Lecture 3: Wednesday, January 30, 2008

HW#1 is due in class next Wednesday, February 6.
We will cover the material needed today.
We will have a Q&A session Monday.
Reminders: handwrite (neatly) or use Word.
OK to discuss and check answers with friends, but write it up yourself, and show all work!

The class web site
http://www.physics.rutgers.edu/~karin/140
includes required reading (articles and weblinks) and useful course information (including the homeworks)

Special permission?
Email Ms. Julia Sotory jsotory@physics.rutgers.edu

1 gallon gasoline	20 lbs CO_2
1 gallon heating oil	26 lbs CO_2
1 therm of natural gas	13 lbs CO2
1 thousand cubic ft of natural gas	14 lbs CO2
1 kWh electricity	1.3 lbs CO_2 (US average)

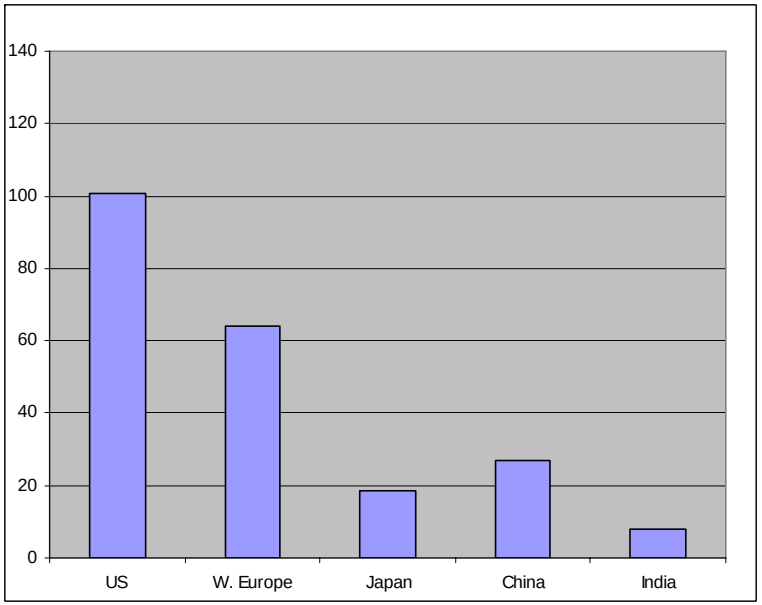
Source: Safeclimate.net

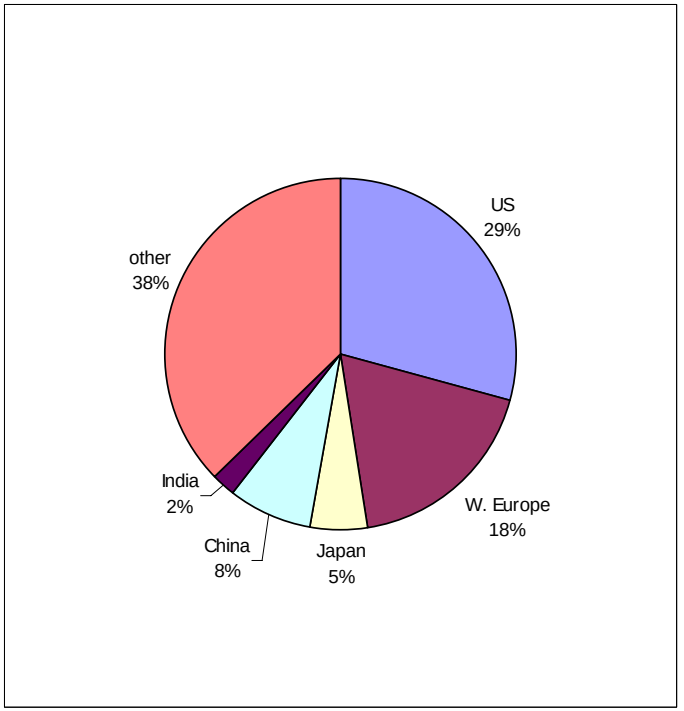
Energy content of various fuels

1 barrel (42 gallons) of crude oil = 5,800,000 Btu
1 gallon of gasoline = 124,000 Btu
1 gallon of heating oil = 139,000 Btu
1 gallon of diesel fuel = 139,000 Btu
1 barrel of residual fuel oil = 6,287,000 Btu
1 cubic foot of natural gas = 1,026 Btu
1 gallon of propane = 91,000 Btu
1 pound of coal = 10,000 Btu
1 kilowatthour of electricity = 3,412 Btu

