AGENDA: 3

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Overview of Energy Issues

Advisory Council
April 9, 2014

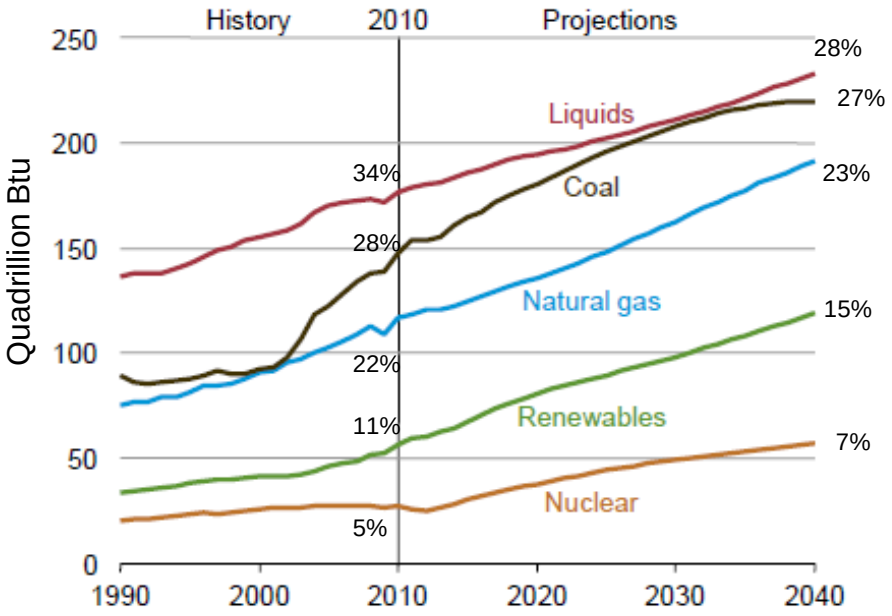
Brian Bateman
Health & Science Officer

Presentation Outline

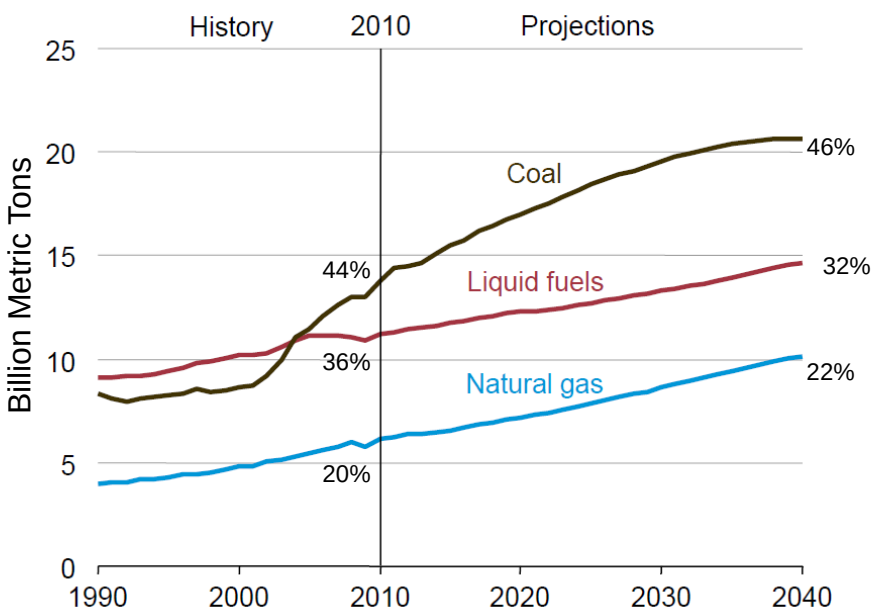
- Use and Production of Energy
  - Fuels
  - End-use sectors
    - Residential
    - Commercial
    - Industrial (including agriculture)
    - Transportation
  - Trends and projections
    - Projections assume continuation of existing laws, regulations and policies
- Air pollution focus will be on carbon dioxide (CO_2)
- Most information is from the U.S. Energy Information Administration
- Scope
  1. World
  2. United States
  3. California
  4. Bay Area

World Energy Consumption and Related CO_2 Emissions by Fuel Type

World Energy Consumption by Fuel Type



World Energy-Related CO_2 Emissions by Fuel Type

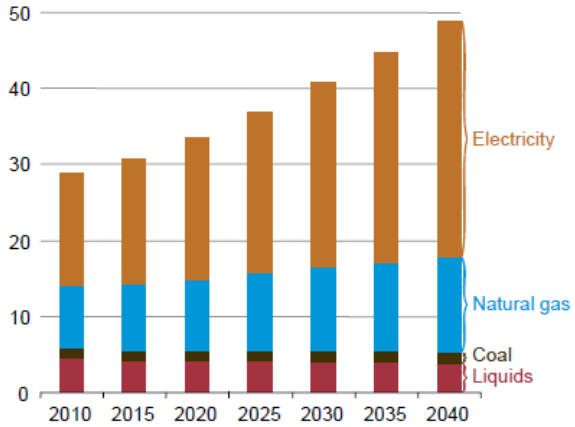


"Liquids" are 98% petroleum-based in 2010, and 96% petroleum-based in 2040, but also include liquid biofuels.

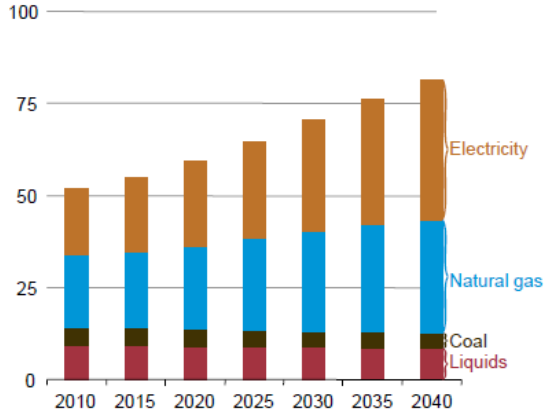
Source: International Energy Outlook 2013, U.S. Energy Information Administration. Projections are for IEO2013 Reference case based on laws, regulations, and policies in effect Sep. 1, 2012.

Worldwide Delivered Energy Consumption by Sector and Fuel

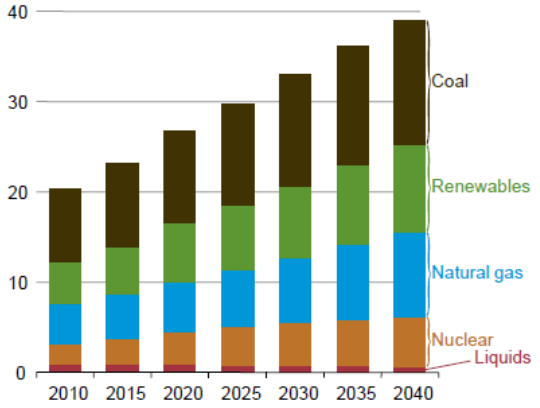
Commercial - 8% (2010)



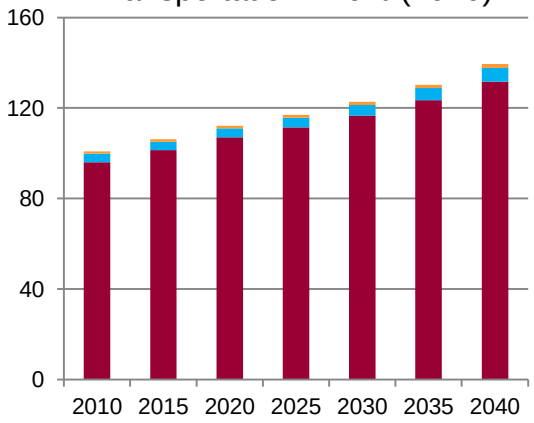
Residential - 14% (2010)



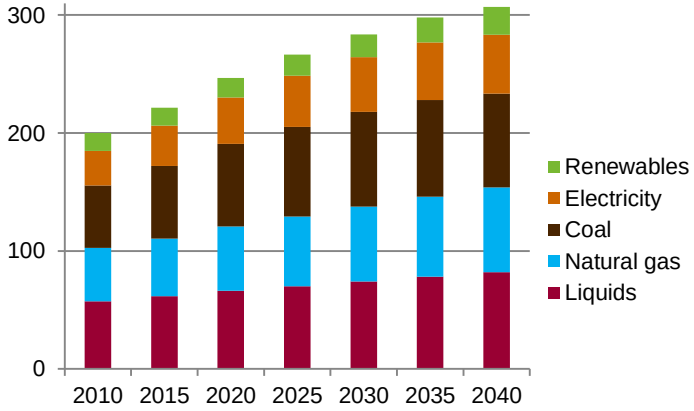
Electricity



Transportation - 26% (2010)



Industrial – 52% (2010)



Renewables (electricity)

2010
81% hydro
8% wind
2% geothermal
1% solar

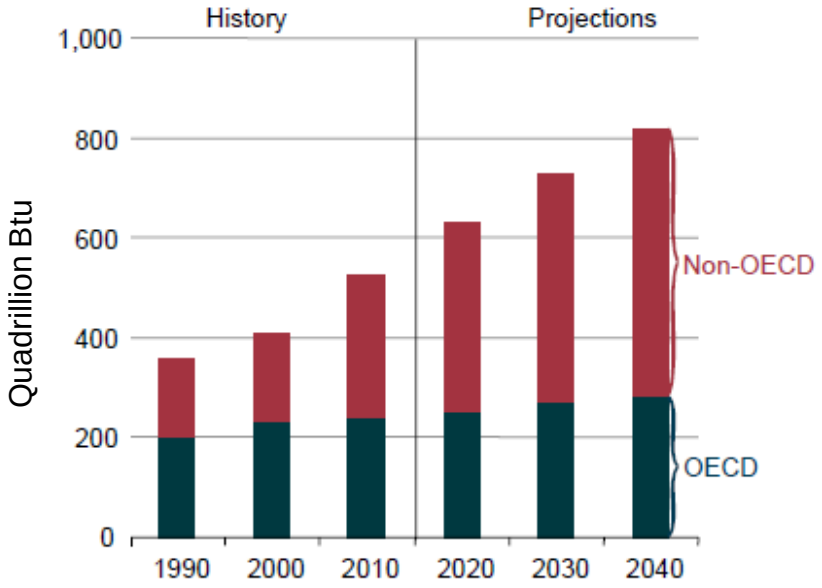
2040
65% hydro
19% wind
5% solar
2% geothermal

- Energy consumption is quadrillion Btu, except for "Electricity" which is trillion kilowatt-hours. "Liquids" are 98% petroleum-based in 2010, and 96% petroleum-based in 2040.

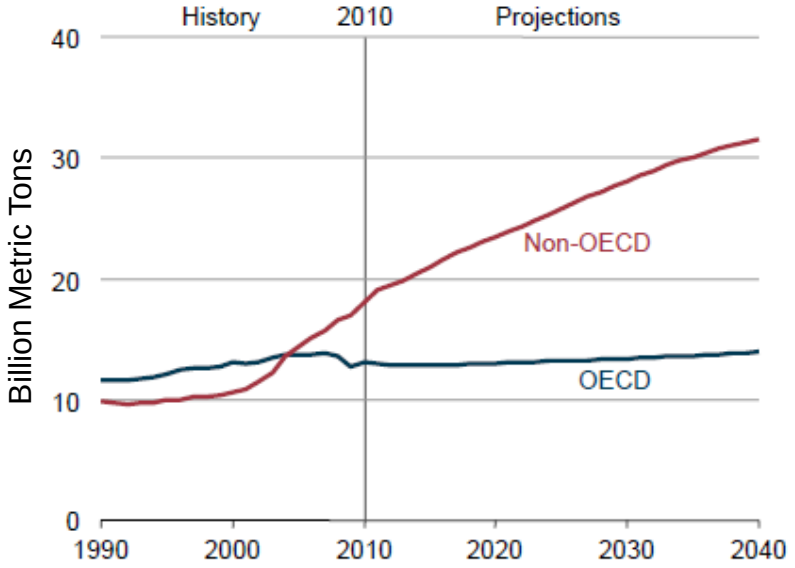
Source: International Energy Outlook 2013, U.S. Energy Information Administration.

