SOLVENTS

A Market Opportunity Study

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UNITED SOYBEAN BOARD
Making Your Checkoff Pay Off.

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SOY SOLVENTS MARKET STUDY
TABLE OF CONTENTS

INDEX OF TABLES AND EXHIBITS

EXECUTIVE SUMMARY

INDUSTRIAL SOLVENTS MARKET

Industrial solvents are used as component ingredients in formulated products or as processing aids in manufacturing. Annual U.S. solvents demand is about 12 billion pounds valued at about $5 billion. Demand will grow modestly but the mix of solvents will continue to change dramatically under environmental and regulatory pressure designed to reduce emissions of ODS (Ozone Depleting Substances), VOCs (Volatile Organic Compounds) and HAPs (Hazardous Air Pollutants).

Due to regulatory pressure, traditional products and processes that utilize conventional solvents have been reformulated and redesigned to replace or reduce unacceptable solvents or recover and recycle solvents in closed systems to eliminate emissions. This has significantly impacted all solvent markets in the manufacturing, transportation and construction industries.

As a result of these changes, market opportunities are emerging for higher value specialty solvents, environmentally friendly “green solvents” and conventional solvents that are regulation exempt to replace conventional hydrocarbon and chlorinated solvents.

This will happen in all primary use markets in manufacturing – paints and coatings, printing inks, adhesives, cleaning products, construction and transportation. Although the use of conventional solvents will continue to dominate these markets, green solvent use is projected to grow from 6% of demand in 1995 to 14% of total demand by 2010. This growth will be assisted by the higher prices of petrochemical solvents that began escalating in 2004 as a result of record high pricing of crude oil and natural gas feedstocks.

Since the publication of the original Solvents Market Opportunity Study in early 1997, much has been learned about the industrial solvents industry and the market potential for soy chemistry-based solvents. Methyl soyate as an industrial solvent is now accepted as a viable commercial green solvent alternative. Use volume has grown considerably from virtually zero demand in 1995 to an annual U.S. demand approaching 40 million pounds in 2007. Market and industry awareness is widespread and use is expanding across a variety of market applications beyond those identified in the original study – parts cleaning, carrier solvents and the removal and cleanup of paints, inks and resins. With the current (2006) development of a new family of soy-based solvents by BioSpan Technologies, additional market opportunities are emerging for broader conventional solvent replacement and commercialization of entirely new applications.

SOLVENTS MARKET OVERVIEW

BACKGROUND

Industrial solvents are used as component ingredients in formulated products or as processing aids in manufacturing. Annual U.S. solvents demand is about 12 billion pounds valued at about $5 billion. Demand will grow modestly but the mix of solvents will continue to change dramatically under environmental and regulatory pressure designed to reduce emissions of ODS (Ozone Depleting Substances), VOCs (Volatile Organic Compounds) and HAPs (Hazardous Air Pollutants).

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INDUSTRIAL SOLVENT MARKETS

The market segments and industries that utilize solvents vary widely but all manufacturing and non-manufacturing uses involve solvents to dissolve, suspend, carry or remove other materials. Table 1 summarizes the primary manufacturing and non-manufacturing solvent markets including transportation, construction and dry cleaning. The category “other” includes many products and processes for which soy solvents have no application potential such as cosmetics, pharmaceuticals, food processing and electronics. The transportation sector involves antifreeze and aircraft deicing fluids with no potential for soy. Dry cleaning also holds no soy potential. All other market segments listed offer application opportunities for soy.

Market growth projections for most conventional solvent applications are modest to flat. Green solvent usage, however, in both the manufacturing and non-manufacturing segments is projected to grow significantly due to environmental pressures, growing favorable economics favoring green solvents and expanded development effort to use more green products.

TABLE 1

U.S. SOLVENT DEMAND BY MARKET SEGMENT

	2005 MILLION POUNDS	%	2010 MILLION POUNDS	%	GROWTH %/YR
MANUFACTURING:					
Paints & Coatings	2.53	31	2.54	30	0
Printing Inks	1.33	17	1.47	17	2.0
Cleaning Products	1.02	13	1.08	13	1.1
Adhesives & Sealants	0.49	6	0.48	6	0
Asphalt	0.26	3	0.26	3	0
Parts Cleaning	0.15	2	0.13	1	- 0.2
Ag Chemicals	0.09	1	0.09	1	0
Other	2.19	27	2.42	29	0.2
TOTAL	8.06	100	8.47	100	
SOLVENT TYPE:					
Conventional	7.11	78	7.26	76	0.2
Green	0.95	12	1.21	14	4.5
TOTAL	8.06	100	8.47	100	
NON-MANUFACTURING:					
Transportation	2.80	73	2.95	73	0.15
Construction	0.70	18	0.71	18	0
Dry Cleaning	0.35	9	0.35	9	0
TOTAL	3.85	100	4.01	100	
SOLVENT TYPE:					
Conventional	3.69	96	3.81	95	0.1
Green	0.16	4	0.20	5	0.2
TOTAL	3.85	100	4.01	100	
TOTAL SOLVENTS DEMAND:	11.91		12.48		1.0
Conventional	10.80	91	11.07	89	0.5
Green	1.11	9	1.41	11	5.4
	11.91	100	12.48	100	

