

TRANSPORTATION OF ENERGY IN NORTH AMERICA

IN SOLID, LIQUID, OR GASEOUS FORMS

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TRANSPORTATION OF ENERGY

Use a Common Unit of Energy Btu

- British thermal unit (Btu)
- 1 gal crude oil ~ 132,000
- 1lb coal ~ 10,000 Btus
- 1lb dry biomass ~ 8,000 Btus
- 1 gal gasoline ~ 115,000 Btus
- 1 gal ethanol ~ 76,000 Btus

TRANSPORTATION OF ENERGY

What is a Quad (of Btus)

- One Quadrillion Btu or 10^{15}
(1,000,000,000,000,000) or one million billion
is equivalent to

172 million bbls of crude or

50 short tons of coal or

973 billion cu.ft. of natural gas

100 Quads are the equivalent of

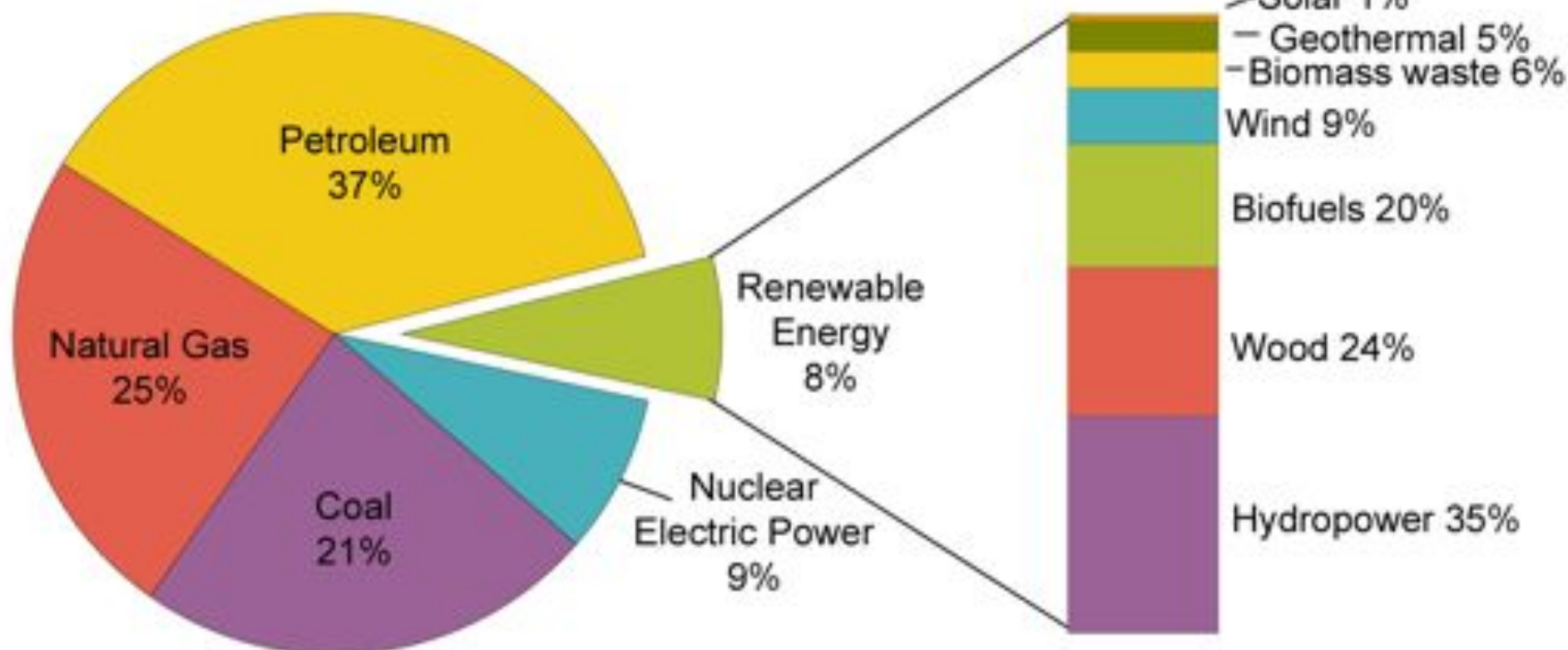
- 17,241 million bbl crude oil
or 47 million bbl crude oil/day or 25 supertankers a day
- 5,000 million short tons coal/year
or 500,000 mile-long coal trains
- 97,276 billion ft³ natural gas/year
- About what the US consumes annually

ENERGY SOURCES

U.S. Energy Consumption by Energy Source, 2009

Total = 94.578 Quadrillion Btu

Total = 7.744 Quadrillion Btu

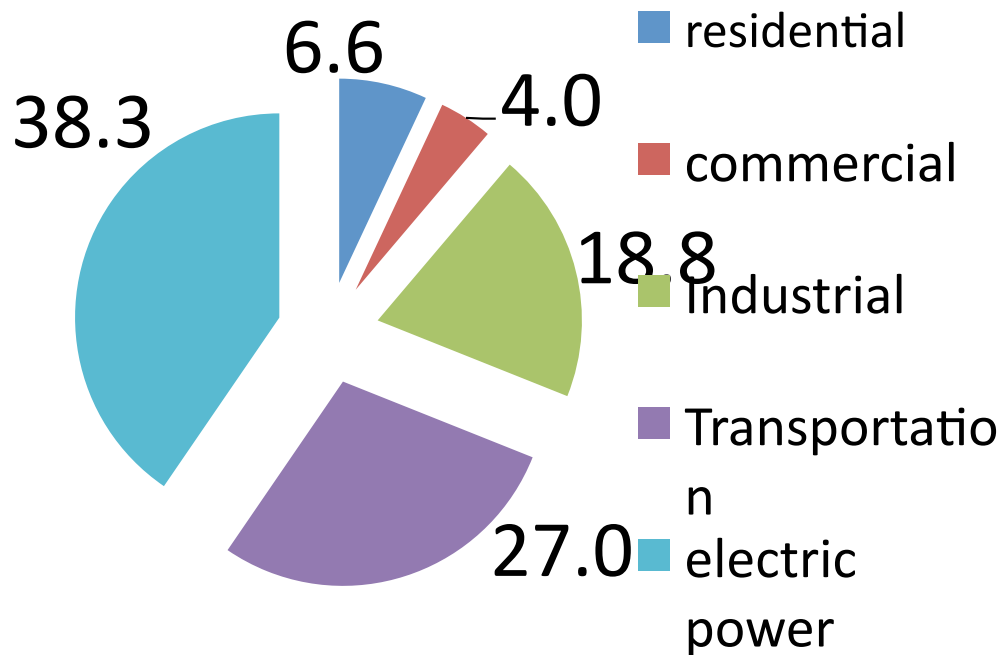


Note: Sum of components may not equal 100% due to independent rounding.
 Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).

