
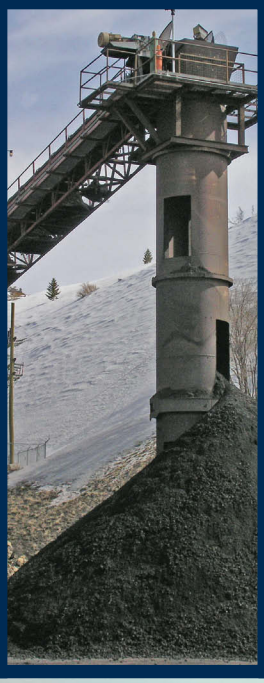
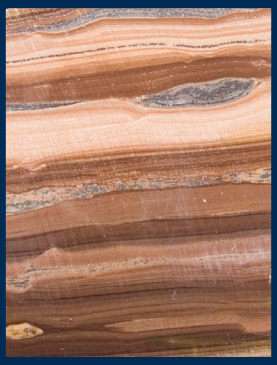


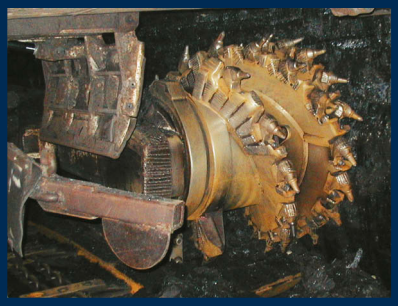


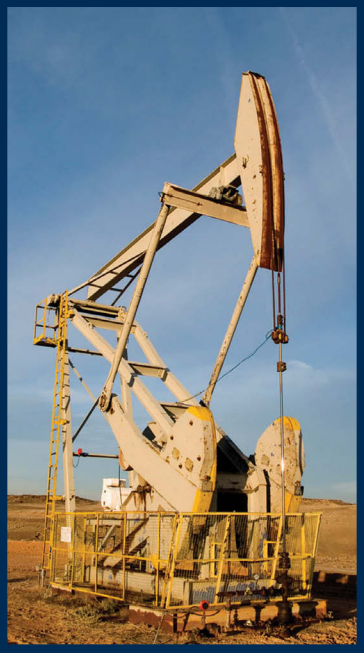

Utah's Energy Landscape

by Michael D. Vanden Berg

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UTAH GEOLOGICAL SURVEY
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DEPARTMENT OF NATURAL RESOURCES
2009

Utah Geological Survey 60 years 1949 2009 Excellence, Integrity, and Objectivity

State Energy Program UTAH GEOLOGICAL SURVEY

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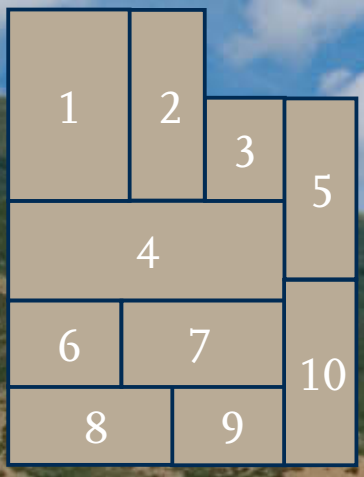

Cover photo captions

1. *Utah State Energy Program (USEP) staff constructing a 50-meter anemometer tower. (Photo by Jason Berry)*
2. *Coal loadout at the Horizon mine.*
3. *Utah oil shale sample.*
4. *The Hatch geothermal electric plant. (Photo courtesy of Raser Technologies)*
5. *Spanish Fork wind farm.*
6. *Longwall mining machine at the Deer Creek coal mine.*
7. *Coal loadout at the SUFCO mine.*
8. *Hunter coal-burning power plant.*
9. *Swaner Nature Center in Park City. (Photo courtesy of Swaner Nature Center)*
10. *Crude oil pump jack from the Aneth oil field.*

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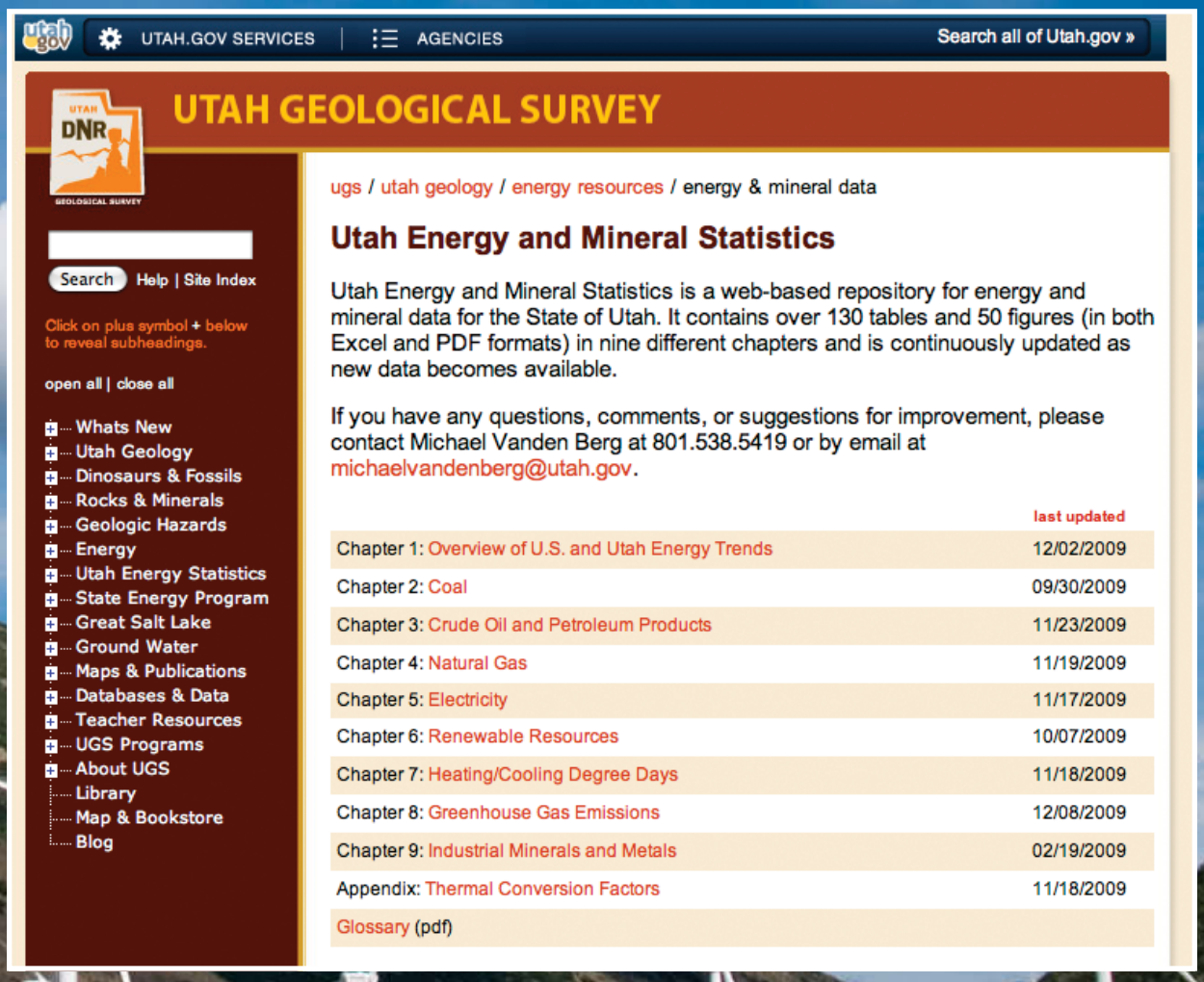
INTRODUCTION

The state of Utah is fortunate to have abundant and diverse energy resources including large reserves of conventional fossil fuels, several areas suitable for renewable resource development, and vast quantities of untapped unconventional fossil fuel energy sources. This publication, Utah's Energy Landscape, was created to offer a complete, visual-based, description of Utah's entire energy portfolio.

The graphs found within this document were created using data compiled by the Utah Geological Survey (UGS) from several different sources, including the U.S. Department of Energy's Energy Information Administration (EIA) and the Utah Division of Oil, Gas, and Mining (DOGM), as well as in-house surveys and conversations with individuals and companies.

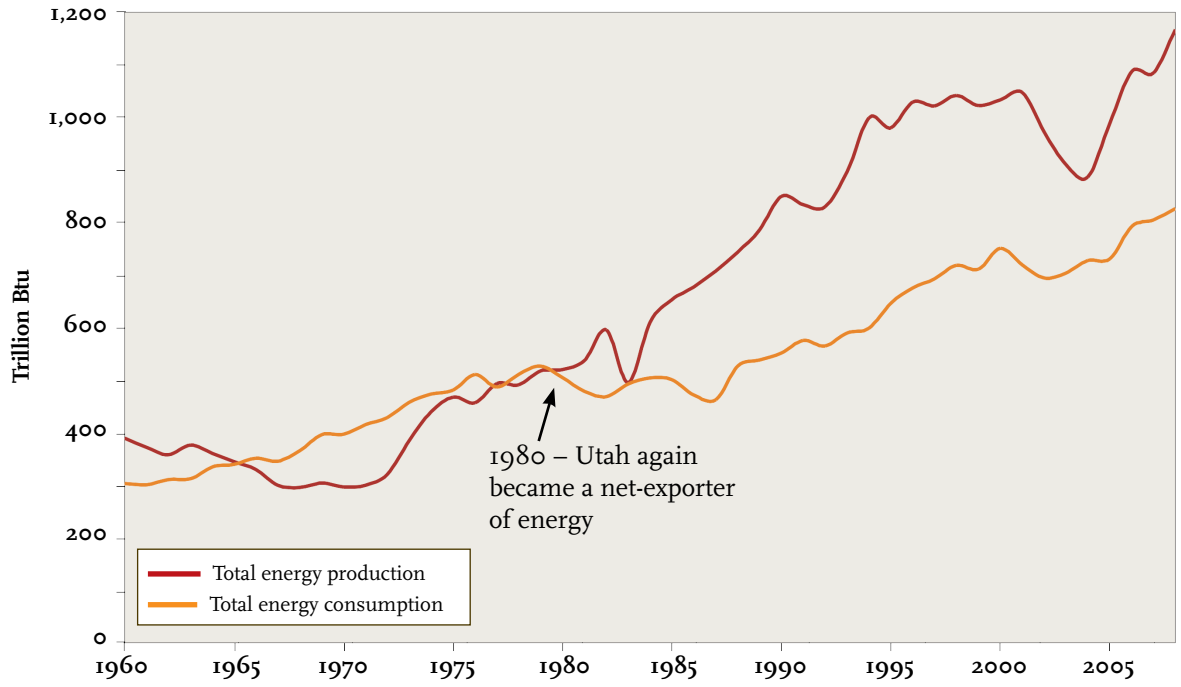
Utah Energy and Mineral Statistics (UEMS) is a Web-based data repository located on the UGS Web site (see screen shot below) and contains all the energy data used to create the graphs contained in this report. Each graph includes a reference table number, indicating where the data can be found and downloaded either as a Microsoft Excel® file or an Adobe® PDF file.

Utah Energy and Mineral Statistics Web page: http://geology.utah.gov/emp/energydata



Overview

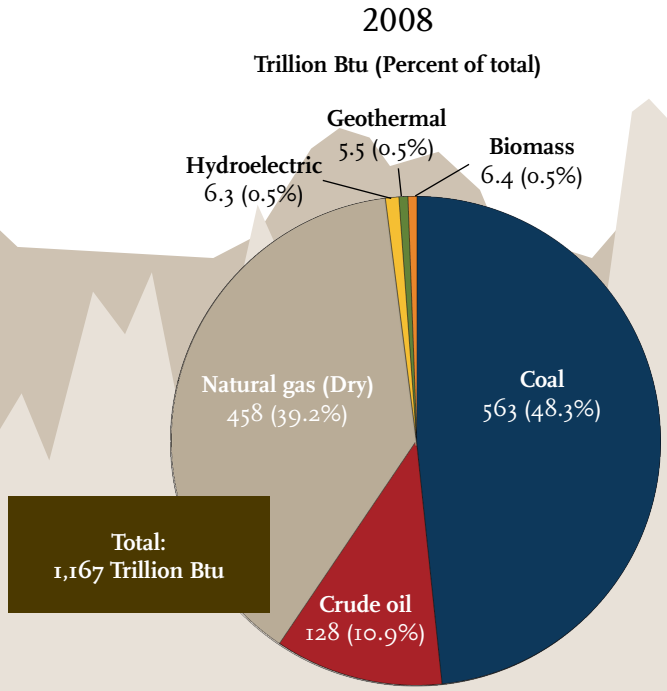
Utah Energy Balance: Production and Consumption, 1960–2008



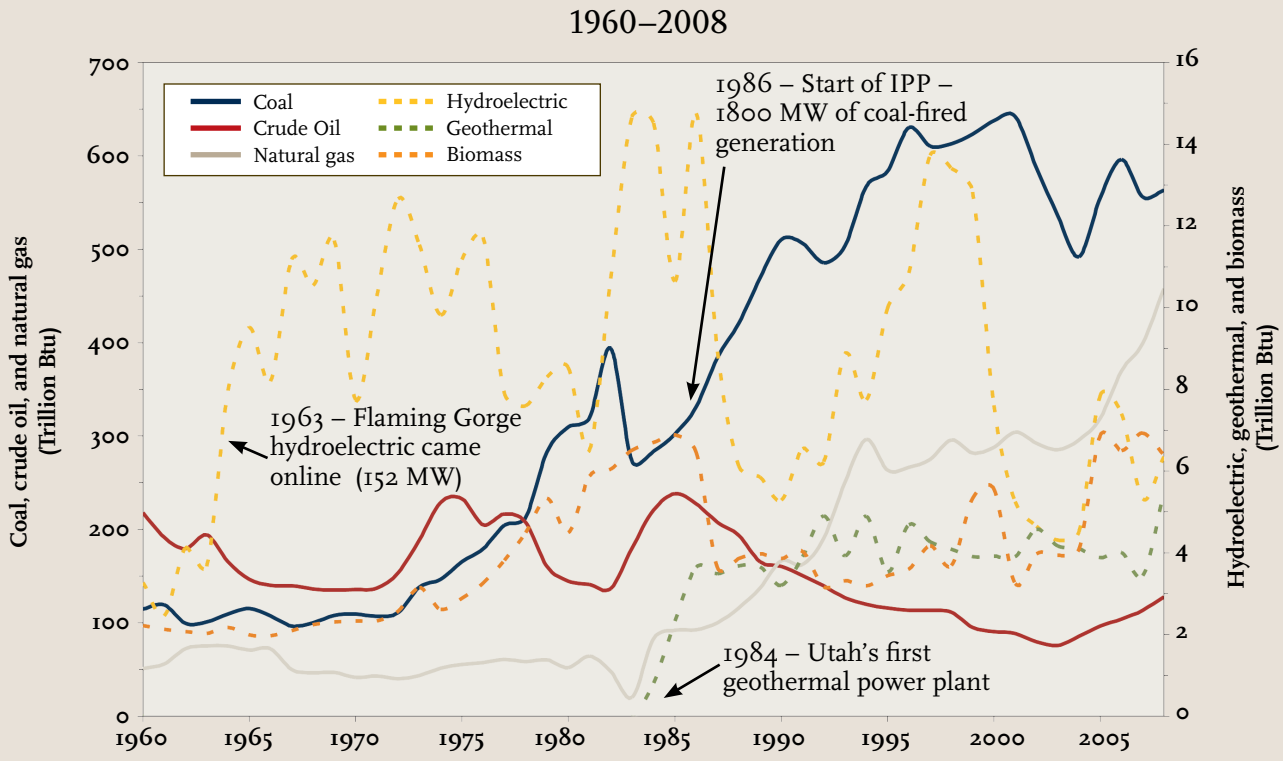
UEMS Web page table: Table 1.4
Source: EIA, UGS
Note: 2008 data is estimated.

Utah produced 29% more energy than it consumed in 2008, making the state a net-energy exporter. The majority of this excess energy was in the form of exported coal and natural gas. Utah also exports significant amounts of electricity, produced from both fossil fuels and renewable sources.

Energy Production in Utah by Source



Fossil fuels made up 98.4% of Utah's total energy production in 2008, while renewable sources accounted only for 1.6% of Utah's production portfolio.

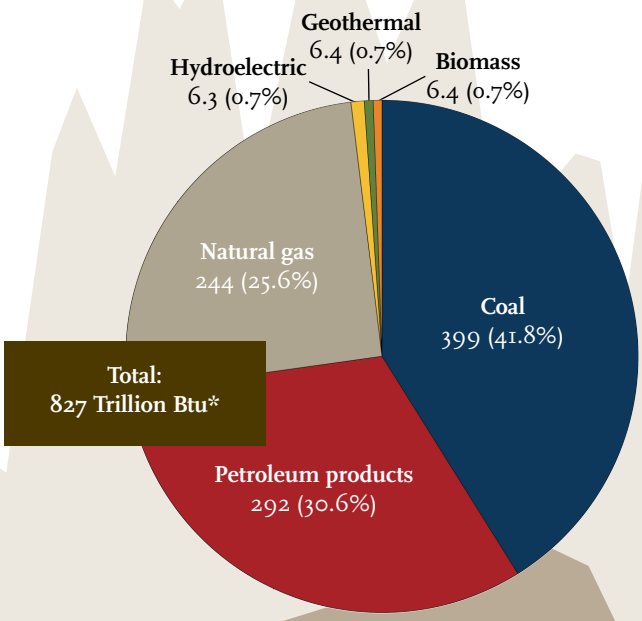


UEMS Web page table: Table 1.8
Source: EIA, UGS
Notes: 2008 data are estimated; production from wind and solar are negligible; IPP=Intermountain Power Project.

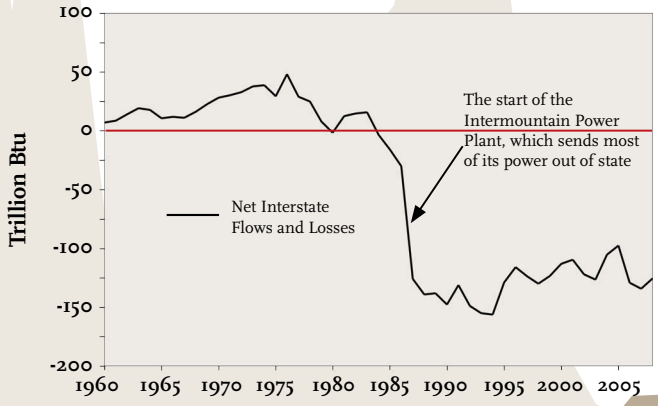
Energy Consumption in Utah by Source

2008

Trillion Btu (Percent of total)

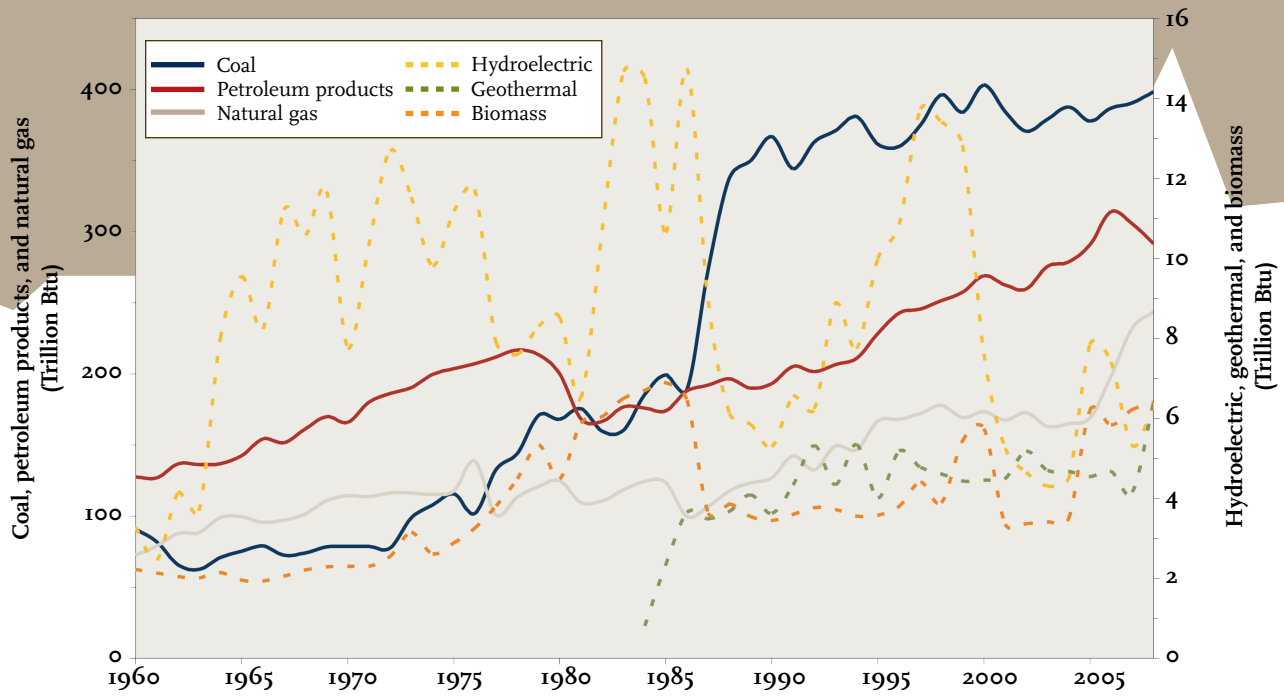


Net Interstate Flows and Losses in Utah, 1960–2008



Fossil fuels made up 98.0% of Utah's total energy consumption in 2008, while renewable sources only accounted for 2.0% of Utah's consumption portfolio. These graphs do not include net interstate flows and losses (see inset graph); Utah exported 127 trillion Btu of electricity (including losses) in 2008, thus reducing total consumption to 827 trillion Btu.

1960–2008



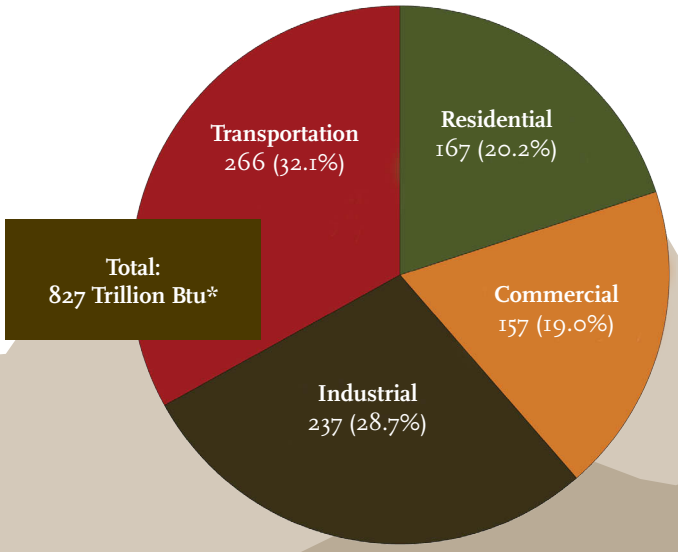
UEMS Web page table: Table 1.14
Source: EIA, UGS
Notes: 2008 data are estimated; consumption from wind and solar are negligible.

**Total includes net interstate flows and losses. Net interstate flow of electricity is the difference between the amount of energy in the electricity sold within a state (including associated losses) and the energy input at the electric utilities within the state. A positive number indicates that more electricity (including associated losses) came into the state than went out of the state during the year; conversely, a negative number indicates that more electricity (including associated losses) went out of the state than came into the state.*

Energy Consumption in Utah by Sector

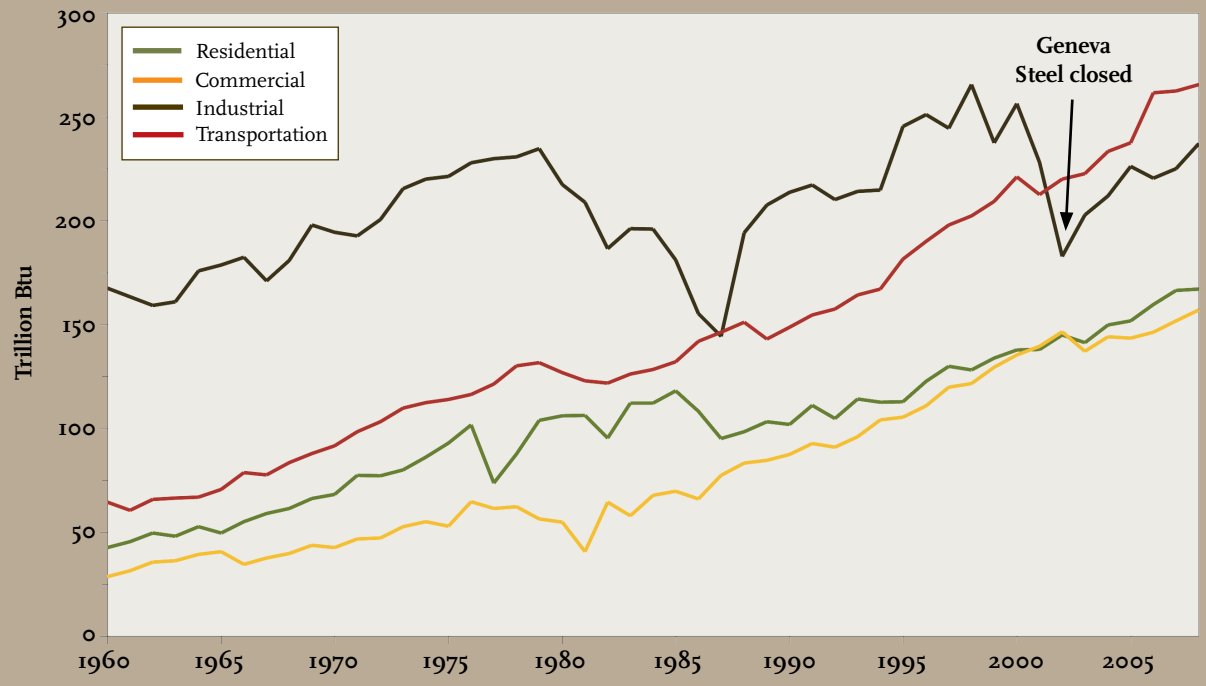
2008

Trillion Btu (Percent of total)



The transportation sector, mostly gasoline and diesel for vehicles, was the largest consumer of energy in Utah in 2008 (32.1%). The residential, commercial, and transportation sectors have all gradually increased over time, consistent with increasing population and increasing energy consumption per capita, while the industrial sector follows a pattern more closely tied to the national economy (e.g., an economy-related dip in the mid-1980s).

