



Fuels 101

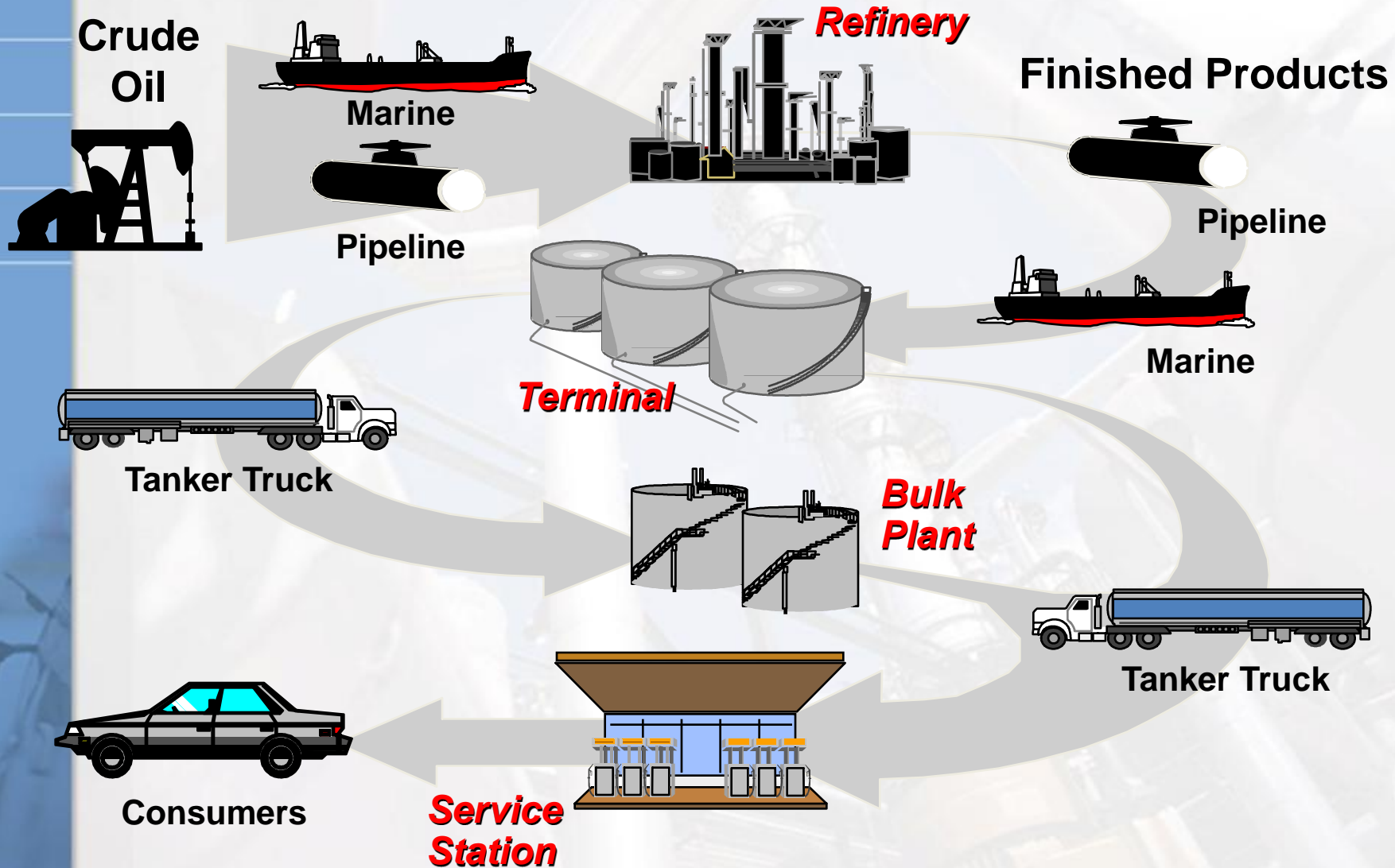
LADCO Regional Meeting on Fuels

October 27, 2010
Holiday Inn Select
Rosemont, IL

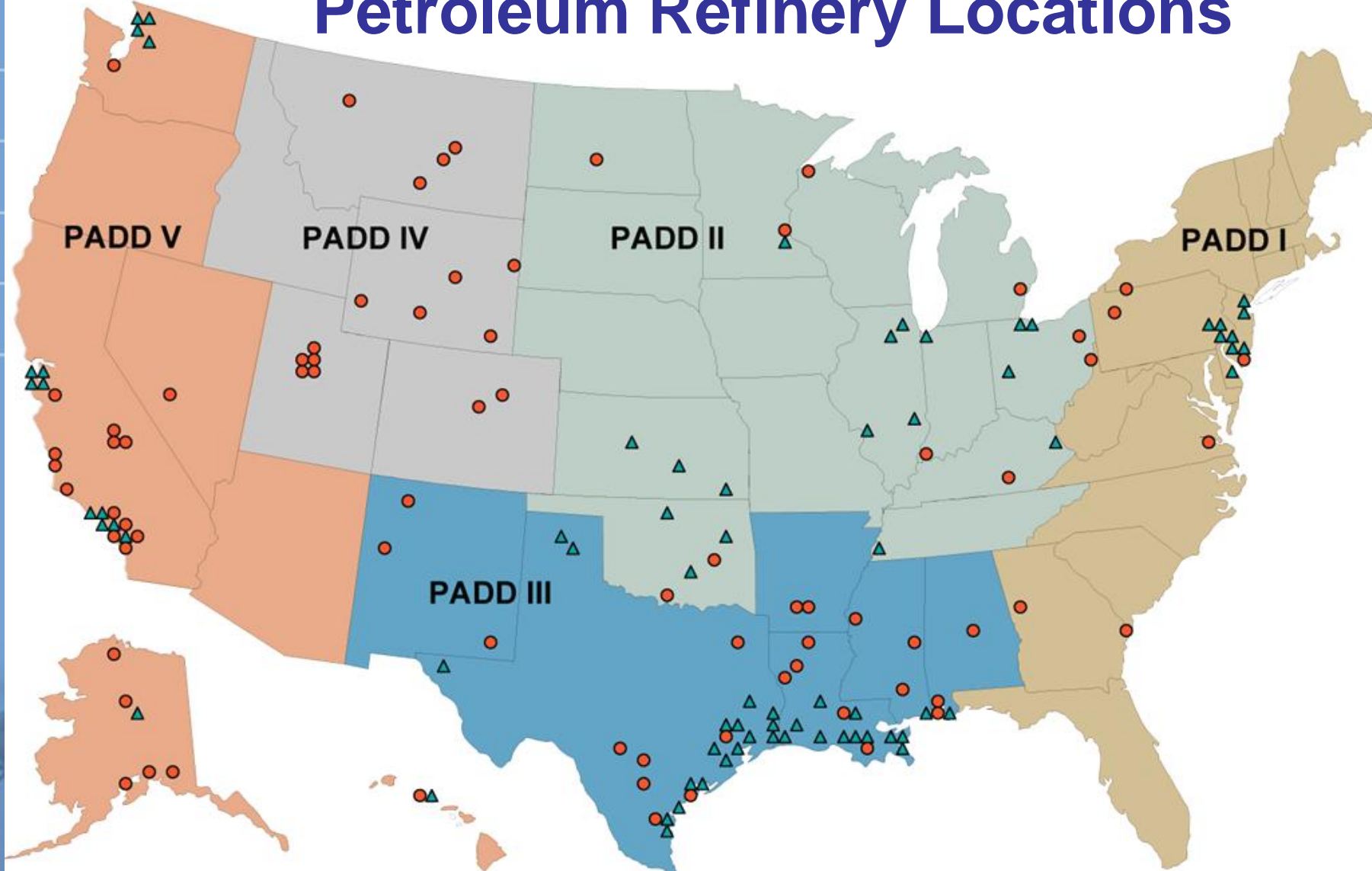
Downstream Segment

- **Transportation to Refinery**
 - Ship crude oil to refinery by pipeline or ship
- **Refining**
 - Convert crude oil to petroleum products & petrochemical feedstocks
- **Distribution**
 - Transport products via pipeline, ship, rail or truck to wholesale (terminals) & retail (gas stations)
- **Marketing**
 - Sell products at wholesale & retail outlets
- **Facilities**
 - 144 Refineries (295,000 b/d, 800 employees, 4000 acres)
 - 1,400 Terminals
 - 7,500 Bulk storage plants
 - 35,000 Gasoline tanker trucks
 - 169,000 Retail outlets

