Fuels 101
LADCO Regional Meeting on Fuels

October 27, 2010

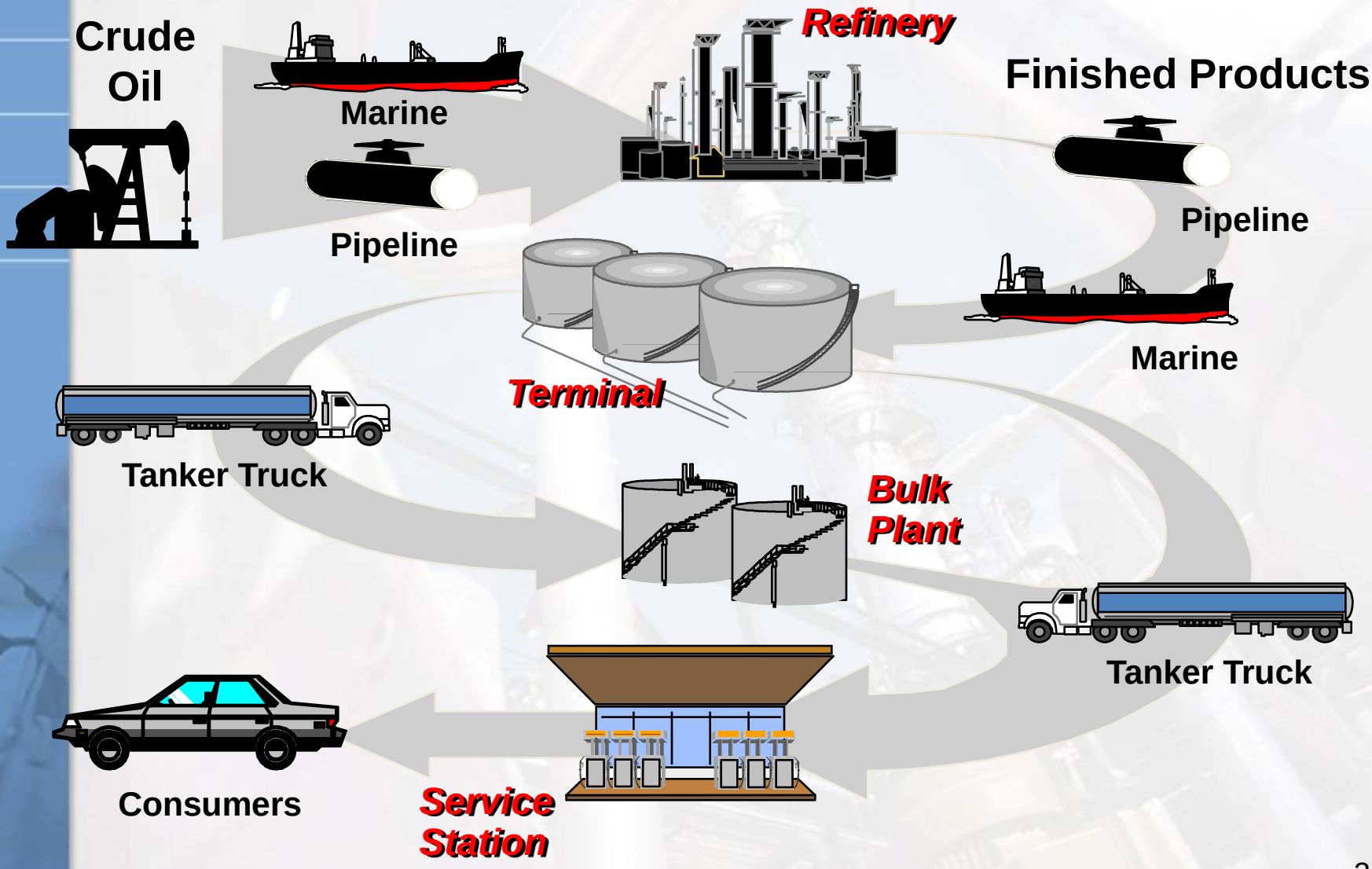
Holiday Inn Select

Rosemont, IL