The best market opportunities for soy solvents as identified in the original study still involve solvent cleaning applications – parts cleaning and removal and cleanup of paints, coatings, inks, adhesives, resins, graffiti and asphalt. Printing ink solvent use as soybean oil is well commercialized as are all of the applications listed above. Good use potential exists in paints and coatings, asphalt production, chemical processing and in ag chemicals but further product and process development work is necessary to ensure commercialization. Most of these opportunities involve the continuing replacement of hydrocarbon and chlorinated solvents.

SOLVENT PRODUCTS AND PROCESSES

Industrial Solvent Types

Table 2 summarizes the classification of industrial solvents as Conventional Solvents or Green (environmentally friendly) Solvents. The solvents that offer replacement opportunities for soy solvents are noted. Replacement can be prompted by regulatory and environmental pressure or by worker health and safety concerns. The product abbreviations will be used in later report tables and exhibits.

Solvent Use By Market Segment

The primary conventional and green solvents used in the market segments with soy solvent use potential are shown in Table 3. Other market segments with low soy solvent use potential are listed.

Conventional Solvents vs. Soy Solvents

The conventional solvents that offer the best replacement opportunities for soy solvents are listed in Table 4. Annual demand, demand growth projections and current market prices are shown for the chlorinated solvents, MEK, d'Limonene and hydrocarbon solvents. Methyl soyate demand data based on both Omni Tech and Freedonia estimates are shown for comparison.

TABLE 2

INDUSTRIAL SOLVENT TYPES

	MILLION POUNDS (2005)	ABBREVIATION
CONVENTIONAL SOLVENTS		
Alcohols	3,600	Al
Glycol Ethers	2,600	GE
*Hydrocarbons – Napthas, Mineral Spirits, Toluene, etc.	2,500	HC
*Ketones	780	MEK
Acetate Esters	630	AE
*Chlorinated – $MeCl_2$, TCE, Perc	700	Cl
	10,810	
GREEN SOLVENTS		
Propylene Glycols	565	PG
Butanediol	190	BDO
Soybean Oil, Methyl Soyate, New Soy Solvents ($^{++}$)	165	SME NSS
*Terpenes – d'Limonene, Orange Oil, Pine Oil	150	d'Lim
Others – Tetrahydrofuran, Hydrogen Peroxide	100	THF
	1,170	
TOTAL	11,980	

*Replacement potential for Soy Solvents
$^{++}$New Soy solvents being developed by BioSpan Technologies

TABLE 3

SOLVENT USE BY MARKET SEGMENT WITH SOY SOLVENT USE POTENTIAL

MARKET SEGMENT	CONVENTIONAL SOLVENTS USED	GREEN SOLVENTS USED	SOY SOLVENT OPPORTUNITIES
Paints & Coatings	HC, Al, MEK, AE	PG	SME
Printing Inks	HC, Al, MEK	Soy oil, PG	Soy oil
Cleaning Products(1)	HC, Al	PG, d'Limonene, GE, SME	SME
Adhesives & Sealants	HC, MEK, Al	PG	SME
Asphalt	HC	SME, NSS	NSS, SME
Parts Cleaning	Cl, HC	d'Limonene, SME	SME, NSS
Ag Chemicals	HC, Cl, Al	BDO, SME, PG	SME (WNV)[2]
Construction	HC, Al	d'Limonene, SME	SME
Chemical Processing	Cl, MEK, HC		NSS

(1) Industrial & Institutional Cleaning Products
(2) West Nile Virus Larvicide

OTHER MARKET SEGMENTS WITH LOW POTENTIAL FOR SOY SOLVENTS:

- Cosmetics & Toiletries
- Chemical Processing
- Pharmaceuticals
- Plastics & Rubber Processing
- Electronics
- Food Processing
- Transportation – Antifreeze, Aircraft Deicing
- Dry Cleaning

TABLE 4

CONVENTIONAL SOLVENTS THAT COMPETE WITH SOY SOLVENTS
ANNUAL DEMAND - MILLION POUNDS

	2000	2005	2007	2010	% GROWTH
$MeCl_2$	200	187	185	181	-0.5
TCE	200	225	235	255	2.0
Perc	350	380	390	400	0.5
MEK	420	427	430*	455	0.7
d'Limonene	70	110	120	135	3.2
Hydrocarbon: Total	2,800	2,500	2,400	2,300	-3.0
Solvent 140	200	150	130	100	-3.0
Methyl Soyate (OTI estimate)	5	25	35	45	10.0
Methyl Soyate (Freedonia estimate)		27	42	68	

