Status of the US Biodiesel Industry for NORA Technical Workshop September 14, 2016

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Reacting:

In the presence of a catalyst

Yields:

100 Lbs. Vegetable Oil or Animal Fat

+

10 Lbs. Alcohol

100 Lbs. Biodiesel

+

10 Lbs. Glycerine

Produces mono-alkyl esters – chemically similar to diesel fuel

What's NOT Biodiesel?

- Raw vegetable oil/SVO
- Recycled cooking oil
- Ethanol
- Ethanol, methanol, or water blended with diesel and an emulsifier
- Other "Renewable Fuels"

US Domestic Feedstocks

Cottonseed Oil

Yellow Grease

Poultry Fats

Beef/Pork Fats

Corn Oil By-Product from Ethanol Plants

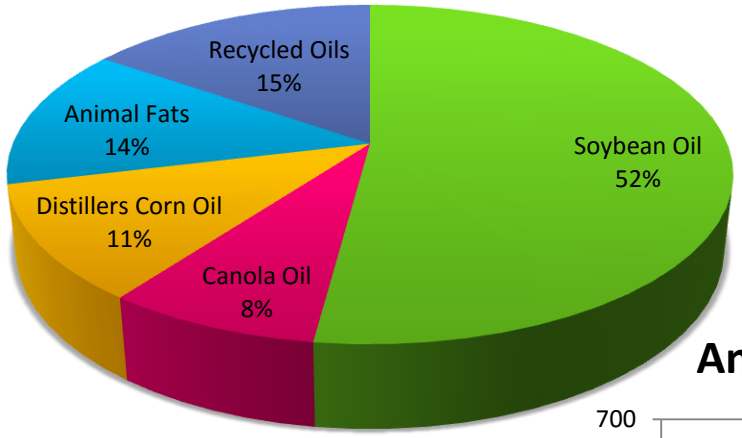
Canola Oil

Camelina Oil

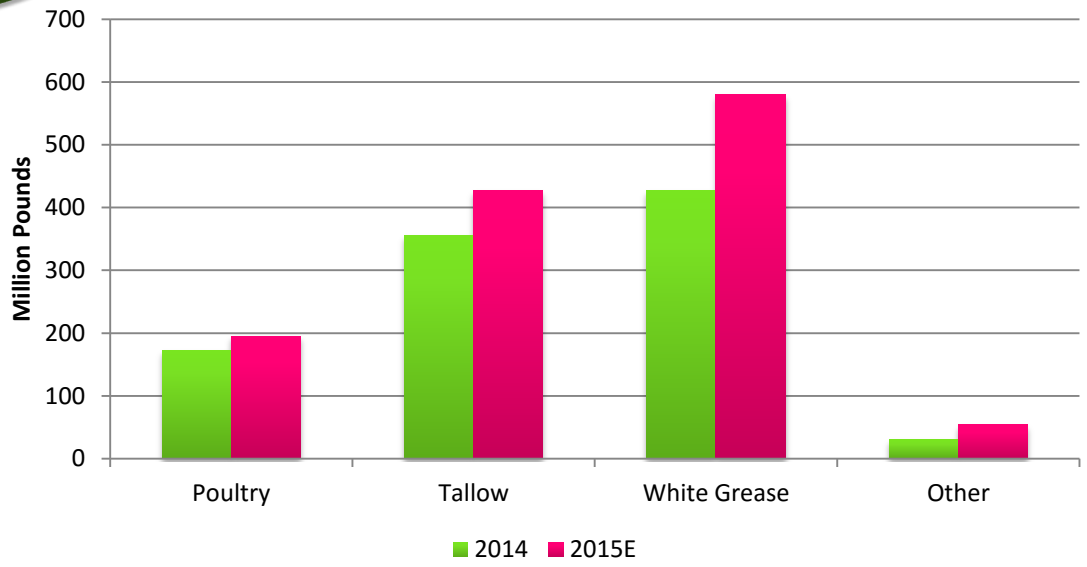
Soybean Oil

2015 Estimated US Feedstock Use

EPA Approved Biodiesel Feedstocks Utilized in 2015

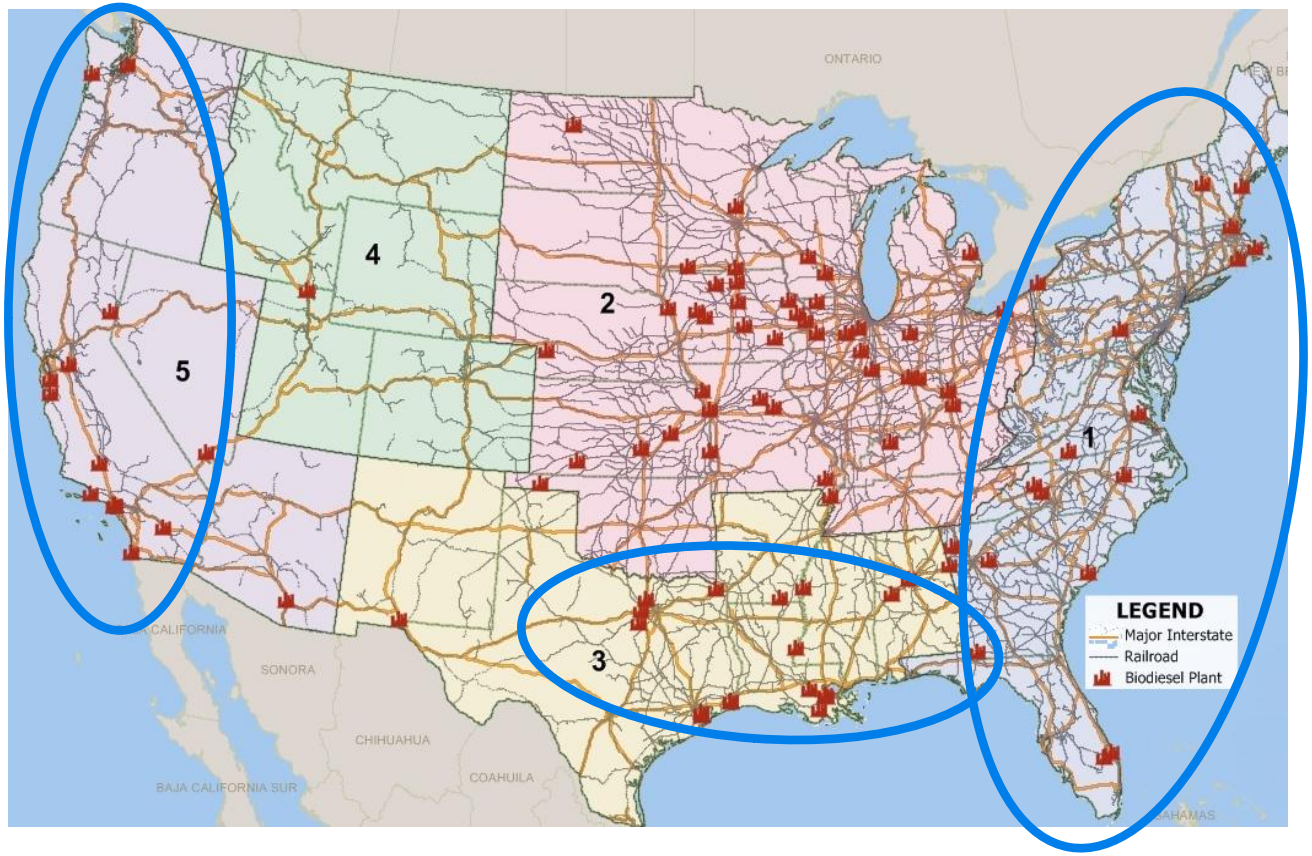


Animal Fat Use for Biodiesel Production



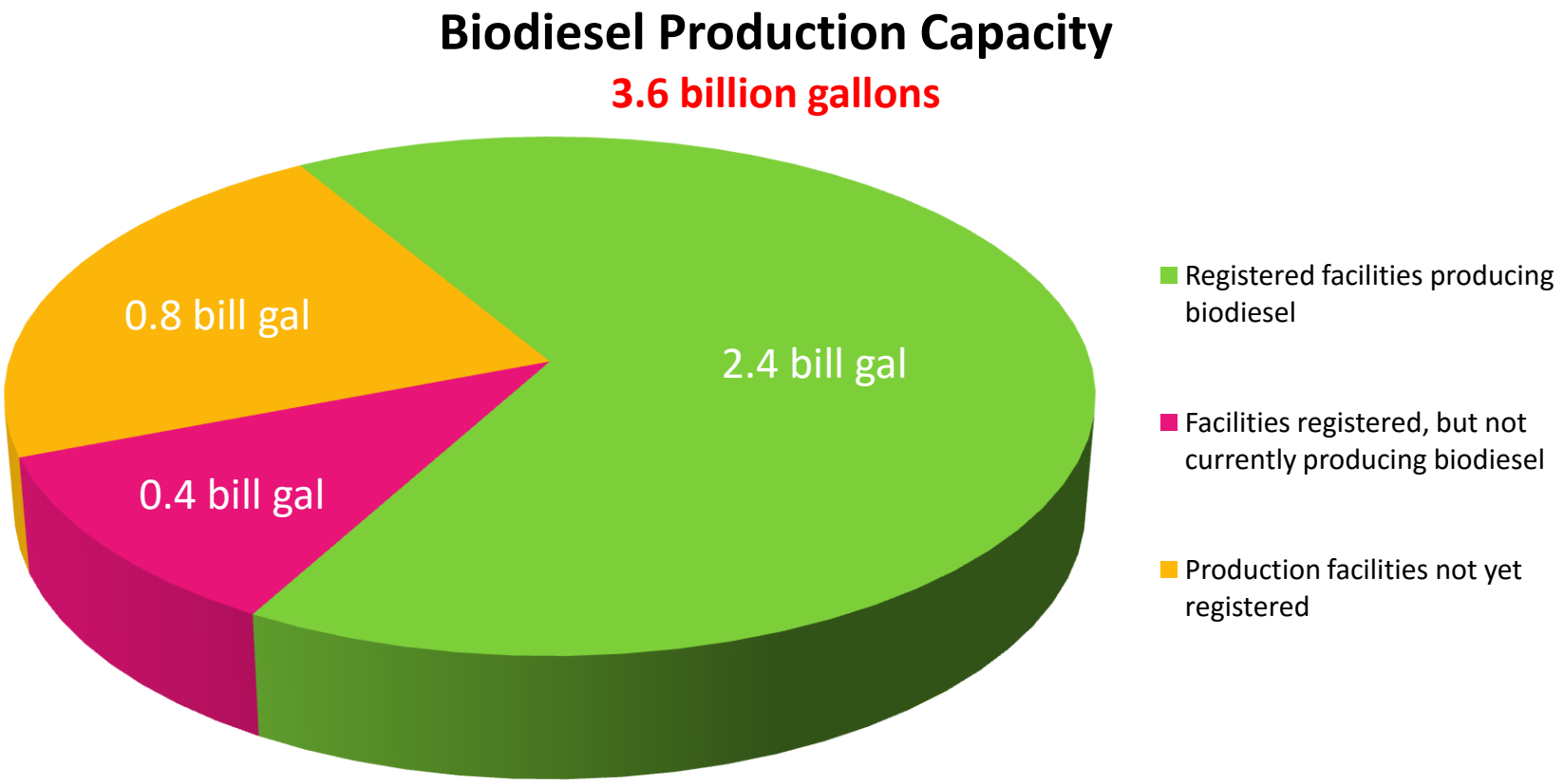
Biodiesel Has Expanded and Diversified Production Capacity