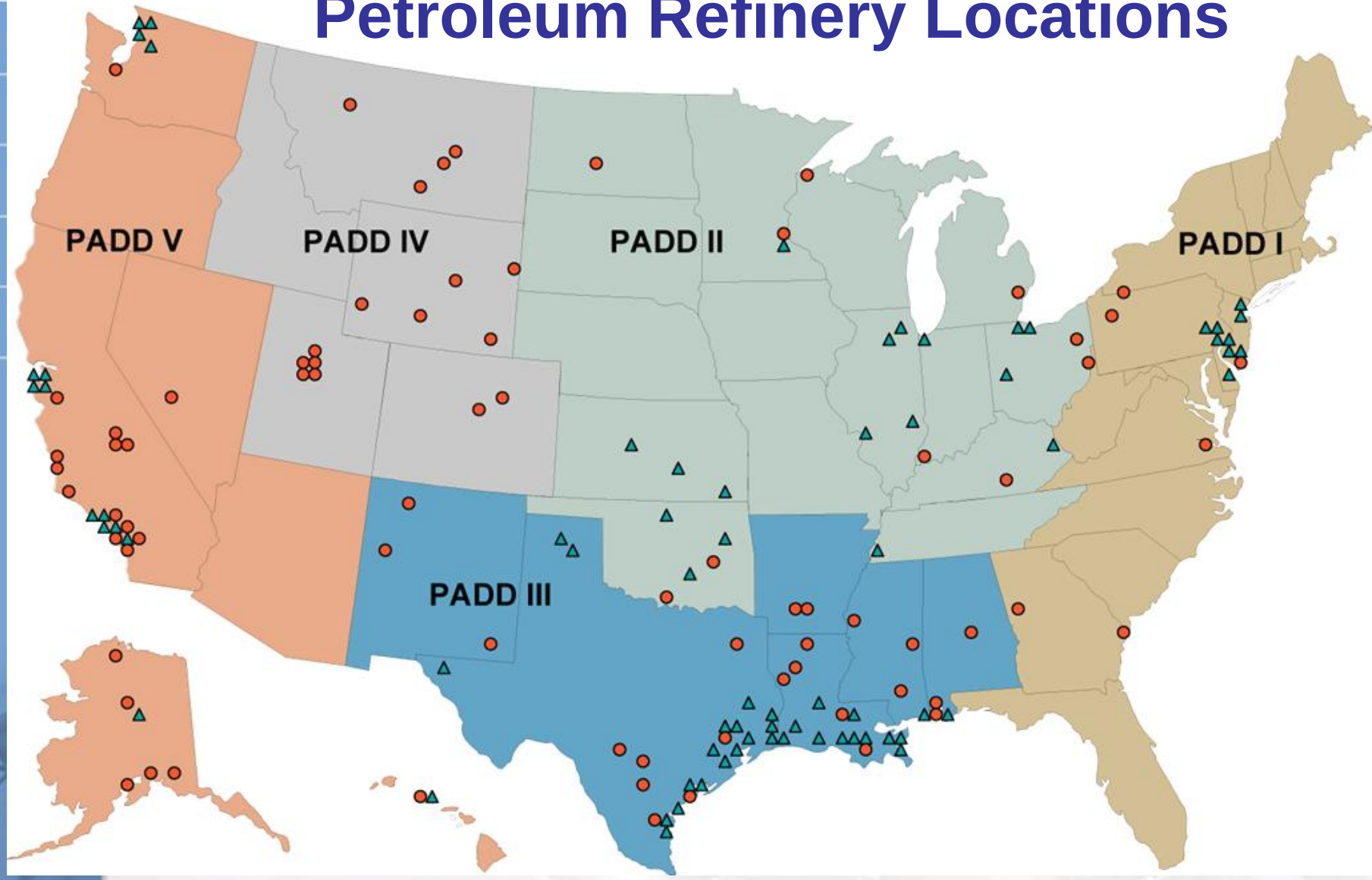
Downstream Segment

- 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



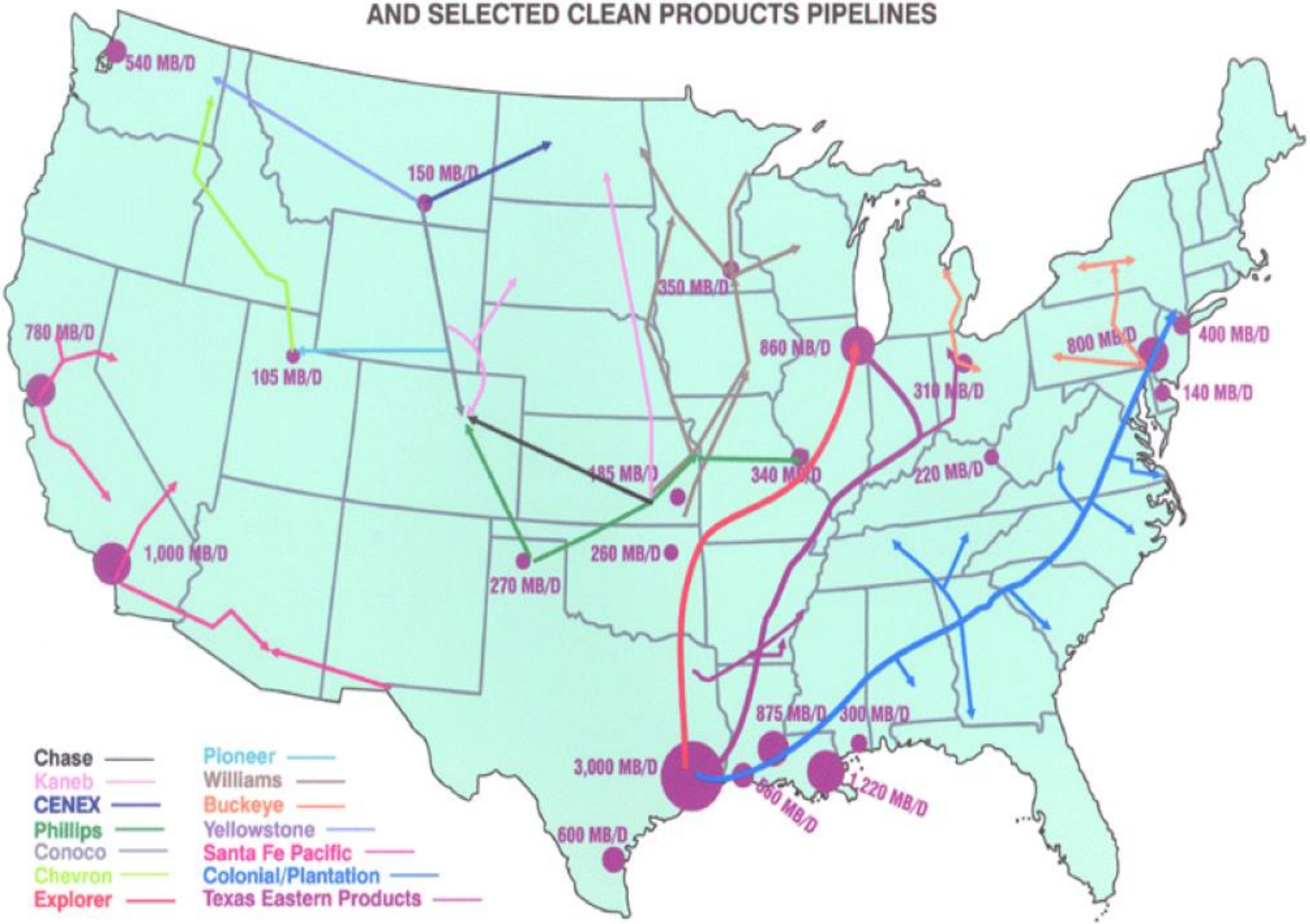