1990

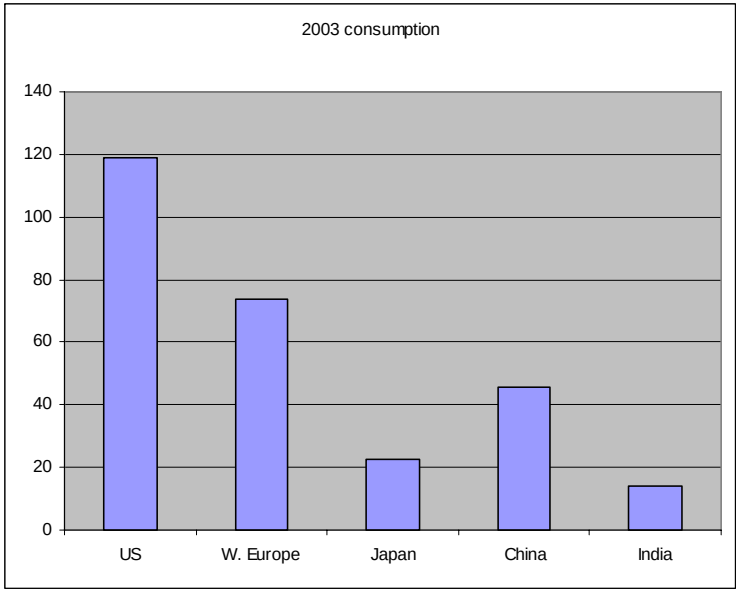
Annual energy consumed, in quads

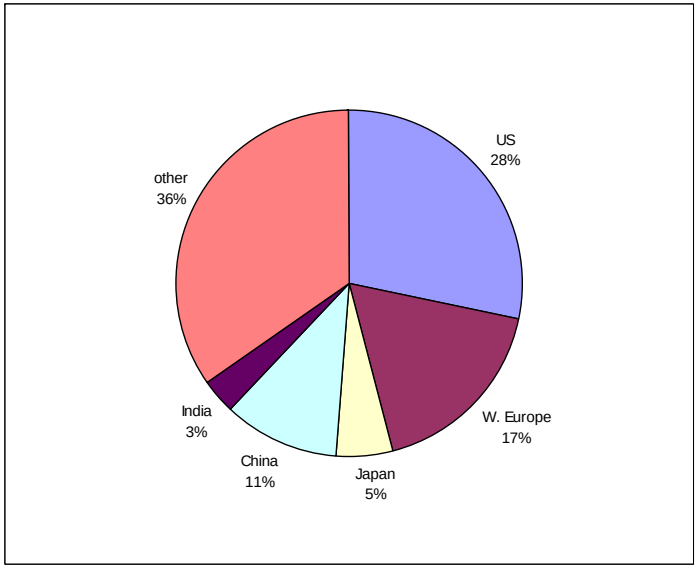




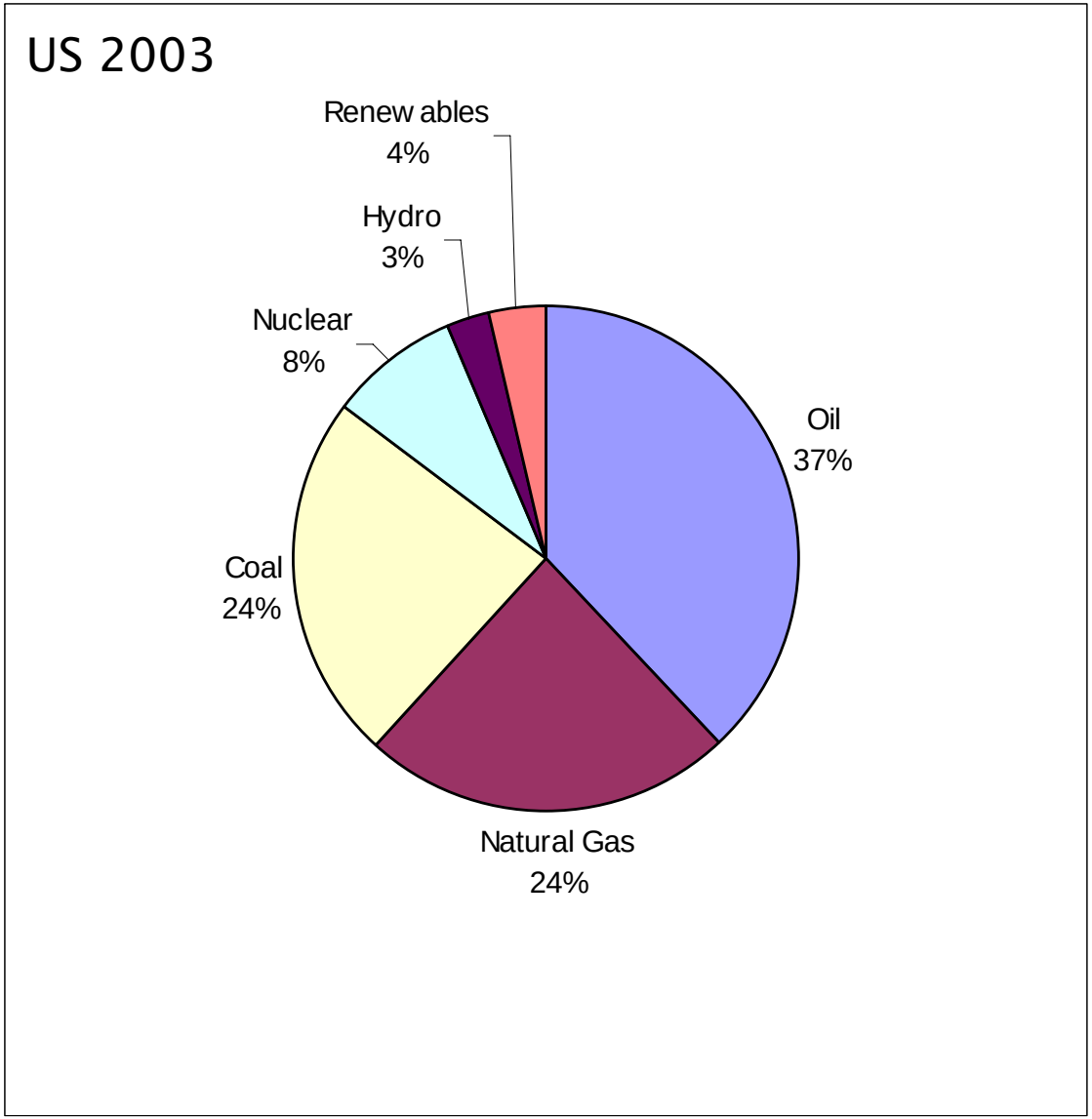
2003

