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Petroleum Displacement Analysis

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SzIBR Project Execution Plan

Sub-criteria for Review Criterion 1:

1. Overview of Solazyme's Proposed Integrated Biorefinery (Topic 5)

Solazyme proposes to build, operate and optimize a pilot-scale "**S**olazyme **I**ntegrated **B**iorefinery." SzIBR will demonstrate integrated scale-up of Solazyme's novel heterotrophic algal oil biomanufacturing process, validate the projected commercial-scale economics of producing multiple advanced biofuels, and enable Solazyme to collect the data necessary to complete design of the first commercial-scale facility.

1.1. Solazyme's Innovative Heterotrophic Algal Oil Biofuel Process

Some algae possess internal biochemical pathways that synthesize oil more efficiently than any other known natural or engineered process. Under the right conditions, certain algal species produce so much oil that the oil constitutes over 75% of the dry weight of the cells, so it's not surprising that the world's petroleum deposits consist largely of the fossilized remains of prehistoric algal blooms.

Many strains of algae are *heterotrophic*: they can grow in the dark by ingesting organic molecules derived from domestic, renewable, scalable, and environmentally sustainable biomass sources. Solazyme has identified and isolated strains of algae that achieve high cell densities, high carbon flux (productivity) and carbon yield (utilization), and fast cell doubling times — comparable to standard microbial fermentation systems. This breakthrough enables Solazyme to exploit the proven, mature technology of industrial biomanufacturing, but for the first time apply it to produce inexpensive, high-quality **renewable oil**.

Solazyme has already produced over 70 metric tons of dried algal biomass in the same size fermentors that will be employed in the proposed project, and extracted over 2,000 gallons of algal oil from a small portion of the biomass produced. Existing oil refineries can transesterify Solazyme's algal oil neat or blended to yield biodiesel (ASTM D6751), or hydrotreat it to make renewable diesel, which is identical to petroleum diesel (ASTM D975). More than 110 gallons of Solazyme's

algal oil have already been transformed into these standard fuels, and independent tests confirm that they comply fully with the specifications. Renewable jet fuel has passed the critical subset of tests that have been performed in work to date.

Solazyme's novel biomanufacturing technology provides several key advantages:

- Algae produce lipids with the ideal chain length and chemical structure for conversion to diesel and other fuels, in contrast to the short chain alcohols produced by other biofuel processes. Solazyme's purified algal oil is a high quality triglyceride vegetable-like oil composed predominantly of oleic acid.
- Algal oil feeds directly into the vast infrastructure that refines, distributes, retails and consumes petroleum products. Other scalable biofuel approaches present significant incompatibilities with pre-existing infrastructure and vehicles. Solazyme aims to capture rather than disrupt the petroleum economy.
- Solazyme's process is efficient and cost-effective. Algae have evolved to tolerate the oil they produce, enabling high titers, and Solazyme has discovered and honed an inexpensive method to extract the oil from cells with oil seed presses. Ethanol, in contrast, poisons yeast, and distilling it is energy intensive.
- Algae are robust organisms, better suited to tolerate the toxic compounds released during conversion of lignocellulosic biomass into fermentable sugars, and thrive on a wide range of feedstocks.

Solazyme's approach forges the crucial link from high-impact, domestic, renewable lignocellulosic feedstocks to oil-based transportation fuels that leverage and remain fully compatible with the petroleum economy. Most competing biofuel approaches that utilize lignocellulosic biomass produce fuels — such as alcohols — that are not fully compatible with petroleum-based infrastructure and vehicles, and that exhibit less desirable physical and chemical properties than petroleum-based fuels. A few other approaches do yield oil-based fuels, but they are either not scalable (e.g. biodiesel from vegetable oil or waste grease) or they are inefficient and not environmentally sustainable (e.g. long chain F-T synthesis).

It's important to distinguish Solazyme's novel approach from conventional algal biofuel concepts, which rely on *autotrophic* algae to produce their own sugar via photosynthesis. Directly photosynthetic approaches are sensible for high-priced nutraceuticals, but remain far from being economically viable for commodity fuels. A discussion of the technical and economic hurdles they confront is beyond the scope of this proposal. None of the valid criticisms of conventional algal biofuel concepts pertain to Solazyme's approach, however, which uniquely exploits *heterotrophic* growth to produce algal oil in a well-established industrial context, far more efficiently than is possible via photosynthesis. Of course, the biomass feedstocks fed to the algae exploit photosynthesis. Converting sunlight and CO_2 directly to oil sounds seductive, but separating the processes of photosynthesis and oil synthesis turns out to be most cost effective.

1.2. Summary of SzIBR Components, Scale, Feedstocks, Schedule, and Operations

1.2.1. Biorefinery Components

SzIBR will integrate the following operations:

- **Ferment** — The algae are grown from the inoculum in a media formulation optimized to promote rapid cell division. The conditions and media are then switched to promote oil production and accumulation.