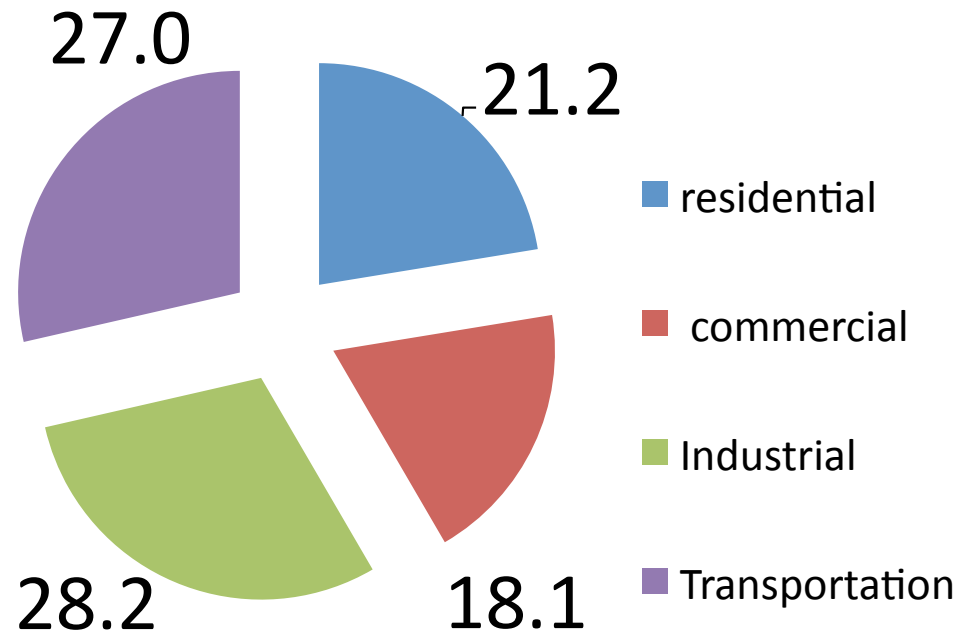
Primary Energy Use 2009

94.7 Quadrillion Btu

Utilization



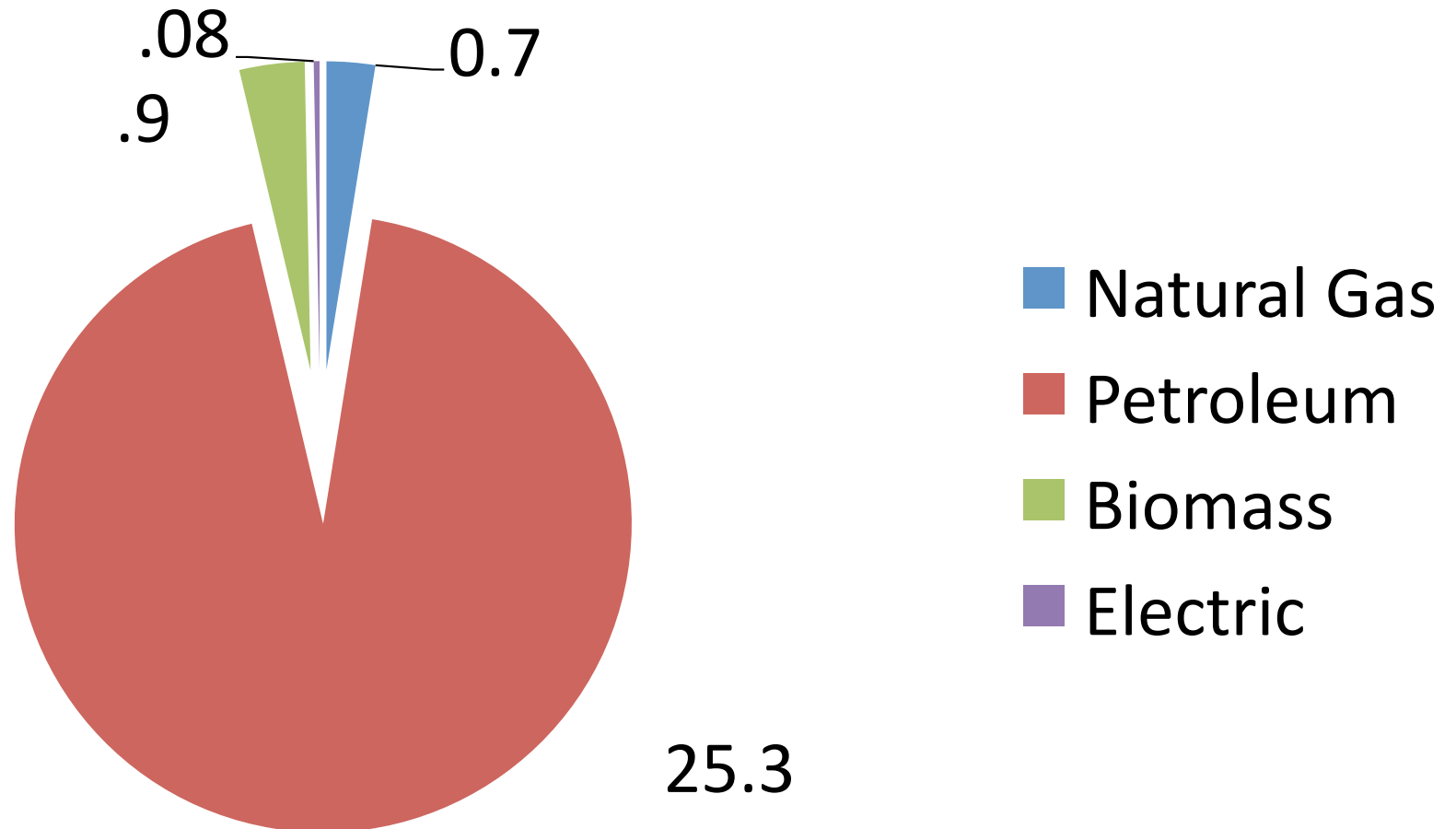
By End Use Sector



Source: US Energy Information Administration, Annual Energy Review, 2009

Transportation Energy Sources

27 Quads

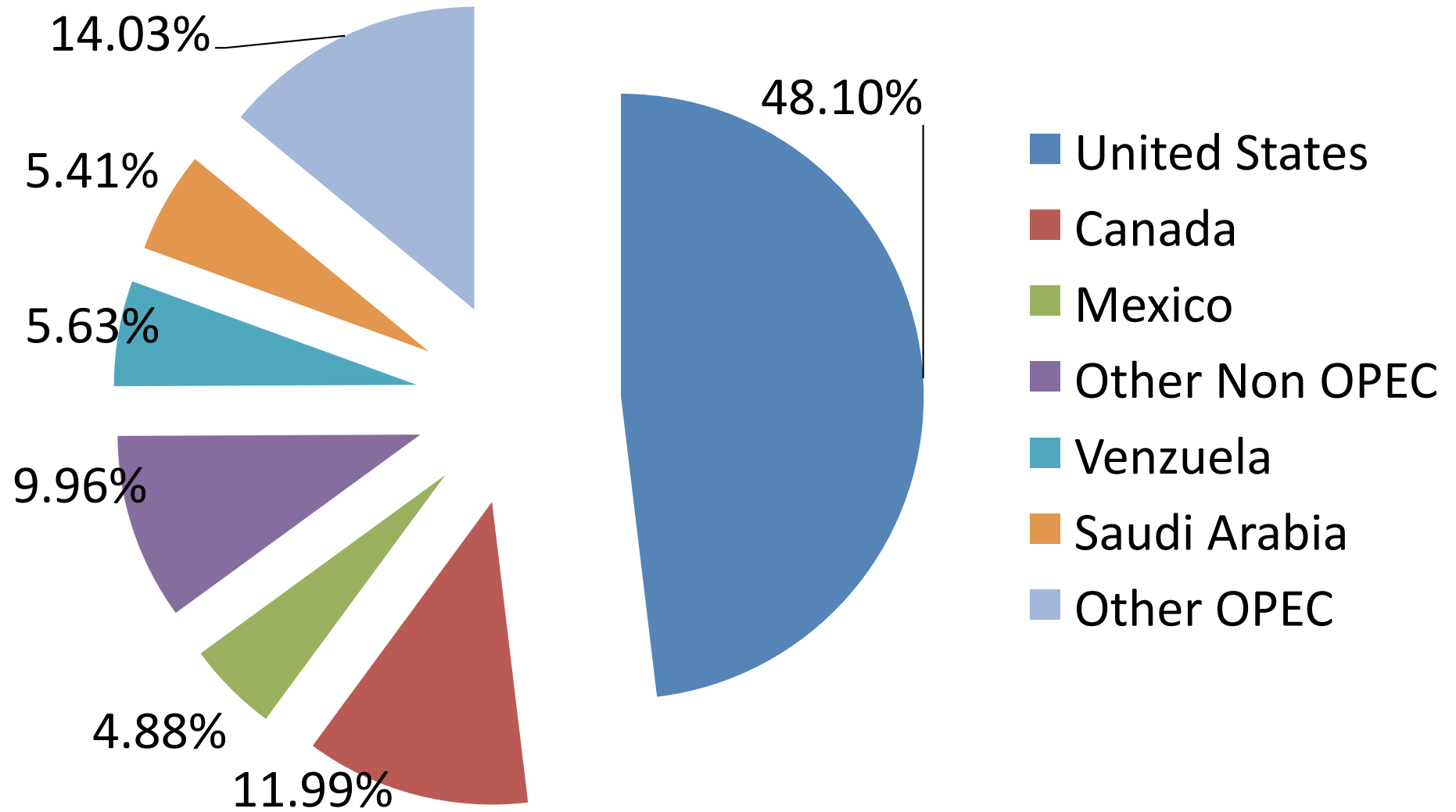