- Biodiesel production has expanded beyond the Midwest
- New capacity closer to other markets uses diversified feedstocks



Source: NBB

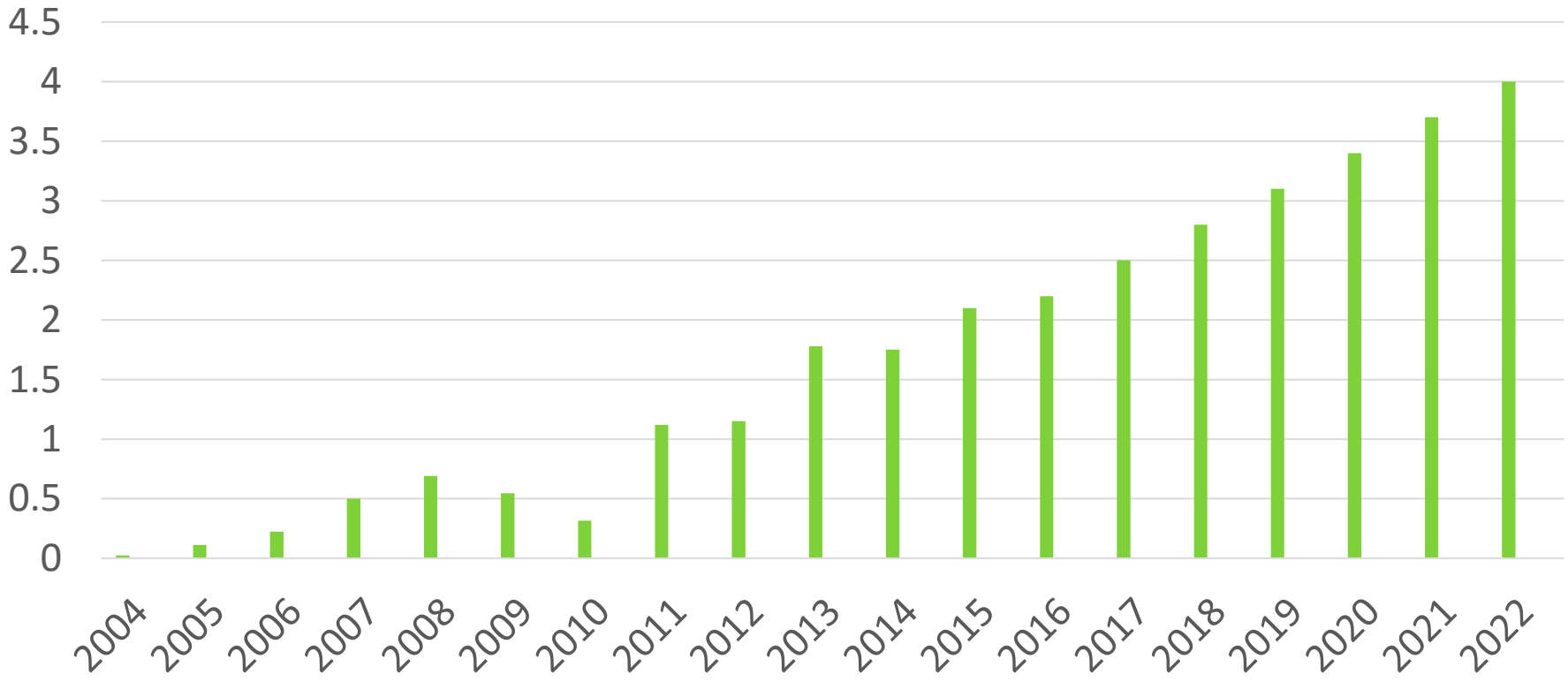
Biodiesel production increases are not constrained by available biodiesel capacity



Source: Biodiesel plant list 2-6-13 from Docket EPA-HQ-OAR-2013-0479; numbers are from a combination of NBB, EIA, and EPA databases.