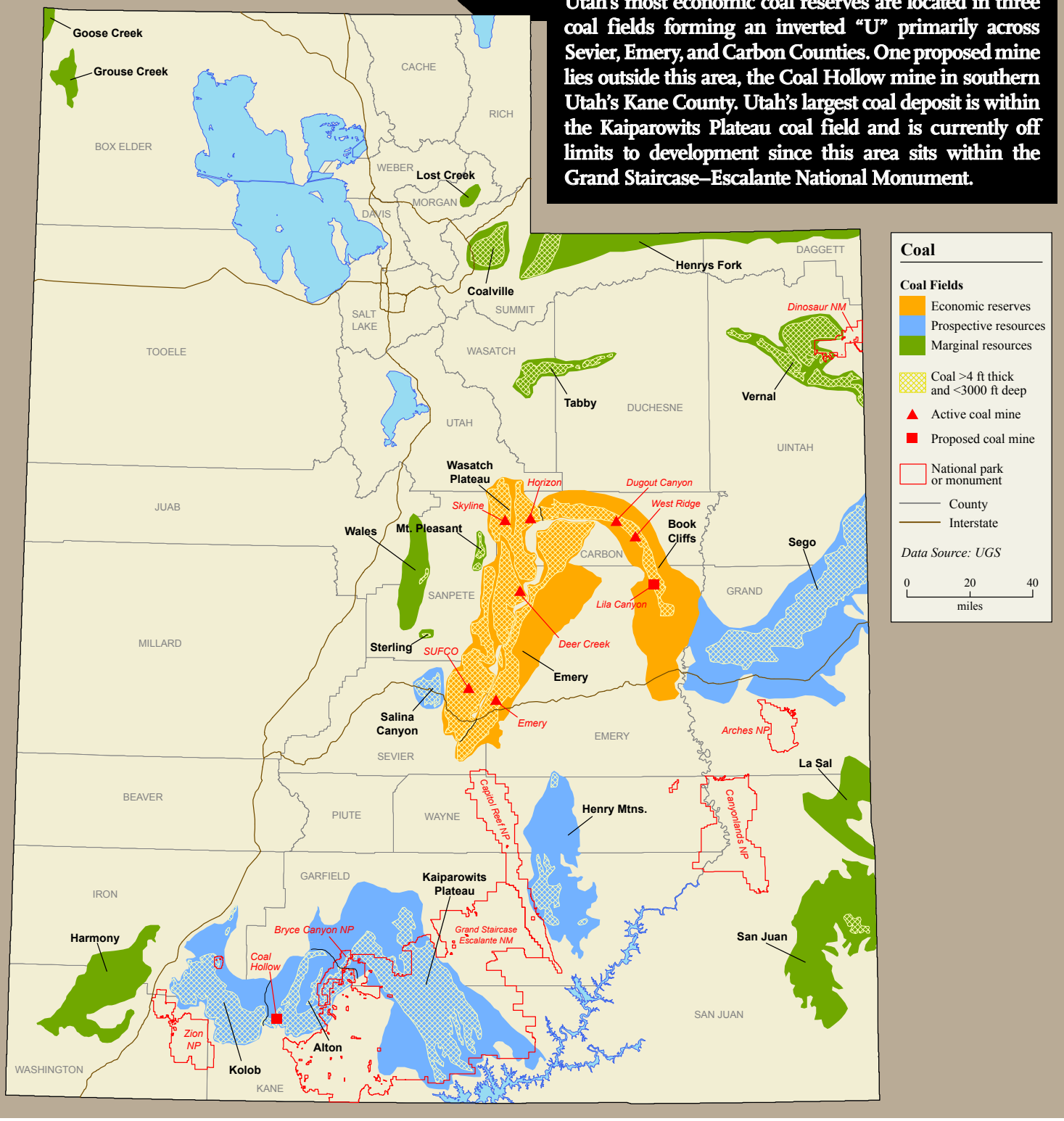
1960–2008



UEMS Web page table: Table 1.16
Source: EIA
Note: 2008 data are estimated
**includes net interstate flows and losses*

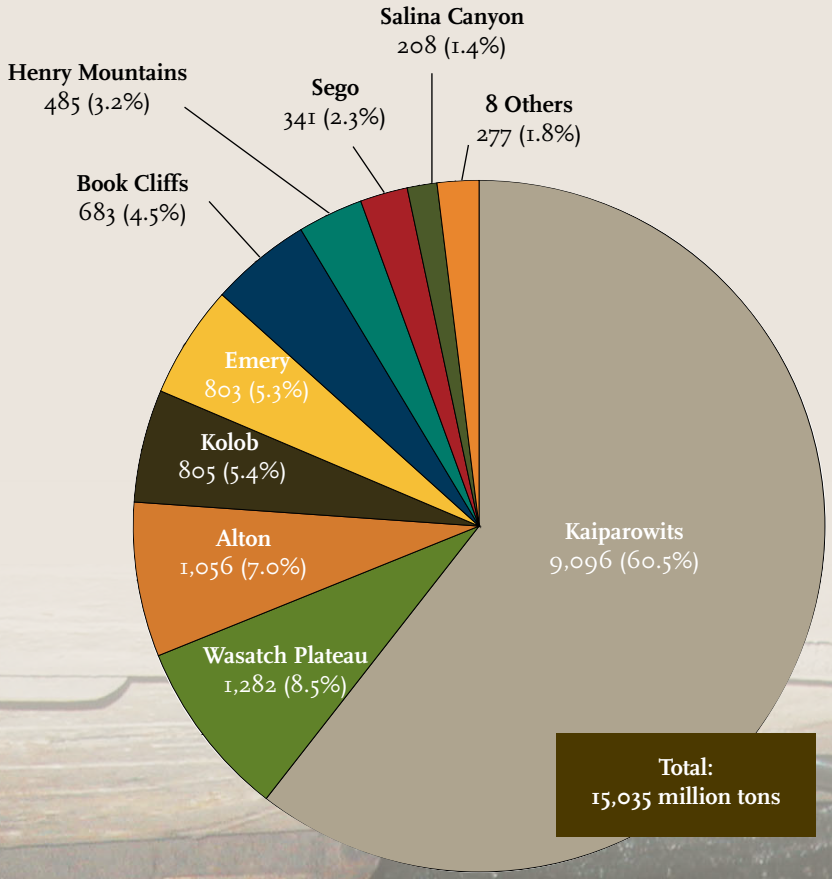
Coal

Utah's most economic coal reserves are located in three coal fields forming an inverted "U" primarily across Sevier, Emery, and Carbon Counties. One proposed mine lies outside this area, the Coal Hollow mine in southern Utah's Kane County. Utah's largest coal deposit is within the Kaiparowits Plateau coal field and is currently off limits to development since this area sits within the Grand Staircase–Escalante National Monument.



Utah's Recoverable Coal Resources by Coal Field, 2008

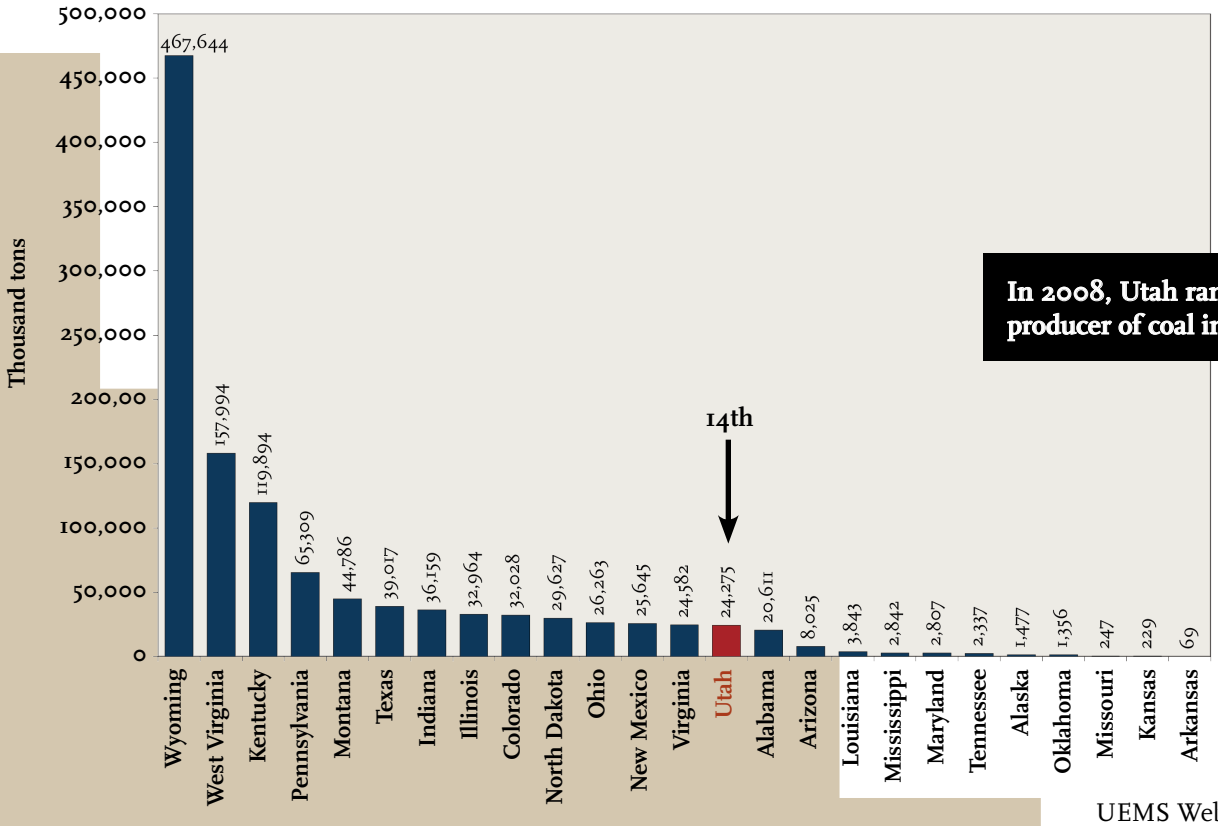
Million tons (Percent of total)



The majority of Utah's recoverable coal resources are located in the Grand Staircase–Escalante National Monument within the Kaiparowits coal field (60.5% of Utah's estimated recoverable coal, as of 2008). Only the Wasatch Plateau, Emery, and Book Cliffs fields currently contain economically recoverable reserves and active mines.

UEMS Web page table: Table 2.3
Source: UGS
Note: For Wasatch Plateau, Alton, Emery, Book Cliffs, and Henry Mountains, resources were constrained by a seam height minimum of four feet, with no more than 3000 feet of cover. For the remaining fields, resources were constrained by an estimated resource factor ranging from 30% to 40% of principal (unconstrained) resources. These resources do not take into account economic or land-use constraints.

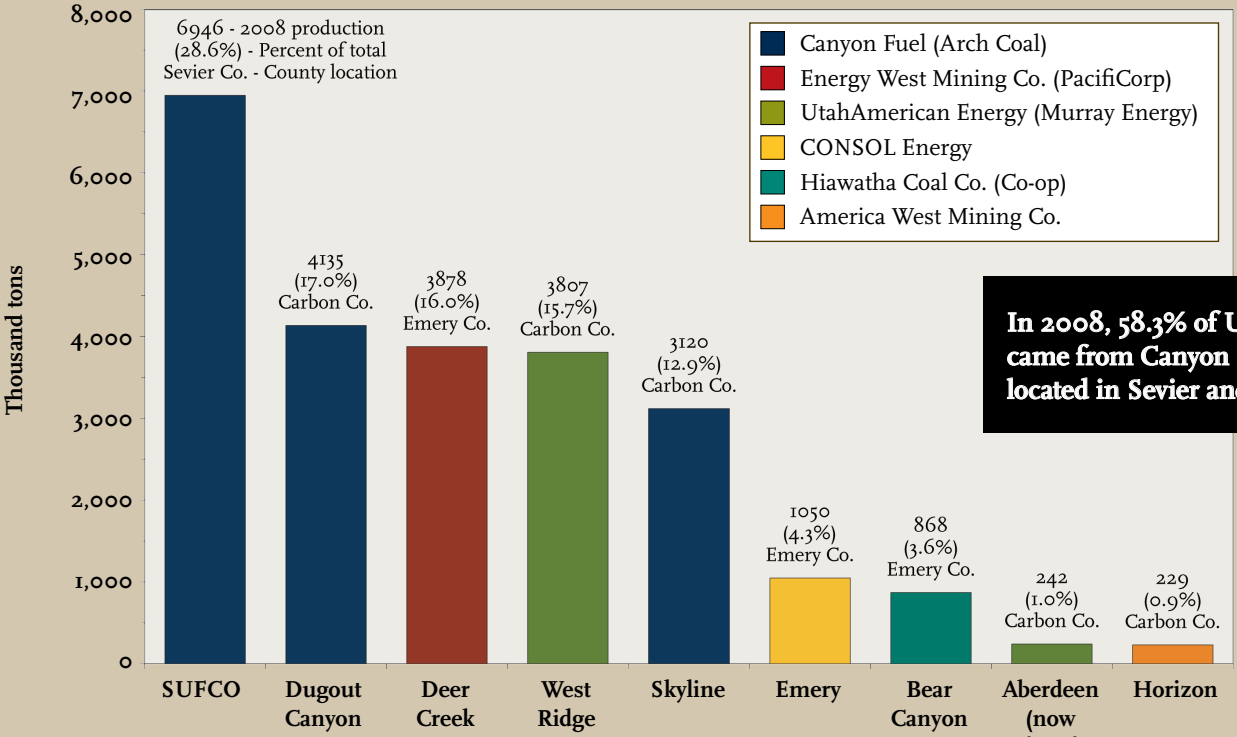
U.S. Coal Production by State, 2008



In 2008, Utah ranked as the 14th largest producer of coal in the United States.

UEMS Web page table: Table 2.7
Source: EIA, UGS

Utah Coal Production by Mine, 2008



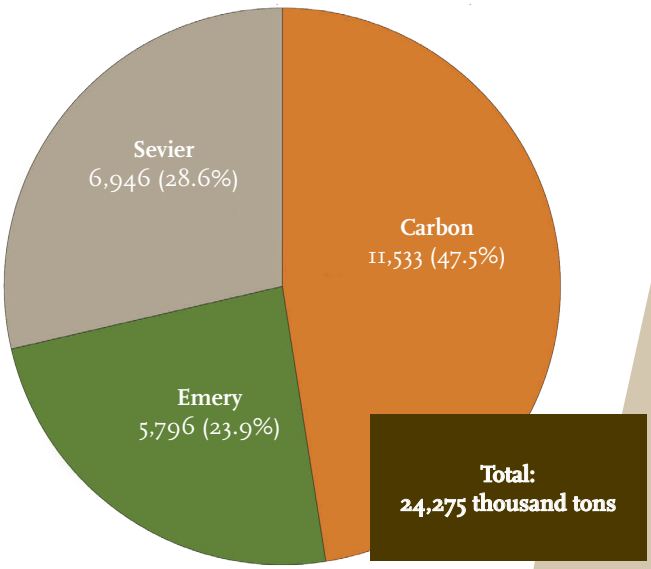
In 2008, 58.3% of Utah's coal production came from Canyon Fuel Company mines located in Sevier and Carbon Counties.

UEMS Web page table: Table 2.8
Source: EIA, UGS

Utah Coal Production by County

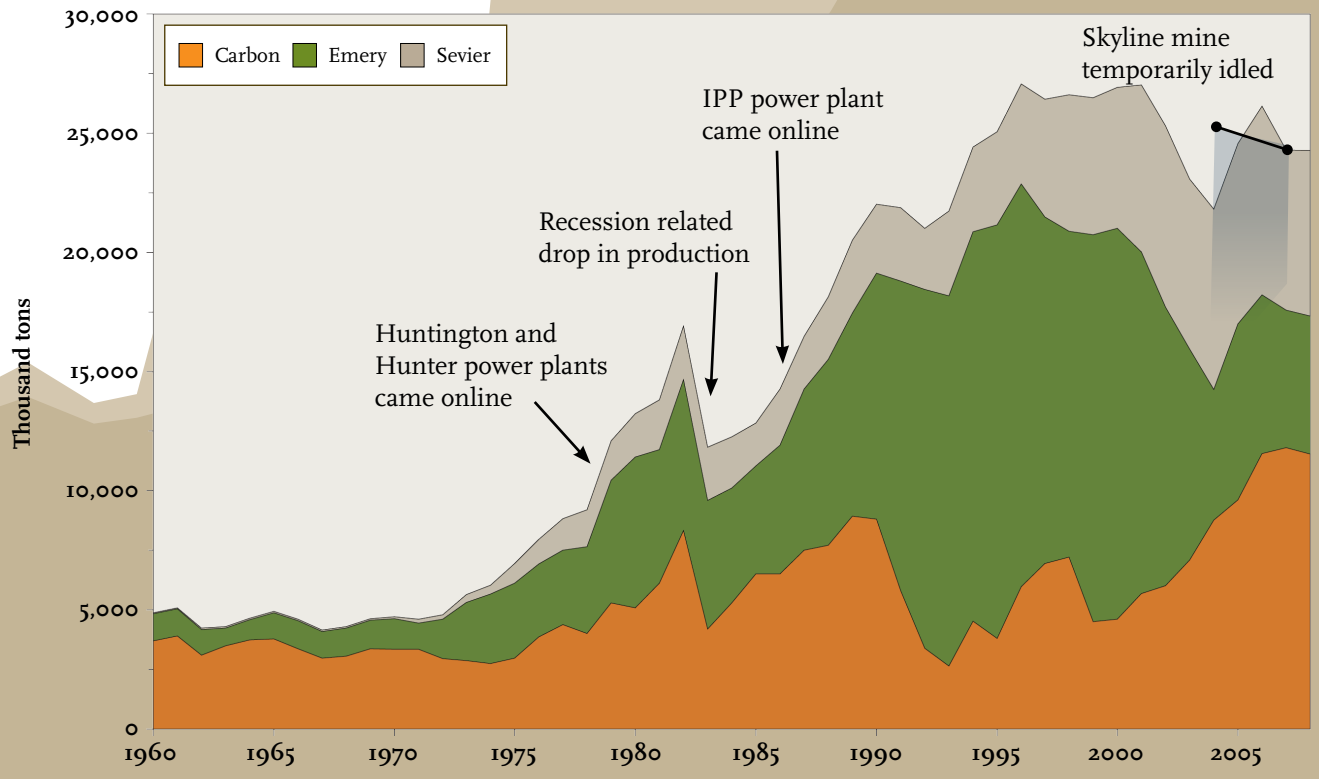
2008

Thousand tons (Percent of total)



In 2008, Utah produced its 1 billionth ton of coal. In recent years, coal production growth in Carbon County has outpaced that of Emery and Sevier Counties on strength of the West Ridge, Dugout, and Skyline mines. Only one large mine, Deer Creek, remains in Emery County, while the only coal produced in Sevier County is from the SUFCO mine. In the next few years, the percentage of coal mined from Emery County should increase when the new Lila Canyon mine commences production and mines in Carbon County deplete their reserves. In addition, the proposed Coal Hollow mine in the Alton coal field of southern Utah's Kane County could result in the first significant coal production outside Carbon, Emery, and Sevier Counties in over 50 years.

1960–2008

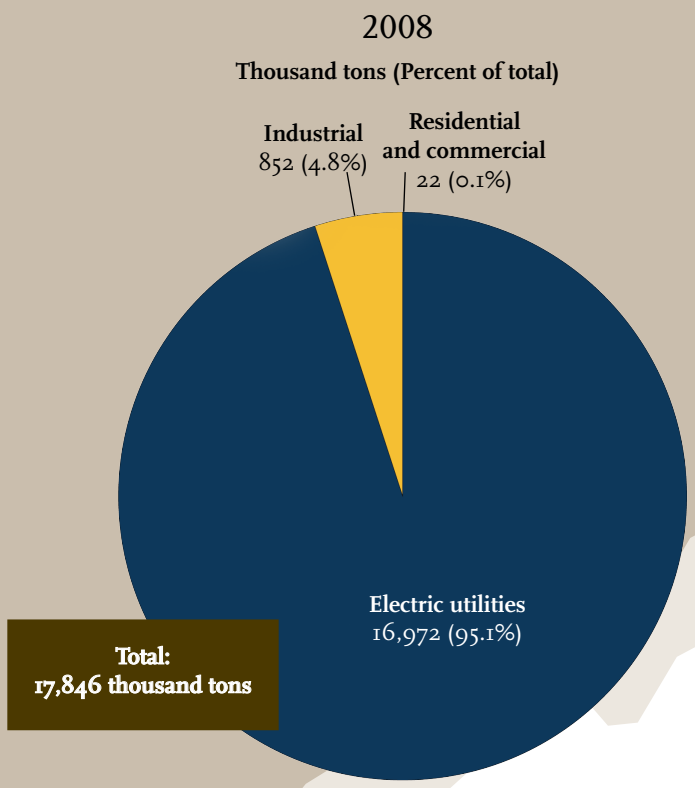


UEMS Web page table: Table 2.10

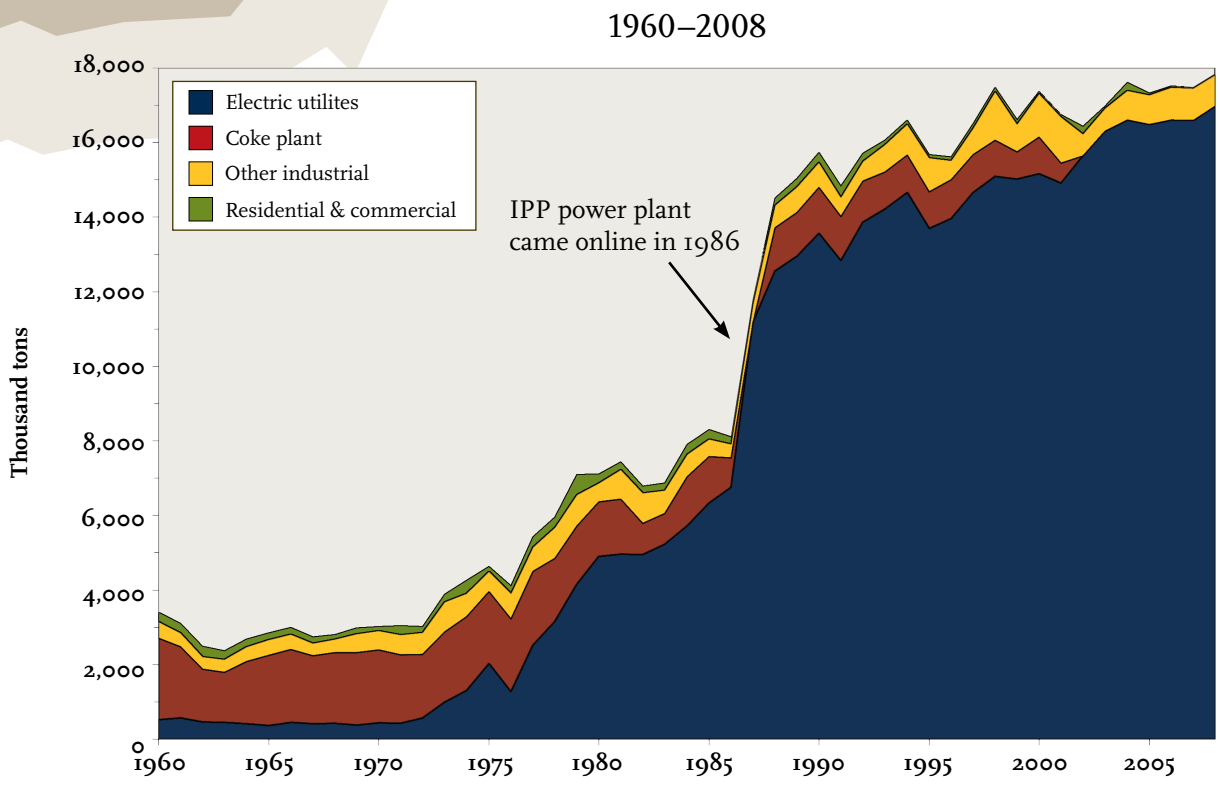
Source: UGS

Note: Production too small to be seen on graph was reported from Summit, Iron, and Kane Counties, mostly between 1960 and 1972.