Annual energy consumed, in quads





Energy consumption by source



End uses of energy by sector: US 2003

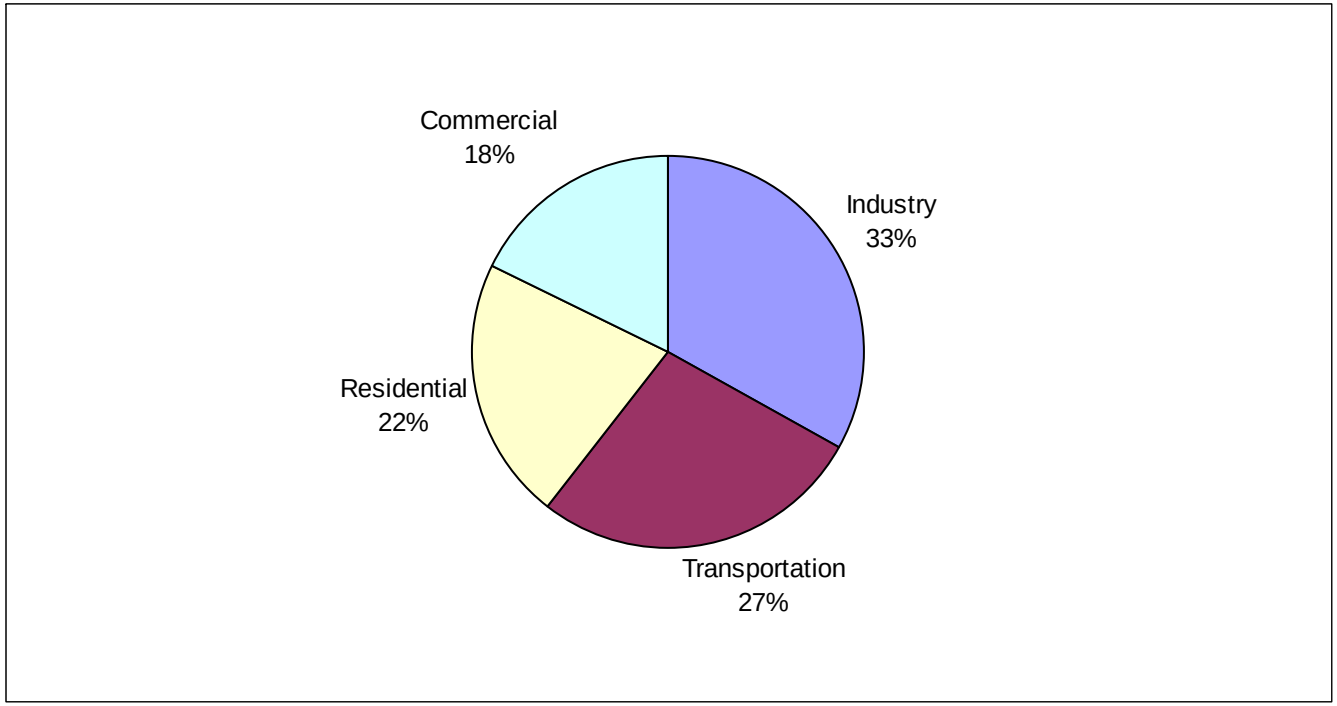
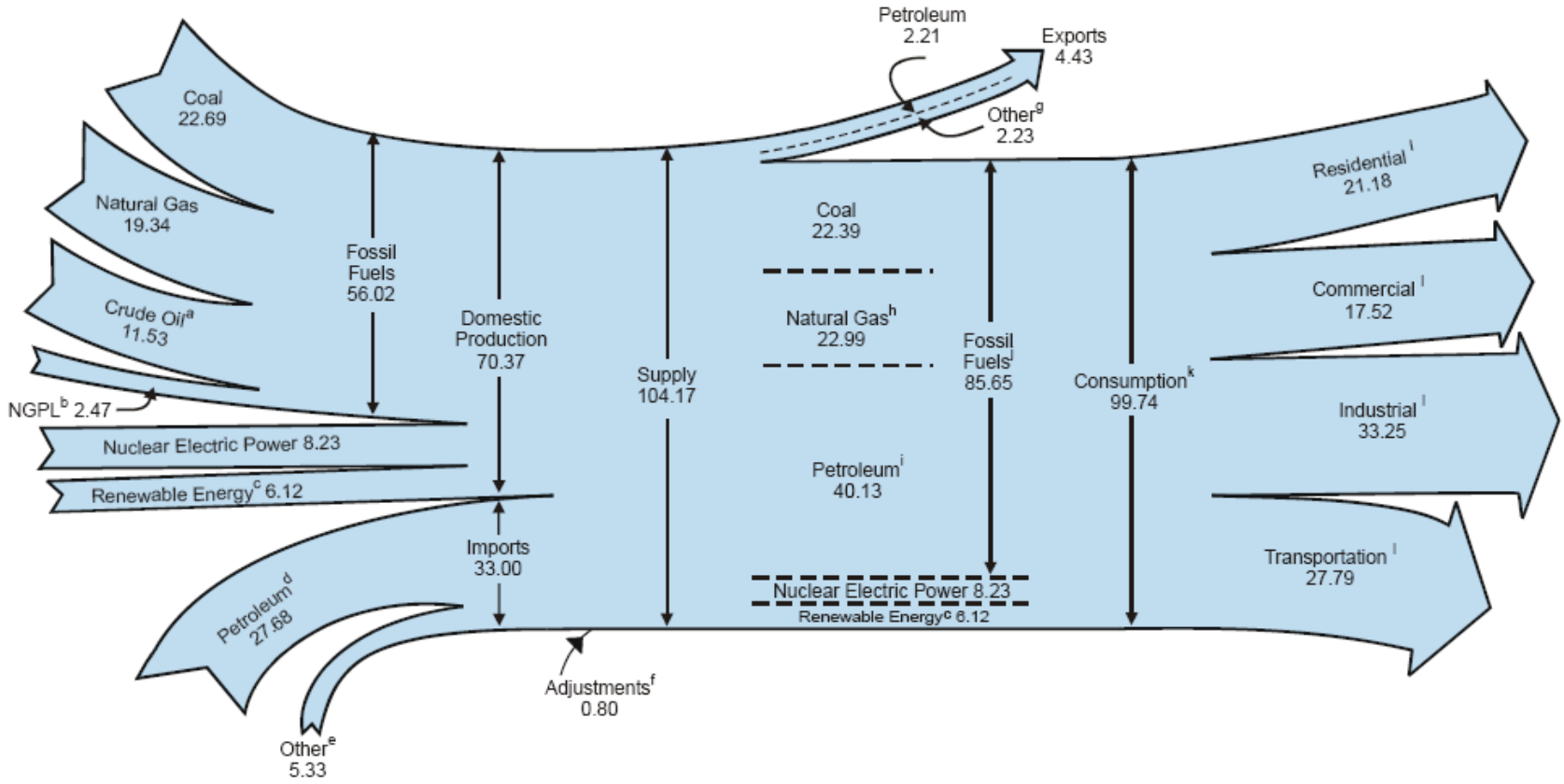