Petroleum Refinery Locations



EIA and NPRA

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

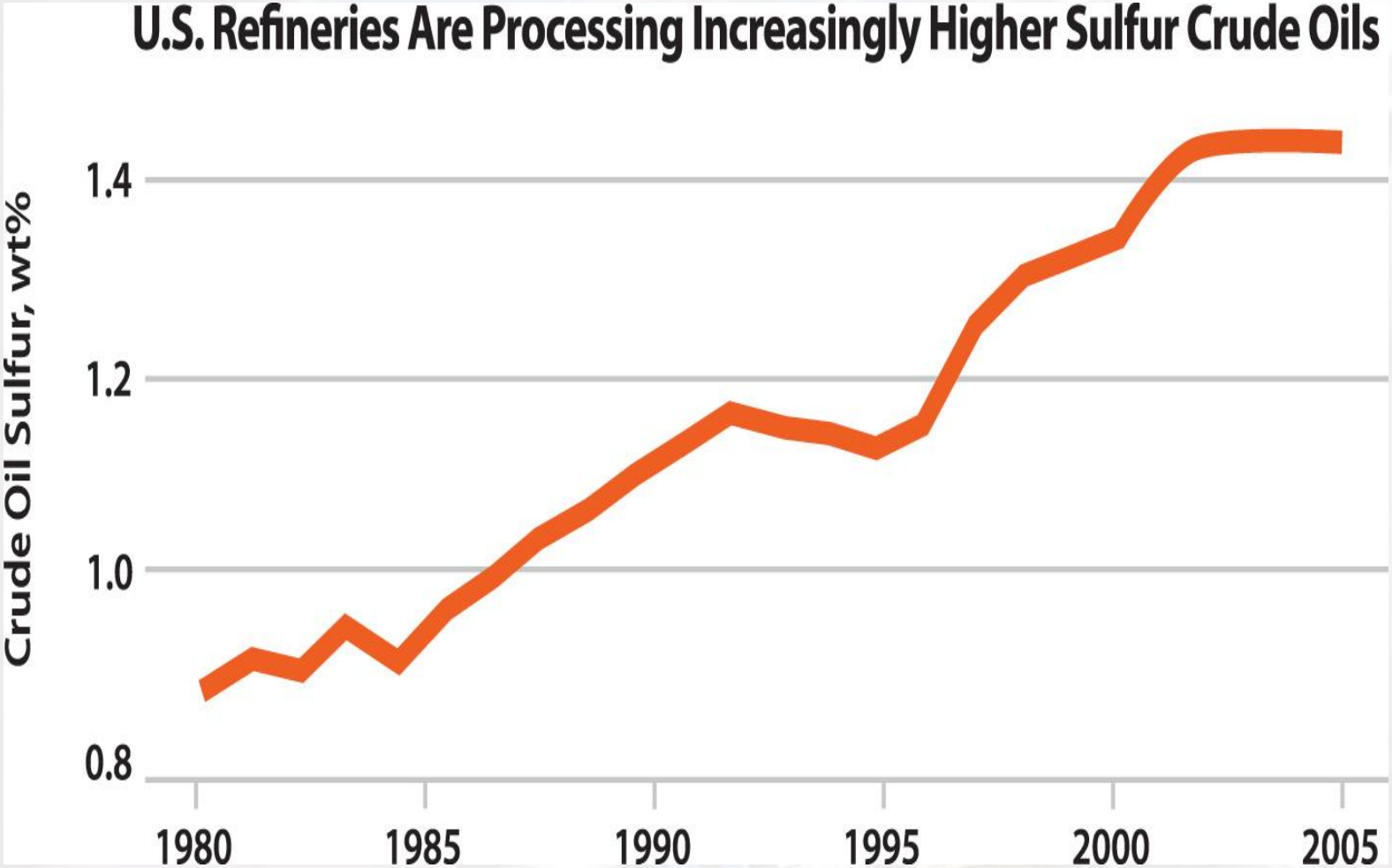
