ARIZONA'S ENERGY SECTOR 2008

Daniel Jensen and Maile L. Nadelhoffer

Economic and Business Research Center
Eller College of Management
The University of Arizona
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SUMMARY

In 2005, Arizona's population was 5.9 million. This was just over a 2% - or 1 in 50 - share of the total U.S. population of 296.9 million.[1] Arizona ranks in the middle of total energy consumption per state at 26th, consuming 1,479.7 trillion Btu annually – a share of total U.S. consumption of less than 1.5%.[2] Per capita consumption was only 248.6 million Btu, making Arizona the 5th most efficient state in 2005.[3]

Electricity in Arizona is generally lower-cost. Compared with 2007 national averages, electricity in Arizona was 13.9% less expensive for Residential customers, 16.4% less for Commercial, and 8.6% less for Industrial.

Motor-grade gasoline sold at roughly the national average in 2007, however Arizona ranked 17th in motor gasoline consumption.

Natural gas prices for Residential consumers were 29.4% higher than the national average, however only 38% of Arizona homes use natural gas compared with 51.2% nationally. The vast majority of natural gas (three quarters of the state's total demand) goes to electricity producers, for whom the price is not significantly different from the national average.

Arizona is a net exporter of electricity. In 2005, some 212.5 trillion Btu[4] of electricity was sent to markets outside of the state, particularly southern California. At the national average rate of 5.74 c/Kwh for Industrial electricity, this export was worth roughly $3.57 billion.

CURRENT PRODUCTION

Energy Production in Arizona by Source

In 2005, Arizona produced a total of 1,692.1 million Btus of energy from all sources (this energy was harnessed for transportation, electricity, heating, cooking, and more). Some 590.8 million Btu was derived from petroleum (all derivatives), 428.4 from coal, 327.7 from natural gas, 268.9 from nuclear generators, 64.1 from hydroelectric generators, and the remaining 12.2 million Btus includes all other sources of power.[5] A graphical representation of this distribution can be seen in Figure 1:

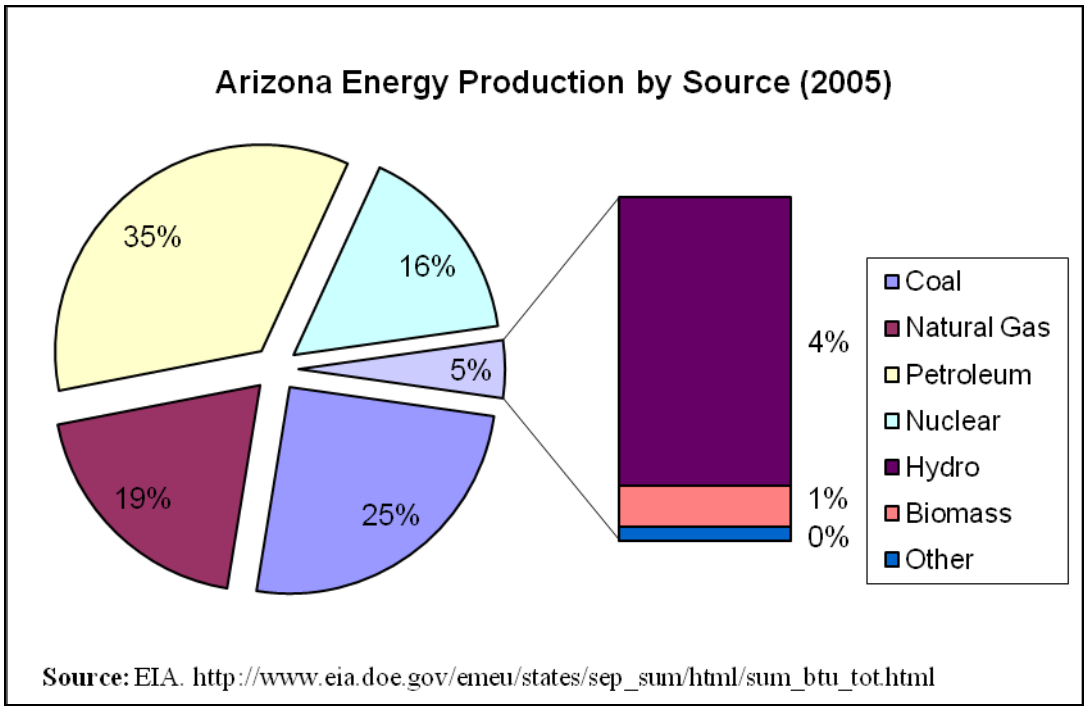


Figure 1

Arizona Fuel Sources

Arizona has very limited petroleum production capabilities (3,000 barrels per day), and no refining capability, and is therefore primarily supplied by two major pipelines, one entering the state from Texas and the other coming in from southern California.

Coal is primarily supplied by the Black Mesa region, in which lies one of the largest lignite (low-grade) coal deposits in the U.S. This deposit is being exploited by the Peabody Western Coal Company as the Kayenta Mine. In 2006, it was the 19th largest coal mine (as measured by output) in the United States.[6]

Arizona also has no production capability in natural gas. Its annual demand for over 358 billion cubic feet of natural gas (2006) is met with pipelines which enter Arizona from the energy-rich Rocky Mountains and from Texas.[7]

Nuclear fuel for the Palo Verde plant is purchased from the United States Enrichment Corporation (USEC), the sole enriched uranium producer in the U.S. and a government corporation under the oversight of the U.S. Department of Energy.

Hydroelectric energy is almost entirely supplied by the Glen Canyon and Hoover/Boulder Dams located on the Colorado River.

There are a large number of small solar energy plants around the state, whose contribution to net **energy** (not electricity) production is less than 0.19%.

CURRENT CONSUMPTION

Four major resources are consumed in order to power Arizona: petroleum, coal, natural gas, and uranium. Table 1 gives the total amount of the resource consumed in either 2005 or 2006, and the percentage of this consumption that was allocated to each of five major categories (Renewable energy is not included as no resources are consumed).

Table 1 Arizona Annual Resource Consumption by Resource, as Delivered by Sector

Source	Resource Consumption (Delivered to Consumers)	Electrical Generation (%)	Residential Sector (%)	Commercial Sector (%)	Industrial Sector (%)	Transportation Sector (%)	Total*
1) Petroleum (2005)	590.3 trillion Btu (All derivatives)	*n*	0.53	0.59	11.71	87.18	100%
2) Coal (2006)	21.25 million short tons	96.51	< 0.01	0	3.48	0	100%
3) Natural Gas (2006)	358 bil. Cu. Ft.	73.98	10.75	9.78	5.50	0.61	100%
4) Enriched Uranium (2006)	80.95 tons (Approx)	100	0	0	0	0	100%

1) EIA. Consumption: By End-Use Sector. http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=AZ
2) U.S. Coal Consumption by End Use Sector http://tonto.eia.doe.gov/state/SEP_MoreConsump.cfm
3) Natural Gas Consumption by End Use http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_m.htm
4) Finch, James. "New Mexico Joins the Nuclear Renaissance." StockInterview.com 26 June 2006. http://www.stockinterview.com/newmexico1.html
* Totals might not equal 100% due to independent rounding
n Indicates a negligible amount

Imports/Exports

Arizona imports the majority of its non-renewable energy resources. In fact, as measured in Btu, Arizona imports over 85% of its energy needs when including renewable energy, and over 90% when only considering non-renewables.[8]

Arizona does produce a negligible amount of crude oil. In 2006, Arizona's total production amounted to about 55,000 barrels.[9] This accounted for less than five hundredths of a percent (< 0.05%) of the total 110.8 million barrels.[10] Petroleum is imported into the state via two large pipelines, one from southern California and the other from Texas.[11]

A much smaller fraction of coal is imported. The large "Kayenta" coal mine in northern Arizona produced 8.22 million short tons in 2006, accounting for almost 39% of the total 21.25 million short tons consumed.[12] The balance is transported in from outside the state.

Arizona also produces a negligible amount of natural gas. In 2006, Arizona produced 611 million cubic feet of natural gas.[13] This amounted to a small fraction (approximately 0.17%) of the total 358 billion cubic feet of natural gas consumed in Arizona that year.[14] The remainder was supplied by two large pipelines which enter Arizona via the New Mexico border on the way to southern California.

Enriched uranium is shipped to Arizona's sole nuclear plant, Palo Verde, from the United States Enrichment Corporation's facility in Paducah, Kentucky.

Petroleum

As indicated in Table 2, Arizona consumed 590.3 trillion Btu of energy in 2005 in the form of petroleum derivatives. In the same year, the average annual residential household electricity consumption in Arizona was 1,034 KwH.[15] Therefore Arizona's petroleum

consumption in 2005 would have been theoretically equivalent to the annual power requirement of 167.3 billion "average" Arizona homes.

Table 2

Arizona Petroleum Consumption by Derivative and Sector (2005)						
	Residential	**Commercial**	**Industrial**	**Transportation**	**TOTAL**	**%**
Asphalt and Road Oil			30.3		30.3	5.13
Aviation Gasoline				0.9	0.9	0.15
Distillate Fuel	n	2.8	28.7	119.2	150.7	25.53
Jet Fuel				45.5	45.5	7.71
Kerosene	n	n	n		0	0.00
LPG	3.1	0.5	0.7	0.7	5	0.85
Lubricants			1.4	1.9	3.3	0.56
Motor Gasoline		0.2	5.5	346.4	352.1	59.65
Residual Fuel			0.1		0.1	0.02
Other			2.4		2.4	0.41
TOTAL	3.1	3.5	69.1	514.6	**590.3**	100.00
Percentage	0.53	0.59	11.71	87.18	100.00	

