bob Bechtold's environmental commitment, reducing greenhouse gas emissions.

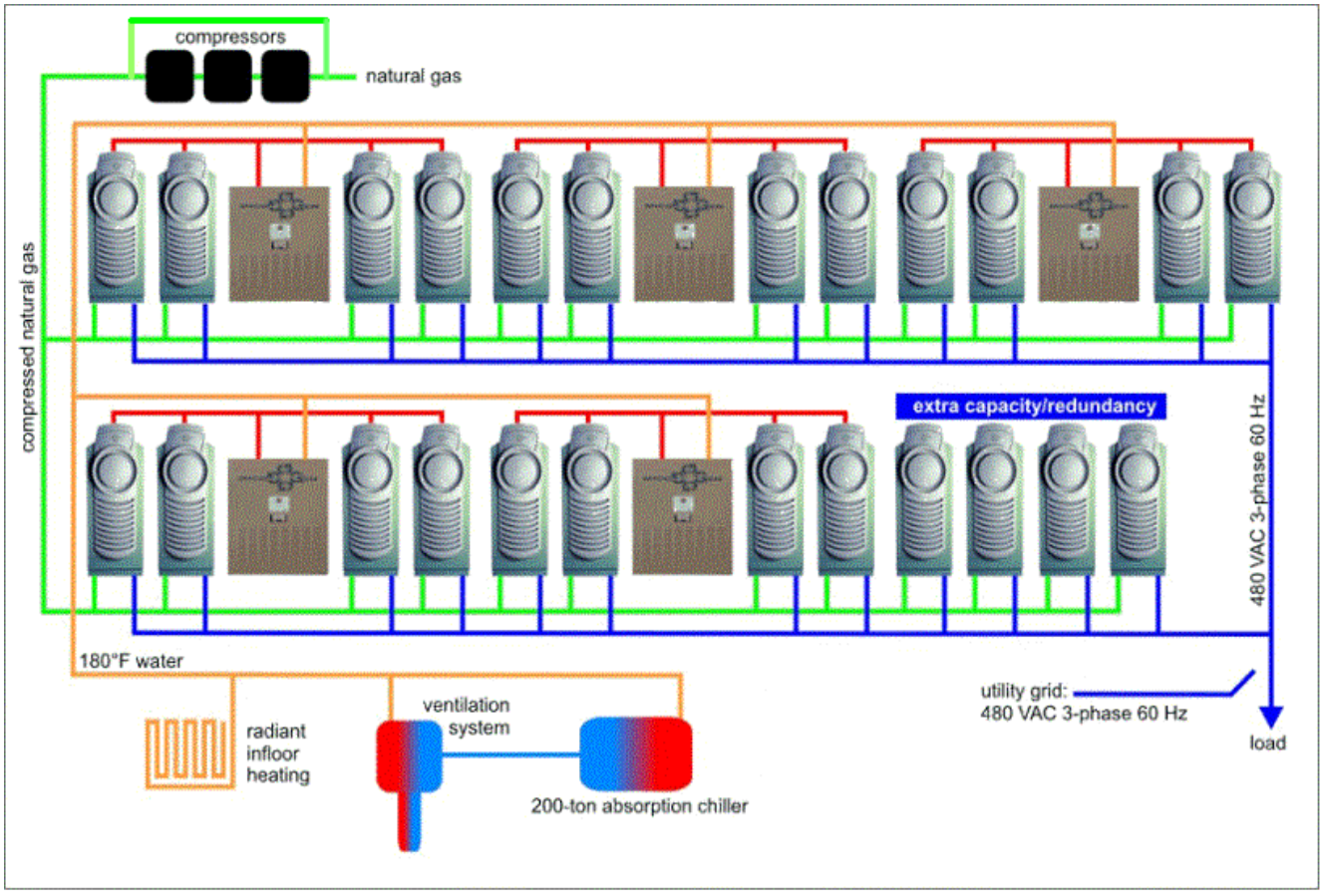

Diagram of combined heat & power project, integrating micro turbines, heat exchangers & absorption chiller.

"Green" Building
Since the new equipment would need a dedicated area, convenient to the plant's utilities, Harbec needed to evaluate its needs for expanding the existing factory, while minimizing the impact of new construction on the natural environment. Once again Energy Concepts Engineering played a key role, helping to evaluate the US Green Building Council's Leadership in Energy & Environmental Design (LEED) program. This voluntary, nationwide rating system for green building encompasses architectural design, site orientation, building materials, indoor air quality and landscaping. Although initially developed with schools, municipal and office buildings in mind, Bob Bechtold found the LEED concept of a high performance sustainable building attractive. The team considered a number of features, settling on extensive use of day lighting via skylights, pre-engineered wall segments with insulation, interior and exterior siding all preinstalled, a system that re-circulated warm air around the warehouse, and radiant floor heating, taking advantage of the waste heat from the combined heat and power project.



Sustainable building at Harbec Plastics: skylights and efficient lighting, wall panels, radiant heating.

