Biotechnology Solutions for Renewable Specialty Chemicals & Food Ingredients

Introduction

Many products consumers purchase and use on a daily basis are made from petroleum, natural gas or petrochemicals. The availability and affordability of these products contributes to improved standards of living for consumers in countries around the world.

The volatility of oil and natural gas prices presents a challenge to manufacturers seeking to keep consumer goods at competitive costs. Further, consumers are increasingly seeking products with natural or renewable ingredients, enhanced performance qualities, or environmental benefits. The use of biotechnology presents an opportunity to meet these consumer demands.

Biotechnology enables the use of renewable resources for chemicals that are identical, drop-in replacements for petrochemicals. In many cases, the only difference between the petrochemical and renewable chemical is the stability of the price. In other cases, renewable chemicals provide enhanced formulation qualities.

Biotechnology processes are inherently cleaner than petrochemical or thermochemical processes, producing fewer byproducts or using less energy. Renewable chemicals can meet consumer expectations for environmental sensitivity.

Renewable chemicals represent an opportunity to commercialize innovative biotechnology applications because they are competitive on cost and performance in low-volume, high value markets. The capital investment costs for building small-scale renewable chemical production plants is lower than for a bulk chemical such as a biofuel.

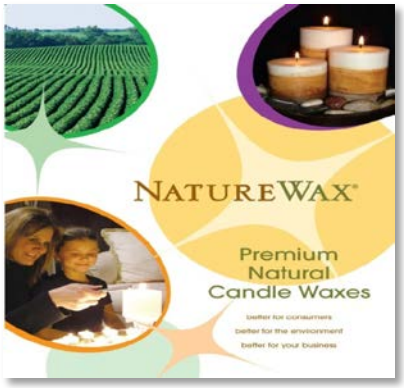
Senomyx's Technology Can Reduce Table Sugar While Maintaining Flavor

DuPont's Enzyme Technologies Can Improve Freshness and Reduce Waste

Metabolix Develops an Innovative Process for Creating Biobased Chemicals

Green Biologics Transforms the Global Chemicals Market with GreenInside™

Personal Care Products That Combine Performance with Natural Ingredients



Consumers look for natural ingredients in personal care products such as shampoos, cosmetics and creams, often paying a premium for them. Using natural ingredients alone in these products can present challenges in terms of shelf stability and consistency. However, using petrochemical ingredients as stabilizers and emulsifiers can defeat the purpose of formulating a product with natural ingredients.

Elevance Renewable Sciences has developed technology for producing emulsifiers, waxes and emollients from natural lipids derived from soy. These products are being used by Dow Corning to replace petrochemical products – such as polyethylene glycol and petrolatum – in creams, lotions, hair pomade, and cosmetics.

Elevance employs metathesis – a process that uses proprietary catalysts to rearrange the carbon bonds in a natural lipid – to transform soy into novel olefins. Metathesis technology often utilizes fewer process steps and lower process temperatures than petrochemical synthesis. It also minimizes byproducts and produces products with less toxicity.

Through a partnership with Elevance, Dow Corning now offers Soy Wax and a Soy Wax blend that can be used as a naturally derived alternative to petrolatum in both hair and skin care products. The wax contributes to these products a natural moisturizing agent with a smoother, less greasy feel. A newly introduced Emulsifying Soy Wax eliminates the need for multiple emulsifiers and thickeners, reducing ingredients and costs for product formulation.

Delivering Enhanced Cleaning Products

Each year, approximately 5.7 billion barrels of oil go into 30 to 50 chemical raw materials that form the backbone of modern society and appear in end products that range from automobiles, fabrics and plastic bottles to adhesives, cell phones, shoes and building materials. The chemical market is worth $2 trillion annually.

Levulinic ketals are bio-based compositions with performance advantages in many applications. Enabled by selective ketalization of levulinic acid esters, these compounds have broad solubility and can be used as cleaning solvents or coupling agents in liquid formulations. When extended by trans-esterification, levulinic ketals can make effective plasticizers for compounds such as PVC, polyols for polyurethane materials, and polyester thermosets or thermoplastics.