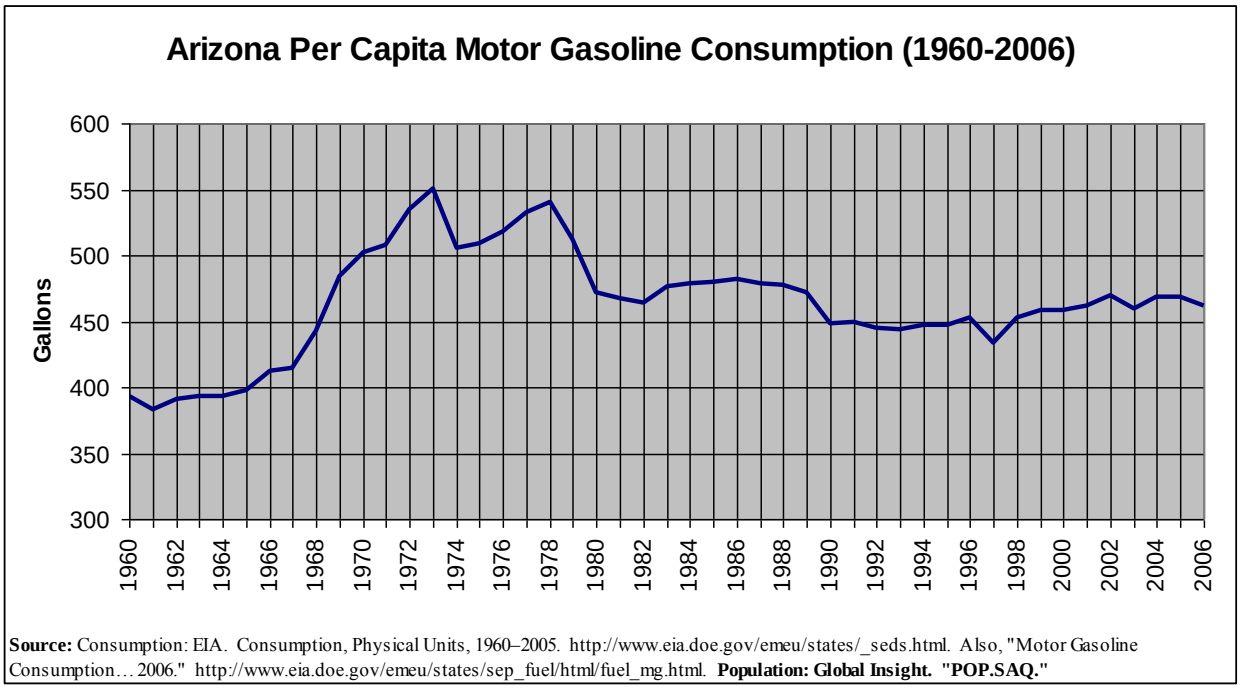
Measured in trillion Btu; *n* indicates a negligible amount (<0.05 trillion Btu)

Source: EIA. Consumption: By End-Use Sector.
http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=AZ

The state of Arizona ranked 24th in petroleum consumption in the U.S. in 2006 at 111 million barrels of petroleum. The largest was Texas at 1.2 billion barrels, followed by California at 713.7 million.[16]

Specifically in terms of motor gasoline consumption, California held the lead with 383 million barrels compared to Texas' 285 million. Arizona ranked 16th in motor gasoline consumption in 2006 with 69.3 million barrels.[17]

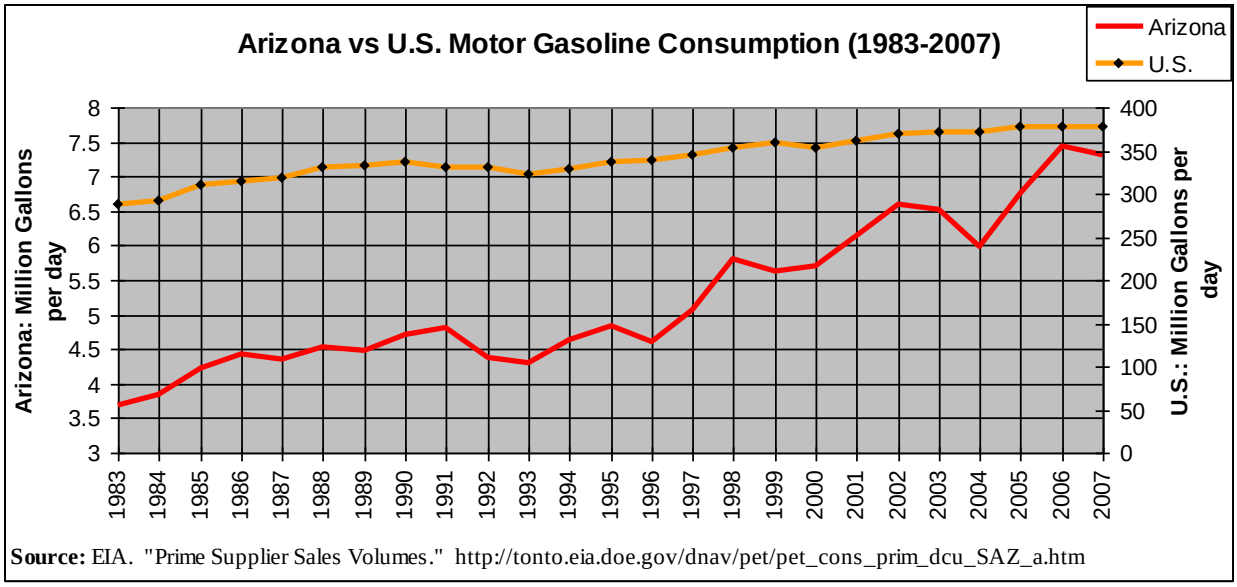
As Figure 2 shows, annual per capita consumption has increased in Arizona in the past half-century. This is despite an increase in average U.S. motor vehicle fuel economy from 12.4 miles per gallon in 1960 to 17.2 miles per gallon in 2006 (an increase of 38.7% in 46 years).[18] In 2006, per capita consumption was up over 17.5%, to 462.3 gallons, from the 1960 level of 393.3 gallons.[19] This equates to an increase in mileage of over 63%, from 4,876.9 miles per year to 7,951.6 miles per year.



Source: Consumption: EIA. Consumption, Physical Units, 1960–2005. http://www.eia.doe.gov/emeu/states/_seds.html. Also, "Motor Gasoline Consumption… 2006." http://www.eia.doe.gov/emeu/states/sep_fuel/html/fuel_mg.html. **Population: Global Insight. "POP.SAQ."**

Figure 2

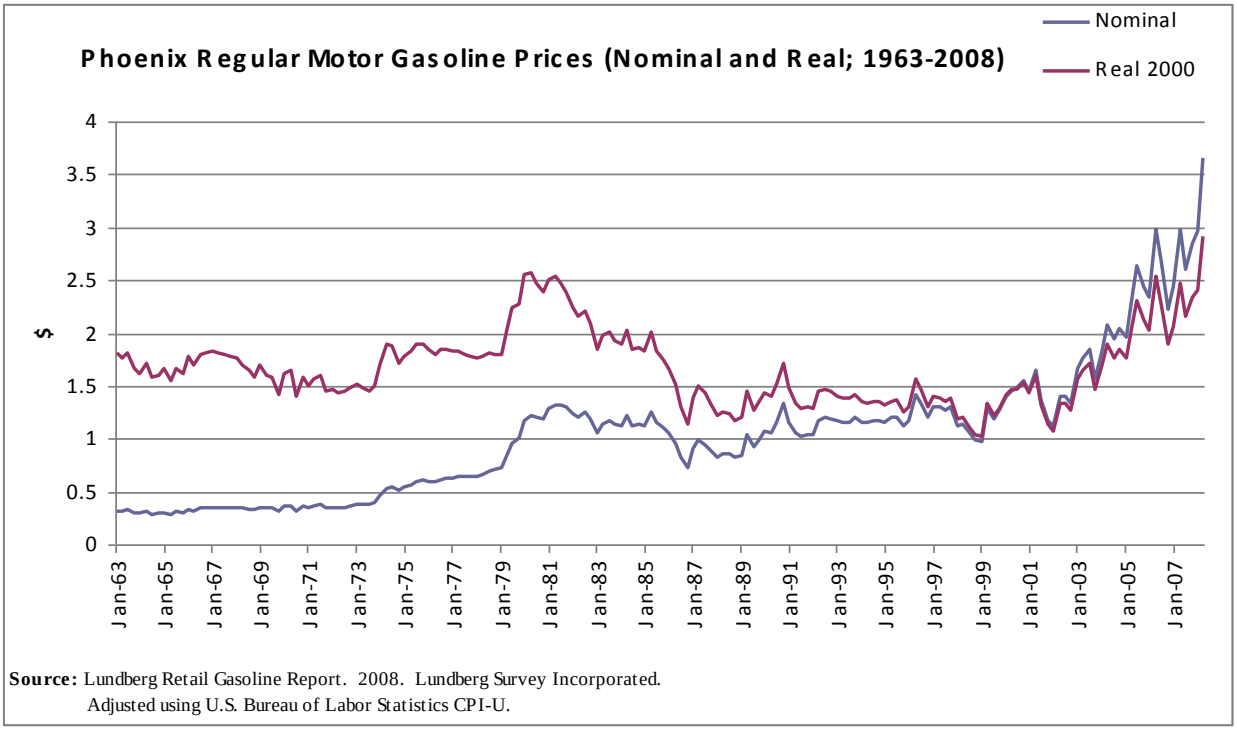
Arizona's motor gasoline consumption is increasing at a higher rate than that of the U.S. as a whole. Figure 3 displays Arizona's consumption as compared with that of the U.S. In the 24-year period between 1983 and 2007, Arizona's per-day gasoline consumption increased by 98.2% while the U.S. total only increased by 31.5%.



Source: EIA. "Prime Supplier Sales Volumes." http://tonto.eia.doe.gov/dnav/pet/pet_cons_prim_dcu_SAZ_a.htm

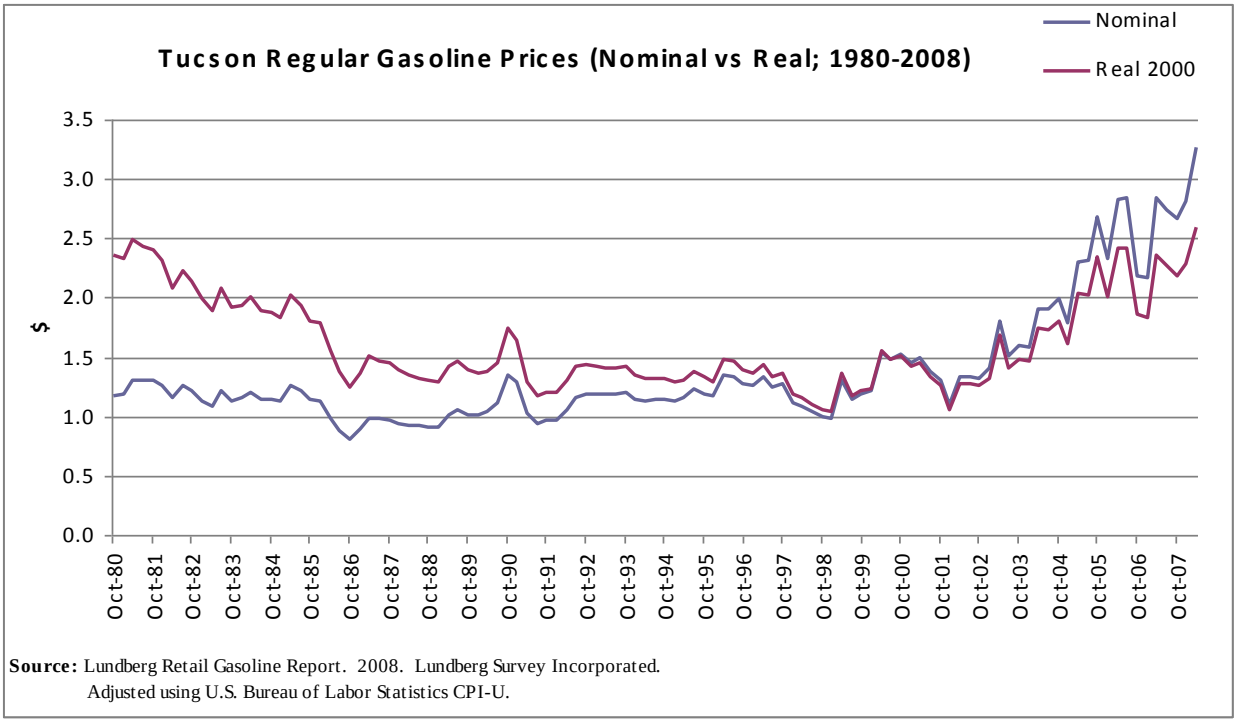
Figure 3

These increases in per-capita and state gasoline consumption are also remarkable in that they are occurring in the face of steep real price increases. Figures 4 and 5 are the historical nominal and real prices of motor gasoline in Phoenix and Tucson.