UNITED STATES REFINING CENTERS [1] AND SELECTED CLEAN PRODUCTS PIPELINES



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

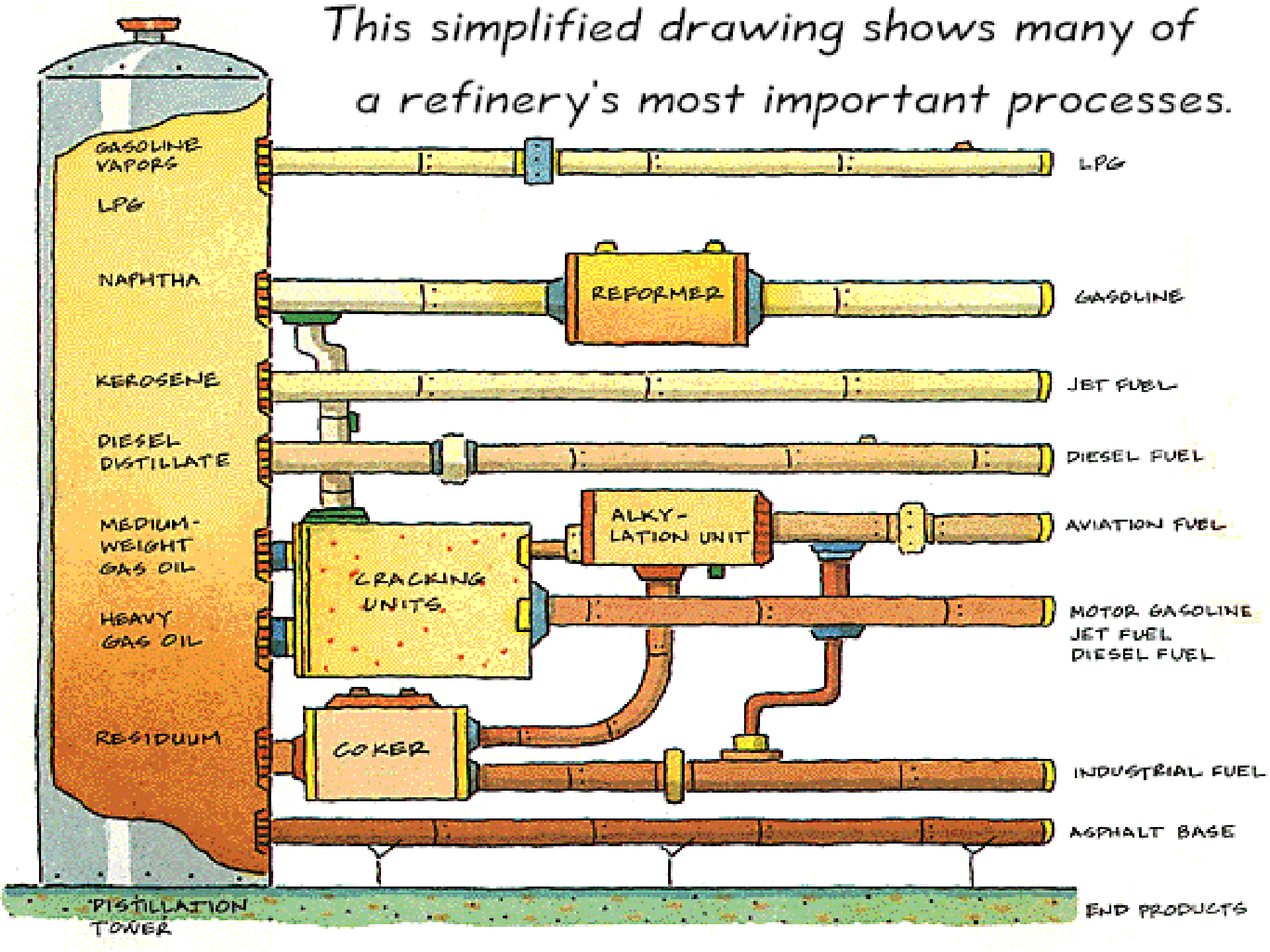
Crude Oil

- 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
Crude Oil Sulfur, wt%
1.4
1.2
1.0
0.8
1980
1985
1990
1995
2000
2005