Utah Coal Consumption by Sector

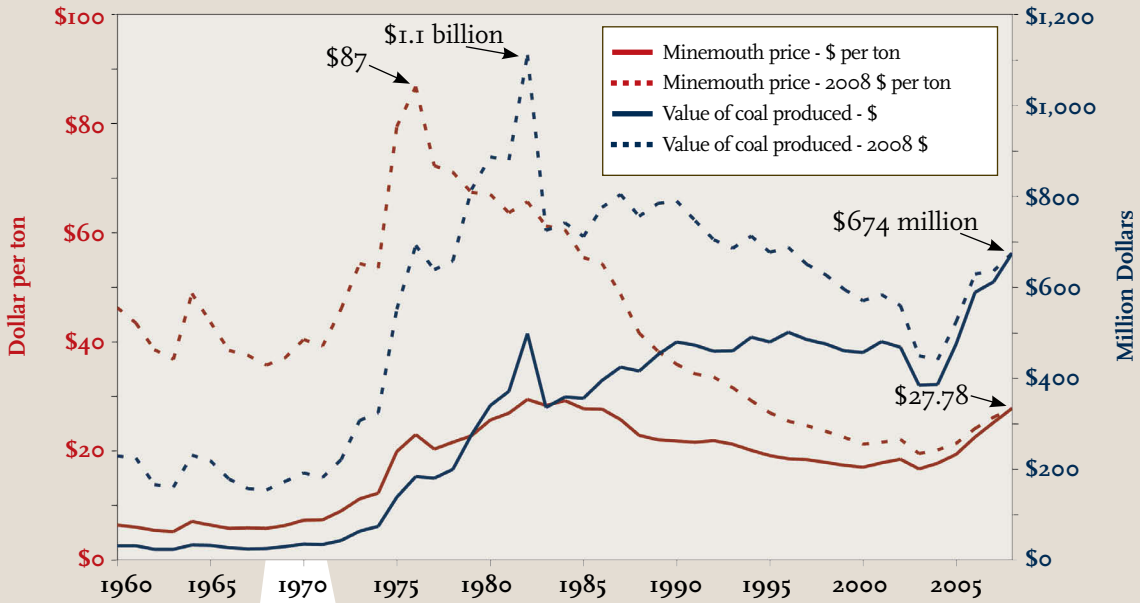


The vast majority of coal in Utah (95.1%) is consumed at electric power plants. The second-largest amount (4.8%) is consumed by the industrial sector at cement/lime plants and Kennecott Utah Copper's power plant which provides electricity for copper smelting. Coke consumption ceased in 2001 when Geneva Steel went out of business.



UEMS Web page table: Table 2.21
Source: EIA, UGS
Note: 2008 data are estimated.

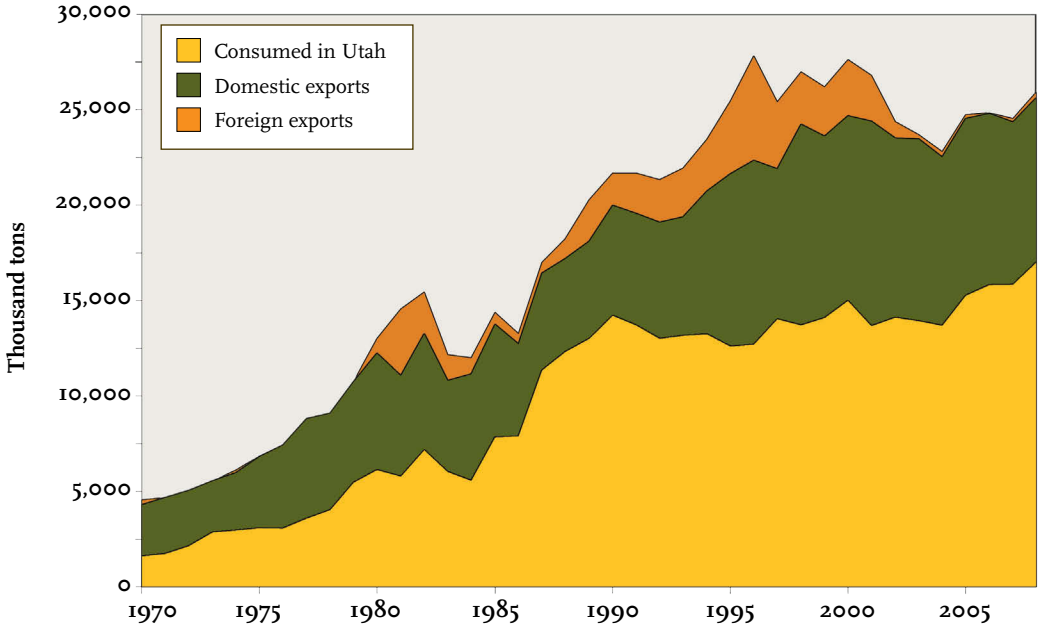
Average Minemouth Price and Value of Utah Coal, 1960–2008



Utah's minemouth price (the price at the mine) of $27.78 in 2008 was the 4th highest in history in nominal dollars, but was well below the inflation-adjusted high of $87 reached in 1976. The 2008 value of produced Utah coal equaled $674 million, a record in nominal dollars, but much less than the inflation-adjusted value of $1.1 billion recorded in 1982.

UEMS Web page table: Table 2.22
Source: UGS
Note: 2008 data are estimated.

Distribution of Utah Coal, 1970–2008

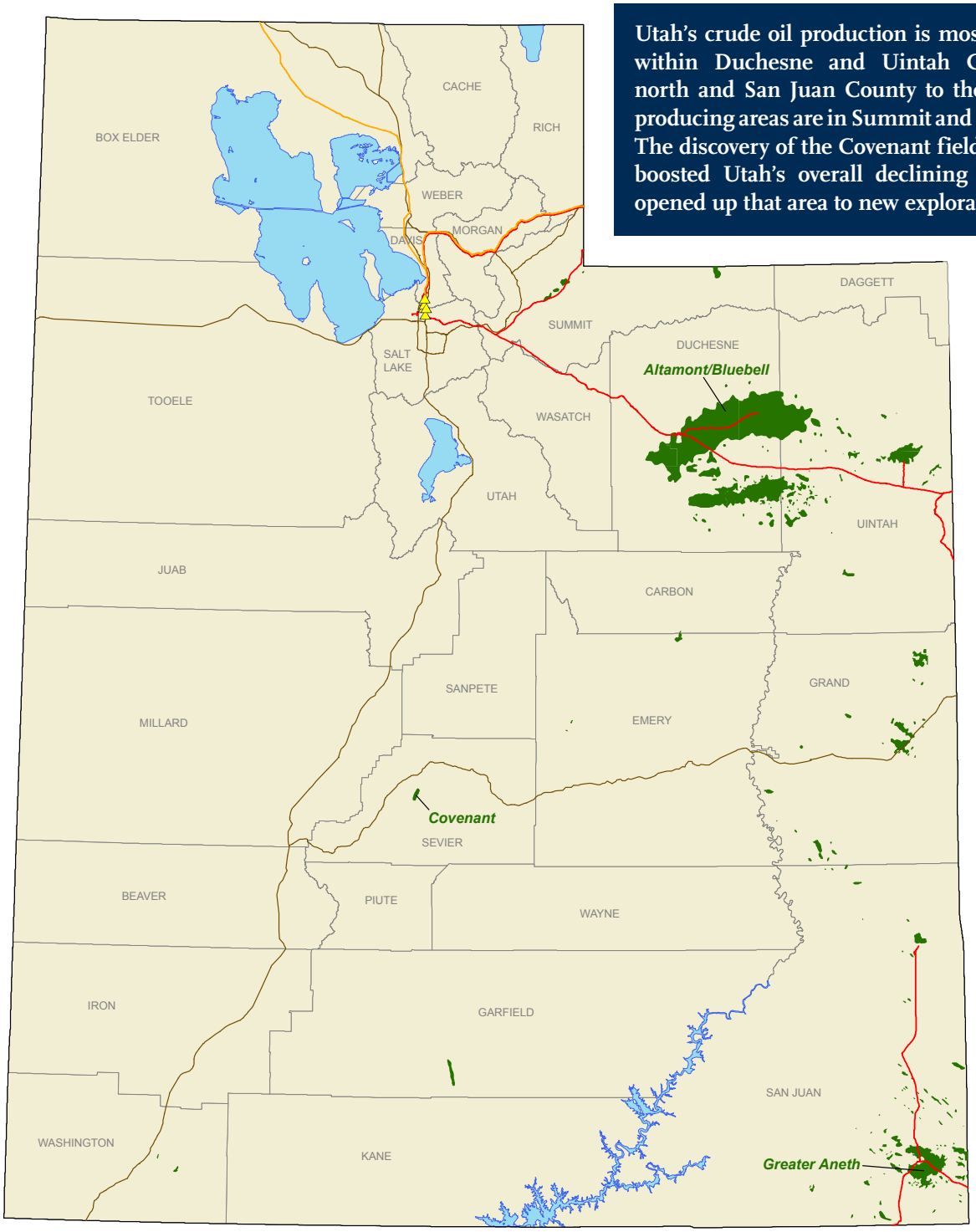


The majority of Utah coal, 65.6% in 2008, is used in state, while 33.2% was shipped out of state, and 1.2% was shipped to other countries. Foreign exports, mostly to Asia, peaked in 1996 when 5.5 million tons, or 19.7%, of Utah coal was shipped to foreign markets. This export market ceased to be economic as Australia and China increased production.

UEMS Web page table: Table 2.19
Source: UGS
Note: 2008 data are estimated.

Crude Oil and Petroleum Products

Utah's crude oil production is mostly concentrated within Duchesne and Uintah Counties to the north and San Juan County to the south; smaller producing areas are in Summit and Grand Counties. The discovery of the Covenant field in central Utah boosted Utah's overall declining production and opened up that area to new exploration.



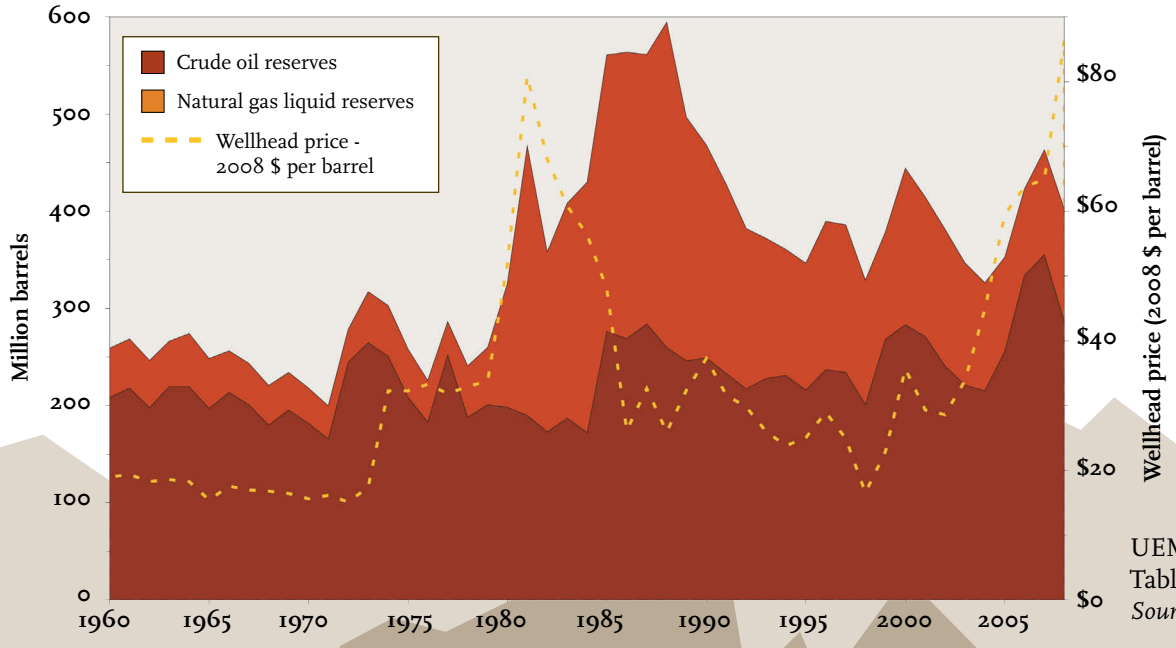
Crude Oil

- Crude oil field
- Petroleum refinery
- Crude oil pipeline
- Pet. products pipeline
- County
- Interstate

Data Source: UGS, DOGM

0 20 40
miles

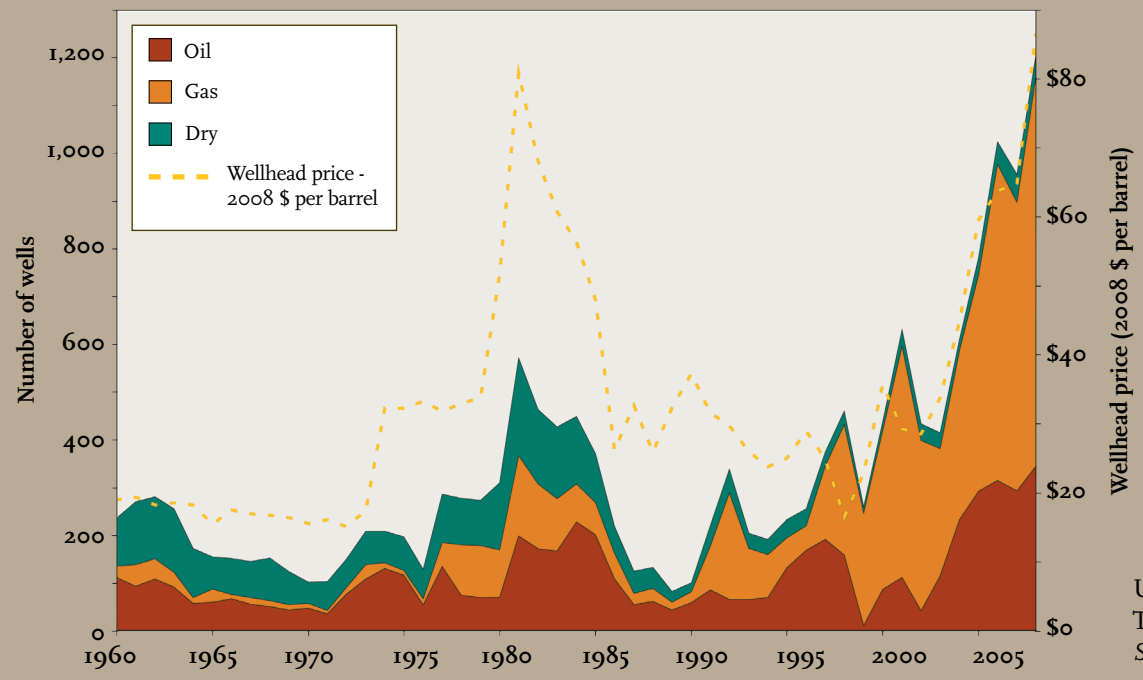
Crude Oil and Natural Gas Liquid Reserves in Utah, 1960–2008



UEMS Web page tables: Table 3.2 and Table 3.20
Source: EIA

Natural gas liquid reserves surged in 1979, coinciding with a spike in crude oil prices, and peaked in the late 1980s. The recent increase in crude oil price has translated into record crude oil reserves in 2007 (355 million barrels), but has since declined in 2008.

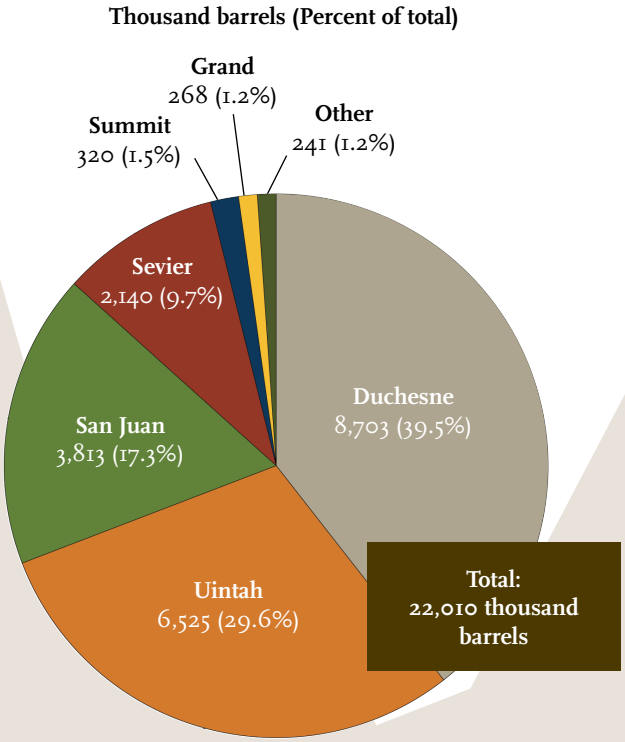
Oil and Gas Well Completions in Utah, 1960–2008



UEMS Web page tables: Table 3.5 and Table 3.20
Source: DOGM, EIA

The number of well completions (both oil and gas) has tracked closely with wellhead price, both peaking in the early 1980s and again in recent years. The recent price surge has facilitated a record high of 1207 wells drilled in 2008. Also of note is the decrease in the number of dry wells through the years as drilling and exploration techniques have improved and high-risk wildcat drilling has decreased.

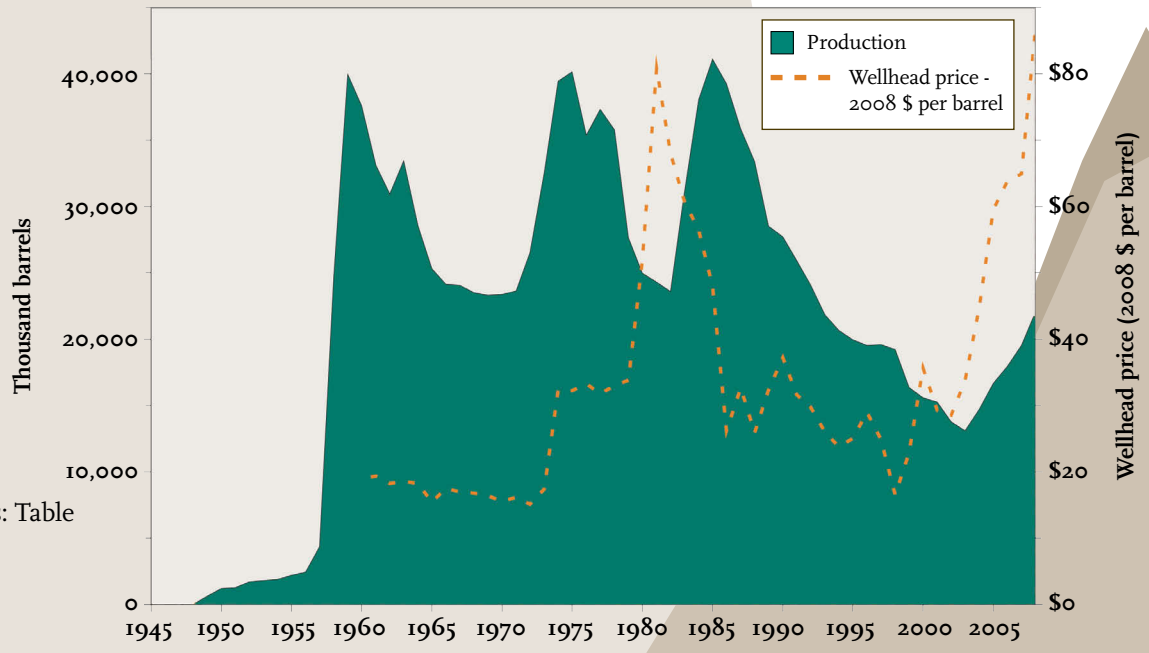
Utah Crude Oil Production by County, 2008



Crude oil production in Utah is mostly concentrated in Duchesne, Uinta, and San Juan Counties. Recently production has started in Sevier County with the discovery of the Covenant field in central Utah.

UEMS Web page table: Table 3.8
Source: DOGM
Note: "Other" includes Garfield, Carbon, Emery, Sanpete, and Daggett Counties.

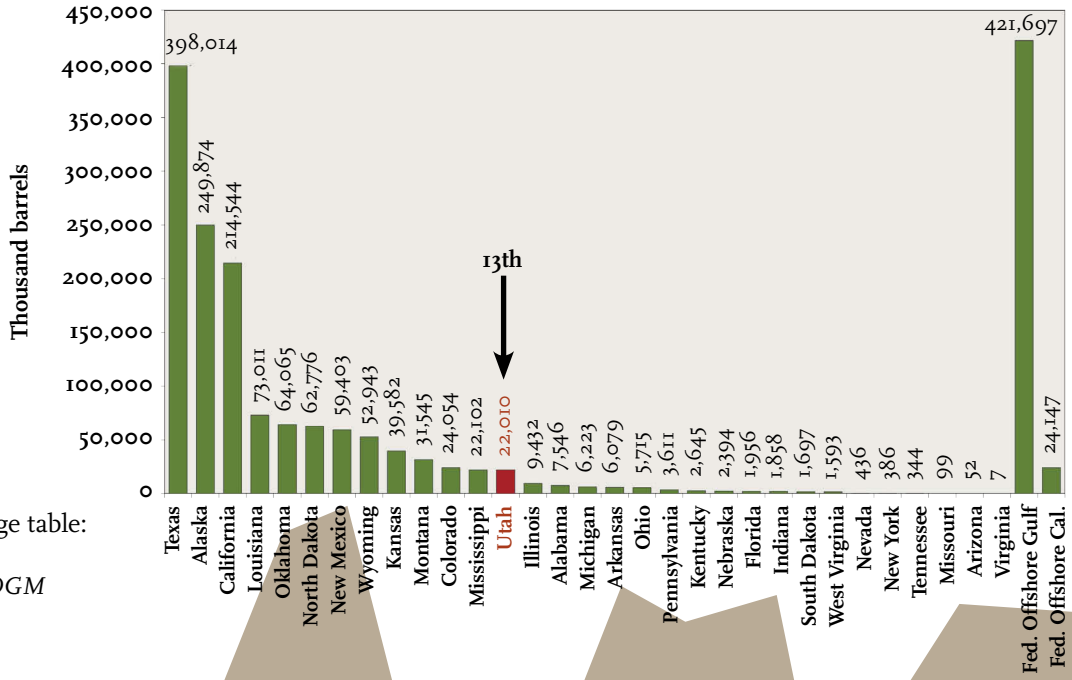
Utah Crude Oil Production, 1945-2008



UEMS Web page tables: Table 3.7 and Table 3.20
Source: DOGM, EIA

Utah has experienced three oil booms in the past 60 years and is currently defining a fourth. The first spike in crude oil production followed the discovery of the very large Bluebell and Greater Aneth fields in 1955 and 1956, respectively. The second spike coincided with a 1971 increase in wellhead price as well as the discovery of the Altamont field. The third spike in production resulted from the price spike of the early 1980s and followed the 1980 discovery of the Anschutz Ranch East natural gas field, which also produced large amounts of crude oil. The current rise in crude oil production is related to higher prices resulting in higher production from existing fields, as well as the discovery of the Covenant field in central Utah.