Fuels Distribution System



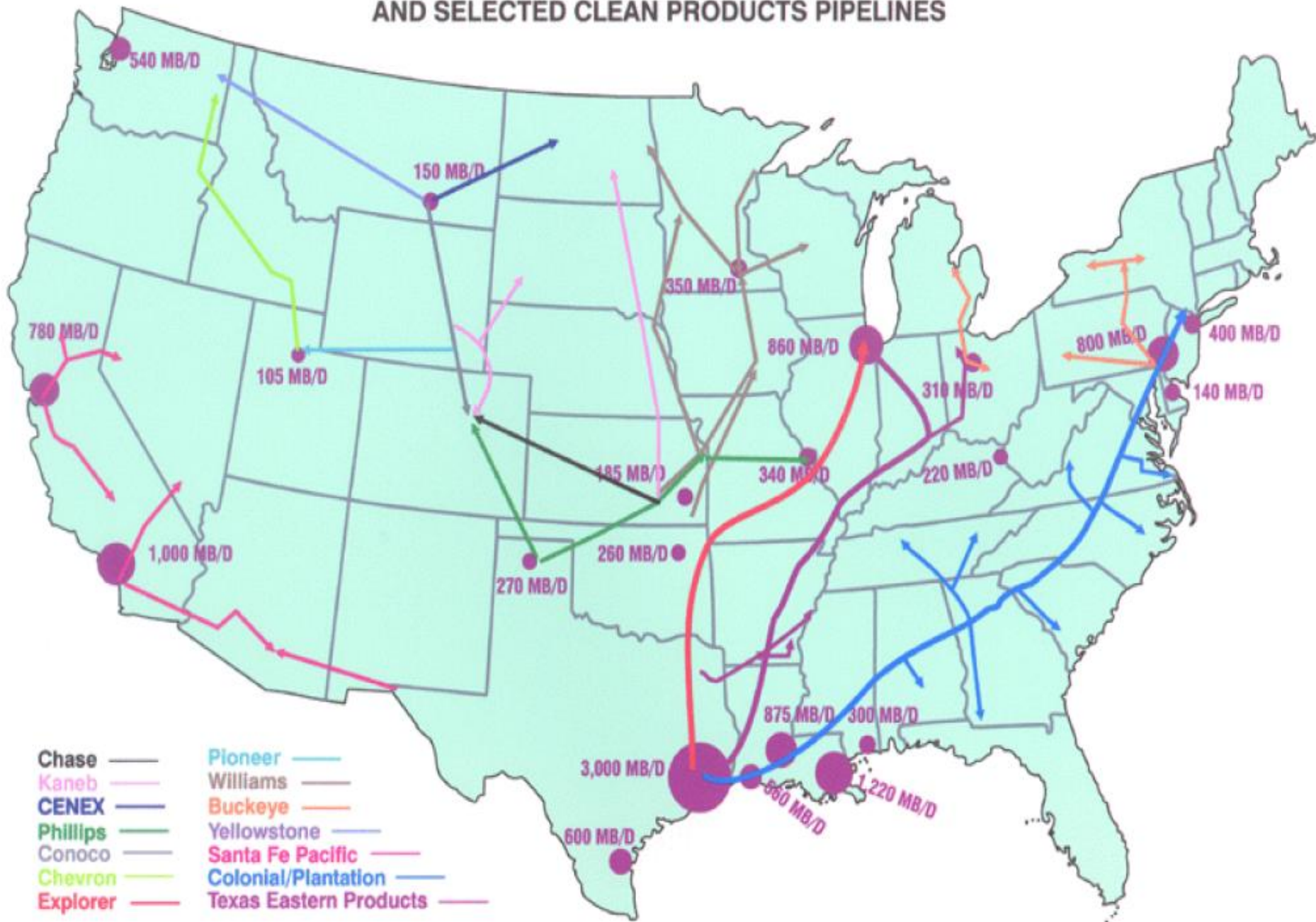
Petroleum Refinery Locations



EIA and NPRA

▲ Large: Over 75,000 B/D
● Small: Under 75,000 B/D