Source: Lundberg Retail Gasoline Report. 2008. Lundberg Survey Incorporated.
Adjusted using U.S. Bureau of Labor Statistics CPI-U.

Figure 4

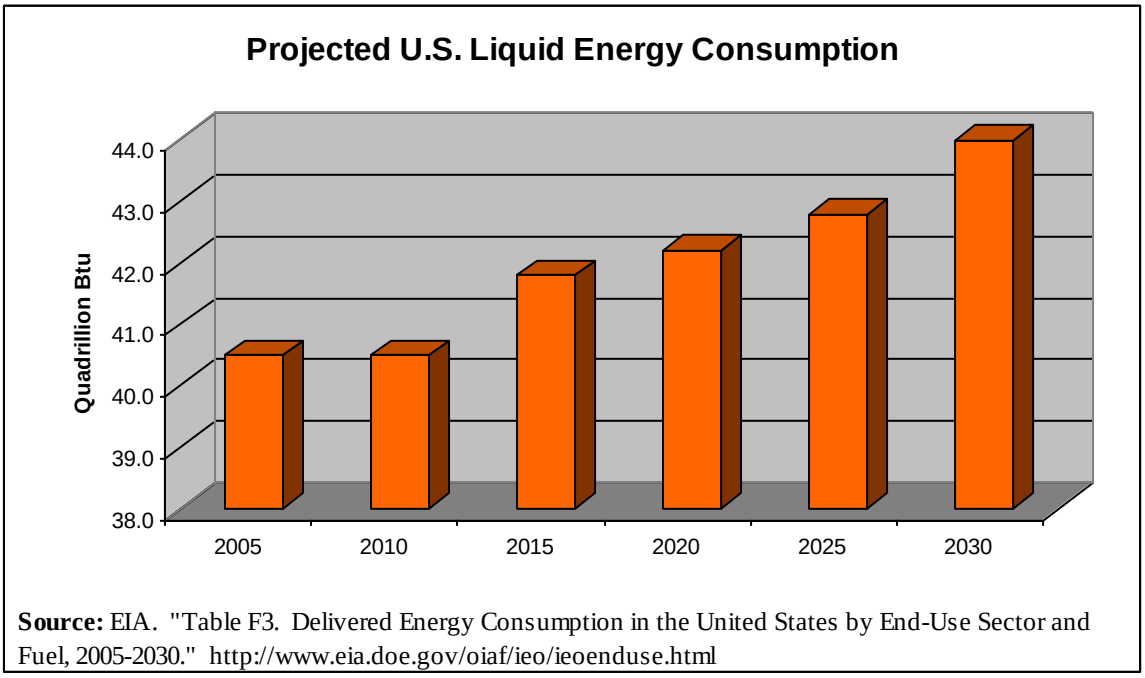


Source: Lundberg Retail Gasoline Report. 2008. Lundberg Survey Incorporated.
Adjusted using U.S. Bureau of Labor Statistics CPI-U.

Figure 5

Judging by the information presented above, it is clear that Arizona is seeing the largest sustained increase in the price of gasoline in modern history. Unsurprisingly, as crude oil is the primary input for motor gasoline and the U.S. imports two-thirds of its crude oil supply, the U.S. as a whole is also undergoing a similar sustained price increase.

As seen in Figure 6, U.S. consumption of energy liquids (i.e. all petroleum derivatives) is projected to increase by an average of 0.3% annually until 2030.



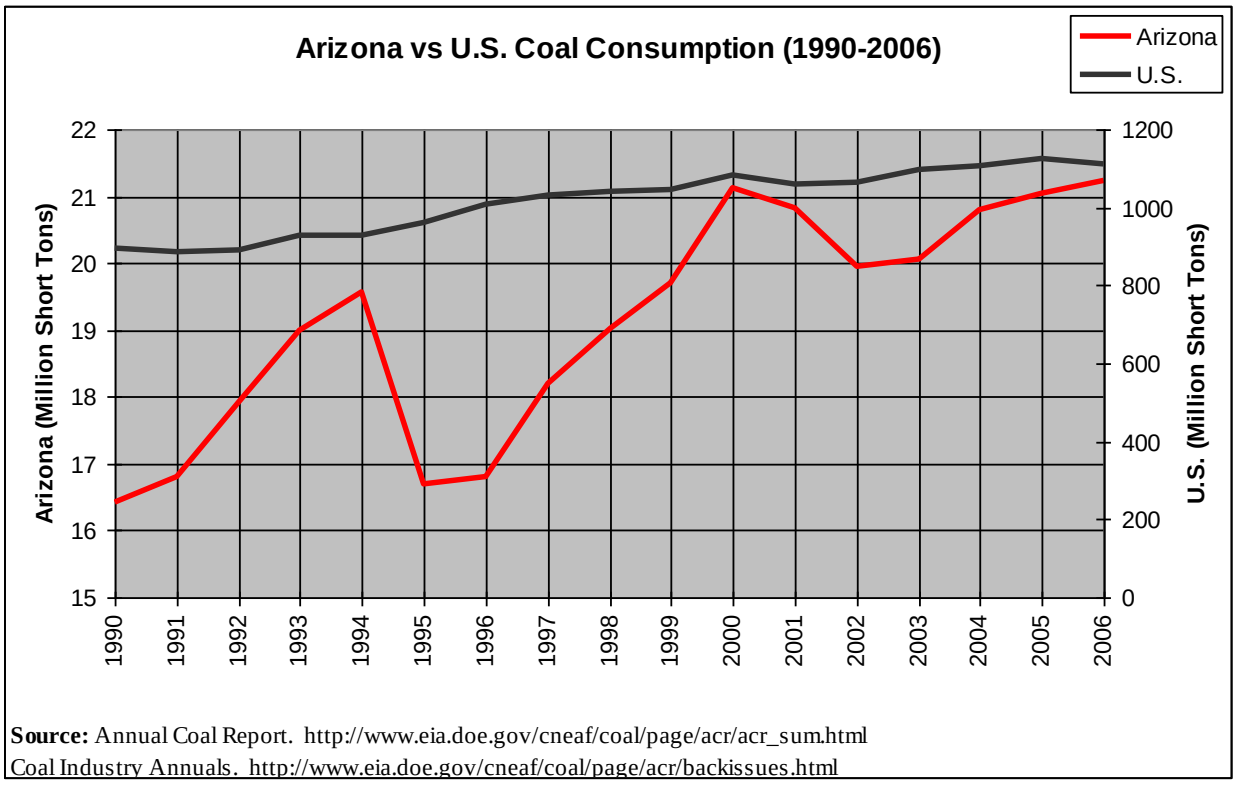
Source: EIA. "Table F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2005-2030." http://www.eia.doe.gov/oiaf/ieo/ieoenduse.html

Figure 6

Coal

Arizona consumed slightly less than 21.25 million short tons of coal in 2006. Of the 32 states for which coal consumption data was available that year, Arizona ranked 12th. Texas consumed the most coal with 103.8 million short tons, followed by Missouri with 46.9 million short tons.[20]

In 2006, Arizona consumed 29.4% more coal than in 1990. Figure 7 represents total coal consumption in Arizona as compared with the U.S. between 1990 and 2006.

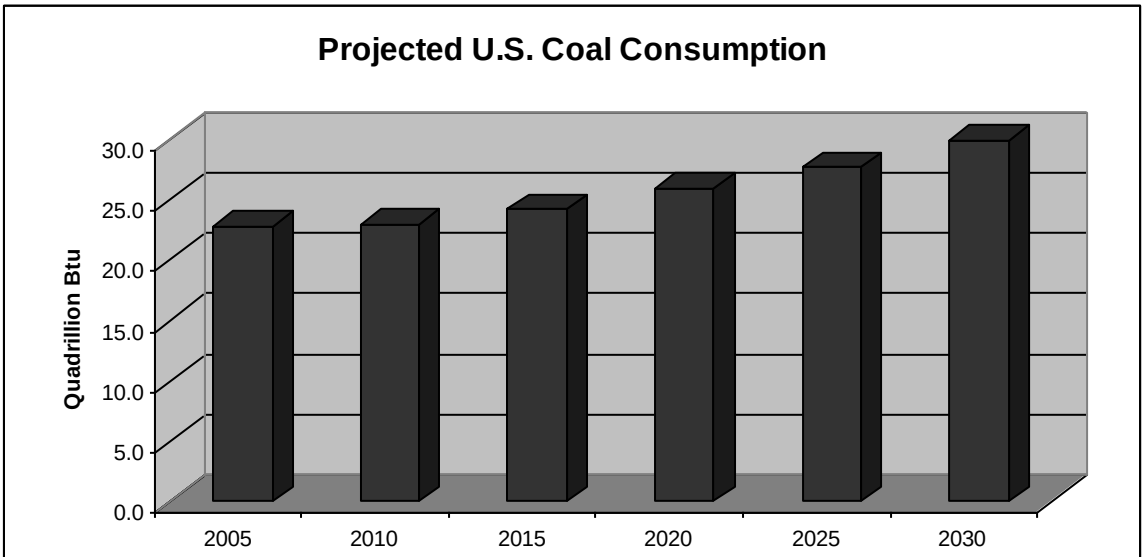


Source: Annual Coal Report. http://www.eia.doe.gov/cneaf/coal/page/acr/acr_sum.html
Coal Industry Annuals. http://www.eia.doe.gov/cneaf/coal/page/acr/backissues.html

Figure 7

Of the 21.25 million short tons consumed in Arizona in 2006, electric production accounted for approximately 20.5 million short tons, or 96.5% of the total. This was at an average price of $28.48 per ton for a total final cost of over $584 million. Another 740 thousand short tons, 3.5%, was supplied to the Industrial sector for non-electric production purposes at $48.22 per ton for a total of $35.7 million.[21] (The residential sector consumes roughly 1,000 tons, which is negligible.) Coal consumption in Arizona cost a total of approximately $619.7 million in 2006.