By applying industry standards for performance, Segetis is able to identify the specific levulinic ketals that enable reduction or replacement of fossil-fuel-based chemicals and plastics on a functional and cost basis.

> "We're incredibly proud of this innovation because it solves one of the traditional problems in green cleaning – how do you clean effectively without dirty solvents? Instead of formulating around the problem as others must, Method delivers powerful solvency in our products through renewable alternatives."
> *Adam Lowry, Method Co-Founder and Chief Greenskeeper*

Segetis, Inc. a technology enabled green chemistry company, has established a new partnership with Method Products, Inc., a manufacturer of home cleaning and laundry products, to use bio-based materials in a variety of Method's products moving forward. Segetis' materials deliver a performance and sustainability profile that matches Method's clean, safe, and sustainable objectives. The new bio-based molecules in Method's products offer awesome performance and replace the traditional fossil fuels that are commonly found in ordinary cleaning products. This new partnership between Method and Segetis highlights the potential for a new biobased technology to enhance the home care products category. The two companies share a desire and mission to be industry catalysts bringing novel, efficacious green chemistries to market quickly.

Personal Care Products from Sustainable, Renewable Raw Materials

Surfactants are among the most useful and widely sold chemicals because they enable the stable blending of ingredients that do not typically mix well, like oil and water. In addition, surfactants are the ingredients that give shampoos and body washes their cleansing power.

Today, nearly all surfactants are manufactured from either petrochemicals or seed oils, such as palm or coconut oil. Petrochemical surfactants introduce carbon dioxide into the atmosphere as they degrade. Expansion of palm and coconut oil production can also introduce carbon dioxide into the atmosphere if it displaces rainforest.

Modular Genetics, Inc. has developed microorganisms that convert clean agricultural residue into surfactants by the natural process of fermentation. Modular has demonstrated that these surfactants can be produced from a wide variety of underutilized agricultural materials, including soybean hulls (the woody case that protects the soybeans), crude glycerol from biodiesel production and potato waste generated by the food processing industry. These raw materials are typically sold as low value animal feed. Modular is able to convert these low-value raw materials into high-value surfactants that will be used in personal care products like cosmetics and shampoos.

Making Alternatives into Mainstream Products

On a pound-for-pound basis, producing bio-based 1,3 propanediol consumes 38 percent less energy and emits 42 percent fewer greenhouse gas emissions compared to petroleum based propanediol or propylene glycol.

Bio-PDO™ is fermented from corn sugar using a biotech process. The 1,3 propanediol monomer is separated from the fermentation broth and then available to be used in direct product formulations or as an ingredient in polymers. Over a dozen products can be made using Bio-PDO™ (renewably sourced 1,3 propanediol) as a key ingredient.

Zemea® and Susterra® propanediol are two grades of 100 percent renewably sourced Bio-PDO™, manufactured by DuPont Tate & Lyle Bio Products. Zemea® propanediol has been developed for use in cosmetics, personal care and home cleaning products, offering high purity, low irritation and sustainability to formulators and manufacturers. Zemea® propanediol also offers a luxurious feel and superior hand in lotions and creams.

Susterra® propanediol is used in aircraft deicing, anti-freeze and heat transfer industrial fluids as well as unsaturated polyester resins and polyurethanes. In fluid applications, Susterra® propanediol offers excellent low-temperature characteristics and improved degradation versus conventional glycols. In polymer applications, the unique structure of Susterra® propanediol contributes to increased flexibility and better impact resistance. Susterra® propanediol is a key ingredient for DuPont™ Sorona® polymer and DuPont™ Cerenol™ polyols.

DuPont™ Sorona® contains 37 percent renewably sourced 1,3 propanediol by weight. Fabrics made with Sorona® offer a unique combination of attributes including: exceptional softness, comfort, stretch and recovery, and easy care.