UNITED STATES REFINING CENTERS (1) AND SELECTED CLEAN PRODUCTS PIPELINES

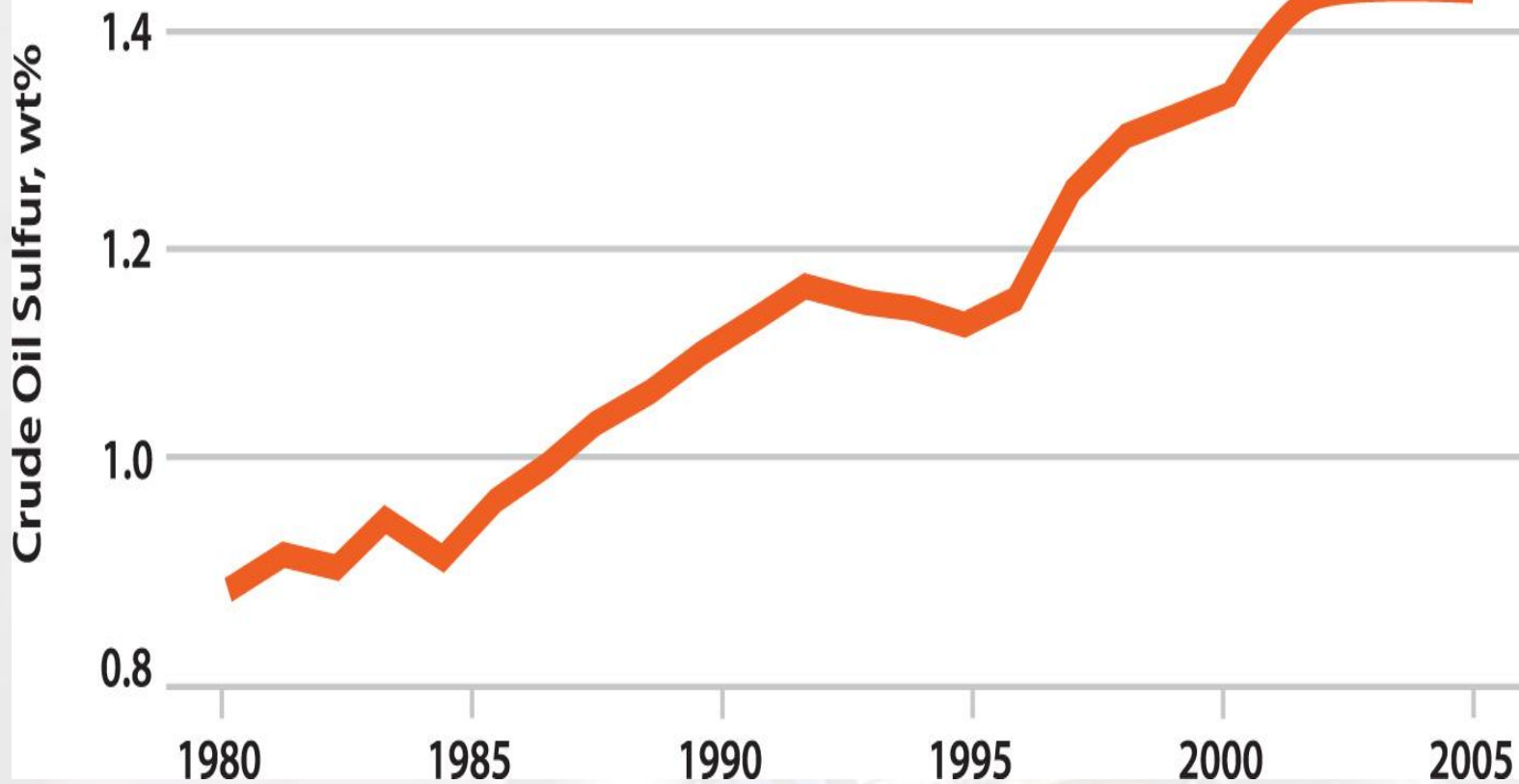


(1) Based on Crude Capacity from 12/21/98 *Oil & Gas Journal*.