As seen in Figure 8, coal-based energy consumption in the U.S. is expected to increase at an average of 1.1% annually until 2030.

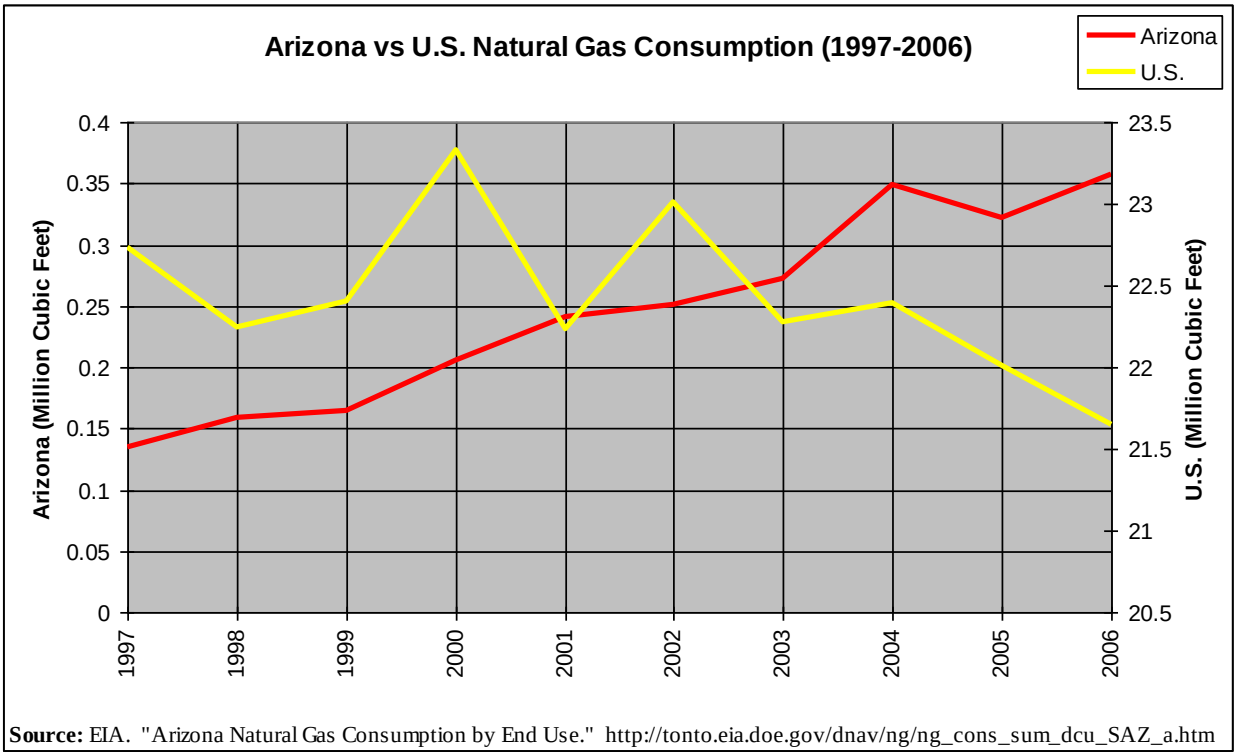


Source: EIA. "Table F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2005-2030." http://www.eia.doe.gov/oiaf/ieo/ieoenduse.html

Figure 8

Natural Gas

Arizona consumed over 335.4 billion cubic feet of natural gas in 2006, and ranked 19th in overall consumption in the United States. Texas ranked 1st at 3.4 trillion cubic feet, followed by California with 2.3 billion.[22] As Figure 9 shows, Arizona's natural gas consumption was up from 134.7 billion cubic feet in 1997, an increase of 166% in ten years, as compared with an overall U.S. decrease of almost 5%.



Source: EIA. "Arizona Natural Gas Consumption by End Use." http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_SAZ_a.htm

Figure 9

Almost 74% of the total natural gas consumed in Arizona in 2006 was used in the generation of electric power. Some 10% was used in the Residential sector (primarily for heating and appliances), 9% in the Commercial, and 5% in the Industrial. Less than 1% was used for vehicle fuel.[23] Figure 10 represents this distribution graphically.

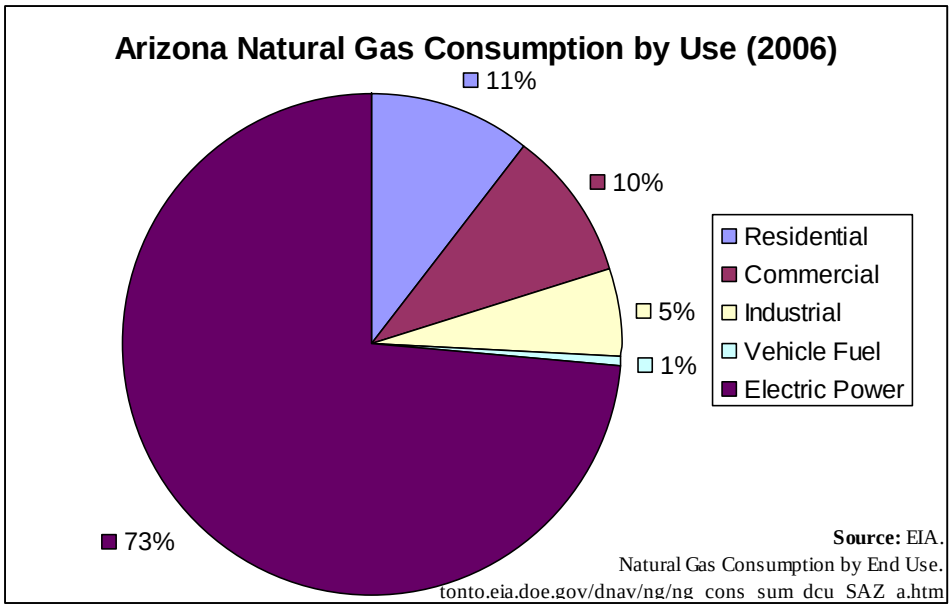


Figure 10

As seen in Figure 11, natural gas consumption in the U.S. is projected to peak at around 2015 and by 2030 to have declined back to approximately 2008 levels. Annual growth is projected to average out to 0.1% by 2030. This is the lowest growth rate of the five main energy categories.

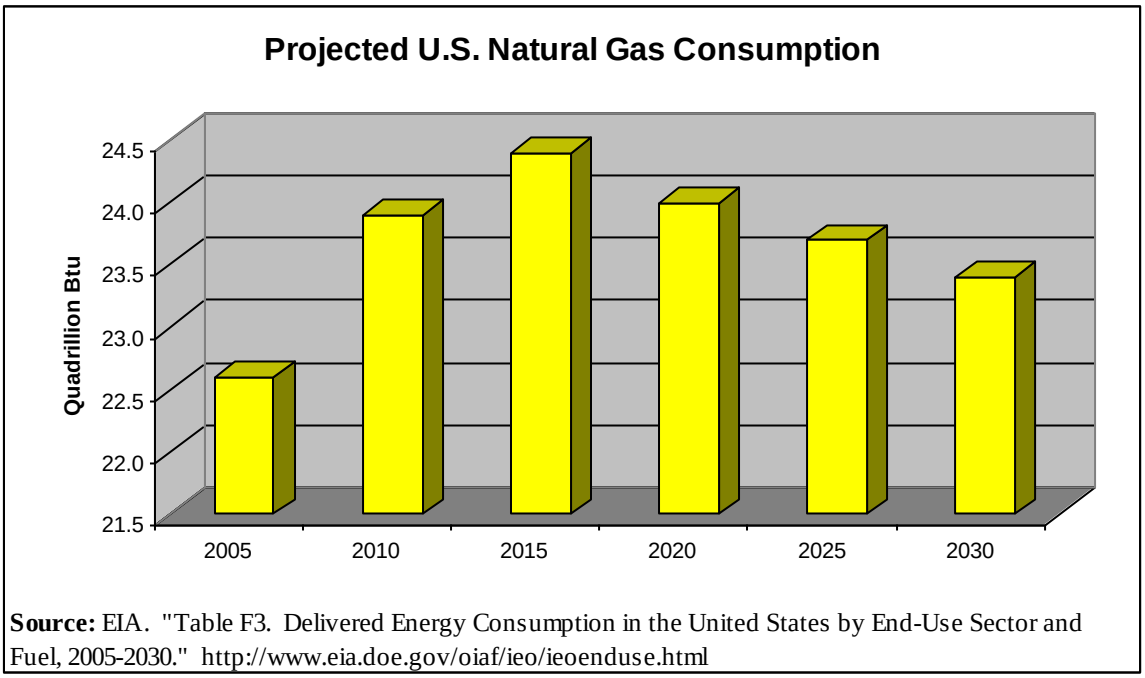


Figure 11

Natural gas consumption is projected to increase in step with expanded production and decreased prices until 2016. After 2016, supply is expected to dwindle and cause a "gradual" run-up in prices which will force consumption back down.[24]

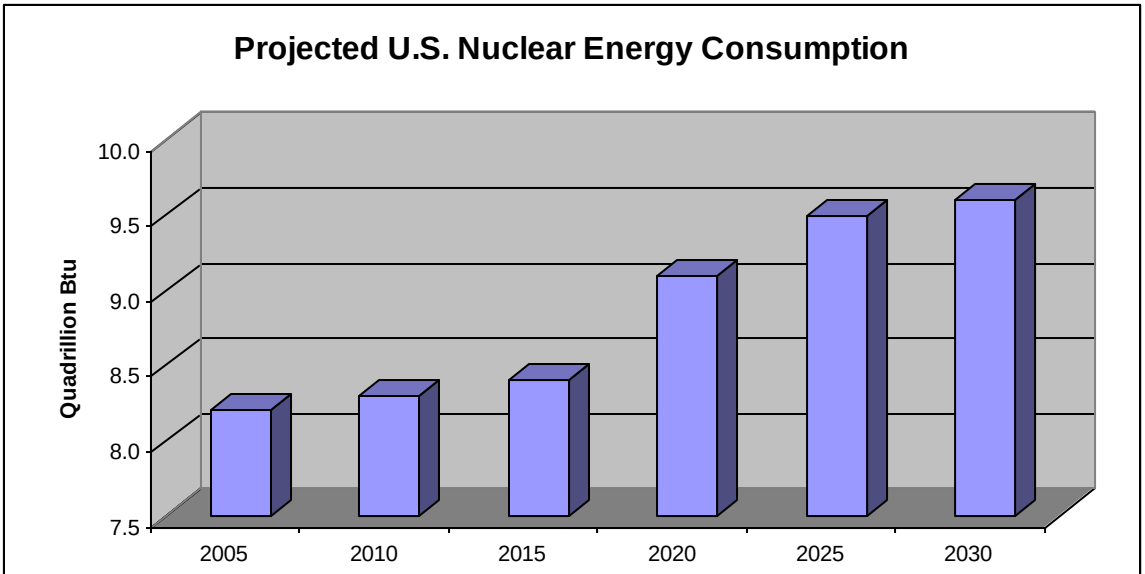
The annual unweighted average price for natural gas provided to Arizona electric power providers in 2006 was $6.6318 per thousand cubic feet.[25] For residential consumers, it was $18.4692, for commercial $12.3092, and for industrial $9.9167. Therefore, the total cost for natural gas consumption in Arizona in 2006 was approximately $2.9 billion.

