Prospectus

Liquid Biofuels: The Next Generation

Nexant

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The Next Generation

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Contents

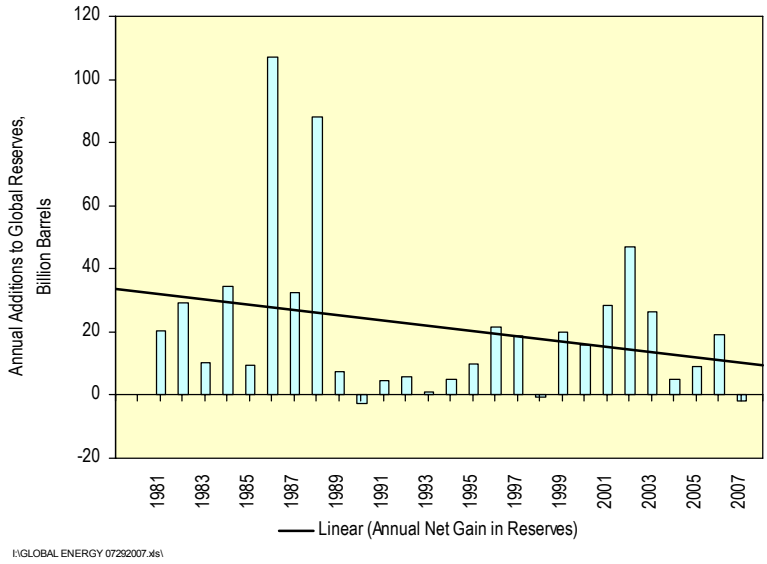
Section 1 Abstract

1.1 BUILDING ON A STRONG FOUNDATION

Nexant's landmark report "Liquid Biofuels: Substituting for Petroleum", published in late 2006, has over 50 subscribers, including the world's leading national and multinational oil and gas companies, chemical and agricultural giants, seed and enzyme biotech developers, biofuels producers, government environmental and energy agencies, and entrepreneurs. Since its publication, the technical, market and industry framework have dramatically changed in many ways. Global crude oil prices have risen dramatically, reaching a peak of US$147 per barrel in July, and currently is just below US$110 per barrel (early September). Despite the recent market pullback, since 2006, the outlook for energy prices has dramatically increased, opening new opportunities as well as challenges for the global biofuel industry.

Nexant believes that crude oil prices will remain above the levels that existed in 2006, driven by growth in consumption due to economic expansion as well as population growth. Demand increases are likely to be concentrated in major markets that control refined prices below international market levels, which insulate their consumers from price increases and any disincentive to consume. These include emerging economies such as China, India, Indonesia, Venezuela and others. In addition, the rate at which global proved reserves of petroleum have been added has slowed dramatically. As illustrated below, while global reserves have been increasing, the trend in reserves replacement has been declining, and the incremental cost of replacement has increased rapidly.

Figure 1.1 Oil Reserve Replacement Not Keeping Up with Demand



Because of the shortcomings of incumbent commercial biofuels, specifically grain and sugarcane-based ethanol and natural oil-based biodiesel, money and time continues to be invested by private entities and governments in researching new types of biofuels, feedstocks, and production technology. This activity has become more intense and broad and has entered new areas since Nexant's earlier report.

Due to many factors, many nations and organizations have recently joined in new biofuels activities, while some of the earlier activities have slowed or have been curtailed. Since 2006, the world biofuels market development picture has become more complex and even chaotic in some aspects.

Nexant provided a number of opinions and conclusions in its earlier report that the current generation of biofuels is likely to be transitional to different biofuels in a regime more based on utilizing non-food cellulosic biomass feedstocks rather than food commodities, and more via thermochemical conversions than fermentations. We predicted growing interest in higher alcohols and hydrocarbons made from biological feedstocks. Evidence indicates that the biofuels sector is trending exactly in these ways.

1.2 FEEDSTOCK CHALLENGES HAVE EMERGED

Challenging biofuels development, the "food versus fuel" debate has escalated with both the public and among public policy-makers. Biofuels in the popular press are being blamed for high food prices as well as hunger in developing countries. As a result, China and other countries have banned grain and certain land use for biofuels. Germany and other counties are back-peddling on biofuel goals. Critiques have also been published of biofuels as having a poor "carbon footprint" and being uneconomic without subsidies. Each of the above issues is as yet unresolved, with much of the information published being based on incomplete analysis or in some cases politically motivated.

Biofuels production based on food commodities or even using agricultural lands is falling out of favor with many, with the obvious exception of corn and sugarcane industry producers and stakeholders. Concerns are being raised over CO_2 emissions from agricultural fuel and fertilizer use, N_2O greenhouse gas emissions from fertilizers and tilling, and ethanol and biodiesel processing energy use. Additional agricultural/environmental issues have been raised over land use, soil depletion, water use, and deforestation. Because these concerns have received so much attention, the focus of much industry activity has shifted to development of feedstocks based on cellulosic biomass and non-food lipid sources such as jatropha and algae. Others worry that these solutions are being over-hyped and are not as feasible as claimed by their proponents.