Renewable Electricity
Since Harbec was taking a comprehensive approach to planning its future, the company seized the opportunity to reexamine the prospects for green power, harnessing the steady winds coming off nearby Lake Ontario. Even though the location was found to be less than the level traditionally sought by commercial wind farm developers, the value of the power produced was higher because it was displacing power purchased at a high electric rate. Coupled with the on-site distributed power, it would more than meet the company's power needs well into the future. The design team settled on a 250kW unit capable of generating approximately 350,000 kWh of electricity annually, and proceeded to erect the 130-foot tower and three blade Danish upwind designed Fuhrlaender Wind Turbine adjacent to the planned addition. According to Bechtold, wind alone has the potential for supplying 20-25% of Harbec's total energy requirements. Financially, this means they are able to predict that amount of their energy bill, 25 to 30 years into the future.

So far, so good. But real challenges lay ahead for Harbec. First, it faced a complicated series of regulations in New York for companies generating their own power. Even though the project could produce more electricity than the company would consume, Bechtold, a firm believer in the advantages of distributed power in strengthening of our national grid, preferred to remain connected to the power grid. This meant paying hefty standby tariffs – since the local electric utility would be legally obligated to maintain the capacity to provide for Harbec's requirements in the unlikely event that the on-site systems should fail. New York State does not offer a net metering program for commercial or industrial customers, though such programs are encouraged by the US Department of Energy. With net metering, companies like Harbec would receive the fair market rate for power exported to the grid in a case where their production of electricity exceeded their own demand; at the same time the utility would save resources by not having to construct additional power plants to meet peak needs. Instead, Harbec puts its excess power on the grid and receives nothing for it.

A more serious obstacle concerned project financing. As Harbec developed a plan for the combined heat and power coupled with plant expansion, the price tag naturally rose, as did the perceived risk for potential lenders. Many bankers balked at the idea of a small, privately held firm getting into the power

generation arena, in part due to their lack of experience in analyzing such deals – the prospects of a seven- to ten-year pay back period, for instance, lay beyond the parameters of traditional lending policies. Over the course of meetings at various financial institutions, Bob Bechtold heard that rejection message repeated more than 30 times. Finally, after a chance meeting with one of the first loan officers, a creative solution emerged. By bringing together four financial institutions, the project could get the money to proceed with no one organization carrying more than 40% of the debt load.

Combined Waste and Water

Often in the course of running a corporation, conditions are just right to solve several problems simultaneously. The injection molding business generates millions of tons of material annually that does not meet customer standards; a small percentage can be reworked, but the bulk of this waste is destined for the landfill, since resins or residue from the machinery makes it unsuitable for recycling. At Harbec, problems arose when the Canadian company that used their scraps to make composite-building materials stopped accepting their waste plastic.

Around the same time, Bechtold's insurance company informed him that because of a reassessment of risk by the industry in the wake of 9/11, the factory would soon see its annual premiums triple, due to the lack of a sprinkler system. In addition to the cost of installing the needed sprinkler system, the downside to Harbec's quiet rural location was the lack of adequate water pressure to even maintain such a system. Addressing the water pressure problem involved creating an 800,000 gallon holding pond connected to pumps charging the sprinklers. But keeping the water clear of impurities from the air and runoff from the building and parking lot raised still more problems. Combining this pond dilemma with that of the waste disposal question, a creative solution was born.

Working with a local environmental consultant Larson Engineering, Harbec's employees reshaped the waste plastic into small balls, called EcoStones, to line the inflow shore areas of the pond. The Eco-stones, interspersed with cattails, serve as a growth medium for bacteria to help break down organic matter - replacing a number of alternatives including dolomite, and other man-made structures. In this function, the Stones could find their way into anaerobic digesters on farms and sewage treatment plants where they would serve a similar role. Harbec also uses the reservoir to cool process water, and plans to stock it with fish to help sustain the ecosystem in the pond.

Combining Fuels for a Green Fleet

Harbec's Green Fleet

In the summer of 2004 the company purchased equipment to produce biodiesel, a plant-based biofuel for diesel engines produced from oils such as soybean, rapeseed or waste fryer oil. The plan is to collect waste cooking oil from area restaurants on a weekly basis producing up to 42 gallons of cleaner burning fuel per day. The new fuel, known as B100, is similar to low-sulfur diesel, requiring no engine modification, or loss of performance, while boosting lubrication, though special precautions are necessary for operation in colder climates.

According the U.S. Environmental Protection Agency, the lifecycle production and use of biodiesel significantly reduces carbon dioxide, hydrocarbons, and sulfur dioxide emissions. In addition to turning trash into treasure, increased consumption of biodiesel helps shift the international balance of trade since it means fewer dollars to import petroleum products in favor of US farmers who could grow a valuable new cash crop.