Source: US Energy Information Administration, Annual Energy Review, 2009

PETROLEUM



US Petroleum Sources 2009 in Percent



Top Crude Oil Producing States, 2009

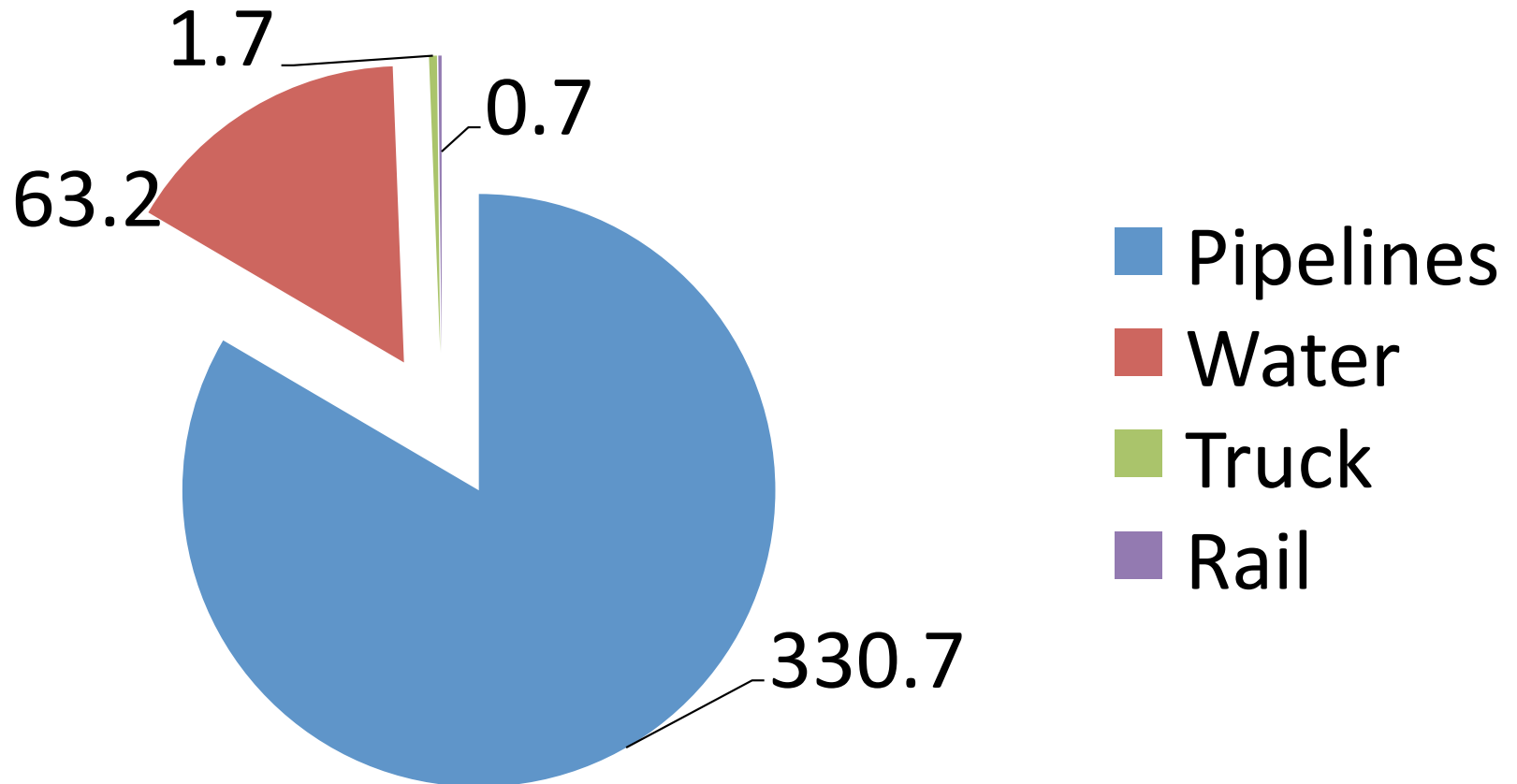


Texas (21%)
Alaska (12%)
California (11%)
North Dakota (4%)
Louisiana (3.5%)

Source: U.S. Energy Information Administration.