*Delisted as a HAP (Hazardous Air Pollutant) December 2006. Still listed as a VOC (Volatile Organic Compound)

KEY:
$MeCl_2$ = Methylene Chloride
TCE = Trichloroethylene
Perc = Perchloroethylene
MEK = Methyl Ethyl Ketone
Hydrocarbon = Mineral Spirits, Naphthas, Toluene
Solvent 140 Mineral Spirits for parts cleaning
Methyl Soyate = Soy Methyl Esters

INDUSTRIAL SOLVENT MANUFACTURES, DISTRIBUTORS & FORMULATORS

There are about sixty companies that compete in the U.S. solvents industry as manufacturers and distributors. The primary market channel for solvents is through national and regional distributors although no sales tracking is done to document this. There are about twenty-five major solvent manufacturers but six of them supply about 50% of U.S. demand – Dow, Lyondell, Exxon Mobil, Celanese, Eastman and Shell. It is estimated that nearly 80% of conventional solvent sales move through distributors. The sale of methyl soyate is mainly direct by manufacturers with the exception of Stepan Co. which utilizes an existing chemicals distribution network.

PRIMARY SOLVENT MANUFACTURERS

CONVENTIONAL SOLVENTS:

Alcohols
Celanese
Eastman
Lyondell
Exxon Mobil
Shell

Hydrocarbons
BP
Chevron Phillips
Exxon Mobil
Shell
Sunoco

Ketones (MEK)
Exxon Mobil
Celanese

Acetate Esters
Celanese
Eastman
Dow
Lyondell

Chlorinated
Dow
PPG
OxyChem

GREEN SOLVENTS:

Propylene Glycol & Glycol Ethers
Dow
Lyondell

Butanedial & Derivatives (NMP, THF)
BASF
Lyondell
Invista (Koch Ind.)

Terpenes

Pine Oils
Arizona Chem (Intl. Paper)

Forest Product Co.

Orange Oils & d'Limonene
Florida Chem.
Brazilian Imports
(30 distributors)

Soybean Oil & Methyl Soyate
ADM
AGP
Cargill
Cereol
Columbus Foods
Peter Cremer NA
Stepan Co.
West Central Coop.

Primary Chemical Distributors
Univar N.V.
Ashland Distribution Co.
Brenntag North America
Harcros Chemicals
Aceto Corp.
Superior Solvents & Chemicals
C.P. Hall
E.T. Horn
Barton Solvents
G.S. Robins
Solvents & Chemicals

There are hundreds of specialty chemical product formulators in the U.S. Included are many major chemical manufacturers that have integrated forward to market formulated solvent containing products directly to end users. They also sell conventional solvents to formulators who are not basic chemical producers. The specialty products formulators that are utilizing biosolvents to produce “green” products are typically small to medium sized companies that have started as new businesses with a strong entrepreneurial spirit that are “under the radar screen” of the traditional chemical industry and earning their way in the market by offering safer, cleaner product alternatives.

Many of these formulators listed in Table 5 are companies that are actively involved with the United Soybean Board and TAPs (Technical Advisory Panels) and are industry acquaintances through tradeshows and industry conferences. This list represents only the companies that utilize soy solvents that we know of. There are dozens of additional firms using soy that are not yet known.

TABLE 5

FORMULATORS OF SPECIALTY CHEMICALS THAT UTILIZE SOY SOLVENTS

	PAINTS & COATINGS	I & I CLEANERS	REMOVERS	PAINT STRIPPERS	PARTS CLEANERS
Athea Labs		X			X
Bi-O-Kleen		X			
BioSpan Technologies		X	X	X	X
Cortec Corp.		X			X
CPC Aeroscience		X			X
EcoSafety Products				X	
Franmar Chemical		X	X	X	X
GEMTEK Products		X	X		
Johnson Diversey Inc.		X			
Mr. Goodchem			X		
3M					X
NCH Corp.		X			
New Century Coatings	X				
Rechitt Benckiser Inc.		X			
Rochester Midland Corp.		X			
Soy Base		X	X		
Soy Clean	X	X	X	X	
Soy Safe	X	X	X	X	
Soy Technologies	X	X	X	X	X
SoySolv Products		X	X		X
Spartan Chemical		X	X		X
State Industrial Products		X			
SYSCO Corp.		X			
Takeoff Inc.				X	
Twin Chemical			X	X	
Vertec Biosolvents			X	X	X
Workcell Systems					X
Zep Manufacturing					X
Zinsser Company				X	

SOLVENT PROPERTY AND PERFORMANCE REQUIREMENTS

Across all market applications, common properties and performance attributes are utilized to select cost-effective solvent products. Favorable environmental attributes are increasingly important as regulatory pressures mount. However, performance and cost factors must be a first priority to formulators when seeking to replace conventional solvents that have long been an integral component in successful commercial products. The solvent properties and performance requirements/attributes listed in Table 6 are nearly universal across most market segments.