Biodiesel Production Goal:

4 Billion Gallons by 2022



Similar National Volumes as US Based Heating Oil

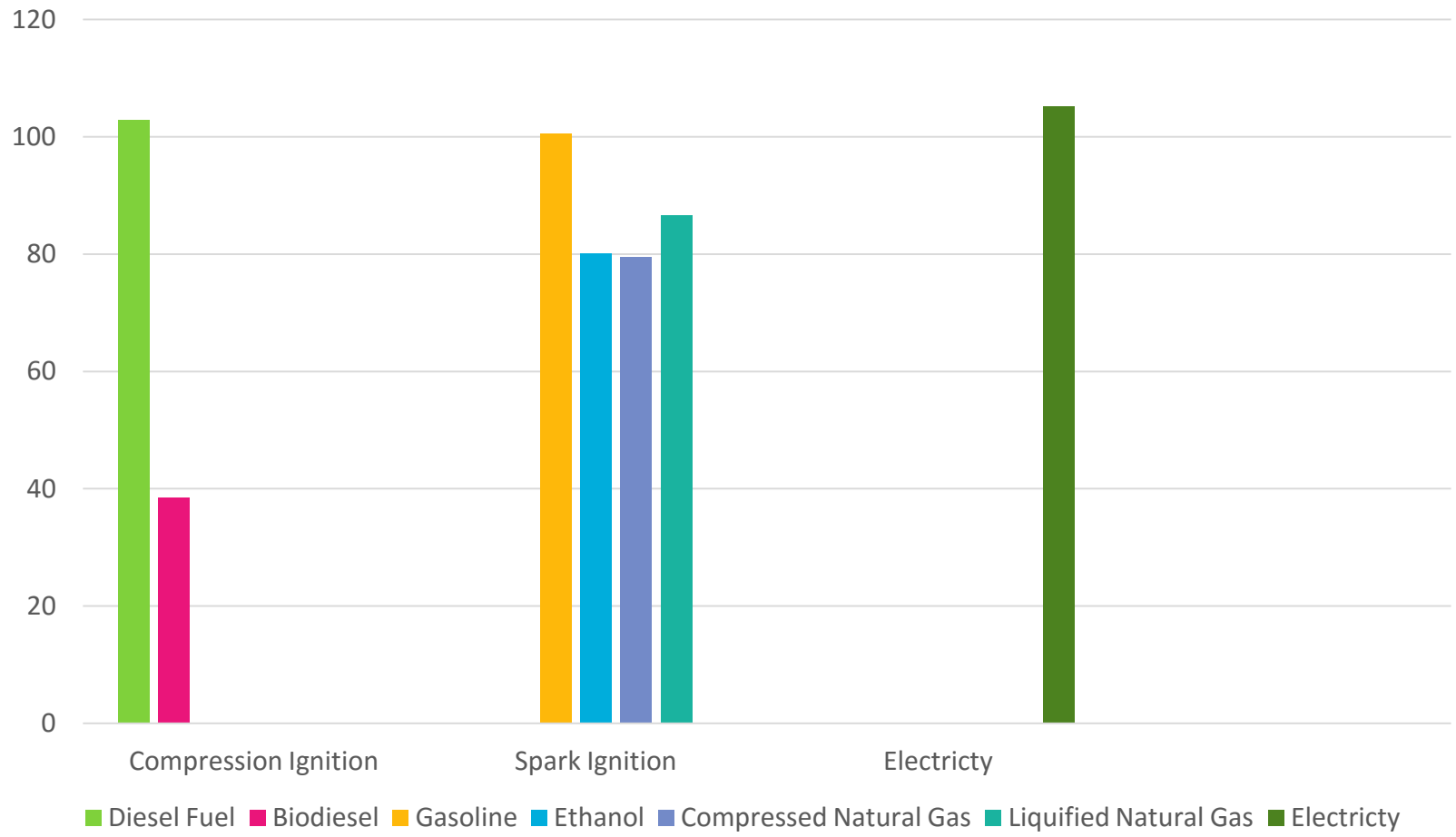
US Biodiesel Is Cleaner

US Biodiesel Reduces Global Warming

- Closed Carbon Cycle: CO_2 Used to Grow Feedstock is Put Back Into Air
  - Over 78% Life Cycle Decrease In CO_2
- Energy Balance 5.4 to 1
  - Over 5 times as much energy out as it took to make the biodiesel

