

Emerging Issues About Biofuels Under EPA's Emergency Response Program

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Presentation Overview

- Legislative Initiatives
 - Relevant Biofuel Laws and Mandates
- Biofuel Generation, Storage, and Distribution
 - Biofuel Supply Chain
 - Conversions Technologies
 - Biofuel Integration into *Existing/New* Storage and Distribution Infrastructure
 - Pipelines, Storage tanks, Transloading, Terminals
- Emergency Response and Regulatory Management
 - Biofuels and Regulatory Programs

Legislative Initiatives

- **Energy Security Act (1980)**

- Established the Office of Alcohol Fuels in DOE
- Established the Synthetic Fuels Corporation
 - Eliminated by the Consolidated Omnibus Budget Reconciliation Act (1985)

- **Energy Policy Act of 1992**

- Light duty alternative fuel vehicles in certain Federal Fleets
- Federal support for renewable energy technologies

Legislative Initiative (continued)

- **Energy Policy Act of 2005** (P.L. 109-58)
 - Biofuel mandates increase from 4 bgy (2006) to 7.5 bgy (2012)
 - Requires EPA to promulgate regulations implementing a renewable fuel program. (§ 1501)
 - Specifies the total volume of renewable fuel used in gasoline sold
 - Specifies the total volume increases over time
 - **Renewable Fuel Standard (RFS 1)**
 - Provides **enhanced tax incentives** for biofuel usage.
 - Energy Policy Tax Incentives (Title XIII)
 - **Renewable diesel** from “thermal depolymerization process”

Legislative Initiatives (continued)

- **Energy Independence & Security Act (EISA) (2007)**
 - Requires EPA to develop a new RFS. (§ 202)
 - **Expand biofuels to 36 billion gallons by 2022**
 - **Lifecycle GHG assessments** of different fuel types and blends compared to petroleum fuel
 - Ethanol pipeline feasibility study (§ 243)
 - Biofuels distribution and advanced biofuels infrastructure (§ 248)
 - **R&D on existing transportation fuel distribution infrastructure and new alternative distribution infrastructure.**

Legislative Initiatives (continued)

➤ **Energy Independence & Security Act (EISA) (2007)**

➤ Focus on the physical/chemical properties of biofuels and efforts to prevent or mitigate against adverse impacts of those properties in the areas:

- ***corrosion*** of metal, plastic, rubber, cork, fiberglass, glues, or any other material used in ***pipes and storage tanks***;
- ***dissolving of storage tank sediments***;
- clogging of filters;
- ***contamination from water*** or other adulterants or pollutants;
- poor flow properties related to low temperatures;
- ***oxidative and thermal instability*** in long-term storage and uses;
- ***microbial contamination***;
- problems associated with electrical conductivity

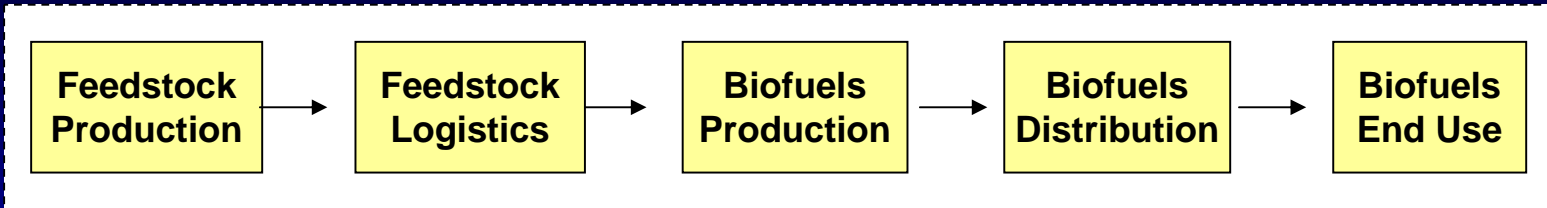
Legislative Initiatives (continued)

- **Energy Improvement and Extension Act (EIEA) (2008)**
 - Division A - Emergency Economic Stabilization Act (2008)
 - Division B – EIEA (*P.L. 110-343*)
 - **Extends certain tax credits** to December 31, 2010
 - **Broadens definitions for new conversion processes to qualify eligibility for tax credits**
 - Expanded renewable diesel tax credits by removing the term “thermal depolymerization process”
 - Replaced term “diesel fuel” with “liquid fuel”
 - Aviation fuels from renewable materials
 - Places limits on **“Splash and Dash” (§ 203)**
 - **“Splash and Dash”** - 100% biodiesel shipped to U.S., 0.1% petroleum diesel added (splash), and shipped to another country (dash), thus qualifying for a tax credit.

Biofuels Regulatory Mandates

- Renewable Fuel Standard (RFS) 1 & 2
 - 40 CFR part 80 – Regulation of Fuels and Fuel Additives
 - RFS - 1 (EPA Act 2005)
 - Federal Register on May 1, 2007 (72 FR 23900)
 - Assessed first order impacts including emissions, air quality, and GHG impacts of RFS standards
 - RFS - 2 (EISA) – Under Development
 - Expand use of renewable fuels to 36 billion gallons per year (bgy) by 2022
 - Ethanol production from corn starch is capped at 15 bgy
 - Cellulosic Biofuel (renewable fuel from any cellulose, hemicellulose, lignin)
 - 0.5 billion gallons by 2012
 - 3 billion gallons by 2015
 - 16 billion gallons by 2022
 - Advanced Biofuels (biomass-based diesel, other biofuels)

Biofuels Supply Chain



Ag Crops
 Ag Residues
 Energy Crops
 Forest Residues
 Wastes
 Algae



Harvesting & Collecting
 Storage
 Pre-Processing
 Transportation



Fuel types
Biochemical Conversion
Thermochemical Conversion
Biological Conversion
Chemical Conversion