TABLE 6

SOLVENT PROPERTY & PERFORMANCE ATTRIBUTES

ATTRIBUTE	CHLORINATED	HYDROCARBONS	MEK	SOY	D'LIMONENE
Good solvency (KB)	Y	N	Y	Y	Y
Low VOC	Y	N	N	Y	N
Non ODC	N	N	N	Y	Y
Non HAP	N	N	Y	Y	Y
Nonflammable	Y	N	N	Y	N
Low toxicity	N	N	Y	Y	Y
Fast evaporation	Y	Y	Y	N	Y
No surface residue	Y	Y	Y	N	Y
Readily biodegradable	N	N	N	Y	Y
Low odor	N	N	N	Y	N
Materials compatibility	Y	Y	N	Y	Y
Competitive cost	Y	Y	Y	Y	N

COMPETITIVE PRICING ANALYSIS

At the time of the original writing of the Solvents Market Study, the pricing of bio-based solvents, especially soy methyl esters (methyl soyate), was an important issue. It was not only little known as an industrial solvent but it was also priced at a significant premium over conventional petrochemical solvents. Much has changed since 1996 in the pricing structure of the solvents industry.

All petrochemicals have experienced severe price escalation due to rises in crude oil and natural gas prices. This began in late 2003. Exhibit 1 shows reliance of selected conventional solvents on crude oil and natural gas as basic feedstocks. Table 7 shows the pricing history of petrochemical solvents and d'Limonene with which soy solvents mostly compete. In 1996, methyl soyate pricing was $0.70 per pound which is the same as the prevailing market price in October 2007. Although prices for soy solvent will continue to fluctuate with changes in soybean and soy oil prices, downstream solvent products should continue to be very competitively priced. Petrochemical solvent pricing, however, is projected to continue at current or higher levels since no relief is expected from current crude oil and natural gas price levels.

TABLE 7

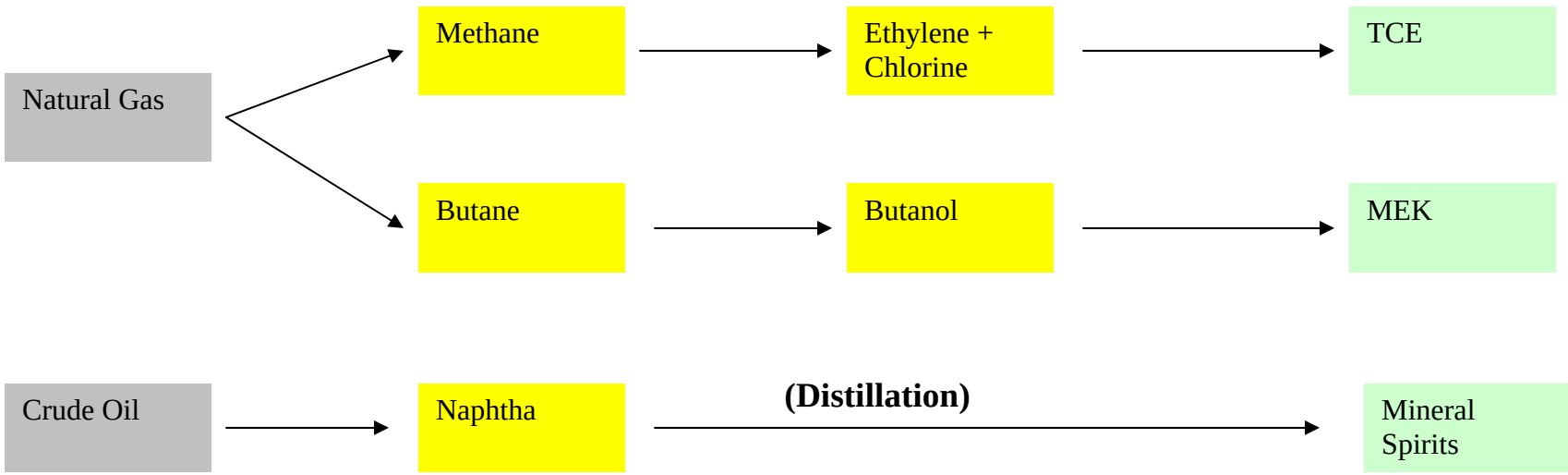
SOLVENT PRICING
DOLLARS PER POUND

	2001	2002	2003	2004	2005	2006	2007
Aliphatic Hydrocarbons							
Mineral Spirits	.29	.27	.33	.42	.51	.51	.53
Solvent 140*	.38	.40	.50	.60	.67	.60	.62
MEK	.36	.38	.35	.67	.68	.62	.69
$MeCl_2$	.21	.24	.28	.38	.44	.45	.45
Perc	.32	.33	.37	.45	.45	.47	.49
TCE	.65	.68	.70	.75	.75	.75	.75
d'Limonene	1.80	1.70	1.50	.75	1.15	1.22	1.28
Methyl Soyate	.46	.55	.62	.57	.60	.62	.70