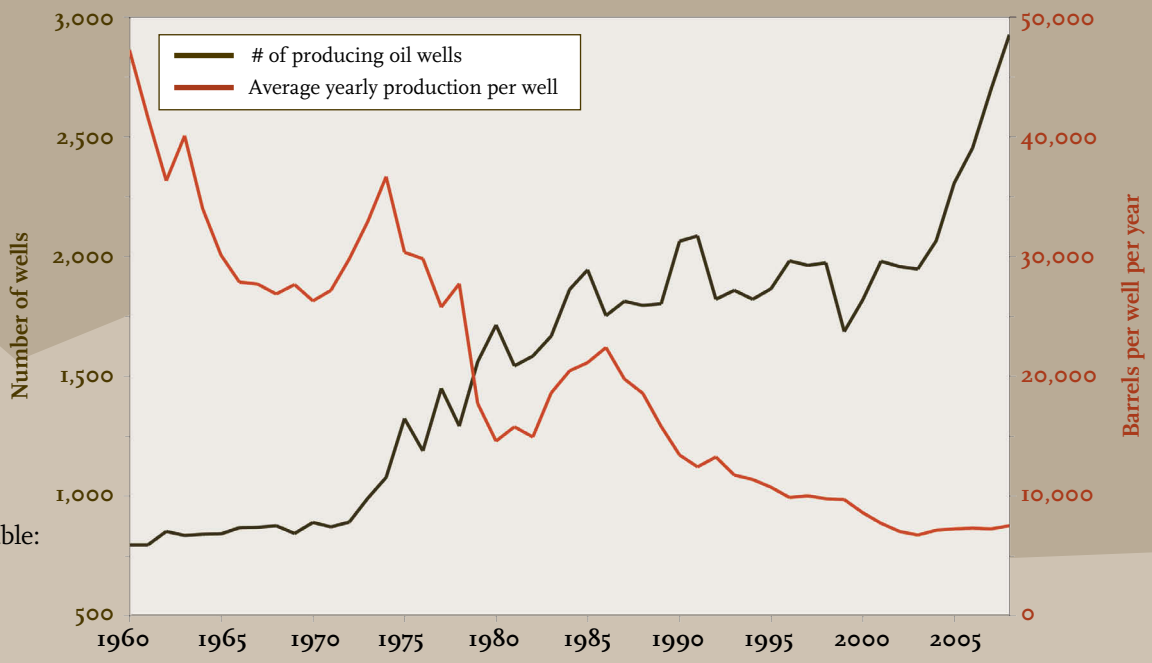
U.S. Crude Oil Production by State, 2008



UEMS Web page table:
Table 3.6
Source: EIA, DOGM

In 2008, Utah ranked as the 13th largest producer of crude oil in the United States (not including federal offshore areas).

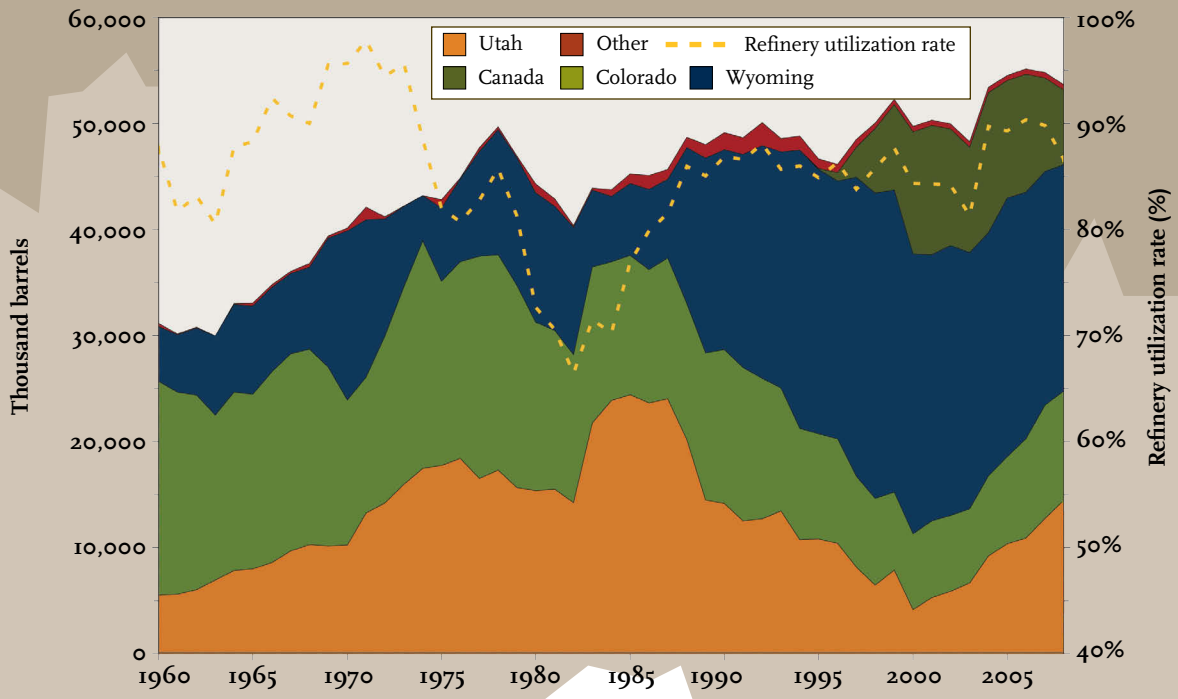
Number of Producing Crude Oil Wells in Utah Versus Average Yearly Production per Well, 1960–2008



UEMS Web page table:
Table 3.7
Source: DOGM

As the total number of producing oil wells has increased over the years, the average yearly production per well has decreased. This graph illustrates how it requires more wells to produce the same amount of crude oil.

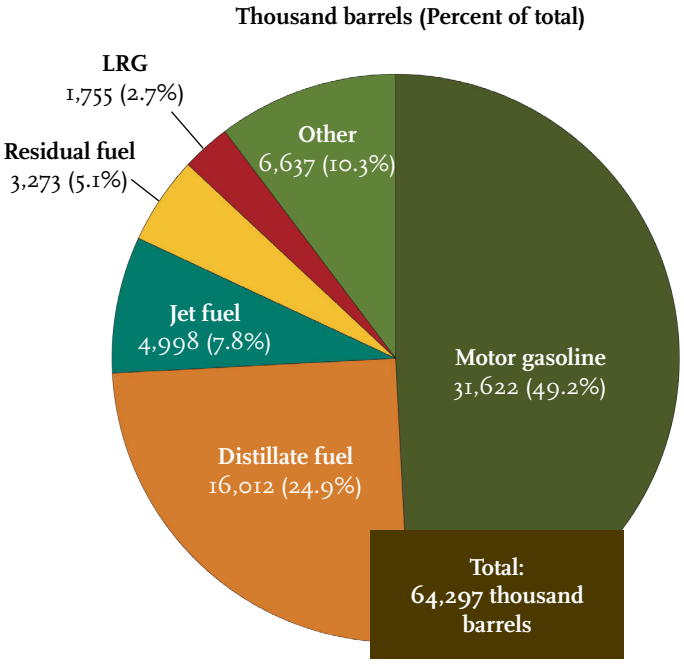
Crude Oil Shipped to Utah Refineries by State or Country of Origin, 1960–2008



Utah refineries receive crude oil from four main sources: Utah, Colorado, Wyoming, and, as of 1995, Canada. Utah's refinery utilization rate, the average ratio of crude oil inputs to total refinery capacity, has averaged 86% over the past 20 years. In 2006, the average rate was greater than 90% for the first time since 1973, but has since dropped to 87% in 2008 as the high price of gasoline helped decrease demand.

UEMS Web page tables: Table 3.15 and Table 3.17
Source: EIA, UGS
Note: "Other" includes small amounts from Nevada, Montana, and New Mexico.

Utah Refinery Production by Product, 2008



Utah refineries produced over 31 million barrels of motor gasoline in 2008, of which roughly 14 million barrels was shipped to surrounding states.

UEMS Web page table: Table 3.16
Source: EIA
Note: LRG = Liquefied refinery gases

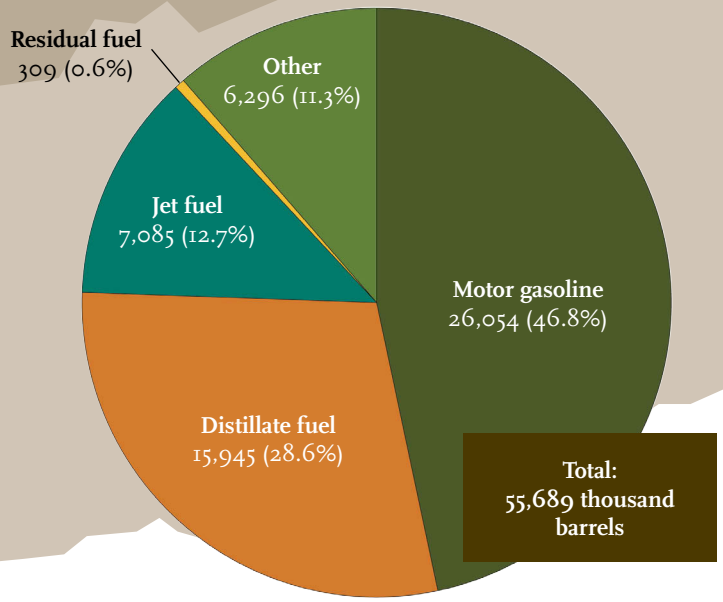
Consumption of Petroleum Products in Utah

Motor gasoline was the most used petroleum product in 2007, accounting for 46.8% of all consumption. Distillate fuel ranked second at 28.6%, followed by jet fuel at 12.7%. Residual fuel use has declined greatly since the mid-1980s since it is no longer used as a fuel in power plants. Overall petroleum product consumption tracks well with Utah's population growth.

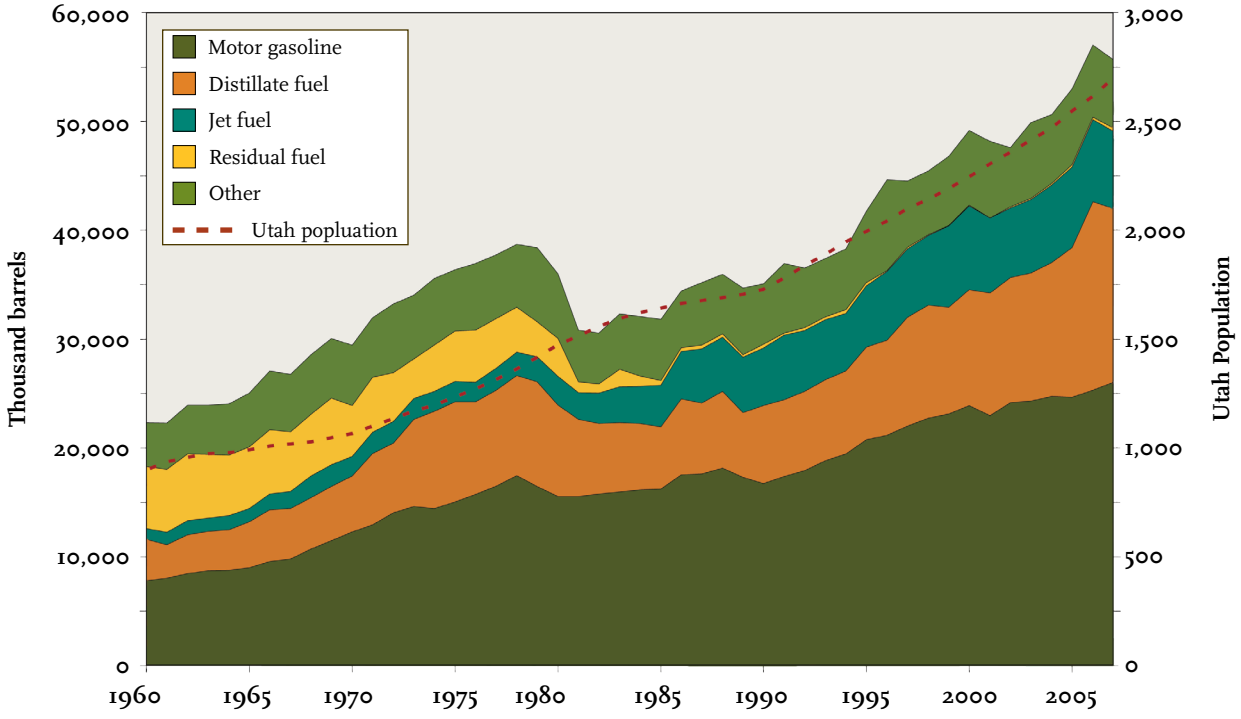
UEMS Web page table: Table 3.18
Source: EIA
Notes: 2008 data are not yet available; "Other" includes asphalt and road oil, aviation gasoline, kerosene, liquefied petroleum gases, lubricants, among others.

2007

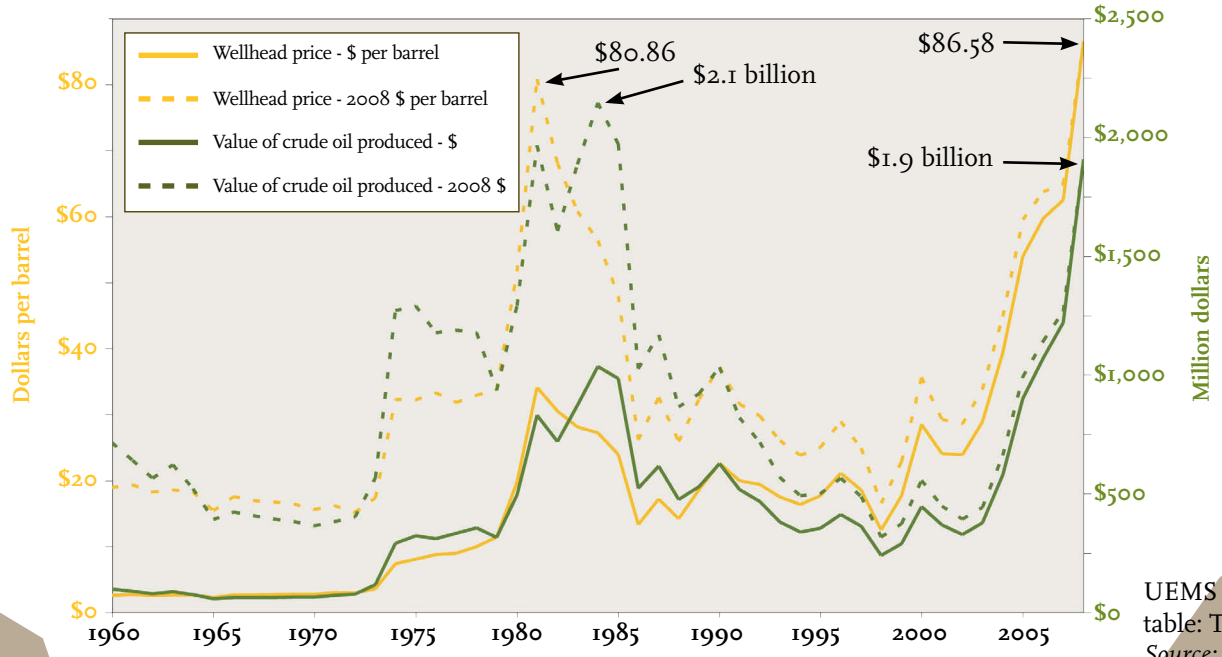
Thousand barrels (Percent of total)



1960–2007



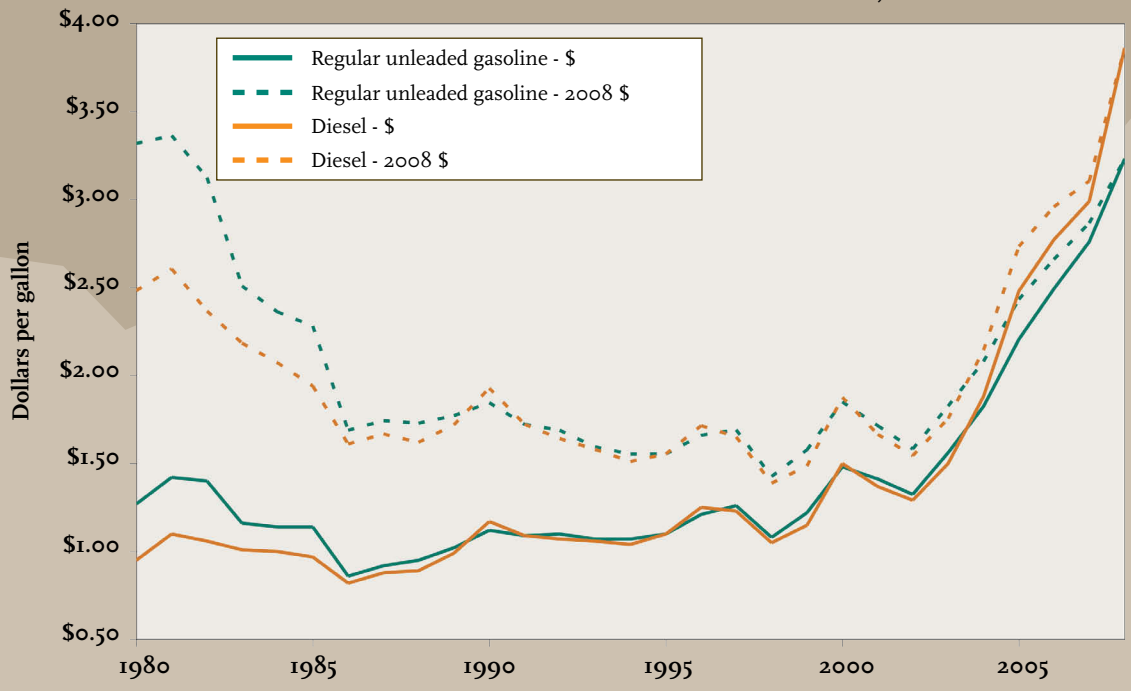
Average Wellhead Price and Value of Crude Oil in Utah, 1960–2008



UEMS Web page table: Table 3.20
Source: EIA

Utah's crude oil wellhead price hit an all-time high of $86.58 per barrel in 2008, even when adjusted for inflation. The value of Utah's crude oil also reached a record high of $1.9 billion in nominal dollars, but is the third-highest value in inflation-adjusted dollars behind 1984 and 1985.

Utah Price of Motor Gasoline and Diesel, 1980–2008

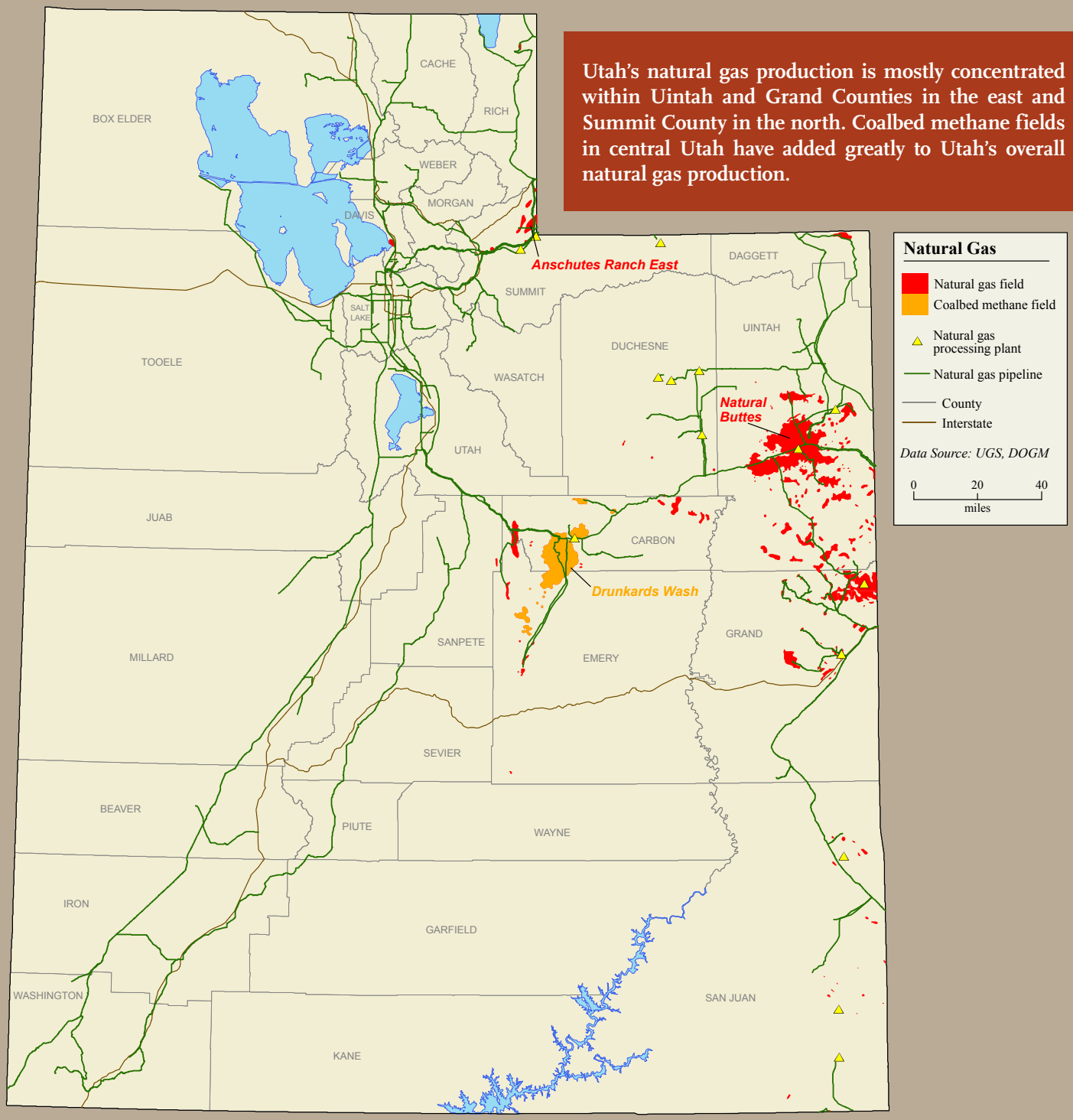


Source: UGS, EIA

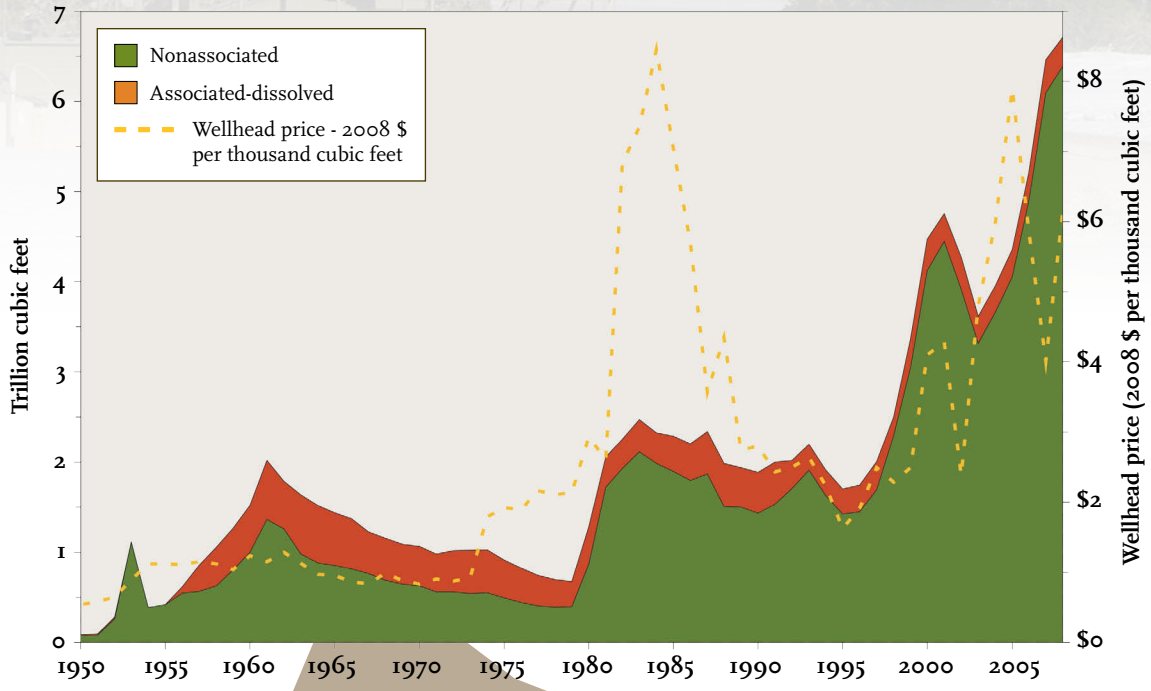
Regular unleaded gasoline reached the highest inflation-adjusted level since 1981, averaging $3.23 per gallon in 2008, while diesel prices hit an all-time inflation-adjusted high of $3.86 per gallon in 2008.

Natural Gas

Utah's natural gas production is mostly concentrated within Uintah and Grand Counties in the east and Summit County in the north. Coalbed methane fields in central Utah have added greatly to Utah's overall natural gas production.



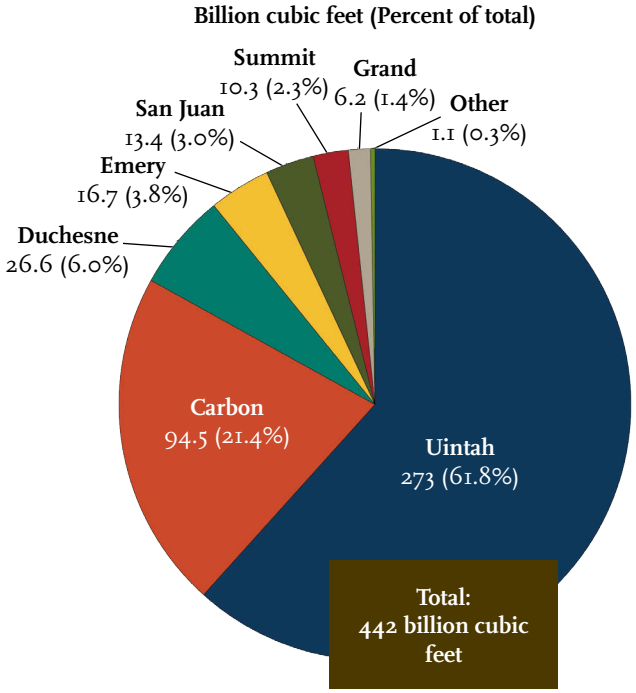
Natural Gas Reserves in Utah, 1950–2008



Natural gas reserves surged in 1980 and 1981, coinciding with an increase in wellhead price, and a second surge occurred in the late-1990s, coinciding with new development of coalbed methane. The current increase in reserves is again the result of higher prices.