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1.4. Description of the Proposed Facility and Rationale for Modifying an Existing Facility

Solazyme proposes to "construct" SzIBR on the site of team member Cherokee Pharmaceuticals' existing commercial facility in Riverside, PA. The Cherokee plant manufactures numerous active pharmaceutical ingredients, biopesticides and nutraceuticals in bulk, and has been manufacturing specialty chemicals for over 55 years. The site encompasses 323 acres, with 127 acres inside the fence-line. The facility has been extensively renovated since 1995 and is fully operational and permitted. A corner of the site comprises a fermentation facility that produced xanthan gum until 2005. Since then it has manufactured various fermented products for external biotechnology companies. Solazyme will leverage spare fermentation capacity in this corner of the site. SzIBR will represent about 10% of the activity in this corner of the site, and a minor blip in the overall activities at Cherokee, which employees about Ex 4

Two Solazyme process engineers will work on-site at Cherokee and supervise the Cherokee employees, who will operate the equipment. Additional Solazyme process engineers will travel to Cherokee for extended periods as necessary.

The available section of Cherokee contains 20 G-tanks (20,000 gallons each), 1 large G-tank (40,000 gal), and 12 F-tanks (1,500 gal) — all pressure, temperature, and sterile airflow controlled and agitated — along with 10 E-tanks (150 gal) for seed culture growth. Two G-tanks, one F-tank and one E-tank will be dedicated to the SzIBR project. Many of the remaining tanks are also available and all the tanks are interconnected, so new tanks could easily be transferred to SzIBR if problems were to develop with any of the assigned tanks, or to facilitate maintenance without interrupting the project. No modifications of any kind are needed to the existing plant with respect to fermentation, and all the necessary supporting infrastructure (pumps, steam generators, air compressors, electrical switchgear, distributed control system, backup power, chillers, waste water treatment, harvest tanks, pH control systems, seed fermentors, sterile filters, continuous sterilizers, media handling, mix tanks, sugar solution handling, fork trucks, railcar and truck receiving, autoclaves, etc.) is available. The tanks that would be assigned to Solazyme are fully operational and ready to operate on short notice. Cherokee has a staff of 12 people tending this section of the

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plant and has committed to add up to . more as the number of fermentors in operation increases, drawing from other sections of the plant. This deep pool can support the surge of effort needed to turn fermentors around quickly — clean, sterilize, prep media, inoculate, etc. — without requiring SzIBR to hire a large dedicated staff. The SzIBR project will pay only for time expended by Cherokee personnel, enjoying the benefits of a large staff during peak work periods without paying for idle time between campaigns.

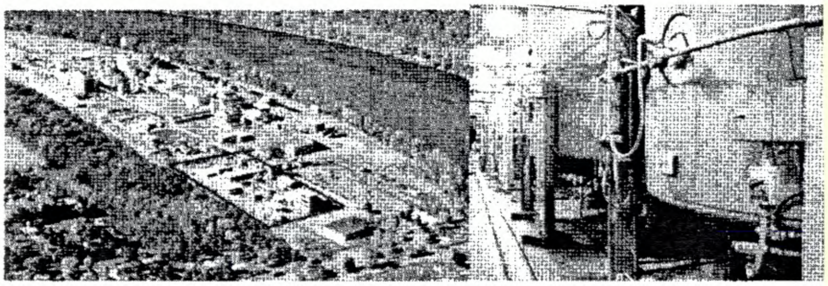

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Figure PEP-1. SzIBR will be constructed within and extensively leverage Cherokee Pharmaceuticals' existing commercial facility in Riverside, PA. (Left) Fermentation area shown in red (Center) A few of the many G-tanks available (Right) Space available in an existing process building to house SzIBR's oil recovery equipment.

Data collection systems include *in situ* probes in the production vessels to monitor pressure, temperature, pH, and dissolved oxygen. On-site laboratory and analytical support capabilities include freezers, drying ovens, laminar flow hoods, centrifuge, autoclaves, incubators, microscopes, spectrophotometer for optical density analysis, two mass spectrometers for continuous off-gas analysis, two YSI biochemistry analyzers for sugar analysis, and pH meters. Complete chemistry and microbiological laboratories are also available on site with additional capabilities (HPLC, GC, AA, NMR, NIRA, FTIR, TOC, etc.).

The equipment downstream of fermentation will need to be installed for drying, extraction, and purification. Cherokee has a suitable, appropriately located process building on the site adjacent to the fermentation tanks with empty space that can host this equipment. This building formerly housed the xanthan gum recovery and processing equipment. Only relatively minor remodeling of the interior space is needed. Nearly all the equipment that SzIBR requires can be ordered and delivered as skid-mounted or floor-standing units and installed accordingly. Utilities such as steam, gas, compressed air and water are already available in the building, but will need to be hooked up. Ample space is available should it prove necessary to bring in additional equipment or exchange equipment. Cherokee staff will also run the downstream process equipment.

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All previous barriers to the scale-up proposed for this project have been overcome. Specific discussion by process stage and unit operation can be found in Sections 3.3-3.7 and the separate PFD Attachment.