Transportation of Crude Petroleum By Mode

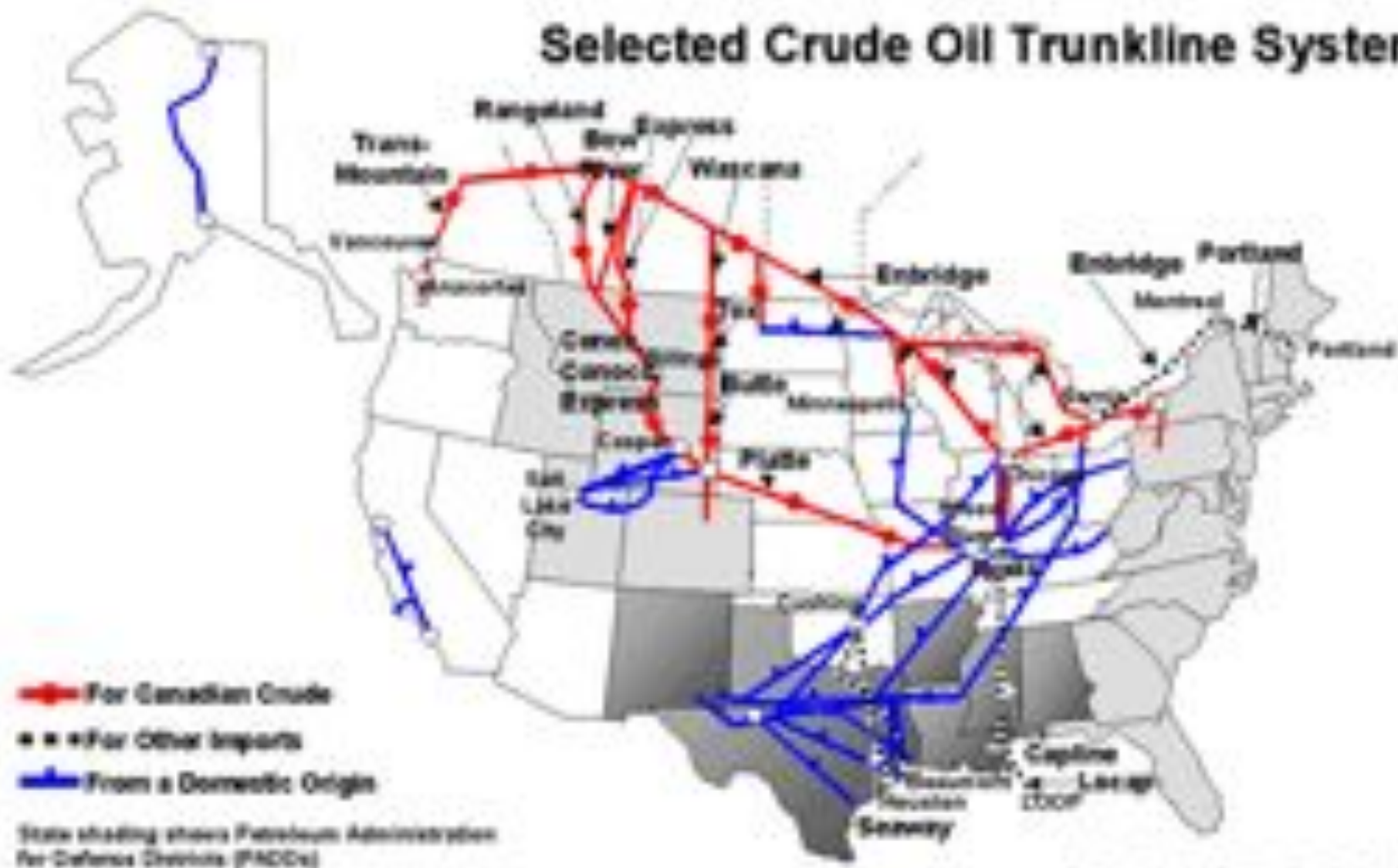
398 billion ton miles in 2008



Pipelines

- The United States has the largest network of energy pipelines – both oil and natural gas -- of any nation in the world. The oil pipeline network alone in the U.S. is more than 10 times larger than that in Europe.

Selected Crude Oil Trunkline Systems



Source: Alerge Energy Group, 2011

CRUDE OIL PRICING

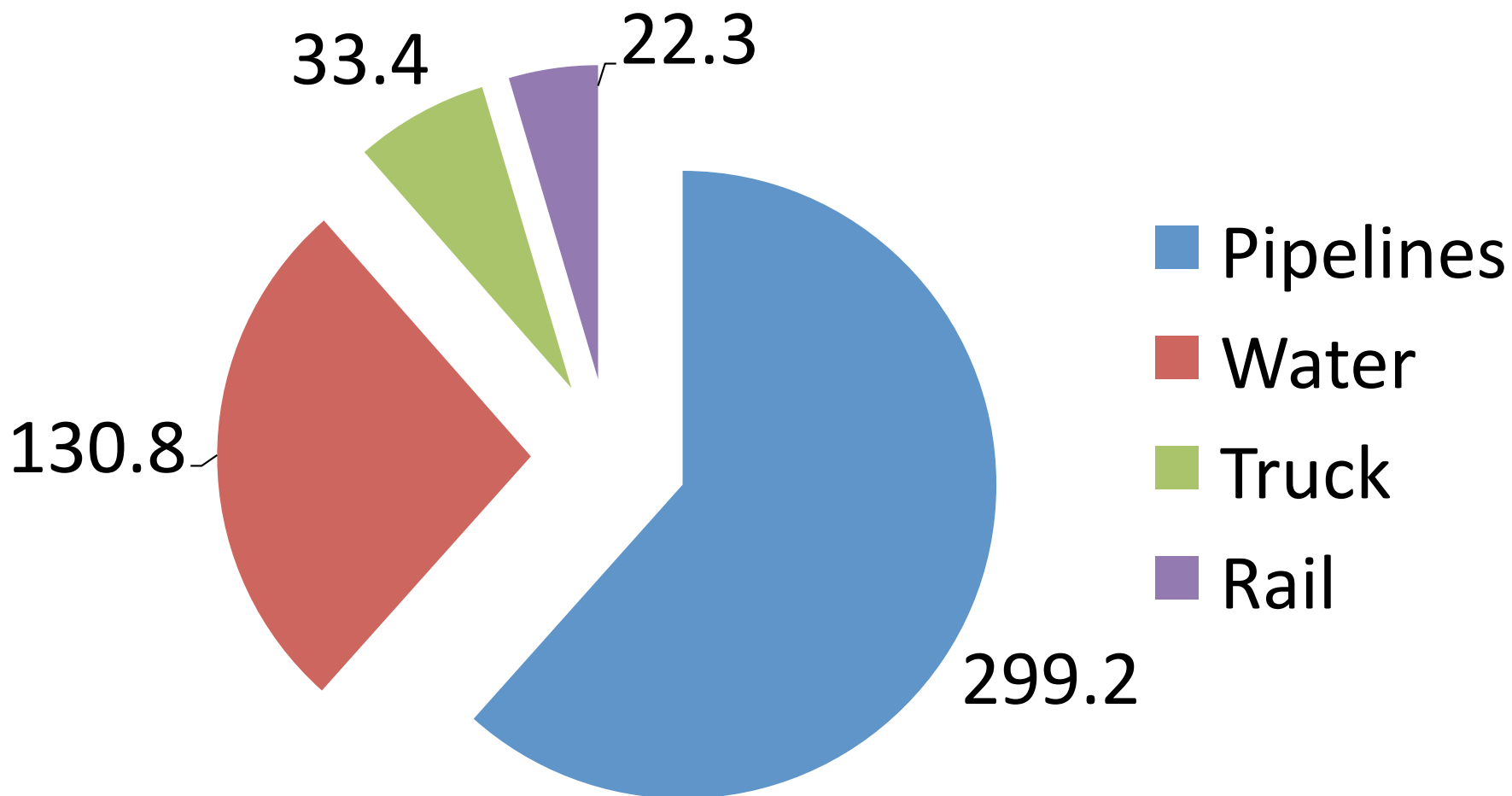


CRUDE OIL PRICING

- **WTI** (West Texas Intermediate) –High Quality, API Gravity 39.6, Sulfur 24%, \$5-\$6 premium to OPEC and \$1-\$2 to Brent
- Brent** (North Sea) API Gravity 38.3, Sulfur 37%
- NYMEX Futures** contract 1000 bbls of WTI
- OPEC Basket** -7 OPEC Crude Oils –heavier and more sulfur than WTI and Brent
- IRAC** Imported Refiner Acquisition Cost (estimate of average World Price but not available for 2-3 months) \$6-\$8 less than WTI

