Massachusetts State Sustainability Program

Greater Boston Breathes Better (GB_3)

Biodiesel Workshop

Municipal: Biodiesel & Municipal Fleets

May 2, 2007

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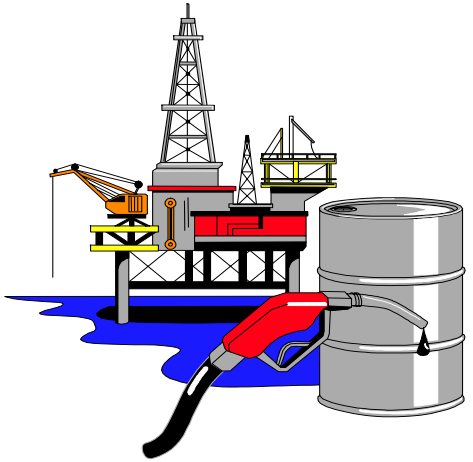
Why Biodiesel?

- Energy Independence
  - Energy Policy Act of 1992 (EPACT)
  - Biodiesel Blending Credit (2008) $1.00 per gallon agri/.50 non agri-biodiesel
  - State mandates
  - USDA Commodity Credit Corporation Incentive
  - Improving heating oil qualities and consumer perceptions
- Enhanced Lubricity
  - Premium Diesel Market Grows as Consumers Demand More From the Fuel They Use
  - 2006 Ultra Low Sulfur Diesel Issues



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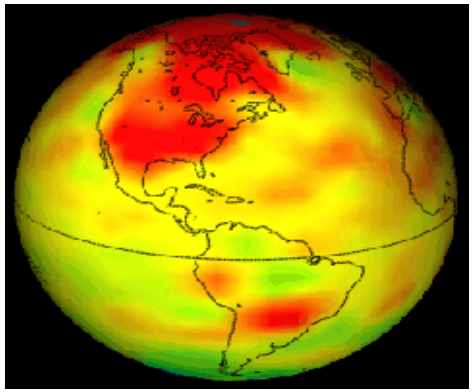
Why Biodiesel?

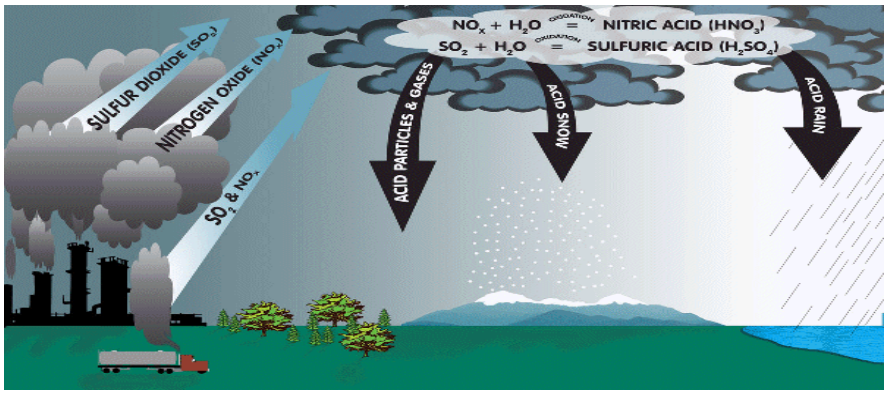
Climate Change



Particulate Emissions (PM 2.5)

Smog

Acid Rain



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Emissions

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA		
Emission Type	**B100**	**B20**
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
Non-Regulated		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

*** Estimated from B100 result**
**** Average reduction across all compounds measured**
***** 2-nitroflourine results were within test method variability**

Benefits - Energy Balance & Environment

- Highest energy balance of any fuel
  - For every unit of fossil energy needed to make biodiesel, 3.2 units of energy are gained
    - USDA/DOE study
  - This takes into account the planting, harvesting, fuel production, transport...
- Biodegrades as fast as sugar
- Nontoxic
- Decreases EPA-targeted emissions
- Virtually free of sulfur & aromatics
- B20: helps diesel portion degrade twice as fast
- Soy B100 reduces lifecycle CO2 by 78%

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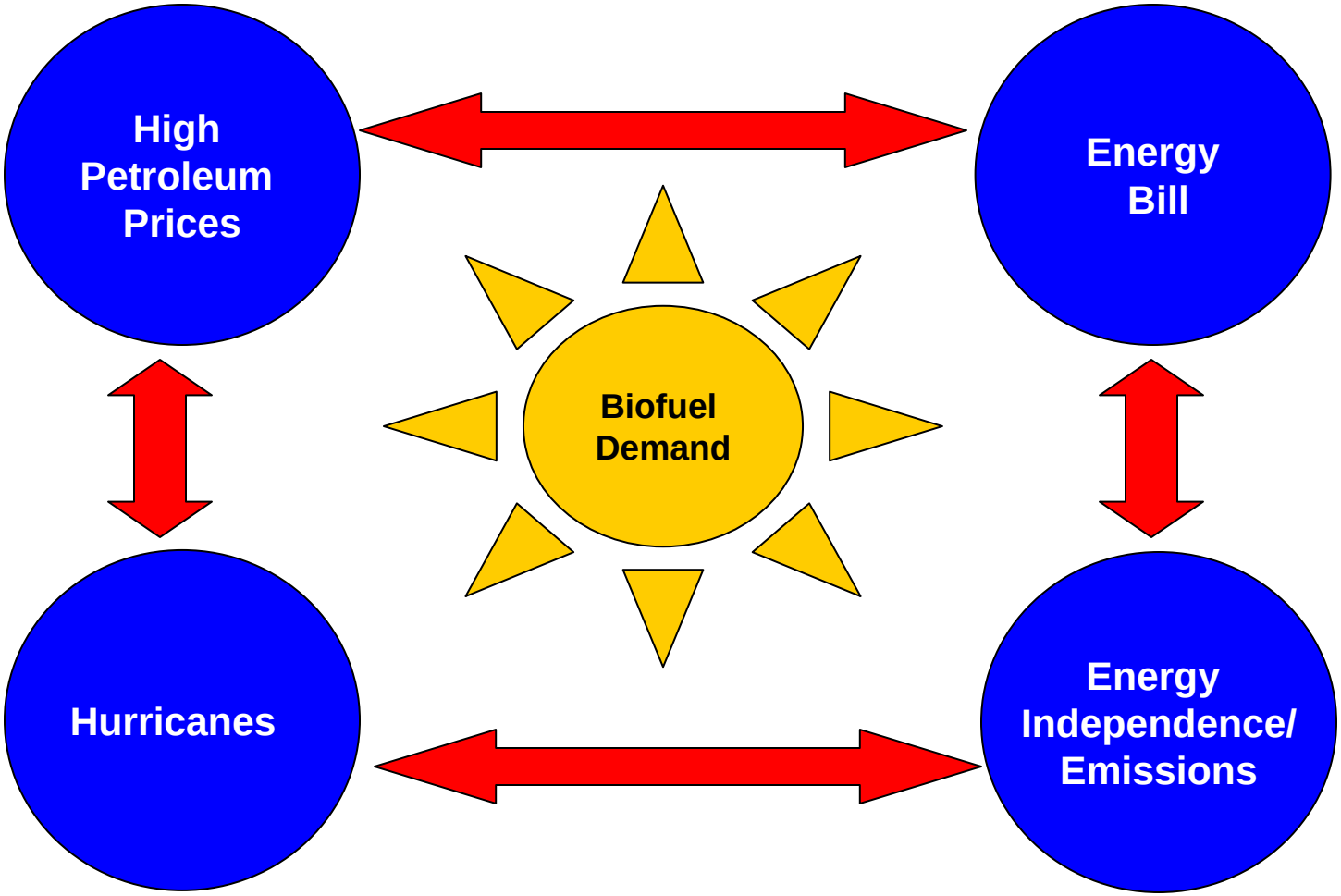
Why Biofuels?

