

Renewable Corn-based Plastics Conserve Fossil Fuels

NatureWorks' bioplastics consume 30- to 50-percent less energy than conventional plastics.



Left: Food service containers made from renewable PLA. Right: Ingeo carpet, wool/Ingeo blend blankets.

The Challenge—In 1994, plastics made from polylactic-acid-based polymers (PLA) were biodegradable, but researchers needed to optimize crystallinity, additives, and degradability of PLA. Conventional plastics can take as long as 300 years to degrade in a landfill, and the feedstock for plastic has become more expensive as demand for petroleum has grown. Cargill received an ATP award in 1994 to develop new polymer-processing technologies. Cargill partnered with Dow Chemical to continue commercial development after the ATP-funded project ended in 1998.

The Economic Outcome—Cargill and Dow opened the world's first commercial-scale plant in 2002 to produce PLA-based polymers from renewable resources. The facility in Blair, Nebraska has the capacity to annually produce 140,000 metric tons of PLA, a polymer resin derived from corn sugars. Produced under the brand name "NatureWorks," PLA products include thermoformed food containers, compostable plastic cups, comforters, and fibers for nonwovens and textiles.

The U.S. market is growing. The Freedonia Group estimated the U.S. market for degradable plastics at 115,000 metric tons, at a value of \$330 million, in 2004, with projected annual growth of 13.7 percent, reaching 170,000 metric tons (\$490 million) in 2008. PLA is projected to represent 36 percent of that market. NatureWorks sales in 2006 more than doubled from 2005. The company projects 30 to 40 percent growth in 2007. They are maximizing capacity and expect to have new capacity in mid-2008. As of mid-2006, 30 percent of NatureWorks' sales were to U.S. converters, primarily for packaging applications

including VersaPak's clear packaging and McDonalds' PLA salad containers. Wal-Mart's packaging for strawberries, cut fruit, herbs, and Brussels sprouts requires 100 million plastic containers a year, saving the equivalent of 800,000 gallons of gasoline.

A case study was performed to assess the economic impact of this project and the analysis showed:

- Benefit-to-cost ratio on ATP's investment ranging from 11:1 to 24:1
- Net present value of ATP's investment ranging from \$21 to \$50 million
- U.S. consumption of imported petroleum reduced by 14 to 16 million barrels
- Greenhouse gases reduced by almost two million metric tons.

The Technical Outcome—NatureWorks' process uses 30- to 50-percent less fossil fuel than petroleum-based plastics, even considering the energy to produce the corn. And because the growing plants consume carbon dioxide, overall emissions are 50-percent lower than conventional plastics. The American Society for Testing and Materials (ASTM) has shown that when composted commercially, PLA biodegrades in 47 days.

NatureWorks earned five awards, including the Presidential Green Chemistry Challenge Award, 2002.

PLA-based fibers compete in cost and performance with conventional polyester, nylon, cotton, and silk. In 2002, the U.S. Federal Trade Commission designated these fibers as a new generic fiber, Ingeo.

Partnering Organization:	NatureWorks LLC (formerly Cargill, Inc.), Minneapolis, MN
Project Duration:	2/1/1995 – 1/31/1998
Project Cost:	\$1.9M ATP cost-share; \$1.8M industry cost-share
Project Brief:	http://jazz.nist.gov/atpcf/prjbriefs/prjbrief.cfm?ProjectNumber=94-01-0173
Project Status Report:	http://statusreports.atp.nist.gov/reports/94-01-0173.htm Research conducted March–May 2005 and April 2006
Economic Case Study	http://www.atp.nist.gov/eao/gcr06-897.pdf