Petroleum Products Transportation By Mode

486 billion ton miles in 2008

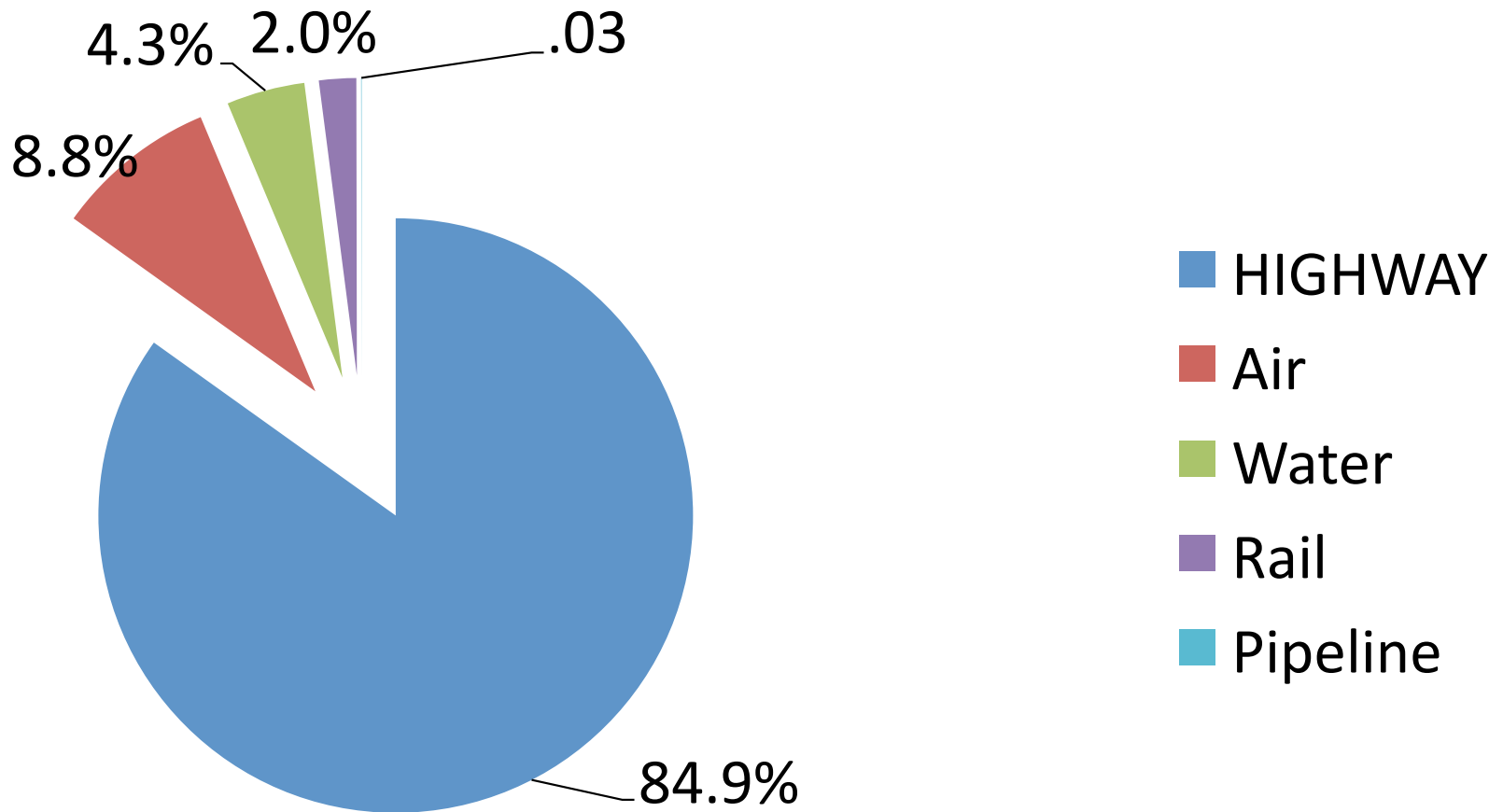


Major Refined Products Pipelines



Source: Allegro Energy Group, 2001

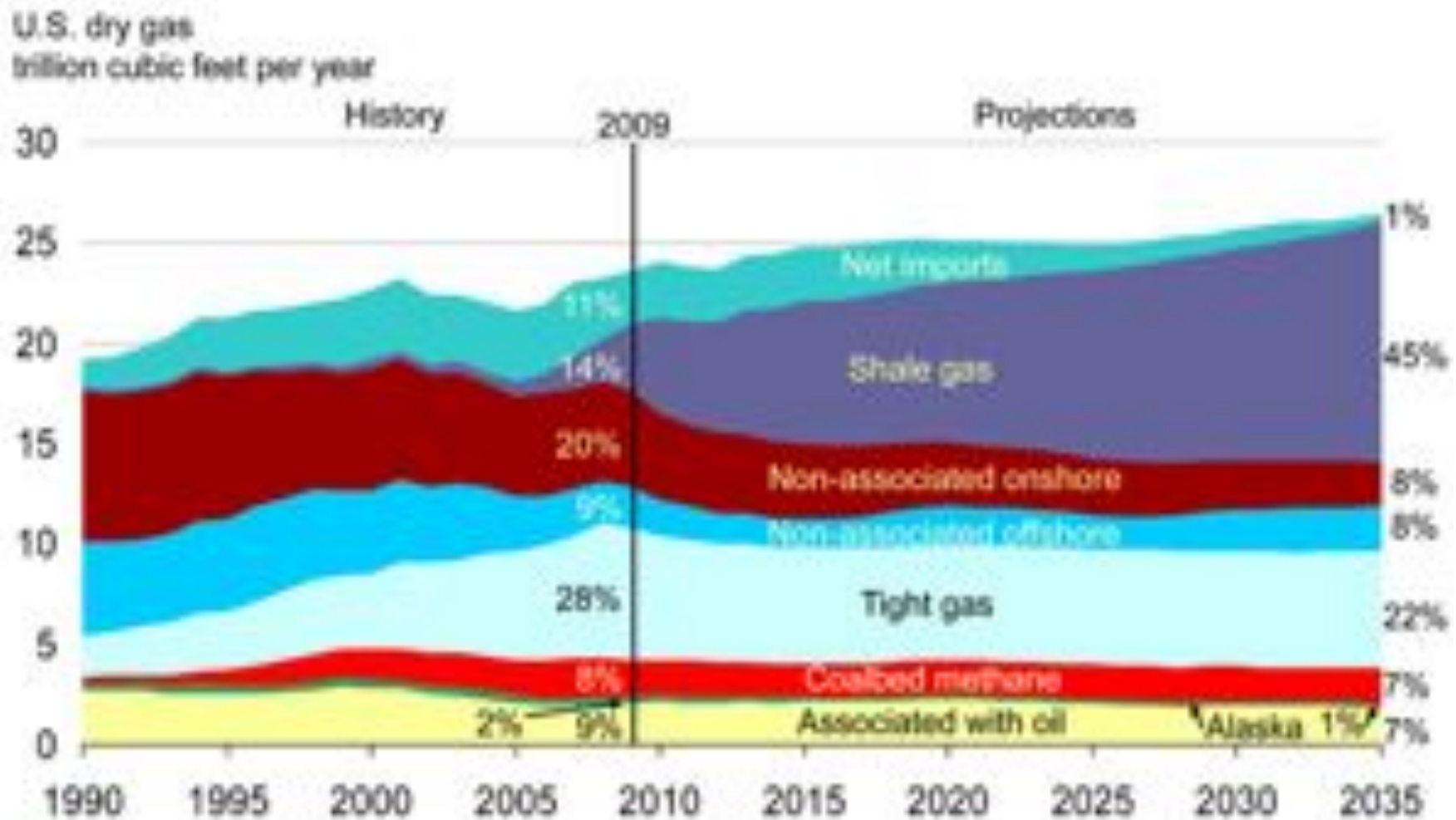
Transportation Petroleum Use Highway and Non Highway 2008