Distribution by barge, truck, rail, pipeline
Storage in tanks
Dispensing

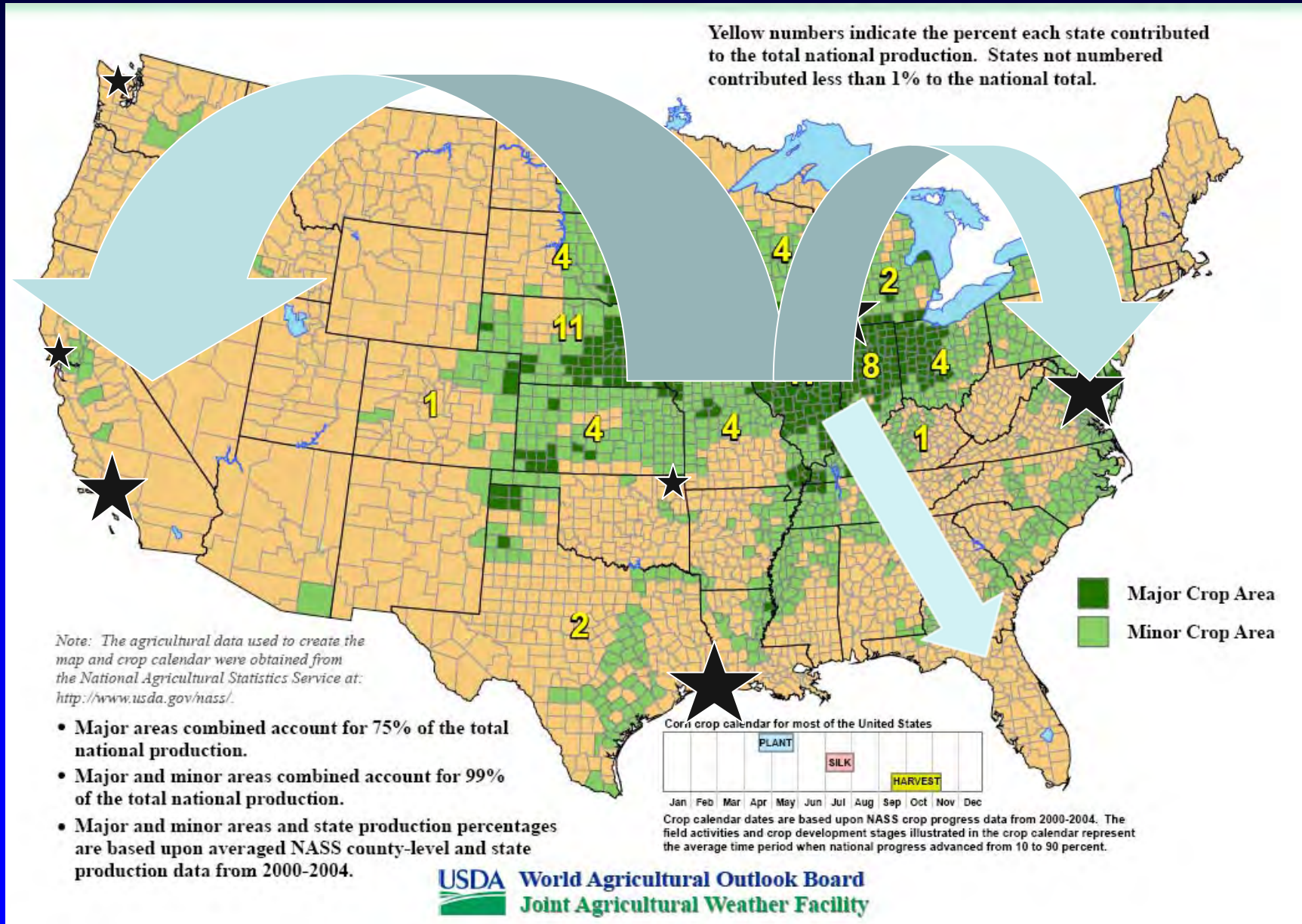


Transportation fuels in light & heavy duty vehicles & trucks, Off-Road vehicles, Locomotives, Flight technologies, Boats/Ships
 Power & Generators
 Feedstocks for Manufacturing