The “Perfect Storm” of factors driving interest in Biofuels



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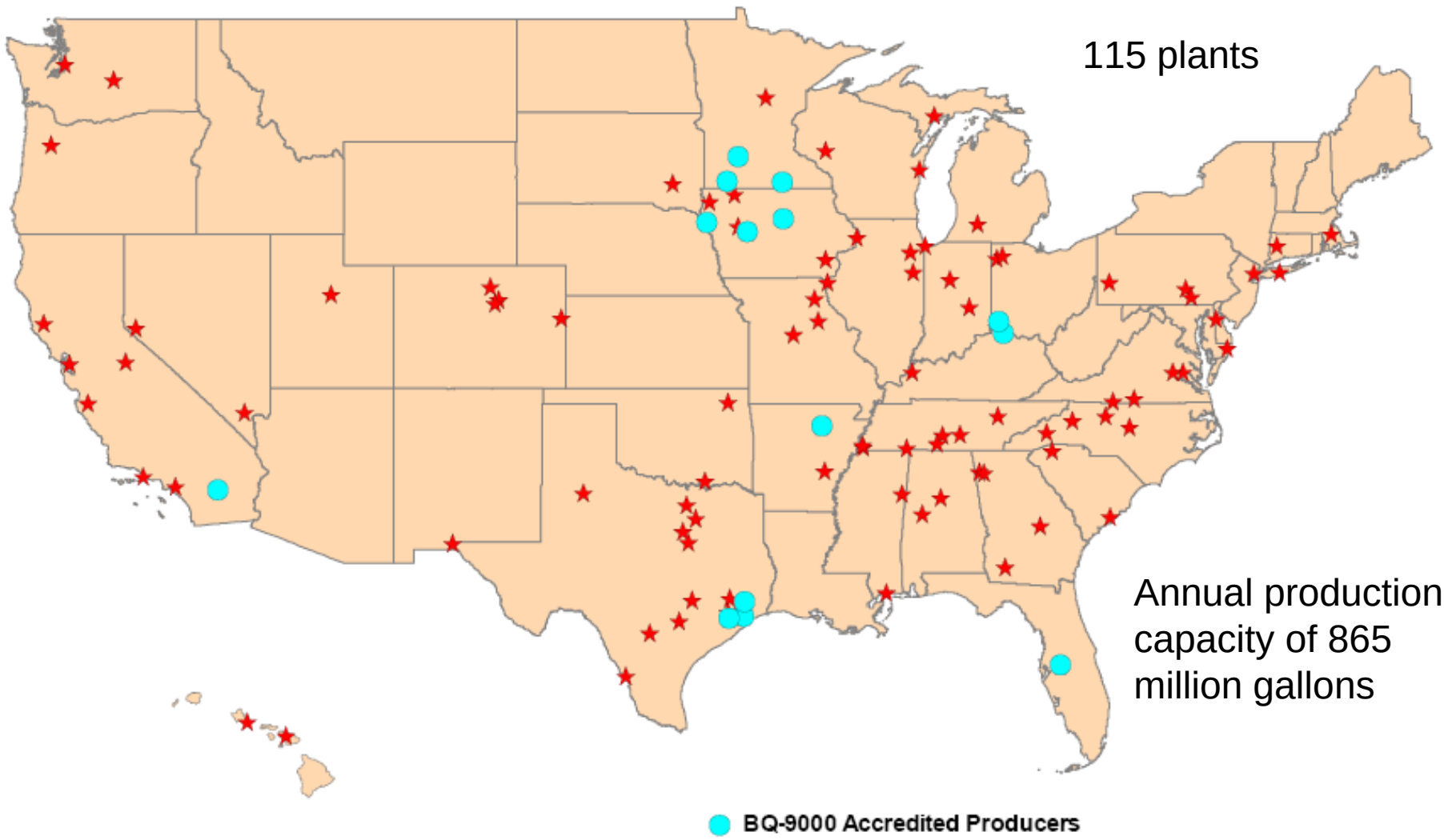
U.S. Biodiesel Production Capacity

- Today 115 plants with an annual production capacity of 865 million gallons exist
- An additional 77 plants currently under construction are scheduled for completion within the next 18 months and eight existing plants are expanding their operations, resulting in another 1.7 billion gallons per year
- Within the next thirty-six months capacity will be in excess of 2.0 billion gallons per year excluding imports
- 27 oil terminals prepared their terminals to electronically rack blend biodiesel and blends
- Anticipated sales to reach 400 million in 2007, 1.0 billion in 2010, with capacity of 2.0 billion available
- Railcar and truck transports move the bulk of biodiesel downstream. Marine transportation is now being utilized and pipeline movements are being evaluated (B5)

Commercial Biodiesel Production Plants*



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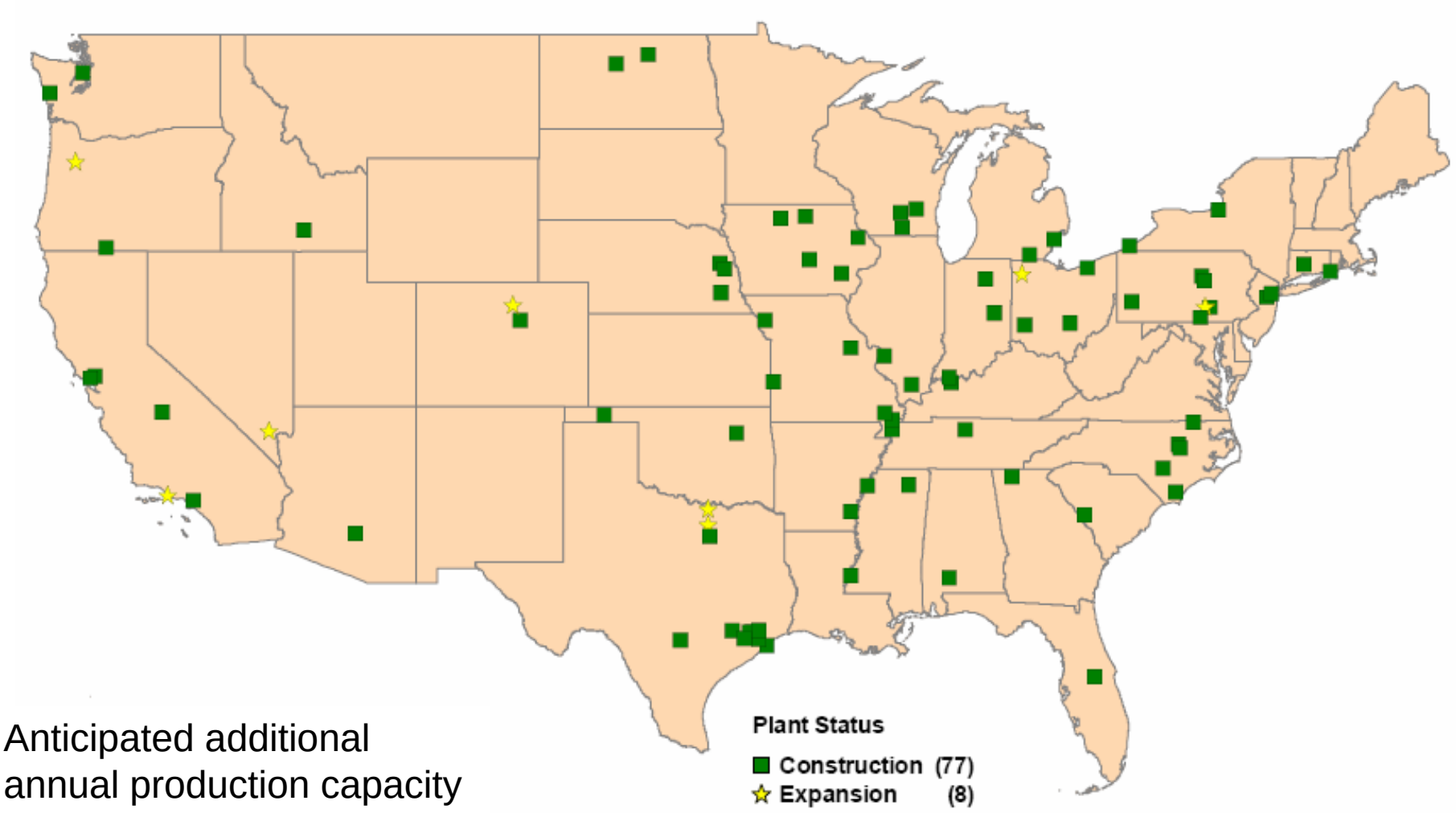
Biodiesel Production Plants Under Construction or Expansion*



Anticipated additional annual production capacity of 1.7 billion gallons

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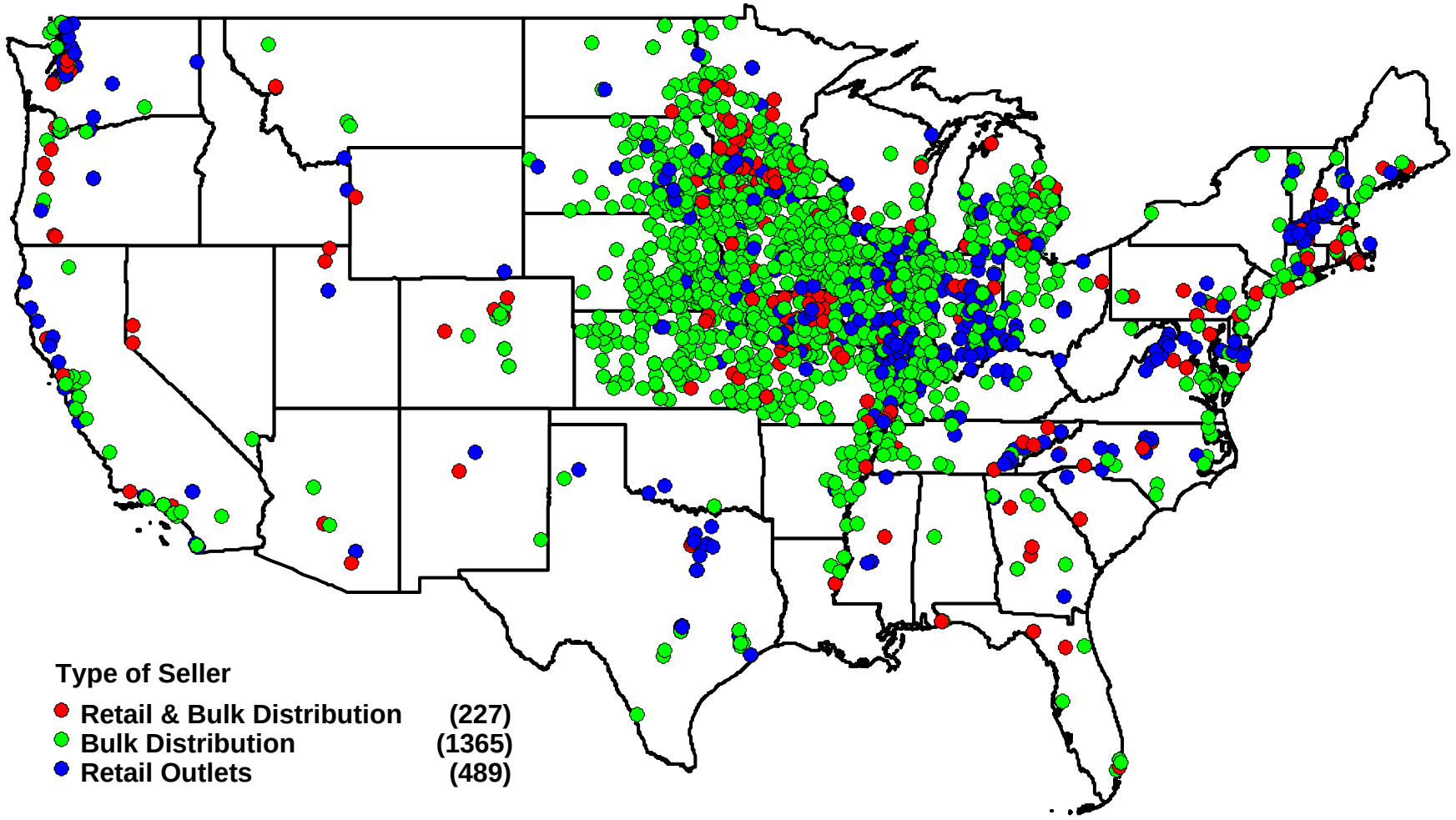
Distribution Locations