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)

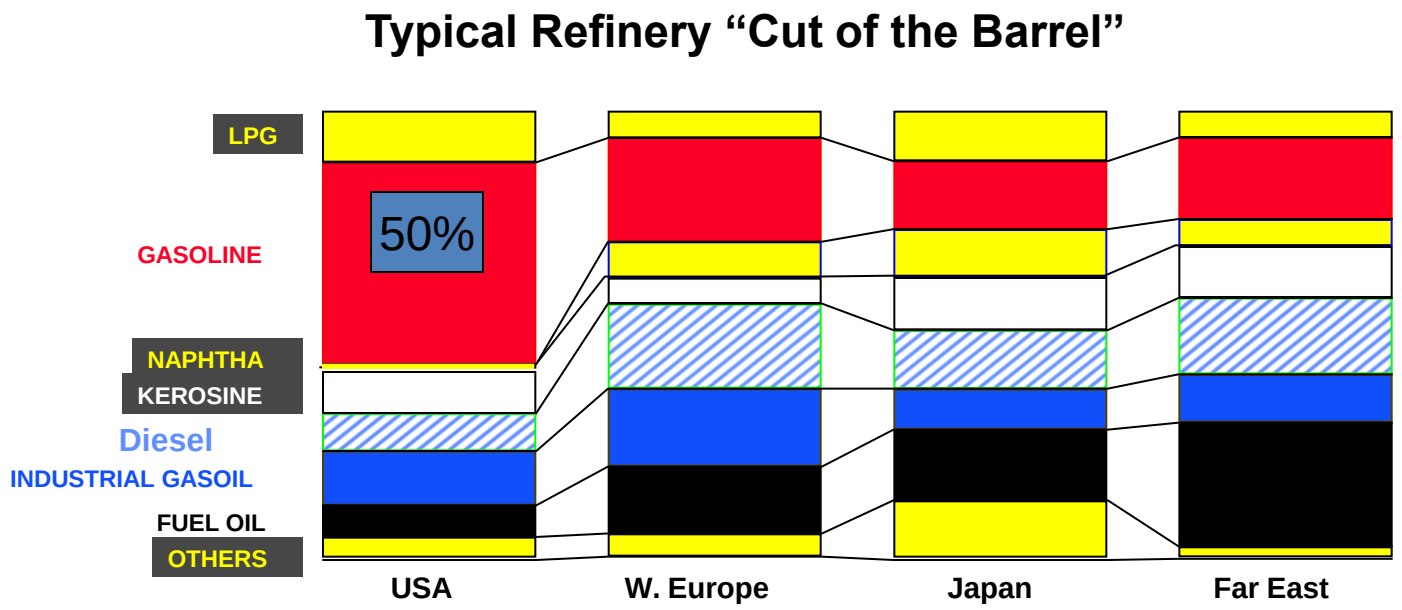

This simplified drawing shows many of a refinery's most important processes.
GASOLINE VAPORS
LPG
NAPHTHA
KEROSENE
DIESEL DISTILLATE
MEDIUM-WEIGHT GAS OIL
HEAVY GAS OIL
RESIDUUM
DISTILLATION TOWER
REFORMER
CRACKING UNITS
ALKY-LATION UNIT
COKER
LPG
GASOLINE
JET FUEL
DIESEL FUEL
AVIATION FUEL
MOTOR GASOLINE
JET FUEL
DIESEL FUEL
INDUSTRIAL FUEL
ASPHALT BASE
END PRODUCTS