However, in the United States, Brazil, and elsewhere, society and governments continue to look tentatively to biofuels as an alternative to petroleum. In the United States, the Energy Independence and Security Act that was enacted in December 2007 increases requirements for total use of renewable fuel (the Renewable Fuel Standard, or RFS) to 36 billion gallons by 2022. As in the 2005 Law, a target trajectory of use buildup is defined. The new 2007-defined RFS is summarized in the following table, along with the required contributions of advanced and cellulosic biofuels and biodiesel during the period.

Table 1.1 2007 Energy Act RFS-Mandated Schedule of Use

Renewable Fuels Required (billions of gallons)				
Year	Total	Advanced Biofuels Contribution	Cellulosic Biofuels Contribution	Biodiesel Contribution
2008	9.0	ns	ns	ns
2009	11.1	0.6	ns	0.5
2010	12.95	0.95	0.1	0.65
2012	15.2	2.0	0.5	1.0
2015	20.5	5.5	3.0	ns
2018	26.0	11.0	7.0	ns
2020	30.0	15.0	10.0	ns
2022	36.0	21.0	16.0	ns

ns= not specified in the Act

As some critics are requesting, this law could be changed by further legislation to slow the pace of scheduled corn ethanol production. It is not expected that the drivers for cellulosic and advanced biofuels will be significantly weakened. Most recently, Congress passed the Obama Administration's US$787 billion American Recovery and Reinvestment Act (ARRA). The Act has many promises that will assist in developing next generation biofuels.

1.3 PRACTICAL ISSUES WITH ETHANOL AND FAME HAVE SHARPENED

Ethanol and FAME biodiesel are also increasingly recognized as inconvenient to handle and use in the existing petroleum refining, distribution, storage, dispensing, and vehicle infrastructure. Because of their extra stress on the infrastructure for distribution of vehicle fuels, interest is growing in different kinds of biofuels, such as higher alcohols or hydrocarbons made through fermentation or thermochemical/catalytic routes, or as with certain strains of algae, biologically producing hydrocarbons rather than lipid oils

Thus, the problems and challenges of implementing biofuels continue to be all along the value chain, not just with developing economically viable conversion technology, but also with obtaining sustainable feedstocks and making more fungible products.

"If you want to do biofuels on a really big scale, such as tens of billions of gallons, you have to fit within the existing infrastructure, or it will not work… ….(with) renewable fuels, there are going to be a lot of unintended consequences. It is a feedstock-limited world."

- Louis Burke, Manager, Alternative Energy and Programs, ConocoPhillips

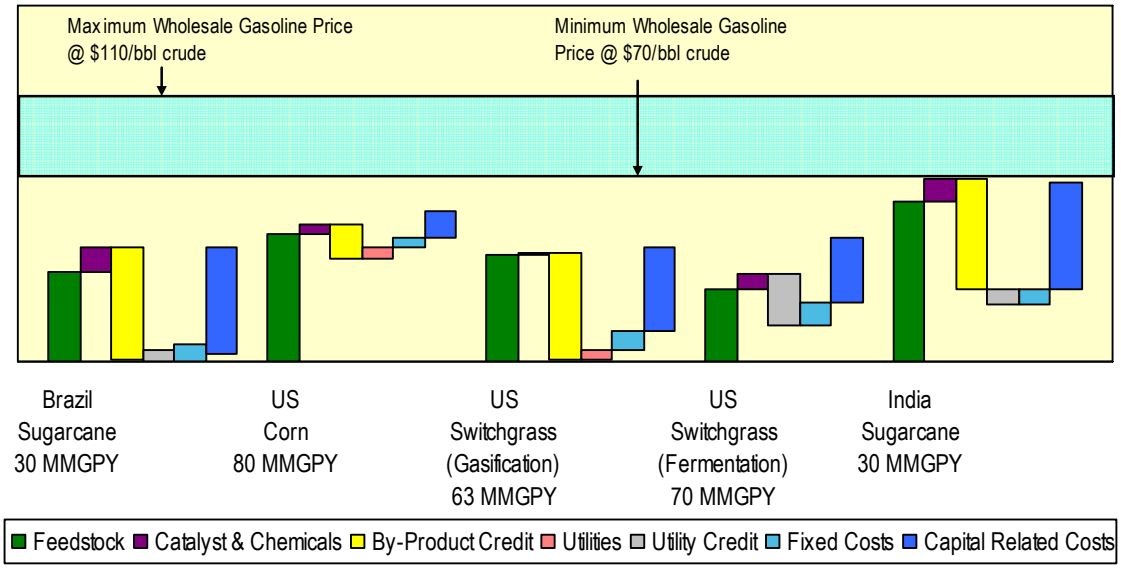
Interest in New Technologies and Biofuels

Fermentation routes are being reconsidered in favor of gasification-based technologies that produce more gasoline and diesel-like hydrocarbons or higher alcohols. The United States DOE is sponsoring a number of projects for biomass-to-biofuels by both fermentation and gasification routes.