World Energy Consumption and Related CO_2 Emissions

World Primary Energy Consumption

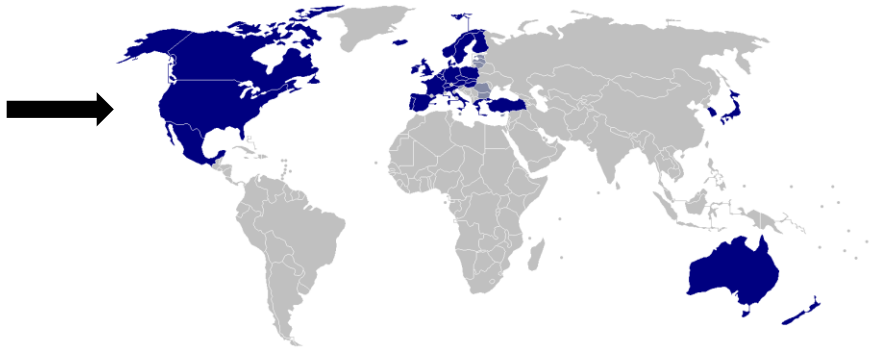


World Energy-Related CO_2 Emissions



(Primary consumption includes electrical system loses)

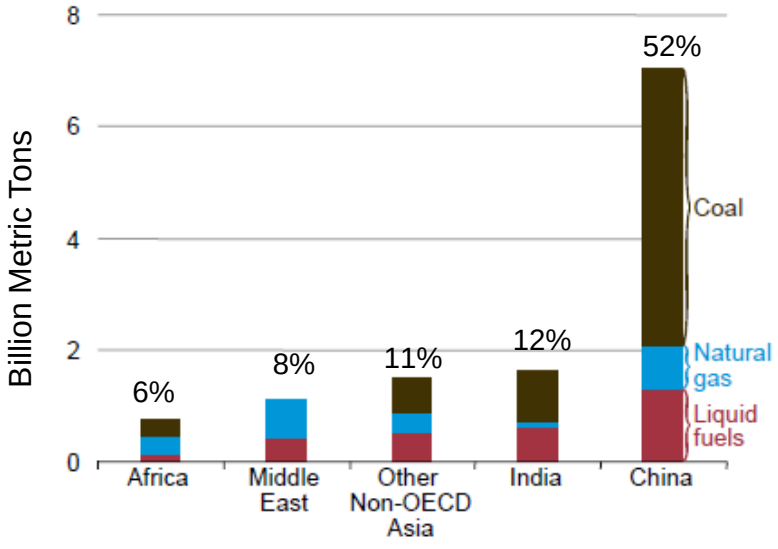
Map of Organization for Economic Cooperation and Development (OECD) member countries. (Map does not show most recent OECD member countries: Chile, Israel, and Estonia.)

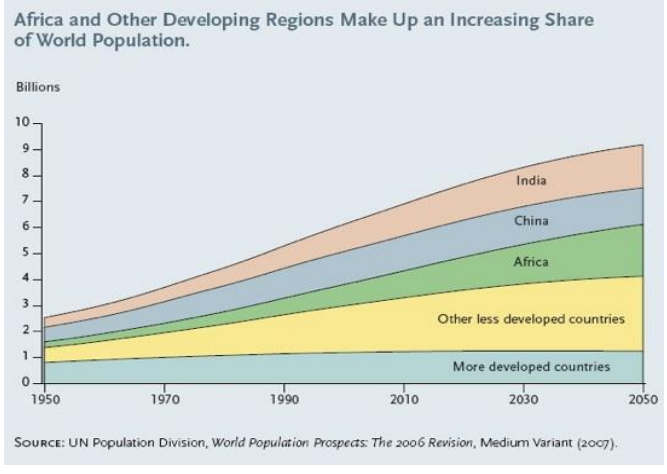


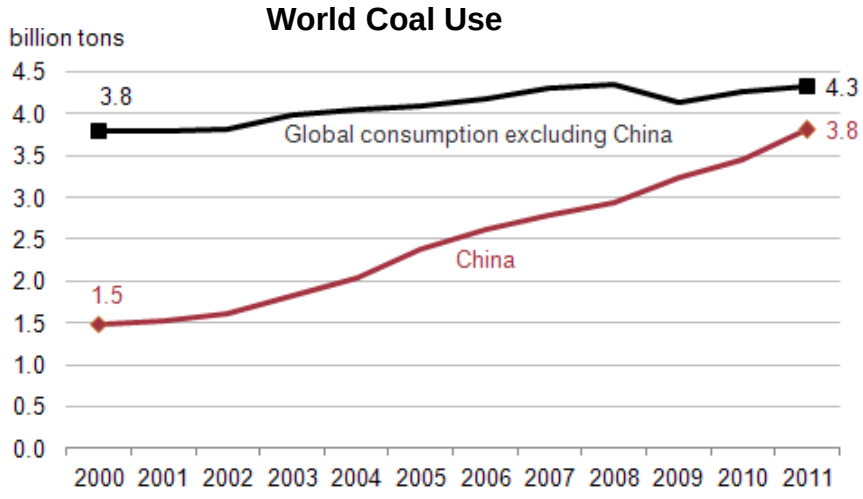
Source: International Energy Outlook 2013, U.S. Energy Information Administration. Projections are for IEO2013 Reference case based on laws, regulations, and policies in effect Sep. 1, 2012.

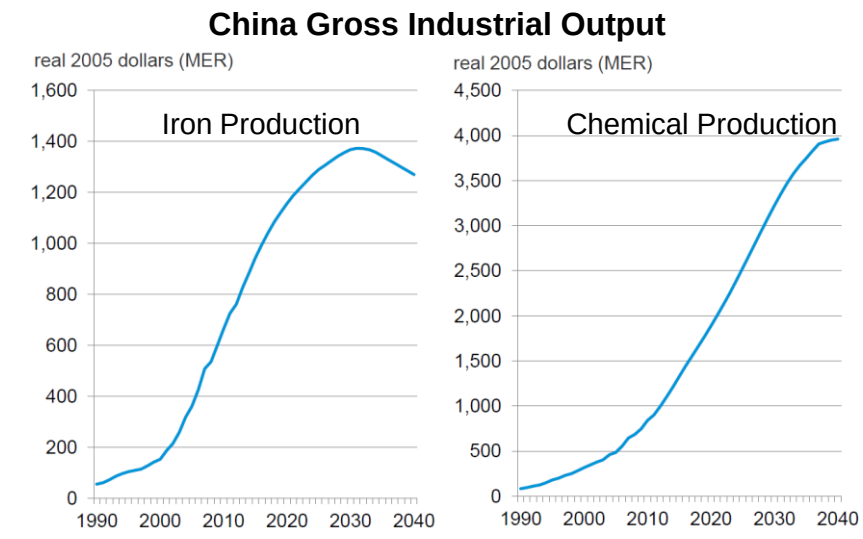
Growth in Energy Use in China and Other Developing Countries

Increases in Energy-Related CO_2 Emissions for Non-OECD Regions with the Largest Increases (2010-2040)





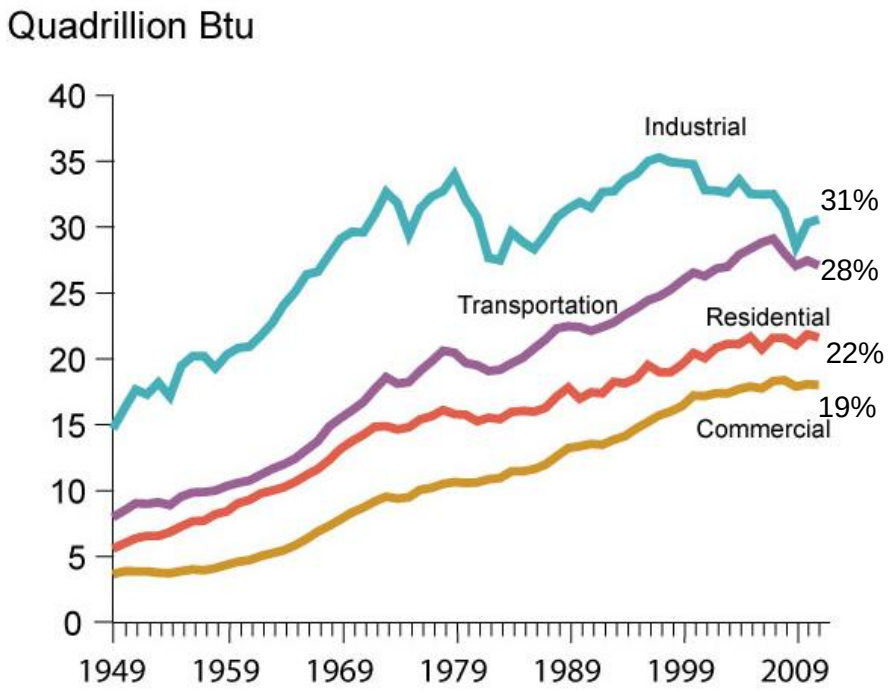




Source: International Energy Outlook 2013, U.S. Energy Information Administration.

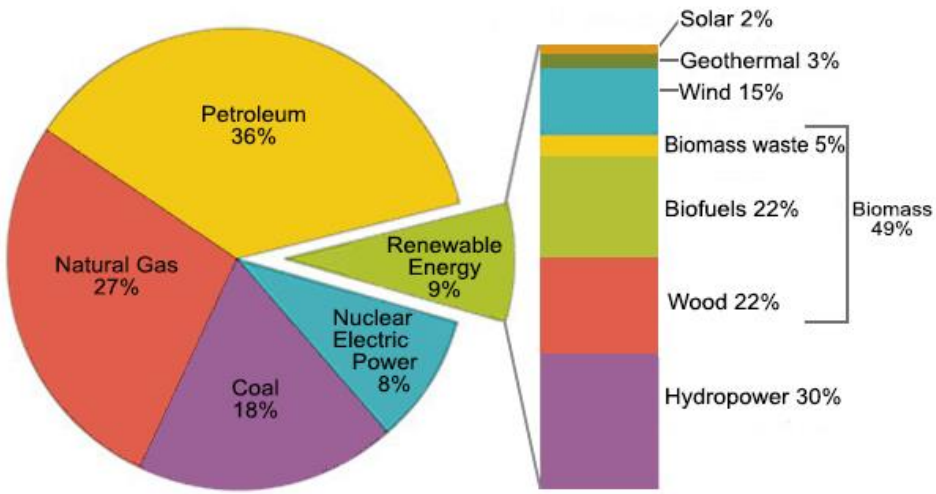
U.S. Energy Consumption

U.S. Energy Consumption by Sector



Source: Annual Energy Review 2011 ,
U.S. Energy Information Administration.