Nuclear

Palo Verde (Arizona's only nuclear generation facility) accounted for 3.86% of the United State's nuclear-generated electricity in 2007.[26] This is virtually unchanged from 2003. Nuclear resources supplied approximately 8.12% of the U.S.'s electricity requirement of 100 quadrillion Btu in 2005.[27]

Producing at its 2007 rate of 3,872 MW, Palo Verde spends approximately $310 million per year on enriched uranium fuel.[28] The national average cost of nuclear energy production is .47 cents per Kwh, however Palo Verde's economies of scale likely mean that its costs are even lower.[29]

As seen in Figure 12, nuclear energy consumption in the U.S. is projected to increase at an average of 0.6% annually until 2030.



Source: EIA. "Table F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2005-2030." http://www.eia.doe.gov/oiaf/ieo/ieoenduse.html

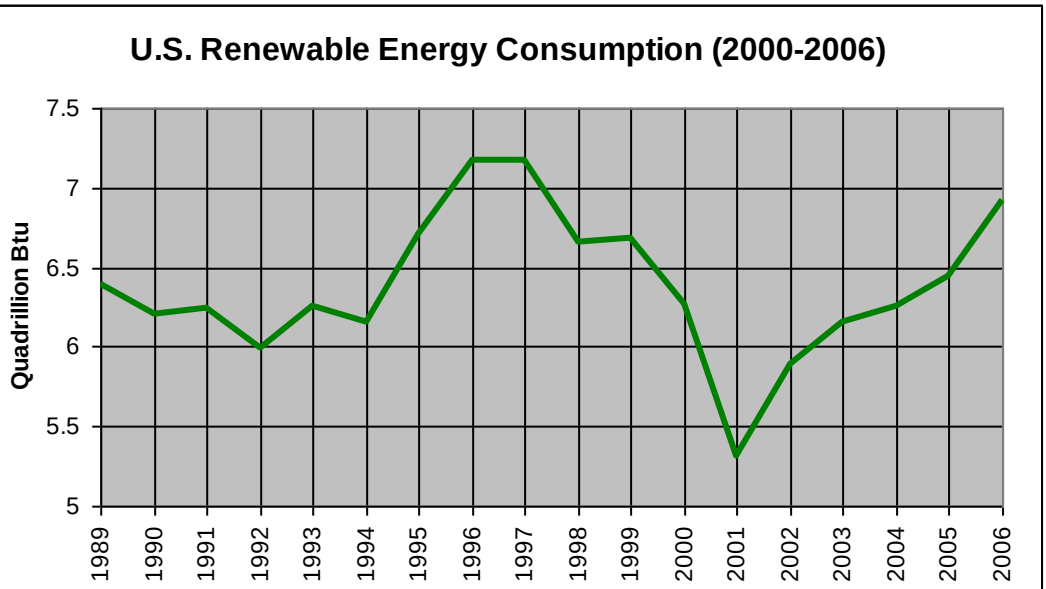
Figure 12

Renewables

Over 6.8 million megawatthours of electricity were produced through the use of renewable resources in 2006, approximately 6.6 percent of the state's total electricity production

for the year.[30] This power was generated using hydro, solar, wood and landfill gas resources (there was no energy captured from geothermal or wind resources).

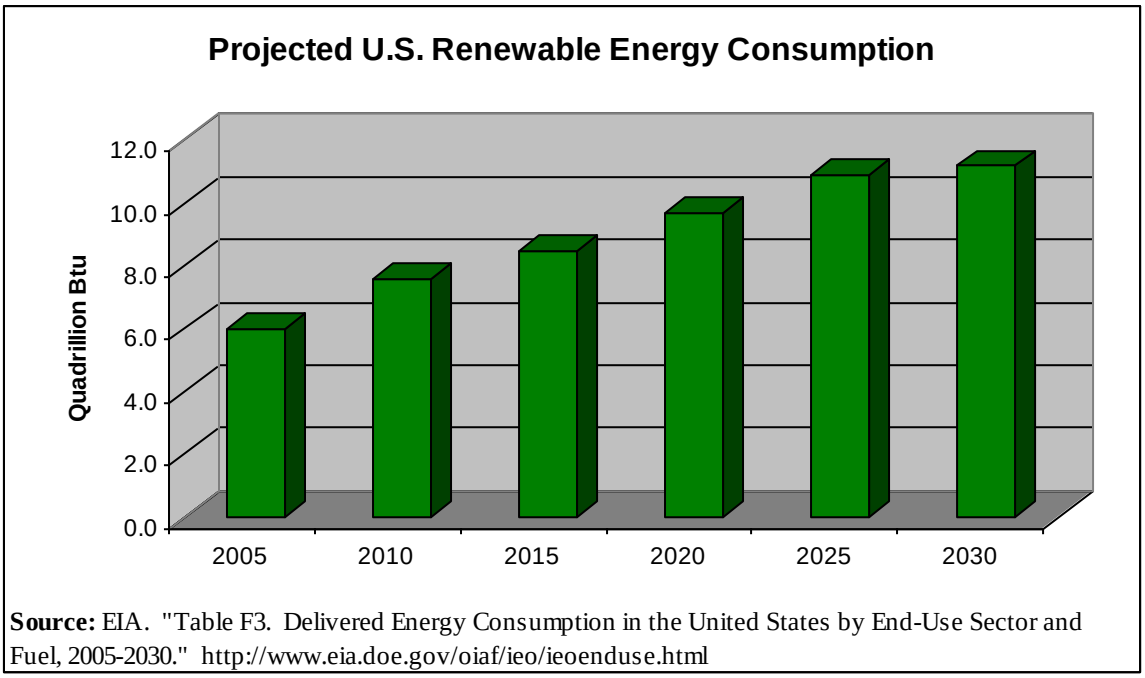
State-level data regarding renewable energy consumption is not readily available, however Figure 13 displays U.S. renewable energy consumption between 1989 and 2006. The precipitous drop in 2001 was attributed by the U.S. Department of Energy "largely to a drought that cut generation of hydroelectric power by 23 percent."[31]



Source: EIA. "Historical Renewable Energy Consumption by Sector and Energy Source." http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table5b.html

Figure 13

Although renewable energy is by far the smallest energy category, popular interest and legislative incentives are pushing it to grow faster than any other. As seen in Figure 14, renewable energy consumption is projected to increase at the relatively high rate of 2.5% per year until 2030. This category has the highest projected growth rate of the five main energy categories.



Source: EIA. "Table F3. Delivered Energy Consumption in the United States by End-Use Sector and Fuel, 2005-2030." http://www.eia.doe.gov/oiaf/ieo/ieoenduse.html

Figure 14

The Hoover and Glen Canyon dams have already capitalized on the best power dam locations in Arizona.[32] As such, further development of hydro-power facilities is unlikely. However, solar, wind, and geothermal power-generation have great potential.

Solar power is considered to be Arizona's most abundant renewable resource for the production of electricity. It is this potential which has prompted Arizona's Governor, Janet Napolitano, to make the highly publicized statement, "There is no reason that Arizona should not be the Persian Gulf of solar energy."[33] Studies have confirmed that Arizona has more solar resource potential than any other U.S. state. By one estimate, Arizona demonstrates potential for 101 million MWh per year.[34] As of 2006, facilities only existed to capture 13,000 MWh per year, about one hundredth of a percent of the available total.[35]

Considerable research has been conducted by the U.S. Energy Information Agency on both geothermal and wind power potential in Arizona. For both energy types, there are promising areas scattered across the state. The Arizona Wind Working Group, operating under the umbrella of Northern Arizona University, conducted a more thorough study on wind power potential.[36] This group estimates that the potential for utility-scale development exists on a scale of roughly 2600 MW. Furthermore, the study concluded that the most promising areas are in the north-eastern plateau regions. The two most promising tracts of land for wind-generated electricity are in the vicinities of Springerville and Cameron, both of which are located in close proximity to major Arizona transmission lines.

ELECTRICITY

There are twenty-five companies in Arizona that have on-grid electric generation capacities of at least 1 MW. Table 2 ranks these companies by their maximum total generation capacities in megawatts.

Table 3

Rank	Company	Total Generation Capacity (MW)
1	Arizona Public Service Co (APS)	9314.9
2	Salt River Project (SRP)	6671.8
3	U S Bureau of Reclamation	2606.2
4	Panda Gila River LP	2476.0
5	Tucson Electric Power Co (TEP)	2056.0
6	Mesquite Power LLC	1383.2
7	New Harquahala Generating Co, LLC	1325.1
8	LS Power- Arlington LLC	713.0
9	Calpine Operating Services Company Inc	708.0
10	Arizona Electric Power Coop Inc (AEP)	660.7
11	Griffith Energy LLC	654.4
12	Abitibi Consolidated Sale Corp.	70.5
13	UNS Electric, Inc.	70.4
14	Falcon Power Operating Co.	62.6
15	Phelps Dodge Mining Co.	41.5
16	Central Arizona Water Conservation District	40.0
17	Colorado River Indian Irrigation Project	19.5
18	USBIA-San Carlos Project	10.0
19	University of Arizona	9.0
20	PIMA County Wastewater Management	4.2
21	Decisions Investments Corp.	3.1
22	Western Renewable Energy LLC	3.0
23	Chemical Lime Co.	2.2
24	Starwood Hotels & Resorts	1.5
25	Japan Energy Corp Ltd.	1.0

Source: EIA. GENY06.XLS. Form EIA-860 Database Annual Electric Generator Report. http://www.eia.doe.gov/cneaf/electricity/page/eia860.html.

There are eleven power generating stations in Arizona with capacities larger than 1,000 MW. Table 4 ranks these stations in descending order of their designed total capacities.