Alternatively, fermentation routes to produce hydrocarbons from sugars are coming forth, such as are being tested by a joint effort between the United States biotech startup Amyris and Brazilian sugar maker Crystalsev. LS9 is developing a similar route. Others are using refinery hydrocracking and FCC processes to make hydrocarbons from biological substrates including natural oils and fats, ethanol, or even biomass. Petrobras in Brazil, among others, is testing these routes. Algenol is developing analgae to ethanol technology demonstration in the Mexican Sonoran desert. Solagyne is developing an algae technology-based not on sunlight and CO_2, but on making lipids by fermenting sugars. Virent is catalytically converting sugar solutions to hydrocarbons. Neste Oil, ConocoPhillips, UOP, and others have similar initiatives in hydrocracking natural oils and fats to aliphatic hydrocarbons ("renewable diesel"). At the same time, ethylene made from ethanol by catalytic dehydration routes is being commercialized for chemicals and polymers manufacture by Dow-Crystalsev and Braskem in Brazil. Dow also has announced a joint effort with the United States DOE to improve Dow's catalysts for converting biomass-based syngas to higher alcohols. This activity is in line with a key NREL report on thermochemical ethanol/higher alcohols production in which Nexant had a major role.

Also emerging is high interest in biobutanol. China, which continued making butanol by fermentation while the rest of the global industry converted to propylene-based petrochemical routes for this important industrial chemical, is now expanding production by the classic ABE (acetone-butanol-ethanol) route. In the United States, the startup company Tetravitae is exploiting Hans Blaschek's improved *Clostridium beijerinckii*-based ABE route. It and other developers will start by producing butanol for chemical use, while the BP-DuPont coalition, and others that are based on different microbes, are aiming more directly for the fuels market. Nexant analyzed these developments and others in its recent multiclient study, *"Biobutanol: The Next Big Biofuel",* as well as in several recent single client assignments. Shown here is a typical presentation of results of a Nexant analysis of biobutanol economics for existing and developing technologies.

Figure 1.2 Ethanol Processes - Economic Comparison



Other commercial biofuels-related chemicals initiatives include glycerine (FAME by-product) derivatives being commercialized by Dow, Cargill-Ashland, Solvay, and others. Nexant has also analyzed glycerine derivatives in recent client assignments for leading companies in this area.

Clearly, while the United States and Brazil are the primary countries for biofuels process development and commercialization. China, India, and specific countries in each of the global regions are also important in the overall picture.

This study provides background for a new subscriber to understand the fundamentals of liquid biofuels, but more importantly brings previous subscribers abreast of the current issues and developments up to the end of 2008/early 2009.

The study was completed in the first quarter of 2009. The cost of the study is US$18,000.00 (eighteen thousand U.S. dollars).

Section 2 Scope

The objective of this study is to assess the technical status and economic competitiveness of the second generation of liquid biofuels that are likely to supersede traditional ethanol and FAME biodiesel in supplementing or replacing petroleum motor fuels.

The following types of liquid biofuels and routes are considered in the study:

- **Biobutanol** made by clostridium-based fermentations or other fermentation routes
- **Hydrocracking natural oils, fats, or greases** to hydrocarbons ("renewable diesel") with a propane byproduct (rather than glycerine)
- **Hydrolysis of cellulose** using mineral acids or enzymes, followed by **fermentation of C_5/C_6 sugars to ethanol** (known as cellulosic ethanol) **or butanol**
- **Pyrolysis or "torrefaction"** of various types of biomass to make a "bio-oil" as a diesel blendstock, diesel substitute, or gasification feedstock, along with a char co-product for use as a fuel or gasification feedstock, or for burial as a soil amendment or as a **carbon sequestration strategy**
- **Gasification** of various biological materials to make syngas to produce biofuels by various catalytic processes at various stages of development and commercialization, including:
  - **Biomass-to-liquids** (BTL) as a diesel blendstock or substitute,
  - **Hydrogen** for petroleum upgrading in refineries
  - **Mixed alcohols, ethanol, or butanol** as gasoline blendstocks or substitute
- Catalytic technology to convert **ethanol to butanol or mixed hydrocarbon** streams as gasoline blendstocks
- **Anaerobic digestion of biomass** (agricultural waste, energy crops, MSW, waste sugar streams, etc.) to make methane, which can be gasified to make syngas, or be used as CNG or LNG vehicle fuel

Each of these fuels and/or process technologies is evaluated from technical, economic and commercial perspectives, as follows:

Technology Evaluation – A review and status assessment of the various process routes is performed for what Nexant deems to be representative of the technology, and the status of process commercial development is characterized, with a listing of existing and announced projects, if any.

Cost of production estimates are developed for conceptual plants representative of the technologies. Sensitivities are performed, typically for feedstock costs and capital costs, technical issues are identified as appropriate, and estimates are made of the costs and impacts of potential improvements.

Economic Evaluation – The study assesses the competitiveness of these products and processes with respect to different feedstock costs, scale factors, policy incentives (tax and other), other key technical economic and market assumptions, and different crude oil price levels.

Commercial Evaluation – Nexant performed an analysis of the major biofuel products considered in the technical and economic evaluation, including addressing issues of commercial viability such as technical compatibility with gasoline and diesel motor fuels in the distribution and refueling infrastructure, and on board vehicles.