Diagram 1. Energy Flow, 2004
(Quadrillion Btu)



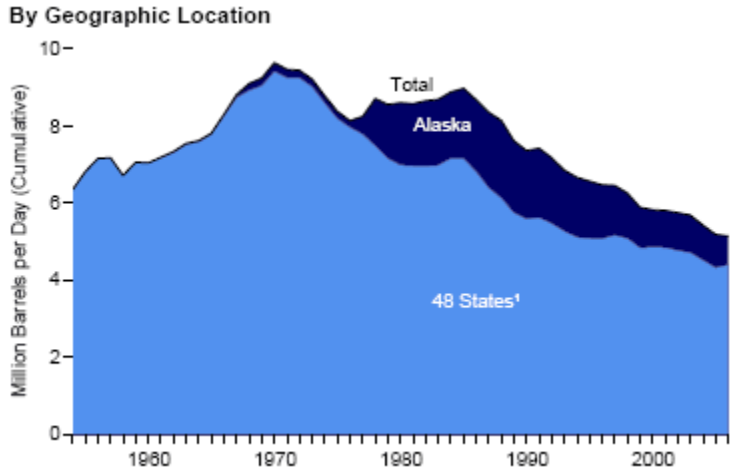
[a] Includes lease condensate.
[b] Natural gas plant liquids.
[c] Conventional hydroelectric power, wood, waste, ethanol blended into motor gasoline, geothermal, solar, and wind.
[d] Crude oil and petroleum products. Includes imports into the Strategic Petroleum Reserve.
[e] Natural gas, coal, coal coke, and electricity.
[f] Stock changes, losses, gains, miscellaneous blending components, and unaccounted-for supply.
[g] Coal, natural gas, coal coke, and electricity.
[h] Includes supplemental gaseous fuels.
[i] Petroleum products, including natural gas plant liquids.
[j] Includes 0.14 quadrillion Btu of coal coke net imports.
[k] Includes, in quadrillion Btu, 0.30 ethanol blended into motor gasoline, which is accounted for in both fossil fuels and renewable energy but counted only once in total consumption; and 0.04 electricity net imports.
[l] Primary consumption, electricity retail sales, and electrical system energy losses, which are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical Systems Energy Losses," at end of Section 2.

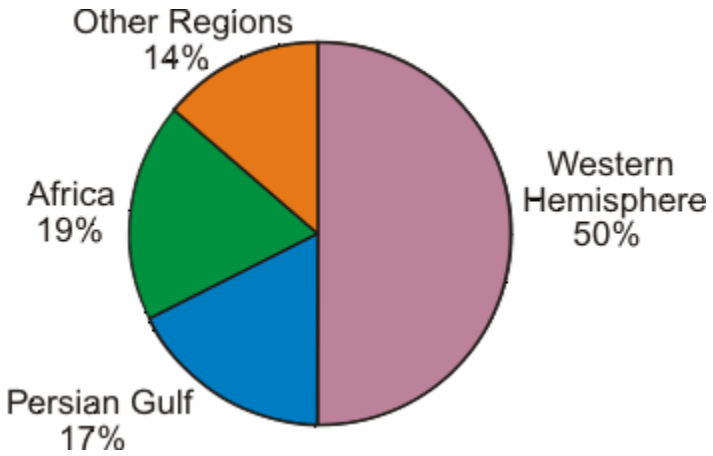
Notes: • Data are preliminary. • Totals may not equal sum of components due to independent rounding.

Sources: Tables 1.1, 1.2, 1.3, 1.4, 2.1a, and 10.1.