Critical Success Factors for the Proposed Project (to Proceed to Commercialization)

In the proposed project, the following critical success factors will guide consideration to proceed along the path to build a full-scale commercial plant:

- Expeditiously commence construction and operations in earnest.
- Integrate all unit operations successfully into a unified biorefinery.
- Validate low cost production at commercial scale.
- Demonstrate refining of the algal oil into fully-compliant liquid transportation fuels.
- Accelerate high-impact lignocellulosic feedstocks to near parity with interim transitional feedstocks.
- Successfully complete the project on schedule.

These CSFs are tied to quantitative technical and process values below. Additional CSFs pertaining to full-scale commercialization are discussed in the Business and Commercialization Plan Section 2.1.

Project Objectives

To achieve the above overarching critical success factors, Solazyme will accomplish the following specific project objectives:

- Complete all preliminary project activities on schedule by preparing in advance to the extent possible and employing best management and environmental assessment practices guided by experts in these areas.
- Build a pilot-scale integrated biorefinery (SzIBR) quickly by leveraging spare fermentation capacity at a pre-selected, pre-existing, fully-operational, commercial-scale bioproduction facility (Cherokee Pharmaceuticals) and adding and integrating the necessary algal oil extraction and purification equipment — all standard commercial equipment that vendors will build quickly to order, deliver and install.
- Operate SzIBR successfully and achieve all technical performance objectives (embodied in the KPPs and milestones tabulated below) necessary to validate production cost projections at full commercial scale. Solazyme has already developed credible cost models and will populate them with technical data that will be collected and proven at integrated pilot scale.
- Refine the purified algal oil to biodiesel and renewable diesel, with the assistance of partners REG and UOP, at a scale sufficiently large to demonstrate quality consistency of the biofuels.
- Optimize fermentation on sugars derived from at least two high-impact lignocellulosic feedstocks (by BlueFire and Abengoa via distinct cellulosic processes from opposite ends of the technology spectrum) at laboratory scale (7L) and transition these feedstocks to integrated pilot scale at SzIBR, with technical performance rapidly approaching parity with the initial transitional feedstock (sucrose).
- Maintain a flexible project plan and adhere to best project management practices to meet all objectives on or ahead of schedule and on or below budget.

These objectives are embodied in specific, actionable milestones, discussed in Section 5.3 and the PMP. The project plan is unusually flexible and robust for this type of project because it extensively leverages existing infrastructure, benefits from (but does not pay extra for) redundancies, follows a very straightforward critical path with remarkably few critical dependencies, and offers straightforward workarounds for nearly all potential problems and failures.

Project Key Performance Parameters (KPPs)

The Key Performance Parameters for the project will progress through three stages, as shown in Table PEP-1. All of the KPPs (and many other parameters) will be tracked, but net cost to produce purified algal oil at commercial scale is what really matters. Solazyme is resolutely focused on this bottom line cost as the primary driver, and the process development team analyzes all process optimizations with respect to impact on the cost model. The KPP levels will be achieved at milestones as summarized in Table PEP-2.

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2.2. Competitive Advantage

2.2.1. Advantages over Competing Processes and Feedstocks

Competing renewable processes and feedstocks that can produce ***oil-based*** transportation fuels include:

- Waste oils, grease, etc. — The supply is limited and already nearly fully exploited.
- Vegetable oils — Oil producing plants require intensive cultivation on prime agricultural land. By 2008, demand for biodiesel already strained the limits of supply at less than 1 billion gallons per year. The recent collapse of oil prices has since resulted in a glut of vegetable oil, but as the economy recovers and fuel prices increase, the limits will be reached again quickly. While US production can increase somewhat above the previous peak, it will exert severe upward pressure on food prices and cannot scale to address the 20+ billion gallon targets of the Renewable Fuel Standard (RFS). Solazyme's algal based biofuel process, in contrast, utilizes carbohydrate feedstocks, which may consist of agricultural residues and wastes, municipal green waste, and dedicated energy crops that can be grown on land not suited for conventional agriculture. Whereas the supply of vegetable oils is constrained, the potential supply of cellulosic feedstocks is highly scalable.
- Photosynthetic algae — These approaches are not even close to being economically viable. A full discussion of the hurdles they confront is beyond the scope of this proposal. In brief, however, it's important to realize that while several companies around the world do profitably grow algae in outdoor ponds, they make specialty nutraceutical products that typically fetch from thirty to hundreds of dollars per kilogram, not commodities like fuels that must sell for less than a dollar per kilogram.
- Pyrolysis, thermal depolymerization, catalytic depolymerization, etc. — These approaches have never been shown to be technically and economically viable, and this is especially true for scalable feedstocks such as biomass (as opposed to high-value inputs that are not scalable). Solazyme's biofuel process, in contrast, is based on credible technical and economic performance data. (See PEP Section 3 and BCP Section 2.)
- Fischer-Tropsch synthesis from biomass — These approaches are technically sound but expensive and extremely energy intensive, and therefore suffer from a poor carbon footprint. Solazyme's process, in contrast, offers competitive economics and has a very favorable greenhouse gas footprint. (BCP 5.0.)