UEMS Web page tables: Table 4.2 and Table 4.16
Source: EIA
Note: Nonassociated natural gas is not in contact with significant quantities of crude oil in the reservoir. Associated-dissolved natural gas occurs in crude oil reservoirs either as free gas (associated) or as gas in solution with crude oil (dissolved gas).

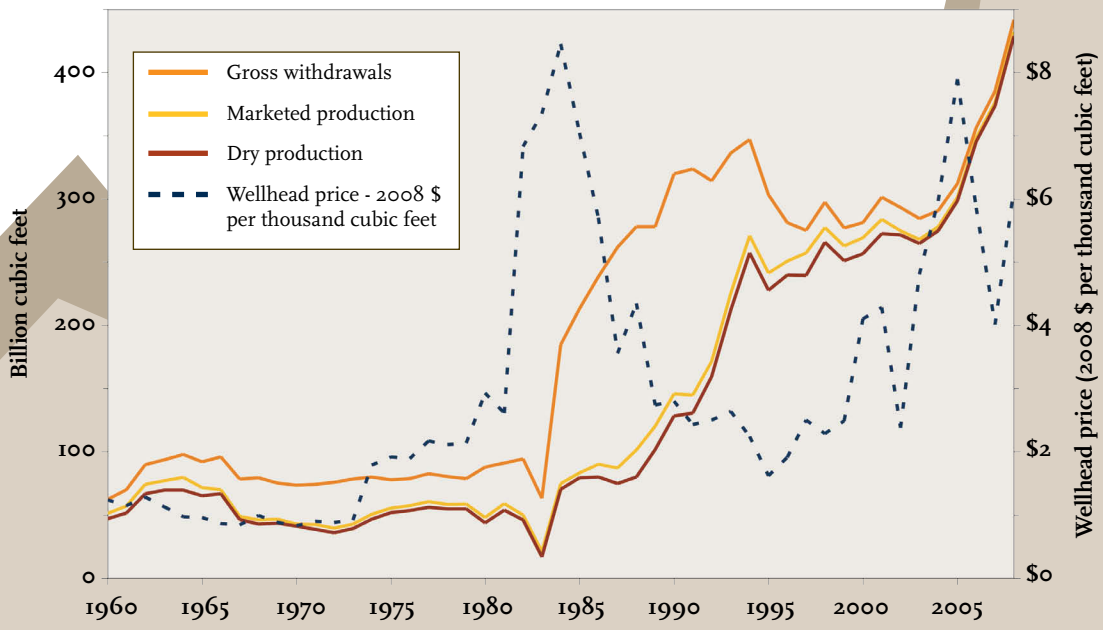
Utah Natural Gas Production (Gross) by County, 2008



Gross natural gas production in Utah is mostly concentrated in Uintah and Carbon Counties (Carbon County production is predominantly from coalbed methane).

UEMS Web page table: Table 4.6
Source: DOGM
Note: "Other" includes Daggett, Sanpete, and Garfield Counties.

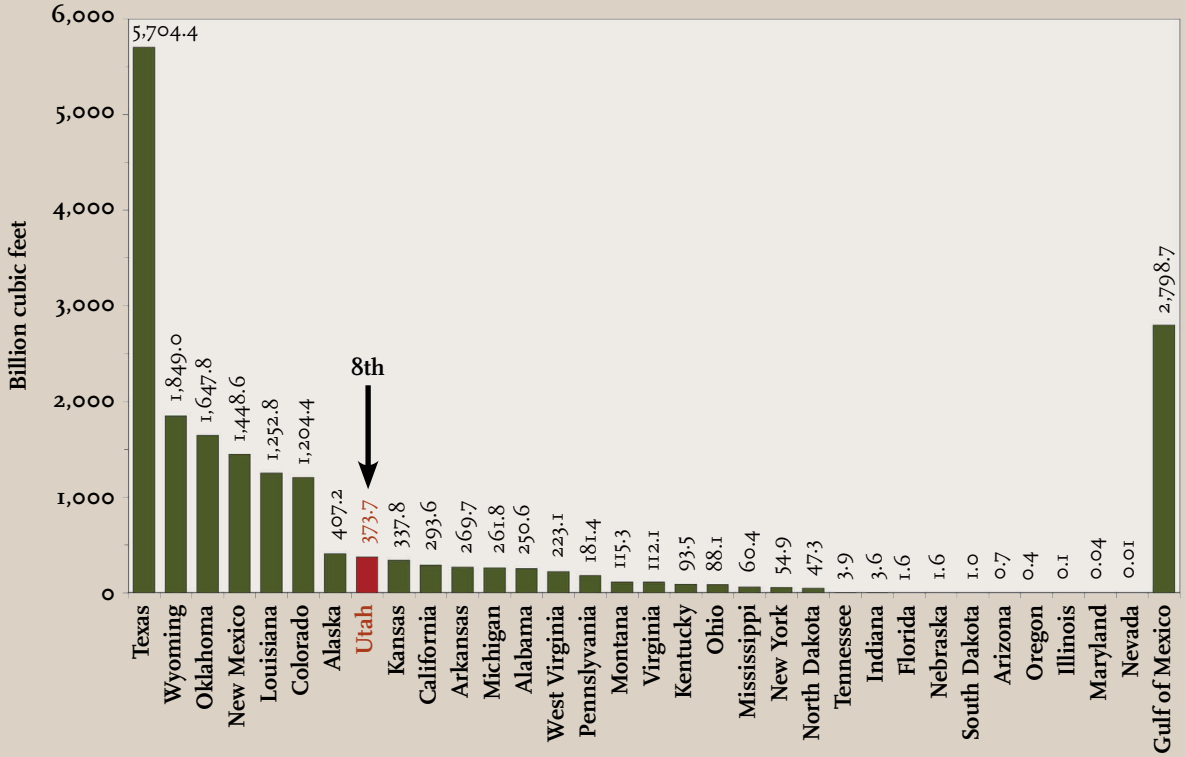
Utah Natural Gas Production, 1960–2008



The first major increase in natural gas production occurred in the mid-1980s, coinciding with a large spike in prices and the discovery of coalbed methane in central Utah. The current surge in production is also price related, with the majority of production centered in Uintah County.

UEMS Web page tables: Table 4.5 and 4.16
Source: DOGM, EIA

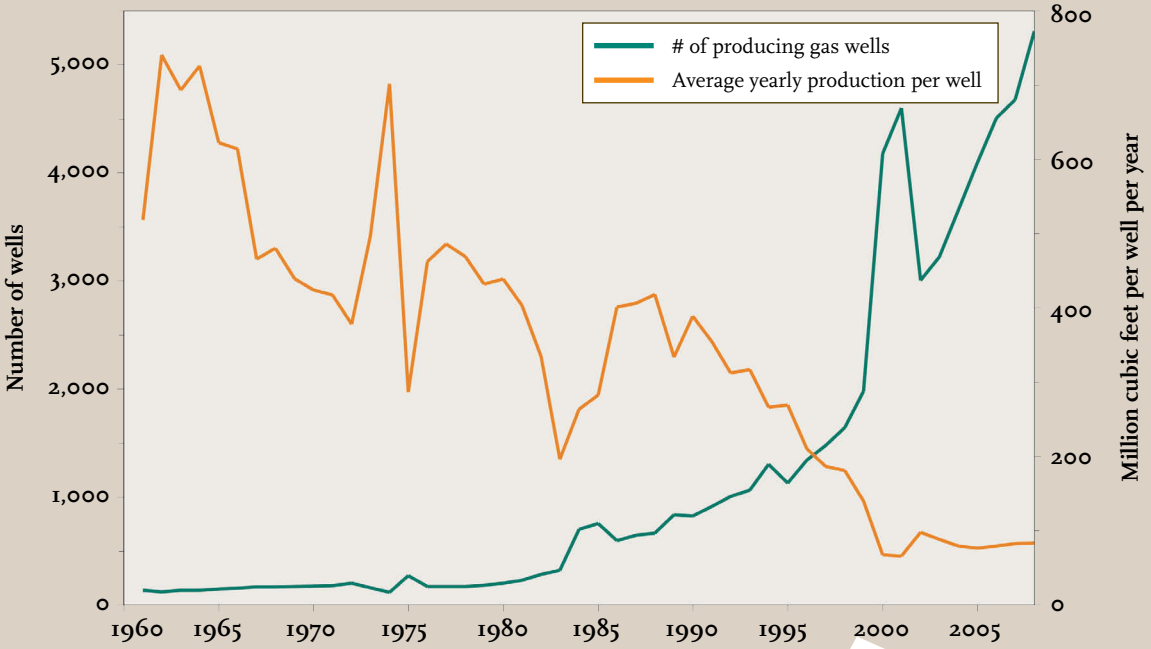
U.S. Natural Gas Production (Dry) by State, 2007



UEMS Web page table: Table 4.4
Source: EIA, DOGM
Note: 2008 data are not yet available.

In 2007, Utah ranked as the 8th largest producer of natural gas in the United States (not including production in the Gulf of Mexico).

Number of Producing Natural Gas Wells in Utah Versus Average Yearly Production per Well, 1961–2008



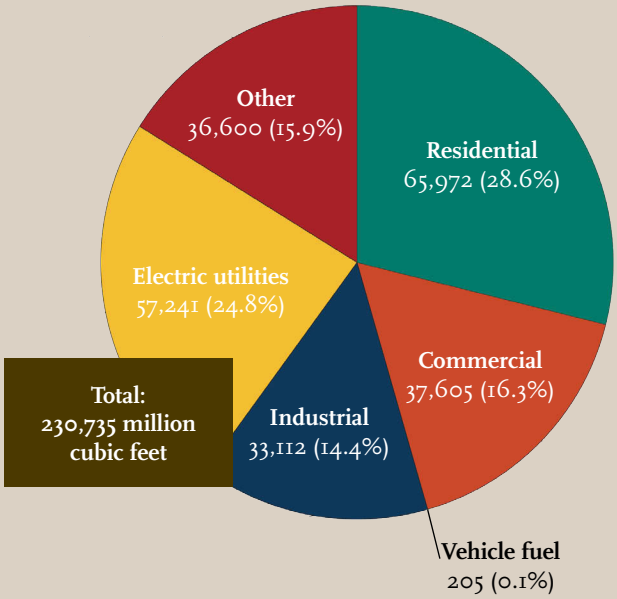
UEMS Web page table: Table 4.5
Source: DOGM

Similar to crude oil, as the total number of producing gas wells has increased over the years, the average yearly production per well has decreased.

Consumption of Natural Gas in Utah

2008

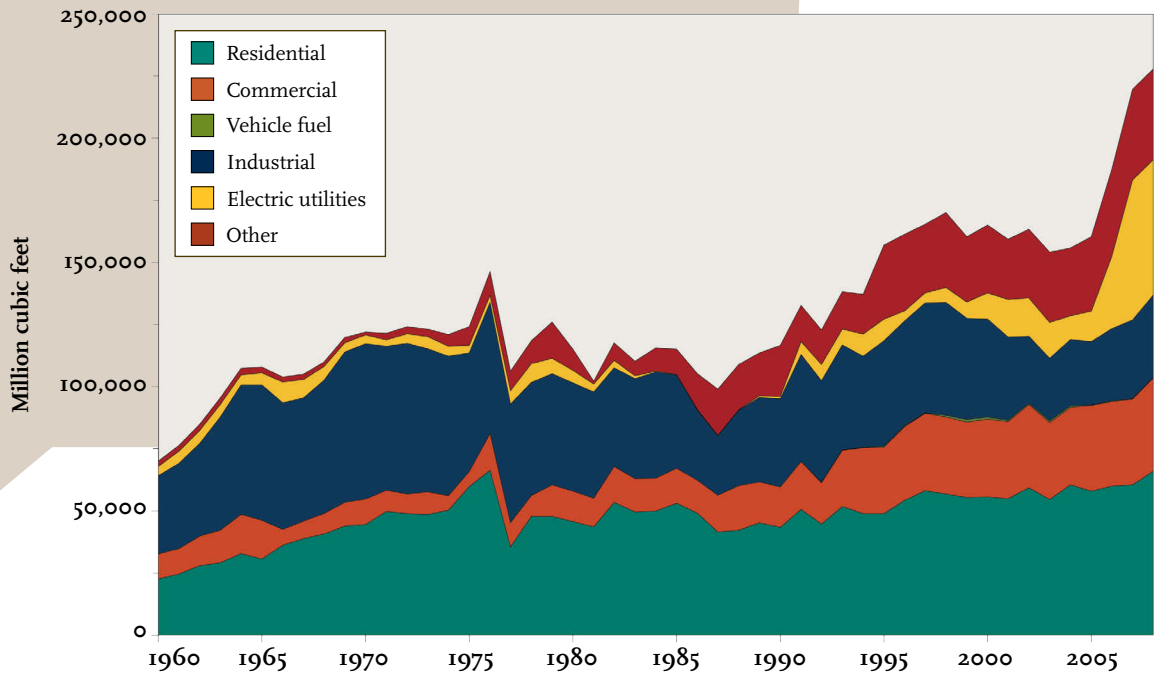
Million cubic feet (Percent of total)



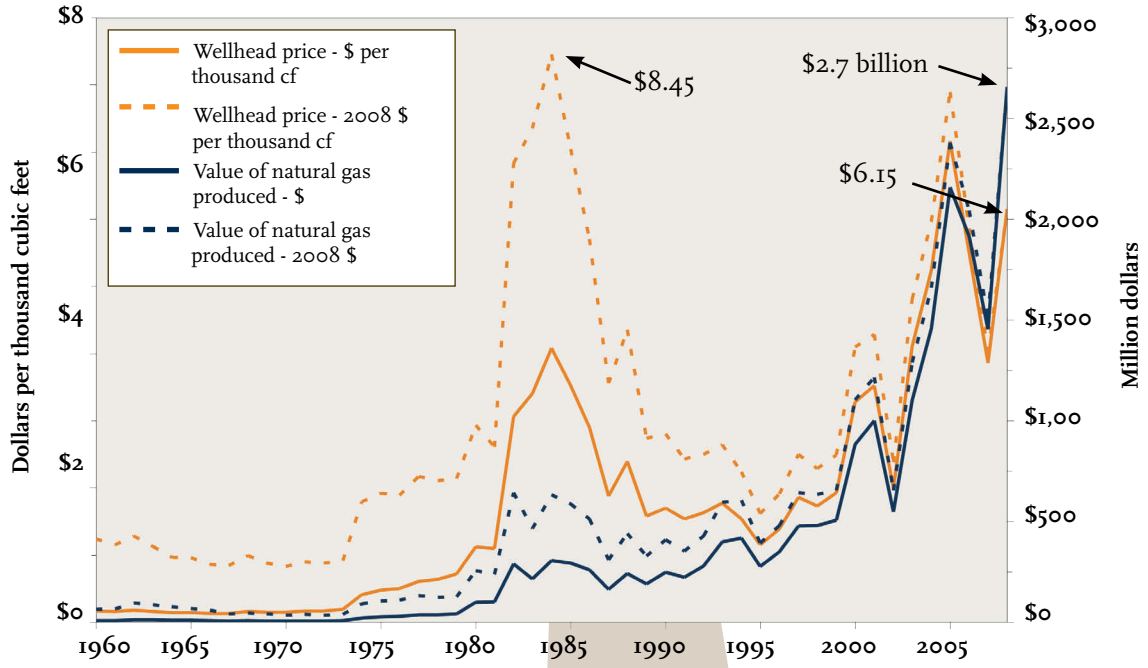
Natural gas is mostly used for home heating (residential, 28.6%), but starting in mid-2004, 1300 MW of new natural-gas-fired electric capacity have come online, greatly increasing the amount used by the electric utility sector (from 7.6% in 2005 to 24.8% in 2008).

UEMS Web page table: Table 4.15
Source: EIA
Notes: 2008 data are estimated; "Other" includes lease use, plant use, and pipeline fuel.

1960–2008



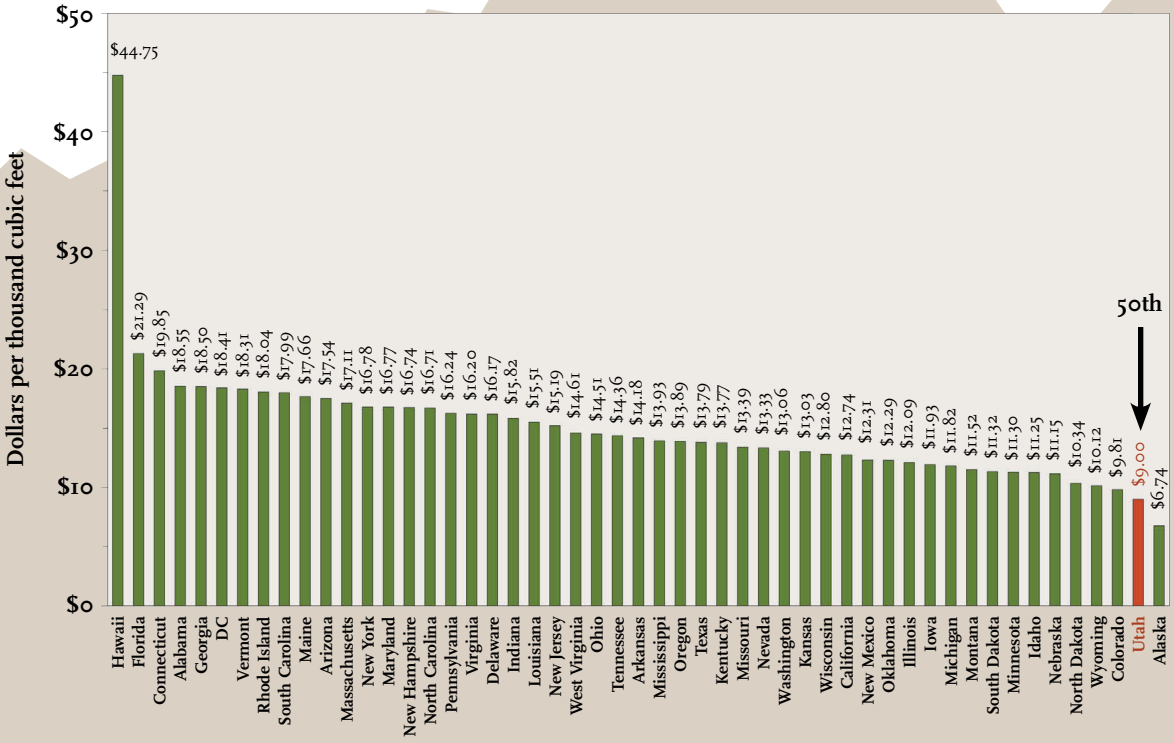
Average Wellhead Price and Value of Natural Gas in Utah, 1960–2008



UEMS Web page table: Table 4.16
Source: EIA

The value of Utah's natural gas production in 2008 reached an all-time high of $2.7 billion, even when adjusted for inflation. This dramatic increase was the product of record high production resulting from near-record-high wellhead prices.

Average Price of Residential Natural Gas by State, 2008



UEMS Web page table: Table 4.18
Source: EIA
Notes: 2008 data are preliminary; includes the District of Columbia.

In 2008, Utah had the second-lowest price for residential natural gas in the country, behind only Alaska.

Renewable Resources

Utah Renewable Energy Zones Task Force Phase I Report: Renewable Energy Zone Resource Identification

To promote and identify Utah's utility-scale electrical renewable energy resources and to assess transmission to bring those resources to load centers in Utah, former Governor Huntsman commissioned the Utah Renewable Energy Zones (UREZ) Task Force to (1) identify geographical areas in Utah where utility-scale renewable energy development could occur (see maps on following pages); (2) assess the electrical generation potential of wind, solar, and geothermal technologies; and (3) identify new and existing transmission needed to bring renewable energy generation sources to market.

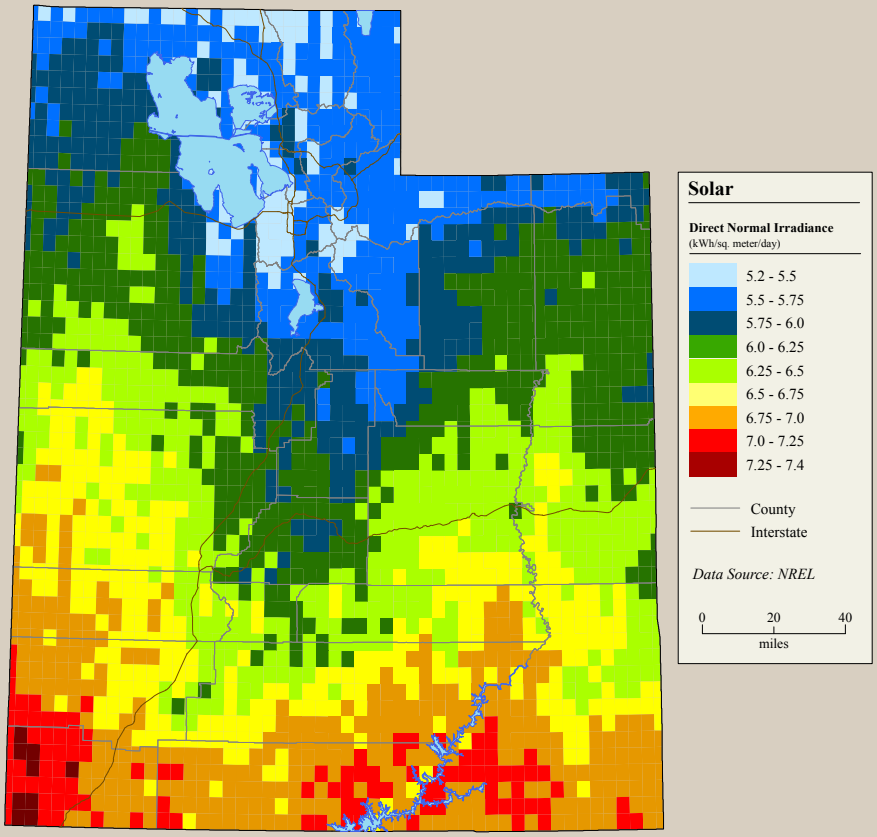
This study identified renewable energy zones totaling approximately 13,262 square miles and an estimated 837 gigawatts (GW) of electrical generating capacity. The multitude of factors that could not be taken into account at this point of the assessment include: project level resource data, site specific land use and environmental restrictions, and federal, state, and local regulatory policies that may complicate or restrict development.

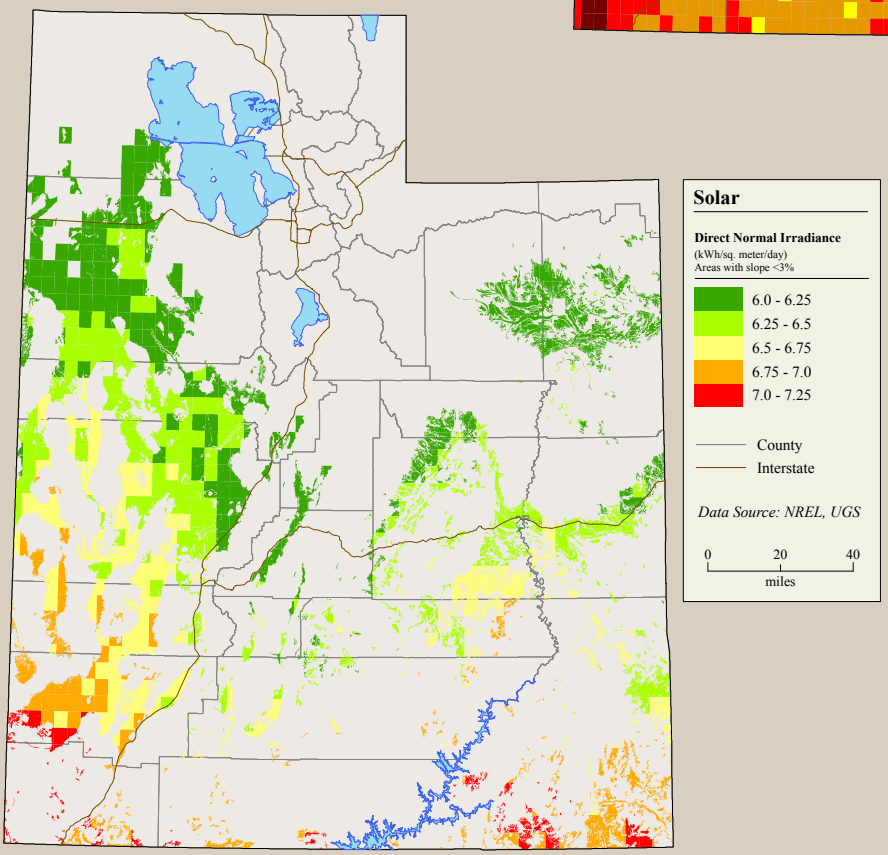
The scope of work for this phase of the UREZ process was not to assess the development potential from an economic perspective. Rather, analogous to estimating resources and reserves in the oil and gas industry, this project's scope of work was to identify the potential resources, within reason, for short-term (~<10 years) and long-term (~>10 years) potential. Again, similar to estimating conventional natural resource reserves, the quantity is a constantly changing value. More importantly, this macro-level assessment will identify likely areas of multiple resource zones that may have utility-scale generation potential.