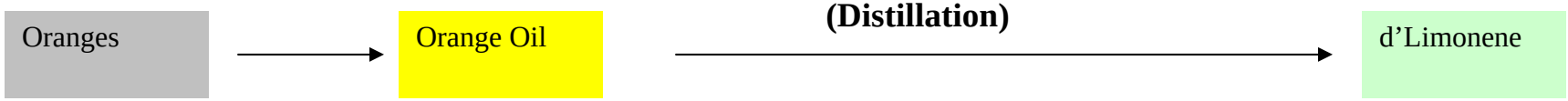
*Solvent 140 = High flash mineral spirits for parts cleaning

EXHIBIT 1
INDUSTRIAL SOLVENT FEEDSTOCKS

PETROCHEMICALS



D'LIMONENE



TARGET COMPANIES

I. Soy Solvent Manufacturers/Suppliers

Methyl Soyate
ADM
Cargill
Citrus Oleo
Columbus Foods
Florida Chemical
IMET Corp.
Stepan Company
Vertec Biosolvents
West Central Coop

New Soy Solvents
BioSpan Technologies

II. Formulators

Industrial & Institutional (I&I) Cleaning Products
Athea Labs
Bi-O-Kleen
Church & Dwight
CPC Aeroscience
Florida Chemical
Franmar Chemical
GEMTEK Products
Johnson Diversey Inc.
NCH Corp.
Rechkitt Benckiser Inc.
Rochester Midland Corp.
Soy Clean
Soy Safe
Soy Technologies
Spartan Chemical
State Industrial Products
Sysco Corp.

Paints & Coatings Additives
New Century Coatings
Soy Clean
Soy Safe
Soy Technologies

Removers/Cleaners, Inks, Adhesives, Graffiti, Resins, Asphalt, Oil Spills
BioSpan Technologies
Copia Labs
Cyto Culture International
Ecolink
Franmar Chemical
I.C. Compound Co.
Mr. Goodchem
Soy Base
Soy Clean
Soy Safe
Soy Technologies
SoySolv Products
Spartan Chemical
Vertec Biosolvents

Paint Strippers
Cyto Culture International
Eco Safety Products
Ecolink
Franmar Chemical
Rust Oleum Brands
Soy Clean
Soy Safe
Soy Technologies
TakeOff Inc.
Twin Chemical
Vertec Biosolvents

Parts Cleaners
3M
Athea Labs
BioSpan Technologies
Cortec Corp.
Franmar chemical
NCH Corp.
Soy Technologies
SoySolv Products
Spartan Chemical
Vertec Biosolvents
Workcell Systems
Zep Manufacturing

III. Other Chemical Specialty Markets

Asphalt Cement Replacement
BioSpan Technologies
Paving Contractors/Distributors
State DOTs
Western Research Institute

Bioremediation
DBI Remediation Products
EOS Remediation
New Age Chemical
RNAS, Inc.
Solutions, IES
Terra Systems

Mosquito Control
BVA Oils
Stepan Company

Crude Oil Processing (Canadian Tar Sands)
BioSpan Technologies
Chevron Texaco
Shell
Syncrude (JV of eight energy companies)

ENVIRONMENTAL & REGULATORY ISSUES IMPACTING SOLVENTS

Clean Air Act – The legislation that has most impacted the solvent market is the **Clean Air act of 1990.** The Act lists and restricts the use of more than 180 chemicals designated as HAPs (Hazardous Air Pollutants). Among the solvents included are some glycol ethers, methanol, perchloroethylene, toluene and trichloroethylene. The Act was soon after amended by the **Montreal Protocol** agreement which set scheduled target dates for the phase-out of specific solvents including chlorofluorocarbons (CFCs and HCFCs) as well as 1, 1, 1-Trichloroethane (TCA).

The EPA regulates solvent emissions and the disposal of waste solvents. The EPA enacted the **33/50 Program** which invites the voluntary reduction of the emissions of certain high priority toxic materials which includes eleven solvents (MEK, Perc, $MeCl_2$, TCE, etc.)

Consumer & Commercial Products National VOC Emission Standard (1996). This act calls for the reformulation of cleaning products and many automotive specialty products. Much of this reformulating has been done.

State Laws – A few states have enacted solvent emission control regulations. The most influencial has been California under the **California Air Resources Board** (CARB). The concern is the photochemical reactivity of various materials, especially solvents, which involves the potential for smog formation. In Los Angeles, the **South Coast Air Quality Management District** (SCAQMD) has set a VOC (Volatile Organic Compound) regulatory standard of a VOC emission maximum of 25 gm/l.