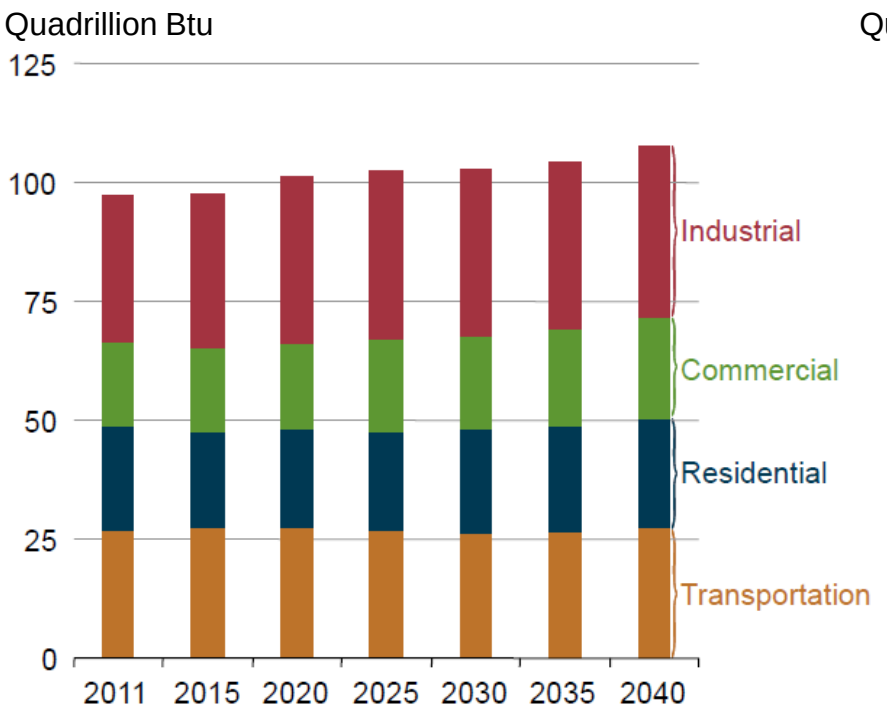
U.S. Energy Consumption by Fuel Type (2012)



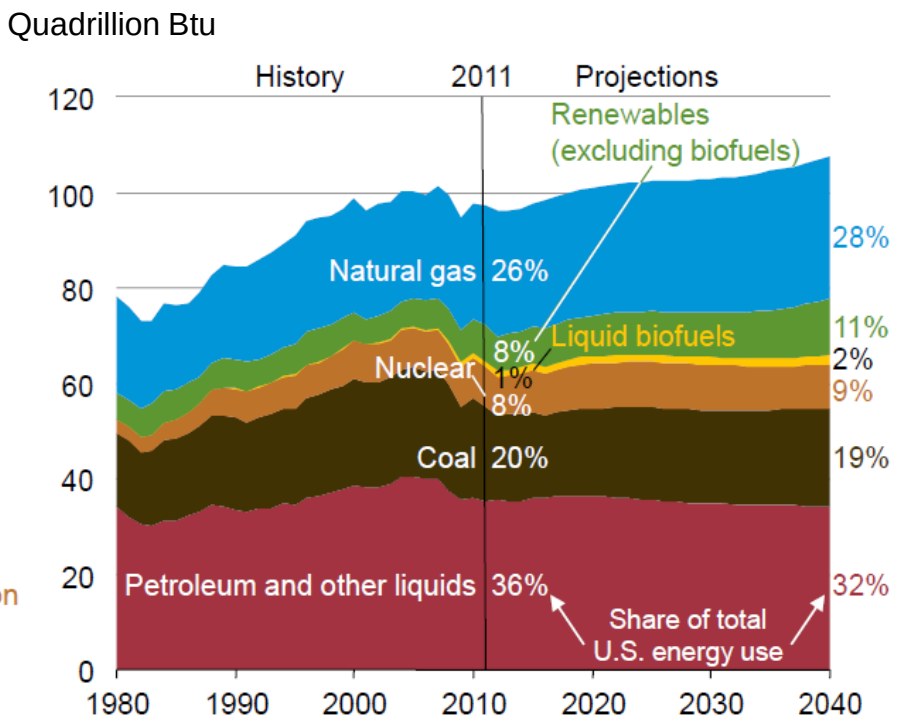
Source: Monthly Energy Review, April 2013,
U.S. Energy Information Administration.

Projections of U.S. Energy Consumption by Sector and Fuel Type

U.S. Energy Consumption by Sector



U.S. Energy Consumption by Fuel

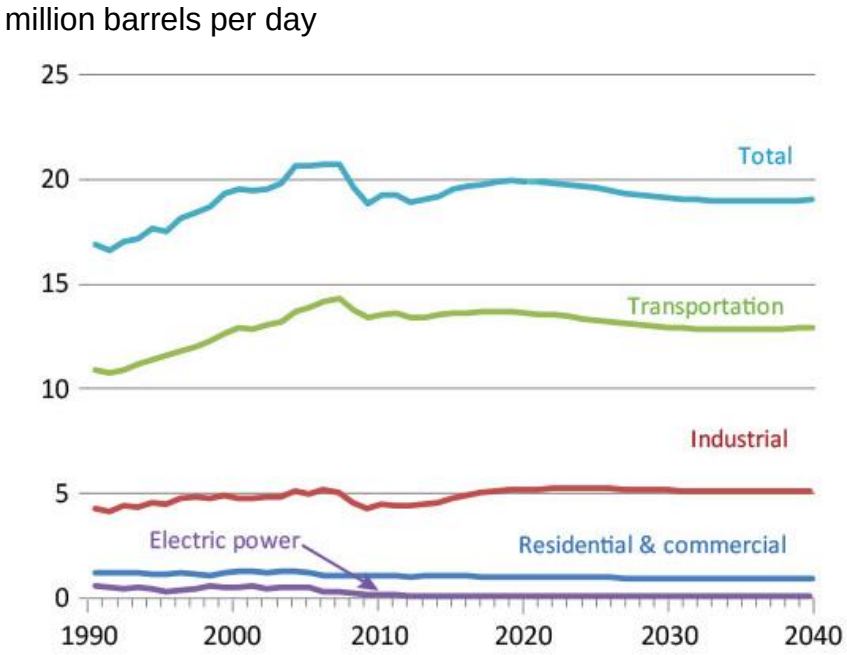


- The Dept. of Energy projects total U.S. energy consumption will increase by 0.3% per year from 2010 to 2040. (The U.S. population is projected to increase 0.9% per year).

Source: Charts are from Annual Energy Outlook 2013, U.S. Energy Information Administration. Projections are for AEO2013 Reference case.

Petroleum and Other Liquid Fuels: U.S. Consumption

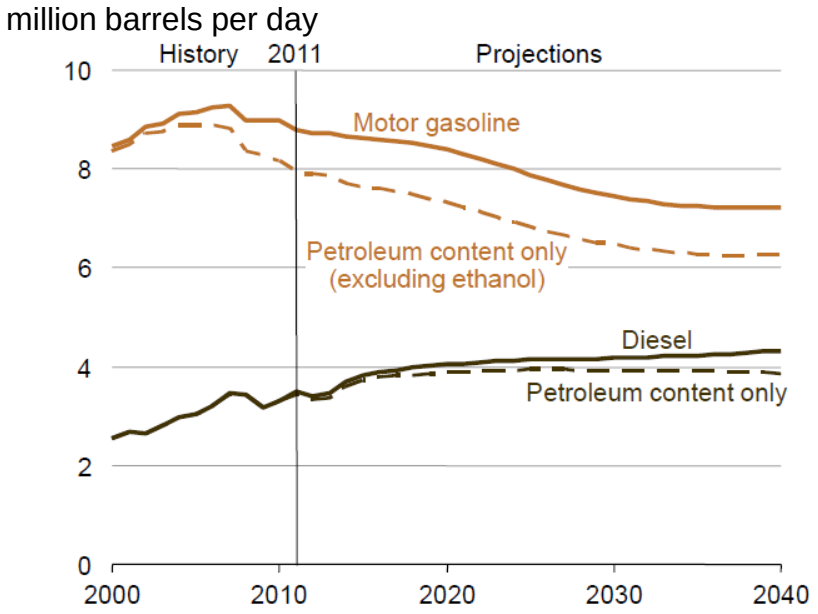
U.S. Consumption of Petroleum and Other Liquids by Sector



- Largest uses of petroleum in the Industrial Sector are petrochemical feed stocks and asphalt and road oil

Source: Charts are from Annual Energy Outlook 2013, U.S. Energy Information Administration.

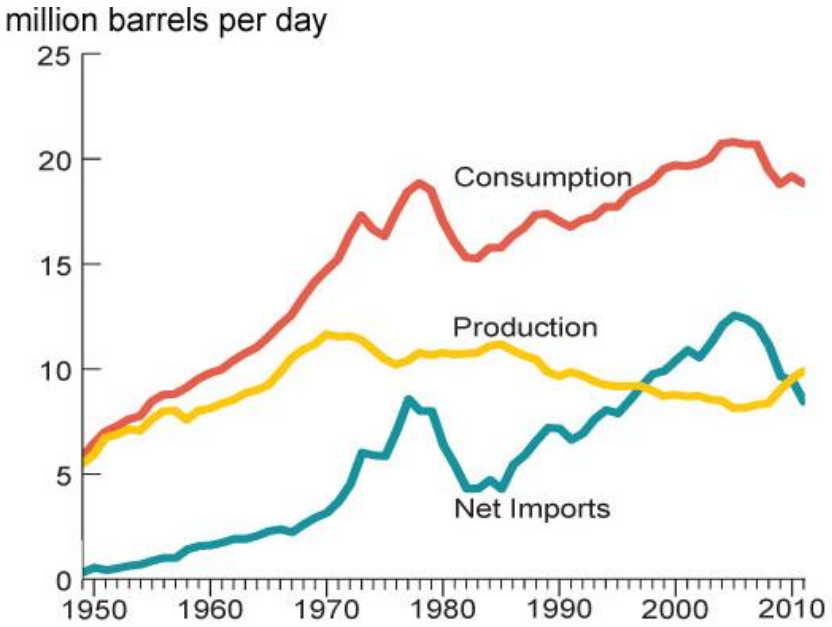
U.S. Motor Gasoline and Diesel Fuel Consumption



- Motor gasoline and diesel fuel contribution to total Transportation Sector energy consumption:
  82% (2010)
  76% (2040)
- The decline in motor gasoline consumption over the projection period reflects the effects of more stringent Corporate Average Fuel Economy (CAFE) standards.

Petroleum and Other Liquid Fuels: U.S. Production and Imports

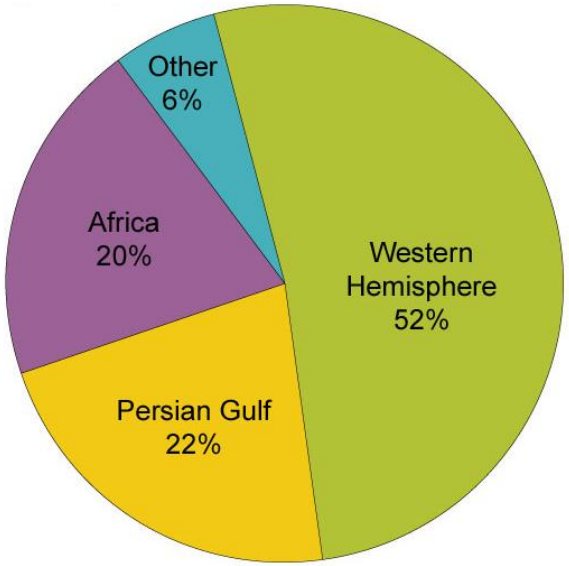
U.S. Petroleum and Other Liquids Consumption, Production, and Imports



- The net import share of U.S. petroleum and other liquids consumption fell from 60 percent in 2005 to 45 percent in 2011. The Dept. of Energy projects that the net import share will fall to 34 percent in 2019, before increasing to 37 percent in 2040. (Under the "High Oil and Gas Reserves" case, net imports are projected to decrease to 7% by 2040).