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Purchasing Biodiesel

- ASTM D 6751
- 15 ppm sulfur maximum
- Virgin soy base?!?!
- BQ-9000 Certification Program or …….
- Rack injection blending
- Rack blending of multiple grades of distillates
- Multiple supply points to store and blend B100

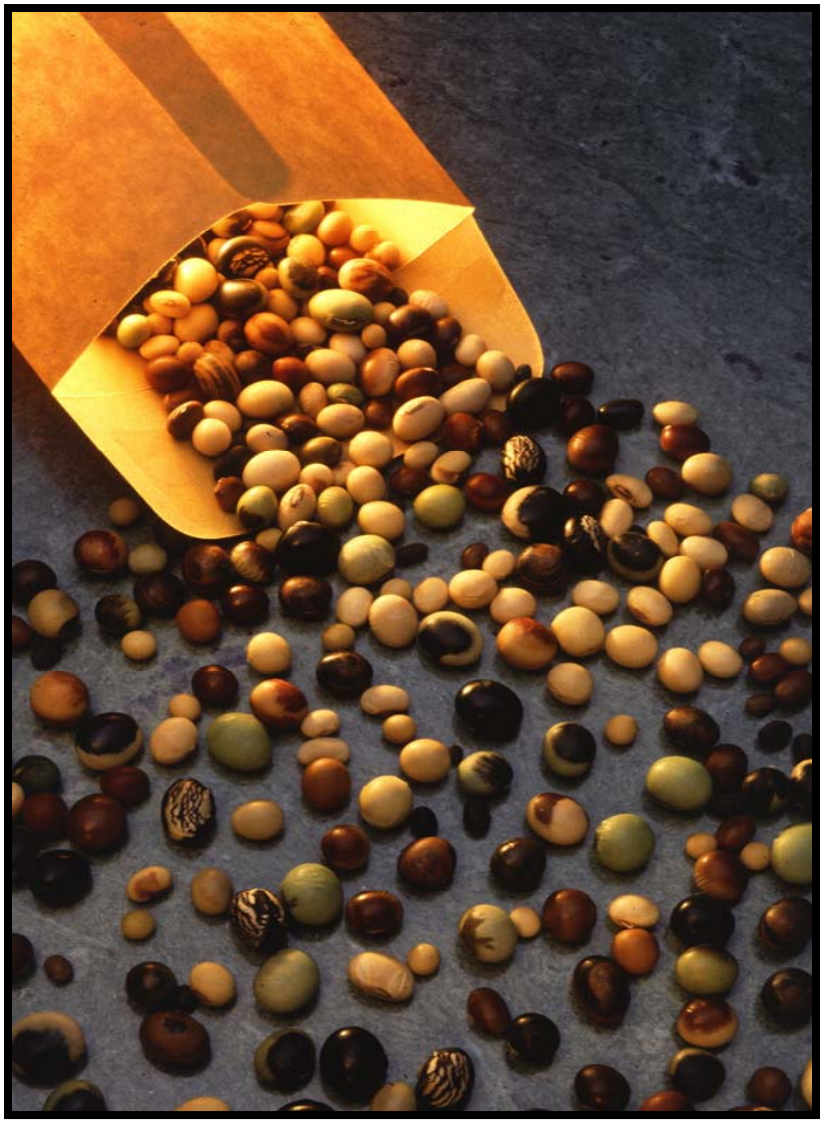
Specification For Biodiesel (B100) – ASTM D6751-07a

Property	ASTM Method	Limits	Units
Calcium & Magnesium, combined	EN 14538	5 max	ppm (ug/g)
Flash Point (closed cup)	**D 93**	**93 min.**	**Degrees C**
Alcohol Control (One of the following must be met)			
1. Methanol Content	EN14110	0.2 Max	% volume
2. Flash Point	D93	130 Min	Degrees C
Water & Sediment	**D 2709**	**0.05 max.**	**% vol.**
Kinematic Viscosity, 40 C	D 445	1.9 - 6.0	$mm^2/sec.$
Sulfated Ash	D 874	0.02 max.	% mass
Sulfur			
S 15 Grade	**D 5453**	**0.0015 max. (15)**	**% mass (ppm)**
S 500 Grade	**D 5453**	**0.05 max. (500)**	**% mass (ppm)**
Copper Strip Corrosion	D 130	No. 3 max.	
Cetane	D 613	47 min.	
Cloud Point	**D 2500**	**Report**	**Degrees C**
Carbon Residue 100% sample	D 4530*	0.05 max.	% mass
Acid Number	**D 664**	**0.50 max.**	**mg KOH/g**
Free Glycerin	**D 6584**	**0.020 max.**	**% mass**
Total Glycerin	**D 6584**	**0.240 max.**	**% mass**
Phosphorus Content	D 4951	0.001 max.	% mass
Distillation, T90 AET	D 1160	360 max.	Degrees C
Sodium/Potassium, combined	EN 14538	5 max	ppm
Oxidation Stability	**EN 14112**	**3 min**	**hours**
Workmanship	**Free of undissolved water, sediment, & suspended matter**		

BOLD = BQ-9000 Critical Specification Testing Once Production Process Under Control

Common Feedstocks

- Soybean – Most widely used in the U.S.
- Corn
- Canola
- Cottonseed
- Sunflower
- Beef tallow
- Pork lard
- Recycled or used cooking oils
- Trap grease



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National Biodiesel Board Objectives of Quality Assurance

- To promote the commercial success and public acceptance of biodiesel
- To help guarantee that biodiesel fuel is produced and maintained at ASTM D 6751 levels
- To avoid redundant testing throughout the production and distribution system
- To provide a mechanism to track biodiesel in the distribution system
  - Identifying biodiesel which meets industry standards
  - Providing a means to reduce the probability of product reaching the marketplace which does not meet D 6751
- To create a nationally recognized standard of certification – BQ-9000

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BQ 9000 Certification

NEWS

FOR IMMEDIATE RELEASE

August 29, 2006

Petroleum Company Takes a Stand for Biodiesel Quality

Sprague Energy first petroleum distributor to earn biodiesel certification

Jefferson City, Mo. – A progressive Northeastern petroleum distributor has become the first petroleum company in the nation to earn the status of "certified marketer" for selling biodiesel. The achievement marks a significant occasion as the biodiesel industry goes into overdrive to ensure that consumers receive only the highest quality fuel in their tanks.

Sprague Energy, Inc., a New Hampshire-based energy wholesaler, earned the certified marketer

Quality, Quality, Quality

SAMPLE SAMPLE SAMPLE

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Service Bulletin

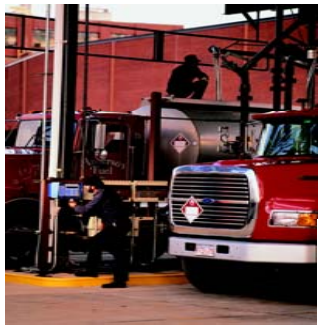
Fuels for Cummins® Engines

NOTE: For North American markets, Cummins Inc. requires that the biodiesel fuel blend be purchased from a BQ-9000 Certified Marketer. The B100 biodiesel fuel used in the blend must be sourced from a BQ-9000 Accredited Producer. Certified Marketers and Producers can be found at the following website: http://www.bq-9000.org. For areas outside of North America, consult your local Cummins® representative for applicable fuel quality standards.

What's Been Missing?