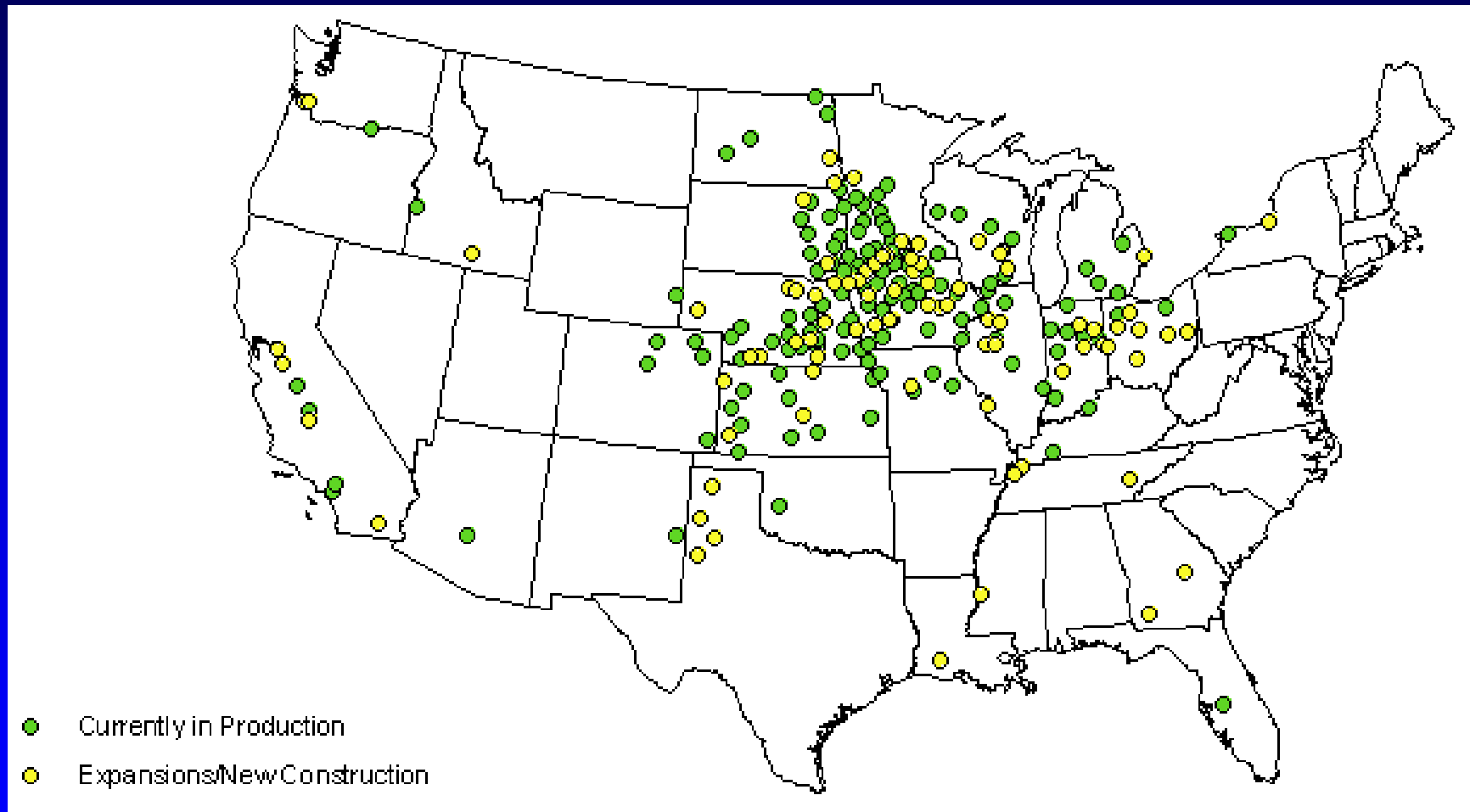
Feedstocks, Conversion Processes, and Fuel Types

Feedstock	Conversion Technology	Products and Uses
<p>Agricultural Crops</p> <p>Agricultural Residues</p> <p>Animal Residues</p> <p>Food Processing Waste</p> <p>Woody Biomass</p> <p>MSW and Construction and Demolition (C&D) Wastes</p>	<p>Thermo-chemical:</p> <ul style="list-style-type: none"> - Pyrolysis - <i>Hydrothermal Depolymerization</i> - Gasification - Combustion - Fuel Synthesis <p>Biochemical:</p> <ul style="list-style-type: none"> - Fermentation - Acid Hydrolysis - Pretreatment & Enzymatic Hydrolysis - Anaerobic Digestion <p>Chemical:</p> <ul style="list-style-type: none"> - Transesterification 	<p>Fuel Types:</p> <ul style="list-style-type: none"> - Ethanol - Biodiesel - Renewable Diesel - <i>Green Diesel</i> - <i>FT Diesel & Gasoline</i> - Higher Alcohols - Dimethyl Ether - Synthesis Gas, Biogases, & H₂ - Hydrogen <p>Other Products:</p> <ul style="list-style-type: none"> - CHP (steam & electricity) - Chemical Feedstock

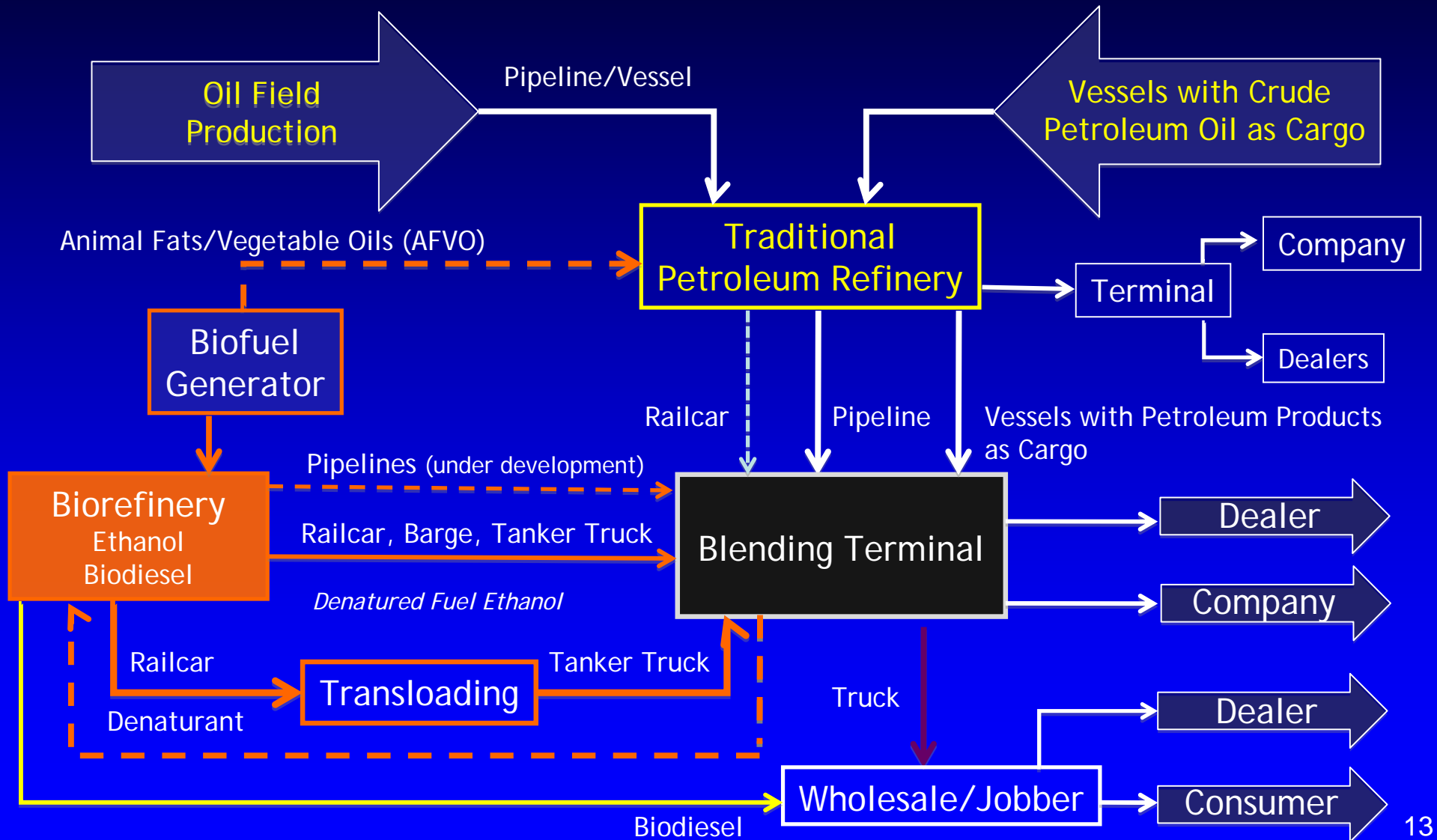
Ethanol Production (supply) – Coastal Consumers (demand)