Source: Monthly Energy Review April 2012, U.S. Energy Information Administration.

Sources of U.S. Petroleum Imports (2011)



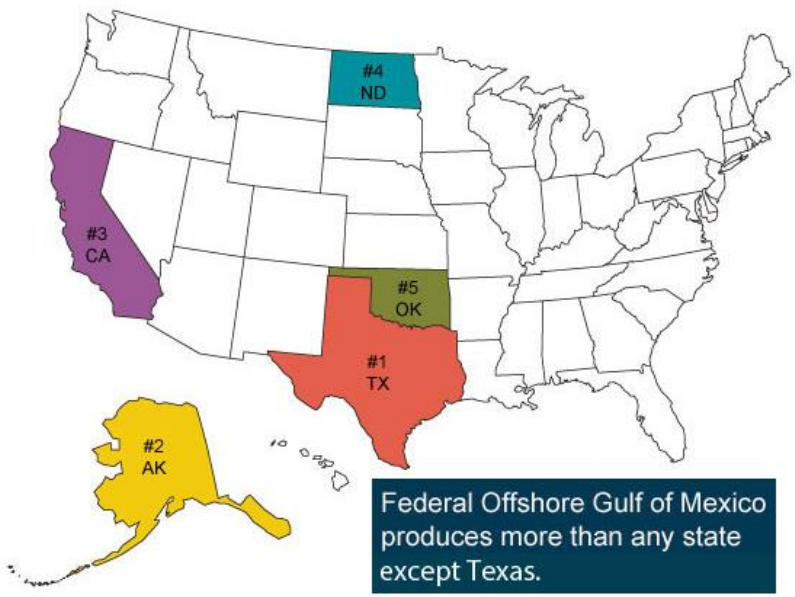
Top U.S. Petroleum Imports by Country (2011)

1. Canada: 29%
2. Saudi Arabia: 14%
3. Venezuela: 11%
4. Nigeria: 10%
5. Mexico: 8%

Source: Petroleum Supply Monthly Feb. 2012, U.S. Energy Information Administration.

U.S. Crude Oil Production

Top Crude Oil Producing States (2011)

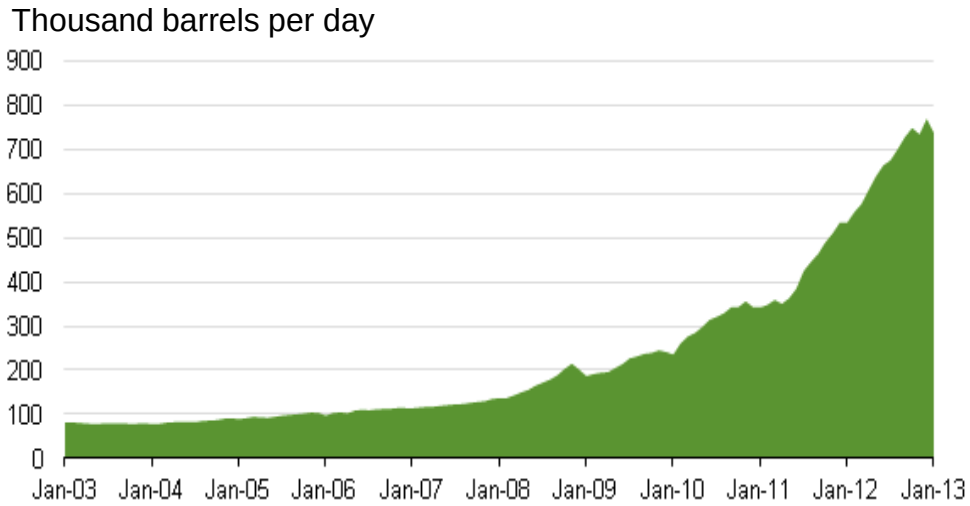


Source: Petroleum Supply Monthly April 2012, U.S. Energy Information Administration.

Top U.S. Crude Oil Producers in 2012:

1. Texas: 31%
2. Gulf of Mexico: 20%
3. North Dakota: 10%
4. California: 8%
5. Alaska: 8%
6. Oklahoma: 4%

North Dakota Monthly Oil Production

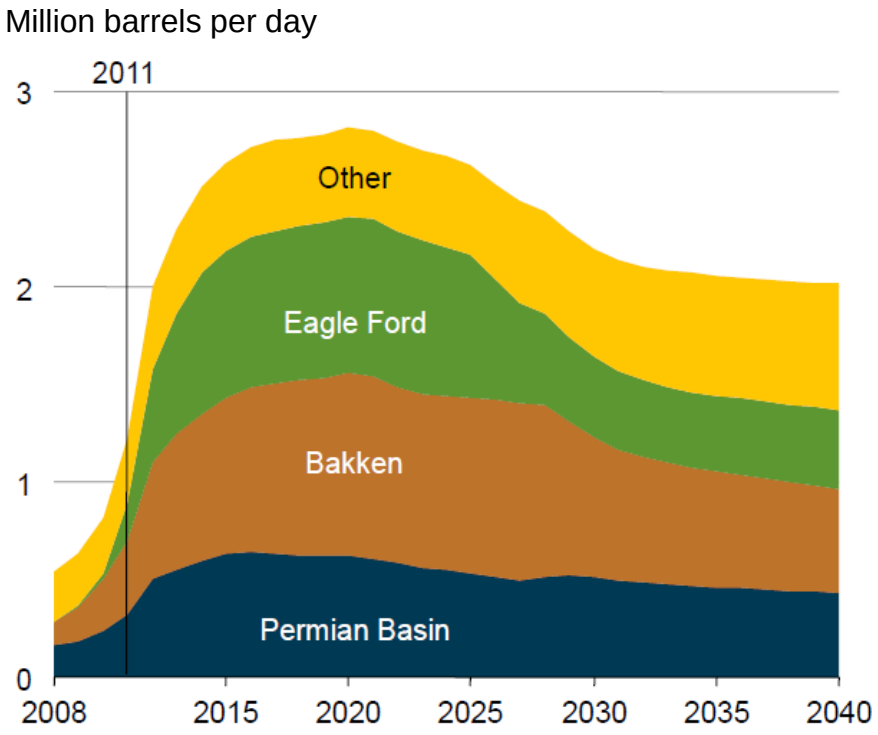


- North Dakota crude oil production tripled between 2009 and 2012 through the use of horizontal drilling and hydraulic fracturing in shale rock in the Bakken Formation.

Source: North Dakota Oil Production Reaches New High in 2012, U.S. Energy Information Administration, March 18, 2013.

Trends and Projections in U.S. Crude Oil Supplies

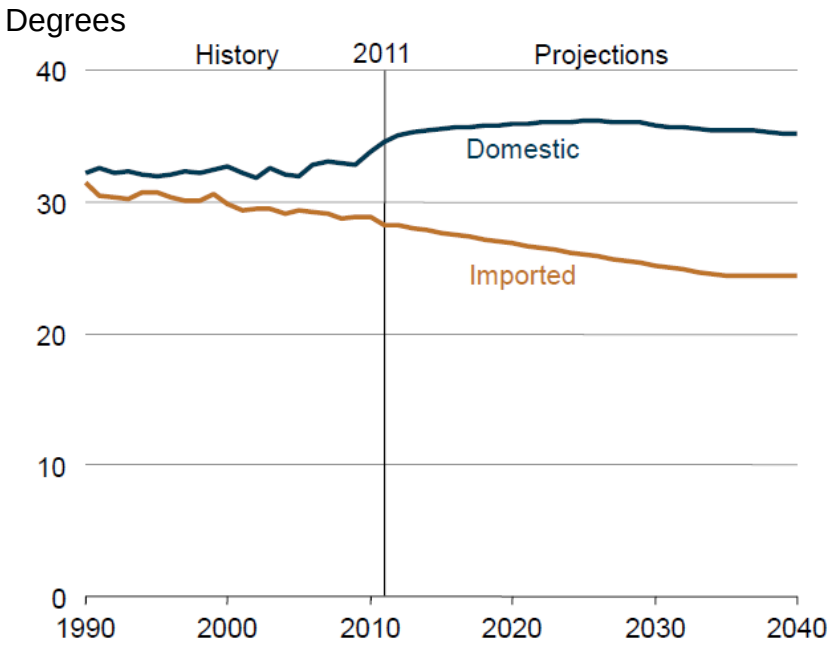
Total U.S. Tight Oil Production by Geological Formation



- "Tight oil" refers to oil trapped in shale, carbonate or sand formations. This oil is being recovered by horizontal drilling and hydraulic fracturing technologies.

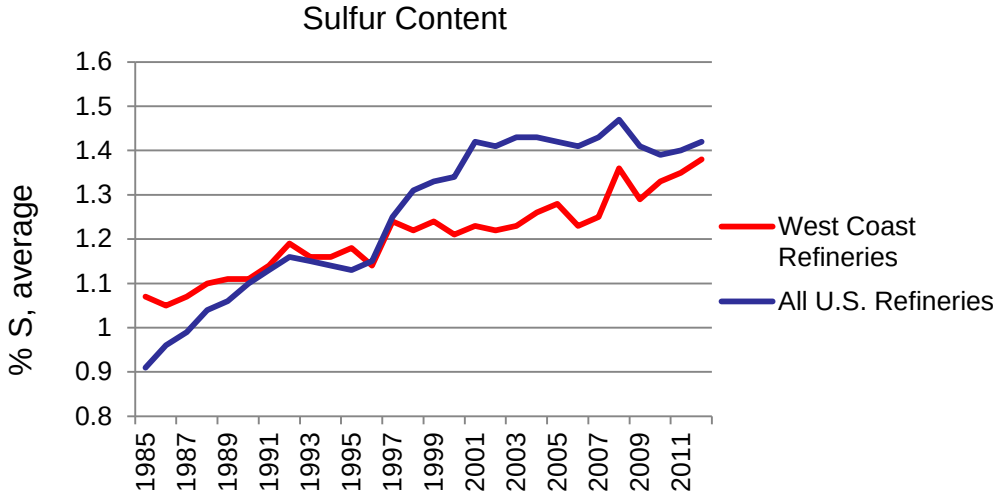
Source of Charts: Annual Energy Outlook 2013, U.S. Energy Information Administration.