Robust Terminal Capacity Necessary To Seamlessly Integrate With Existing Petroleum Infrastructure

Supply



Demand

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Distribution System

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Distribution System

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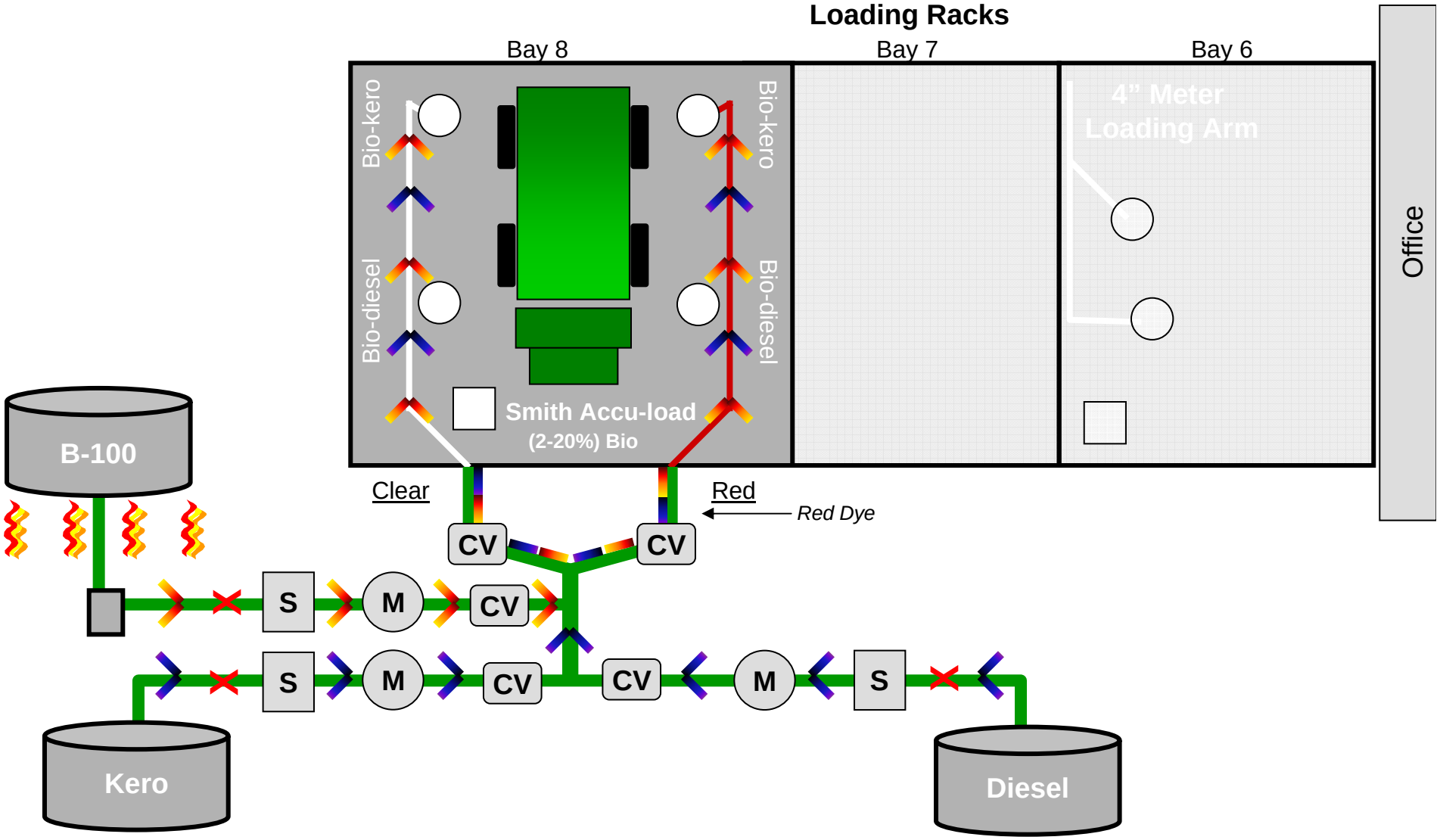
Biodiesel – Multi-Recipe



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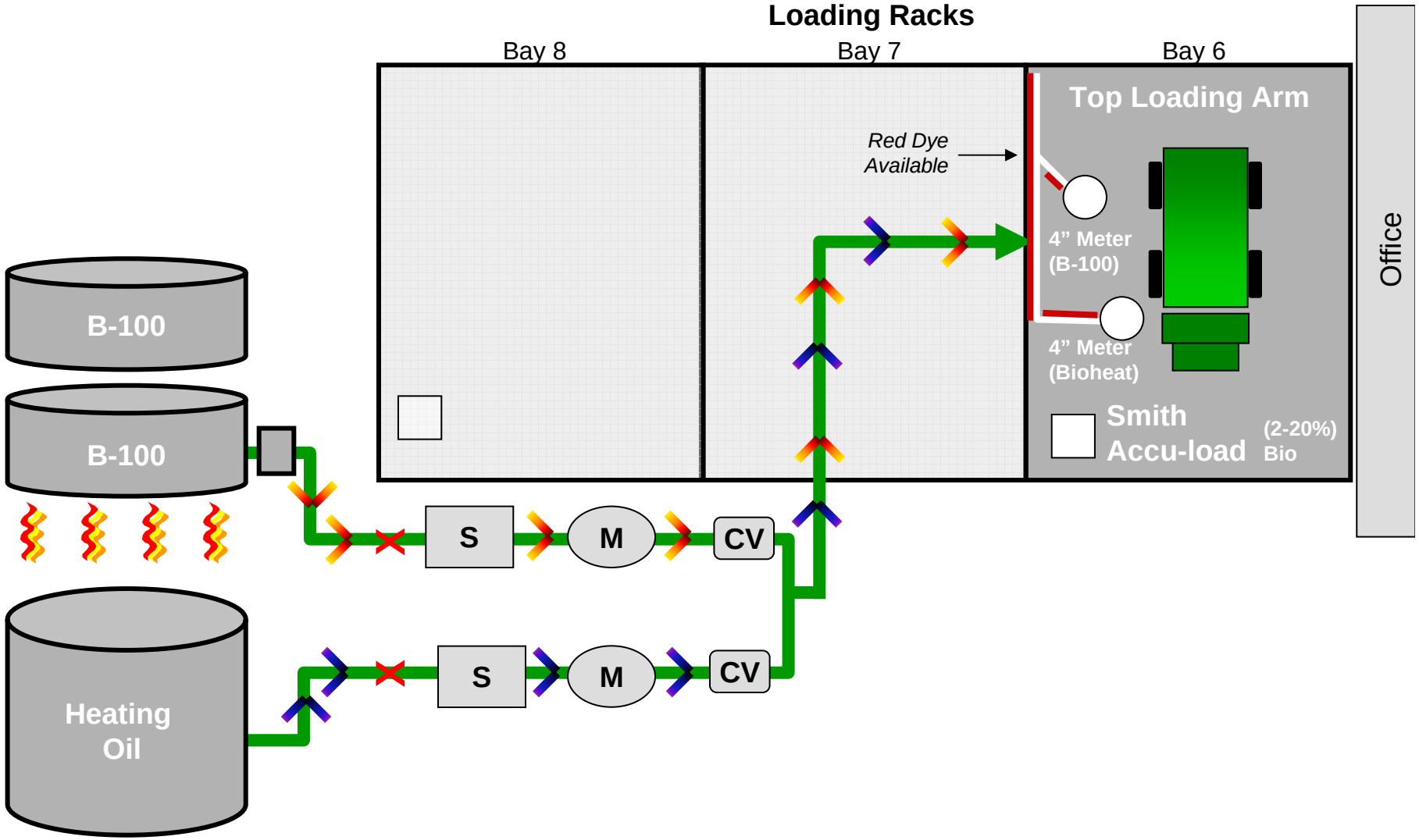
Bioheat Blending Configuration



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Albany, NY Terminal - Biodiesel Storage System

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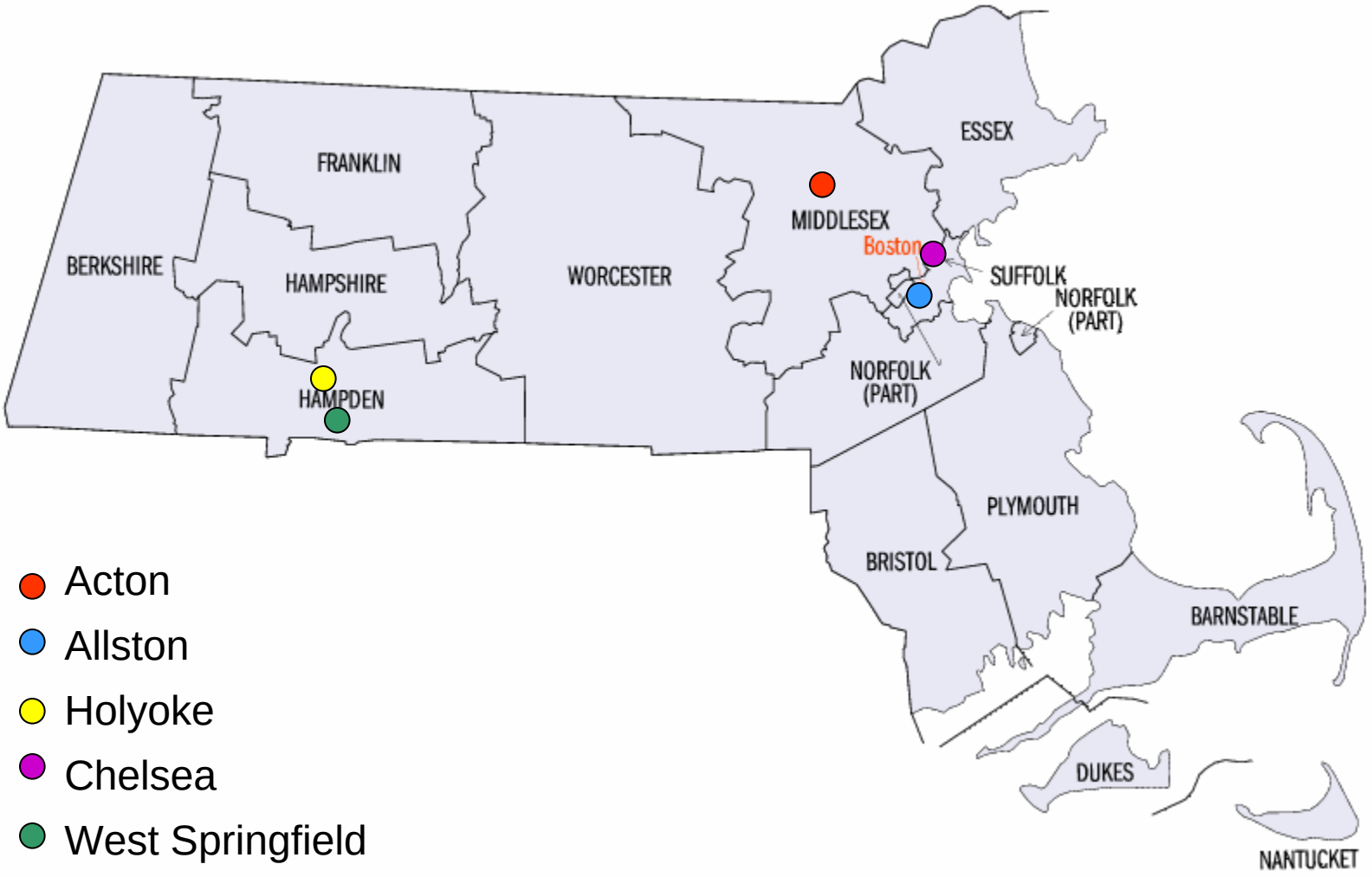