Carbon Intensity of Fuels

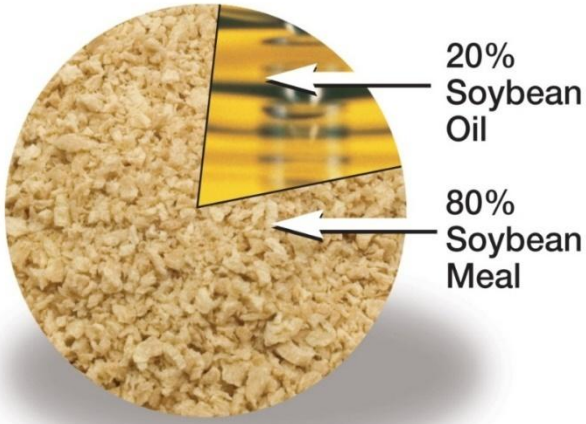
grams CO2e/MJ



Sustainability

- US Biodiesel is produced from a variety of renewable resources, such as plant oils, animal fats, recycled grease, and even algae, making it one of the most sustainable fuels on the planet.

- With US biodiesel, **food isn't sacrificed for fuel.** Oils and fats for biodiesel are a minor by-product of producing food for humans and animals.
  - Soybeans are 80% protein, 20% oil
  - No one grows livestock for its fat content
  - No one cooks more fried food to get used oil for biodiesel



By creating a market and value for excess soybean oil,

Biodiesel decreases US soy protein meal prices by $20-40 per ton.

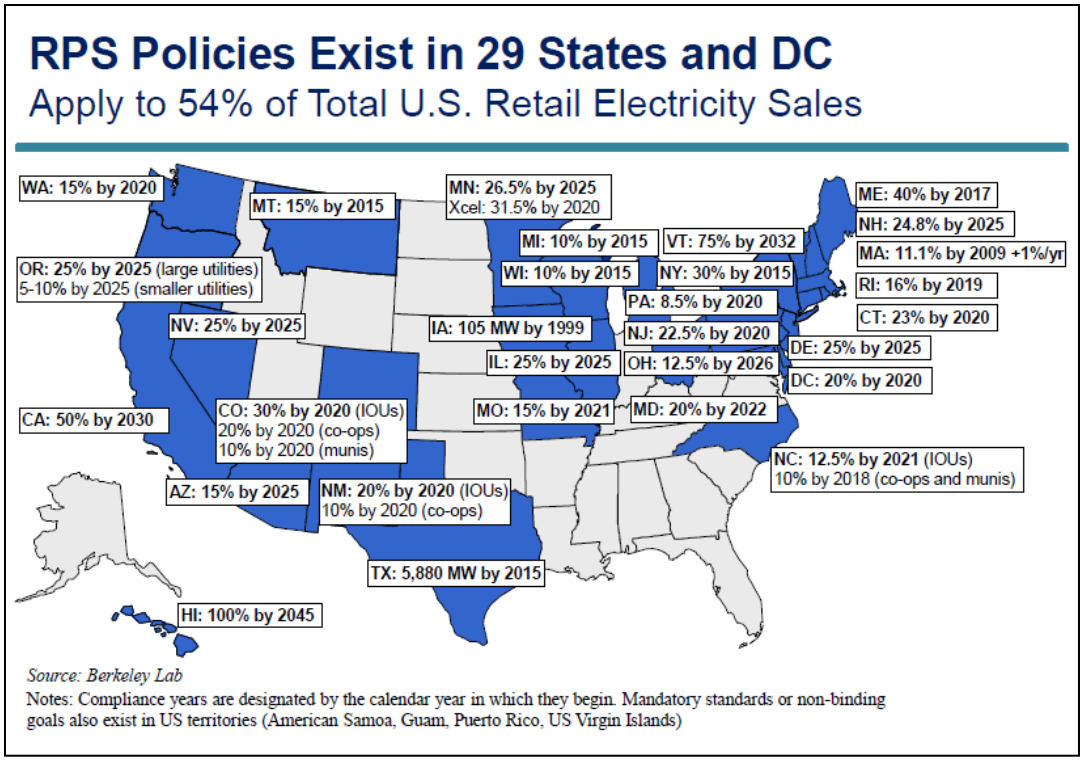
US Biodiesel Does Good Things:

- Provides high quality fuel from domestic, sustainable resources
- Reduces imports and power of oil cartels
- Supports 62,000 U.S. Jobs
- Generates $2.6 Billion in Wages
- Generates $17 Billion total Economic Activity
- Reduces Particulates, Carbon Monoxide, and Unburned Hydrocarbons from Older Engines
- Reduces Green House Gas Emissions
- Best Carbon Footprint of any U.S. Produced Fuel

Biodiesel as a Heating Oil

Why Biodiesel? – Our pathway to a renewable future

- Biodiesel blend level in Bioheat equivalent to Natural Gas for CO_2 Equivalent Emissions:
  - 100 year emissions atmospheric life:
    - B13.7, without indirect land use
    - B14.6, with indirect land use
  - 20 year emissions atmospheric life:
    - B1.7, without indirect land use



Electric utilities purchase Renewable Energy Credits (RECs) to meet increasing annual quotas

Eligible sources include solar PV, wind, hydro, solid biomass, and BIODIESEL-fired power systems

Potential market growth for biodiesel in power generation due to RECs and natural gas price spikes

Regional Greenhouse Gas Initiative

an Initiative of the Northeast and Mid-Atlantic States of the U.S.