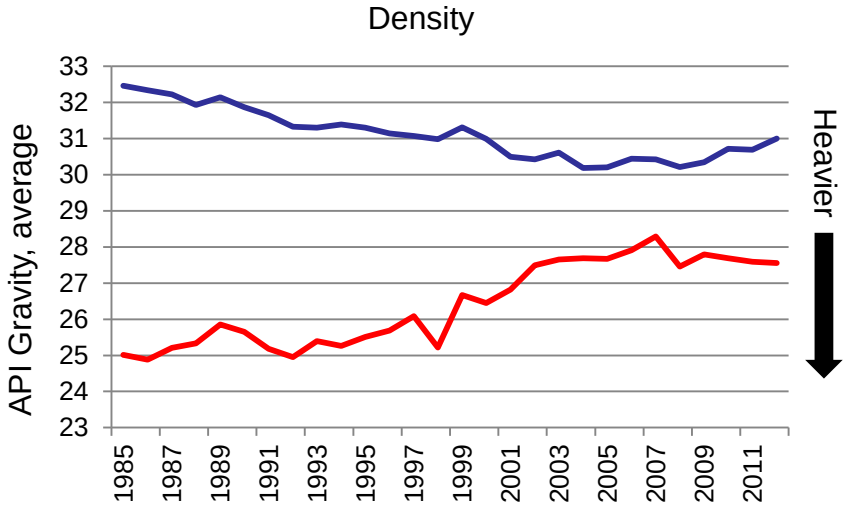
API Gravity of U.S. Domestic and Imported Crude Oil Supplies

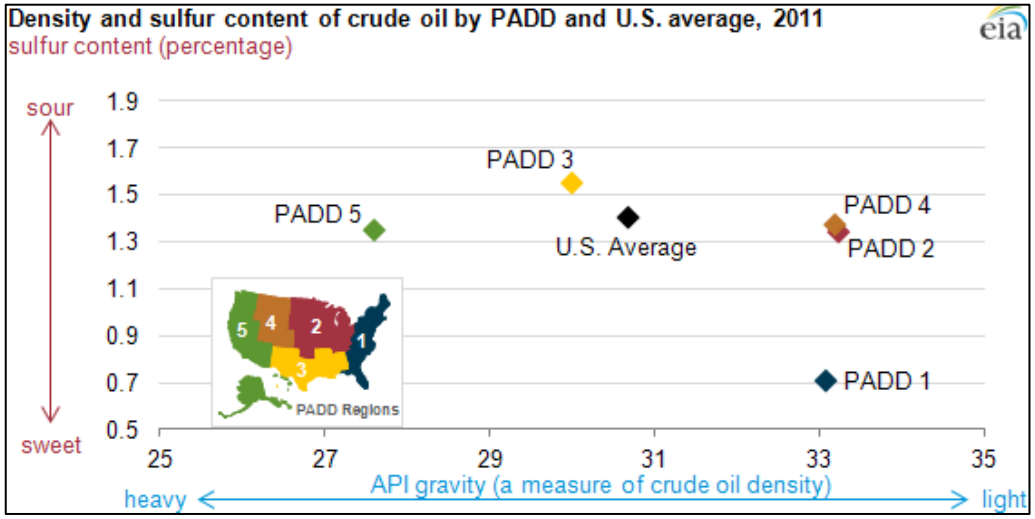


- API gravity is a measure of the density of a liquid. It is expressed in degrees, where a higher number indicates lower density.
- Crude oil with an API gravity greater than about 31 degrees is considered "light".
- Refineries generally process a mix of crude oils with a range of API gravities in order to optimize refinery operations.
- As U.S. refiners run more domestic light crude produced from tight formations, they will need less imported light crude to maintain an optimal API gravity.

Trends in Crude Oil Quality







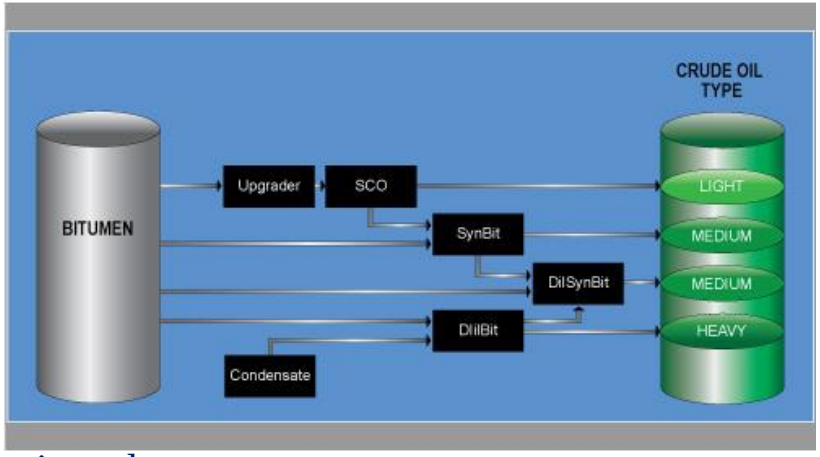
- API gravity is a measure of the density of a liquid. It is expressed in degrees, where a higher number indicates lower density.
- Crude oil with an API gravity greater than about 31 degrees is considered “light”.
- Average crude slate of California refineries (2011):
  - Sulfur content: 1.49%
  - API Gravity: 24.6 degrees

PAD District 5 (West Coast): Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington.

- California currently has 64% of PAD District 5’s refining capacity

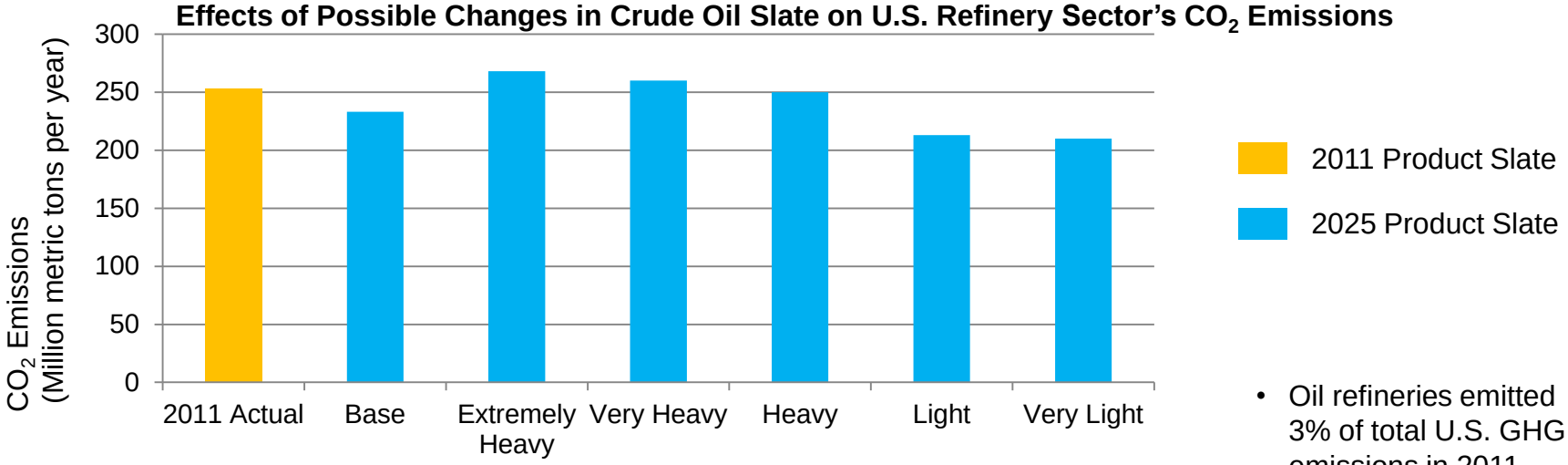
Crude Oil Issues

- Trends in declining quality of conventional crude oil supplies
- Increasing non-conventional crude oil supplies
- Oil (bituminous) sands
  - Mining or in-situ extraction primarily in Alberta, Canada
  - Currently over 50% of Canadian oil production
  - Large increase in Canadian oil production projected from oil sands growth
    - 2.7 million barrels per day (in 2011) to 6.6 million barrels per day (in 2035) (Source: EIA)
  - To allow for transport and use by refineries
    - Synthetic Crude Oil (SCO) - straight upgrading
    - SynBit - combination of bitumen and SCO
    - DilBit - combination of bitumen and a diluent such as natural gas condensate
    - DilSynBit - combination of DilBit and SCO



- Shale oil
  - Horizontal drilling and hydraulic fracturing
  - Significant increase in U.S. shale oil production projected
    - Increase from 33% (in 2011) to 51% (in 2040) of lower 48 states oil production (Source: EIA)
  - Most U.S. shale oils are light and sweet

Crude Slate and Refinery CO_2 Emissions



Crude Slate Scenario	API Gravity	Sulfur Content (%)	CO_2 Emissions	Change from Base Case Scenario
2011 Actual	30.5	1.41	253	-
Estimates for 2025 Product Slate				
Base (same as 2011)	30.5	1.41	233	-
Extremely Heavy	24.6	1.49	268	15%
Very Heavy	26.3	2.04	260	11%
Heavy	28.2	1.90	250	7%
Light	34.2	1.02	213	-9%
Very Light	35.5	0.93	210	-10%

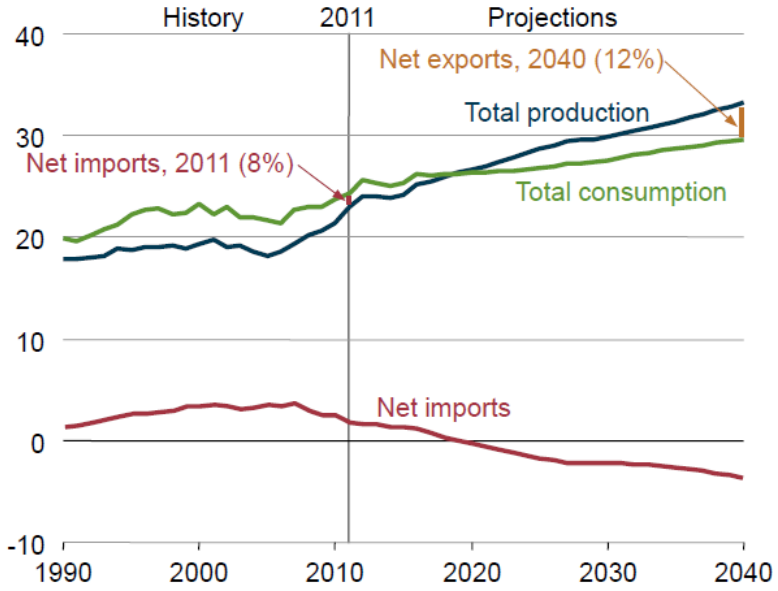
- Oil refineries emitted 3% of total U.S. GHG emissions in 2011.
- The "Extremely Heavy" crude slate scenario denotes the current California crude slate, extended to the U.S. as a whole.

Source: Effects of Possible Changes in Crude Oil Slate on the U.S. Refining Sector's CO_2 Emissions, Final Report prepared for International Council on Clean Transportation by MathPro Inc., March 29, 2013.

U.S. Natural Gas Production

U.S. Natural Gas Consumption, Production, and Net Imports

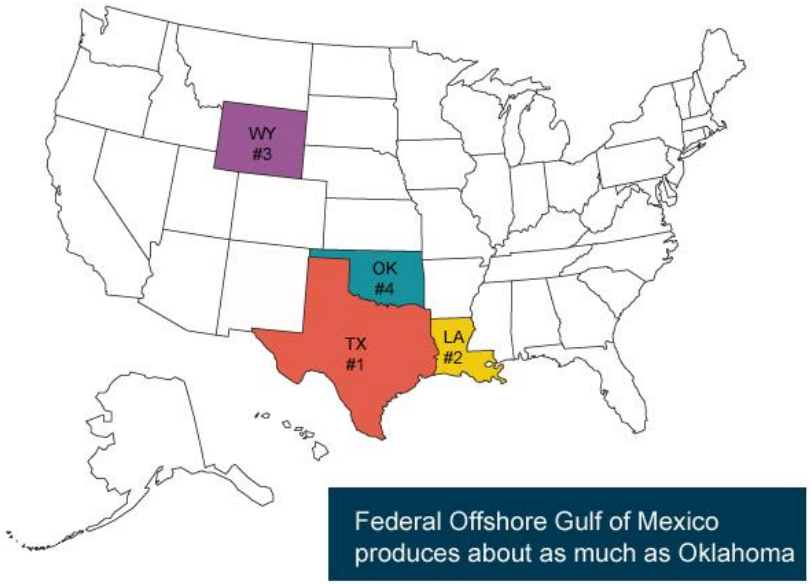
trillion cubic feet



- 90% of 2011 U.S. natural gas imports were from Canada.
- The Dept. of Energy projects that higher developments of shale gas will result in the U.S. being a net exporter of natural gas within 5 years, with exports increasing to 3.6 trillion cubic feet by 2040. Most of the exports will be to Mexico.