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Conclusion

- A “Perfect Storm” of political, environmental, and economic events are in place that support further expansion of biodiesel distribution
- Biofuels are non-toxic, clean burning, renewable, and reduce harmful emissions
- Biofuels have the highest BTU value of any alternative energy source, and can be used with little or no diesel engine or heating system modifications
- Biofuels will compete economically with fossil fuels as the price of energy rises

Key Websites

Link	Organization
http://www.biodiesel.org	National Biodiesel Board
http://www.nrel.gov	National Renewable Energy Laboratory
http://www.eere.energy.gov/cleancities	U.S. Department of Energy – Energy Efficiency and Renewable Energy Clean Cities Program
http://www.eere.energy.gov/afdc/altfuel/biodiesel.html	EERE Alternative Fuels Data Center: Biodiesel

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www.spragueenergy.com

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Sprague Today

Axel Johnson Group, Sweden

|

Axel Johnson, Inc. Stamford, CT

|

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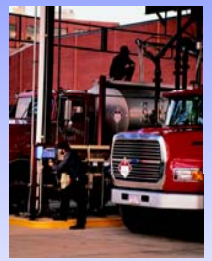
Founded 1870

Market Focus	Energy Distribution and Materials Handling
Marketing Region	Northeast, Mid-Atlantic States
Annually handling and / or distributing over:	135 Bcf of natural gas 60 million barrels of oil 3 million tons of materials handled
Headquarters	Portsmouth, NH
Total Employees	475
Company Ownership	Privately Held

Our Products and Services

End Users

Natural Gas



Fuel Oils

Coal

Clean fuels

Motor fuels

Resellers

Home Heating Fuels

Motor Fuels

Risk Management

Materials Handling

Bulk

Break Bulk

Lumber

Liquid

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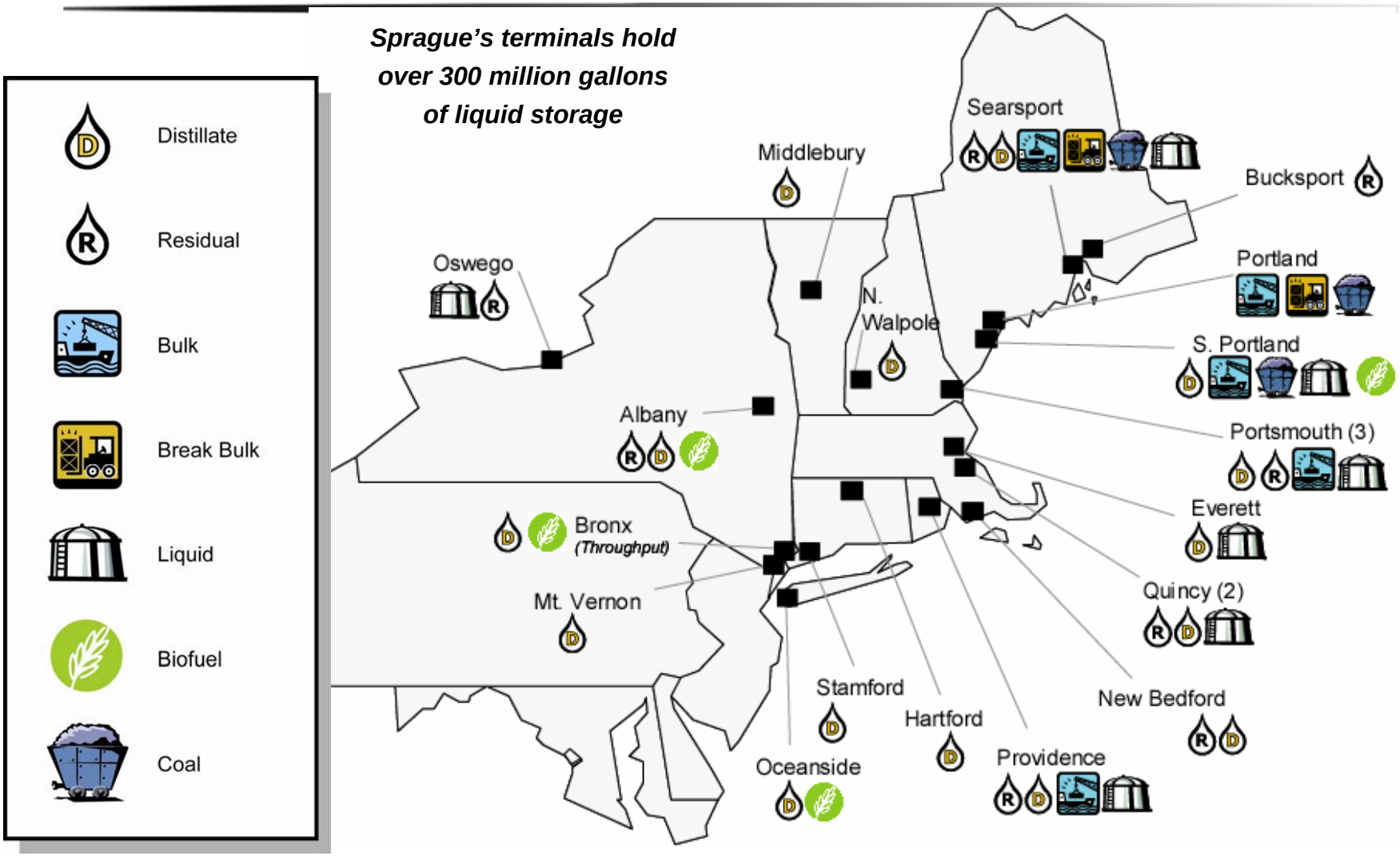
Sprague Owned Terminal Network

Sprague's terminals hold over 300 million gallons of liquid storage



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“The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become, in the course of time, as important as petroleum and the coal tar products of the present time.”