Mohawk Industries offers SmartStrand® with DuPont™ Sorona® carpet. As a fiber for residential carpeting, Sorona® offers a soft carpet that provides durability and permanent stain protection. Carpet made with Sorona® can contribute to Leadership in Energy and Environmental Design (LEED®) credits. In 2009, the U.S. Federal Trade Commission determined that the polymer composition of Sorona® is uniquely different from the composition of polyester and nylon and is worthy of its own generic sub-class name, Triexta.

Exploring Renewable Resources and New Ways of Producing Chemicals

Novozymes' vision is a bio-based society in which biotechnology helps convert renewable biomass (such as corn cobs, stalks and leaves, wood chips, wheat straw, rice straw, sugarcane stalks and leaves, and municipal solid waste) to basic building blocks or intermediates for a large number of industrial and consumer products. These renewable raw materials can replace the shrinking availability of relatively cheap crude oil. Novozymes and its partners develop biotechnology solutions that enable use of renewable raw materials for widely used intermediate chemicals, including acrylic acid, malic acid, and glycols.

Along with partners Cargill and BASF, Novozymes is developing technology to produce acrylic acid from renewable raw materials. Acrylic acid is used in a wide range of applications and materials such as textile fiber, coatings, paints, cosmetic products, and super absorbent polymer, an important component of diapers.

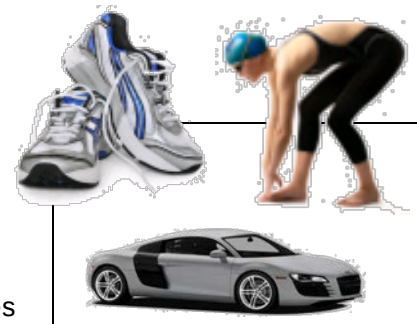
Novozymes has also developed a microorganism that enables efficient production of bio-based malic acid. The technology makes it possible to produce plastic and other oil-derived products from renewable raw materials. Malic acid is used as a flavor enhancer in the food industry and can be converted into other chemical derivatives used for a variety of plastic, polymer and resin products.

The latest examples of biochemicals under development are glycols. As part of a collaboration with the Chinese Dacheng Group, Novozymes will provide the know-how and enzymes to convert biomass into sugar, which the Dacheng Group will subsequently convert into glycols.

Novozymes' leadership and technology are pioneering new markets and sustainable solutions, steadily moving the world closer to a bio-based society.

Sustainable Chemicals for Sustainable Materials on Track for Commercial Production

Many of the materials that surround us, like plastic, paint, carpet and running shoes, are made from chemicals – a multi-trillion dollar industry.



BDO is used to make a wide range of everyday materials. With Genomatica's Bio-BDO, these materials are made from a sustainably produced raw material, reducing environmental impact.

Genomatica has developed technology and manufacturing processes that can make the exact same chemicals from 'sustainable' ingredients rather than crude oil or natural gas hydrocarbons. Genomatica's technology allows it to rapidly develop organisms and cost-effective manufacturing processes for dozens of the most significant intermediate and basic chemicals that make up the core of the chemical industry. Genomatica's technology also offers the potential to use a range of feedstocks, including conventional sugars, cellulosic biomass and syngas.

The first-ever renewable BDO produced for greener materials by Genomatica.

Genomatica has been successfully producing Bio-BDO, a biobased 1,4-butanediol, at pilot scale since the first half of 2010 and is moving to demonstration-scale production of two tons per week in 2011. BDO is used in products like spandex and automotive plastics. Commercial-scale production is expected in late 2013. Waste Management, a Fortune 200 company, signed a strategic joint development agreement where Genomatica will use its technology to create methods to turn syngas from municipal solid waste into higher-value chemicals.

Genomatica's biological production can reduce the cost to build a chemical plant; reduce the production and operating cost; reduce energy use by 60 percent; and reduce greenhouse gases by 70 percent. Better economics is the essence of innovation, which is needed to bring more cleantech manufacturing jobs to the United States. Genomatica's novel approach to making greener materials was named one of '10 Big Green Ideas' by Newsweek and was featured on Forbes.com.