Section 3.10 discusses advantages compared with competing processes that yield different products.

2.2.2. Technical Advancement

Solazyme's technology represents the first and only

- economically viable algal biofuel platform,
- platform utilizing any microbe that produces biofuels fully equivalent to petroleum products,
- biotechnology approach that leverages organisms that can already prolifically produce, sequester and tolerate oil-based biofuels (the difficult problem), and modifies them to utilize multiple carbon substrates (an easier problem) rather than traditional approaches that attempt to import the former capabilities, which aren't even understood yet, into model organisms.

2.2.3. Advancement of National Energy Goals

See BCP Section 1.4.

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9.2. Financial Assurances

Solazyme is a venture backed company that has strong backing from a broad base of institutional and strategic investors. To date, the company has raised in excess of $76 million — most recently raising $57 million in Series C financing. Lead investors include Braemar Energy Ventures, Lightspeed Venture Partners, The Roda Group, Harris Group LLC, Vantage Point Venture Partners. Chevron Technology Ventures is an important strategic investor.

Solazyme has been awarded a number of government collaborative agreements or grants. Among these, Solazyme is currently in year two of a two year, $2 million collaborative agreement with the National Institute for Standards in Technology. In addition, Solazyme was recently awarded an $800,000 grant from the California Energy Commission. The company expects to secure additional government funding by collaborating with multiple government agencies on research programs.

Team members Cherokee Pharmaceuticals, Renewable Energy Group, Abengoa, UOP and Solazyme have all agreed and committed to participate in the cost share. All cost shares are in cash or waiver of reimbursement for direct expenses incurred. Letters of commitment to cost share are included in the Letters Attachment. The breakdown of the cost share among the team members is shown in Solazyme's budget justification file. Solazyme will provide the majority of the cost share.

Net cash used by the Company from March 31, 2003 (inception) to December 31, 2008 to fund operations was approximately $17 million. The company ended December 31, 2008 with approximately $49 million in cash and investments. Solazyme expects these funds will be sufficient to meet the project's cost share obligations as well as any potential cost overruns. (Solazyme does not believe that an explicit contingency reserve is required because approximately 2/3 of the project costs are operating costs, the majority of these costs will be contractually fixed, and any operating overruns can be compensated by slightly scaling back operations if necessary. The equipment costs will similarly be capped by firm fixed price quotes.)

Solazyme also expects to raise additional capital over the proposed project period from a combination of debt financing, license revenues, and collaborative agreements with industry partners. These additional funds will further assure that Solazyme can not only meet the project cost share, but also aggressively move to begin related commercialization activities in parallel with but outside the project scope.

9.3. Consumables

All major consumables are readily available:

- Fermentive organisms — provided by Solazyme.
- Media components — all constituents are readily available without supply constraints.

9.4. Materials Testing

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13.1.1. Solazyme Manufacturing and Process Development

Solazyme has made remarkably fast progress in fermentation development because the company has recruited an exceptionally strong team of bioengineers with extensive closely related industry experience.

David Brinkmann, Vice President of Manufacturing / Project Director, has over 30 years of technical, operations, and leadership experience in the bioproduction industry, most recently at CP Kelco, where he was the manager for ten years responsible for all operational aspects of a large biotechnology pilot plant that provided process R&D and manufacturing support programs such as productivity improvement, cost reduction, and new product development. In his last four years at CP Kelco he was also the Director of Biospecialties Operations, in charge of business development, strategic planning, evaluation, and negotiation of biospecialties deals. He managed a wide range of projects (omega-3 fatty acids, biodegradable plastics, enzymes, pharmaceutical intermediates, vitamins, anti-viral proteins, carotenoids, flavors & fragrances, biopesticides) involving heterotrophic algae as well as more common productive organisms (bacteria, yeast, fungi). Mr. Brinkmann was responsible for the technical groups at CP Kelco that developed the algal bioprocess that Martek Biosciences now employs to manufacture omega-3 fatty acids (a high-value nutraceutical oil). In two years, his groups scaled this process up from the laboratory to 150,000 liter vessels while also improving the product content and titer from low values to over 70% and 180 g dry cell weight / liter. In previous positions at A.E. Staley Manufacturing Co, Weyerhaeuser, Stauffer Chemical Co, and Diamond Shamrock Corp over 22 years he developed and managed the scale-up from laboratory to industrial scale of a wide variety of novel bioproduction processes.