Rudolph Diesel, 1912

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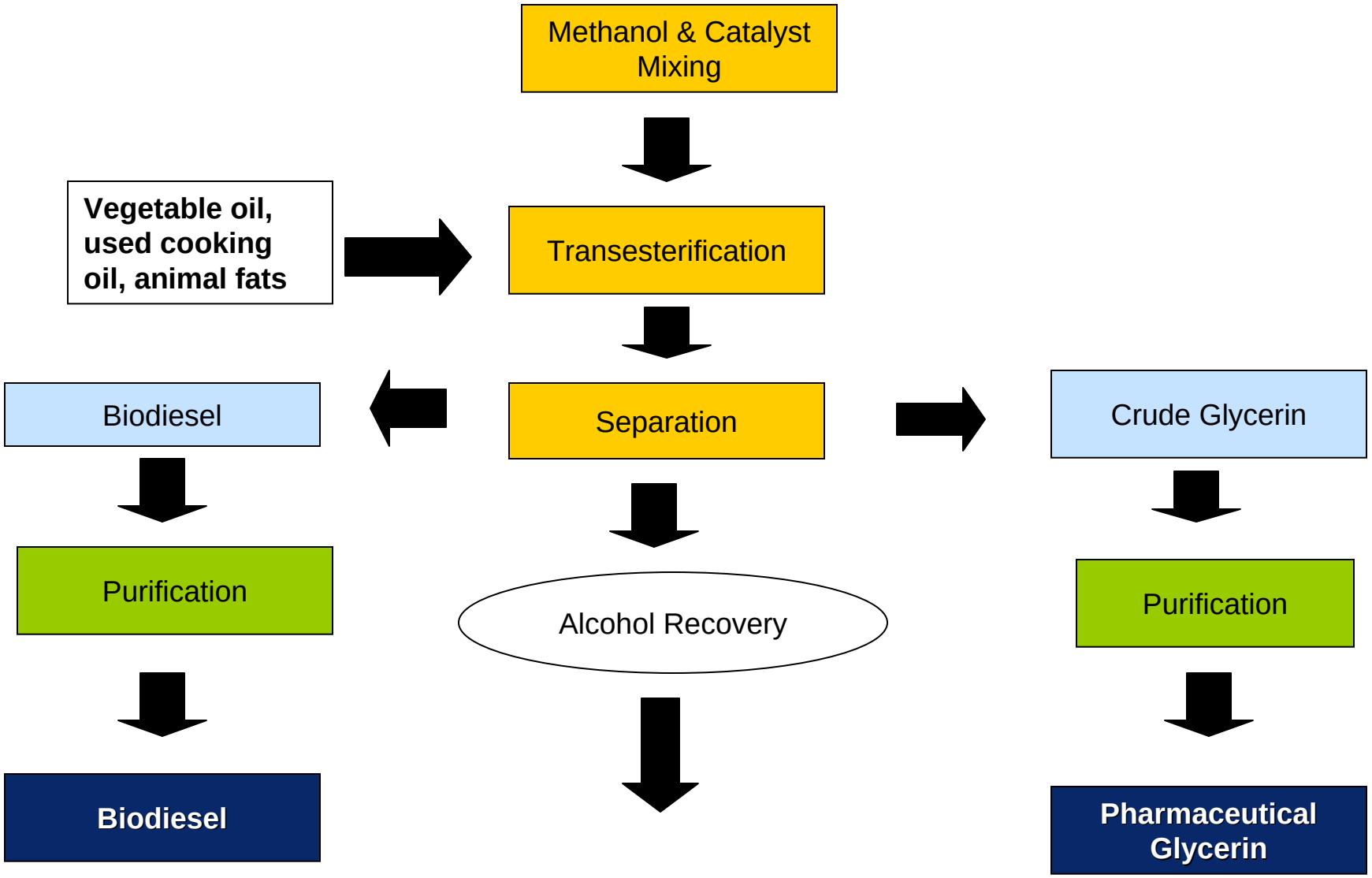
By Definition

- General Definition: Biodiesel is a domestic, renewable fuel for diesel engines derived from natural oils such as soybean oil, and which meets the specifications of ASTM D 6751.
- Biodiesel can be used in any concentration with petroleum-based diesel fuel in existing diesel engines with little or no modification.
- Not the same thing as raw vegetable oil. Biodiesel *must* be produced by a chemical process that removes glycerin from the oil.
- Biodiesel blend, n. – a blend of biodiesel fuel meeting ASTM D 6751 with petroleum-based diesel fuel

Biodiesel Production Process



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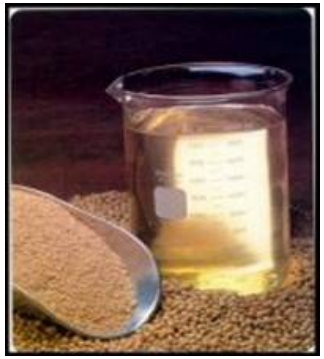
Biodiesel Production

(Catalyst)

100 pounds triglyceride (Vegetable oil or animal fat)	+	10 pounds Methanol	=	100 pounds Biodiesel	+	10 pounds Glycerine

B100 = Biodiesel
Specified by ASTM D 6751

B20 = 20 % B100 blended with 80% petrodiesel



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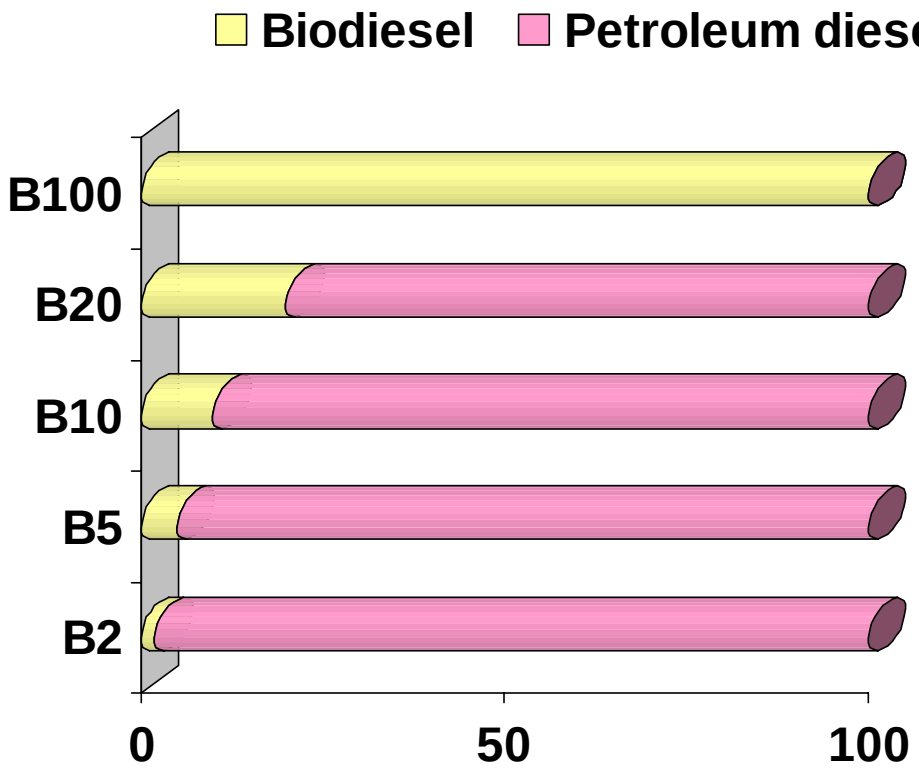
Biodiesel Blends



B100 = 100% biodiesel

B20 = 20% biodiesel + 80% petroleum diesel

B10 = 10% biodiesel + 90% petroleum diesel

B5 = 5% biodiesel + 95% petroleum diesel

B2 = 2% biodiesel + 98% petroleum diesel

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Who is Using Biofuels?

- Retail heating oil distributors
- Port Authority of NY/NJ
- All 4 branches of the U.S. military
- NASA
- United State Postal Service
- United States Forest Service
- 23 National Parks, including Yosemite, Yellowstone, Glacier
- Dozens of school districts
- Cities of Pittsburgh, Philadelphia, St. Louis
- L.L. Bean
- Over 500 major fleets nationwide
- U.S. farmers
- 50 million problem-free miles

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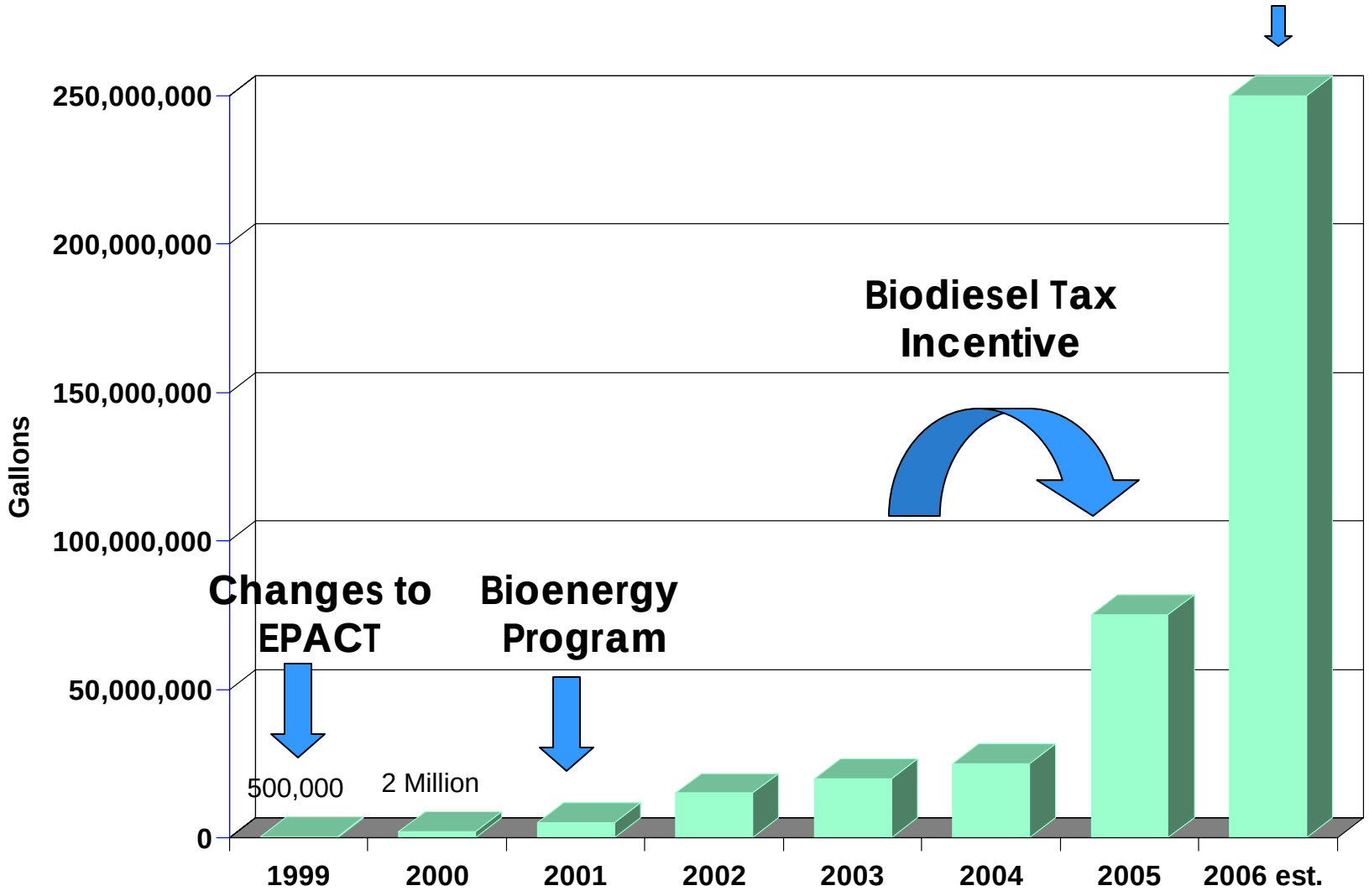
Biodiesel Markets