THE RESULTS

Renewable energy—Harbec Plastic's Fuhrlaender wind turbine produces of 350,000 kWh annually * 1.5 lb of CO2 represents 525,000 lbs (263 Tons) of CO2 that will not enter the air. A three-bladed slender rotor with a diameter of 98 feet sits atop a 130 foot tubular tower adjacent to the main building.

Combined Heat and Power generating plant. 25 Natural gas-fired Capstone 30 kWh coupled with an absorption chiller and radiant in-floor heating in factory. The micro turbines produce 1,500,000 kWh annually, rated by manufacturer as reducing carbon emissions by 90% as compared to traditional fossil fuel power plants. For Harbec Plastics that translates into 1,350,000 kWh of avoided power, and so 2,025,000 lb of avoided CO2* (1012.5 tons) annually.

Vehicles- 2 hybrid Toyota Prius, one electric powered Geo Prism, one CNG powered delivery van, and a Ford Diesel box van using biodiesel, representing 100% of the company fleet as green, resulting in an annual reduction of nearly 10 and a half tons of CO2.

LESSONS LEARNED

On August 14th of 2003, Harbec's distributed generation strategy paid off as large areas of Northeast US and Canada were affected by a devastating blackout, stemming from problems at a single power plant in Ohio that triggered a cascade-effect along the transmission grid covering eight states and one province. The *Wall Street Journal* estimated costs due to the blackout at approximately $6 billion, as homes and businesses – and an estimated 50 million people – in the region went without electricity for up to 30 hours. In a survey of businesses, two-thirds said they lost at least a full day of operations, with one quarter losing more than $50,000 per hour of downtime

By taking on energy costs, the leading reason that corporations were fleeing the empire state, Harbec has transitioned to more energy efficient manufacturing equipment, generating a significant percentage of its own electricity requirements, and has taken a further step away from reliance on fossil fuels by purchasing alternative-powered vehicles for the company fleet. Integrating green building practices for its 17,000 square foot warehouse expansion, the company captures waste energy to provide heating and cooling as well as natural light through a series of skylights. By adopting a different philosophy - "technical innovation with environmental responsibility" – Harbec Plastics has become more sustainable, preserving jobs in the face of an economic downturn, and creating new business opportunities along the way.

Harbec President Bob Bechtold says, **"**I may be the only injection molder in New York State who can go to his customers and talk about energy costs going down, in an industry where energy represents a significant portion of the cost of doing business. Our business strategy is to find new capabilities, new technologies, new opportunities where innovations in plastics or manufacturing are needed, figure out how to make them work, develop those capabilities in-house and then take them back to the customer."

The efforts of Harbec are catching the attention of business leaders and owners alike across upstate New York. Barb Harper, Executive Director of the Wayne County Industrial Development Agency, says most firms would like to do the right thing when it comes to the environment, but their primary focus naturally is staying in business. "They just don't realize that there are options beyond having to pay higher energy bills every year," Harper says, "especially for electricity, which is the number one cost center after labor for many small to medium-sized manufacturers."

She has referred dozens of companies to Harbec to experience the top-down commitment. Harper is going a step further as well, working closely with Bechtold and administrators from a local university to help develop an eco-industrial park on a 40-acre parcel of land adjoining Harbec's property. In addition to spreading the eco-economic decision-making model, companies that choose to locate there might tie into the electricity generated at Harbec, using some of that surplus power being sold at a loss to the grid.

COMPANY PROFILE
HARBEC Plastics Inc. was established in 1977 as a contract tool-and-die/general machine shop, implementing innovative solutions and problem solving through the application of emerging CNC and CAD/CAM technologies. Today these capabilities are enhanced with the state-of-the art Hi-speed CNC, multi-axis CNC milling, and solids based modeling and programming, serving the needs of leading OEM's in the automotive, medical, office products and sporting good industries.

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CLEAN AIR COOL PLANET CASE STUDY RATING
THIS CASE STUDY REDUCES CO_2 EMISSIONS EQUIVALENT TO 1,807.94 TONS:

Avoiding the consumption of approximately nine (9) barrels of oil per day.

Or taking more than 254 vehicles off the road per year (1 car = 20 cars).

Assumptions: 1,093 lbs of CO2 per barrel of oil. Vehicles are average passenger cars (approximately 20 lbs CO2 per gallon of gasoline @ 22.5 miles per gallon, averaging 16,000 miles per year)

About Clean Air - Cool Planet

Clean Air-Cool Planet creates partnerships with campuses, corporations, and communities throughout the Northeast to help them implement measures that will reduce greenhouse gas emissions.

We offer an inventory tool that enables our partners to accurately assess their emissions and plan reduction or elimination strategies. Partners typically employ a combination of energy efficiency measures and renewable energy sources.

We help citizens understand the impacts of global warming by documenting and publicizing the benefits of emissions reduction measures to promote more environmentally sound business and consumer choices.

Through our programs and partnerships, Clean Air-Cool Planet helps other organizations and opinion leaders effectively address the issue of global warming.

CLEAN AIR COOL PLANET

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