Jurgen Dominik, Senior Vice President of Process Development and Manufacturing, is a consultant to Solazyme, where he spends 3 days per week. Most recently, Mr. Dominik was Senior Vice President of global operations for CP Kelco, where his responsibilities included manufacturing, logistics, capital spending, and bioprocess research and development. Mr. Dominik's career at CP Kelco began in 1970 as a research engineer when xanthan gum was an embryonic new product. Over the years, he was instrumental in developing high-volume, low-cost bioproducts produced by microorganisms, including algae, and turning them into global businesses. Mr. Dominik's area of responsibility ultimately spanned operations in North America, South America, Europe, and Asia. His duties have included the management of design, construction, startup, and operation of several large-scale bioproduction facilities and natural product extraction manufacturing plants. Most recently he was responsible for the design and construction of two major expansions to the CP Kelco facilities in San Diego and Oklahoma and two pectin facilities in Denmark and Brazil. These projects all ranged from $40 million to over $100 million in size. In Brazil he implemented new liquid/solid separation technology that increased plant output by 35%. He was responsible for a program that increased xanthan gum fermentation titers by 90% and then subsequently by a further 20%. He was also responsible for the design, construction, start-up, and operation of CP Kelco's biogum plant in Knowsley, England. And most recently prior to joining Solazyme, while acting as an independent consultant, he located and managed the acquisition of a Chinese industrial xanthan gum producer.

Stephen Decker, Senior Manager of Fermentation Process Development, has 14 years of industrial experience in bioproduction process development and characterization, including senior manager and scientist positions at Vaxgen, Amgen, and Merck Research Laboratories. He has led multidisciplinary process development and manufacturing groups involved in development and technology transfer of four manufacturing scale, GMP bioproduction processes. His expertise includes process analytical characterization and validation, process scale up, technical oversight of upstream and downstream operations, Failure Modes and Effects Analysis (FMEA), manufacturing facility due diligence, culture media optimization, and novel biomanufacturing technologies such as on-line sampling.

Felipe Arana, Director of Downstream Process Development, has extensive experience in downstream processing with focus on the oil seed industry. Felipe's academic research focused on membrane extraction of valuable byproducts from oil seeds. He worked on application of membranes technology to corn wet milling and vegetable oil refineries while employed at Praire Gold (Bloomington, IL). Prior to this, Felipe managed and supervised over 100 employees as chemical plant engineer at a Lloreda SA, a major producer of fats and oils, vegetable proteins and soaps in Colombia, South America. While at Lloreda he also completed process and equipment design, construction, commissioning and qualification for several oil seed and vegetable oil manufacturing plants.

Nick Lurty, Downstream Process Development Manager, has more than 10 years of experience in downstream recovery in processing of algal and seed oils. Prior to joining Solazyme, he developed oil extraction processes from bench to commercial scale while working at Martek Biosciences in South Carolina. Martek is currently the only company commercially producing oils from heterotrophically grown algae (for infant formula and as a nutritional supplement). He was responsible for managing all capital projects, generating budgets, bidding, contracting and supervising contractors for a 3.3 million pound/day extraction plant and soy oil refinery at AG Processing, MO, the world's largest cooperative soybean processor and a leading vegetable oil refiner in the United States. Nick also worked at ADM in Decatur, IL where he had P&L responsibility for a $20 million state-of-the-art, hexane extraction/packaging plant with 8 union operators, where he implemented a quality control program to establish process optimization guidelines.

13.1.2. Solazyme Business Development and Financing

See the Business and Commercialization Plan, Section 6.

13.1.3. Solazyme Strain Development

Algal strain selection and optimization is an essential core competence that has prepared Solazyme to engage in the proposed project. As discussed in Sections 3.3, 11, and the PFD, Solazyme has demonstrated its abilities in this area by identifying and developing strains that rapidly accumulate exceptionally large amounts of oil, and converting them to grow on alternate carbon sources, such as sucrose.

Professor Arthur Grossman, PhD, Chief of Genetics, is one of the world's leading algal molecular geneticists. Prior to work at Solazyme, genetic transformation has been accomplished in only four algal strains, one of which was developed by Dr. Grossman, who subsequently achieved the first reported conversion of an obligate photoautotroph to a heterotroph. He has also developed a high efficiency method for transforming the green alga Chlamydomonas and led the Chlamydomonas Genome sequencing and annotation projects. He shares his time between Solazyme and the Carnegie Institution and Stanford University. He is the recipient of the prestigious Darbaker Prize in 2002 & Gilbert Morgan Smith Medal in 2009 for his contributions to algal research.

Peter Licari, PhD, Senior VP of Research & Development, is responsible for the overall strategy and operations of the research organization at Solazyme. Prior to joining Solazyme he has worked at Merck, BASF and most recently, Kosan Biosciences, where he was the Senior Vice President of Manufacturing and Operations. While there he instituted development and manufacturing groups to support in-house production of drug compounds. Internal manufacturing routinely allowed Kosan to enter Phase 1 clinical trials 8-12 months faster than outsourcing and established fermentation and purification development as a competitive advantage for Kosan, routinely reducing cost of goods 20-500 fold with processes that were successfully scaled up to commercial production.

Anthony Day, PhD, VP of Research and Development, is a biochemist with over twenty years experience in industrial and pharmaceutical biotechnology R&D, most recently prior to joining Solazyme as Director of Research at Genencor, where he led numerous pharmaceutical and industrial biotechnology projects, several of which led to commercial products in a number of business areas. He also joined Genencor Healthcare division at its inception and designed, implemented, and ran the company's first healthcare program.