NATURAL GAS



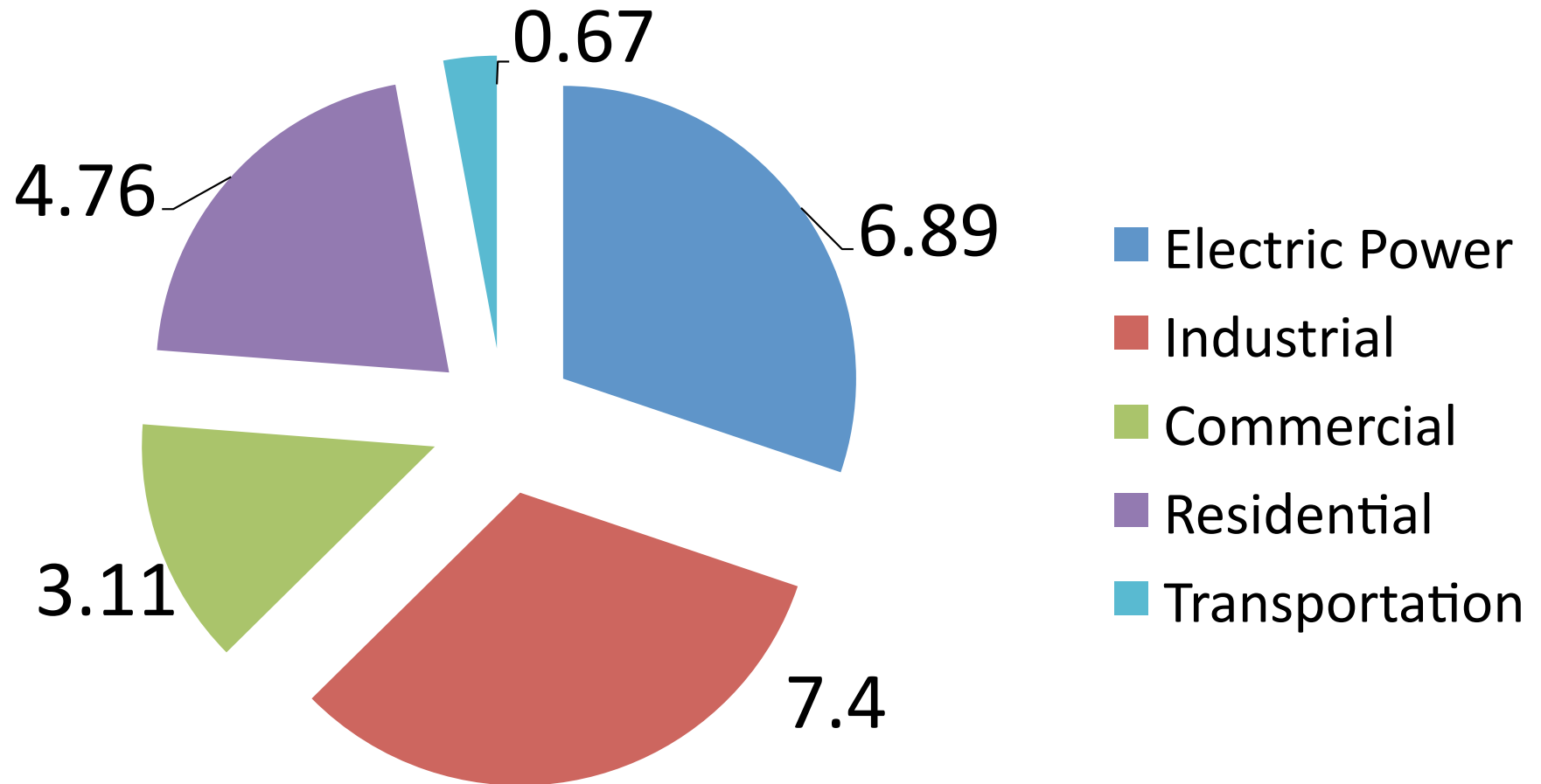
Sources of U.S. Natural Gas, Historical and Projected