The entire document is available on the UGS Web page: http://geology.utah.gov/sep/renewable_energy/urez/phase1

SOLAR ASSESSMENT

Utah's solar resources are clearly abundant (map on right, no screening applied). The analysis identified 6,371 square miles of land that has a theoretical potential of about 826 gigawatts (GW) of utility-scale capacity. The solar analysis used several criteria to shape the methodology (map below): (1) measurements of Direct Normal Irradiance (DNI), with a threshold value of 6.0 kilowatt hours per meter squared (kWh/m²)/ day or greater, (2) screening out steeper areas (slopes of 3% or greater) unable to accommodate a large solar collection field, (3) screening out environmentally sensitive areas such as national parks, wilderness areas, wetlands, etc., that are not available for development, and (4) applying proxy technology, of a 50 megawatt (MW) parabolic trough concentrating solar thermal power plant, to estimate electrical energy capacity.





Major findings from the solar assessment:

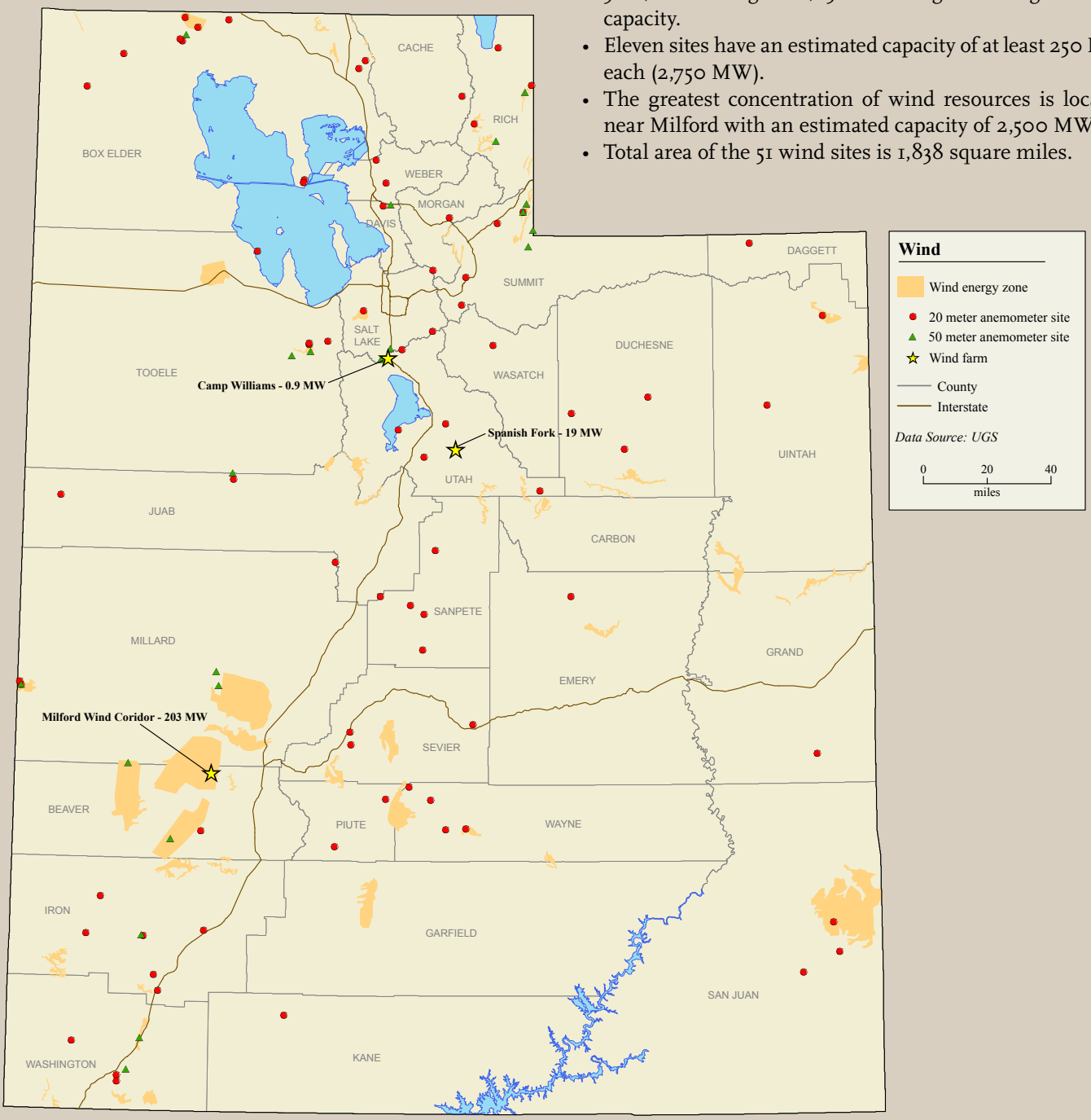
- Sixteen thousand five hundred (16,500) theoretically potential 50 MW solar Renewable Energy Zone (REZ) areas (1 km square zones) were identified (826 GW).
- The geospatial distribution of the quality of the solar resource follows a simple north to south trend.
- Southern Utah has the higher quality resources (6.5 kWh/m²/day or greater), while northern Utah has a slightly lower quality solar resource (6.0 kWh/m²/day or less).
- The prime solar REZ areas constitute less than 1.5% of the identified sites, while the majority of the sites (43.2%) have a lower resource potential.
- The total area of the solar REZs is 6,371 square miles.

WIND ASSESSMENT

Utah's extreme diversity in landscape and climate are well known. These factors significantly affect Utah's wind resources. As a result, Utah has a wide array of locations that may be viable options for wind energy development. The resource analysis to identify REZs was based upon wind data collected from 109 anemometer towers stationed throughout the state. The wind resource analysis incorporated several criteria to shape the methodology: (1) screening out environmentally sensitive areas, (2) setting a maximum elevation of 9,500 feet, (3) eliminating land too rugged for development, (4) deleting military operating airspace, and (5) using a proxy wind turbine, General Electric 1.5 sle model, to estimate electrical energy capacity from identified sites.

Major findings from the wind assessment:

- The combined technical electrical generating capacity is approximately 9,145 MW from the 51 wind REZs (orange areas on map).
- The estimated annual average gross capacity factor for the 51 REZ sites is 27.4%.
- Twelve sites have expected gross capacity factors of at least 30%, accounting for 1,830 MW or greater of generating capacity.
- Eleven sites have an estimated capacity of at least 250 MW each (2,750 MW).
- The greatest concentration of wind resources is located near Milford with an estimated capacity of 2,500 MW.
- Total area of the 51 wind sites is 1,838 square miles.

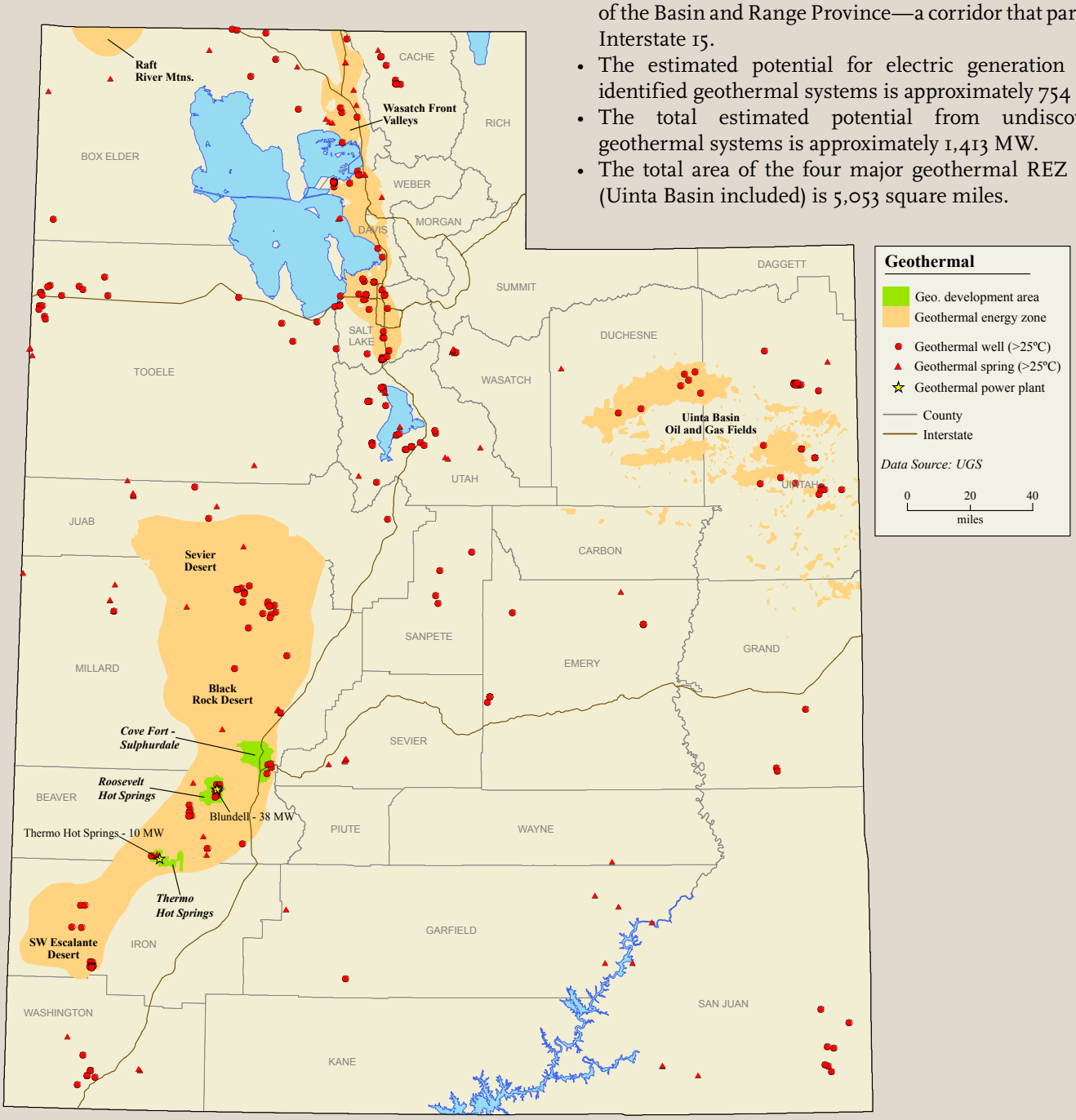


GEOTHERMAL ASSESSMENT

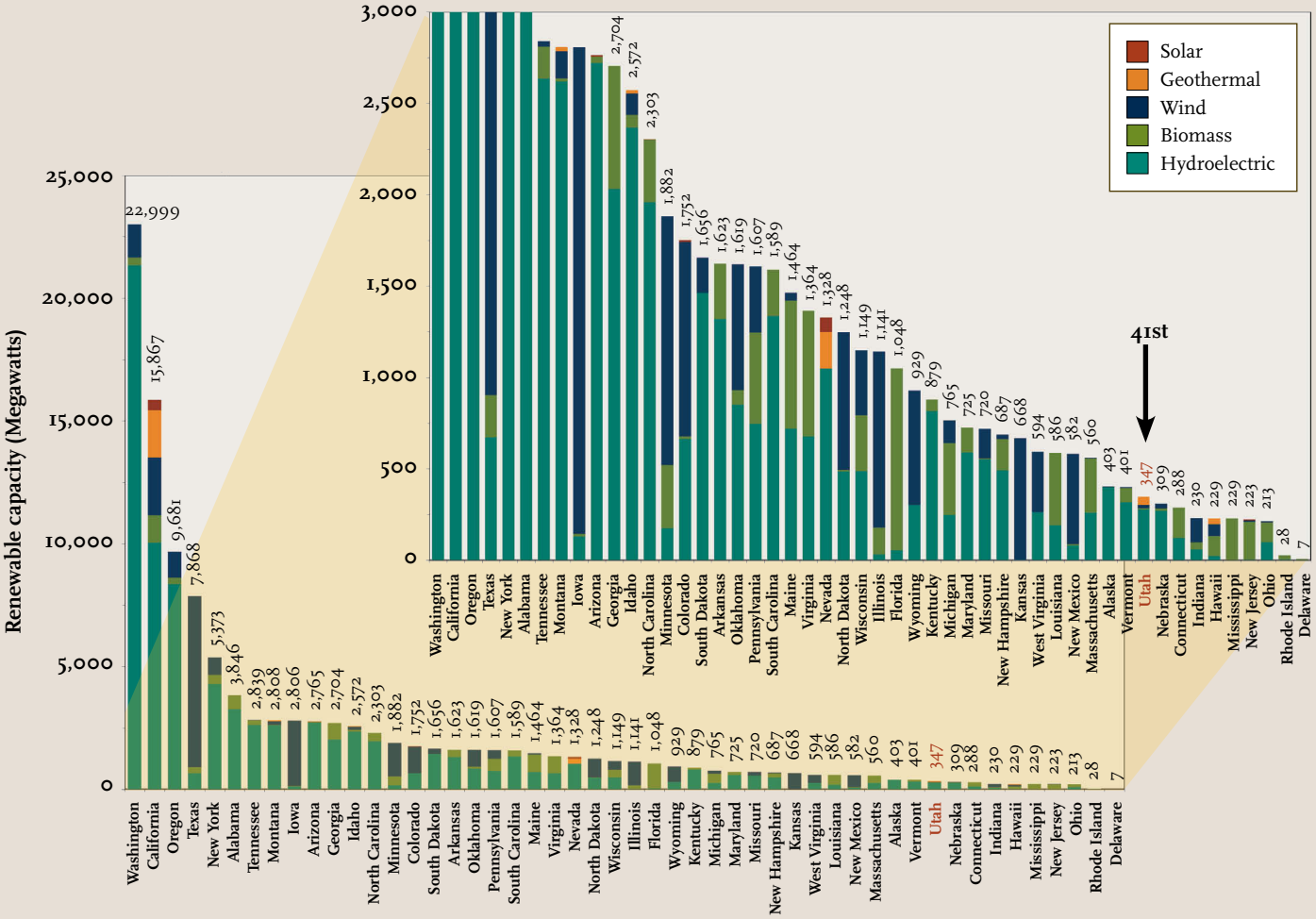
Although a number of geothermal power projects are currently underway, there is a general lack of subsurface drill-hole information for individual resource areas. The effort described here uses published information from various sources, but mostly relies on deep well data and shallow thermal-gradient information. Utah's identified higher-quality geothermal resources lie within a 50-mile-wide corridor along the eastern margin of the Basin and Range Province—a corridor that also parallels Interstate 15. Geothermal power generation projects are underway in southcentral and southwestern Utah. The geothermal analysis incorporated the following criteria to shape the methodology: (1) screening out environmentally sensitive areas not available for development, (2) calculating reservoir volume, and (3) factoring in porosity and sweep efficiency, which characterize the ability of the reservoir to transfer heat.

Major findings from the geothermal assessment:

- A total of 2,166 MW of geothermal development potential exists within the state (orange areas on map).
- Utah's identified higher-quality geothermal resources lie within a 50-mile-wide corridor along the eastern margin of the Basin and Range Province—a corridor that parallels Interstate 15.
- The estimated potential for electric generation from identified geothermal systems is approximately 754 MW.
- The total estimated potential from undiscovered geothermal systems is approximately 1,413 MW.
- The total area of the four major geothermal REZ areas (Uinta Basin included) is 5,053 square miles.



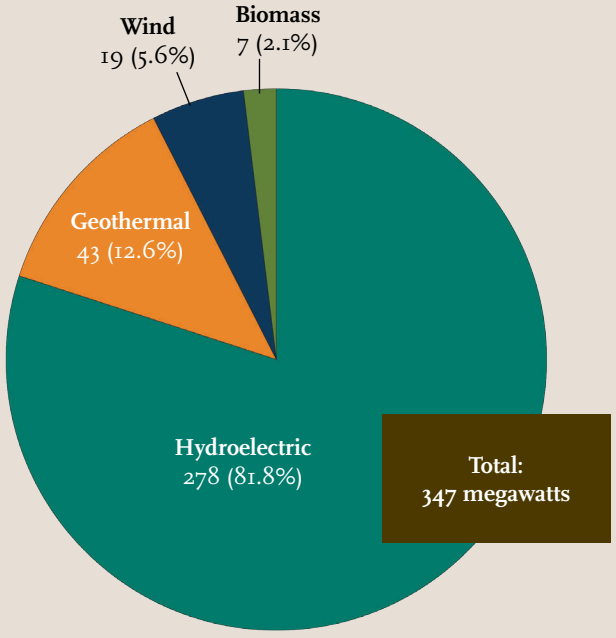
Renewable Net Summer Capacity by Energy Source and State, 2008



In 2008, Utah ranked 41st in the nation in total renewable net summer electric capacity.

Utah's Renewable Net Summer Capacity by Energy Source, 2008

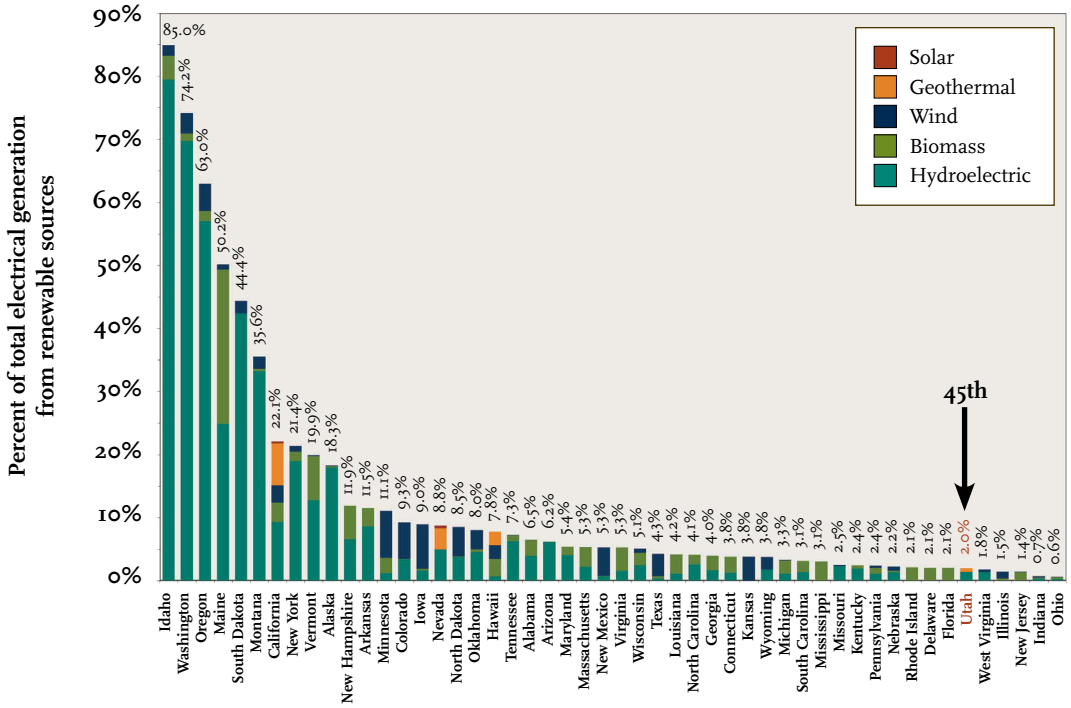
Megawatts (Percent of total)



Utah's renewable electric capacity is dominated by hydroelectric power (Flaming Gorge), with increasing amounts from geothermal (Raser Technologies is planning to build several more 10 MW scale geothermal plants in southwestern Utah) and wind (the 203 MW Milford wind farm came online in late 2009). The biomass portion is mainly from Wasatch Front landfill gas operations. The SunSmart solar array in St. George is Utah's first utility-owned solar installation, but at only 100 kilowatts capacity, it is too small to be recorded by EIA or in the graphs on this page.

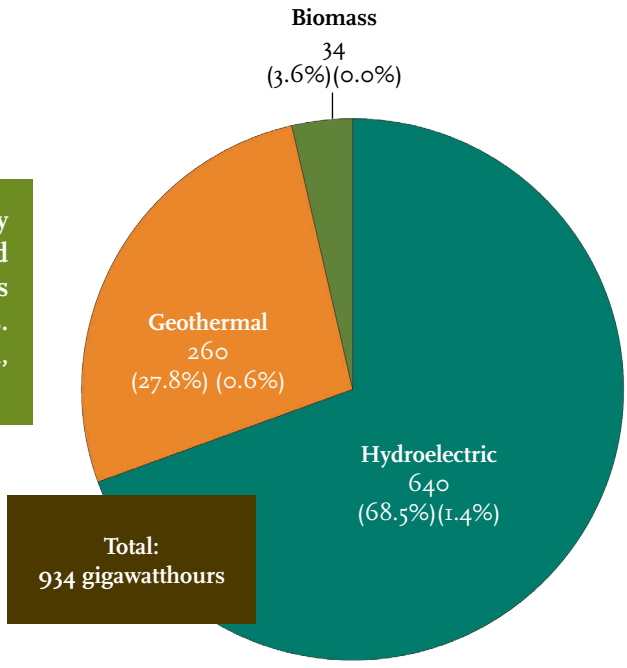
UEMS Web page table: Table 6.1
Source: EIA
Note: Only includes utility scale capacity.

Renewable Electric Generation by State, 2008



In 2008, Utah ranked 45th in the nation in percent of total net electricity generation from renewable resources. Of particular note, Utah is one of only four states where electricity is generated from geothermal resources (two more states, Idaho and Montana, were added to this list in 2009).

Renewable Electric Generation in Utah, 2008

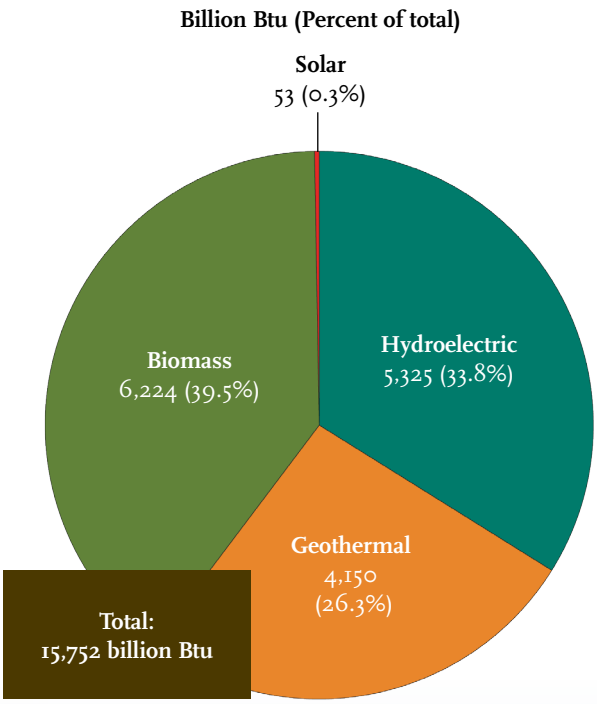


Utah's renewable electric generation is dominated by hydroelectric power, but electricity from geothermal and wind sources will increase in coming years. The biomass portion is electricity generated from burning landfill gases. Two smaller scale anaerobic digesters are located in Utah, but are not utility scale.