Scott Franklin, PhD, Senior Director, heads up the strain discovery and screening efforts at Solazyme. He has over 20 years of experience in virtually all aspects of molecular biology, and molecular genetics applied to microalgal systems. Prior to working at Solazyme he founded and ran his own microalgal based biotechnology company (Rincon) where he developed novel genetic transformation and expression systems. Scott was also the Director of Molecular Biology at the microalgae company Cyanotech where he developed the molecular tools to discriminate between cyanobacterial isolates of commercial interest and led teams that scaled algal isolates from laboratory to 600,000 liter production scale.

13.2. Cherokee Pharmaceuticals

The capabilities and resources of Cherokee Pharmaceuticals' bioproduction plant in Riverside, PA, where SzIBR will be located, are described in Section 1.4.

Jeffrey L. Haney, Director, Fermentation Services at Cherokee will manage Cherokee's activities within the project scope. He is responsible for all aspects of developing and managing the Fermentation Contract Manufacturing Business for Cherokee Pharmaceuticals, including development of cost models to assess economic feasibility. Jeff also directs all aspects of the manufacturing business. Prior to working at Cherokee, Jeff was Director of Manufacturing at Merck & Co's Danville facility where he managed a staff of 150 and directed all aspects of Active Pharmaceutical Ingredients.

13.3. BlueFire Ethanol

BlueFire Ethanol Fuels, Inc. was established to deploy a novel, non-enzymatic, commercially ready, patented, and proven Concentrated Acid Hydrolysis Technology Process for the profitable conversion of cellulosic "Green Waste" materials to ethanol. BlueFire is the only cellulose-to-ethanol company worldwide that has demonstrated production of ethanol from urban trash (post-sorted municipal solid waste), rice and wheat straws, wood waste and other agricultural residues. BlueFire is currently focused on developing its first ethanol biorefinery in Lancaster, CA. The Lancaster facility will use post-sorted cellulosic wastes diverted from landfills in Southern California to produce 3.9 million gallons of fuel-grade ethanol per year. The company also was awarded $40 million by DOE to construct a second plant in Southern California, and has received the first installment of funding from DOE for the development of the BlueFire Mecca LLC plant in Southern California.

John Cuzens, Chief Technology Officer, will manage BlueFire's activities within the project scope. John is responsible for technology development and implementation at BlueFire Ethanol. Prior to working at BlueFire, John had lead engineering roles at a number of energy and energy related companies including Applied Utility systems, Inc., Hydrogen Burner Technology Inc., and Arkenol Inc., the original developer of BlueFire's technologies, where he was responsible for improving the process.

13.4. Abengoa Bioenergy

Team member Abengoa Bioenergy is a division of the Spanish multinational Abengoa SA, which also has complementary business units in the areas of Solar, Environmental Services, Information Technology, and Industrial Engineering and Construction in addition to Bioenergy. Abengoa Bioenergy's total installed capacity for bioethanol production is >340 million gallons. Abengoa has also invested heavily in second generation cellulosic ethanol production. The company has successfully built and run a cellulosic ethanol pilot plant in York, Nebraska using wheat straw as a feedstock. The company is in advanced engineering design phase of a 2500 ton per day biomass plant in Hugoton, Kansas with plans to combine power generation with a 16 Mgal/yr ethanol plant using primarily corn stover as a feedstock. This plant is expected to be fully operational by Q3 2011. The company is also starting up a demonstration unit to convert straw to ethanol in Salamanca Spain with a capacity of 70 t/d. Abengoa Bioenergy has the engineering, project management, technology and financial resources to both carry out the work described in the proposal and to be a partner for subsequent commercialization.

Robert Wooley PhD PE, Director of Process Engineering, will be responsible for Abengoa's activities in the proposed project scope. Robert is responsible for engineering development of all technologies in the New Technology group. He leads a group of 10-15 engineers in the analysis of experimental data; development of models, PFDs, P&IDs and equipment and instrumentation specifications. His projects have included development of processes for cellulose conversion to ethanol and enhancements to the starch ethanol process. Prior to working at Abengoa he worked at Cargill, where led the effort to develop alternative feedstocks (biomass sugars) for the bioproduction of lactic acid and polylactide polymers, and at the National Renewable Energy Laboratory (NREL), where he was responsible for analyses to support the objectives of the DOE Biomass Program. While at NREL he was also accountable to DOE for the planning and execution of NREL and outside subcontracted research of approximately $20 million annually for advancing the National Biofuels Program.

13.5. Renewable Energy Group

Team member Renewable Energy Group, Inc. is the largest producer of biodiesel and crude glycerin in the United States. REG has expertise in design, process engineering, permitting and registration, safety management, site preparation, construction services, and fuel accreditation for biodiesel manufacturing plants. The company has commercialized biodiesel production from diverse oils including white grease, poultry fat, yellow grease, canola, palm and corn from DDG, and has produced biodiesel at non-commercial scale from camelina, jatropha, and moringa. REG has also successfully converted Solazyme's algal oil into high quality biodiesel on multiple occasions. **Glen Meier**, Director, Technology & Feedstock Development will manage all activities within the project scope. Glen evaluates new technologies that are complementary to REG's business. His department also supports the Quality, Production, Procurement and Construction departments.