World consumption: 80 million barrels per day
US consumption: 20 million barrels per day
US imports: 12 million barrels per day

U.S. Petroleum Import Sources, 2005 (Percentage)





PSE&G Gas

Usage	Meter **2829183**
Actual reading Jan 17	935
Actual reading Dec 15	912
Difference	23
Conversion to CCF	x 1.0120
CCF total	23.276
Conversion to therms	x 1.03500
Total therms	24.091

Charges		Rate - RSG
Delivery		
Service charge		$5.79
Distribution charge	24.091 therms @ $0.2519613	6.07
Total Delivery		**$11.86**
Supply*		
BGSS Commodity	24.091 therms @ $0.79822340	19.23
Total Supply		**$19.23**
Total gas charges		**$31.09**

PSE&G Electric

Usage	Meter **126628218**
Actual reading Jan 17	26155
Actual reading Dec 15	25647
Total kWh	508

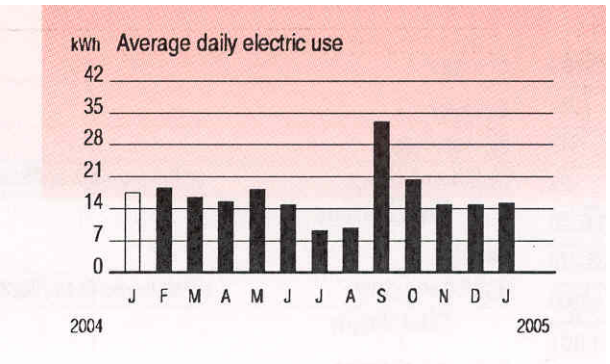
Charges		Rate - RS
Delivery		
Service charge		$2.41
Distribution charges		
kWh charges	508 kWh @ $0.053818898	27.34
Sub-Total Delivery		**$29.75**
Supply*		
BGS Energy		
Charges	508 kWh @ $0.054842520	27.86
Sub-Total Supply		**$27.86**
Total electric charges		**$57.61**

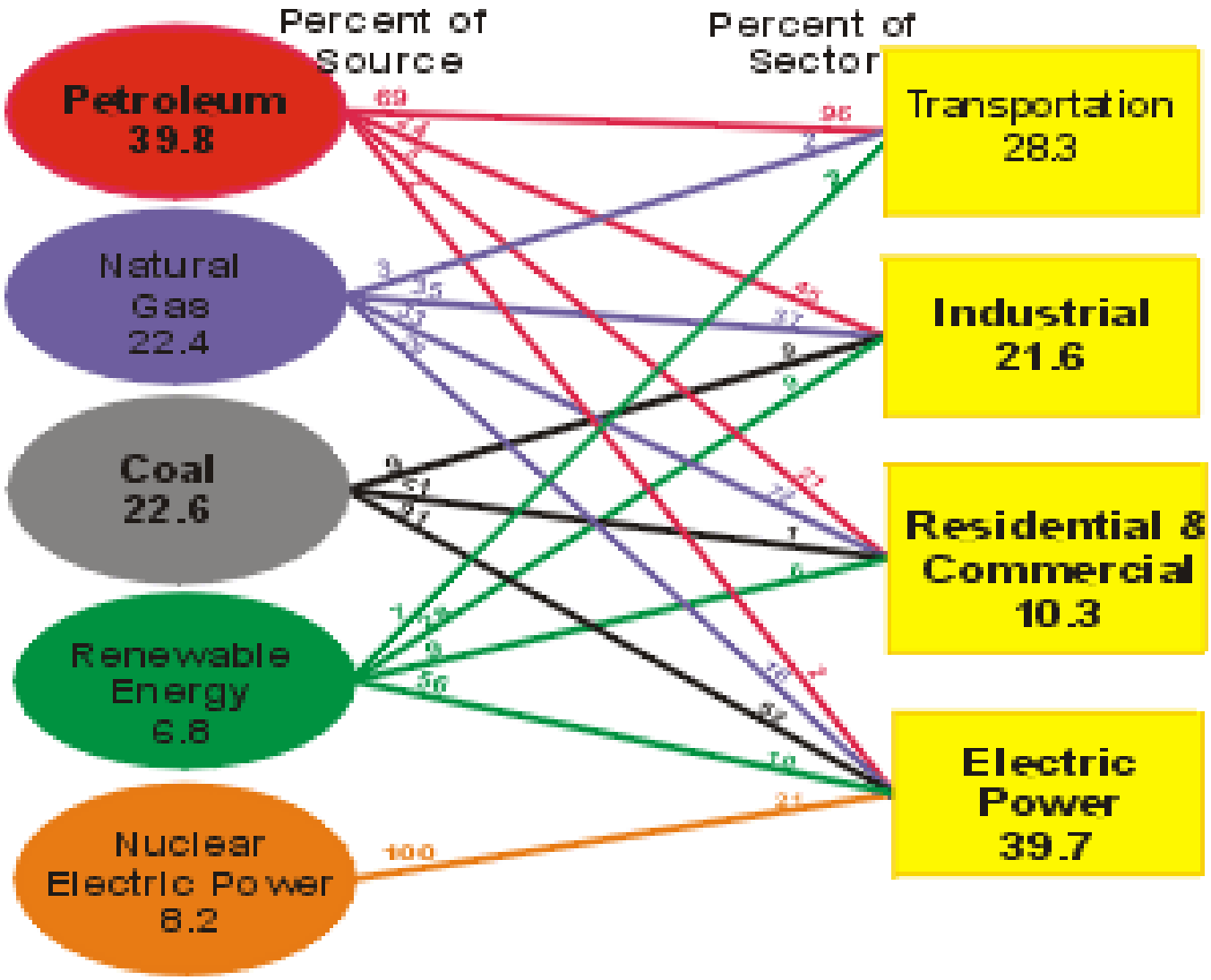
Date Delivered 08:09 1/17/05
Gallons Delivered 180.4
Driver No 429 Truck No 1129

