



Introducing a New Fuel to
Commerce - Not so Easy:
Experience from the Biodiesel
Industry

Bill Ayres, R3 Sciences LLC
Steve Howell, MARC-IV



Considerations for New Fuels

- “ Fuels are some of the most highly regulated and scrutinized commodities in the US
 - Over 200 billion gallons of fuel is used each year in the US
- “ Large multi-national oil companies have deep pockets, and therefore can withstand the costs of regulation, oversight, and approvals
- “ They also protect their existing markets with every means at their disposal
- “ Breaking into the fuel business is not for the faint at heart and requires sustained, major investments by both the private and public sector



Considerations for New Fuels

- Driving Forces
- Fuel Production and Raw Matl's
- Getting Legal
- Getting Accepted



Driving Forces for Change

- For the most part, US customers are happy with their current fuels and vehicles
- They are reliable, relatively inexpensive, and are familiar to everyone
- Some are even fun!
- For this reason, there is strong resistance to change and a reluctance to change based on the problems and issues with alternative fuels introduced thus far



Economic Forces

- Is the new fuel cheaper for the user?
 - Cost per gallon (or mile)
 - Cost of equipment that uses the fuel
 - Ongoing maintenance costs
 - Durability, years to scrap or sale
 - Are incentives available for the fuel or the vehicle?
 - Do technical attributes bring value? (i.e. higher cetane, higher lubricity)



Societal and Economic Forces

- Is the new fuel the cheapest way to meet a company, city, state or federal goal?
 - Safety
 - Environmental
 - Health
 - Sustainability
 - Renewable
 - Domestically/Locally Produced



Regulatory and Economic Forces

- Is the new fuel the cheapest way to meet a local, state, or federal regulation?
 - Clean Air Act Amendments of 1990
 - Energy Policy Act of 1992
 - Renewable Fuels Standard-2, 2008
 - Low Carbon Fuel Standard under consideration by several states
 - Various retro-fit or re-build regulations

Volume Standards as Set Forth in RFS2

**Conventional
Renewable
Fuels**

+

**Total
Advanced**

=

**Total
Renewable
Fuel**

Year	Conventional Renewable Fuels (Grandfathered Or 20% Reduction)	Advanced Biofuel NESTED STANDARDS			Total Advanced Biofuel	Total Renewable Fuel
		Biomass-Based Diesel (50% Reduction)	Non Cellulosic Advanced (50% Reduction)	Cellulosic Biofuel (60% Reduction)		
2008	9.00					9.0
2009	10.50	0.5	0.1		0.6	11.1
2010	12.00	0.65	0.2	0.1	0.95	12.95
2011	12.60	0.80	0.3	0.25	1.35	13.95
2012	13.20	1.0	0.5	0.5	2.0	15.2
2013	13.80	1.0	0.75	1.0	2.75	16.55
2014	14.50	1.0	1.00	1.75	3.75	18.15
2015	15.00	1.0	1.50	3.0	5.5	20.5
2016	15.00	1.0	2.00	4.25	7.25	22.25
2017	15.00	1.0	2.50	5.5	9.0	24.0
2018	15.00	1.0	3.00	7.0	11.0	26.0
2019	15.00	1.0	3.50	8.5	13.0	28.0
2020	15.00	1.0	3.50	10.5	15.0	30.0
2021	15.00	1.0	3.50	13.5	18.0	33.0
2022	15.00	1.0	4.00	16.0	21.0	36.0



Developing a Market Strategy

- “ Based on a thorough analysis of the driving forces for changing fuels a market strategy and image for the product must be developed
 - For biodiesel, the driving forces were cleaner burning, less toxic and more biodegradable, renewable, domestically produced, and least cost way to meet government regulations (EPACT, RFS2, Energy Security Act, etc.)
- “ This image must be shared widely with users, regulators, and stakeholders