13.6. UOP LLC

Team member UOP LLC is a subsidiary of Honeywell Corporation, in its Specialty Materials Strategic Business Enterprise. UOP has been delivering cutting-edge technology to the refining, petrochemical, and gas processing industries for over 90 years. UOP is a leader in the development of technology to convert triglyceride oils to green renewable diesel with properties indistinguishable from petroleum-based fuels. The Ecofining™ process to produce green diesel was co-developed with the Italian refiner Eni. Two Ecofining process units are in development today, with more anticipated this year. The first Ecofining license is to Eni, which plans to start up its facility in 2010 in Livorno, Italy. Galp Energia of Portugal also plans to start up a facility in 2010. The resulting biofuels not only meet but often exceed current specifications for their petroleum equivalents. UOP has successfully converted Solazyme's algal fuel into high quality renewable diesel using the Ecofining process. Work within the scope of the project will be managed by **Andrea Bozzano**, Development Manager – Renewables. Andrea is responsible for Process Development of the UOP technologies Ecofining and Renewable Jet technologies, as well as other technologies based on renewable feedstocks.

14. Intellectual Property Summary

Solazyme owns all the intellectual property necessary to accomplish the tasks set out in this proposal. The intellectual property rights owned by Solazyme have not been licensed to any other parties. None of these intellectual property rights have been licensed from another party. Partners BlueFire Ethanol and Abengoa Bioenergy New Technologies will provide feedstock materials derived from cellulosic biomass to Solazyme. These companies have confirmed that they own all the intellectual property necessary to produce and deliver these materials. Partners Renewable Energy Group and UOP will refine algal oil provided by Solazyme into transportation fuels and return the finished fuels to Solazyme. These companies have confirmed that they own all the intellectual property necessary to perform these operations. The Intellectual Property Statement Attachment contains further discussion.

Applicant Name: Abengoa Bioenergy New Technologies (sub-recipient)   Award Number: DE-FOA-0000096

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1.				$528,082		
2.						
3.				REDACTED		
4.				EXEMPTION 4		
5. Totals				$528,082		

Section B - Budget Categories

6. Object Class Categories	Grant Program, Function or Activity (1)	(2)	(3)	(4)	Total (5)
a. Personnel					
b. Fringe Benefits					
c. Travel					
d. Equipment					
e. Supplies					
f. Contractual					
g. Construction					
h. Other					
i. Total Direct Charges (sum of 6a-6h)					
j. Indirect Charges					
k. **Totals** (sum of 6i-6j)					
7. Program Income					

REDACTED
EXEMPTION 4

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Section C - Non-Federal Resources				
(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) **Totals**
8. Period 1				
9. Period 2	REDACTED			
10. Period 3	EXEMPTION 4			
11.				
12. **Total** (sum of lines 8 - 11)				

Section D - Forecasted Cash Needs					
	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th quarter
13. Federal				REDACTED	
14. Non-Federal				EXEMPTION 4	
15. **Total** (sum of lines 13 and 14)					

Section E - Budget Estimates of Federal Funds Needed for Balance of the Project				
	Future Funding Periods			
(a) Grant Program	(b) First	(c) Second	(d) Third	(e) Fourth
16.				
17.	REDACTED			
18.	EXEMPTION 4			
19.				
20. **Total** (sum of lines 16-19)				

Section F - Other Budget Information

REDACTED
EXEMPTION 4

a. Personnel

PLEASE READ!!!

List costs solely for employees of the entity completing this form (award recipient or sub-recipient). All other personnel costs (of subrecipients or other contractual efforts of the entity preparing this) must be included under f., Contractual. This includes all consultants and FFRDCs.

Identify positions to be supported. Key personnel should be identified by title. All other personnel should be identified either by title or a group category. State the amounts of time (e.g., hours or % of time) to be expended, the composite base pay rate, total direct personnel compensation and identify the rate basis (e.g., actual salary, labor distribution report, technical estimate, state civil service rates, etc.).

Add rows as needed. Formulas/calculations will need to be entered by the preparer of this form. Please enter formulas as shown in the example.

Task # and Title	Position Title	Budget Period 1			Budget Period 2			Budget Period 3			Project Total Hours	Project Total Dollars	Rate Basis
		Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 1	Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 2	Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 3			
1. Generation 2A Receiver Design													
EXAMPLE													
DNLY!!!													

REDACTED
EXEMPTION 4

Task # and Title	Position Title	Budget Period 1			Budget Period 2			Budget Period 3			Project Total Hours	Project Total Dollars	Rate Basis
		Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 1	Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 2	Time (Hours)	Pay Rate ($/Hr)	Total Budget Period 3			
	Total Personnel Costs												

REDACTED EXEMPTION 4

Additional Explanations/Comments (as necessary)

b. Fringe Benefits

	Budget Period 1	Budget Period 2	Budget Period 3	Total
Rate applied:				
Total fringe requested:				

REDACTED
EXEMPTION 4

A federally approved fringe benefit rate agreement, or a proposed rate supported and agreed upon by DOE for estimating purposes is required if reimbursement for fringe benefits is requested. Please check (X) one of the options below and provide the requested information. Calculate the fringe rate and enter the total amount in Section B, line 6.b. ("Fringe Benefits") of form SF-424A.

