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
• 1 lb coal ~ 10,000 Btus
• 1 lb 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

- Petroleum: 37%
- Natural Gas: 25%
- Coal: 21%
- Nuclear Electric Power: 9%
- Renewable Energy: 8%

Total = 7.744 Quadrillion Btu

- Solar: 1%
- Geothermal: 5%
- Biomass waste: 6%
- Wind: 9%
- Biofuels: 20%
- Wood: 24%
- Hydropower: 35%

Note: Sum of components may not equal 100% due to independent rounding.
Primary Energy Use 2009
94.7 Quadrillion Btu

Utilization

- Residential: 38.3
- Commercial: 6.6
- Industrial: 18.8
- Transportation: 27.0
- Electric Power: 4.0

By End Use Sector

- Residential: 27.0
- Commercial: 21.2
- Industrial: 28.2
- Transportation: 18.1

Transportation Energy Sources
27 Quads

- Petroleum: 25.3
- Natural Gas: 0.7
- Biomass: 0.08
- Electric: 0.9

PETROLEUM
US Petroleum Sources 2009 in Percent

- United States: 48.10%
- Canada: 11.99%
- Mexico: 14.03%
- Other Non OPEC: 9.96%
- Venzuela: 5.41%
- Saudi Arabia: 5.63%
- Other OPEC: 4.88%
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.
CRUDE OIL PRICING
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- **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

- Pipelines: 299.2
- Water: 130.8
- Truck: 33.4
- Rail: 22.3
Major Refined Products Pipelines

Source: Allegro Energy Group, 2001
Transportation Petroleum Use
Highway and Non Highway 2008

- Highway: 84.9%
- Air: 8.8%
- Water: 4.3%
- Rail: 2.0%
- Pipeline: 0.3%
NATURAL GAS
Sources of U.S. Natural Gas, Historical and Projected

[Chart showing historical and projected sources of U.S. dry gas, with percentages for different sources over time.]

Source: EIA, Annual Energy Outlook 2017
Natural Gas Utilization 2009
Trillion Cubic Feet

- Electric Power: 6.89
- Industrial: 7.4
- Commercial: 3.11
- Residential: 4.76
- Transportation: 0.67
2009 Natural Gas Pipelines

Legend
- Interstate Pipelines
- Intrastate 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

- Bituminous: 493.7
- Subbituminous: 504.7
- Lignite: 72.6
- Anthracite: 1.9
COAL UTILIZATION BY END USE SECTOR 2009

936.5

- Electric Power: 60.7%
- Industrial: 0.3%
- Commercial: 2.9%
- Residential: 36.0%
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 1,172 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.