The study evaluates the competitive position of biofuels relative to conventional petroleum products. The technologies evaluated represent the key global offerings, including from the United States, Canada, Brazil, Europe, China, India, Japan, and elsewhere. In addition, the report examines the experience with biofuels manufacturing, market development and trade throughout the world, making it relevant to subscribers with multinational concerns.

Roadmap

Nexant conducted an analysis of the likely pathways (or "roadmap") for biofuels development over the next decade, taking into consideration the salient issues going forward, including:

Sustainability:

1. Greenhouse Gas Emissions
    a. Fossil Fuel Use – farming equipment, transport, crop drying, other processing
    b. N_2O Emissions from:
        – Nitrogen fertilizers
        – Soil tilling
2. Water Resources
    a. aquifer, groundwater pollution, runoff
    b. competition with hydropower, river transportation, potable water, wildlife
3. Soil quality – Nutrient depletion, conservation set-asides
4. Species Diversity – botanical, agricultural (monocultures), animal habitat, rainforest/other ecosystem threats (all versus fossil fuel Exploration and Production, mining, and transport)
5. Carbon Trading - status, applicability, potential driver, Terra Preta (char burial)
6. Other issues that Nexant deems important

Non-Food Feedstocks

New Energy Crops

7. Switchgrass, other grasses
8. Energy cane

9. **Jatropha**, Camelina, Chinese Tallow Tree, other new non-food oil seeds
10. Algae
11. Other animal fats

Waste Biomass

1. Crop residues – corn stover, straw (wheat, rice, etc.), corn cobs, soybean pods, etc.
2. Manures, other agricultural residues
3. Processing Residuals – bagasse, DDGs, seed meals, vinasse, food processing waste, etc.
4. Wood Waste - forest thinning, sawmills, utility trimming, etc.
5. Pulp & Paper, Textile Waste fiber
6. MSW

Status of Relevant Biotechnology for:

1. Improving yields of conventional crops
2. New energy crops – switchgrass, energy cane, etc.
3. Enzymes for biomass conversion
4. Enzymes for conversion of C_5 sugars from hemicelluose to ethanol or butanol
5. Enzymes for syngas conversion to ethanol

Market Development

Nexant characterized and analyzed the current markets in major areas and examined the potential for implementing second and third generation biofuels in each one as a function of physical/agricultural, industrial, economic, infrastructural, political and regulatory factors.

Some biofuels, such as biobutanol, may start as chemical commodities or specialty products, similar to ethanol before it became a biofuel. Esters of soybean oil and other oils and fats also continue to have markets as specialty lubricants, hydraulic fluids, solvents, oil and gas drilling mud components, etc. While the focus of the market analysis is for fuels use, these traditional markets are identified when relevant.

The report provides a valuable resource for strategic planning purposes at a critical time in the development and evolution of biofuels. As such, it provides the necessary insights required by existing producers for establishing company strategies, as well as providing a guide for organizations considering major investments or new entry into this dynamic and competitive industry.

Section 3 Approach

The evaluations of conventional technology are based on Nexant's in-house information regarding process technology, augmented by contacts with biofuels manufacturers, academic researchers, process developers, licensors, engineering contractors, government agencies, and other experts in the industry. Analyses of emerging technologies are "built up" from such internal and field-derived information, reviews of patents, other public domain information, and discussions with the technology developing entities.

Much information was leveraged by updating and refining the data and analyses in two previous major multiclient studies by Nexant. These are *"Liquid Biofuels: Substituting for Petroleum"* and *"Biobutanol: The Next Big Biofuel"*. In addition, non-proprietary/non-confidential aspects of numerous relevant single client assignments Nexant has performed for a wide range of clients in the biofuels and renewable chemicals space were employed.

Nexant uses proprietary and commercial state-of-the-art software tools to develop the technology and economic estimates. These are well established engineering tools in the process industry and are used by major engineering contractors.

Commercial information and forecasts are developed from Nexant's extensive in-house databases, augmented with selected regional fieldwork.

Market projections are developed with the aid of Nexant's supply/demand computer modeling systems.

Section 5 Contact Information

Please visit www.chemsystems.com to authorize engagement of the study or return the following authorization form to one of the Nexant offices listed below.

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e-mail: cgibson@nexant .com

1. The undersigned (hereafter "Client") hereby subscribes to purchase from Nexant, Inc. ("Nexant"), Nexant's study, ***Liquid Biofuels: The Next Generation***, in accordance with the following terms and conditions.

   Nexant will provide to Client access to electronic downloads of the report via a password-protected area from www.chemsystems.com

2. While the information supplied by Nexant to Client will represent an original effort by Nexant, based on its own research, it is understood that portions of the report will involve the collection of information available from third parties, both published and unpublished. Nexant does not believe that such information will contain any confidential technical information of third parties but cannot provide any assurance that any third party may, from time to time, claim a confidential obligation to such information.

3. The information disclosed in this report will be retained by Client for the sole and confidential use of Client and its 51 percent or greater owned affiliates in their own research and commercial activities, including loaning the reports on a confidential basis to third parties for temporary and specific use for the sole benefit of Client.