Crude Oil

- **Feedstock for the refinery**
- **Not a chemical compound – thousands of different compounds**
- **Generally combinations of hydrogen and carbon atoms – hydrocarbons**
- **Most important characteristic is that each compound has its own boiling temperature**
- **Each crude oil has a unique “distillation curve” based on the chemical compounds in that crude**
- **Different Types of Crude Oils**
 - **Sweet vs. Sour Crude**
 - **Specific Gravity (API Gravity)**
- **Increasing interest in Canadian “heavy oil” processing**
 - **Increased coking, hydrogen production, hydrotreating & sulfur recovery capacity needed**

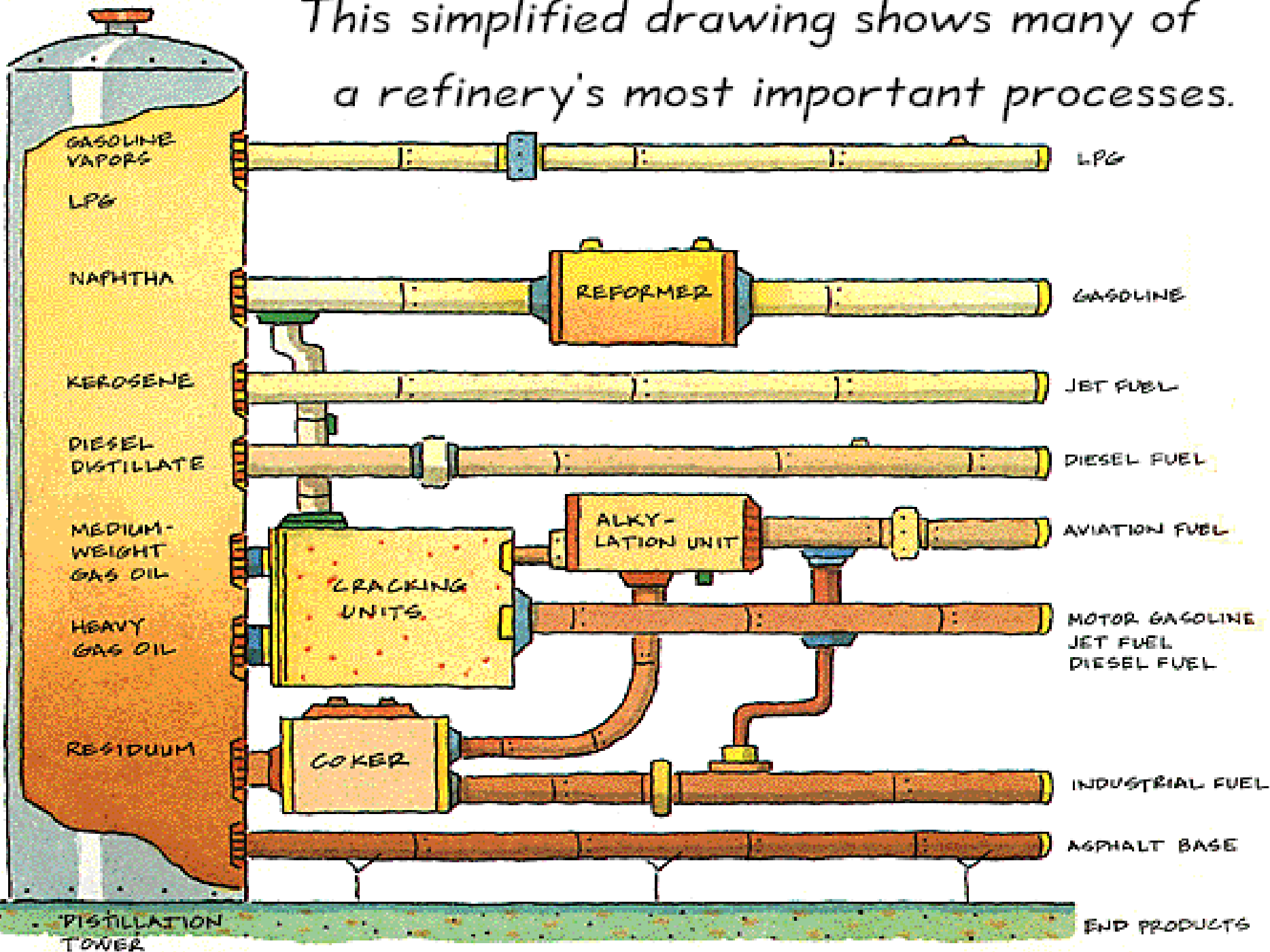
U.S. Refineries Are Processing Increasingly Higher Sulfur Crude Oils