Next Step: Production

- “ If the economics and marketing strategy have promise, the next step is producing the fuel as cheaply as possible
 - Raw material procurement
 - Site location
 - Production technology
- “ For the case of biodiesel, this was relatively simple since methyl esters have been made for years in the fats and oils business, and fats and oils trading is well established



Production—not so simple

- “ Even though methyl esters had been made for years by fats and oil companies, minor components OK for oleochemical use were NOT OK for engines:
 - Mono-, di-, triglycerides
 - PPM levels of left over catalyst soaps
 - Can clog filters or de-activate new diesel catalysts
 - PPM level of phosphorous
 - Can de-activate new diesel catalysts
- “ Changes were needed to make a good fuel



Getting Legal

- Since they are a commodity used by virtually every citizen, fuels are highly regulated commodity
 - Quality, Consumer Protection
 - Emissions
 - Safety
 - Health Impacts



Quality and Specifications

- ASTM International sets US fuel specs
- Engine and vehicle companies, fuel buyers, and fuel regulators require commodity fuels in the US to have an ASTM standard
- The most seasoned experts from major oil companies, engine and vehicle manufacturers, regulators and third party experts at ASTM vote on standards
 - One negative vote can kill a ballot



Quality and Standards

- Biodiesel started in 1993, formal approval for B100 in 2001 and for B20 in 2008
- Over \$60MM in research and testing with engines in the laboratory and large field trials were required to secure the technical information needed to pass the ASTM standards for biodiesel.
- Efforts continue to improve both the petrodiesel and biodiesel ASTM standards



Getting Legal

- Clean Air Act Amendments of 1990
 - All fuels/additives must be registered and show they do not affect the general public more than the existing fuels in the market.
 - Must complete Tier 1 exhaust emissions speciation to quantify all exhaust species
 - Depending on the fuel, must complete Tier 2: 90 day inhalation test with albino rats
- These tests for biodiesel cost over \$2.2MM over 10 years ago



Getting Legal

- Fueling depot's, dispensers, underground tanks, piping, pumps, etc. are all further regulated under state and local agencies, AHJ's (Authorities Having Jurisdiction)
 - Water Board or DNR for tank, plumbing leaks
 - OSHA for personnel safety
 - Fire Marshall for fire safety
- These groups typically require a 'third party listing' of all equipment in order to be legal



Getting Accepted

- Users look to various sources for advise on whether a new fuel is OK for their engine:
 - Newspaper, TV news, internet, magazines, etc.
 - Local dealer or mechanic
 - The engine or vehicle company
- Negative information from any of these sources could cause a user to stay away
- Intense education efforts needed so these entities provide accurate, factual infomation



Getting Accepted

- The effort must start at the engine manufacturer
 - Complete evaluation of fuel system effects
 - Complete evaluation of engine performance (horsepower, torque, startability, etc.)
 - Complete evaluation of long term durability
 - EPA requires emissions to be met after 435,000 miles for heavy duty trucks
 - Many field trials with different uses (i.e. highway vs. city) and climates (warm, cold, humid)
 - Detailed data tracking and equipment tear downs



Getting Accepted

- Most of the \$60MM spent on biodiesel was spent doing the research to secure the acceptance of the engine and vehicle companies
- Some of this may not be needed if targeting only niche markets which use only one or two engine models
- The biodiesel industry is still educating dealers, mechanics, and others on the facts regarding biodiesel use



Getting Accepted

- Distribution and Filling Stations are the next challenge to getting accepted
- How to get the fuel to the user?
 - Pipeline, truck, rail, barge?
- New stations may require new tanks, piping, and dispensers
 - Capital costs, are volumes high enough to justify the expense?
- Sometimes we forget everyone who touches the fuel must make money....



Summary—New Fuels

- “ Breaking into the US fuel market with a new fuel takes significant, sustained investments by both the public and private sector
- “ Having solid Driving Forces is a must
- “ Getting Legal and Getting Accepted takes many years and millions of dollars
- “ But if the driving forces are solid and you don't get discouraged—it can be very rewarding!