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

US Refineries Are Designed and Constructed for Gasoline Production



Diesel Fuel Manufacturing and Supply: Production Technologies

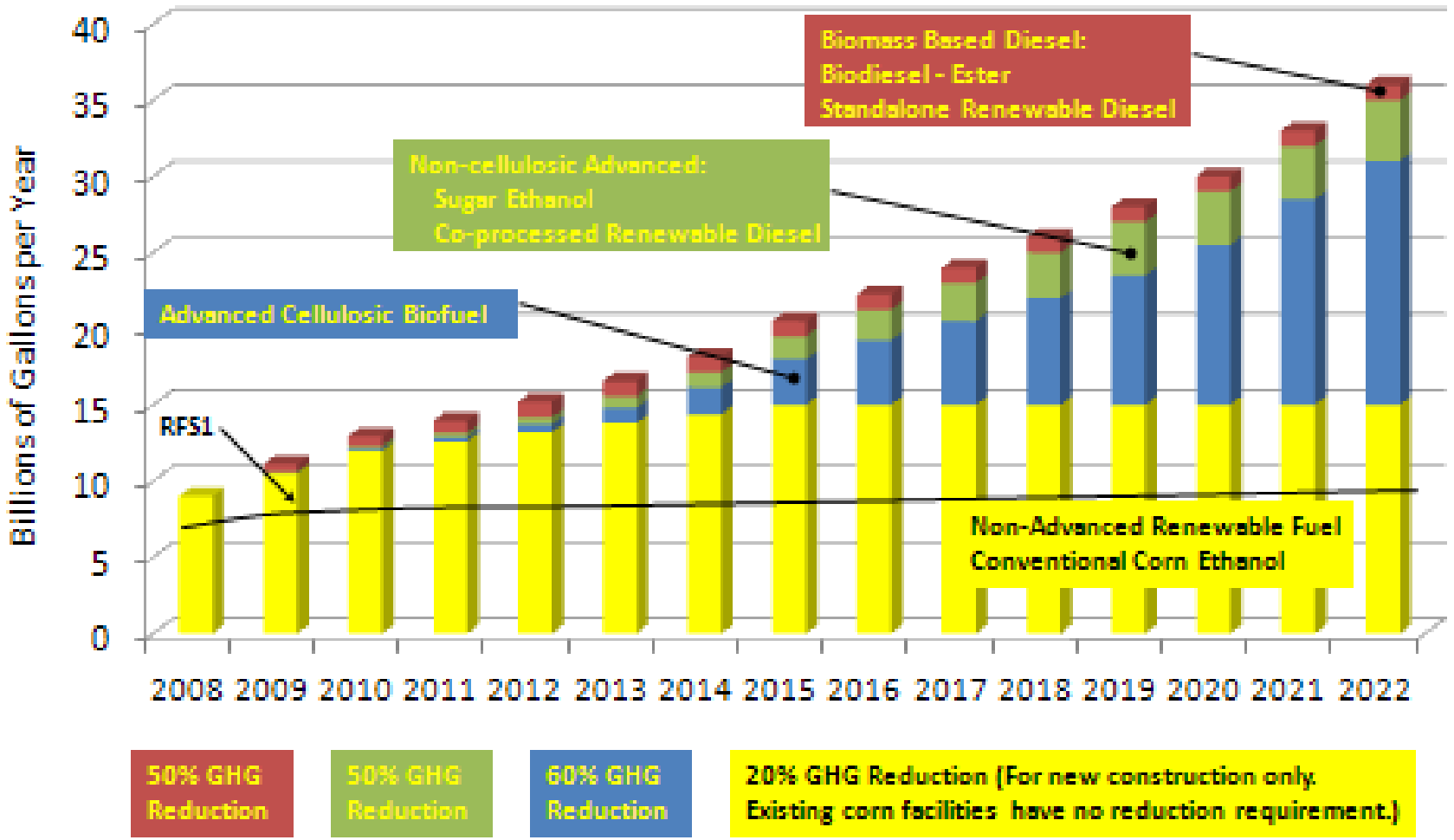
- Because of high gasoline demand and crude quality, US refineries predominantly use Catalytic Cracking refining technology to yield gasoline volume and octane
  - **Catalytic cracking represents 37% of US crude capacity**
  - **Catalytic cracking represents 15% of Europe's crude capacity**