Refining Processing

- **Desalt**
 - Remove salts and trace metals prior to processing
- **Distillation**
 - Heat & separate hydrocarbons by boiling range
- **Restructuring of Hydrocarbon Molecules**
 - Rearrange molecules to improve product quality
 - Combine molecules to produce more blending stocks
 - Convert (“crack”) large molecules into smaller ones
- **Treat**
 - Remove impurities - sulfur, nitrogen, heavy metals (e.g., hydrotreating)
- **Combine/Blend**
 - Mix to make desired products & to meet product specifications (e.g., blend components to make gasoline that meets octane, RVP and other specifications)

This simplified drawing shows many of a refinery's most important processes.



Petroleum Products from Crude Oil

- 42 gallons per barrel (44.7 gallons of products)
- Gasoline (motor fuel) ~ 45% - 50%
- Distillate (diesel fuel, home heating oil) ~ 25%
- Kerosene (jet fuel) ~ 10%
- Coke ~ 5%
- Residual Fuel Oil (industrial heating, ships) ~ 4%
- Petroleum Gases (LPG, methane, butane) ~ 3%
- Asphalt & Road Oils ~ 3%
- Petrochemical plant feedstocks ~ 2% - 3%
- Lubricating Oils & Greases ~ 1%

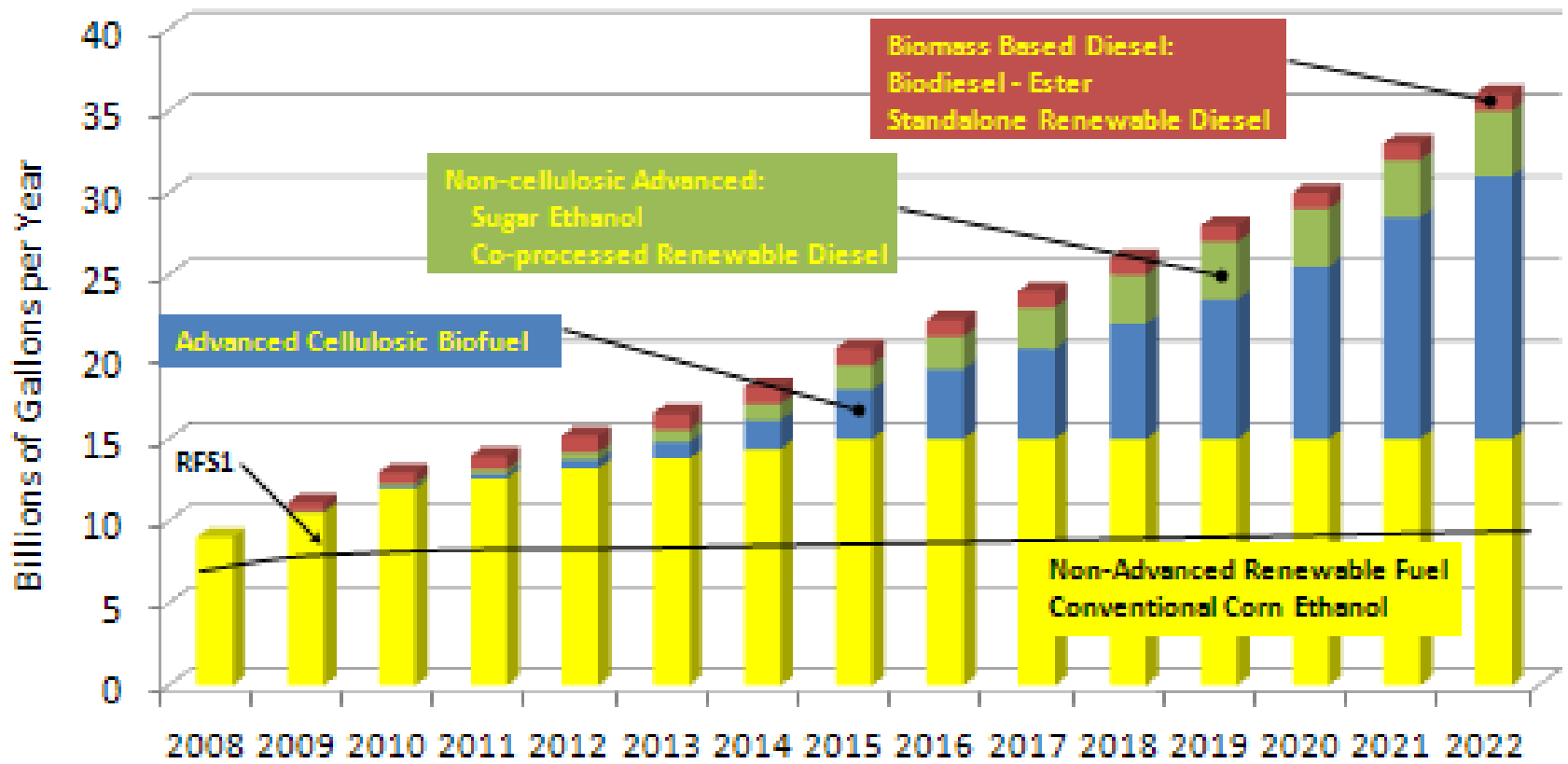
Diesel Fuel Manufacturing and Supply: Production Technologies