- B20
  - EPACT, municipal, school buses
- B100
  - Niche markets
    - Power generation
    - Garbage truck fleets
    - California market
- B2
  - Lubricity component for Ag Fuels
  - Premium diesel fuels
  - RFS compliance with ULSD

US Biodiesel Demand

750,000 mt

950 m liters



Conversions: 1 mmt ~ 300 m gallons ; 1 gallon = 3.8 liters

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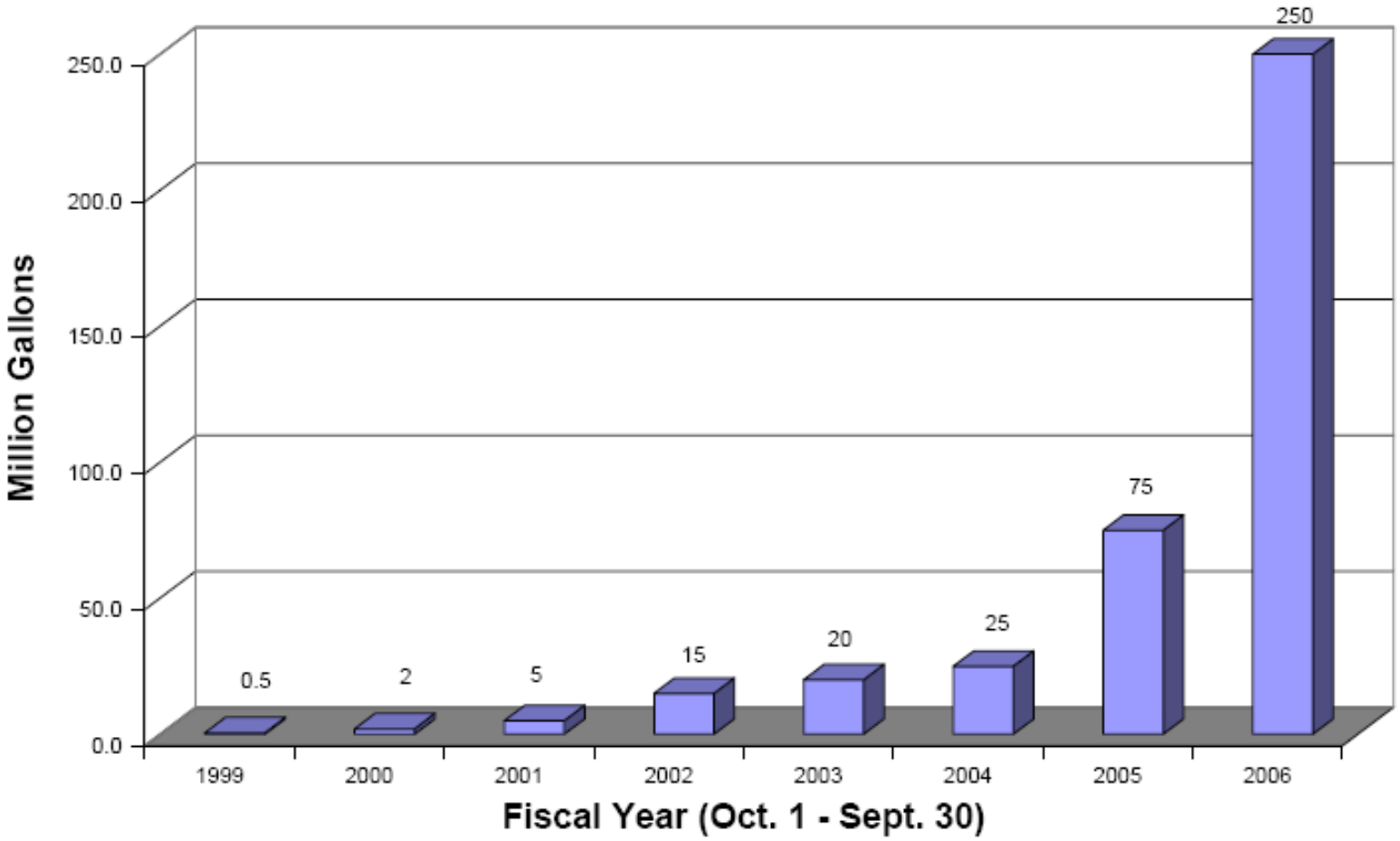
Estimated U.S. Biodiesel Sales



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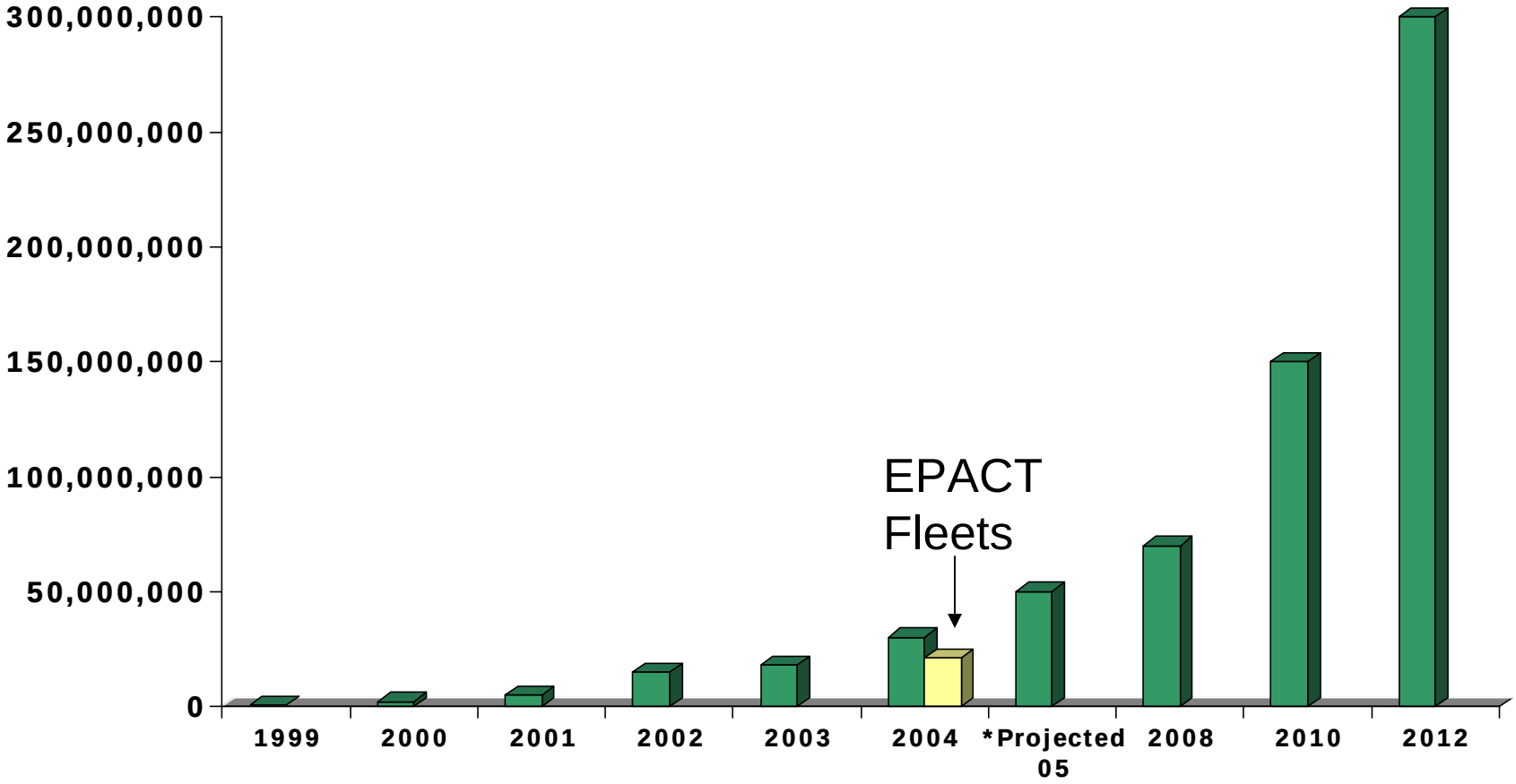
Historical and Projected On-Highway Sales



**Unofficial projections based on biodiesel mixture credit implementation.*

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Rack Injection Blending

- As critical as it is to use ASTM D 6751 product, it is crucial to maintain and purchase product blended at the terminal rack resulting in a thorough homogenous blend. If not, blended product may result in operational issues, especially in the winter months.
- Electronically blending is also important to accurately measure blend quantities.