4. Client further agrees that it will use reasonable efforts to keep the information in the reports for its sole use; however, this restriction shall not apply to information which is or becomes generally available to the public in a printed publication, which is already in the possession of Client, or which is received by Client in good faith from a third party without an obligation of confidentiality.

5. Client shall not republish any of the report except within its own organization or that of its 51 percent or greater owned affiliates. Client further agrees to refrain from any general publication of the reports, either directly or through its affiliates, so as to constitute passage of title into the public domain or otherwise jeopardize common law or statutory copyright in said report.

6. Upon authorization, Client will be billed by and shall pay to Nexant a total of US$18,000.00 (eighteen thousand U.S. dollars). Client shall be invoiced the total amount upon authorization. Amounts are due upon receipt of invoice and payable within thirty (30) days. Late payments shall accrue interest at the rate of 1.5 percent per month. Fees quoted do not include any applicable sales tax, or use or value added tax, all of which are for the account of Client.

7. Hard copies of the report are available at US$500.00 each. The complete report will also be available on CD-ROM at a cost of US$1,000.00.

8. The obligations of paragraphs 3 and 4 shall terminate five (5) years from receipt of reports.

9. Unless specified otherwise, there are no warranties of any kind for reports and consulting services provided under this Agreement. Nexant's total liability under this Agreement is limited to the total amount paid to Nexant for the reports.

10. This Agreement will be governed by the laws of the State of New York.

AUTHORIZATION FORM

AGREED TO AND ACCEPTED BY:		AGREED TO AND ACCEPTED BY:	
CLIENT:	_____	NEXANT, INC.	
Name:	_____	Name:	_____
Signature:	_____	Signature:	_____
Title:	_____	Title:	_____
Date:	_____	Date:	_____

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Section 7 Qualifications

7.1 GENERAL

Nexant uses multidisciplinary project teams drawn from the ranks of our international staff of engineers, chemists, economists and financial professionals, and from other Nexant groups to respond to the requirements of each assignment. Most of the staff of consultants possess credentials in both scientific and commercial disciplines plus substantial industrial experience. The collective talents of our staff, strategically located and closely linked throughout the world, result in valuable insights gained through a variety of perspectives.

ChemSystems is an international consultancy that is now part of Nexant, Inc., and is dedicated to assisting businesses within the global energy, chemical, plastics and process industries by providing incisive, objective, results-oriented management consulting. Over three decades of significant activity translate into an effective base of knowledge and resources for addressing the complex dynamics of specialized marketplaces. By assisting companies in developing and reviewing their business strategies, in planning and implementing new projects and products, diversification and divestiture endeavors and other management initiatives, Nexant helps clients increase the value of their businesses. Additionally we advise financial firms, vendors, utilities, government agencies and others interested in issues and trends affecting industry segments and individual companies. Whether identifying opportunities, managing change or confronting competitive challenges, we adhere to the highest ethical and professional standards.

ChemSystems, founded in 1965, was originally an independent, management-owned consultancy. IBM acquired it in 1998, and from early 1998 until August, 2001 *ChemSystems* was a part of IBM Global Services and IBM's Chemical and Petroleum group. Effective September 1, 2001, the *ChemSystems* unit of IBM was acquired by Nexant, Inc. Nexant, Inc. is an independent industry-expert consulting firm, that was spun off from Bechtel over four years ago, that provides technology solutions and experienced-based technical and management consulting services to electric utilities, energy producers, chemical companies, oil and gas companies, governments, and energy end-users worldwide. All of the staff and intellectual capital of *ChemSystems* was acquired by Nexant, Inc. The acquisition of *ChemSystems* by Nexant, Inc., has enhanced *ChemSystems'* ability to successfully serve its clients. This merger's success arises from complementary methodologies and technologies, which are used to provide services to clients and allow us to provide more complete and effective consulting. Thus, Nexant, Inc., with *ChemSystems* as part of its Chemicals and Petroleum Division, continues to maintain fully-integrated operations in White Plains, New York; London, England; San Francisco, California; Bangkok, Thailand; and Washington, D.C. Other business unit offices are located in Boulder, CO and Phoenix, AZ, and satellite business or project offices are located in Tokyo, Beijing, Seoul, and Houston. We also work with representatives throughout the world.

From major multinationals to locally-based firms and governmental entities, our clients look to us for expert judgment in solving compelling business and technical problems and in making critical decisions.

Nexant's clients include most of the world's leading oil and chemical companies, financial institutions, and many national and regional governments. Nexant, Inc. is active in most of the industrialized countries of the world, as well as in most of the developing areas including the Middle East, Africa, and East and Southeast Asia.

Major annual programs are:

- Process Evaluation/Research Planning® (PERP)
- *ChemSystems* Online® (CSOL)/Petroleum and Petrochemical Economics (PPE) – United States, Western Europe, and Asia

The PERP service covers technology, commercial trends, and economics applicable to the chemical industry. The program has more than 50 subscribers, including most of the major international chemical companies. Many of the processes to be analyzed in this multiclient have been assessed in the PERP program.