- Because of high gasoline demand and crude quality, US refineries predominantly use Catalytic Cracking refining technology to yield gasoline volume and octane
 - **Catalytic cracking represents 37% of US crude capacity**
 - **Catalytic cracking represents 15% of Europe's crude capacity**
- Because of high diesel demand, European refineries predominantly use Hydrocracking refining technology to yield diesel volume and cetane
 - **To respond to increasing diesel demand, hydrocracking capacity in Europe has increased by about 60% between 1995 and 2005 (from 715,000 B/D to 1,150,000 B/D)**

Fuels Timeline (Since 1990)

- 1991 Phase II Low volatility gasoline
- 1992 Winter Oxygenated gasoline
- 1993 Low Sulfur Diesel
- 1993 CARB Diesel
- 1995 RFG Phase I
- 1995 CARB 2
- 2000 RFG Phase II
- 2002 Mobile Source Air Toxics I
- 2004 CARB 3
- 2004 – 06 Low sulfur gasoline
- 2006 RFS1
- 2006 Removal of RFG Oxygenate Mandate
- 2006 Ultra Low Sulfur Diesel – Highway
- 2006 Low Sulfur Diesel – Non-Road, Locomotive and Marine
- 2008 RFS2
- 2010 Ultra Low Sulfur Diesel – Non-Road
- 2011 Mobile Source Air Toxics II
- 2012 Ultra Low Sulfur Diesel – Locomotive and Marine
- 2012 US/Canada Bunker Fuel Sulfur Standard established
- 2015 US/Canada Bunker Fuel Sulfur Standard lowered