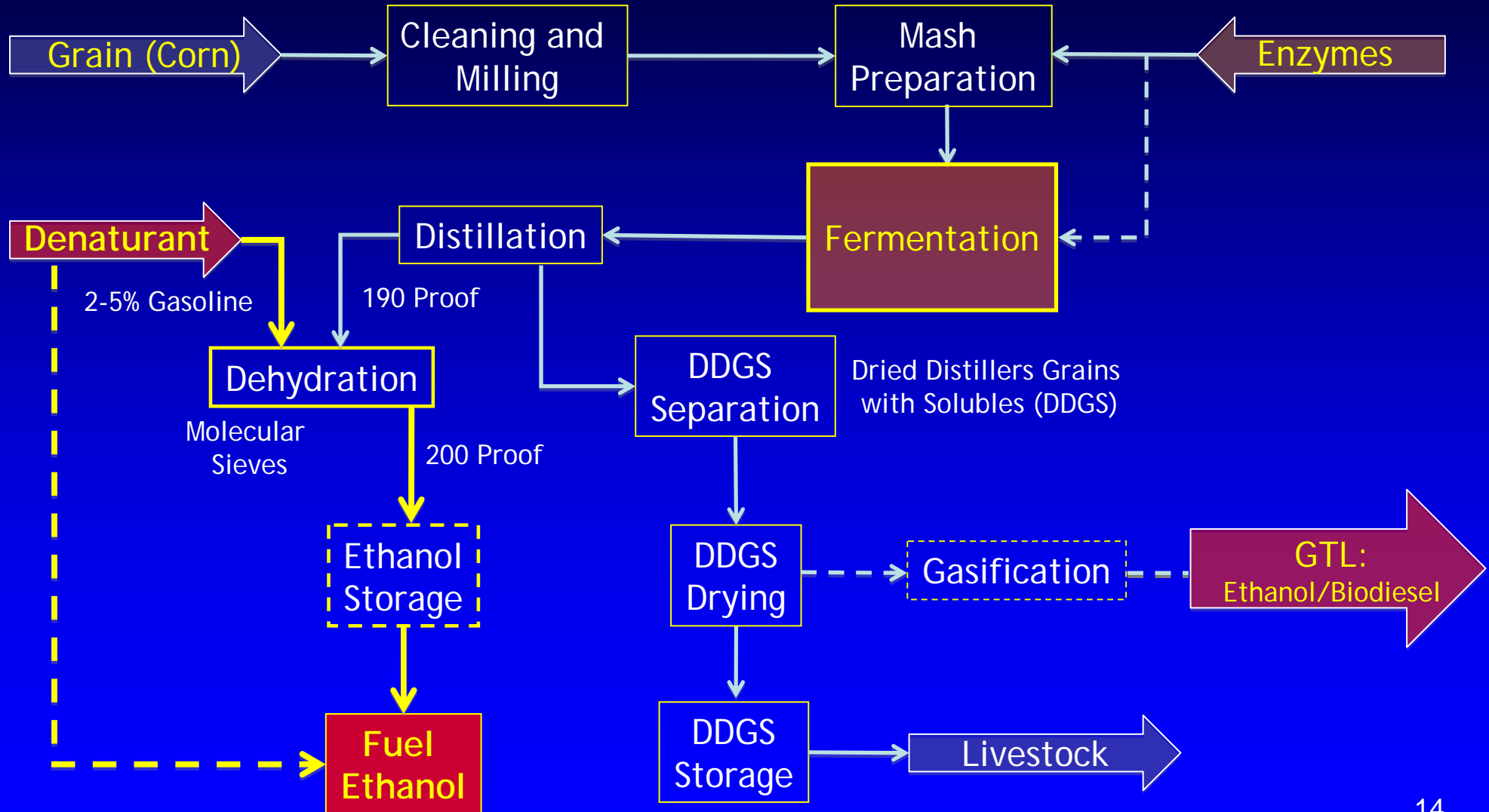
Recent Ethanol Plant Locations



Biofuels Integration Roadmap



Typical Ethanol Dry Mill Process



Denaturant (Ethanol) – Why & How Much

- Alcohol and Tobacco Tax and Trade Bureau (TTB)
 - Render alcohol unfit for human consumption
 - Alcohol for fuel use is regulated under two categories in ATF regulations
 - Fuel alcohol produced at an alcohol fuel plant (AFP)
 - Completely denatured alcohol (CDA) formula no. 20 at a distilled spirits plant (DSP)
 - At least 2 gallons of denaturant to every 100 gallons of fuel ethanol
 - Natural Gasoline
 - Conventional Unleaded Gasoline
 - Straight Run Gasoline
 - Naphtha
 - Kerosene

