TerraVerdae Bioworks Inc.

A White Paper for Investors

Overview

Converting biomass into energy and polymer substitutes for existing petroleum derived products (plastics, etc) is playing an ever increasing role today in reducing our dependency on fossil fuels while at the same time focusing on developing solutions to the world's most pressing problems related to greenhouse gas emissions, energy security and industrial sustainability

TerraVerdae Bioworks, a three year old industrial biotechnology company, is has developed a bioprocess that demonstrates a highly efficient conversion of non-food based renewable materials derived from forestry biomass and industrial, municipal or agricultural waste into a full range of high value bio-based products such as bio-degradable plastics and key metabolites that are used in packaging, wrappings, linings, and other similar commodities. Although these are key applications, Terra Verdae's focus is on higher value applications in automotive and electronics which are the fastest growing segments that are expected to account for 40% of the market by 2025. Additional capabilities include providing the building blocks for biodegradable composites and essential components in new functionalized materials with unique properties for processing.

The key advantage of the TerraVerdae technology is that it creates precursor materials to produce biodegradable polymers that do not come from petrochemicals or sugar sources. It is important to emphasize that no food based agricultural land is sequestered in obtaining feed stocks for their platform technology

Major commercial plastics such as polyethylene and polypropylene are primarily derived from fossil fuels such as petroleum and natural gas. They have been developed over the last 50+ years and are performing in a variety of useful applications. They are recyclable but do not degrade. However, serious questions have been raised on a global basis as to the economic, security and environmental sustainability of the continued growth in the use of fossil fuels. A big opportunity that responds to these global questions is the production of plastics from sustainable sources with equal or improved performance over fossil based plastics and has the added advantage of being biodegradable. This is the vision of TerraVerdae.

By linking industrial genetics, bioprocess engineering and bio-polymer technologies, TerraVerdae has created an integrated biorefinery "platform" that has broad application across a full range of markets including bioenergy, waste management, bioremediation, forestry, agrochemical, pharmaceutical and biotech research. When compared to existing processes, TerraVerdae's technology demonstrates the potential for significant technical and production advantages with a dramatic improvement in both efficiencies and cost reductions in the production of bio-based materials and biochemicals while avoiding competition with food based feedstocks.

The Technology

TerraVerdae's technology is a bioprocess for a number of important platform chemicals and polymers that links industrial microbiology, synthetic biology, biopolymer chemistry and process engineering. The platform is an ideal production factory that is highly efficient for producing a number of poly-hydroxyalkanoates (PHAs) including polyhydroxybutyrate (PHB).

PHAs are a general class of linear polyesters produced in nature by bacterial fermentation of sugar or lipids, or in TerraVerdae's case, single carbon compounds such as methanol. They are produced by the bacteria to store carbon and energy. More than 150 different monomers have been identified within this family and they have a wide range of properties that can be used in a variety of polymer materials. PHAs have varying degrees of biodegradability depending upon how they are modified (blending, compounding, etc.). Petrochemical polymers are, essentially, not biodegradable.

PHBs are a sub class of PHAs and are highly interesting bio-based polymers leading to compostable and biodegradable plastics with a range of potential applications for film, extrusion and molding products and provide the building blocks for biodegradable composites.

Properties of PHB

PHBs are water insoluble and relatively resistant to hydrolytic degradation. This differentiates PHB from most other currently available biodegradable plastics, which are either water soluble or moisture sensitive.

- Good oxygen permeability.
- Good ultra-violet resistance but poor resistance to acids and bases.
- Soluble in chloroform and other chlorinated hydrocarbons.
- Biocompatible and hence is suitable for medical applications.
- Melting point 175°C and glass transition temperature 2°C.
- Tensile strength 40 MPa, close to that of polypropylene.
- Sinks in water (while polypropylene floats), facilitating its anaerobic biodegradation in sediments.
- Nontoxic.
- Less 'sticky' when melted, making it a potentially good material for clothing in the future

TerraVerdae's PHA/PHB production system is highly flexible with low production and processing costs. According to William C. Bardosh, President and CEO; "We have a route to be competitive cost-wise with polyethylene (PE) and polypropylene (PP). Our goal is to focus on performance, not cost, but cost is important to get down".

PHBs are thermoplastic offering a key advantage in that they can be processed as films, extrusions and moldings leading to many different applications and products.

Bioengineered Bioplastics Market

TerraVerdae is targeting the $50B bio-substitutable segment of the $400B plastics market. Current estimates forecast CAGR of 25-35% annually to 2025 for biobased polymers, while bioengineered polymers are forecast to achieve 41% CAGR over this period. The currently addressable target market is 125 kilotons by 2013 and expected to grow to approximately 70 million tons or 13% of the projected global plastics market by 2020. Bioengineered materials are expected to have an increasing impact on commercialization of bioplastics, contributing to 25% of the total bio-plastic market by 2020. Key applications are currently in packaging, however automotive and electronics segments are the fastest growing, expected to account for 40% of the market by 2025.

Investment Opportunity

- Emerging green market with significant long term growth (25-40%/yr)
- Large substitution potential into established plastics market (100B/yr)
- New growth market for landfill, biomass residue and other waste derived feedstock
- Significant environmental benefits (waste, Climate Change/Greenhouse Gas)
- Defensible technology and scale barriers to market entry
- Sustainable technology from waste-derived feedstock to biodegradable products

Business Model

TerraVerdae is targeting specific high impact, high value product opportunities. The aim is to leverage the company's waste-derived methanol to bioproduction platform with its proprietary metabolic engineering and polymer development tool kit and chemistries. The company looks to generate revenue from product sales and/or licensing of the commercial production process.

- Short-to-mid term: Revenue will be derived from commercial development services and corporate collaborations.
- Mid-to-long term: Significant long-term revenue will be derived from development of proprietary high-value products and licensing of the production technology.

Investment Needs

TerraVerdae has secured $7M in public funding for two major initiatives that are also supported through collaborations with major industry partners that will yield a total of $16M in commercial development. The company is seeking immediate financing of $1.5M to trigger these investments to reach key milestones in year 1. Further strategic investment and/or partnership revenue is expected for year 2.

Statemement of Projected Operations ($ 000's)

	FY12	FY13	FY14	FY15	FY16	FY17
Revenue	1,015	1,559	5,125	12,500	31,300	90,600
Grants	925	1,134	3,200	7,000	10,000	14,000
Collaborations	90	425	1,425	2,500	6,000	12,000
Product Sales			500	3,000	15,300	64,600
Expenses	2,517	3,457	3,038	7,700	18,700	69,200
EBITDA	(1,502)	(1,899)	2,087	4,800	12,600	21,400

The company anticipates positive cash flow in year 3. Anticipated exit is proposed within 3 years through strategic buyout, IPO, or other mutually agreeable vehicles.

Current Grants (abstracts available upon request)

Manufacturing High Value Chemicals through Industrial Biotechnology; Technology Strategy Board (UK) Grant Award; £ 333,000 over 2 years

Integrated Biodegradable Plastic Production from Waste and Biomass Residue Feedstock Gasification: Optimization, Demonstration, and Techno-Economic Analysis;Alberta Innovates Bio Solutions (Canada): Grant Awarded; $1,200,000 over 3 years

Product (Co)Development Centre to Support Commercialization of a New Class of Biodegradable Plastics from Waste-Derived Feedstock; Regional Growth Fund (UK); Grant Awarded £3,250,00 over 3 years

For further Information, please contact:

Bob Bruno
R P Bruno and Associates
www.rpbrunoassociates.com
robert.p.bruno@gmail.com
617-939-6646