EISA Renewable Fuel Standard 2007-2022



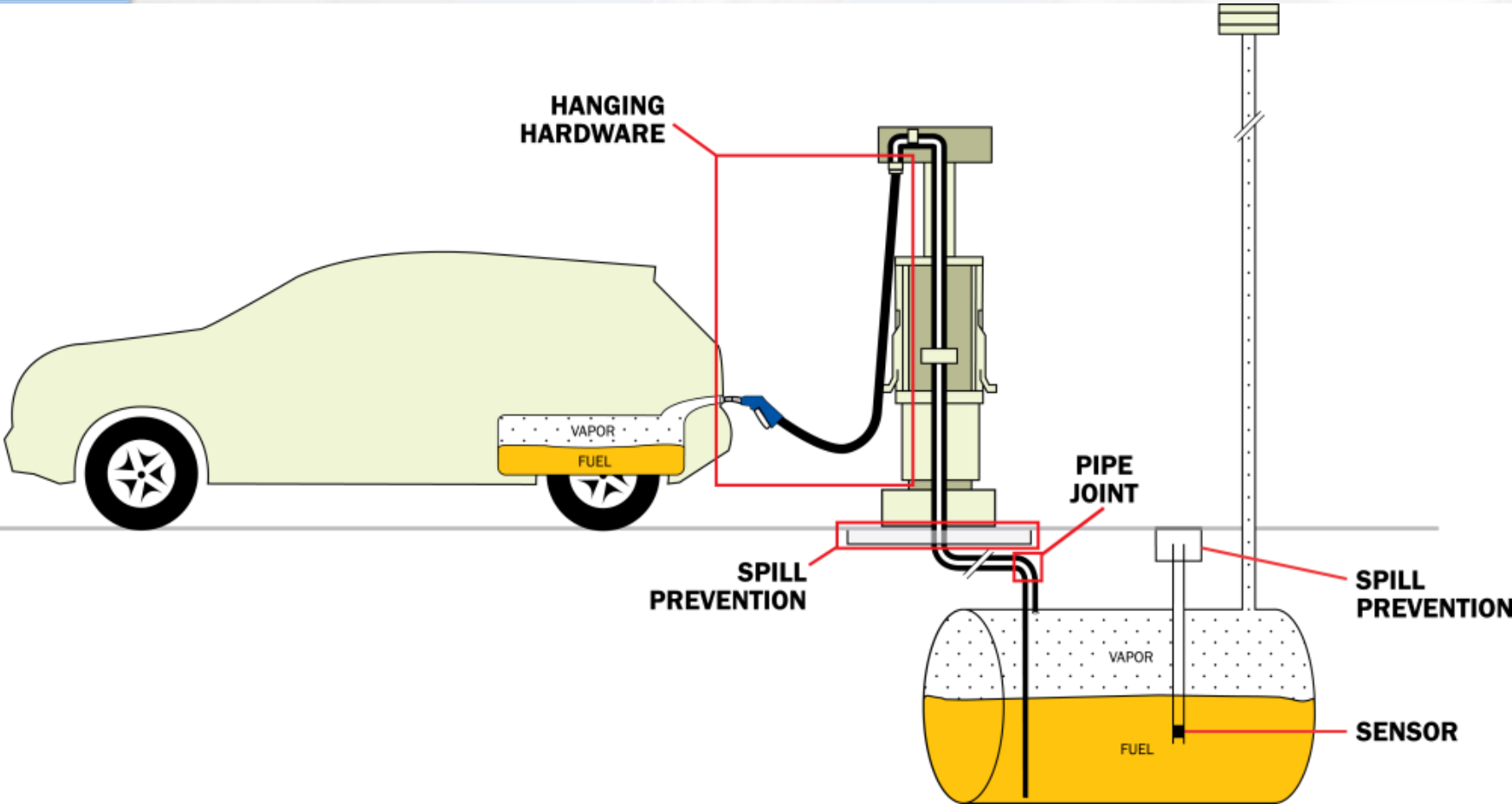
50% GHG Reduction

50% GHG Reduction

60% GHG Reduction

20% GHG Reduction (For new construction only. Existing corn facilities have no reduction requirement.)

GAS STATION REFRESHER





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