CSOL/PPE covers the market and manufacturing economics for major petrochemicals.

Over the past four years, the program has been completely overhauled and upgraded. The models and databases that run the analysis have been replaced with a start-of-the-art industry simulation program that has taken the 30 years of industry knowledge and experience of our consultants and enhanced it to a proven new level of forecasting expertise.

The new simulation model is used to generate the PPE reports and also an internet serviced brand *ChemSystems* Online® that provides global data, analysis, and forecasts of:

- Plant capacity
- Production
- Consumption
- Supply/demand and trade
- Profitability analysis
- Forecast
- Price forecast
- Techno-economic analysis

A subscription to *ChemSystems* Online® includes both written reports (the PPE program) on the petroleum and petrochemical industry and internet access to all data analysis and forecasts. Your subscription may be tailored to meet your specific company requirements and the fees reflect the value brought to your business. Insightful analysis and a reliable forecasting methodology provide the means to significantly improve your business performance though better investment decisions and improved competitive position.

7.2 SPECIFIC SINGLE-CLIENT EXPERIENCE RELEVANT TO BIOFUELS PRODUCTION AND USE

Nexant is exceptionally qualified to perform this comprehensive analysis based on our multidisciplinary business approach and has been carrying out studies of this type throughout our more than 40 year history.

RELEVANT NEXANT PERP PROGRAM MULTICLIENT SUBSCRIPTION REPORTS

Relevant recent reports from this program include:

"Green" Polyethylene – Analysis of the technology and economics of converting ethanol to ethylene by catalytic chemical dehydration and next to polyethylene by conventional polymerization technology, including comparisons with the incumbent routes from hydrocarbon feeds.

Biomass Gasification – A review of developments in gasification of biomass and technology, economics and commercialization initiatives, including of making liquid biofuels by catalytic processes.

Biogasoline – Techno-economic and market analyses of various types of bio-based alcohols and hydrocarbons that can blend with or substitute for petroleum gasoline

Ethanol – Analysis of fuel ethanol production by dry corn milling fermentation

Biodiesel (including a 2008 update – Developments in Biodiesel Production Technologies) – A review and analysis of production technologies (commercial and developmental) and economics, feedstock issues, regulatory and market drivers, supply and demand, and byproduct glycerine disposition

Glycerine – Comparison of the natural oil and synthetic-based production routes – considering production technologies, economics, feedstocks, and global markets

Glycerine Conversion to Propylene Glycol – Review of routes to the important industrial chemical, propylene glycol, from the glycerine that has become more abundantly available as a byproduct of FAME biodiesel production, with comparisons to the conventional petrochemical routes.

Methanol – Nexant has done a number of PERP as well as other Multiclient and single client reports on methanol and its derivatives.

Plants as Plants – A study of the emerging biotechnology, processing technologies and economics of producing and recovering polyhydroxyalkanoates (PHAs) - natural polyesters – by alternative routes of fermentation and in crops, including analyses of agricultural production economics, PHA extraction costs, byproduct biomass fuel utilization, and potential PHA markets.

Biotransformation Routes to Specialty Chemicals – Includes consideration of conversions of natural oils, fatty acids, fatty acid esters, fatty alcohols and fatty amines, and fermentation technologies and commercial overviews of many bio-based product markets.

Refinery of the Future as Shaped by Environmental Regulations – Reviews issues of supply and quality of crude oil feeds to refineries, trends in quality and volume requirements for refined products, and environmental drivers for both refinery operations as well as fuel specifications.

Biodesulfurization of Petroleum Fractions – Compares various versions of conventional refinery hydrodesulfurization with developments in fermentation based biodesulfurization.

INDIVIDUAL CLIENT STUDIES

A partial list of relevant projects includes:

Due Diligence on Biobutanol Technology Development and Business Plan – For an investor, Nexant performed a full-scope technical, economic, and commercial assessment of the developments and business plan of a startup company seeking to commercialize a leading fermentation-based biobutanol technology.

Jatropha Biodiesel Feedstock Feasibility Assessment – Nexant reviewed the status of agricultural and industrial development of this emerging sub-tropical plant-based non-food oil seed option for biodiesel feed, with special attention to the question of cost of producing the oil, and the feasibility of achieving a mechanical harvesting model despite the property of co-current flowering and seed maturation.

Sourcing Low-Cost Fats, Oils, and Greases for a Biodiesel Business – For an emerging biodiesel producer Nexant developed volumetric US-wide source models based on geography, population, demographic, and industrial/commercial parameters, and special sources of waste oils, fats, and greases to feed their technology which is capable of handling low-grade, high FFA waste lipids. This was the second project with this subject for Nexant, following a technology and finance due diligence on a similar project/business roll-out for another client.