Source: Annual Energy Outlook 2013, U.S. Energy Information Administration.

Top Natural Gas Producing States (2011)



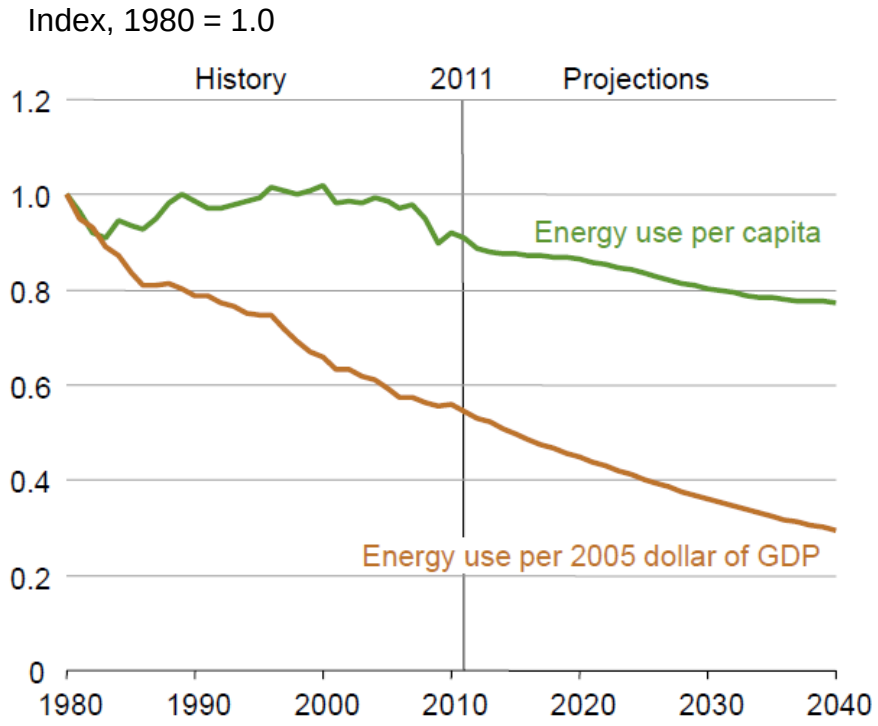
Top 2011 U.S. Natural Gas Producers:

1. Texas: 29%
2. Louisiana: 13%
3. Wyoming: 9%
4. Oklahoma: 8%
5. Gulf of Mexico: 8%

Source: Natural Gas Monthly April 2012, U.S. Energy Information Administration.

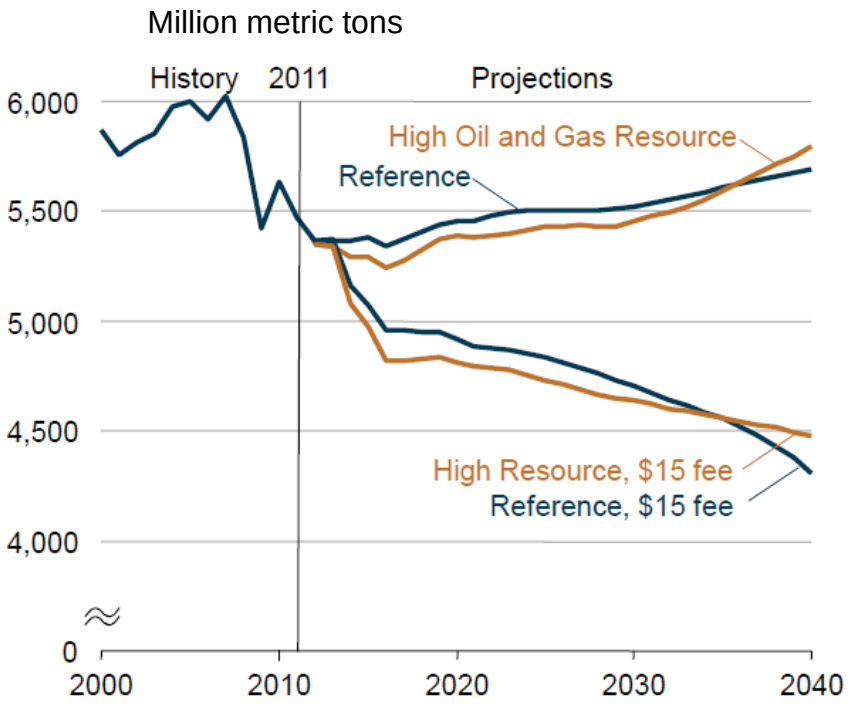
U.S. Per Capita Energy Use and Energy-Related CO_2 Emissions

U.S. Energy Use per Capita and per Dollar of GDP



- The projected decline in energy use per capita is largely due to gains in appliance efficiency and an increase in vehicle efficiency standards. Other contributing factors include the retirement of less efficient power plants, and the continued shift in the economy away from manufacturing (e.g., iron and steel and chemical production).

U.S. Energy-Related CO_2 Emissions

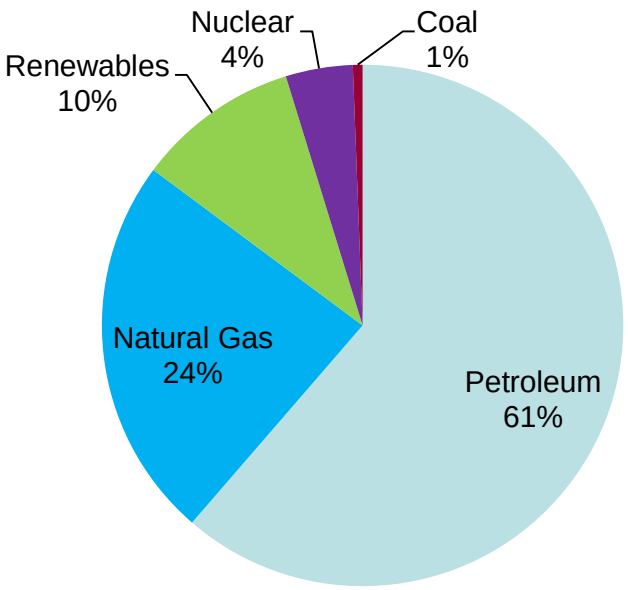


- The "$15 fee" case assumes a $15 per metric ton carbon-fee is imposed in 2014 and is increased by 5% per year.
- 1990 energy related CO_2 emissions were 5041 MMT.

Source of Charts: Annual Energy Outlook 2013, U.S. Energy Information Administration.

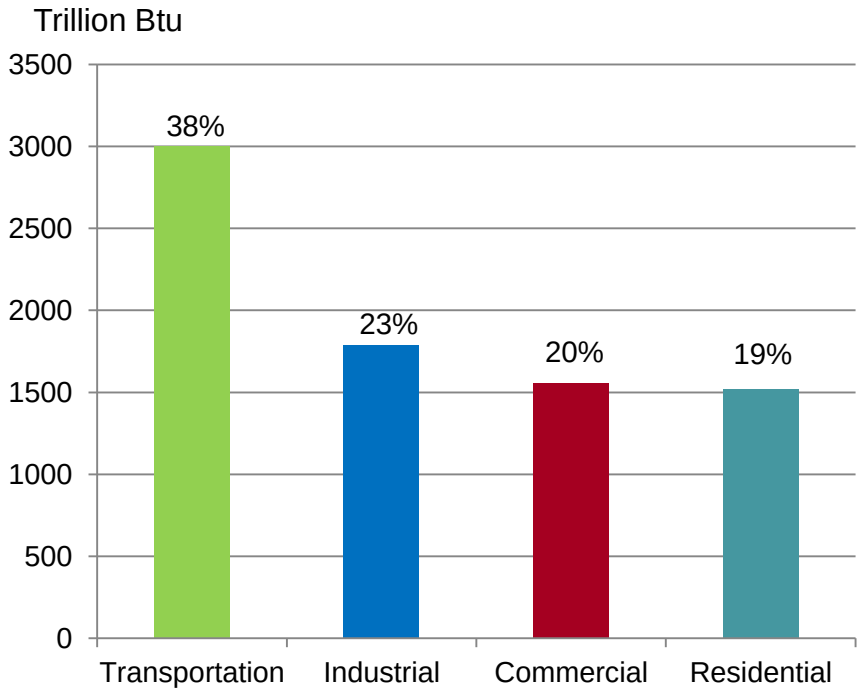
California Energy Consumption

California Primary Energy Consumption by Fuel (2011)



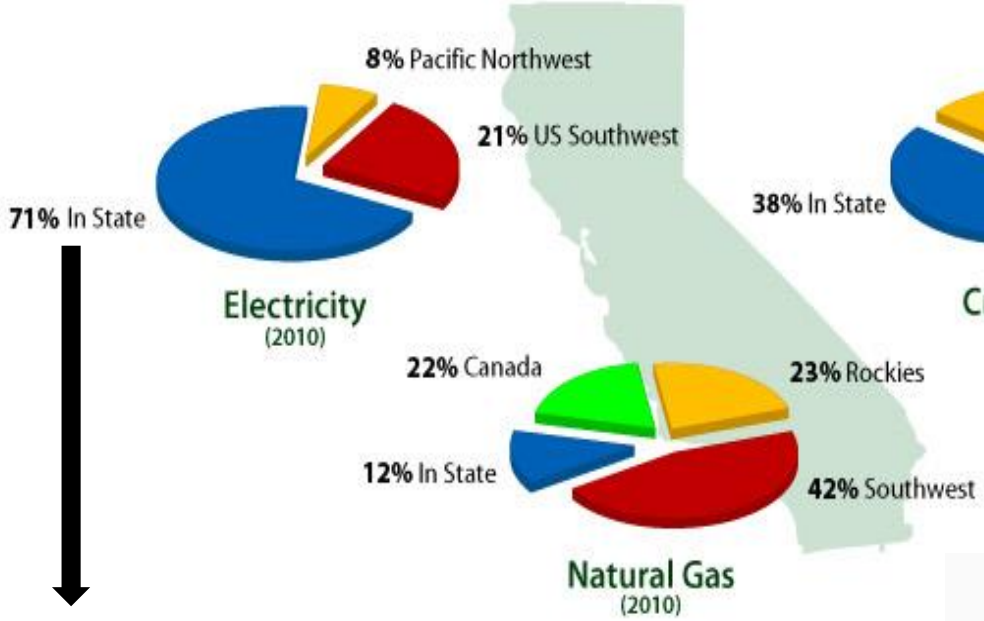
- 45% of renewable energy consumption was hydroelectric.

California Delivered Energy Consumption by End-Use Sector (2011)



Source of Data: State Energy Data System, U.S. Energy Information Administration.