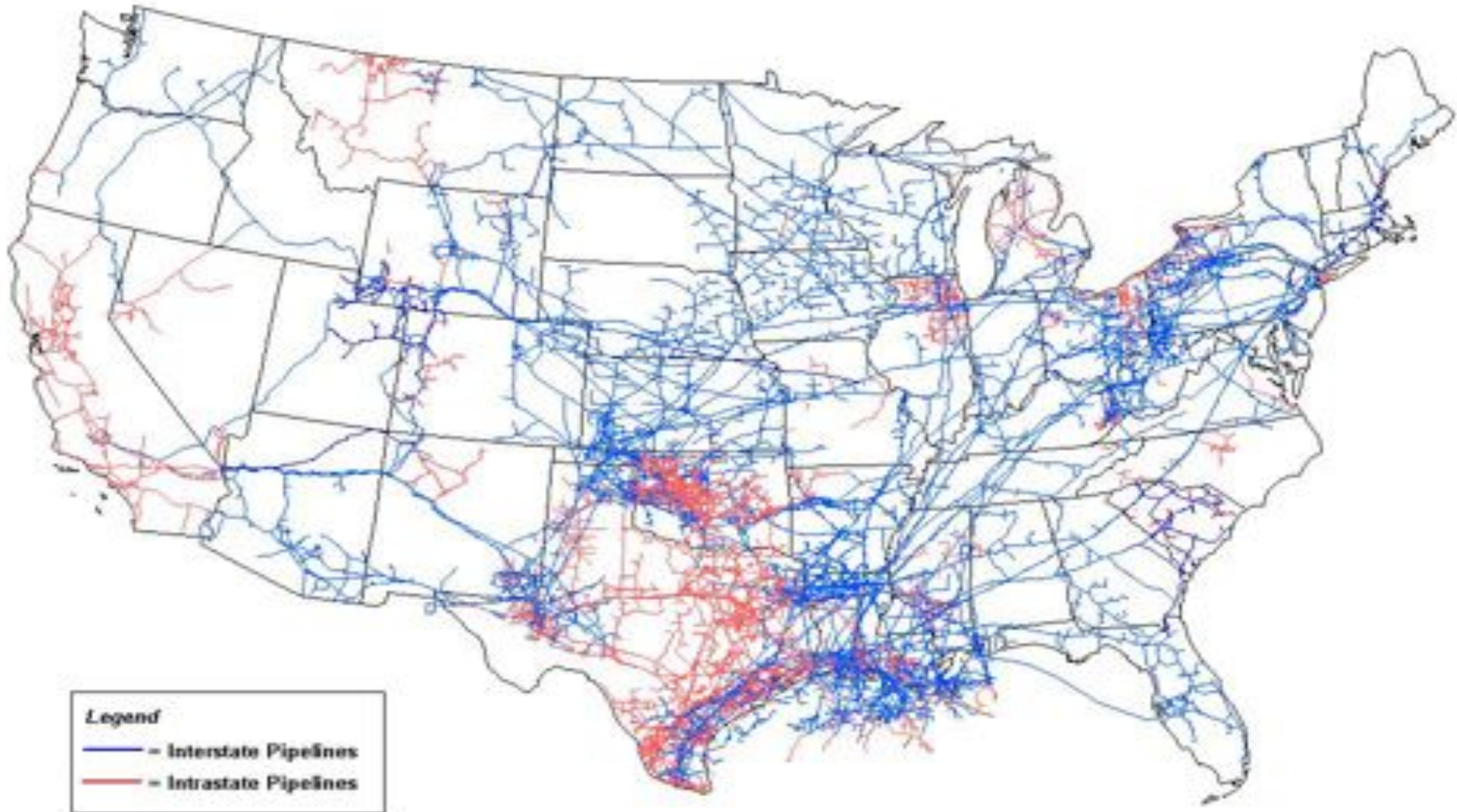
Source: EIA, Annual Energy Outlook 2011

Natural Gas Utilization 2009

Trillion Cubic Feet



2009 Natural Gas Pipelines



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

COAL



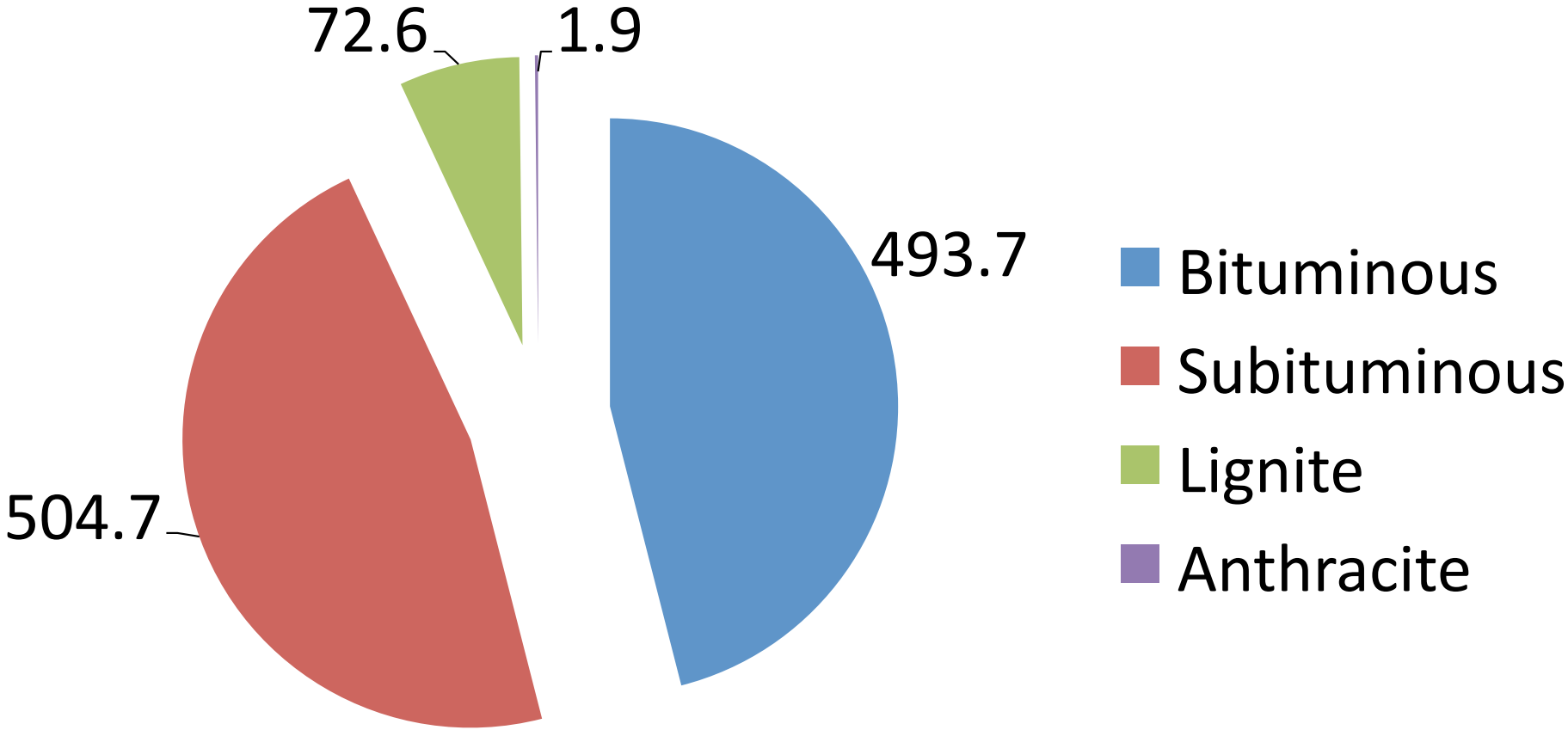
United States Coal Fields



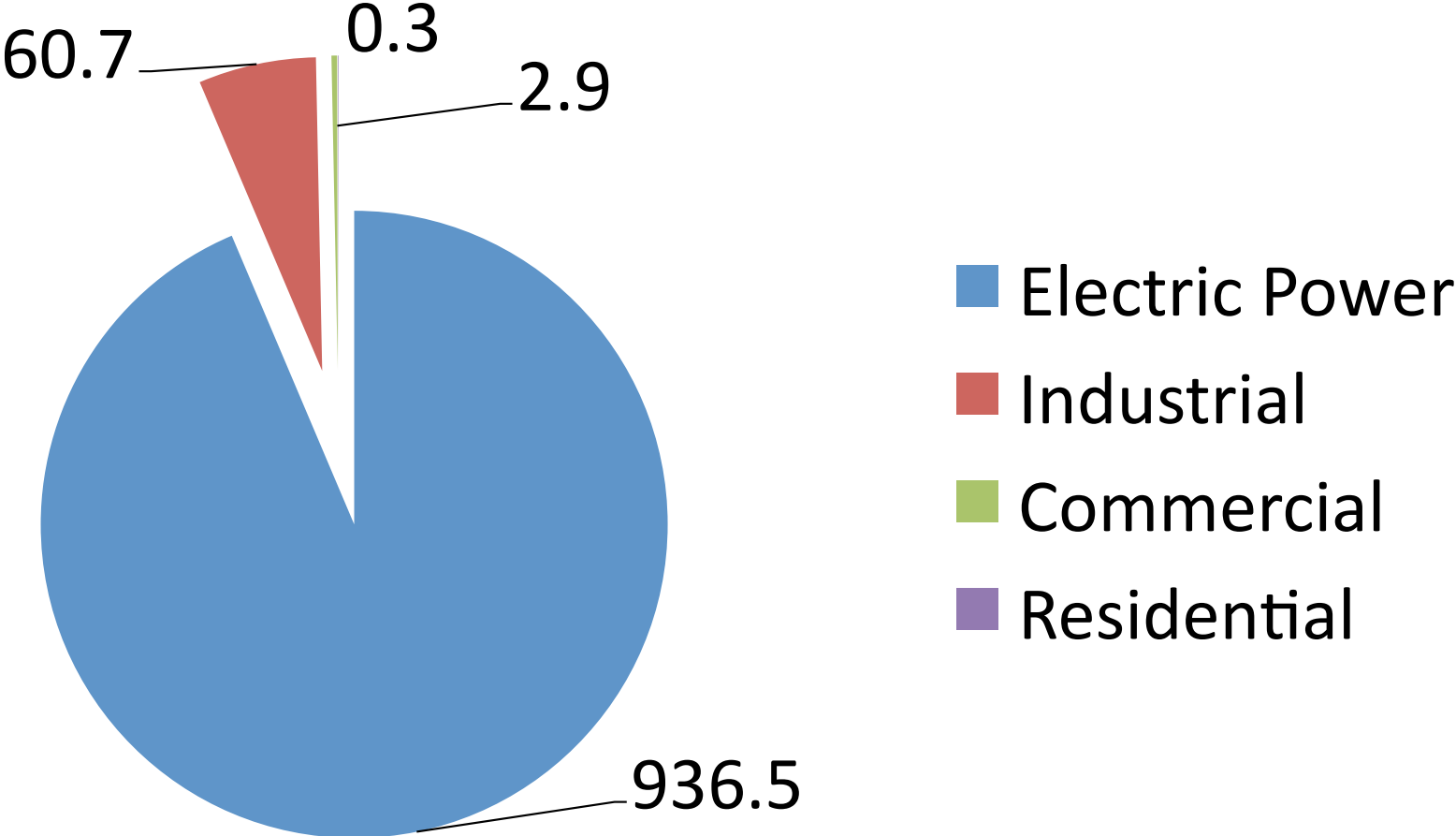
Coal Production by Coal-Producing Region, 2009