_____ **A fringe benefit rate has been negotiated with, or approved by, a federal government agency. A copy of the latest rate agreement is included with this application, and will be provided electronically to the Contracting Officer for this project.**
**In the area designated below, identify the full calculations used to derive the total fringe costs. See further information below.*

__X__ **There is not a current, federally approved rate agreement negotiated and available.**
*When this option is checked, the entity preparing this form shall submit a rate proposal in the format provided at the following website, or a format that provides the same level of information and which will support the rates being proposed for use in performance of the proposed project. Go to https://www.eere-pmc.energy.gov/forms.aspx and select PMC 400.2 Sample Rate Proposal. * In the area designated below, identify the full calculations used to derive the total fringe costs. See further information below.*

Additional explanation/comments (as necessary)

*IMPORTANT: In the space provided below (or as an attachment) provide a complete explanation and the full calculations used to derive the total fringe costs. If the total fringe costs are a cumulative amount of more than one calculation or rate application, the explanation and calculations should identify all rates used, along with the base they were applied to (and how the base was derived), and a total for each (along with grand total). The rates and how they are applied should not be averaged to get one fringe cost percentage. NOTE: <u>The fringe benefit rate should be applied to both the Federal Share and Recipient Cost Share.</u>

c. Travel

PLEASE READ!!!

Provide travel detail as requested below, identifying total Foreign and Domestic Travel as separate items. Purpose of travel are items such as professional conference, DOE sponsored meeting, project management meeting, etc. The Basis for Estimating Costs are items such as past trips, current quotations, Federal Travel Regulations, etc.

All listed travel must be necessary for performance of the Statement of Projecct Objectives.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Purpose of travel	No. of Travelers	Depart From (not required for domestic travel)	Destination (not required for domestic travel)	No. of Days	Cost per Traveler	Cost per Trip	Basis for Estimating Costs
		Budget Period 1					
Domestic Travel							
EXAMPLE ONLY!!! Visit to PV cell mfr. to set up vendor agreement							
			REDACTED EXEMPTION 4				
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 1 Total							

Purpose of travel	No. of Travelers	Depart From (not required for domestic travel)	Destination (not required for domestic travel)	No. of Days	Cost per Traveler	Cost per Trip	Basis for Estimating Costs
Budget Period 2							
Domestic Travel							
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 2 Total							
Budget Period 3							
Domestic Travel							
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 3 Total							
PROJECT TOTAL							

Additional Explanations/Comments (as necessary)

d. Equipment

PLEASE READ!!!

Equipment is generally defined as an item with an acquisition cost greater than $5,000 and a useful life expectancy of more than one year. Further definitions can be found at 10 CFR 600 found on the PMC Recipient Resources Forms page at https://www.eere-pmc.energy.gov/Forms.aspx#regs .

List all proposed equipment below, providing a basis of cost such as vendor quotes, catalog prices, prior invoices, etc., and briefly justifying its need as it applies to the Statement of Project Objectives. If it is existing equipment, and the value of its contribution to the project budget is being shown as cost share, provide logical support for the estimated value shown. If it is new equipment which will retain a useful life upon completion of the project, provide logical support for the estimated value shown.

For equipment over $50,000 in price, also include a copy of the associated vendor quote or catalog price list.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
			Budget Period 1		
EXAMPLE ONLY!!! Thermal shock chamber					
				REDACTED EXEMPTION 4	
Budget Period 1 Total					
			Budget Period 2		
Budget Period 2 Total					

Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
			Budget Period 3		
				REDACTED	
				EXEMPTION 4	
Budget Period 3 Total					
PROJECT TOTAL					

Additional Explanations/Comments (as necessary)

e. Supplies

PLEASE READ!!!

Supplies are generally defined as an item with an acquisition cost of $5,000 or less and a useful life expectancy of less than one year. Supplies are generally consumed during the project performance. Further definitions can be found at 10 CFR 600 found on the PMC Recipient Resources Forms page at https://www.eere-pmc.energy.gov/Forms.aspx#regs.

List all proposed supplies below, providing a bases of cost such as vendor quotes, catalog prices, prior invoices, etc., and briefly justifying the need for the Supplies as they apply to the Statement of Project Objectives. Note that Supply items must be direct costs to the project at this budget category, and not duplicative of supply costs included in the indirect pool that is the basis of the indirect rate applied for this project.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

General Category of Supplies	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
			Budget Period 1		
EXAMPLE ONLY!!! Wireless DAS components					
				REDACTED EXEMPTION 4	
Budget Period 1 Total					
			Budget Period 2		
			REDACTED EXEMPTION 4		
Budget Period 2 Total					