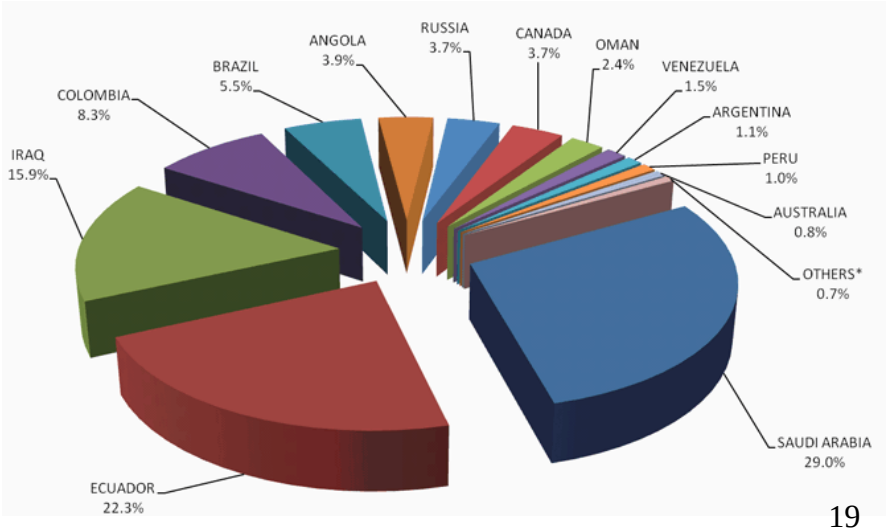
California Energy Sources



California In-State Electricity (2010)

1. Natural gas: 53%
2. Nuclear: 16%
3. Large Hydro: 15%
4. Renewables: 14%
5. Coal: 2%

Foreign Sources of Crude Oil Imports (2011)



Source: Energy Almanac, California Energy Commission.

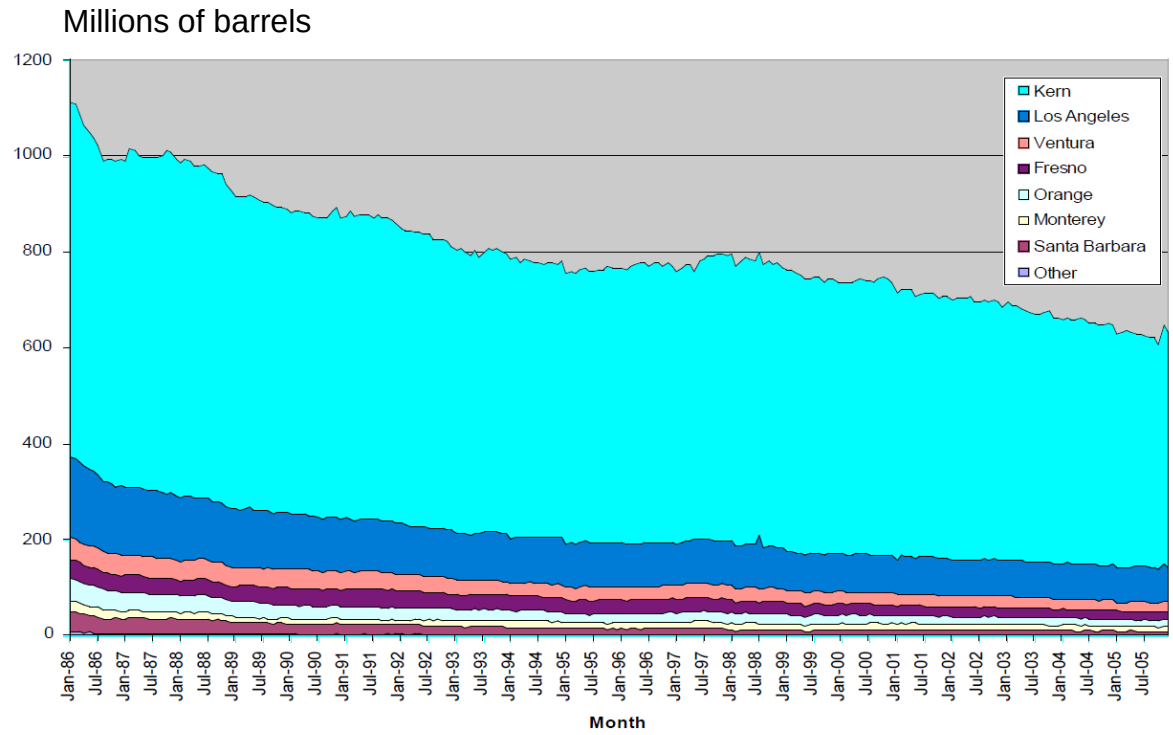
California Per Capita Energy Use (2011)

Rank	Residential Sector		Commercial Sector		Industrial Sector		Transportation Sector		Total Consumption	
	State	Million Btu	State	Million Btu	State	Million Btu	State	Million Btu	State	Million Btu
1	North Dakota	99.8	District of Columbia	193.1	Louisiana	585.8	Alaska	277.3	Wyoming	974.7
2	West Virginia	90.9	Wyoming	119.2	Wyoming	568.2	Wyoming	200.7	Louisiana	886.5
3	Missouri	89.4	North Dakota	106.9	Alaska	435.7	North Dakota	172.8	Alaska	881.3
4	Tennessee	87.8	Alaska	94.1	North Dakota	388.9	Louisiana	158.0	North Dakota	768.4
5	Kentucky	87.4	Montana	78.4	Iowa	243.4	Oklahoma	122.3	Iowa	493.6
6	Nebraska	87.3	South Dakota	75.8	Texas	237.5	Mississippi	120.9	Texas	476.2
7	Montana	87.1	Kansas	75.4	Nebraska	201.9	Montana	119.3	Nebraska	473.0
8	Wyoming	86.6	Virginia	75.0	Indiana	201.6	South Dakota	116.4	South Dakota	464.3
9	South Dakota	86.5	Nebraska	73.7	South Dakota	185.6	Nebraska	110.1	Indiana	440.3
10	Oklahoma	85.7	Maryland	73.3	Kentucky	184.2	Texas	109.9	Kentucky	437.7
11	Indiana	85.4	New Jersey	71.5	Alabama	168.6	New Jersey	108.3	Oklahoma	421.4
12	Kansas	85.3	Missouri	68.8	West Virginia	148.6	Kentucky	108.1	Kansas	405.0
13	Arkansas	83.8	Iowa	67.9	Oklahoma	147.9	Hawaii	105.9	Alabama	402.0
14	Ohio	81.2	Oklahoma	65.4	Kansas	146.7	Iowa	102.1	Montana	398.4
15	Louisiana	81.2	Delaware	64.9	Mississippi	138.0	Alabama	101.4	Mississippi	390.7
16	Iowa	80.3	Minnesota	63.9	Arkansas	137.8	Arkansas	99.1	West Virginia	390.5
17	South Carolina	79.1	Wisconsin	62.5	Minnesota	122.5	Tennessee	98.1	Arkansas	380.2
18	Idaho	78.8	Michigan	61.8	Idaho	116.0	New Mexico	97.8	Minnesota	349.1
19	Alabama	78.5	Ohio	61.7	New Mexico	114.5	Kansas	97.6	South Carolina	344.6
20	Virginia	78.0	Louisiana	61.5	Montana	113.6	South Carolina	96.3	Tennessee	343.9
21	Michigan	77.2	Illinois	61.4	South Carolina	113.2	Georgia	96.2	Idaho	331.9
22	Mississippi	76.8	New Mexico	61.0	Ohio	106.6	Indiana	95.4	Ohio	331.6
23	North Carolina	76.3	Texas	60.7	Maine	105.1	Missouri	94.4	New Mexico	331.0
24	Illinois	76.2	New York	60.6	Wisconsin	101.9	Maine	92.6	Wisconsin	313.4
25	Georgia	76.0	Tennessee	60.5	Tennessee	97.6	West Virginia	90.8	Missouri	312.5
26	Delaware	74.7	West Virginia	60.2	Illinois	95.6	Utah	89.4	Maine	310.5
27	Washington	74.7	North Carolina	60.0	Pennsylvania	95.1	Minnesota	88.3	Illinois	309.3
28	Wisconsin	74.5	Arkansas	59.4	Delaware	91.1	Virginia	87.9	Georgia	305.9
29	Minnesota	74.4	Kentucky	58.0	Washington	85.9	Washington	87.7	Washington	304.9
30	Alaska	74.2	Indiana	57.8	Colorado	82.8	Idaho	83.1	Delaware	299.1
31	Vermont	73.5	Georgia	57.5	Utah	77.6	Ohio	82.2	Virginia	294.7
32	Pennsylvania	72.5	Washington	56.7	Georgia	76.2	Colorado	81.5	Pennsylvania	292.3
33	Maryland	71.6	Colorado	56.1	Michigan	71.7	Florida	80.6	District of Columbia	291.2
34	Colorado	69.0	Utah	56.1	Oregon	63.4	Vermont	80.4	Colorado	289.4
35	Oregon	68.1	South Carolina	56.0	Missouri	59.9	Oregon	80.1	Michigan	283.8
36	Texas	68.1	Mississippi	55.1	Nevada	58.6	California	79.6	Utah	283.3
37	Connecticut	66.8	Idaho	53.9	North Carolina	57.5	New Hampshire	78.5	New Jersey	276.0
38	New Hampshire	65.9	Alabama	53.5	Virginia	53.9	Illinois	76.1	North Carolina	266.6
39	New Jersey	65.2	Arizona	53.4	California	47.4	Pennsylvania	74.7	Oregon	262.2
40	Maine	64.9	Connecticut	51.4	Hawaii	46.6	Wisconsin	74.4	Maryland	244.3
41	Florida	64.5	Florida	50.9	Vermont	37.8	Maryland	74.4	Vermont	238.3
42	Massachusetts	64.2	New Hampshire	50.5	Massachusetts	35.5	Michigan	73.1	Nevada	232.5
43	Arizona	61.0	Oregon	50.5	Arizona	34.2	North Carolina	72.8	New Hampshire	221.6
44	Utah	60.3	Pennsylvania	50.1	New Jersey	31.0	Arizona	72.7	Arizona	221.3
45	District of Columbia	58.0	Maine	47.9	New Hampshire	26.8	Nevada	72.6	Florida	221.0
46	New Mexico	57.7	Vermont	46.5	Maryland	25.0	Massachusetts	69.3	Massachusetts	211.1
47	Nevada	57.4	Nevada	44.0	Florida	25.0	Delaware	68.4	California	208.5
48	Rhode Island	57.1	Massachusetts	42.1	Connecticut	22.4	Connecticut	66.2	Hawaii	207.5
49	New York	54.9	Rhode Island	41.8	Rhode Island	17.9	Rhode Island	58.3	Connecticut	206.8
50	California	40.2	California	41.3	New York	17.8	New York	52.0	New York	185.4
51	Hawaii	25.5	Hawaii	29.5	District of Columbia	4.7	District of Columbia	35.4	Rhode Island	175.0
	United States	68.6	United States	57.6	United States	99.2	United States	87.1	United States	312.6

State Energy Data 2011: Consumption: U.S, Energy Information Administration.

California Crude Oil Production

California Crude Oil Production from 1986 to 2005



Source: California Crude Oil Production and Imports, California Energy Commission, April 2006.

Monterey Shale Formation

- The Monterey Shale Formation is estimated to hold 64% of the total shale oil resources in the United States.

Source: Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays, U.S. Energy Information Administration, July 2011.