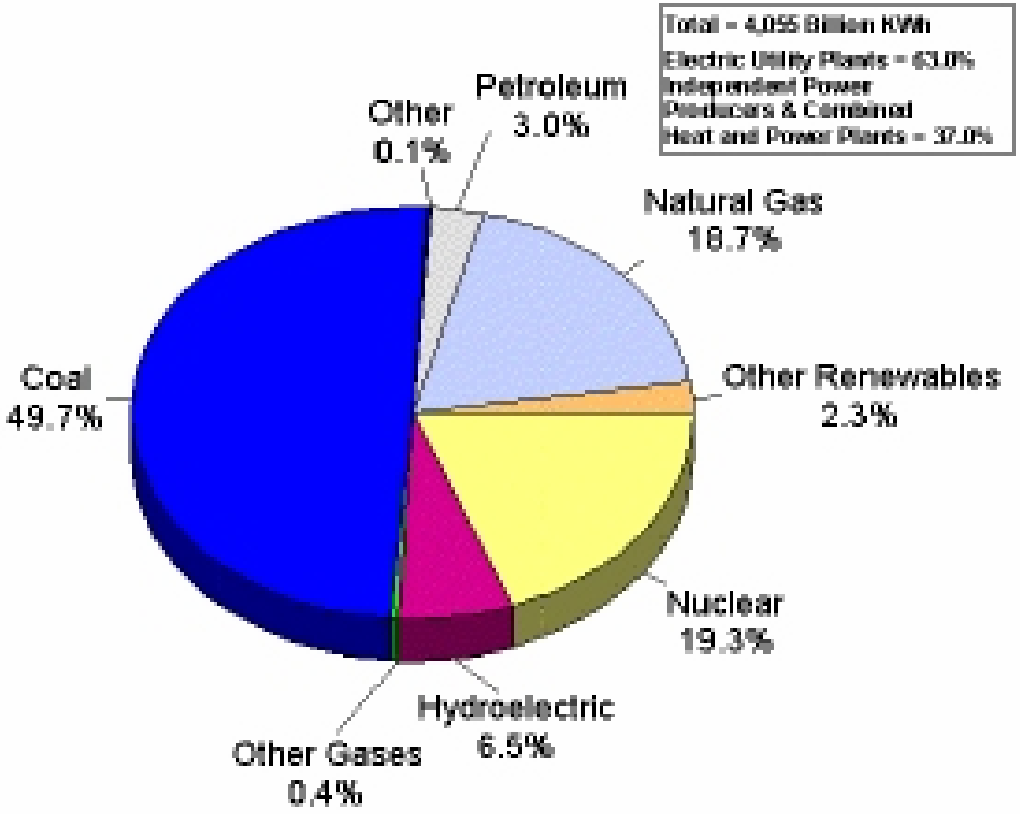
DESCRIPTION OF CHARGE	AMOUNT
#2 HEATING OIL	351.60
<180.4 Gallons @ $1.949>	
TOTAL $ THIS DELIVERY	$351.60

SALESMAN: _____

ITEM	QTY	PRICE	AMOUNT
UNLEAD	8.428 gal	1.839	15.50
		TAX	0.00
		TOTAL $	15.50




Percent of Source
Percent of Sector
Petroleum 39.8
Natural Gas 22.4
Coal 22.6
Renewable Energy 6.8
Nuclear Electric Power 8.2
Transportation 28.3
Industrial 21.6
Residential & Commercial 10.3
Electric Power 39.7



US electricity generation 2005
from www.eia.doe.gov

Energy Source

The electricity you consume comes from the Pennsylvania-New Jersey-Maryland (PJM) power grid, which receives power from a variety of power plants and transmits electricity to meet the requirements of customers throughout the region. Your electric supplier is responsible for generating and/or purchasing electricity that is added to the power grid in an amount sufficient to satisfy electric usage requirements. Resources used to generate electricity fall into two categories: Non-Renewable and Renewable Energy Resources.

Non-Renewable Energy

Coal	35.02%
Gas	10.47%
Hydroelectric (large)	0.82%
Nuclear	47.38%
Oil	2.63%

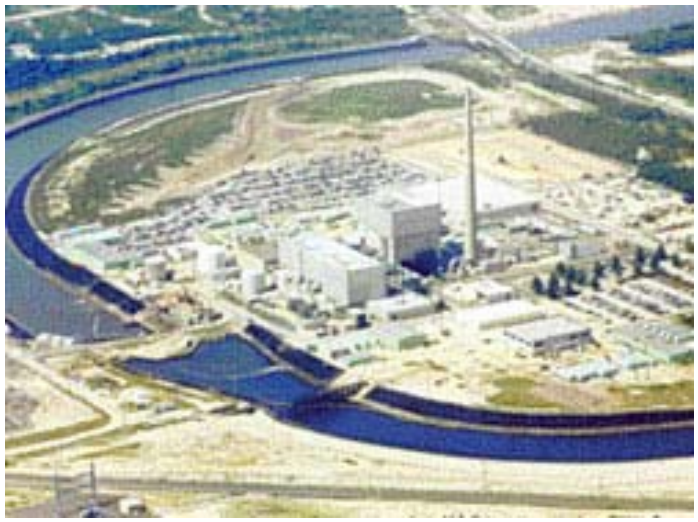
Non-Renewable Energy Resources are fossil fuels (gas, oil and coal) which are burned to produce electricity, or nuclear power. Among fossil fuels, natural gas is cleaner than coal. Coal can be burned producing fewer emissions with extensive investments in advanced pollution control equipment. Nuclear power produces electricity without any CO2, NOx, or SO2 emissions. PSEG produces power from gas, oil, coal and nuclear sources. PSEG has made investments in advanced pollution control equipment at its coal plants and operates state-of-the-art natural gas facilities.