UEMS Web page table: Table 6.2
Source: EIA

Renewable Energy Consumption in Utah

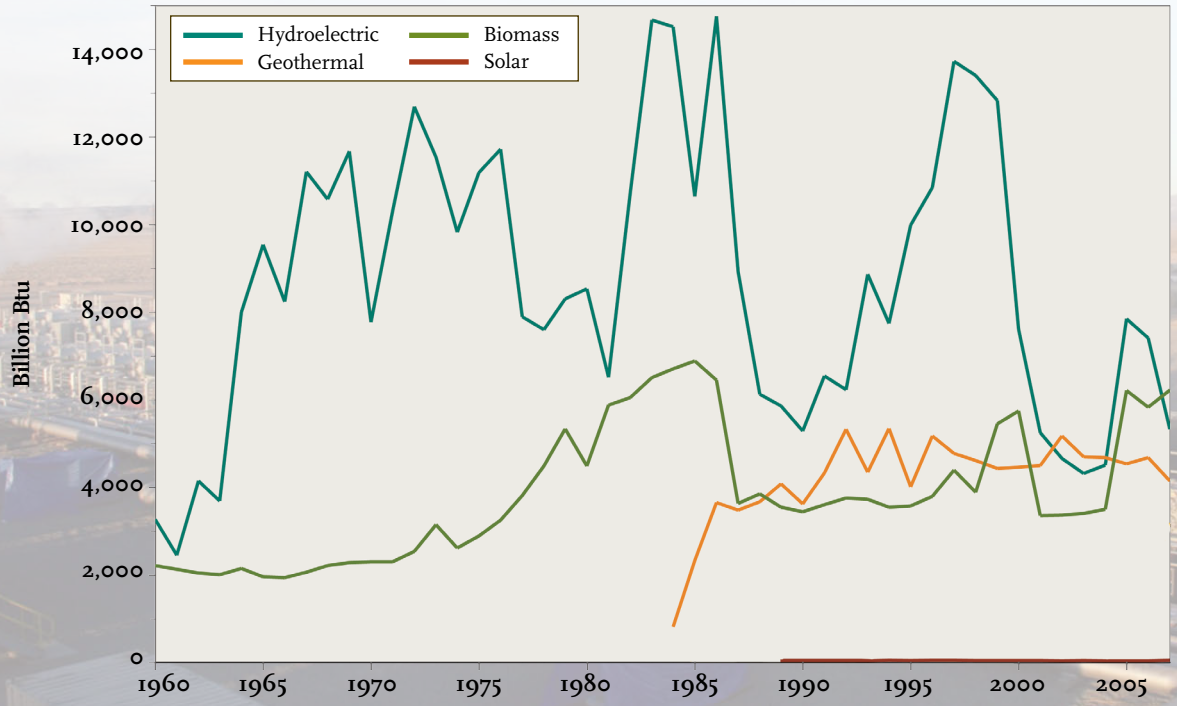
2007



Utah's 2007 consumption of energy from renewable sources was evenly split between hydroelectric, geothermal, and biomass, with very small amounts coming from commercial- and residential-scale solar photovoltaic arrays.

UEMS Web page table: Table 6.7
Source: EIA
Notes: 2008 data are not yet available; includes the electric utility sector; data on Utah wind energy consumption not available.

1960–2007



Unconventional Petroleum Resources

OIL SHALE

The Utah Geological Survey recently completed a comprehensive oil shale resource assessment for deposits in the state of Utah. This assessment answers the questions of "where" and "how much" that many people ask about Utah's largest unconventional resource by providing detailed basin-wide resource maps and estimates of in-place shale oil.

- A continuous interval of oil shale that averages **50 gallons of oil per ton of rock (GPT)** contains an in-place resource of **31 billion barrels** of shale oil.
- A continuous interval of oil shale that averages **35 GPT** contains an in-place resource of **76 billion barrels** of shale oil.
- A continuous interval of oil shale that averages **25 GPT** contains an in-place resource of **147 billion barrels** of shale oil (see included map).
- A continuous interval of oil shale that averages **15 GPT** contains an in-place resource of **292 billion barrels** of shale oil.

After calculating total in-place resource numbers, the UGS imposed several constraints on the total endowment to offer a more realistic impression of Utah's potentially economic oil shale resource. The constraints used were:

- deposits having a richness of at least 25 GPT (assumed minimum grade),
- deposits that are at least 5 feet thick (assumed minimum mining thickness),
- deposits under less than 3000 feet of cover (maximum underground mining depth),
- deposits that are not in direct conflict with current conventional oil and gas operations, and
- deposits located only on U.S. Bureau of Land Management, state trust, private, and tribal lands.

Accounting for these constraints, UGS estimates that approximately **77 billion barrels** of shale oil are located in north-central Utah.

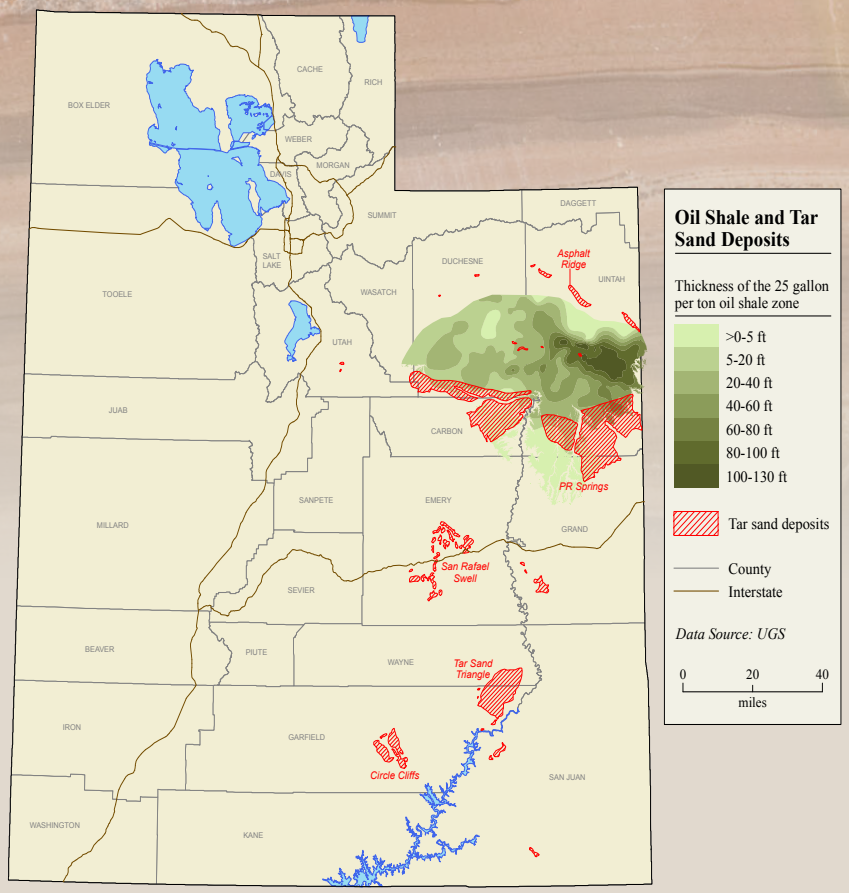
Currently, only a handful of companies are pursuing oil shale development in Utah, including the Oil Shale Exploration Company (OSEC), which was the only company awarded an oil shale research and development lease from the U.S. Bureau of Land Management.

TAR SANDS

North America has the greatest tar sand resources in the world, the majority of which are in Canada. Utah's tar sand resource, though small in comparison to that of Canada, is the largest in the United States. Utah's tar sand deposits contain 14 to 15 billion barrels of measured in-place oil, with an additional estimated resource of 23 to 28 billion barrels. Twenty-four individual deposits exist in the Uinta Basin, mainly around its periphery, and an additional 50 deposits are scattered throughout the southeastern part of the state. Utah's major tar sand deposits individually have areal extents ranging from 20 to over 250 square miles, as many as 13 pay zones, gross thickness ranging from 10 to more than 1000 feet, and overburden thickness ranging from zero to over 500 feet.

With the current high price of crude oil as an incentive, new drilling, bitumen extraction, and upgrading techniques developed in Canada may provide the necessary knowledge for successful and sustainable development of tar sand in Utah in the near future. However, factors such as site accessibility, adequate infrastructure, water availability, environmental concerns, land access and permitting, and the problems associated with the heterogeneity of reservoir sands must be resolved before tar sand development can become a reality in Utah.

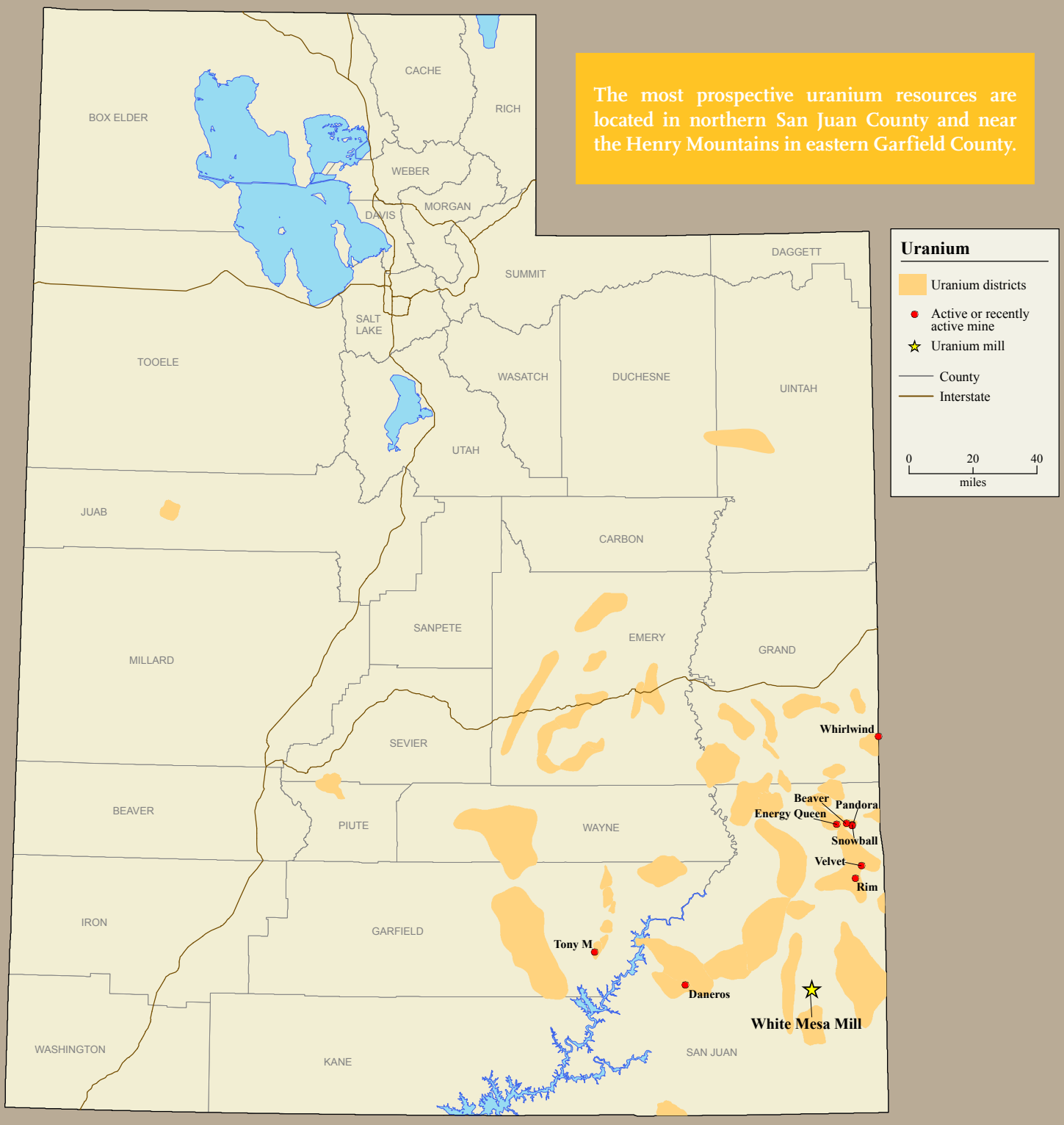
Currently, two companies are researching development of tar sands within the Asphalt Ridge deposit, and one company is looking at possible development in the PR Springs area.



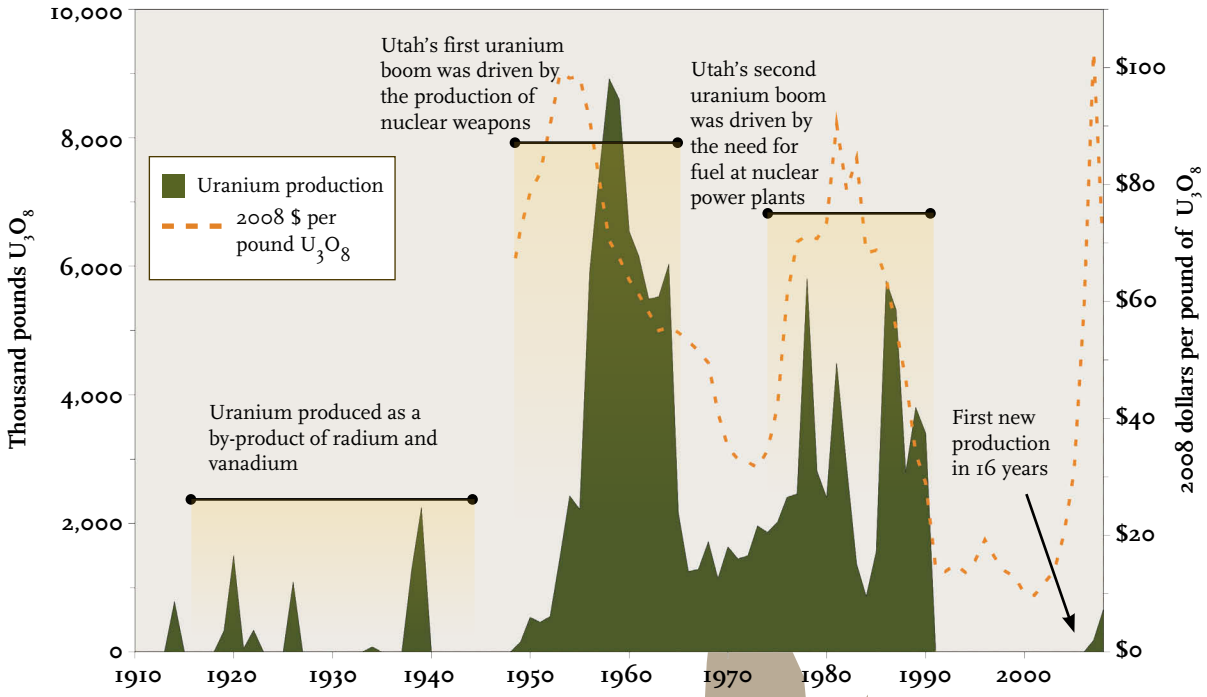
The most prospective unconventional fossil fuel resources are located in the Uinta Basin in northeastern Utah.

Uranium

The most prospective uranium resources are located in northern San Juan County and near the Henry Mountains in eastern Garfield County.



Uranium Production in Utah, 1910–2008

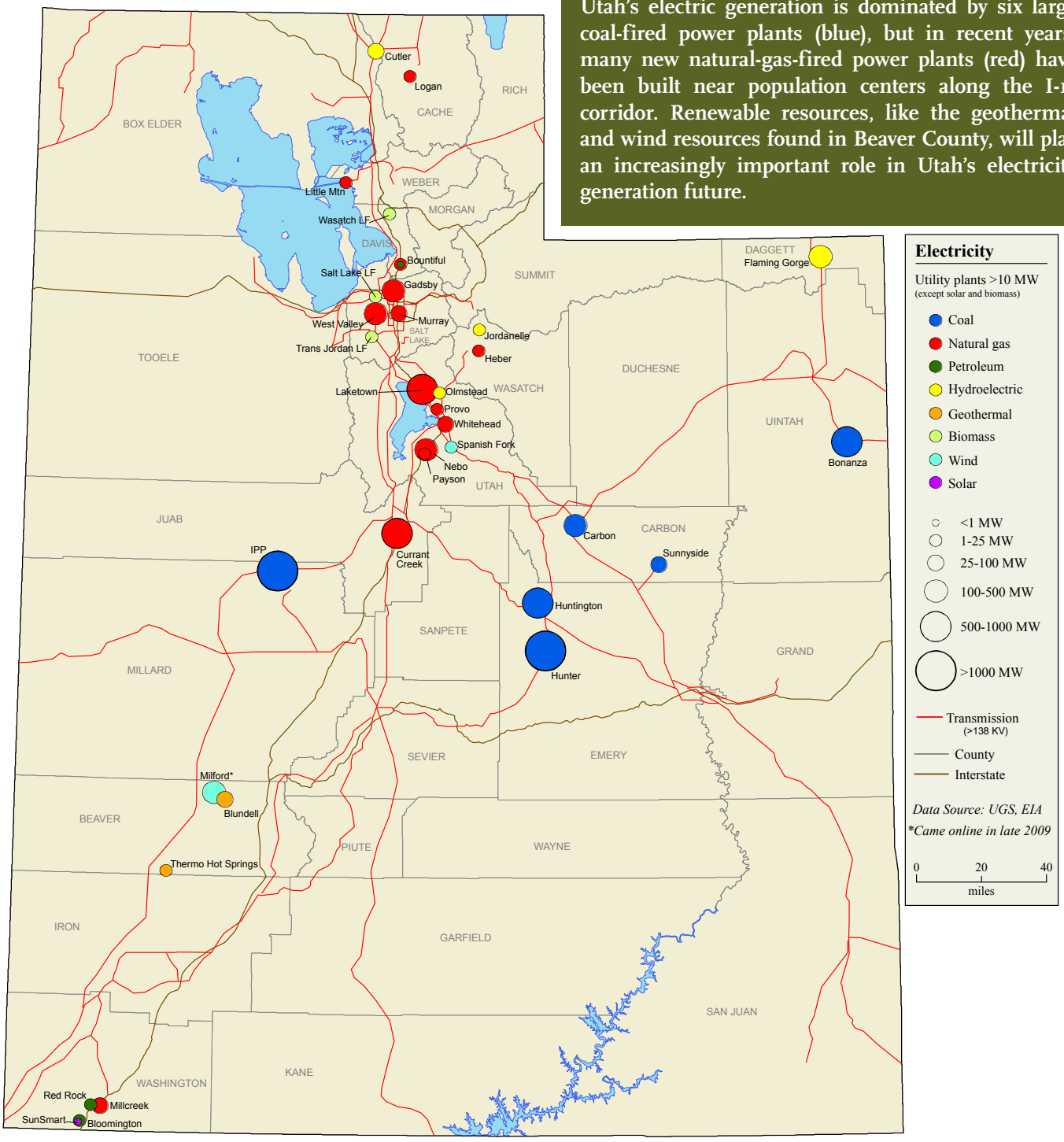


From 1909 to 1940, uranium was produced as a byproduct of first radium, then vanadium. Utah's first big uranium boom started in 1948 when the U.S. Atomic Energy Commission set a guaranteed price and bonus schedule for domestic uranium ore, driven by the requirements of nuclear weapons production. Utah's uranium production grew rapidly during the late-1940s and 1950s, peaking in 1958 at 8.9 million pounds of U_3O_8 before declining in the mid-1960s. During this time, production occurred at over 500 individual mines. A second period of uranium production began in the early 1970s with the development of the nuclear power industry, peaking in 1978 at 5.8 million pounds U_3O_8. Since the mid-1980s, Utah's underground ores had difficulty competing with other lower cost operations, exacerbated by the discovery of very large, high-grade, near-surface uranium ore in Canada and Australia. By 1990, all of Utah's uranium production had ceased, and within a few years there were no longer any underground uranium mines operating in the United States. Beginning in 2004, the price of uranium began to rise, reaching an inflation-adjusted record high of $102 per pound in 2007. This new resurgence in uranium price resulted in the reopening of several Utah mines which produced 183,000 pounds in 2007 and 670,000 pounds in 2008. In addition, the White Mesa uranium mill, located outside of Blanding, Utah, once again began processing uranium ore.

UEMS Web page table: Table 9.1
Source: EIA
Note: 2008 data are preliminary.

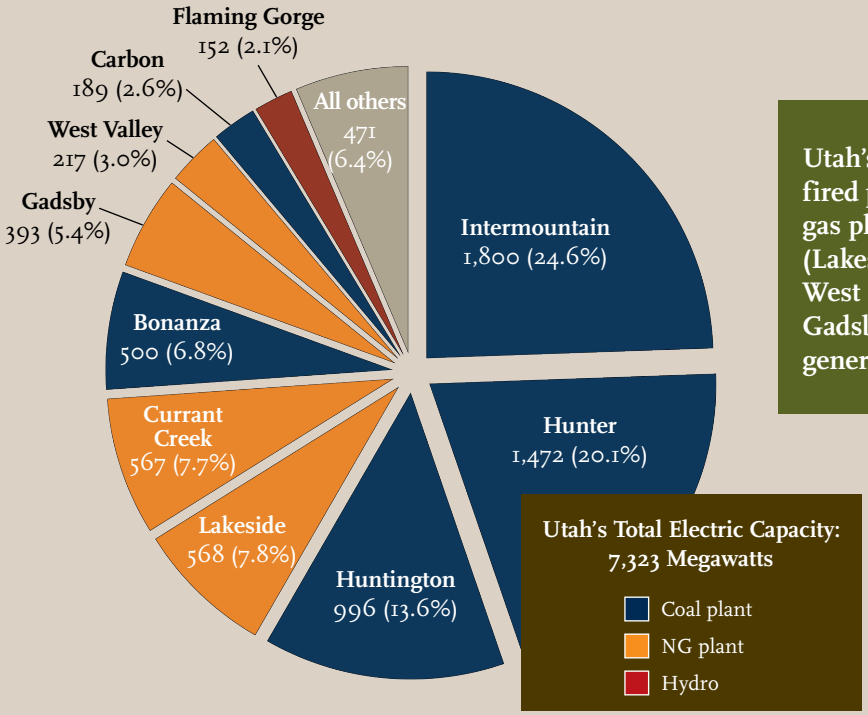
Electricity

Utah's electric generation is dominated by six large coal-fired power plants (blue), but in recent years, many new natural-gas-fired power plants (red) have been built near population centers along the I-15 corridor. Renewable resources, like the geothermal and wind resources found in Beaver County, will play an increasingly important role in Utah's electricity generation future.



Utah's 10 Largest Power Plants, 2008

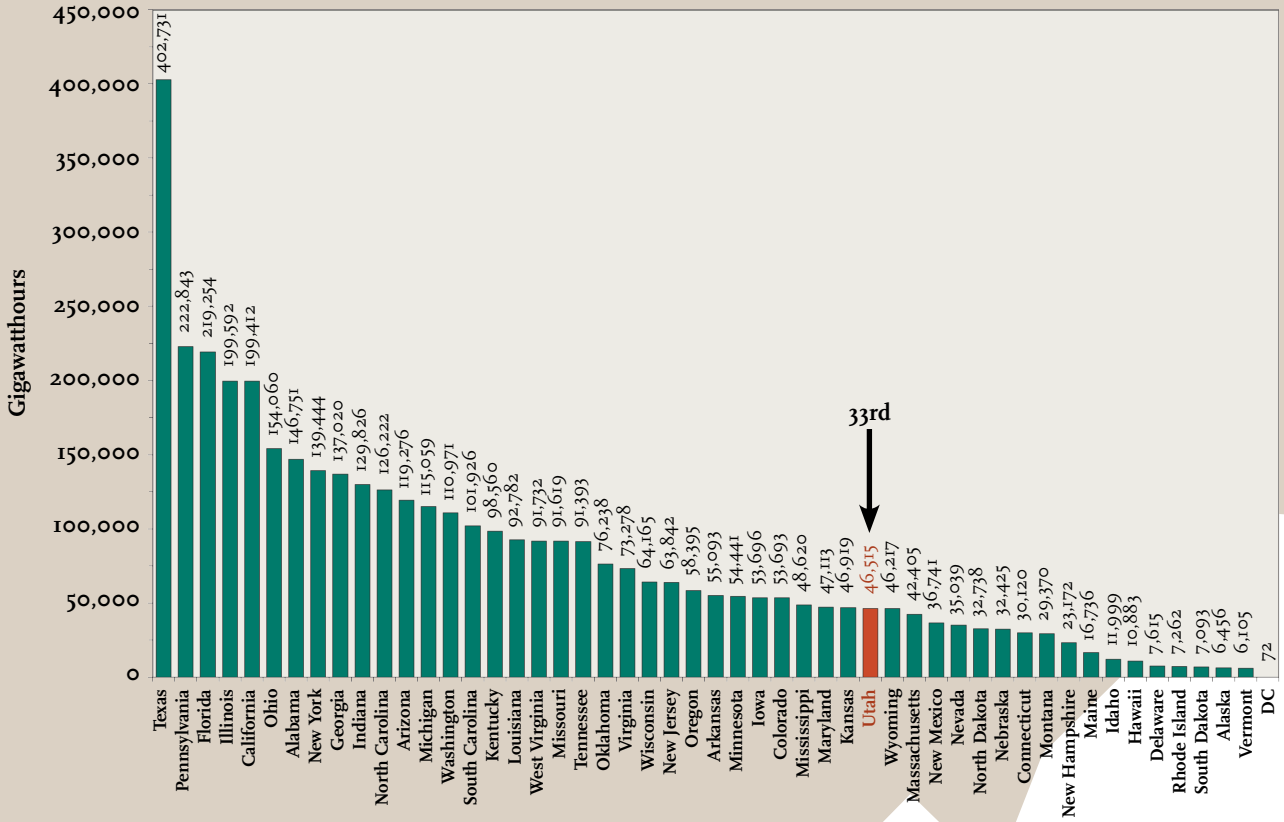
Capacity in megawatts (Percent of total)



Utah's electricity portfolio is dominated by coal-fired power plants. However, several new natural gas plants have been built in the past eight years (Lakeside – 2007, Currant Creek – 2005–2006, West Valley – 2002, and three new units at Gadsby – 2002) decreasing our reliance on coal generation.