Table 4 Arizona Powerplant Facilities Over 1000 MW Capacity

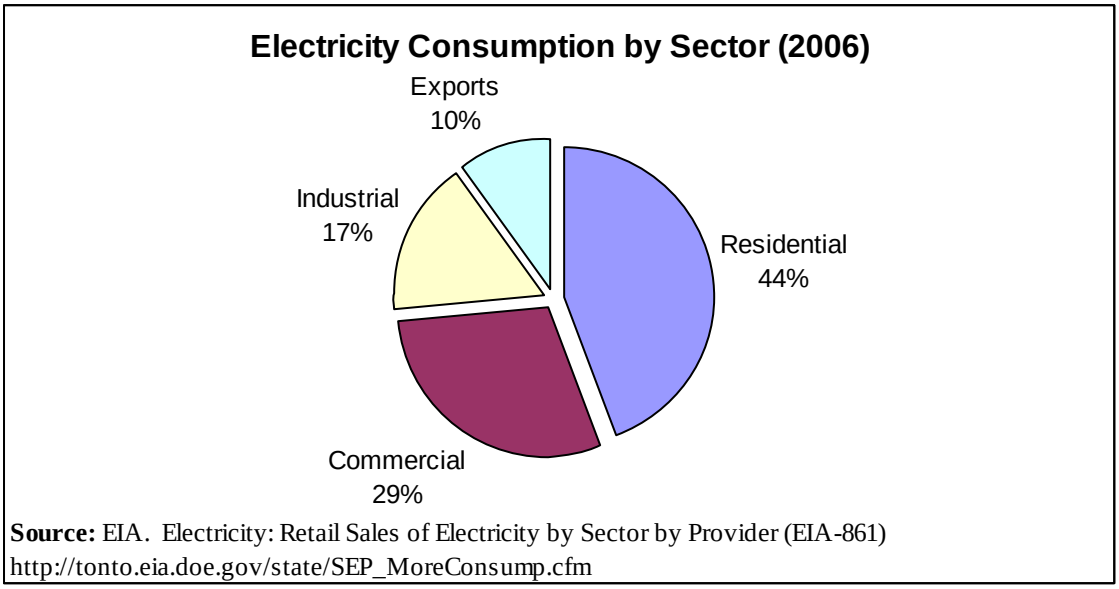
Rank	Facility	Type	Designed Capacity (MW)	Winter 2006 (Estimated Actual)	Capacity Utilization (%)	Operating Company
1	Palo Verde *	Nuclear	4209.3	3872	91.99	APS
2	Gila River	Natural Gas	2476	2212	89.34	Panda Gila River LP
3	Navajo	Coal	2409.3	2250	93.39	SRP
4	Mesquite	Natural Gas	1383.2	1181.8	85.44	Mesquite Power LLC
5	West Phoenix	Natural Gas	1326.3	1134.3	85.52	APS
6	Santan	Natural Gas	1326	1339	100.98	SRP
7	Harquahala	Natural Gas	1325.1	1128	85.13	New Harquahala

						Gen. Co.
8	Glen Canyon Dam	Hydro	1312	1312	100.00	U.S. Bureau of Reclamation
9	Springerville	Coal	1304.7 **	1205.1	92.37	TEP
10	Redhawk	Natural Gas	1136	1007	88.64	APS
11	Hoover Dam	Hydro	1039.4	1039.7	100.03	U.S. Bureau of Reclamation

* Palo Verde is the largest power plant in the U.S. Unit 2 is the largest single reactor in the U.S.
** SRP-funded one-unit expansion to be completed in 2009 will increase capacity to 1560 MW total. Source: http://www.srpnet.com/about/stations/springerville.aspx

Note: Generation is measured by nameplate capacity, not actual output
Source: EIA. GENY06.XLS. Form EIA-860 Database Annual Electric Generator Report. http://www.eia.doe.gov/cneaf/electricity/page/eia860.html.

Arizona's electricity utility industry produced 73.25 million megawatts-hours in 2006. Of this, the Residential sector consumed 32.37 megawatt-hours, the Commercial 21.38, and the Industrial 12.26.[37] Exports of electricity account for the remaining 7.25 MWh (equivalently measured as 212.5 Btu).[38] Figure 15 represents this division graphically:



Source: EIA. Electricity: Retail Sales of Electricity by Sector by Provider (EIA-861) http://tonto.eia.doe.gov/state/SEP_MoreConsump.cfm

Figure 15

Six different fuels are used by electric utilities to generate power in Arizona. Coal is used to generate the largest portion, followed by nuclear energy, natural gas, and hydro-power. Table 5 shows a breakdown of the resources used to generate electricity in 2005.

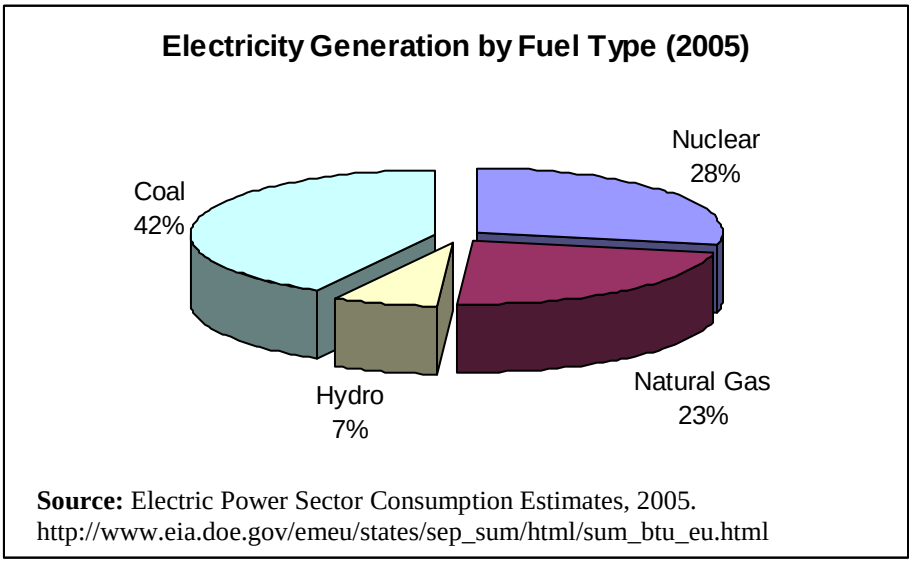
Table 5

Electricity Generation by Fuel Type (2005)		
Fuel Type	Trillion Btu	Percentage of Total

Coal	412.5	42.55%
Nuclear	268.9	27.74%
Natural Gas	222.8	22.98%
Hydro	64.1	6.61%
Biomass	0.6	0.06%
Petroleum	0.5	0.05%
Solar/PV	0.1	0.01%
TOTAL	969.5	100.00%

Source: Electric Power Sector Consumption Estimates, 2005. http://www.eia.doe.gov/emeu/states/sep_sum/html/sum_btu_eu.html

Figure 16 displays these same figures graphically (omitting the negligible contributions of biomass, petroleum and solar/photovoltaic).



Source: Electric Power Sector Consumption Estimates, 2005. http://www.eia.doe.gov/emeu/states/sep_sum/html/sum_btu_eu.html

Figure 16

Electricity production fueled by coal produces by far the most emissions. Of the total 43.5 million metric tons of carbon dioxide (CO_2) released by electric utilities in 2005, 38.8 million tons (89%) was generated by the use of coal.[39] Similarly, coal was the cause of almost 100% of 47,832 metric tons of sulpher dioxide (SO_2) and 97% of 72,033 metric tons of nitrogen oxide (NOX). In each case, all but a tiny fraction of the remainder was generated by natural gas.

Prices in Arizona, as compared to the remaining seven states of the Mountain region, tend to be moderate. Table 5 displays the average annual prices of each Mountain region state from 2000 to 2007.

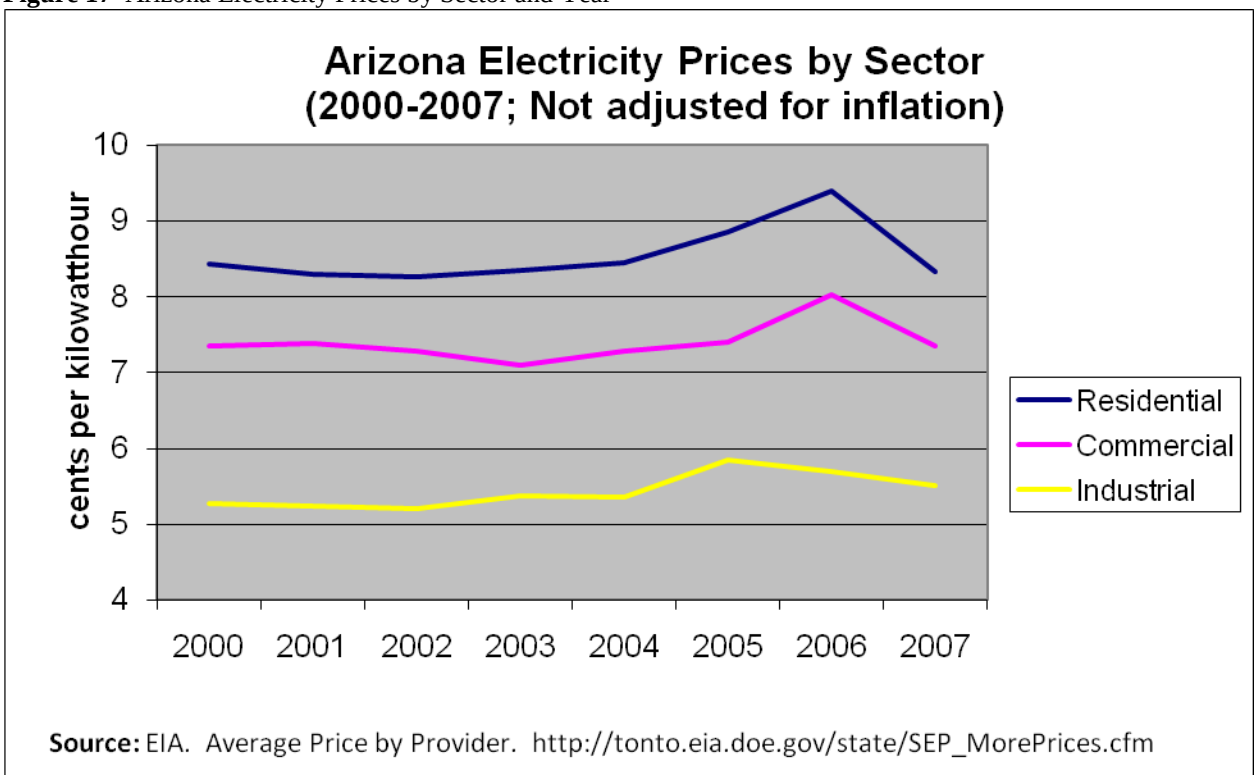
Table 6 Mountain Region Residential Electricity Prices 2000-2007 (Real 2000 Dollars)

	Arizona	Colorado	Idaho	Montana	Nevada	New Mexico	Utah	Wyoming
2000	8.44	7.31	5.39	6.49	7.28	8.36	6.29	6.5
2001	8.62	7.76	6.24	7.15	9.43	9.08	6.98	7.03

2002	9.14	8.15	7.29	7.99	10.43	9.40	7.51	7.71
2003	7.94	7.74	5.93	7.19	8.57	8.26	6.56	6.69
2004	6.82	6.79	4.92	6.34	7.82	6.99	5.81	5.81
2005	5.87	6.01	4.17	5.37	6.76	6.05	4.99	4.96
2006	5.51	5.29	3.64	4.86	6.50	5.31	4.45	4.55
2007	4.50	4.80	3.42	4.59	6.48	4.78	4.18	3.93
Source: EIA. Average Price by Provider. http://tonto.eia.doe.gov/state/SEP_MorePrices.cfm								

Within Arizona, Residential customers pay the most per kilowatthour of electricity. Industrial customers pay the least. Figure 17 demonstrates the progression of nominal electricity prices in Arizona between 2000 and 2007.