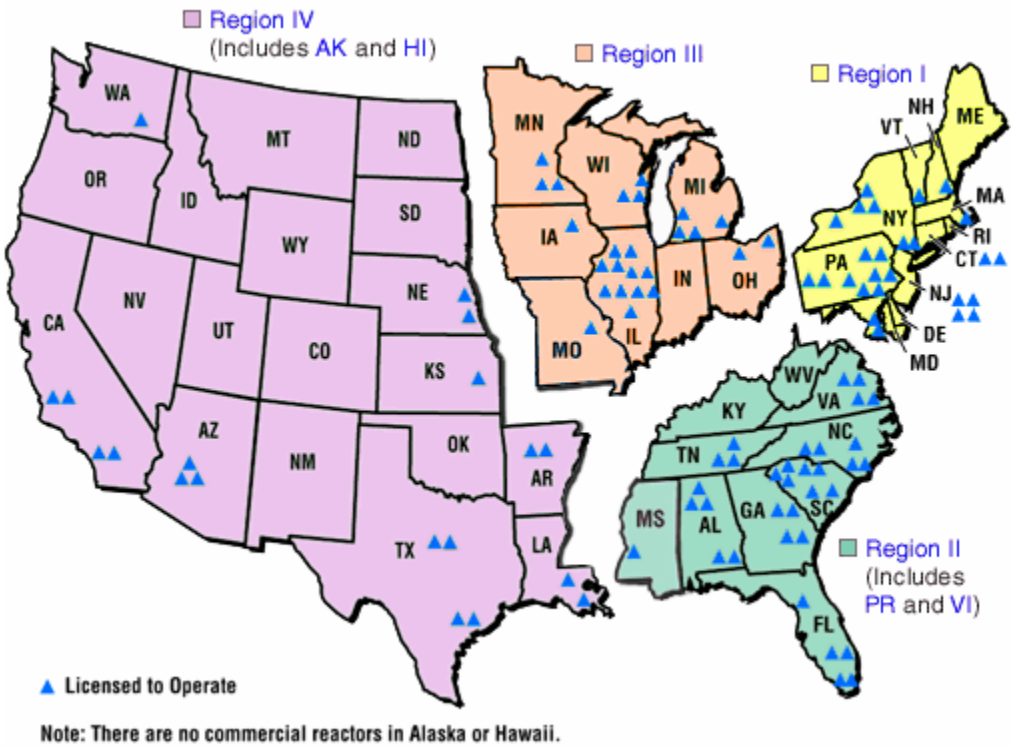
Renewable Energy

Captured methane gas	0.71%
Fuel cells	0.00%
Geothermal	0.00%
Hydroelectric (small)	0.13%
Solar	0.00%
Solid Waste	2.83%
Wind	0.01%
Wood or other biomass	0.00%

Air Emissions Air Emissions for CO2, NOx, and SO2 are presented as a percent of the New Jersey Benchmark. The benchmark is set at the average emissions performance of all electric generating units in New Jersey. Approximately 50% of the electricity generated in New Jersey comes from nuclear power. Nuclear power produces electricity without CO2, NOx and SO2 emissions; therefore, New Jersey's benchmark is low. Carbon Dioxide (CO2) is released when fossil fuels (coal, oil and gas) are burned. Carbon dioxide, a greenhouse gas, may contribute to global warming. Nitrogen Oxides (NOx) form when fossil fuels and biomass are burned at high temperatures. They contribute to ground-level ozone (or smog), and to the formation of acid rain. Sulfur Dioxide (SO2) is formed when fuels containing sulfur, primarily coal and oil, are burned. SO2 combines with water and oxygen in the atmosphere to form acid rain.