UEMS Web page table: Table 5.1
Source: EIA
Note: Only includes utility plants.

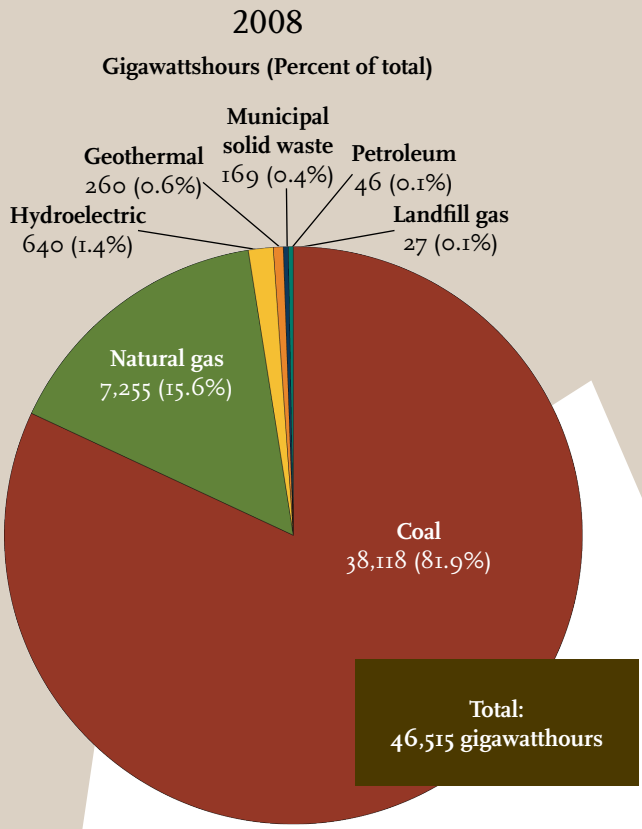
U.S. Electricity Generation by State, 2008



Utah's total net generation of electricity ranked 33rd in the nation in 2008.

UEMS Web page table: Table 5.9
Source: EIA
Note: 2008 data are preliminary.

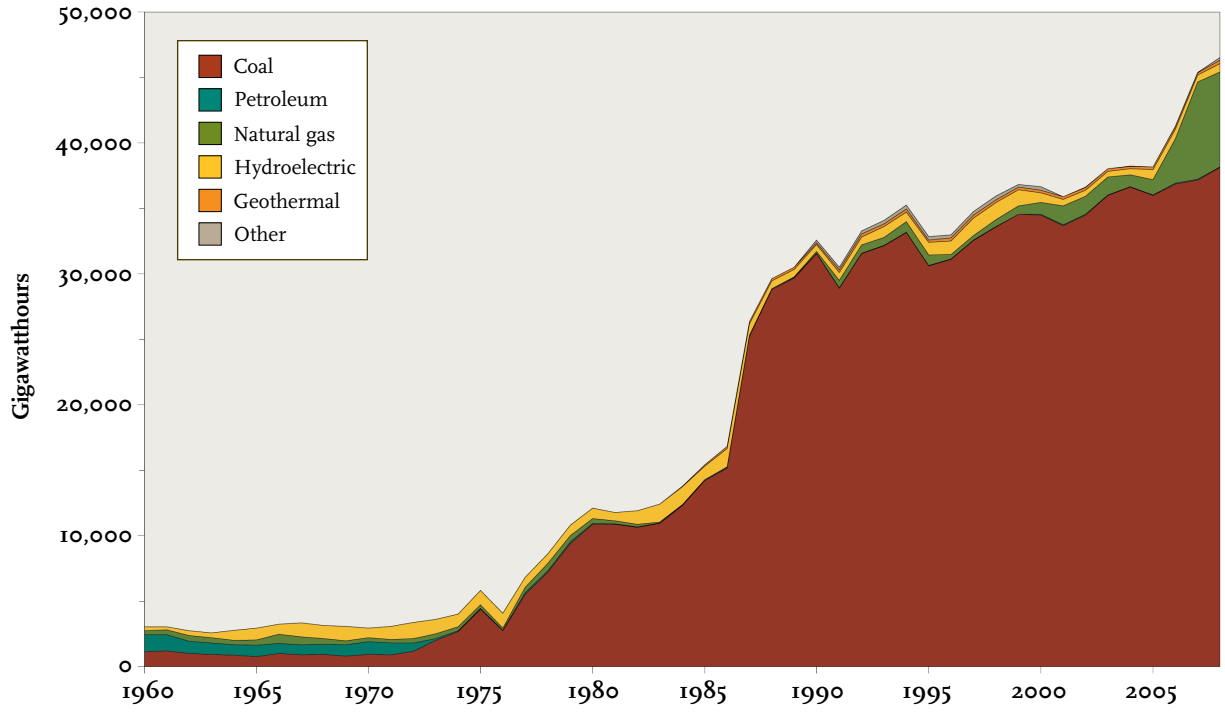
Net Generation of Electricity in Utah by Energy Source



Coal has always dominated Utah's electricity generation portfolio, accounting for 94.2% of Utah's total net generation in 2005. However, in the past five years, 1318 megawatts of new natural-gas-fired electric capacity were built, decreasing coal's overall share to 81.9% in 2008 and increasing natural gas's share to 15.6%.

UEMS Web page table: Table 5.10
Source: EIA
Notes: 2008 data are preliminary; "Other" includes municipal solid waste, landfill gas, and other gases derived from fossil fuels.

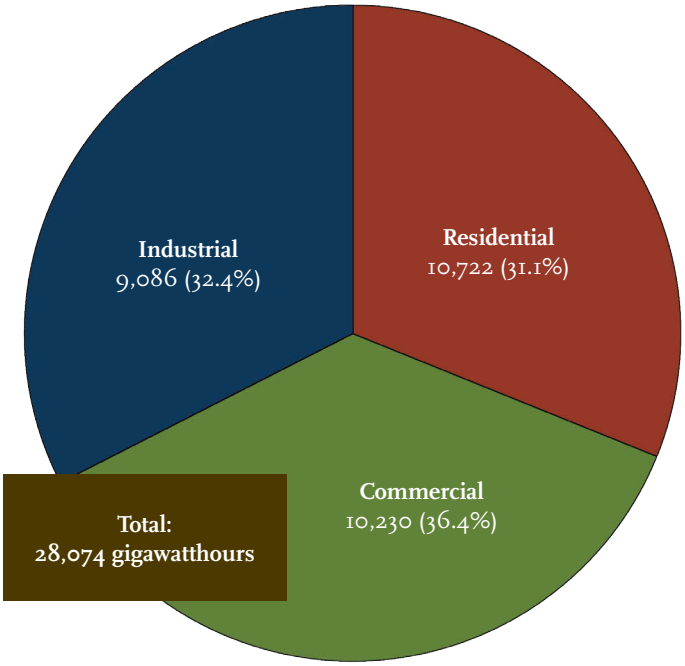
1960–2008



Sales of Electricity in Utah by Sector

2008

Gigawattshours (Percent of total)



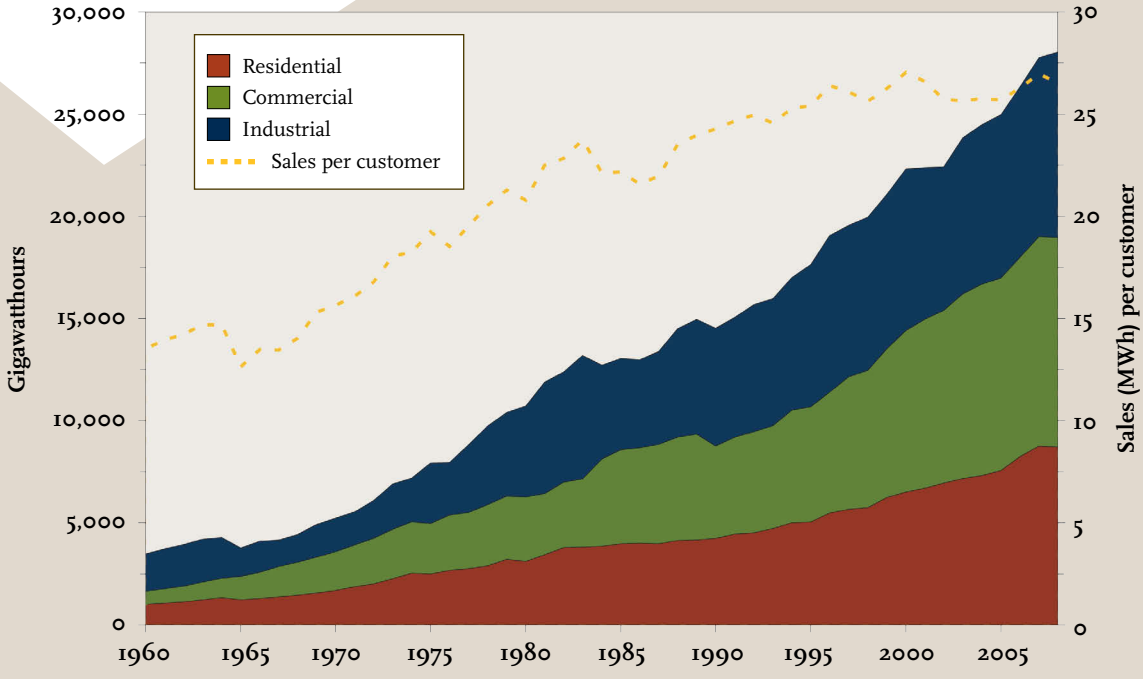
Electricity sales in Utah have averaged a 4.5% increase each year since 1960, roughly following increases in population (an average increase of 2.4% per year) and increases in per customer electricity use (an average increase of 3.0% per year). Each customer in Utah used roughly 13 MWh per year in 1960, and today each Utahn uses about 27 MWh per year.

UEMS Web page table: Table 5.19

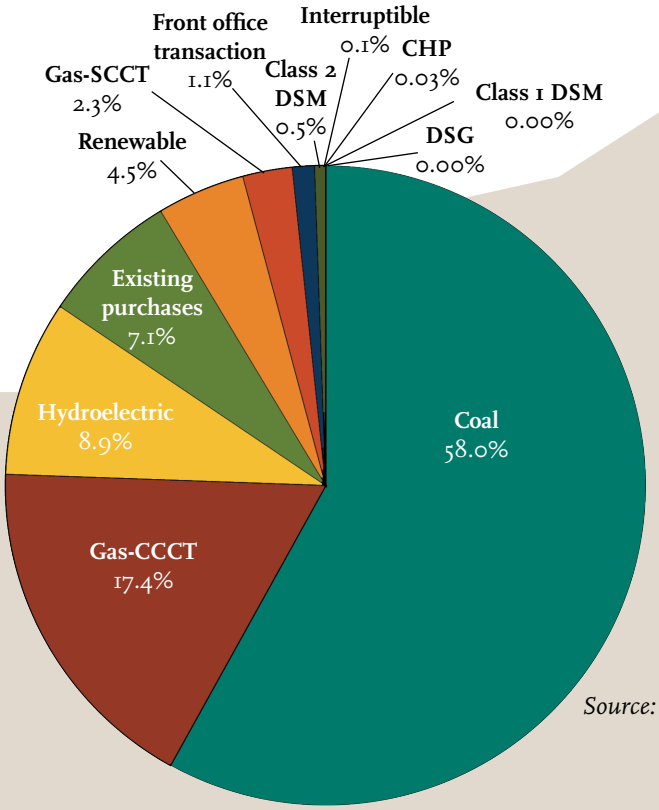
Source: EIA

Notes: 2008 data are preliminary; Electricity used by the transportation sector (UTA transit) is very small (35 GWh in 2008) and is not shown on the graphs.

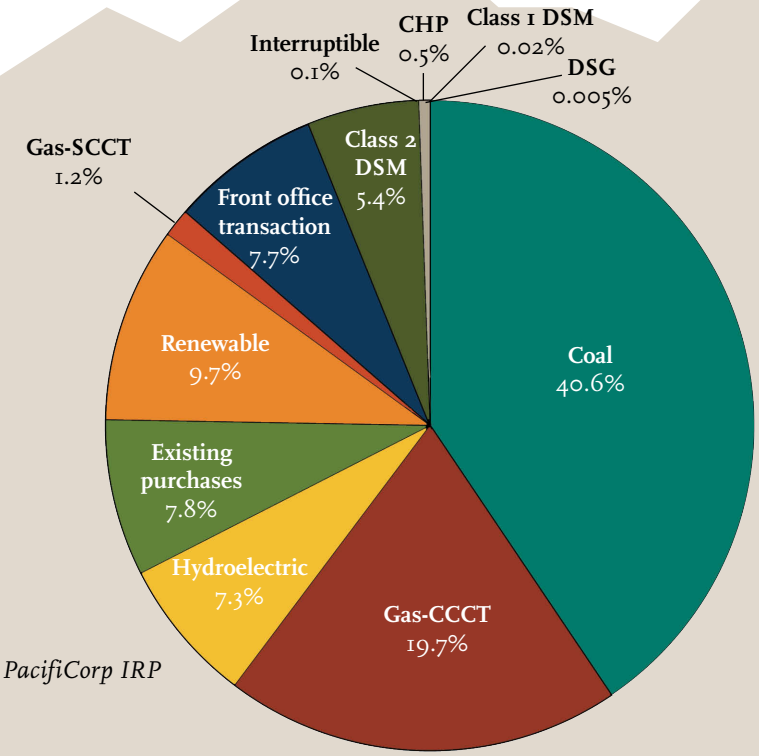
1960–2008



PacifiCorp's 2009 Resource Energy Mix



PacifiCorp's 2018 Projected Resource Energy Mix



Source: PacifiCorp IRP

Utah's net generation portfolio shows the fuel used to generate electricity at power plants in Utah; however, it is not a reliable indicator of the source of the electricity we actually use since much of the electricity generated in Utah travels out of state (e.g., about 75% of the electricity generated at IPP is consumed in California). The source of the electricity at the customer's electric outlet can be estimated based on PacifiCorp's (Utah's largest electricity provider) resource energy mix. For example, in 2009, a PacifiCorp customer can assume that 4.5% of the electricity they consume was generated by renewable resources such as wind, solar, geothermal, or biomass and that 8.9% comes from hydroelectric sources.

CHP: Combined heat and power

Class 1 DSM: Demand side management (i.e., energy efficiency measures) – Class 1 programs are those for which capacity savings occur as a result of active company control or advanced scheduling. Once customers agree to participate in Class 1 DSM program, the timing and persistence of the load reduction is involuntary on their part within the agreed limits and parameters of the program. In most cases, loads are shifted rather than avoided.

Class 2 DSM: Demand side management (i.e., energy efficiency measures) – Class 2 programs are those for which sustainable energy and capacity savings are achieved through facilitation of technological advancements in equipment, appliances, lighting, and structures.

Class 2 programs generally provide financial and/or service incentives to customers to replace equipment and appliances in existing customer owned facilities (or to upgrade in new construction) to more efficient lighting, motors, air conditioners, insulation levels, windows, etc. Savings will endure over the life of the improvement.

DSG: Distributed standby generators

Existing Purchases: Power purchase agreements, PURPA qualified facilities (may include renewables).

Front Office Transactions: Proxy resources that represent procurement activity made on an annual forward basis to help the company cover short term positions (i.e., spot market purchases may include renewables).

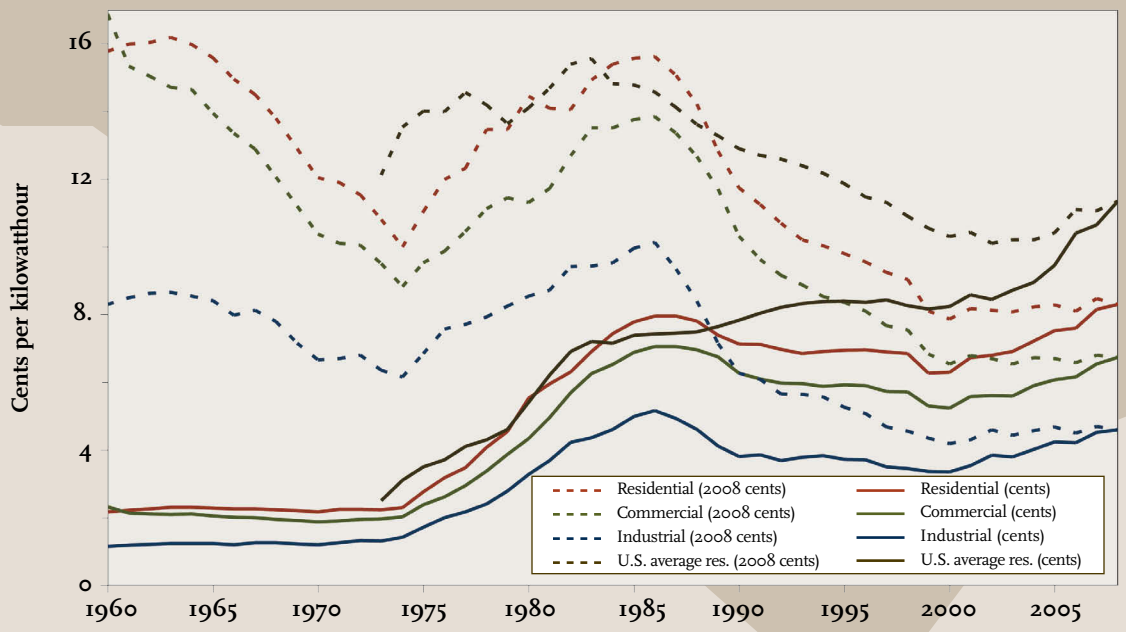
Interruptible: Directly curtailed loads

Gas-CCCT: Combined-cycle combustion turbine

Gas-SCCT: Simple-cycle combustion turbine

Renewable: Wind, geothermal, solar, and biomass

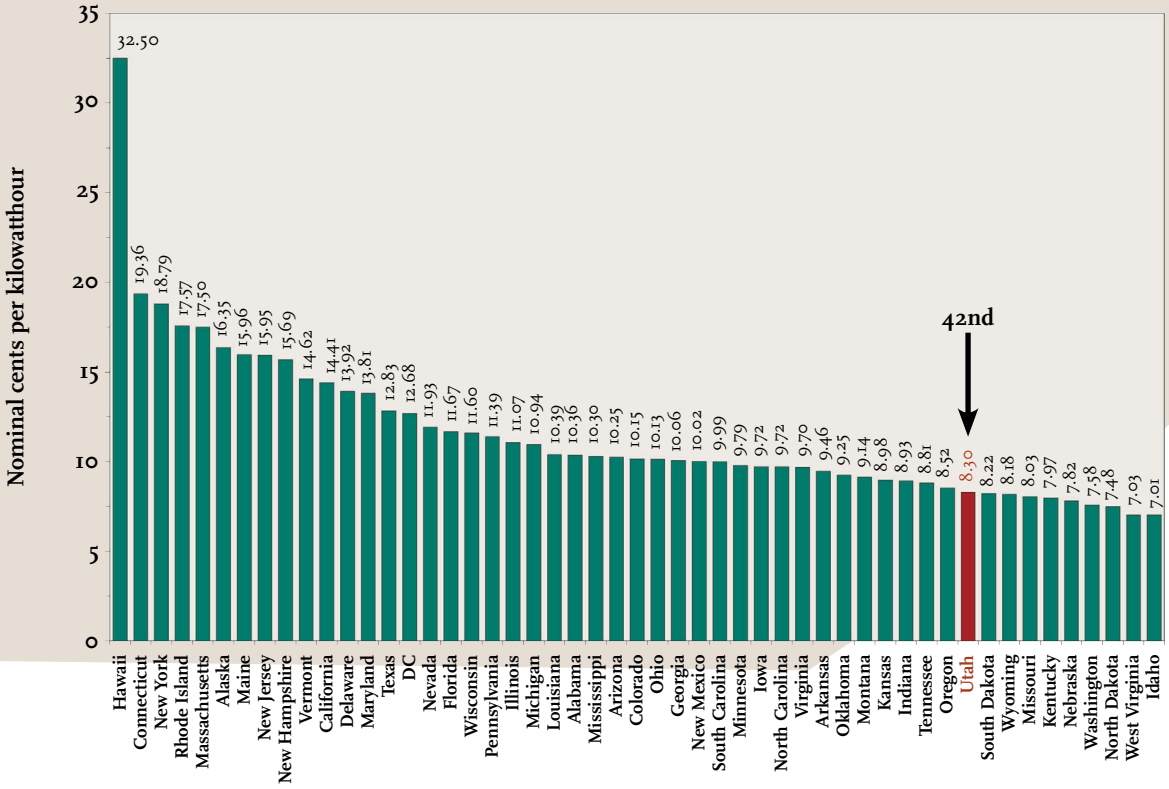
Price of Electricity in Utah by Sector, 1960–2008



UEMS Web page table:
Table 5.20
Source: EIA
Note: 2008 data are preliminary.

The price of electricity in Utah has generally decreased (when examining inflation-adjusted prices) over the years, with an average residential price of 8.3 cents per kilowatthour in 2008. Also, since 1989, Utah's residential price has averaged 1.7 cents less than the national average.

Average Residential Price of Electricity by State, 2008

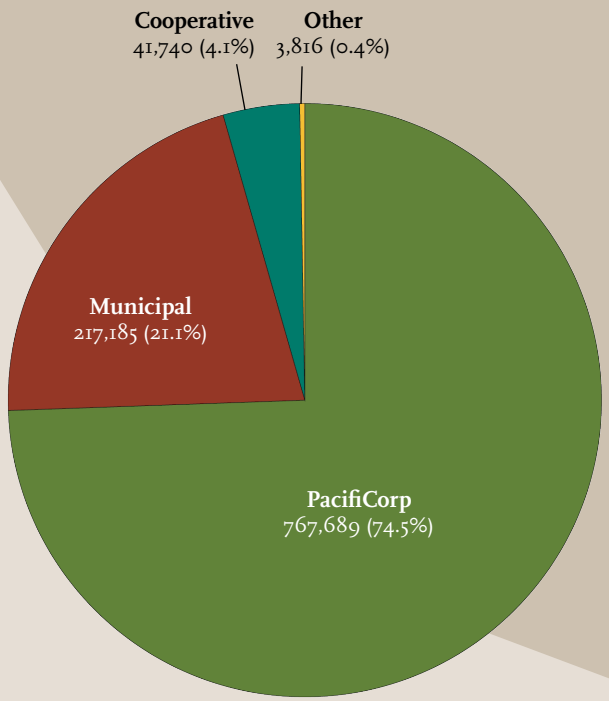


UEMS Web page table:
Table 5.21
Source: EIA
Notes: 2008 data are preliminary; includes District of Columbia.

Utah's average price of residential electricity ranked 10th lowest in the nation in 2008 because of Utah's fully amortized coal-fire generation.

Electric Utility Customers in Utah by Class of Ownership, 2007

# of customers (Percent of total)

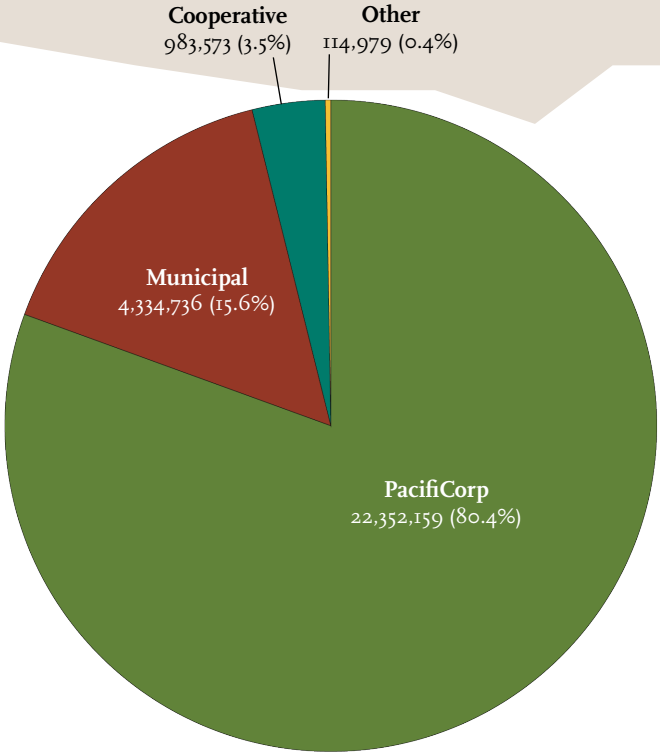


The majority of electricity in Utah is provided by PacifiCorp, supplying 75% of Utah customers and accounting for 80% of in-state sales. Thirty-eight municipal-owned utilities provide the next-largest contribution, followed by nine cooperative electric utilities.

UEMS Web page table: Table 5.24
Source: EIA
Notes: 2008 data are not yet available; "other" includes state, political subdivision, and federal.

Electric Utility Sales in Utah by Class of Ownership, 2007

Megwatthours (Percent of total)



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