Figure 17 Arizona Electricity Prices by Sector and Year



Despite moderate electricity prices, total electricity bills (for all sectors) tend to be among the highest in the Mountain region. Table 7 compares average electricity bills between the Residential, Commercial, and Industrial sectors of each of the Mountain region's eight states.

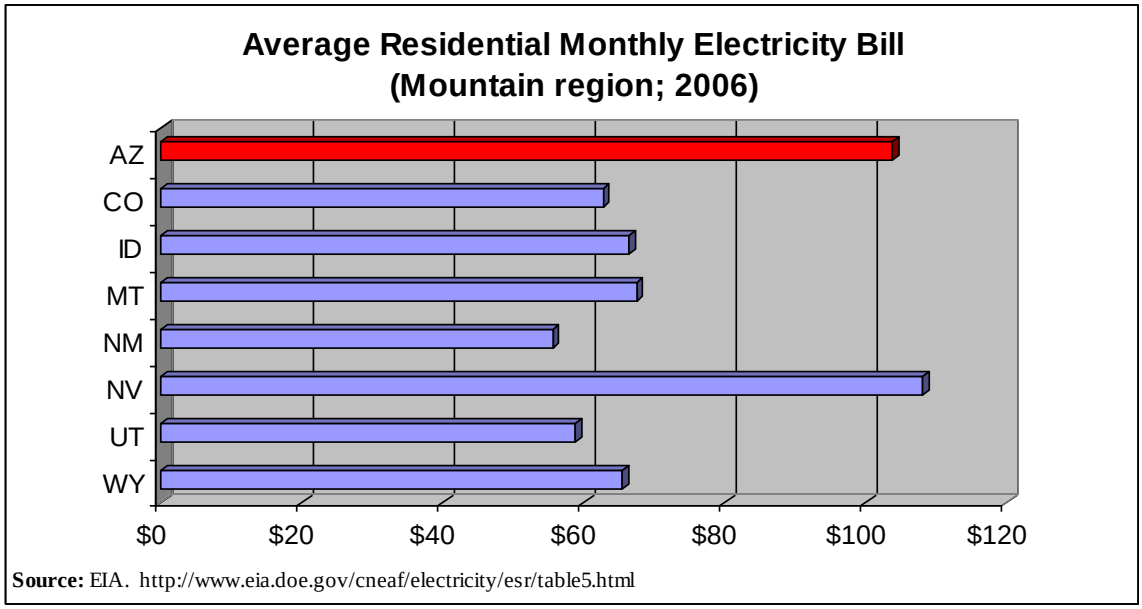
Table 7 Mountain Region Average monthly electricity bill (2006)

	Residential	**Commercial**	**Industrial**
Mountain Region	79.46	457.89	4,487.63
AZ	**103.76**	**682.83**	**7,857.96**
CO	62.74	365.01	4,606.97

ID	66.36	269.79	1,040.43
MT	67.50	300.82	4,264.17
NM	55.60	419.26	5,759.40
NV	108.19	528.57	2,692.27
UT	58.79	462.30	3,200.36
WY	65.50	387.59	3,494.30

Source: EIA. U.S. Average Monthly Bill By Sector, Census Division and State. http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html

Figure 18 demonstrates graphically the very high average electricity bill of the typical Arizona residential household from 2006.



Source: EIA. http://www.eia.doe.gov/cneaf/electricity/esr/table5.html

Figure 18

Electricity production is not without costs, however. The harmful pollutants emitted from fossil-fueled power plants include Carbon Dioxide (CO_2), Sulpher Dioxide (SO_2), and Nitrogen Oxide (NOX). Figure 19 shows Arizona's electric industry's output trends of each of these pollutants between 1990 and 2006.

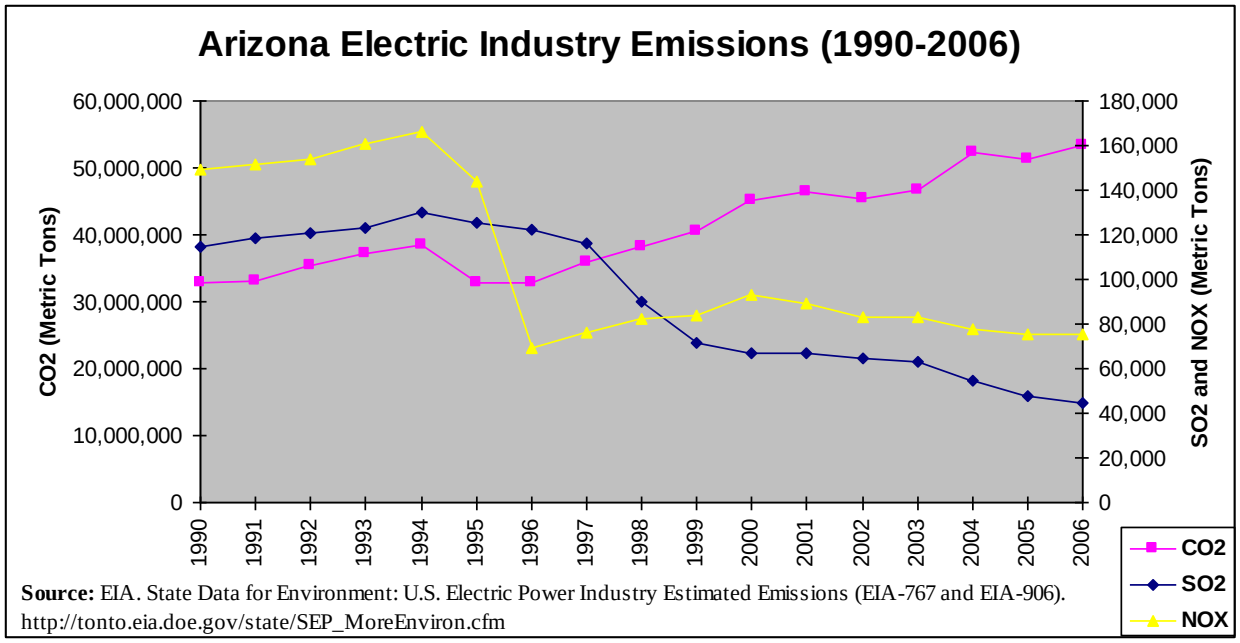


Figure 19

Of the three, SO2 and NOX outputs are steadily decreasing despite the fact that capacity has increased. In fact, in 2006, SO2 was at 39% of 1990 levels and NOX was at 50%. This is due to the increased use of "scrubbers" (most of which have been legislatively mandated) that clean the output gases produced by electric generation stations. Scrubbers are not as effective, however, at eliminating CO_2. Between 1990 and 2006, CO_2 emissions increased by 63%, from 32.7 to 53.7 million metric tons.

PUBLIC POLICY

Gasoline

In Arizona, the excise tax on gasoline is currently 18 cents per gallon. With the addition of the 1 cent per gallon Underground Storage Tank, or UST, tax, state taxes levied directly on gasoline amount to a total of 19 cents. In the Mountain region (which is composed of 8 states), Arizona ranks 3rd lowest in gasoline taxes, as represented in Figure 20 below.[40] .

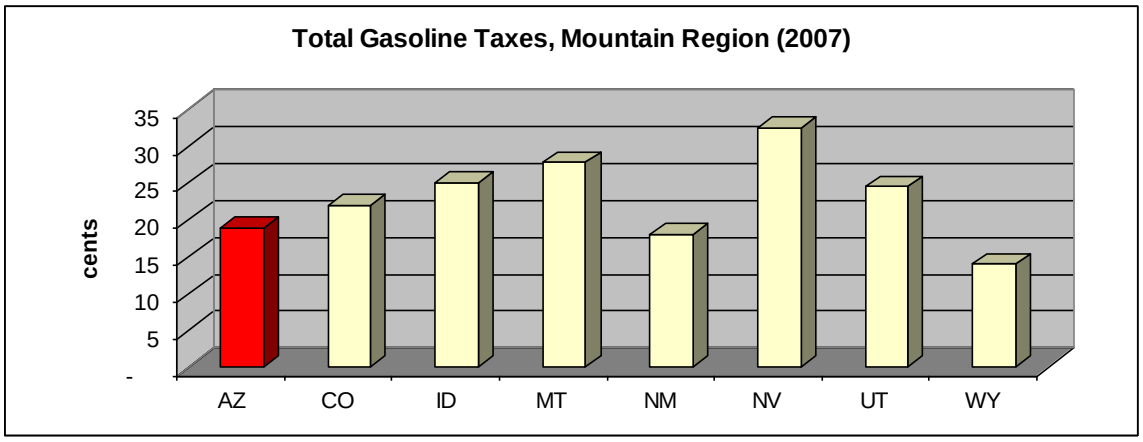


Figure 20

Biofuel

According to the U.S. Environmental Protection Agency (EPA), the average American vehicle travels 12,012 miles per year.[41] In 2007, U.S. passenger vehicles will have an average fuel economy of 20.2 miles per gallon (this is unchanged from 2006). [42] According to these statistics, the average U.S. driver consumed 595 gallons of gasoline in 2007. Considering that transportation (largely motor gasoline) accounts for two-thirds of foreign petroleum imports, it can be estimated that 397 of those gallons were derived from foreign sources.[43]

This dependence on foreign energy sources, coupled with the rapidly increasing U.S. prices for crude oil since 2002, have prompted petroleum consumers to search for alternative sources of energy. In light of this fact, Congress has begun implementing measures aimed at encouraging energy independence. One such measure is the support being given to biofuels.

Biofuels are popular due to their derivation from renewable resources and typically cleaner-burning nature. The most notable fuel in this class is ethanol, which accounted for roughly 97% of biofuel energy produced in the U.S. in 2005.[44] Biodiesel accounted for the remainder.

In 2005, Congress passed the Energy Policy Act. This introduced the Renewable Fuel Standard, the requirement that by 2012 at least 7.5 billion gallons per year of ethanol be mixed with U.S. motor gasoline. As the U.S. consumed 142.38 billion gallons of motor gasoline in 2007, and ethanol supplies 30% less energy than gasoline, 7.5 billion gallons of ethanol in 2007 would have displaced approximately 3.7% of the gasoline consumption that year.[45]

Roughly 95% of ethanol production in the U.S. is derived from corn.[46] It is estimated that 30% of the U.S. corn crop is being used for ethanol in 2008, up from 14% in 2004/5.[47] [48]

Subsidies of $0.51 per gallon were introduced for companies that blend ethanol into motor gasoline. In addition, a tariff of $0.54 per gallon was instituted for foreign imports.[49] Despite this Congressional support, there are academic concerns that biofuels, particularly corn-derived ethanol, are not viable.