- 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)**

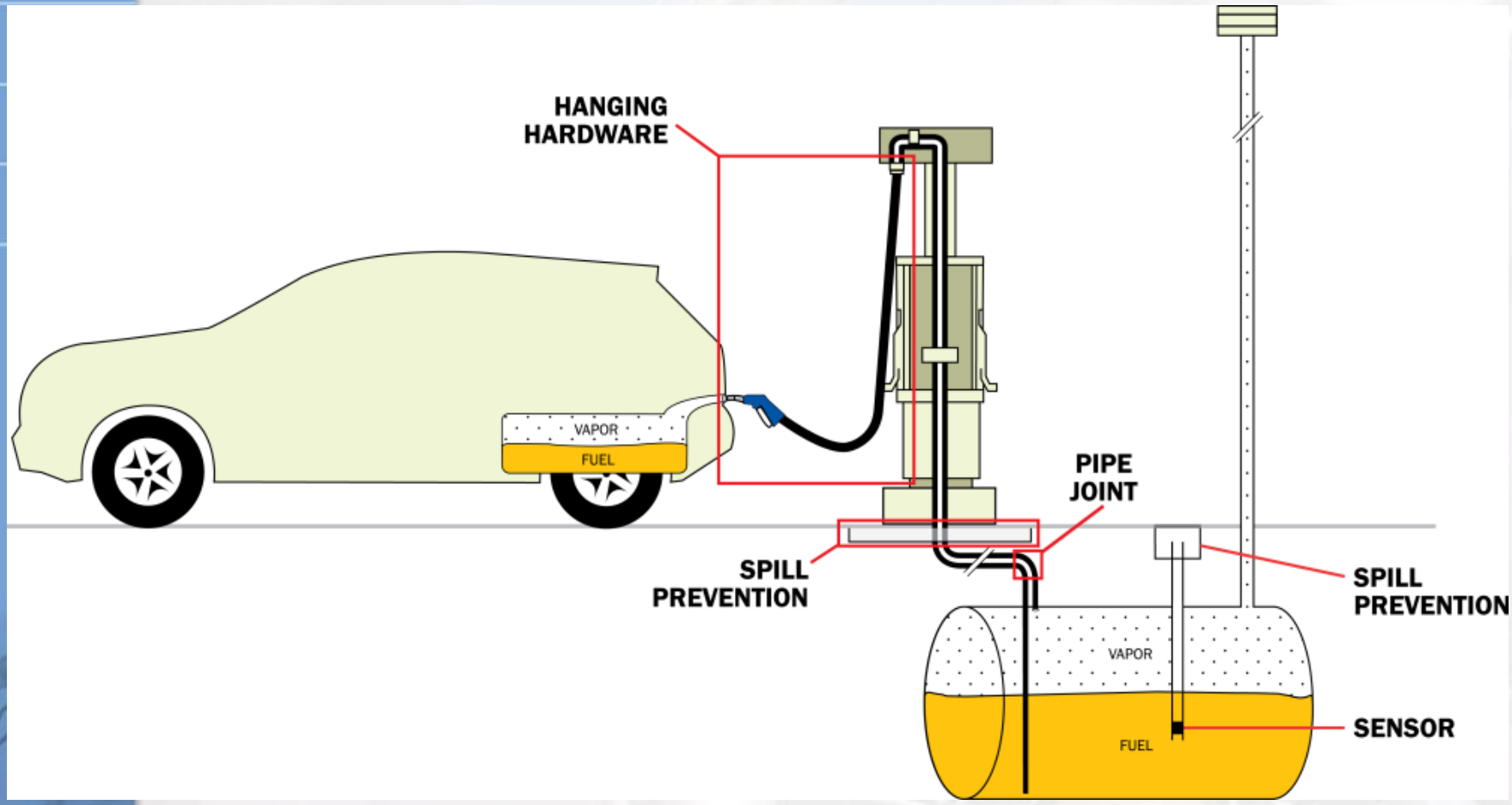
Fuels Timeline (Since 1990)

- 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



GAS STATION REFRESHER



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