NAME(S) & TITLE(S)
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AFFILIATION(S)
HelioBioSys, Inc.

PROJECT TITLE
Commercialization of Cosmetics and Biomaterials from Cyanobacterial Polysaccharides

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PARTNERS
Advanced Biofuels Process Demonstration Unit; NSF I-Corps program

INTELLECTUAL PROPERTY STATUS, PATENT OR TECH TRANSFER NUMBER

PROJECT/COMPANY STATUS
Company or LLC formed, Other DOE funding, I-Corps participant, FLOW, CTO or other business plan competition(s), Founder(s) only

TIME TO MARKET – 1 - 3 Years

C2M OBJECTIVES
1. A 360-degree analysis of the commercial cosmetic and bioplastic market opportunities for biomaterials derived from cyanobacterial polysaccharides.  
2. Determination of best product market fit between cosmetic ingredients, biobased microbeads and bioplastic food packaging.  
3. Comprehensive prioritized list of potential strategic partners, potential customers and potential funders.  

Identify and evaluate priority market segments based on HelioBioSys’s product suitability, competitiveness with incumbent producers, total addressable market, and opportunities to expand or disrupt existing markets. Identify and research potential customers and prioritize them based on addressable market computations. In particular, analyze opportunities to be a USDA Biopreferred provider for consumer packaged goods, a supplier for biodegradable microbeads, or as a feedstock for a range of cosmetic applications.

End products include a market research survey, strategic business planning documents, and financial model comparisons that support commercialization, partnerships and investment.

TECHNOLOGY
HeliobioSys uses a defined community of marine cyanobacteria (consortium) to produce a novel extracellular polysaccharide suitable for a variety of biobased materials, including
biodegradable plastics and cosmetic ingredients with unique properties. Our mixed population of carefully selected non-genetically modified cyanobacteria obtain their energy from the sun, carbon and nitrogen from the atmosphere and essential elements from seawater in managed open raceway ponds. Our approach is to couple the unique traits of our patented consortium with an efficient seawater cultivation system. This system will be designed to have low capital and operational costs and simple processing of excreted polysaccharides into high margin products that meet customer specifications for biopolymer technical performance, price and sustainability criteria. Proof of concept at the laboratory scale (150 liters) has been successfully performed and small pilot scale tests in 1,000 liter indoor open raceway ponds have shown high product yields at Sandia National Laboratory (Livermore, CA). Product characterization (polysaccharide yield, sugar profile, biomaterial characterization) is nearing completion at the DOE - Advanced Biofuel Process Demonstration Unit (APBDU, Emeryville, CA). In collaboration with HelioBioSys Inc., researchers at the ABPDU conducted research to (1) develop recovery and saccharification processes, and to analyze the composition and material properties of the polysaccharide material. Researchers at the USDA Bioproducts Research group in Albany, CA are examining potential applications for the materials including thin films, microfibers and microbeads.

TECHNOLOGY READINESS LEVEL
TRL 4 - LAB PROTOTYPE: Component testing in a laboratory environment.

POTENTIAL CUSTOMERS
Market opportunities for sustainable alternatives to petroleum based products are abundant and diverse. Potential applications will depend on mechanical and functional properties of the polysaccharides, and how they fit into existing and emerging markets. The range of applications includes: thermo formable films (food packaging applications), water/oil resistant food wrap and packaging materials, microbeads (cosmetics, 3-D printing substrates), medical applications (slow release gel capsules, single use medical plastics), emulsifiers and thickeners (cosmetics, food additives), spray gels, and natural binding agents. Each of these broad categories has its own market potential, competitors and strategic partners. Regulatory considerations are driving much of the shift toward biobased materials, along with consumer demand for sustainable, biodegradable and compostable products and packaging.

Support from the Cleantech to Market program provides precisely the thorough detailed analysis of this complex and emerging market, in a few targeted segments, that will ensure that our technology is initially targeted toward a successful commercial market, at an appropriate scale for a small company first entering a global market with a broad array of competitors and potential partners.