2009 COAL PRODUCTION BY TYPE



COAL UTILIZATION BY END USE SECTOR 2009



COAL TRANSPORTATION

- Coal is shipped primarily by rail but also by truck, ship and barge.
- Coal Accounts for 11.29% of all freight tonnage in the US
- Coal accounts for 836 billion ton or 25 % of all domestic freight ton miles

COAL TRENDS

(million short tons)

Coal production increased from 1,029 M tons in 1990 to 1172 M tons in 2008

- Production **West of the Mississippi** has increased from < 400 M tons in 1990 to 672 M tons in 2006 (East declined from 630 M tons to <500 M tons)
- **Sub bituminous** increased from < 250 M tons in 1990 to >M 539 tons in 2008
- **Longer distances** and **fewer Btus** per pound resulting in **increased transportation needs**

COAL TRENDS (2)

(million short tons)

- Production **from surface mines** has increased from 600 M tons in 1990 to 815 M tons in 2008
- Production **from underground mines** declined from 424 M tons in 1990 to 357 M tons in 2008

CLOSING COMMENTS

- Unlike coal, oil and products, and natural gas, biomass relies on truck and highway transportation for its first movement and not its movement to the end user
- This causes in more congestion and environmental impacts
- Biomass must be collected from small , multiple sources , unlike point sources like mines and wells.

CLOSING COMMENTS (2)

- Biomass generally has fewer Btus per pound than fossil fuels. This requires more transportation capacity vehicles and moving more ton-miles than a similar amount of fossil fuels.

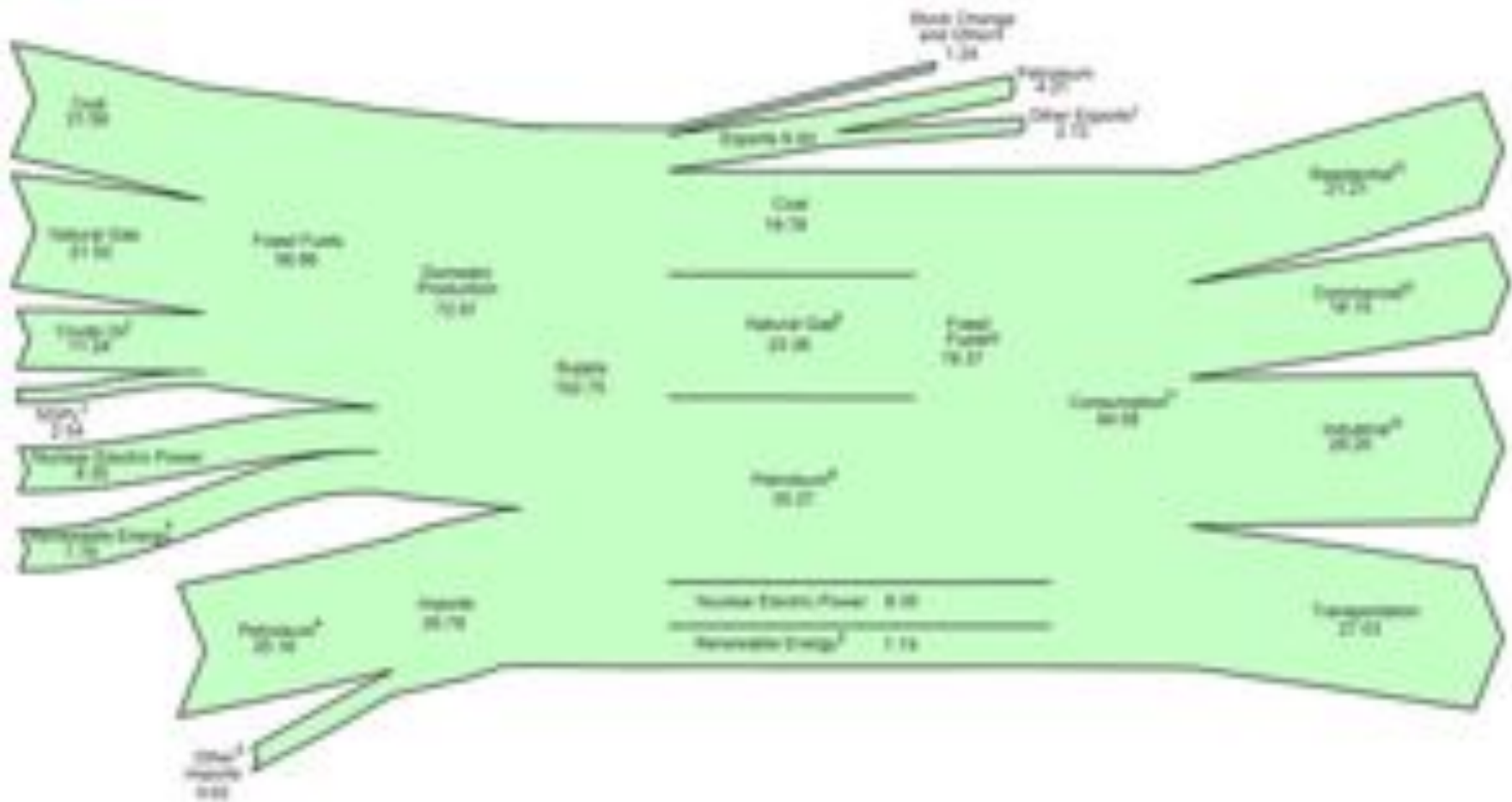
Thank You
Questions??

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The Big Picture



Energy Movements by Mode

- Rail
- Pipeline (Crude Oil)
- Pipeline (Products)
- Pipeline (Natural Gas)
- Water (Domestic)
- Water (Ocean)
- Motor Carrier
- Electric Transmission Lines

Transportation Costs Can be Significant

- Once coal is mined, it must be moved to where it will be consumed. Transportation costs add significantly to the delivered price of coal. In some cases, as in long-distance shipments of Wyoming coal to power plants in the East, transportation costs can be more than the price of coal at the mine.
- Most coal is transported by train, barge, truck or a combination of these methods. All of these transportation methods use diesel fuel and so increases in oil prices can significantly affect the cost of transportation and, in turn, the final delivered price of coal.
- In 2009 the average sales of coal at the mine was \$33.24 per ton and the average delivered price to electric utility power plants was \$44.47 per ton, roughly implying a transportation cost of \$11.23 per ton, or 25% of the total delivered price.