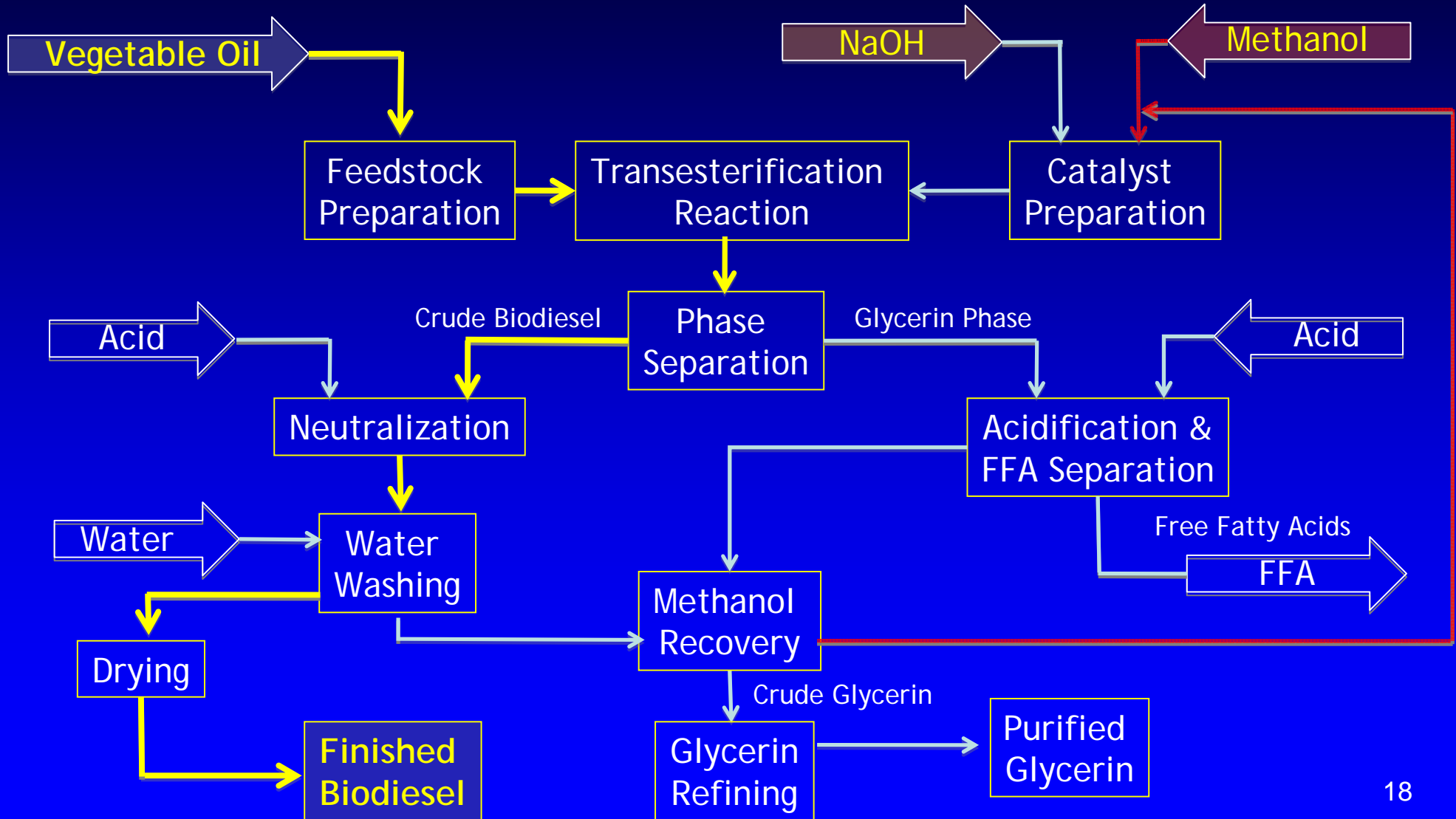
Denaturant (Ethanol) – Why & How Much

- Ethanol producers traditionally add ~ 4.76 % (volume)
- ASTM Standards for fuel ethanol blends
 - ASTM D4806 - 08a **Standard Specification for Denatured Fuel Ethanol for Blending** with Gasoline for Use as Automotive Spark-Ignition Engine Fuel
- Food, Conservation, and Energy Act of 2008
 - Calculation of volume of alcohol for fuel (§ 15332)
 - Encourages **2% denaturant** use to receive applicable tax credit
 - Internal Revenue Bulletin (IRB) 2009-3 (Notice 2009-6) (page 311)

Ethanol Plant Process Chemicals

- **Ethanol production process (pH adjustment, nutrients)**
 - Sulfuric Acid - Corrosive
 - Sodium Hydroxide (Caustic Soda) – Corrosive
 - Ammonia Source - Anhydrous, Hydrous - Corrosive
- **Cleaning chemicals keep fermentation clean**
 - Chlorine-based Solution - Corrosive
 - Caustic Soda - Corrosive
- **General water treatment chemicals**
 - Chlorine- or Bromine-based Solution - Corrosive
 - Ammonia-related Solution - Some Hazards
 - Surfactants - Some hazards, typically mild