California Crude Oil Production (cont.)

County	Field	Percent of 2005 Production	API Gravity & Sulfur	Type
Kern & San Luis Obispo	Midway Sunset	18.47%	12.6, 1.6%	Heavy, Sour
Kern	Kern River	14.36%	13.3, 1.1%	Heavy, Sour
Kern	Elk Hills	7.91%	34.6, 0.8%	Light, Sour
Los Angeles	Wilmington	6.49%	17.1, 1.7%	Heavy, Sour
Kern	Lost Hills	4.96%	18.4, 1.0%	Heavy, Sour
Ventura	Ventura	1.75%	30.2, 1.0%	Medium, Sour
Kern	Belridge N. Lt.	1.63%	31.3, 0.3%	Light, Sweet
Monterey	San Ardo	1.52%	12.2, 2.3%	Heavy, Sour
Los Angeles	Inglewood	1.24%	21.0, 1.8%	Heavy, Sour
Orange	Huntington Beach	1.07%	19.4, 2.0%	Heavy, Sour
Los Angeles	Long Beach	0.65%	25.0, 1.3%	Medium, Sour
Kern	Mount Poso	0.26%	16.0, 0.7%	Heavy, Sour

- Statewide Weighted Average:

  API Gravity: 18 degrees
  Sulfur Content: 1.3%

- Most California refineries have been designed to process heavier, more sour crudes, which require more energy intensive processes.

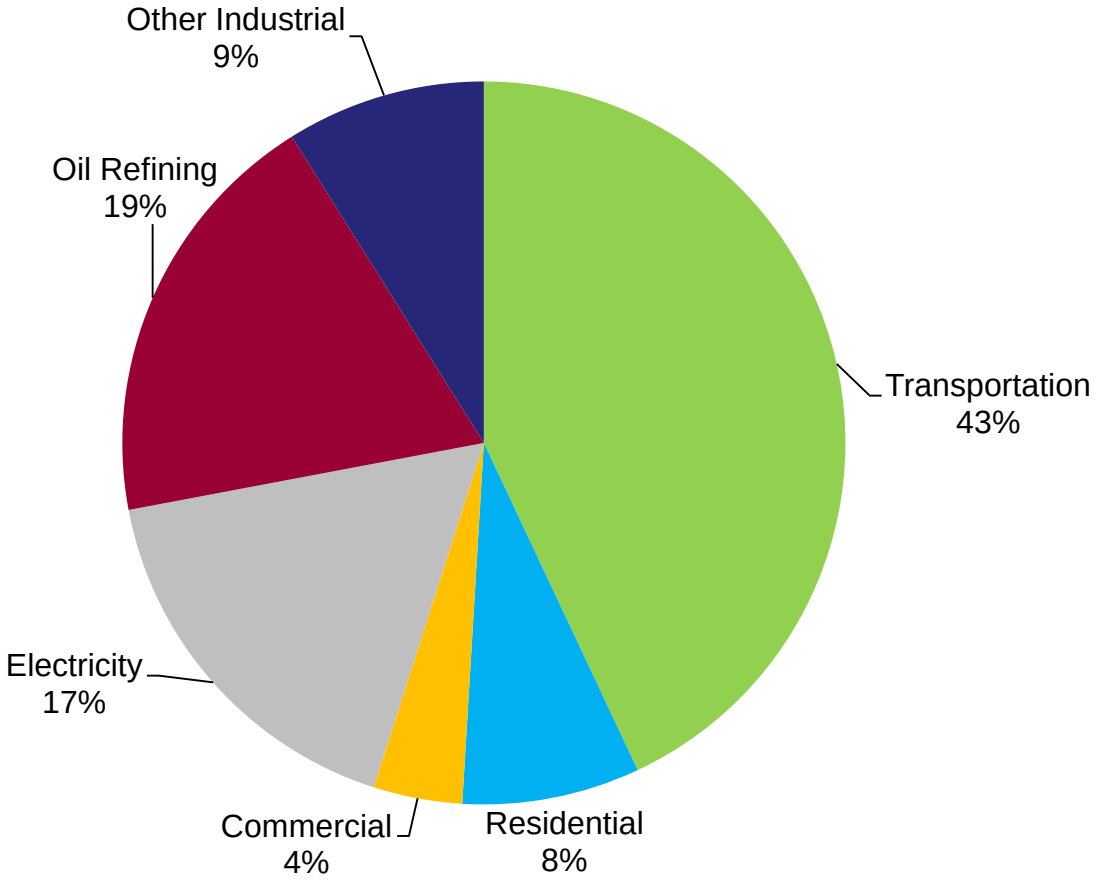
- API Gravity and Sulfur content figures are averages.

Source: California Crude Oil Production and Imports, California Energy Commission, April 2006.

Key California Measures for Reducing CO_2 Emissions from Energy Use

- Energy efficiency/GHG standards for passenger vehicles
  - Now are also federal requirements
- Energy efficiency measures
  - Scoping Report for Energy Efficiency Program for Existing Buildings, California Energy Commission, Aug. 2012
- Cap-and-trade regulation
- Renewable Electricity Standard
  - 33% renewables by 2020
- Low Carbon Fuel Standard
  - Provisions included for processing of High Carbon Intensity Crude Oil
- Transportation-related GHG targets for regions
- Goods movement measures

Bay Area Energy-Related GHG Emissions (2012) – CO_2e

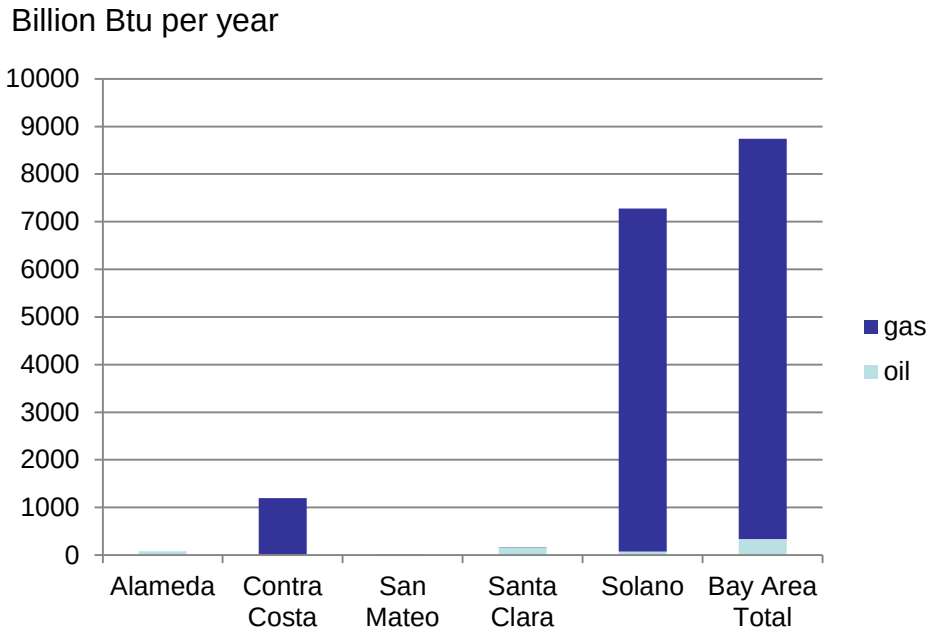


- "Electricity" includes direct emissions from Bay Area power plants (including cogeneration), and emissions from production of imported electricity.

Source: Data from BAAQMD Emissions Inventory.

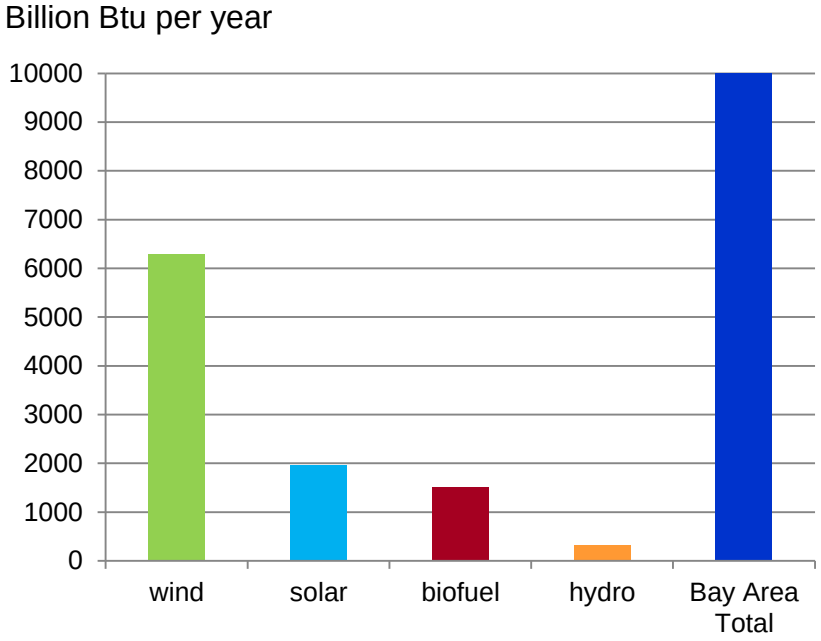
Bay Area Energy Production

Fossil Fuels



Source: 2011 Annual Report of the State Oil and Gas Supervisor, California Department of Conservation.

Renewables



- Chart does not include energy from geothermal power plants located in northern Sonoma County.

Source: All figures for renewables estimated based on installed capacity and typical annual capacity factors. Wind, biofuel, and hydro installed capacities taken from CEC lists. Solar installed capacity taken from Go Solar California website and includes installed projects, and projects with approved applications for incentives.

Bay Area Power Plants

- Bay Area power plants with a peak output of 0.1 MW or greater

Type	Number	MW online	Percent of total MW
Fossil fuel	58	7010	82.5%
Wind	38	1395	16.4%
Waste-to-energy	20	76	0.9%
Hydroelectric	4	14	0.2%
Solar	2	6	0.1%
Total	120	8501	100%

Source: Figures taken from CEC Website, posted 9/6/2012.

- Thousands of smaller "distributed energy" plants
  - Reciprocating engine, micro-turbine, photovoltaic, fuel cell

New Bay Area Power Plants

- Mariposa Energy Project
  - Northeastern Alameda County
  - 200-MW
  - Online 10/2012
- Marsh Landing Generating Station
  - Unincorporated Antioch
  - 760-MW
  - Online 5/2013
- Russell City Energy Center
  - Hayward
  - 600-MW
  - Online 8/2013
- Los Esteros Critical Energy Facility – Phase 2
  - San Jose
  - Phase 2: 320-MW (conversion from 180-MW)
  - Online 8/2013

Summary

- Growth in China and other developing countries is projected to have a dominant impact on world energy use and energy-related CO_2 emissions over the next 30 years
- Modest increases in energy use and energy-related CO_2 emissions are projected for the U.S. over the next 30 years based on existing laws, regulations and policies (significant CO_2 reductions are possible with enactment of carbon tax or other regulatory measures)
- Energy-related CO_2 emissions in California and the Bay Area are projected to decrease by a greater percentage than the U.S. as a whole by 2020 due to AB 32 and other measures
- Changing gas and crude oil supplies
  - Improvements in horizontal drilling and hydraulic fracturing technologies are resulting in rapid development of non-conventional oil and gas production, making the U.S. more energy independent
  - Canadian production of oil sands have increased and may double over the next 10 years
  - Quality of conventional crude oil supplies expected to continue to decline
  - Need to continue to evaluate and track potential impacts on emissions and air quality