SCALING
We recognize the need to incrementally develop a biologically robust and economically compelling process from R&D to a revenue producing demonstration facility and finally to a full-scale integrated biorefinery.
• Established proof of concept at laboratory scale. Completed 2010-2014, self-funded.
• External validation of R&D milestones. Completed 2015-2016 with ABPDU.
• Cultivation scale up and polysaccharide biomaterial characterization. 2016-2018 via U.S. Dept. of Energy SBV grant.
• Pilot-scale facility. Expand production capacity to ca. 50 acre pond area to meet initial commercial product production goals (~2020)
• Integrated Biorefinery. Expand production capacity to ca. 500 acre pond area and extend product line to co-located commercial partners producing chemicals and/or fuels
ADVANTAGES
Cyanobacteria have remarkable photosynthetic efficiency and resilience to changing environmental conditions. Our consortium has advantages over algae and cellulosic crops: (1) high photosynthetic efficiency; (2) ability to obtain nitrogen from the atmosphere; (3) excretion of polysaccharides and (4) resistance to predation. Combined with their rapid growth rates these traits represent a novel crop capable of addressing the challenges of sustainable production of non-food based industrial polysaccharide feedstock. At Sandia we have demonstrated remarkable system stability and resilience in open growth systems, which controls a key cost in management of aquatic organisms for industrial purposes.

The material properties of the polysaccharide confer distinct advantages over fossil fuel derived analogs. The polysaccharides attenuate UV-A and B, are anti-oxidants, act as moisturizers and exhibit anti-inflammatory properties. These attributes align with customer interviews that revealed consumers place a premium on safe and effective products with several characteristics in a single ingredient. Material solubility properties create thin films that are insoluble at high water content and high pH, yet soluble at lower pH. Most soluble films do not exhibit this property. Petroleum-based microbeads are facing intense regulatory scrutiny, our materials are both sustainably-derived and biodegradable, providing an important alternative to these widely used materials.

BARRIERS
The principal competitor for bioplastics is from well established, fossil fuel based plastic producers. Biobased plastics are a small, but rapidly growing competitor for petroleum derived plastics. Drop-in replacement plastics (e.g. bio-PE, bio-PET, PLA) have no advantage over petroleum derived plastics in performance characteristics and must compete on a commodity price basis. Biobased materials, especially those with biodegradable and compostable properties, create sustainable alternatives for industry leaders, brand owners and retailers that seek to support their brand’s environmental profile and corporate sustainability goals. However, careful attention to performance, application versatility and price must be part of any new biobased material brought to market.

Technology barriers (product separation, material properties, potential applications) are being addressed by current and proposed projects. As technologists we have less experience evaluating the complex bioplastic/biomaterial market and developing the business tools required for successful adoption of our technology by a commercialization partner.

Technical evaluation of material properties, coupled with a robust commercial evaluation will permit us to carefully evaluate and prioritize the most promising initial product market fit.

FEEDBACK
In 2013 we participated in the Cleantech Open and NREL Industry Growth Forum and presented our industrial sugar production process to a broad spectrum of potential investors. We consistently heard that the underlying technology and business model were sound but that investment would require outdoor proof of concept at a larger scale. The advice to seek undiluted capital to demonstrate productivity at scale led us to securing U.S. Dept. of Energy funding. In addition we have pivoted away from a biofuel and bio-based chemical strategy to the current emphasis on biomaterials based on data derived from the DOE grants. Biobased materials, bioplastics and cosmetic ingredients reduce barriers to market entry (e.g. smaller production facilities, higher margins).

In November 2017 we participated in the NSF Regional I-Corps program and conducted 30 customer interviews targeting product market fit in the cosmetics market. We
interviewed both boutique and major brands, as well as over 100 end-users in an on-line survey targeting sunscreen products. Results from that work will be used to inform work in the C2M program.

TIME TO MARKET BACKGROUND
We anticipate establishing a commercial partnership within 2 years to create a pilot-scale facility. It is unrealistic for our small company to own and operate a bioindustrial facility, or to compete directly with embedded major players in the biomaterials market. Rather, our goal is to demonstrate economically compelling production of a novel source of polysaccharides with compelling sustainability attributes that will provide an important source of biomaterial in a carefully evaluated market niche. The work proposed here is critically important for us to identify and evaluate the proper market niche.

SUPPORTING MATERIALS
HBS Haas Marketing Plan Summary.pdf – Executive Summary from work conducted by students from Haas School of Business in the Fall of 2017. Marketing plan focused on sunscreen and cosmetic application of HelioBioSys polysaccharides. Included >100 end user on line survey with analysis and an initial go to market strategy. We would like to build upon this initial step to develop a more comprehensive review of options and a detailed marketing plan.

HBS 2017 SBFC poster.pdf: Provides details on work done by HelioBioSys and the ABPDU on material characterization for biofuel, bioplastic and cosmetic applications. Poster prepared and presented by Eric Sundstrom, Ph.D in May 2017.

HBS NSF STTR Project Summary.pdf - The summary is from an outstanding NSF STTR grant application (submitted Dec. 2017) that provides additional details about how we will partner with the Arizona Center for Algae Technology and Innovation and the ABPDU to conduct outdoor scale-up testing and detailed biomaterial characterization to support commercialization.