Typical Biodiesel (e.g., FAME) Generation

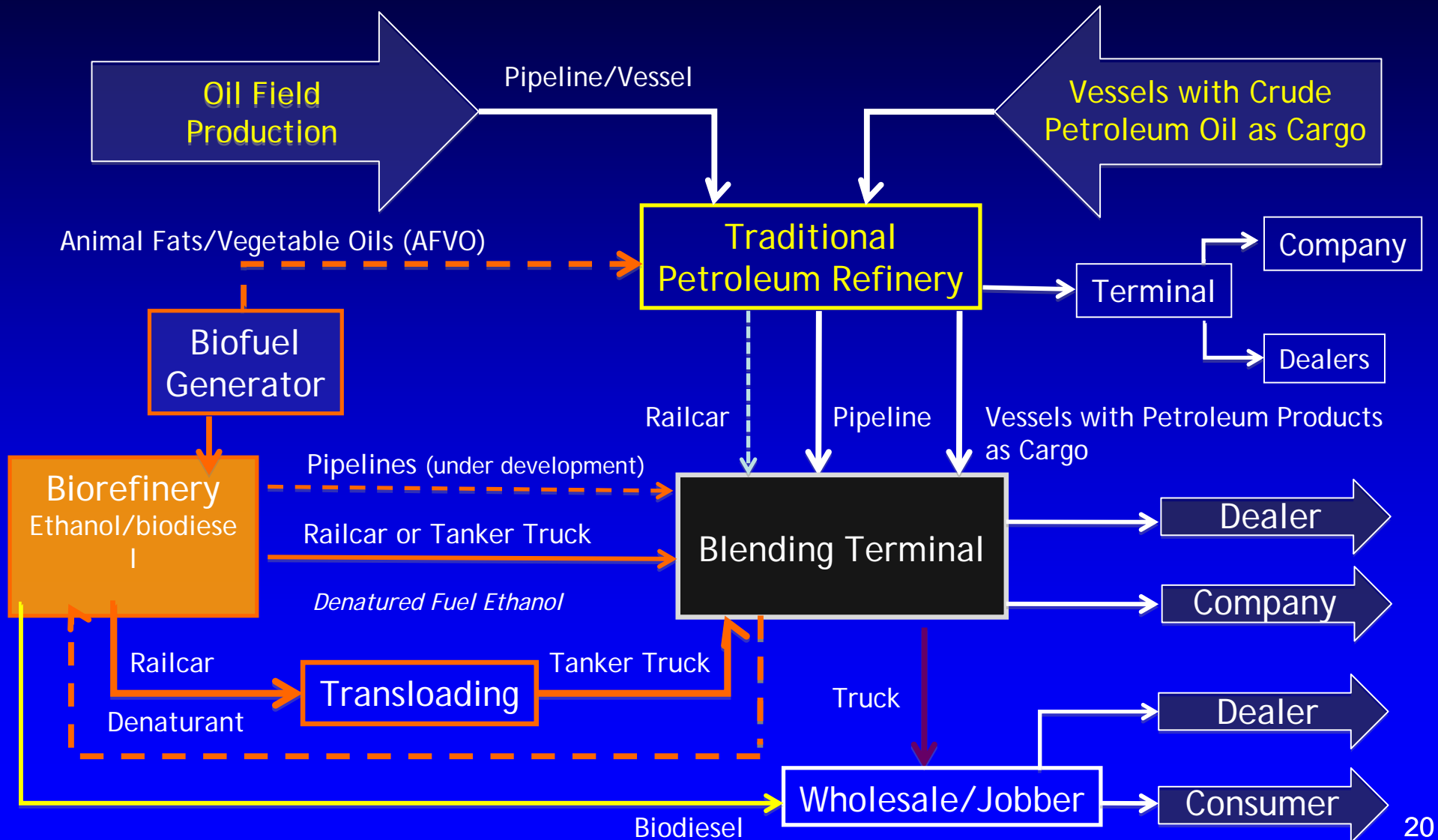


Biodiesel Plant Process Chemicals

- **Biodiesel production process**
 - **Methanol**
 - Volatile; Flammable (Class 3)
 - **Sodium Hydroxide (Caustic Soda)**
 - Corrosive; Catalyst
 - **Potassium Hydroxide**
 - Corrosive; Catalyst
 - **Sodium Methylate**
 - Catalyst
 - **Hexane**
 - Volatile; Flammable (Class 3)
 - **Glycerol (glycerine)**



Biofuels Integration into Infrastructure



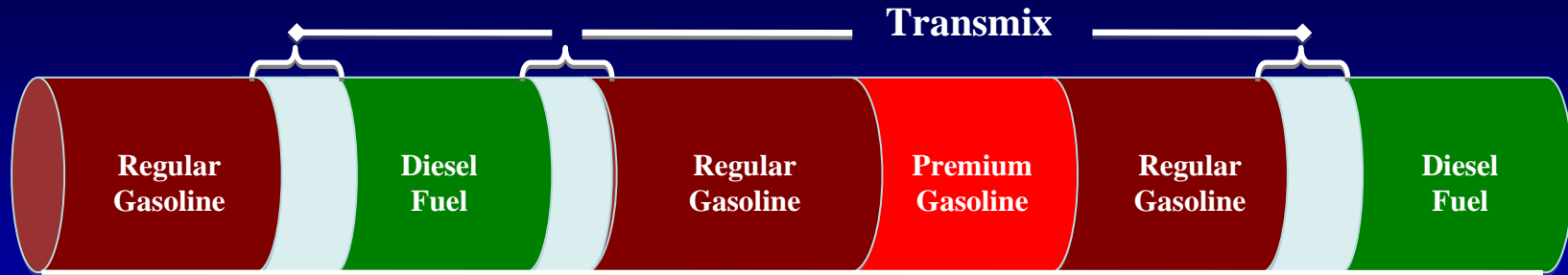
Biofuels Infrastructure

- Infrastructure includes:
 - Pipelines, rail lines/railcars, barges/waterways, tank trucks
 - Terminals, Storage tanks, Blending facilities, Transfer hubs
- Ethanol and biodiesel currently do not use many of the traditional petroleum products infrastructure (i.e., pipelines)
- Ethanol and biodiesel infrastructure needs may be different
- In 2005, rail: 60% of ethanol (approximately 2.9 billion gallons of ethanol), Tank trucks: 30%, and barges: 10%