WHAT IS RGGI?

The Regional Greenhouse Gas Initiative (RGGI) is the nation's first mandatory, market-based program to reduce emissions of carbon dioxide (CO_2).

The states participating in RGGI have established a regional cap on CO_2 emissions from the power sector and are requiring power plants to possess a tradable CO_2 allowance for each ton of CO_2 they emit.

Building Confidence, Minimizing Risk

- B5 passed into ASTM D396 in 2008
  - About the same level of experience as we have now with B20
  - **ASTM did its job**—B5 and lower blends made with D6751 biodiesel and meeting the D396 values have been used over the last 7 years with positive results
    - Some say they experience fewer issues
    - Issues occurring have been those normal of conventional heating oil, or attributed to using raw oils or fats that do not meet the spec
- The key: Buy Only Good ASTM D6751 B100

Building Confidence, Minimizing Risk

- Having an ASTM specification gave confidence to dealers, technicians, and users B5 would work

- This allowed the Bioheat industry to build to what it is today
  - And provided a platform for trying higher blends

Building Confidence, Minimizing Risk

- Developing higher blend level specs at ASTM
- Lab Testing:
  - Compatibility for gaskets, seals, tubing, nozzles
  - Pump durability
  - Combustion, etc.
- Marry up the ‘Lab Scale” research with experience in the field
  - Technical experts want data from the field to verify the results of successful lab testing

bioheat® technical steering committee

NATIONAL BIODIESEL BOARD
NATIONAL OILHEAT RESEARCH ALLIANCE

Accomplishments

D396 – 15a

TABLE 1 Detailed Requirements for Fuel Oils[A,B]

Property	ASTM Test Method[C]	No. 1 S500[C]	No. 1 S5000[C]	No. 2 S500[C]	No. 2 S5000[C]	B6–B20 S500[C]	B6–B20 S5000[C]	No. 4 (Light)[C]	No. 4	No. 5 (Light)	No. 5 (Heavy)	No. 6
Flash Point, °C, min	D93 – Proc. A	38	38	38	38	38	38	38	...	...	...	...
	D93 – Proc. B	...	...	...	...			...	55	55	55	60
Water and sediment, percent by volume, max	D2709	0.05	0.05	0.05	0.05	0.05	0.05	...	...	...	...	...
	D95 + D473	...	...	...	...			(0.50)[D]	(0.50)[D]	(1.00)[D]	(1.00)[D]	(2.00)[D]
Distillation Temperature, °C	D86											
10 % volume recovered, max		215	215	...	...	...	...					
90 % volume recovered, min		...	...	282	282	282	282					
90 % volume recovered, max		288	288	338	338	343	343					
Kinematic viscosity at 40 °C, mm^2/s	D445											
min		1.3	1.3	1.9	1.9	1.3	1.3	1.9	>5.5	...	...	...
max		2.4	2.4	4.1	4.1	4.1	4.1	5.5	24.0[E]			
Kinematic viscosity at 100 °C, mm^2/s	D445											
min		...	...	...	...			...	...	5.0	9.0	15.0
max		...	...	...	...			...	...	8.9[E]	14.9[E]	50.0[E]
Ramsbottom carbon residue on 10 % distillation residue percent by mass, max	D524	0.15	0.15	0.35	0.35	0.35	0.35	...	...	...	...	...
Ash, percent by mass, max	D482	...	...	...	...			0.05	0.10	0.15	0.15	...
Sulfur, percent by mass max[F]	D2622	0.05	0.5	0.05	0.5	0.05	0.5					
Copper strip corrosion rating, max, 3 h at a minimum control temperature of 50 °C	D130	No. 3	No. 3	No. 3	No. 3	No. 3	No. 3	...	...	...	...	...
Density at 15 °C, kg/m^3	D1298											
min		...	...	...	...			>876[G]	...	...	...	...
max		850	850	876	876	876	876	...	...	...	...	...
Pour Point °C, max[H]	D97	–18	–18	–6	–6	–6	–6	–6	–6	...	...	[I]
Oxidation Stability, hours, min	EN 15751	...	...	...	...	6	6					
Acid Number, mg KOH/g, max	D664	...	...	...	...	0.3	0.3					
Biodiesel Content, percent (V/V)[J]	D7371	...	...	...	...	6. – 20.	6. – 20.	...				

4.3.3 Fuel oil containing up to 5 % by volume biodiesel shall meet the requirements for the appropriate grade No. 1 or No. 2 fuel as listed in Table 1.