Leading the Global Shift Towards the Production of Cost-Competitive Bio-based Chemicals

The chemical industry has been delivering solutions for many years, At Myriant, there's a better, greener way to produce the products people use every day. With a world-class R&D team, Myriant has developed a proprietary process using anaerobic bacteria to convert renewable sugars into high-value, bio-based chemicals. Using state of the art microbiological process, Myriant is directing the smallest of all living things for the largest of all human ambitions—to reduce dependence on fossil fuel based products.

Myriant has built the first chemical plant in North America to produce green bio-succinic acid. Our plant, located in Louisiana, is now shipping commercial quantities of bio-succinic acid to our customers globally. Succinic acid is used to make plastics, paints, urethanes and other applications. In addition, the Company's bio-succinic acid can replace harsh and toxic chemicals, including Maleic Anhydride (MAN) and Phthalic Anhydride. MAN, made from benzene – a known carcinogen -- is a chemical used in the production of butanediol (BDO), another chemical intermediate used to make food packaging, specialty fibers such as Spandex® and Lycra®, as well as popular adhesive tapes and polyurethane foams. Myriant has built a global network of strategic investors, global distributors and strategic partners to ensure its commercial success, including PTT GC, Uhde ThyssenKrupp, Sojitz, and Bayegan.

Biosuccinic Acid: Superior Performance, Cost, and Environmental Profile

Consumers and companies today are looking for products that perform, are cost-effective and have a better environmental profile. BioAmber's biobased succinic acid platform offers all three advantages.

Succinic acid, commonly referred to as amber acid, is a key building block for a wide range of secondary chemicals used in the chemical, pharmaceutical, food and agricultural industries. Until now, succinic acid was produced from petroleum feedstocks. Offering cost-competitiveness and superior functionality and performance, BioAmber's biosuccinic acid can replace conventional petroleum-based succinic acid, substitute for other chemicals like adipic acid in products such as nylon, and serve as the starting material for the production of high-value, high-volume chemicals such as 1,4-butanediol (BDO) and tetrahydrofuran (THF).

BioAmber is a renewable chemistry company, leading the field in biobased succinic acid. BioAmber's new product platform creates a foundation for customer innovation in a broad range of applications and markets, where biobased succinic acid is cost-competitive and offers superior functionality or performance with a better environmental footprint.

Biobased succinic acid is one of the core building blocks of renewable chemistry and the foundation of a portfolio of products, including polybutylene succinate (PBS), an innovative biodegradable polymer with high growth potential globally. BioAmber's modified PBS (mPBS) has better heat resistance and overall processability than other biodegradable polymers. It can be used to replace plastics made from oil in any number of applications, from everyday disposable items like coffee cup lids and cutlery to durable applications like medical devices, office equipment and vehicle components. Green solvents, green plasticizers and biorenewable plastics are among the applications in development through partnerships with industry leaders.

> "We don't just plan to produce Biosuccinic Acid. We already do."
>
> *Jean-Francois Huc,*
> *Chief Executive Officer,*
> *BioAmber*

BioAmber's biosuccinic acid platform harnesses the power of biology, combining it with chemistry, to enable a portfolio of cost-effective renewable products that can replace more energy-intensive and expensive petrochemical-derived chemicals and materials. In addition, BioAmber's fermentation process to produce biosuccinic acid consumes CO2, helping to reduce emissions of greenhouse gases. By eliminating the need for fossil fuel combustion, BioAmber's biorenewable processes also reduce the production of other gases that are harmful to human health.

A Renewable Chemical That Replaces a Scarce Natural Resource

Synthetic cis-polyisoprene is a suitable replacement for natural rubber in many applications. BioIsoprene™, derived from renewable feedstock, is expected to deliver a more sustainable alternative to petrochemical-based isoprene in producing synthetic rubber. The BioIsoprene™ process offers a real possibility for obtaining meaningful quantities of low-cost isoprene, which is needed to produce a high-volume alternative to Hevea natural rubber and petroleum-derived isoprene.