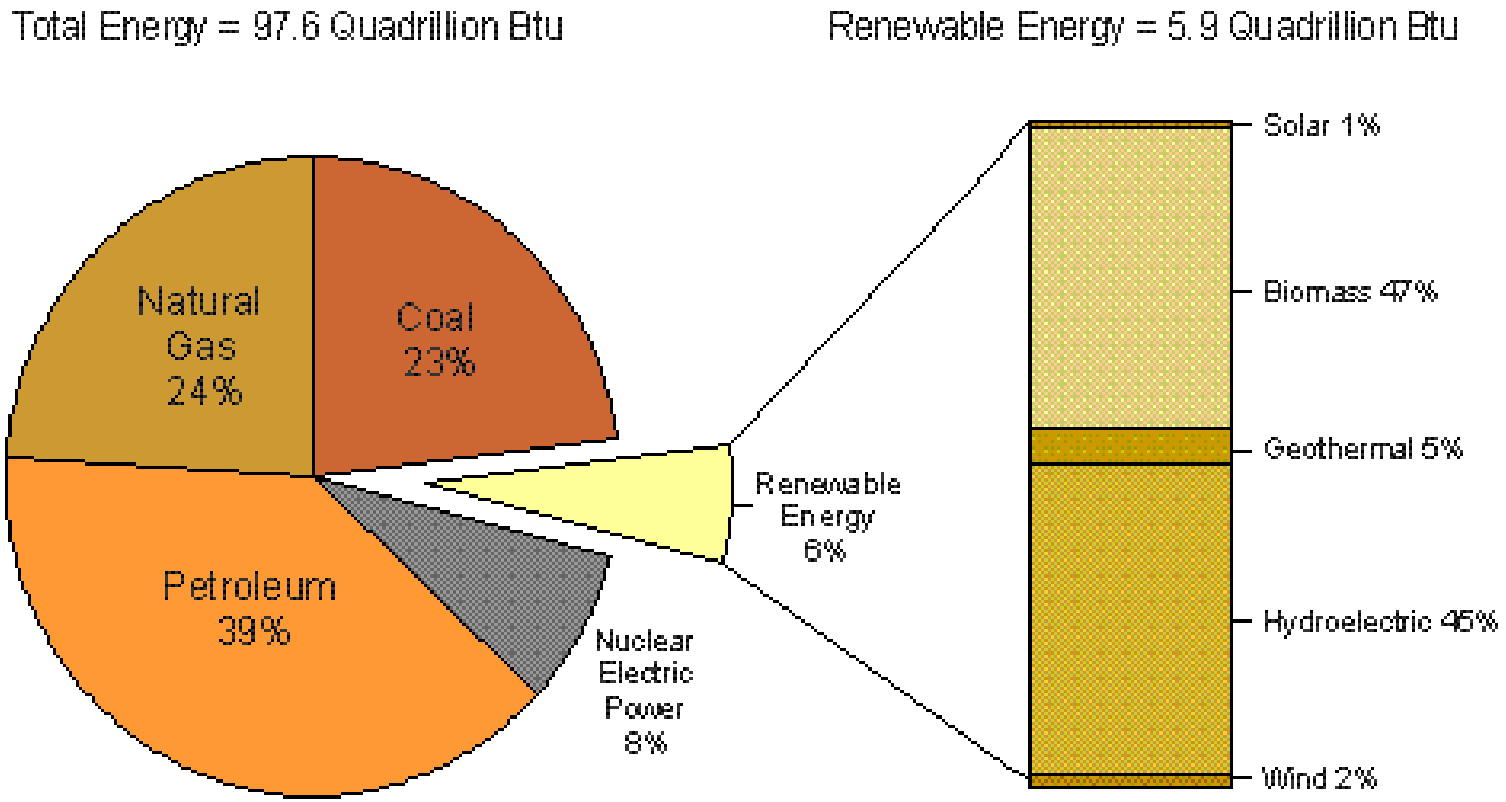
Nuclear power





104 plants
96,980 MW
Oyster Creek 619 MWe
Three Mile Island 802 MWe

Overview of renewable energy



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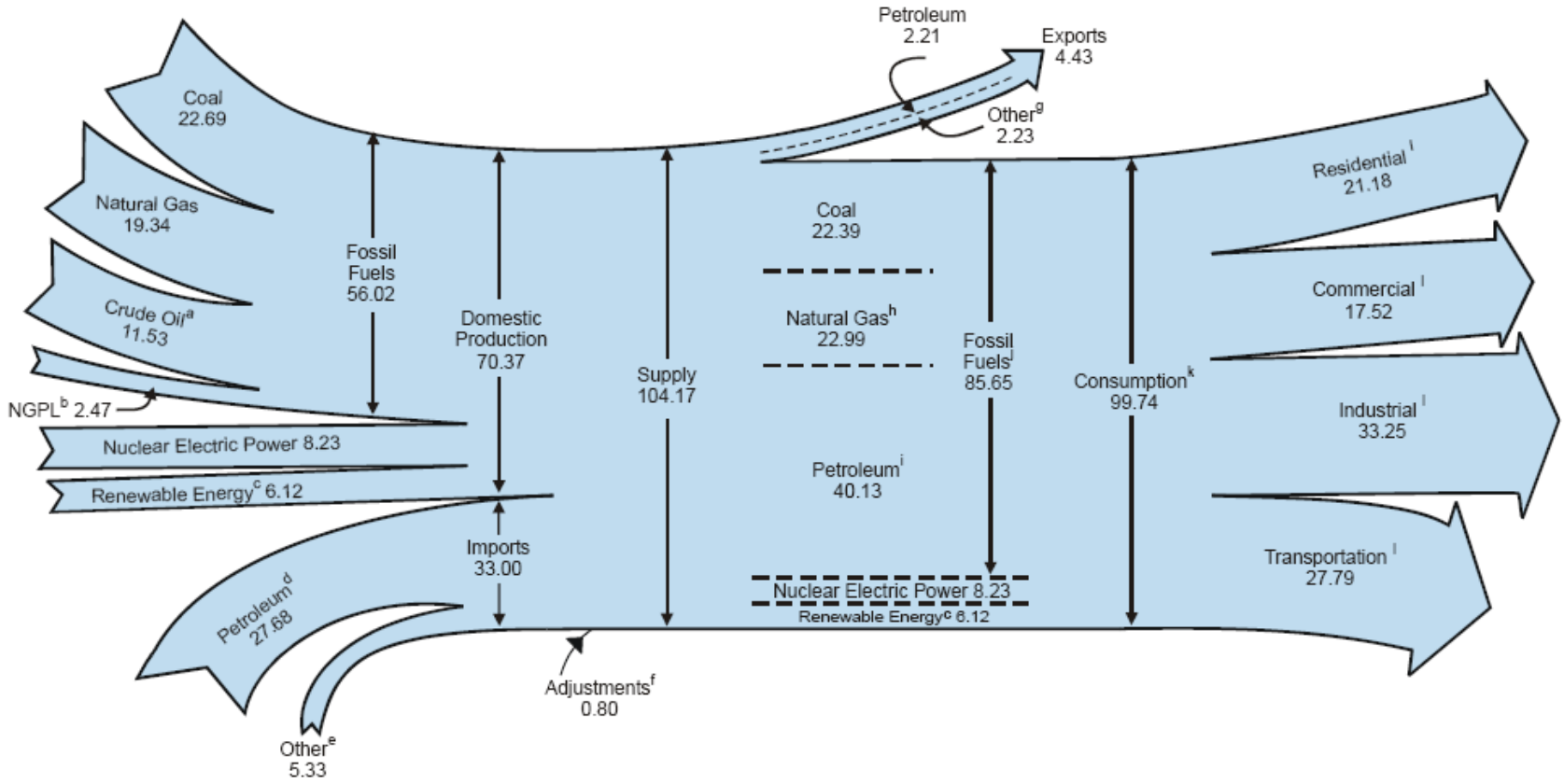

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