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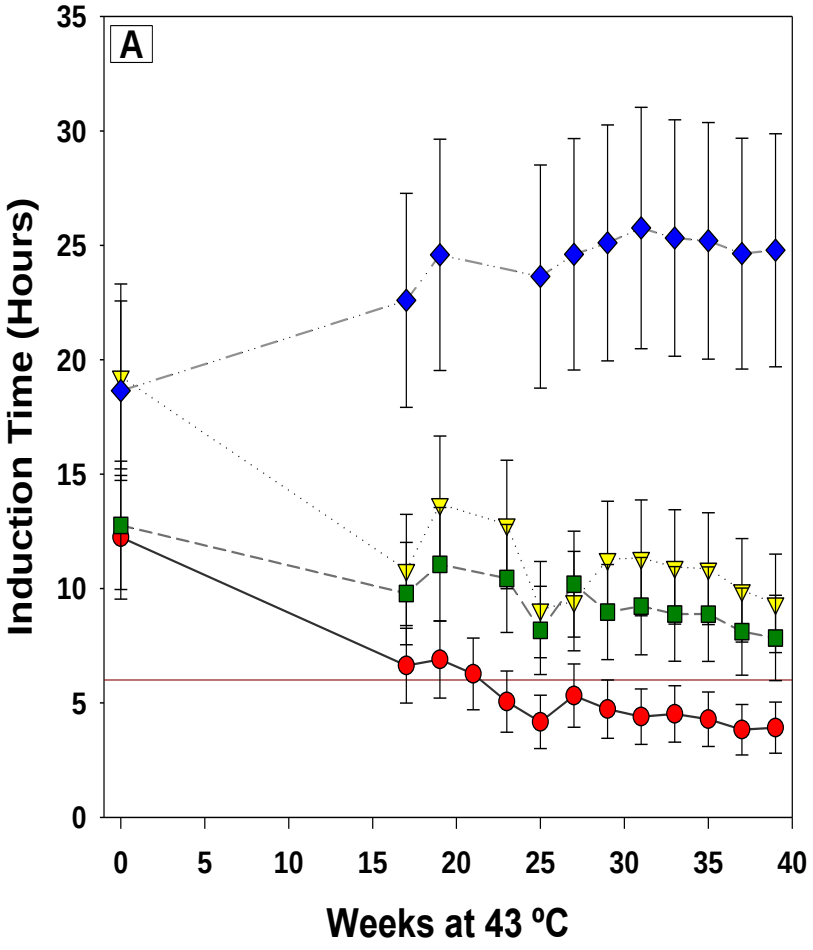
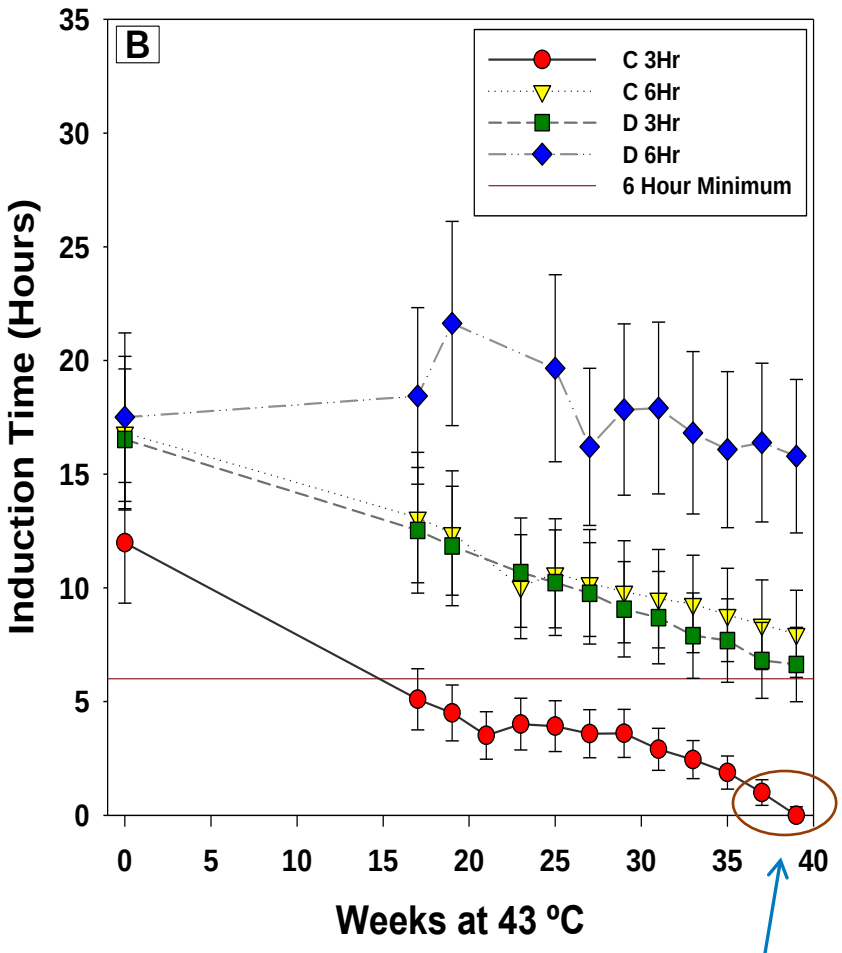
NORA-Oilheat.org