BioIsoprene™ offers a lower carbon footprint in the manufacture of synthetic rubber and the potential for various other applications, such as specialty elastomers and adhesives as well as advanced biobased transportation and jet fuels derived from the BioIsoprene™ C5 building block. The development of BioIsoprene™ represents a major achievement for industrial biotechnology because it has the potential to enable production of isoprene from renewable raw materials to deliver commercial quantities of a basic C5 hydrocarbon that, in principle, can be used as a feedstock for a large number of value-added products. DuPont™ unveiled a breakthrough prototype tire made with BioIsoprene™ through a collaborative research effort with the Goodyear Tire and Rubber Company.

Unlike other biobased systems used to produce biochemicals, BioIsoprene™ is produced as a gas-phase product that is released as soon as it is produced into the vapor phase of the reactor without any noticeable negative physical or inhibitory impacts on the biological host. Polymer-grade BioIsoprene™ is recovered from the integrated process. Potential benefits of the gas-phase nature of the product include:

- reduction and/or elimination of feedback inhibition by the isoprene product on further synthesis;
- efficient recovery and purification of polymer-grade BioIsoprene™ product from the fermentation broth; and
- possibility to use low-cost feedstocks.

DuPont™ has a long history in the design and operation of cells that function as factories. Examples of these factories at work include industrial enzymes, commodity chemicals and advanced metabolic pathway systems for the production of biochemicals, including amino acids (lysine, tryptophan, threonine), 1,3-propanediol, indigo and ascorbic acid.

Isobutanol: A Sugar-Derived Building Block for Chemicals and Fuels

Isobutanol is a building block that can be used in solvents, plastics, polyester, rubber, and transportation fuels, each of which constitute multi-billion dollar markets. Through chemistry, isobutanol can be converted into feedstocks for the production of nearly 40 percent of traditional chemicals (such as butenes, toluenes and xylenes) as well as many transportation fuels. Used as a solvent, isobutanol appears in paints and cosmetics such as nail polish. The solvent, petrochemical and fuel markets are each worth several billion dollars.

Volatility in petroleum prices can have a significant impact on these markets. Bioisobutanol is a drop in replacement for petroleum-based products that offers greater stability in pricing and a potential cost savings.

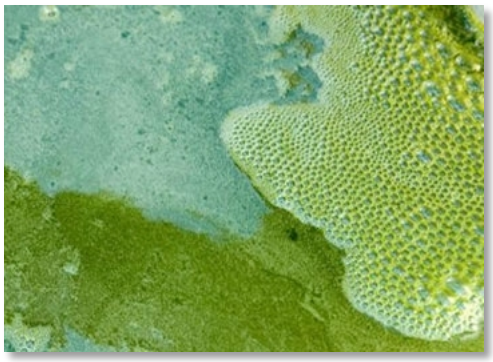
Gevo has developed the Gevo Integrated Fermentation Technology® (GIFT®) that combines genetically engineered yeast with a continuous separation process to separate the isobutanol from the fermentation broth, allowing for higher yields of isobutanol and lower separation costs. Using synthetic biology, Gevo has engineered a yeast to concentrate on the production of isobutanol – which is a standard product of fermentation by brewer's yeast, as in beer or wine making – by blocking the production of ethanol and acetic acid. Through this integrated process, Gevo has reached 94 percent of theoretical yields.

Gevo's production process was demonstrated at a commercially relevant scale with the retrofit of ICM's 1 million gallon per year plant in St. Joseph, Mo. Gevo has demonstrated production of butyl rubber, butenes, solvents and lubricants through partnerships with chemical manufacturers Lanxess, Sasol and Toray. Gevo has also a biorefinery in Silsbee, TX that converts isobutanol into bio-jet fuel, paraxylene, and iso-octane. Gevo's bio-jet fuel has been purchased by the US Army, Navy and Air Force. Gevo's paraxylene will be sold to Toray for the production of PET and other polyesters. Gevo's isooctane has been used in race cars and high performance engines. The company is currently commissioning a corn ethanol plant in Luverne, Minn., to produce up to 18 million gallons per year of isobutanol, ethanol, or a combination of both.