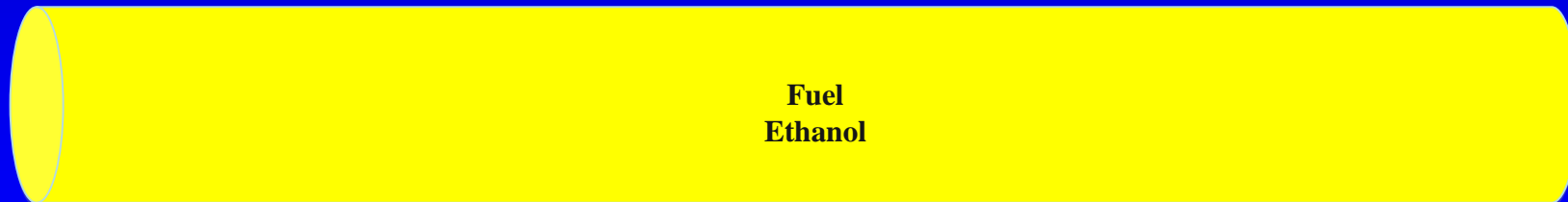
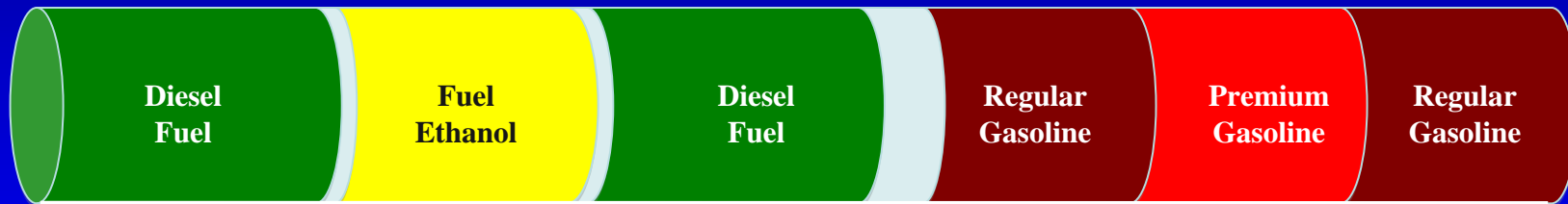


Transport of Biofuels Through Pipelines

Current Multi-Products Pipeline



Potential Future Options for Biofuel Pipelines – Multi-products & Dedicated



Storage Tank & Pipeline Issues – Denatured Fuel Ethanol

- Survey suggests:
 - Number of leaks have occurred in equipment handling fuel ethanol due to cracking of the carbon steel
 - Number of cases of cracking and leaks have been reported in various types of equipment
 - Includes storage tanks, piping and associated handling equipment in the distribution systems for fuel ethanol,
 - A concern for ethanol pipelines (similar grades of steel)
- Technical factors affecting storage and transportation of denatured fuel ethanol
 - **Moisture**
 - **Material compatibility**
- Ethanol can dissolve and carry impurities that are present inside storage tanks and multi-product pipeline systems

Storage Tank & Pipeline Issues - Ethanol

- Stress Corrosion Cracking (SCC) - SCC is the formation of brittle cracks in a material that occurs as a result of corrosion processes and stress
- Factors that may lead to ethanol SCC
 - Fuel ethanol meeting the ASTM D4806 guidelines
 - **Chloride** and methanol content
 - Appear to increase susceptibility, but are not essential for SCC to occur
 - **Dissolved oxygen** content
 - Galvanic contact with corroded steel
 - Plate steels (e.g., ASTM A36)

Storage Tank & Pipeline Issues - Ethanol

- Cracks are typically branched and intergranular (low chloride ethanol), occasionally transgranular (high chloride or methanol-containing ethanol)
- SCC has occurred in less than one year
- Historical data suggests SCC appears at distribution terminals
- Tank liners, selective post-weld heat treatment, and the coating of internal critical zones may help
- API Technical Report 939-D - **Stress Corrosion Cracking of Carbon Steel in Fuel Grade Ethanol: Review, Experience Survey, Field Monitoring, and Laboratory Testing, Second Edition**
- API Technical Report 939-E - **Identification, Repair, and Mitigation of Cracking of Steel Equipment in Fuel Ethanol Service, First Edition**

Biodiesel Storage and Distribution Issues

- Storage and Distribution Modes
 - Tanker Truck / Rail car / Pipeline / Barge
 - Some terminals do not have rail spurs
 - Some terminals do not have water access
 - Currently biodiesel blends are not in the pipeline system
 - Biodiesel systems are typically heated
 - Feedstock tanks and lines
 - Truck and rail off-loading system and lines
 - Loading rack lines, valves, and meters
 - Blend system for 2 - 4 % biodiesel blend may be different than system needed for >5% system

Transloading Biofuels

- Federal and local jurisdictional issues
- Typical individual railcar capacity
 - ~30,000 U.S. gallons
- Shipped in unit trains
 - Can be as high as 100 railcars
- Transferred from rail cars to tank trucks for delivery to blending terminals
- Transfer process equipment not necessary “fixed” in a single location