ASTM D4625: B20 Long-Term Storage Stability

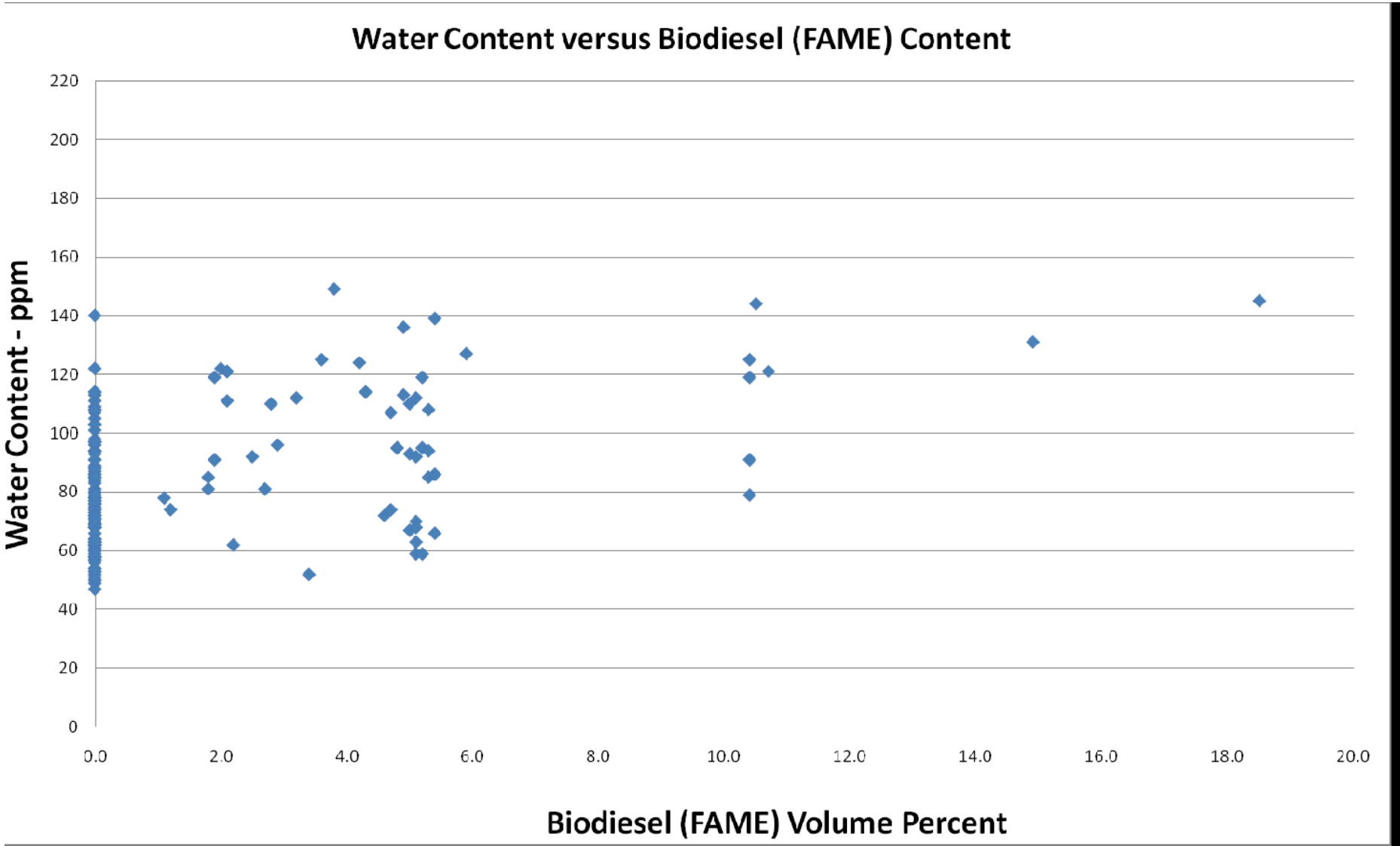




High peroxides and acids, no insolubles

Christensen, E., McCormick, R. L. "Long-Term Storage Stability of Biodiesel and Biodiesel Blends" Fuel Processing Technology 128 (2014) 339-348

Engine Mfg Survey USA 2012



What next for B21-B100?

- Use the successful model used for B6-B20
  - Identify potential issues
  - Conduct technical efforts to address the issues
    - Bioheat Technical Steering Committee
  - Let the technical information drive the specification considerations and values
- Start this work now.
  - The market is already using higher blends…
- The effort at ASTM has already begun
  - Use D396 for all finished blends up to B100
    - One stop shopping for users, similar to jet fuel
  - Adopt ULSD (S15 grade) before doing any more with higher biodiesel blends

B21-B100 Next Steps

- Utilize the Bioheat Technical Steering Committee to guide technical needs
- Utilize ‘industry specs’ while developing the needed data to secure a successful ballot
- Use the ASTM Biodiesel Task Force as group to provide input and vet proposals/ideas

- A work in progress!

Thank You!
Questions…?

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