Bio-Ethanol and Bio-Methanol Market Feasibility - For a venture seeking to commercialize alcohols production from syngas via gasification of the paper fraction of municipal garbage streams, Nexant analyzed markets and logistics (storage and shipment) for sale of chemical and fuel alcohol streams in selected proposed project locations around the US

Chemicals from Corn – This is a broad-based study for the National Corn Growers Association (NCGA), funded by the U.S. DOE, to identify and screen chemicals that could be feasibly produced from corn. The study considers a wide range of potential sugars, and fermentation-derived acids, alcohols, and other building blocks, but emphasizes fuel ethanol derivatives, including basic petrochemicals, solvents, intermediates and specialties, and application of the Reactive Distillation technology sponsored by the NCGA. The basic economics of ethanol production and potential improvements, economies of scale, logistics, and other production and value chain issues, are addressed in the study.

Biodiesel Glycerine Byproduct - Market Dynamics – For a major U.S.-based multi-national agricultural and food company with a growing stake in biofuels, Nexant analyzed the market demand/price elasticity (with a growing glut of biodiesel glycerine byproduct), existing uses of glycerine, potential substitutions for others polyols such as propylene glycol and sorbitol, and potential future applications, including reaction derivatives of glycerine in various applications and fuel uses. Nexant considered the near term and emerging and long-term market outlets for USP and other refined grades of glycerine, as well as for crude biodiesel glycerine byproduct, which is of a more problematic quality than soap and oleochemical byproduct. The study required developing views of biodiesel growth, and pricing scenarios under various assumptions. This subject was also addressed in two recent papers presented at international conferences.

Switchgrass Energy Utilization – For a major multinational energy company examining a technology that would express natural polyesters and extract them form switchgrass, Nexant performed an evaluation of options for energy utilization of the ground and solvent-extracted of the switchgrass residue at world-scale. The study included integrated fermentation and gasification, and free standing gasification processes, as well as the option of co-firing in a specific group of coal-fired power plants in Iowa.

Ethanol versus MTBE – Litigation Support – Nexant advised the U.S. Department of State in an action defending California against methanol interests for claims of losses in the phase-out of MTBE and use of ethanol as a substitute gasoline oxygenate. This work included a detailed analysis of the ethanol production and distribution infrastructure in the United States and addressing practical, environmental, safety, and issues of using ethanol in gasoline.

Ethanol Market and Cost Competitiveness Evaluation - Nexant was retained by an ethanol producer and its financial advisor to provide an independent market study and evaluation of project cost competitiveness to help raise funds to convert an existing sugar- and corn-based ethanol plant in Louisiana to process organic waste (biomass) as a feedstock.

Biobased Fuel Cells – At the BIO World Congress on Industrial Biotechnology and Bioprocessing, Orlando, FL, April 20-22, 2005, Nexant presented a paper on biofuels use in fuel cells based on a study of Stationary Fuel Cells for Nexant's PERP program, and also chaired a panel on Bio-based Fuel Cells, which included discussions of enzyme-based fuel cell membrane and electrode technologies to utilize hydrogen or biofuels.

Biomass Ethanol Process Evaluation - Nexant performed a detailed technical and economic analysis of a commercial scale plant for the production of fuel grade ethanol from wood biomass via fermentation, a process developed by a national energy laboratory. Among the goals of the program was the incorporation of the latest R&D developments into the design. The results from this study were compared against earlier designs.

Biomass Ethanol Development Technical Support - Under a multi year program, Nexant provided technical support for the SERI program to develop viable alcohol fuels production technology based on cellulosic feedstocks. Activities included: investigation of prototype cellulose to ethanol via hydrolysis plant designs for capacities of 50 MM to 250 MM gallons per

year; detailed design and capital cost estimate for an anhydrous ethanol plant based on enzymatic hydrolysis of hardwood chips; techno-economic evaluation of proposed processes including biomethanation of biomass pyrolysis gases and liquid fuels from cellulosic biomass.

Ethanol Project Management - A Midwestern U.S. ethanol producer of corn-based gasohol retained Nexant to assist in the implementation of its 40 million gallon per year project. This included a review of the process technology and hardware provided by technology licensors and vendors. Nexant's study assisted the client to obtain Federal loans and secure bank financing.

"Forest Refinery" Industry Evaluation - A U.S. national laboratory retained Nexant to assess the technical and economic feasibility of a forest refinery designed to manufacture chemical products from trees. The analysis screened a variety of biomass conversion technologies and compared the production costs and energy consumption levels of each route to conventional routes. Processes evaluated included fermentation, lignocellulose separation, lignin conversion and gasification.

Cellulosic Ethanol Feasibility Analysis - A synfuels company retained Nexant to determine the technical and economic feasibility of using cellulosic feedstocks to produce commercial quantities of fuel grade ethanol. Alternatives feedstocks (corn and other grains) and by-products were included in the evaluation.

Enzyme Process Assessment - Nexant assessed the impact on process economics and energy consumption resulting from substituting immobilized cells of Zymomonas Mobilis for conventional yeast in a commercial corn-based ethanol facility.

Fuel Ethanol Opportunity Analysis - A major oil/chemical company interested in developing fuel grade ethanol facilities in the Midwest retained Nexant to assess the competitive aspects of ethanol/gasohol. Factors evaluated included state incentive programs and change prospects, freight costs to prospective markets and the current level of penetration of unleaded gas by ethanol.