Relevant Emergency Response Issues

- Fires and spills involving ethanol and ethanol/gasoline blends pose some complex challenges for emergency responders
- Ethanol is a polar/water-miscible flammable liquid (one that mixes readily with water)
 - Degrades the effectiveness of fire fighting foams that are not alcohol resistant
- DOT Guide 127 - Flammable Liquids Polar/Water-miscible, 2004 Emergency Response Guidebook (ERG2004)



Relevant Emergency Response Issues

- **Alcohol-Resistant – Aqueous Film Forming Foam (AR-AFFF)**
 - Effective with ethanol blends from E10 through E95
 - E10 can be extinguished with AFFF and AR-AFFF but require higher application rates to prevent burn back
 - Passes a sprinkler application, which is typical of the fire suppression systems at many storage terminal loading racks
 - Creates a physical, polymer-membrane barrier between the foam blanket and fuel surface
 - Alcohol Resistant – Film Forming Fluoroproteins (AR-FFFP)
 - Burn back test

Ethanol/Gasoline blends and Placards

- DOT Federal Register notice (73 FR 4699)
 - Published on January 28, 2008

Ethanol/Gasoline Blend	Example of Shipping Name
Gasoline, with not more than 10% ethanol	Gasohol, UN1203 or Gasoline, UN1203
Gasoline/ethanol blends with more than 10% ethanol	Ethanol and Gasoline Mixture, UN3475
E85 (85% ethanol, 15% gasoline)	Ethanol and gasoline mixture, UN3475
Alcohol mixtures containing up to 5% gasoline E95 (95% ethanol, 5% gasoline)	Denatured alcohol, NA1987 Alcohols, n.o.s., UN1987

E100

Ethanol or Ethyl Alcohol, UN1170

Regulatory Implications

- Spill Prevention, Control, and Countermeasures
- Facility Response Plans
- Risk Management Plans
- Emergency Planning and Community Right to Know



Biodiesel Feedstock Spill

- Properties similar to petroleum
 - Light non-aqueous phase liquid (LNAPL).
- Harmful effects: coating of feathers, fur, and gills
 - Absence of odor and sheen results in reduced avoidance.
 - Reduces thermal insulation and buoyancy.
- May burn if ignited
- May clog water treatment plants (due to the polymerization property).

Effects of Biodiesel Feedstock Spills

- High BOD may cause oxygen depletion
 - Greater effect on DO than petroleum oils
- Unsaturated oils (liquids at cold temperatures) are subject to (abiotic) oxidation
 - Polymerization due to chemical oxidation and cross-linking
 - Rancid odors may develop rapidly
 - Unsaturated oils form gum balls and varnishes in presence of oxygen, which resist biodegradation
- Some saturated or unsaturated oils turn solid or semi-solid at cool temperatures, highly resistant to biodegradation
- May be toxic or form toxic products
 - Especially free fatty acids and chemical oxidation products.

SPCC Applicability

- 1975 Federal Register Notice
 - Addressed applicability of 40 CFR part 112 to non-petroleum oils
 - Re-affirmed that non-petroleum oils such as AFVOs are subject to oil spill reporting and other requirements under Section 311 of FWPCA
- 2002 Revised SPCC rule amendments
 - Includes new subparts outlining the requirements for various classes of oil (pursuant to EORRA)
- 2006 Revised SPCC rule amendments
- 2008 Revised SPCC rule amendments
 - Establishes an alternative integrity testing option for AFVOs that are regulated under FDA (21 CFR part 110) and meet certain criteria

Biofuels & Facility Response Plans

- EPA (OSWER) letter to the Renewable Fuels Association on FRP applicability (November 07, 2006).
 - Ethanol denatured with oil (e.g., gasoline) is subject FRP
- Many existing and new biodiesel or ethanol plants may be subject to FRP requirements due to their storage capacity and potential for significant harm.
- A number of existing ethanol plants have a FRP
 - Total oil storage capacity (e.g., largest tank) greater than 1 million gallons
- Biodiesel plants are likely to require an FRP given large oil storage capacity (AFVO feedstocks *and* finished products)

Biofuels & Hazardous Chemical Reporting

Section 311 & 312

- Gasoline – 75,000 gallons
 - At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)
- Gasohol (90% gasoline and 10% ethanol) – 75,000 gallons
 - At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)
- Diesel – 100,000 gallons
 - At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)
- All other Non-EHS hazardous chemicals – 10,000 lbs
 - Alternative Fuels (Ethanol and Methanol mixtures; E85, E95, M95), aviation fuel, heating fuel, kerosene

Summary

- Recent energy legislation mandates biofuel usage.
 - Requires EPA to develop a new Renewable Fuel Standard.
 - Expand biofuels to **36 billion gallons by 2022.**
 - Lifecycle GHG assesement
- New generation, storage, and distribution infrastructure challenges
 - Integrating biofuels into traditional fuel supply chain
 - Infrastructure needs
- Fires and spills involving ethanol and ethanol/gasoline blends pose some complex challenges for emergency responders
- Current biofuels: Ethanol and biodiesel; **Future biofuels: ?**

Additional Resources

- DOT PHMSA Guide 127 - Flammable Liquids Polar/Water-miscible.
 - 2004 Emergency Response Guidebook (ERG2004)
 - <http://hazmat.dot.gov/pubs/erg/g127.pdf>
- Ethanol Emergency Response Coalition (EERC)
 - <http://www.ethanolresponse.com>
- Guidebook for Handling, Storing, & Dispensing Fuel Ethanol (DOE)
 - <http://www.nrel.gov/docs/fy02osti/30849.pdf>
- EPA Region 5 - Ethanol & Biodiesel Response Manuals
 - OSC website
- EPA Region 7 - Ethanol & Biodiesel plant Manuals
 - http://epa.gov/region07/priorities/agriculture/biodiesel_manual.pdf
 - http://epa.gov/region07/priorities/agriculture/ethanol_plants_manual.pdf