Worker Safety Issues – Worker safety standards are established and regulated by OSHA. In the case of solvents, regulated product attributes include flammability (flash points) and health risk exposure (toxicity). These regulations require reformulation to replace unsafe components with safer materials and solvent recycling to reduce usage levels.

SOY SOLVENT MARKET OPPORTUNITIES

SOY SOLVENTS MARKET OVERVIEW

Since the publication of the original Solvent Market Opportunity Study in early 1997, much has been learned about the industrial solvents industry and the market potential for soy chemistry-based solvents. Methyl soyate as an industrial solvent is now accepted as a viable commercial green solvent alternative. It's use has grown considerably from virtually zero demand in 1995 to an annual U.S. demand approaching 40 million pounds in 2007. Market and industry awareness is widespread and use is expanding across a variety of market applications beyond those originally identified in the original study – parts cleaning, carrier solvents and the removal and cleanup of paints, inks and resins. With the current (2006) development of a new family of soy-based solvents by BioSpan Technologies, additional market opportunities are emerging for broader conventional solvent replacement and commercialization of entirely new applications.

COMMERCIAL METHYL SOYATE MARKET APPLICATIONS

1996	2007
Printing ink cleaners	Parts cleaners
Waterless hand cleaners	Paint strippers
Asphalt removers	Concrete & wood stains
Form release agents	Adhesive & mastic removers
Hand lotions	Graffiti removers
	Hard surface cleaners
	Paint & coatings vehicles
	Plastic waste reduction
	Asphalt cement for paving & shingles
	Glass cleaners
	Household cleaners
	Floor cleaners
	Industrial degreasers
	Bathroom cleaners
	Penetrating lubricants
	Printing ink cleaners
	Hand cleaners
	Concrete curing agents
	Concrete & wood sealers
	Metal working fluids
	Corrosion protectants
	Rust removers
	Hand lotions
	Form release agents

New commercial market applications for methyl soyate have exploded since 1996 as shown above. Other uses continue to be developed by creative formulators and end users still seeking safer green solvent-based products. We learn about them at tradeshows and through industry contacts. These current uses utilize methyl soyate with its existing physical and chemical properties, some of which limit use in many applications that still rely on unsafe conventional solvents that are toxic and often flammable. So the search goes on for safer solvents that perform as well as the conventional solvents and are competitively priced.

The development and early market introduction of BioSpan's new soy solvents indicates that the improved physical properties of these solvents in terms of faster evaporation rates and no residual drying films may offer yet better green solvent replacement choices to the industrial solvents market.

The utilization of soy solvents in industrial product formulations and processes usually occurs as a targeted effort to replace an unsafe or regulated conventional solvent. Occasionally, however, creative entrepreneurs and formulation chemists develop unique new products based on soy chemistry that results in entirely new products that can replace a conventional end product and not just the solvent component. BioSpan Technologies has developed an asphalt cement replacement based on waste polymers dissolved in a blend of biosolvents that include methyl soyate and some newly created soy solvents.

SOY SOLVENT REPLACEMENT OF CONVENTIONAL SOLVENTS

The primary market opportunities for methyl soyate will continue to be the replacement of unsafe and regulated conventional solvents in traditional applications. Table 8 shows the conventional solvents that offer the best replacement opportunity potential for soy solvents within five years. This is not a forecast but an estimate of potential. The conventional solvents, mainly hydrocarbons and chlorinated, are vulnerable due to ongoing VOC, HAP, toxicity, flammability and worker safety issues. The primary solvent uses are listed and the soy opportunities are highlighted.

TABLE 8

SOY SOLVENT REPLACEMENT POTENTIAL (OF CONVENTIONAL SOLVENTS) MILLION POUNDS

CONVENTIONAL SOLVENT	TOTAL DEMAND 2007	PRIMARY MARKET APPLICATIONS	MARKET PENETRATION OPPORTUNITIES FOR SOY SOLVENTS
$MeCl_2$	185	**Paint Strippers***, Adhesives, Parts Cleaning	25
TCE	235	Chemical Processing, **Parts Cleaning**	15
Perc	390	Chemical Processing, Dry Cleaning, **Parts Cleaning**	10
MEK	430	Coatings, Adhesives, **Removers**	20
d'Limonene	120	**Cold Cleaning**	20
Hydrocarbon solvents (Hi Flash Mineral Spirits)	2,400 (130)	Coatings, Adhesives, Cleaners, **Asphalt, Parts Cleaning**	50 (20)
	3,760		140 (by 2012)

*Best applications for soy solvents highlighted

TARGET MARKET APPLICATIONS

The previous solvent market study focused on cleaning products – cold cleaners, parts cleaners and paint strippers. Over the last ten years, the market presence and awareness of methyl soyate has grown significantly and, consequently, the number of market application opportunities has expanded considerably.