Corn is currently the main feedstock for ethanol production in the U.S.[50] According to studies conducted by researchers at Cornell University, UC Berkeley, and MIT, "Ethanol production using corn grain required 29% more fossil energy than the ethanol fuel produced."[51] Similar or worse energy returns were found with other resources. There are clear indications that biofuels are not currently technologically advanced enough to be a viable energy alternative.

Critics of biofuel have advised that the money currently being spent through the Renewable Fuel Standard to subsidize biofuel would reap greater rewards if applied toward research in the field of vehicle efficiency.

Renewable Energy

In recent years, there has been a considerable number of legislative incentives introduced at both the state and federal levels to promote energy efficiency and renewable energy. Tables 9 and 10 summarize some of these incentives for the Commercial and Residential sectors, respectively:

Table 8

Commercial Incentives				
Level	Name	Description	Max	Expires
Federal	Business Energy Tax Credit	Tax credit of 30% of expenditures (10% for microturbines and geothermal).	Fuel Cell: $500 per 0.5 kW; Microturbines: $200 per kW; Other: No maximum	31-Dec-08
Federal	Business Energy Tax Credit (Starting 1 Jan 2009)	Tax credit of 10% of expenditures (Microturbines and fuel cells **NOT** eligible)	No maximum	
Federal	Energy Efficient Commercial Buildings Tax Deduction	$0.30-$1.80 per square foot, depending	$1.80 per square foot	31-Dec-08
Federal	Renewable Electricity Production Tax Credit (PTC)	2.0¢/kWh for wind, geothermal, closed-loop biomass; 1.0¢/kWh for other eligible technologies. Applies to first 10 years of operation.		31-Dec-08
Federal	Modified Accelerated Cost-Recovery System (MACRS)	Accelerated depreciation deductions		
Federal	Bonus Depreciation	50% deduction of the adjusted basis of the property in 2008	50% adjusted basis	31-Dec-08
State	Non-Residential Solar & Wind Tax Credit	10% of installed cost	$25,000 for any one building in the same year and $50,000 in	31-Dec-12

			total credits in any year	
State	Solar Energy Property Tax Exemption	100% of increased value	None	NONE
State	Solar and Wind Equipment Sales Tax Exemption	100% of sales tax on eligible equipment	None	31-Dec-10
Source: DSIRE (Database of State Incentives for Renewables & Efficiency). /www.dsireusa.org/index.cfm.				

Table 9

Residential Incentives				
Level	Name	Description	Max	Expires
Federal	Residential Solar and Fuel Cell Tax Credit	Personal income tax credit of 30% of expenditures	Solar: $2,000; Fuel cells: $500 per 0.5 kW	31-Dec-08
State	Income Tax Subtraction for Energy Efficient Residences	5% of sales price excluding commissions, taxes, interest, points, and other brokerage, finance and escrow charges	$5,000	31-Dec-10
State	Residential Solar and Wind Energy Systems Tax Credit	25% of installed cost	$1,000 per residence	
State	Solar Energy Property Tax Exemption	100% of increased value	None	NONE
State	Solar and Wind Equipment Sales Tax Exemption	100% of sales tax on eligible equipment	None	31-Dec-10
Source: DSIRE (Database of State Incentives for Renewables & Efficiency). /www.dsireusa.org/index.cfm.				

Until December 31, 2008, a business or homeowner that takes advantage only of the state and federal tax credits can essentially cut the purchase price of the renewable energy resource by 37% (assuming a $10,000 base price).

A number of incentives have also been implemented for the construction and electric utility sectors. These include tax breaks for the use of renewable energy rather than conventional technologies, and for the construction of energy-efficient homes.

The push for renewable energy has not only involved incentives, but mandates which involve penalties for non-compliance. In 2006, the Arizona Corporation Commission (ACC) updated its "Portfolio Standard" policy. This rule, which applies to utility companies, requires

that every Arizona company in the business of providing energy would be required to generate a minimum portion of its energy using renewable resources (including Solar Electricity Resources, Solar Water Heaters, Solar Space Cooling systems, Landfill Gas Generators, Wind Generators, or Biomass Electricity Generators). The standard is dictated by a schedule which provides for annual increases in the portfolio requirement. For 2008, the portfolio requirement stands at 1.75%. By 2024, this requirement will have incrementally increased to 14%, and after 2024 the requirement will hold at its upper limit of 15%.[52] Utilities which do not meet the Portfolio Standard will be subject to fine.

CURRENT PROJECTS

Yuma Oil Refinery

As of May, 2008, Arizona Clean Fuels is in the final stages of collecting roughly $3.7 billion in financing for an oil refinery to be built near Yuma. It will be the first oil refinery to be built in the United States since 1976.[53] It is expected to be operational by 2012 with daily output of "150,000 barrels of gasoline, diesel and jet fuel."[54] Its input of crude oil will come from Canada via tanker ship to Mexico, where it will be piped across the southern Arizona border to Yuma.

Springerville Generating Station

SRP has received approval from TEP and the relevant Arizona oversight organizations to build a 4th unit onto the coal-fired Springerville Generating Station. Budgeted to cost between $600 and $700 million to construct, and will be rated at 400MW. It is expected to be operational by 2009.[55]

Palo Verde Generating Station

In Arizona, APS has suggested expanding the Palo Verde nuclear plant from its current 3-units to the full complement of 5 units for which it was designed.[56] Details are not forthcoming, however as the price of fossil fuels continues to rise, nuclear-powered energy is becoming increasingly viable.

Solana Generating Station

APS is currently sponsoring the construction of a massive solar electricity facility by Abengoa Solar, a Spanish company. The Solana Generating Station will be located some 70 miles southwest of Phoenix near Gila Bend. It is slated to begin operations in 2011 at a capacity of 280MW, which could potentially make it the world's largest solar electric generation facility. The plant is expected to produce some $4 billion in revenue over its expected lifespan of 30 years.[57]

Dry Lake Wind Project

In July of 2008, Iberdrola Renewables, another Spanish company, announced plans to construct a 63MW wind farm 18 miles northwest of Snowflake. Salt River Project (SRP) has signed a 20-year contract with Iberdrola to purchase the facility's energy.[58]

ARIZONA'S ENERGY FUTURE

As detailed above, U.S. consumption in all five major energy categories is forecasted to grow in the next twenty years:

	Category	Projected % Annual Change
1	Petrolem	0.3%
2	Coal	1.1%
3	Natural Gas	0.1%
4	Nuclear	0.6%
5	Renewable	2.5%

With this in mind, there will be two topics of foremost concern regarding energy in the United states:

- Energy independence / security
- Pollution and global warming

The same set of answers might actually be the best overall response to both issues. First of all, reducing dependence on imported sources of energy (particularly petroleum) can be most directly effected through increased efficiency. Being able to squeeze more energy out of what we consume would directly constitute a downward pressure on demand. If technological advances in efficiency were to be developed and implemented consistently enough, growth in imports of foreign energy sources could be halted. At the same time that energy security concerns would be addressed, more efficient vehicles and powerplants would burn less fuel and emit less pollution than those of previous eras. Such measures would directly limit harmful outputs and would constrain any potentially destructive effects on the environment.

For instance, the Congressional Budget Office estimated in 2004 that a 3.8 mile-per-gallon increase in the CAFE standard (a measure of the average fuel economy of new motor vehicles) would theoretically reduce gasoline consumption by 10 percent. Naturally, this reduction would likely be wholly applied to imports and, as mentioned earlier, transportation (largely motor gasoline) accounts for two-thirds of foreign petroleum imports.[59] Therefore a 10 percent reduction in gasoline consumption could actually amount to a 15 percent reduction in petroleum imports. The important caveat, however, is that it would take fifteen years to accomplish that decrease, as it would require the gradual retirement of today's less fuel-efficient vehicles.[60] Clearly the downside to the "efficiency answer" is its long payback period.

Another answer can be implemented more immediately. It is behavioral, rather than technical, in nature: limiting everyday energy use. If American energy habits could be altered in such a way as to minimize energy use, both of the two major energy concerns would be directly addressed. Moderation in consumption would spell lower total energy requirements, and therefore lower energy-related imports and less reliance on foreign resources to meet U.S. energy demands. Simultaneously, decreased energy production would proportionally decrease the production of pollutant byproducts. Perhaps most importantly, the payback period of moderation is rapid in terms of energy security, and immediate in terms of pollution. Cutting back

consumption would quickly cause accommodating cutbacks in imports and would avoid altogether the creation of a certain amount of pollutants.

Let us return to the example of motor vehicles and their primary fuel of gasoline. The U.S. Environmental Protection Agency (EPA) estimates that the average American drives 33 miles per day.[61] Reducing that number by less than four, to 29.7 miles, would amount to a 10 percent decrease in gasoline consumption. Again, this would likely amount in a 15 percent decrease in petroleum imports. However, unlike the fifteen years needed to reap the full benefit of forced increases in efficiency, moderation could be implemented tomorrow and its full benefits felt within weeks.

Renewable energies fall under the umbrella of more efficient technologies. Yet despite the substantial popular interest in renewable energy technologies such as photovoltaic and wind-turbine, the simple fact remains that fossil fuels are generally less expensive. For consumers, this results in lower per-unit costs, which means that fossil fuels remain in higher demand than renewable energies. Until renewable technology advances to the point that it can compete economically against power plants fired by coal, natural gas, and petroleum, it is unlikely that anything more than a small fraction of Arizona's power will be captured from the sun, wind, or any other renewable resource. Legislatively-mandated incentives help to tip the balance in renewable energy's favor, however the historically intermittent nature of these incentives is making development difficult for this fledgling industry.

There is concern that preparations for the Solana generating station, the Dry Lake wind project, and others will be scrapped. This is due to the expiration of the Business Energy Tax Credit (See Table 8 above) which is due to expire along with the Tax Relief and Health Care Act of 2006 (H.R. 6111) on 31 Dec 2008.[62] Without this incentive, which would provide for a tax credit of 30% of the installed cost of a renewable energy plant, far fewer renewable energy projects can be commercially viable.

On the whole, it is likely that neither the issues of energy independence nor pollution will be addressed in the near future. The economic reality is that the financial costs of these as-yet rather lofty concerns are outweighed by the everyday dollars and cents savings of fossil fuels. With enough investment, both the goals of energy independence and minimal pollution could be realized. However, this investment would likely require that significantly higher energy prices be shouldered by Americans in essentially all categories. The choice is between energy independence and minimal pollution, or low energy prices. For now, the U.S. is favoring the latter.

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