Industrial Cooling Fluid from Algae Oil

Electrical transmission over long distances requires transformers. To insulate and cool some these transformer units, the industry uses more than 500 million gallons of dielectric insulating fluids. These fluids must withstand electric stress and heat without impeding the flow of the electrical current.

Currently, mineral oil, high-temperature hydrocarbons, silicone fluids, and vegetable oil are used. In the past, polychlorinated biphenyls (PCBs) were used, but they presented a potential environmental hazard. Solazyme has developed algal oils for a new generation of dielectric fluids that are fire safe, environmentally sound, and provide increased performance for transformers and other electrical applications.



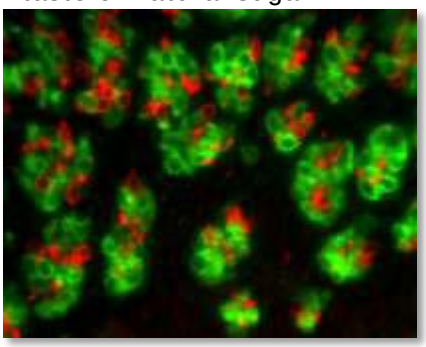
Solazyme's technology allows algae to produce oil and biomaterials in standard fermentation facilities quickly, efficiently and at large scale. These oils can be tailored as replacements for fossil petroleum and plant oils in a diverse range of products running from clean fuels and chemicals to cosmetics and foods. Under the terms of the joint development agreement, Dow will combine its extensive knowledge of specialty fluid formulations and dielectric insulation capabilities with Solazyme's unique feedstock capabilities to develop of a new class of algal oils tailored for optimized performance and cost in dielectric insulating fluids.

Dow may obtain up to 20 million gallons of Solazyme's oils for use in dielectric insulating fluids and other industrial applications in 2013 and up to 60 million gallons in 2015.

New Flavor Ingredients Help Reduce Sugar While Maintaining the Taste Consumers Desire

High sugar consumption is a primary cause of obesity, which has been linked to increased risks for diabetes, heart and respiratory diseases, cancers, and mortality. Although many consumers would like to decrease their sugar intake, some find products with lower sugar or an “artificial sweet taste” unappealing.

Senomyx has used its proprietary technologies to discover and develop a new flavor ingredient that allows manufacturers to reduce the sucrose (table sugar) content of food and beverage products by up to 50 percent while maintaining the taste of natural sugar.



Senomyx pioneered the use of taste receptors for the discovery of new flavor ingredients. Proteins on the tips of sweet taste cells, for example, function as receptors that bind sucrose and other sweeteners. Using high-throughput screening, Senomyx identified and optimized a new flavor ingredient that also binds to the receptor, reducing the amount of sucrose needed to create a sweet taste sensation.

Firmenich SA, a leading global ingredients supply company, is conducting pre-commercialization activities with Senomyx’s first enhancer for sucrose, which is applicable for virtually all food product categories and selected beverages. Senomyx is also working to develop additional sucrose enhancers as well as flavor ingredients that enable the reduction of fructose, a key component of high fructose corn syrup. In addition to decreasing calorie content, reducing sugar and fructose during processing has a positive impact on sustainability and costs, including lowered water usage and transportation expenses.

Reducing Waste on Grocery Store Shelves

Consumers look for freshness when they are choosing among bakery products in a supermarket or corner store. How do they test for it? They squeeze the products. It's the moment of truth when a product feels markedly fresher than others – not just the first day, but also for several days afterward.

DuPont enzyme technologies help bakeries around the world distinguish their products at the markets. By altering the molecular structure of starch, the enzyme has a strong effect on retrogradation – the main contributor to the staling process. POWERFresh® Bread and POWERFresh® Special are bakery enzymes that ensure shoppers get the freshest quality products. Developed together with the baking industry, this advanced technology makes it possible to extend shelf life while maintaining superb eating quality. Combined with competitive cost-in-use, these enzymes provide a powerful competitive edge.

Specifically, this technology helps solve some of the most pressing issues facing the baking industry, such as short shelf-life, fast-fading resilience, and dry, crumbling structure. For bakeries, fewer crumbs mean enhanced efficiency and production cost savings. For consumers, the enzyme means that sliced bread does not break when they butter it, and that the hot dog bun does not break into two.