ASTM Standards - Diesel vs. Biodiesel

Test	ASTM Test Method	Diesel	Biodiesel	Typical Biodiesel Ranges
Flash Point, °F	D 93	101	266	251-365
Sulfur, % mass, ppm	D 129	0.5	0.0015	0.0006
Pour Point, °F	D 97	0	N/A	32 - 59
Cetane Number, min	D 613	40	47	47 – 70
Lubricity, HFRR, 520 M max	D 975	520	N/A	300 - 360
BTU Content	-	139,000	128,000 (equivalent to kero)	-

- Seamless and transparent with existing petroleum infrastructure
- Completely miscible with middle distillate fuel pool
- Safe – Health effects test confirm it is 10x less toxic than table salt and biodegrades as fast as sugar
- Virtually sulfur free
- Fuel efficiency is the same as diesel or #2 oil

Biodiesel & OEMs

- Many engine manufacturers support biodiesel blends:
  - Caterpillar
  - Cummins
  - Detroit Diesel
  - International
  - John Deere
- EMA approves a B20 specification
- The use of B20 and below will not void the warranty of any major US engine manufacturer
- Position statements can be found at www.biodiesel.org
  - Caterpillar
  - Cummins
  - Detroit Diesel
  - International
  - John Deere
  - Case New Holland
  - Volkswagen

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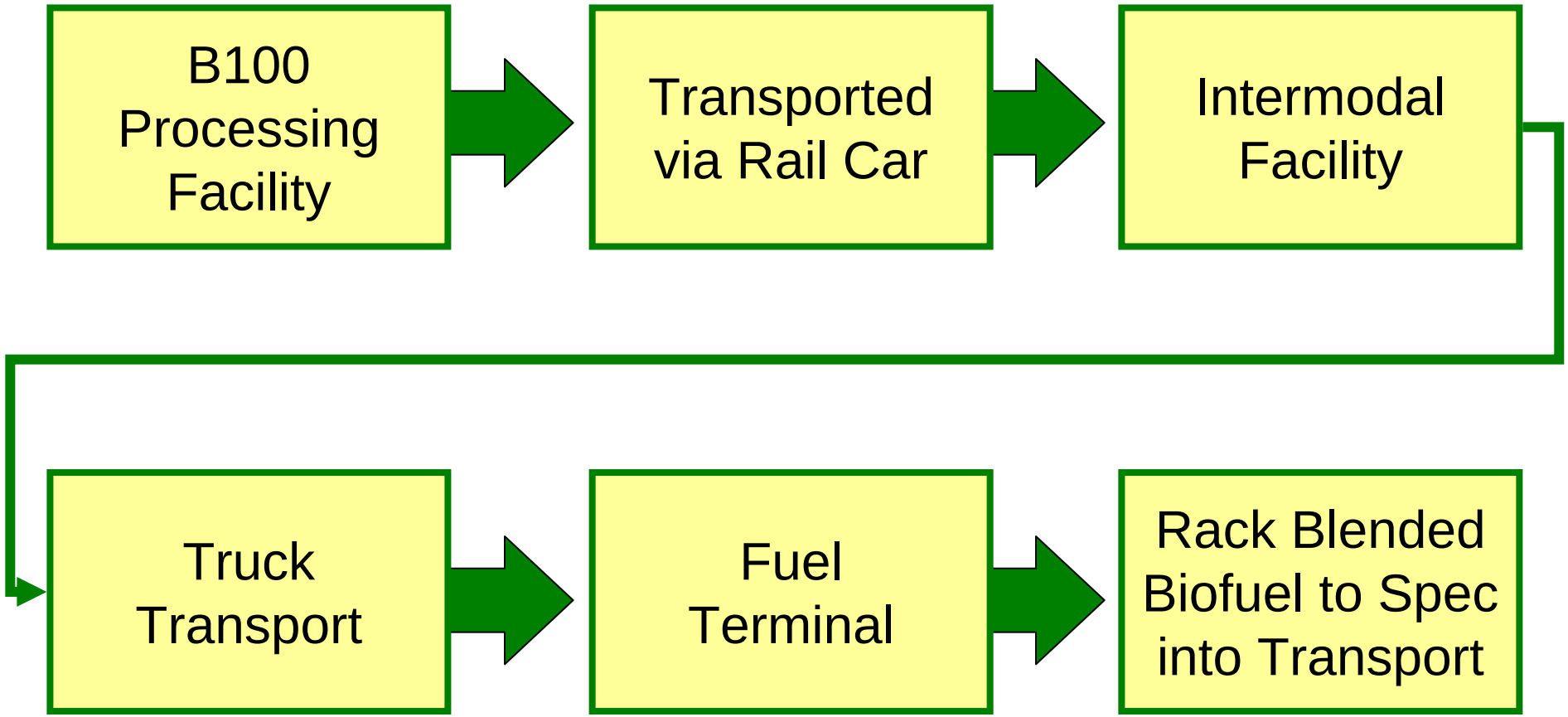
Biodiesel - Supply and Distribution



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Energy Content

- Since efficiency of diesel engines is the same whether using biodiesel, diesel or biodiesel blends, differences in performance are due to volumetric energy contact.
  - Energy content of biodiesel is much less variable than that of petrodiesel
  - With biodiesel meeting ASTM D 6751 standards, energy content depends more upon feedstocks

Average Density and Heating Value of Biodiesel and Diesel Fuel

Fuel	Density, g/cm3	Net Heating Value Avg., Btu/gal.	% Difference vs. No. 2 Diesel Avg.
No. 2 Diesel	0.850	129,500	
Biodiesel (B100)	0.880	118,296	8.65 %
B20 Blend (B20)	0.856*	127,259*	1.73 %*
B2 Blend (B2)	0.851*	129,276*	0.17 %*

* Calculated Values from those of No. 2 Diesel and Biodiesel (B100)

- While BTU changes of 1-2% can be picked up in lab tests for horsepower, torque and fuel economy, it is difficult to detect these differences in day to day operations.

Biodiesel Performance

- Similar power to petroleum diesel
- Highest BTU content of any alternative fuel
- High cetane
  - Minimum cetane of 47, which is higher than most #2 diesel
- High lubricity
  - Even biodiesel levels as low as 1% can provide up to a 65% increase in lubricity in distillate fuels
- Cold flow – B2 the same as #2 petroleum diesel
- High flash point – 260°F vs. 117°F for diesel

Material Compatibility (tanks)

- Biodiesel and biodiesel blends will form high sediment levels when in contact with brass, bronze, copper, lead, tin and zinc
- Biodiesel is compatible with mild and stainless steel, aluminum

Materials Compatibility

B100 may adversely impact

- Elastomers manufactured from natural or nitrile rubbers
- Teflon and Viton recommended
- Elastomers used after 1993 are compatible with B100
- Blends (B20) effect is less, or non-existent
- Consult with your parts supplier or mechanical engineering partners if unsure of materials

Cold Flow Properties

- **Biodiesel realizes cold temperature operability issues faster than most petroleum diesel**
- **Untreated B20 freezes 2-5 °F faster than #2 petroleum diesel, depending on:**
  - the cold flow properties of the biodiesel
  - the cold flow properties of the petroleum diesel
- **Utilize the same precautions!**
  - Utilization of an additive that enhances cold flow properties
  - Blending with kerosene
  - Storage of the vehicles in or near a building when not in use

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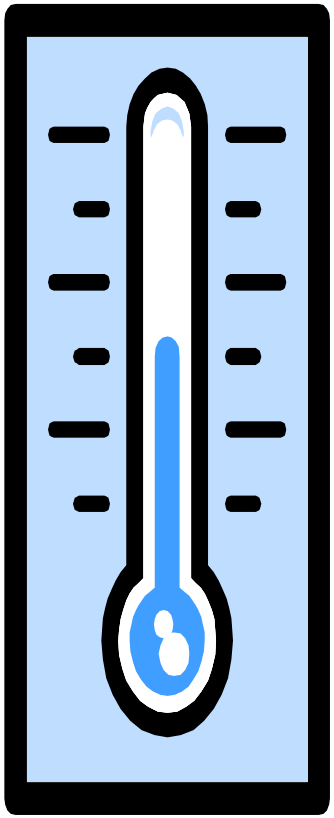
Biodiesel Cold Weather Characteristics



Common Cold Weather Problems	Solution: Sprague Ratio Blending
B100 congeals in cold weather storage	B100 stored in heated environment at temp >10 ° above cloud point
Loading B100 into a cold tank truck	Warm B100 introduced into a continuous stream of distillate creating miscible biodiesel recipe
Switch loading in order to create a homogeneous cold weather blend	One rack, ratio blended. Fast, easy, efficient, on spec

B100 must be stored at least 10° above cloud point to successfully blend with diesel fuel.

- *NBB, Cold Weather Blending study, 2005*

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Extended Biodiesel Storage

- Biodiesel shelf life shorter than typical distillate
- It is best to store B100 pre-blended with some kind of distillate as soon as possible regardless of the season in small scale bulk plants
- Blends of biodiesel and diesel should be stored at temperatures at least 10F above blended products cloud point
- Consider stabilizing fuels being stored in excess of six months
- In above ground tank environments remember the rules shown above and protect all lines, pumps and dispensers from cold – Heat Trace/Insulate