European Ethanol Markets Analysis - A study for a Japanese client reviewed the Western European ethanol business including synthetic and fermentation sources. Demand, pricing, grades, end-uses, ethanol production by location and production economics were provided. In another study for this client, Nexant compared the economics of the four plants producing synthetic ethanol with the most efficient (molasses) fermentation ethanol producer.

Ethanol Drying - For a Japanese client, Nexant reviewed the methods used in Western Europe to dry ethanol (including fermentation sources), discussed the merits of newer technologies, and investigated international legislative actions to restrict the use of benzene or cyclohexane in azeotropic distillation.

Ultra Clean Fuels Study – For Conoco, under U.S. DOE sponsorship, Nexant performed a comprehensive review of the future for ultra low sulfur diesel and other petroleum distillates in transportation: considered regulatory and market drivers, production technology and economics, petroleum refining impacts, environmental/resource depletion impacts, vehicle engine and

performance, consumer acceptance, distribution and refueling logistics, diesel and gasoline ICE operational issues, stationary combustors, fuel cells: the objective was to determine the feasibility of using GTL fuels – Fischer-Tropsch distillate and naphtha and methanol (comparisons to hydrogen, ethanol and biodiesel included). At issue was the use of biodiesel as a lubricity additive to counter the reduced lubricity with loss of sulfur in ulsd and GTL.

Synthesis Gas (Future Sources) - This report reviewed the technology for production of synthesis gas (H_2, CO mixtures) from a number of sources. Most emphasis was devoted to coal and biomass (municipal solid waste and wood) gasification and new gasification technology. The report discussed downstream processing requirements and examined coal and biomass properties and their impact upon gasifier design. The economics of producing industrial fuel gas (gasifier effluent after acid gas removal) via different routes were compared to the direct use of natural gas and low sulfur fuel oil.

LNG Competition with Clean Diesel – For a multinational industrial gas company with a stake in technology for LNG as an alternative vehicle fuel/CNG refueling strategy, Nexant studied the current status of "clean diesel" (e.g., engine modifications along with ultra low sulfur diesel fuel enabling use of particulate traps and catalytic tailpipe controls to reduce soot and NOx emissions), and assessed the competitiveness of biodiesel in this context.

Global Finished Automotive Lubricants Market Drivers – For a leading U.S.-based multinational lubricants additives maker, Nexant studied the current and projected global market dynamics for finished automotive lubricants for the next two decades. Market segments/products included passenger car and diesel/heavy-duty crankcase, gear oil, automatic transmission, tractor, off-road and small engine lubricants. Fleet growth in various regions, ultra low sulfur diesel, and trends to "dieselization" of fleets in various regions were relevant issues examined. In this and other related work, Nexant has opined that a key vector for use of biodiesel, aside from as a fuel per se, will be as a lubricity additive to ultra low sulfur diesel. Also key will be demand for biodegradable, non-toxic biodiesel fuel in small boats in place of other marine fuels.

Synthetic-Based Drilling Fluids (SBFs) – For a multinational specialty chemicals company with a stake in oleochemicals and GTL, Nexant studied market issues and projected markets for SBFs in deepwater drilling, as driven by recent U.S. EPA regulations or these oil-based systems with respect to disposal of drilling spoils (especially in the Gulf of Mexico, but in other seas as well). The only systems allowed, by consensus in a stakeholders-involved regulatory development process, are those based on Internal Olefins (IOs) and vegetable esters (essentially, "biodiesel"). These alternatives strike a balance in meeting both toxicity and biodegradability limits.

Biodigestion of Food Wastes – Nexant performed technology audits and market studies for MOM-ECAP, and another, Kuwait-based developer of projects in New York City, New Jersey and Kuwait to ferment food wastes to produce liquid and solid fertilizer/fungal disease suppressant products by the (aerobic) EATAD process of IBRC of Vancouver, BC. This also included analyses of competitive anaerobic based biodigestion technologies.

M2M Feasibility for Developing Economies – For USAID, Nexant studied the feasibility of capturing various streams of fugitive methane and bringing them to market ("methane-to-market", or M2M), including anaerobic biodigestion of agricultural waste biomass.

Fatty Alcohols from Coconut Oil Project – (Cebu, The Philippines) – this was an extensive technical and market due diligence for a bank on the client's proposed new fatty acids/fatty alcohols plant, which involved visiting the client on Cebu, and a number of experts and oleochemicals sites in the Philippines, meetings with the process technology vendor, Lurgi AG, in Cebu and in Frankfort, Germany to review technology, flowsheets and project budget, and performing a competitive market study (Asia and global supply/demand, prices, competition, etc.). The study included consideration of byproduct glycerine purification and disposition.

Oleochemicals Feasibility Study - For London-Sumatra's proposed new production in Indonesia, Nexant surveyed the global oleochemicals industry and markets, focusing on palm and palm kernel oils, glycerine, fatty acids, and fatty esters compared to other natural oil-based products and competition with food markets.

Surveys of Global Oleochemicals Markets and Technologies – Nexant addressed natural and synthetic-based oleochemicals markets for Dow Chemical.

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