TARGET MARKET	OPPORTUNITY
Cleaning Products	Industrial & Institutional Cleaners Replace hydrocarbons, chlorinated
Coatings, Inks, Adhesives	Carrier Solvents Replace hydrocarbons, MEK
Parts Cleaning	Replace TCE, Mineral Spirits
Paint Strippers	Replace $MeCl_2$
Chemical Processing	Crude Oil Extraction (Tar Sands) Replace hydrocarbons
Asphalt Cement	Replace Petro Asphalt Cement

COMPETITIVE POSITION OF SOY SOLVENTS

METHYL SOYATE

Advantages

- Good solvency KB 58
- Low VOC's <25gm/l
- Non HAP
- Non ODC
- High flash point 370° F
- Low acute toxicity
- Readily biodegradable
- Cost competitive
- Good materials compatibility
- Compatible with other organic solvents

Disadvantages

- Slow evaporation
- Film residue
- Water insoluble

Methyl soyate, in practice, is not utilized as a neat solvent. It is a primary component of formulated products designed to accomplish specific work involving cleaning, removing or dissolving other materials. Formulators have, consequently, learned to modify, utilize or overcome the evaporation, residue and solubility properties of methyl soyate. These properties can be adjusted by formulating with other organic cosolvents and surfactants to accelerate evaporation, reduce residual film formation and make products water rinsable.

Numerous proprietary emulsion and microemulsion products have been developed and marketed by formulators that are based on methyl soyate. In addition, manufacturers and suppliers of other biosolvents are marketing various cosolvent blends of their solvents with methyl soyate. This was done to incorporate the performance and cost advantages of methyl soyate with their solvents. Primary examples are Florida Chemical's "Citrusoy" – methyl soyate plus d'Limonene and Vertec Biosolvent's "Vertec Gold" – methyl soyate plus ethyl lactate. These blends lower VOC levels, raise flash points and lower the cost of their solvents.

NEW SOY SOLVENTS

The "New Soy Solvents" being introduced by BioSpan Technologies have been specifically designed to improve the performance properties of methyl soyate that are perceived as disadvantages – slow evaporation and film residue as well as some properties of other widely used biosolvents. There are three new soy-based solvents that are being market evaluated that should become commercially available during 2008.

COMMERCIALIZATION RECOMMENDATIONS & STRATEGIES

A. Accomplishments vs. Strategies from original Solvents Market Opportunity Study

1. Commercial development with **Industrial Partners**
   The "Target Companies" section of this report lists the numerous industrial partners relationships developed for soy solvents. This includes solvent manufacturers, formulators and marketers of soy-based end user products.
2. **Technical Advisory Panels**
   On April 15-16, 2008 the twelfth annual Solvents TAP will convene under the new market segment designation "Emerging Industrial Opportunities." These TAP's have typically been attended by about 50 representatives from the target companies as well as participants from various universities, government agencies and USB associates.
3. Various independent **Testing Laboratories** have conducted critical studies on methyl soyate to develop valuable **Product Property Data** such as VOCs and acute toxicity that have been published and disseminated throughout the solvents industry.
4. **Marketing Communications Program**
   With valuable assistance of the Osborn & Barr staff, numerous methyl soyate product publications have been produced and distributed. In addition, numerous trade press articles have been published and presentations given at industry conferences.

   Product Brochures:
   - Methyl Soyate, The natural solution for safer solvents
   - The Formulary Guide for Methyl Soyate
   - Solvents Market Opportunity Summaries

   Trade Articles:
   - *"Methyl Soyate, the New d'Limonene",* Cleaner Times, July 2007
   - *"Solvent Alternatives",* Clean Tech, September 2004
   - *"Methyl Soyate a New Green Alternative Solvent",* Chemical Health & Safety, April 2002
   - *"The Solvency of Soy",* Industrial Paint & Powder, September 2001
   - *"Clean Machines From Beans",* Chemical Innovation, May 2001
   - *"One Mean Bean",* Parts Cleaning, May 1998

   Trade Shows
   Over the past ten years, methyl soyate has been highlighted in the USB booth at numerous annual tradeshows and conferences.
   - Precision Cleaning
   - Clean Tech
   - ISSA/Interclean (International Sanitary Supply Association)
   - The Solvent Substitution Workshop

- The Cleaner, Sustainable Industrial Materials & Process Workshop (CSIMP)
- ICE (International Coatings Expo)

Other **Solvent Industry Publications:**

- "USB Methyl Soyate Specification for Solvent Applications"
- "Clean Air Solvent Certification", Guidelines for methyl soyate suppliers and formulators
- "Bio-Based Co-Solvents" – Waste Recovery and Disposal Analysis
- "Physical and Cleaning Performance Properties of Methyl Soyate"
- "A survey of Recent Chemical Price Trends"

5. **Clean Gredients Program** – EPA Design for the Environment, a green solvent database for formulators of cleaning products.
   A green solvent database has been established for formulators to help them select environmentally friendly components for cleaning products. These components include solvents, surfactants, chelating agents and fragrances. This work was done by a Technical Advisory Committee consisting of representatives of chemical manufacturers, formulators, consulting firms and government agencies during 2006-2007. Two Omni Tech representatives were part of the 33 member TAC that developed the solvents module during 2007. The Clean Gredients Program was introduced in October 2007 at the ISSA/Interclean show. It can be accessed on the internet at www.cleangredients.org.