Witness an Innovative Process for Creating Biobased Chemicals

Metabolix is developing cost-effective methods for producing biobased chemicals for a variety of high–value industrial and consumer product uses. Growing awareness among manufacturers, brand owners and consumers for products containing renewable content is also becoming an increasingly important factor in accelerating conversion to renewable chemicals. Metabolix's PHA ("polyhydroxyalkanoate") technology is a unique platform for producing biopolymers and biobased chemicals.

Metabolix's fermentation and recovery technology is applicable across the range of C2 to C6 chemicals. Metabolix has demonstrated that PHA monomers created through fermentation of sugar can produce key chemicals in the C4 and C3 value chains—including butanediol (BDO), gamma-butyrolactone (GBL), tetrahydrafuran (THF), and acrylic acid. This offers attractive possibilities for a wide range of applications—from adhesives, fabrics and coatings, to personal care products and semiconductor manufacturing.

The Metabolix process for creating biobased industrial chemicals involves engineering metabolic pathways into microbes that go through a fermentation process to produce specific biopolymers that serve as precursors for the target chemical. Metabolix is able to control the biology of the industrial microbe to achieve high concentrations of specific, naturally-occurring biopolymers that accumulate inside cells as they metabolize sugars. This intracellular accumulation of the biopolymer in the microbes is a unique and differentiating aspect of Metabolix's technology.

Metabolix has developed proprietary microbial strains and fermentation technology to produce biopolymer, which is then coupled with its novel "FAST" recovery ("fast-acting, selective thermolysis") process to convert the biopolymer into the target biobased chemical using heat. Using its technology, Metabolix has produced the biopolymer poly-4-hydroxybutyrate (P4HB), and converted it directly to GBL, and has also demonstrated production of bioacrylic, an important C3 chemical. Metabolix continues to innovate and has recently demonstrated a process to produce "ultrapure" biobased chemicals using its "FAST" process, and has also demonstrated the use of cellulosic sugars as renewable feedstock in its process. The technology and process developed by Metabolix has the potential to open new pathways for producing renewable chemicals to meet the growing demand for sustainable products.

Putting GreenInside™ For Everyday Products

Green Biologics is a renewable chemicals company focussed on developing and delivering green alternatives for everyday products. The Company's technology platform is built on both biology and chemistry founded on core expertise in advanced *Clostridium* microbial fermentation.

Our world-class platform can convert a wide range of sustainable feedstocks into high value green chemicals such as *n*-butanol, acetone and, through chemical synthesis, derivatives with optimal performance in downstream formulations.

This green chemistry is used in applications including cosmetics and personal care products, household and industrial cleaners, paints, inks, textiles and food ingredients.

A winner of the coveted Bloomberg Energy Pioneer Award, Green Biologics is transforming the global chemicals market and will work in close collaboration with partners to provide customers with end products that are more sustainable and higher value than those using petroleum-based alternatives. Green Biologics is headquartered in Abingdon, Oxfordshire, England with U.S. offices in Columbus, OH and Richmond, VA. There are commercial manufacturing projects in the US and China, with additional projects under assessment in Brazil and India.

Our core focus is the North American market with a project underway that will deliver commercial scale volumes of bio-based designed and engineered renewable chemicals and offer performance that adds value to everyday products. Our Little Falls, Minnesota production facility shown here is scheduled for completion in Q1 2016.

Green Biologics' advanced *Clostridium* microbial fermentation technology overcomes challenges faced by competing high performance chemical production technologies, enabling improved *n*-butanol production yields with lower capital expenditures and operating costs. Through collaborations with partners and customers, we will incorporate our core chemicals into high value downstream derivatives. Our *Clostridium* platform provides an attractive and exciting foundation for future C3 and C4 chemicals and derivatives.

Green Biologics is an environmentally sensitive company, focussing on sustainable agricultural feedstocks, reducing GHG emissions, and creating jobs and opportunities for the rural community and beyond.