Obstacles To Market Entry

Methyl soyate has become an accepted commercial reality as a viable green alternative industrial solvent on its own merits. Market demand has grown over the past ten years to nearly 40 million pounds in the U.S. This is despite some perceived solvent property deficiencies.

Methyl soyate property shortcomings:

- Slow evaporation (drying) rate
- Residual oily film
- Water insoluble

These "negative" properties have been more than overcome by the positive properties of methyl soyate – good organic solvency, low VOCs, high (safe) flashpoint and low toxicity. Formulators have learned to utilize methyl soyate in its numerous solvent applications by formulating with polar (water soluble) cosolvents and/or surfactants to create water rinsable cleaners and removers that dry faster and don't leave a residual film.

Other market obstacles to further market entry by methyl soyate are more commercial in nature:

- Narrow base of manufacturers of “industrial methyl soyate” despite the widespread production of biodiesel
- Few chemical distributors offer or market methyl soyate
- Market applications for methyl soyate are very fragmented, diverse and specialized product niches. No known major, large volume uses have developed to expand awareness of its benefits.

COMMERCIALIZATION RECOMMENDATIONS & STRATEGIES FOR SOY SOLVENTS

Methyl Soyate

1. Complete, publish and disseminate the updated Solvents Market Opportunity Study
2. Continue to encourage and support USB funded product, process, application and commercial development projects based on soy solvent chemistry
3. Support a broader presence of soy solvents in the marketplace by encouraging an expanded base of methyl soyate manufacturers, distributors and formulators
4. Continue annual TAP (Technical Advisory Panel) meetings in concert with the coatings, inks and adhesives market sectors to expand awareness and interest in the utilization of soy solvents to replace hydrocarbon solvents
5. Expand marketing communications programs
    - Promote trade press articles especially case histories involving successful solvent substitution
    - Tradeshow & conference participation
        - ISSA – International Sanitary Supply Association
        - ICE – International Coatings Expo
        - CSIMP – Cleaner Sustainable Industrial Materials & Process Workshop
        - Green Build
6. Continue development work with industrial companies involving methyl soyate co-solvent blends to create new solvent utility and promote partial petrosolvent replacement
7. Targeted market applications with good replacement potential:
    - Coatings, inks and adhesives – carrier solvents to replace mineral spirits
    - Parts cleaning – replace mineral spirits, work with Safety Kleen, etc.
    - Paint strippers – continue focus on methylene chloride replacement for improved user safety
    - I&I Cleaners – expand network of aggressive formulators and marketers of cleaning products

NEW SOY-BASED SOLVENTS

In 2004, BioSpan Technologies, Inc., Washington, MO began the development of new soy solvents produced from soybean oil and soy methyl esters to replace d'Limonene and orange oil terpene solvents. Twenty-three new solvent compounds were identified in the lab and three were selected that provided improved solvent properties – solvency, drying rate, no residual film and viscosity, over both d'Limonene and methyl soyate. Manufacturing process development, field sample evaluation, process cost definition and patent applications have been underway since.

Based on further application development and customer feedback, some significant new product and market application opportunities emerged.

1. Asphalt Cement (binder) replacement in paving products and roofing shingles
2. Crude oil processing from the Canadian Tar Sands
3. d'Limonene and petroleum solvent replacement in cleaning products, paint strippers, graffiti removers, etc.

At this writing, these new soy solvents are still in various states of process scale up and semi-commercial production. Patent applications are pending so product composition and properties cannot yet be disclosed but extensive application development, solvent and paving product manufacturing and field paving trials are underway. The primary market opportunities have been targeted:

1. Asphalt paving and roofing shingles
2. Crude oil processing

NEW SOY SOLVENTS PRICING

The three new soy solvents developed and now being scaled up for manufacture by BioSpan are, so far, identified as Solvents A, B and C. Preliminary selling price estimates by BioSpan are:

Solvent A - $0.60 – 0.65/lb
Solvent B - $0.45 – 0.50/lb
Solvent C - $0.65 – 0.70/lb

Current market pricing for some other commercial solvents:

d'Limonene - $1.28/lb
Methyl Soyate - $0.70/lb
High Flash Mineral Spirits - $0.62/lb