Summer 2005

Initial Market Sector Report
Potential for CHP-based Chillers > 100 RT in North America

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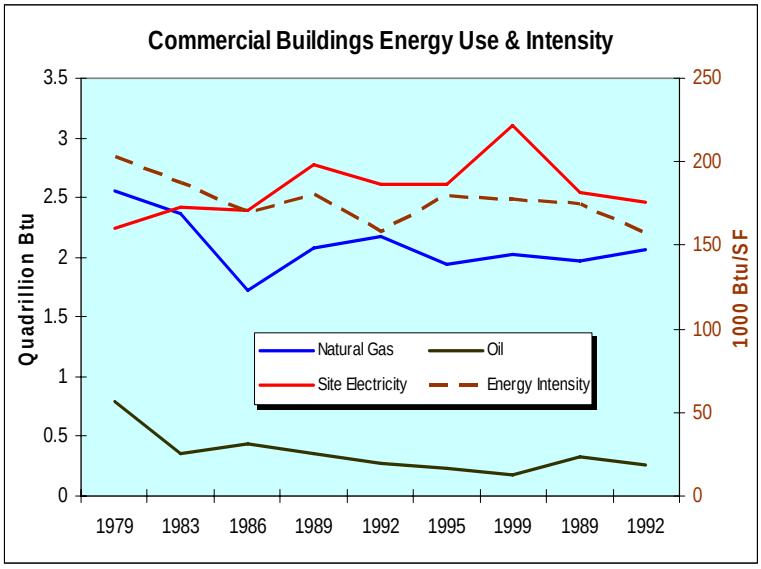
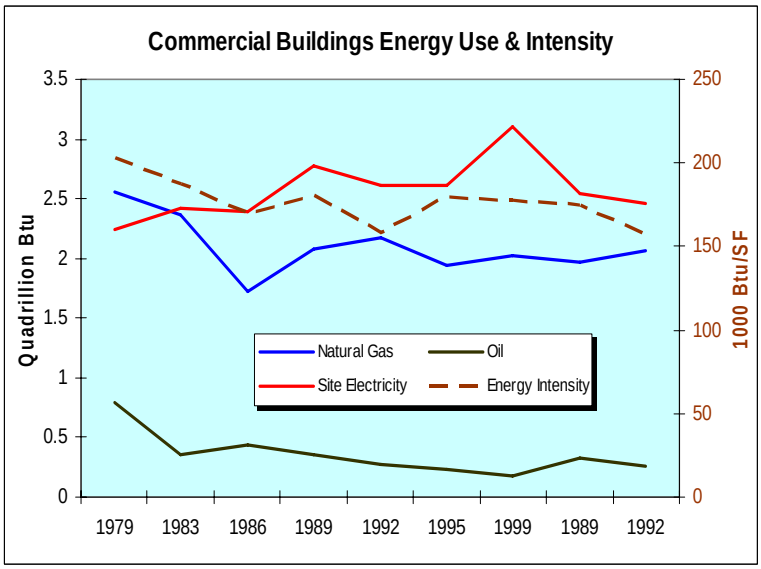
Commercial Buildings



The commercial sector consists of business establishments and other organizations that provide services. The sector includes service businesses (e.g., retail stores, hotels, and restaurants), public and private schools, correctional institutions, and religious and fraternal organizations. Excluded from the sector are the goods-producing industries: manufacturing, agriculture, mining, forestry and fisheries, and construction. Nearly all energy use in the commercial sector takes place in, or is associated with, the buildings that house commercial activities.

The Energy Information Agency (EIA) provides annualized national statistics identifying building distribution by region, size, energy use, industry sector, type of heating/cooling system, year constructed, etc. The EIA is the official information dissemination arm of the Department of Energy.



EIA's Commercial Buildings Energy Consumption Survey (CBECS) collects data from a sample of buildings representative of the commercial buildings sector in the United States. In 1999, the sector had more than 4.6 million buildings that comprised more than 67 billion square feet of floorspace. To survey this population, a representative sample of buildings is selected. For example, in the 1995 CBECS, 6,639 buildings were selected; of those, building characteristics survey interviews were completed at 5,766 buildings for a response rate of 87 percent.

The target population of CBECS consists of all commercial buildings in the United States with more than 1,000 square feet of floorspace. A commercial building defined by CBECS is an enclosed structure with more than 50% of its floorspace devoted to activities that are neither residential, industrial, nor agricultural. The numbers provided by the report are an average over the entire US and are intended to be indicative only. Each value should be thought of as an estimate with a range of uncertainty rather than a point estimate. The graphs and information used in this report are based on the most recently available EIA data.

This report reviews the various sectors in the commercial buildings market as well as state level utility pricing and regional issues. The market sectors are compared in order to identify the most favorable targets for York based CHP systems.

Commercial Energy Use

The number of commercial buildings and the amount of floorspace increased from 1979 to 1992, while total energy consumption remained flat.

Energy sources used for specific end uses changed over the period. For example, the use of electricity for space heating increased and use of fuel oil declined, while the use of natural gas and district heat remained constant. Building efficiency has led to reduced energy intensity, keeping energy consumption flat while increasing the building population.

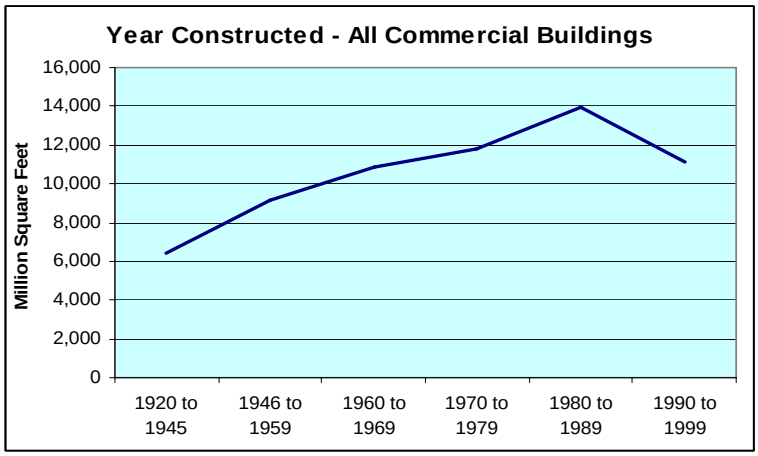
Electricity and natural gas consumption greatly exceeded other major sources from 1979 to 1995; and by 1986, the consumption of electricity exceeded natural gas.

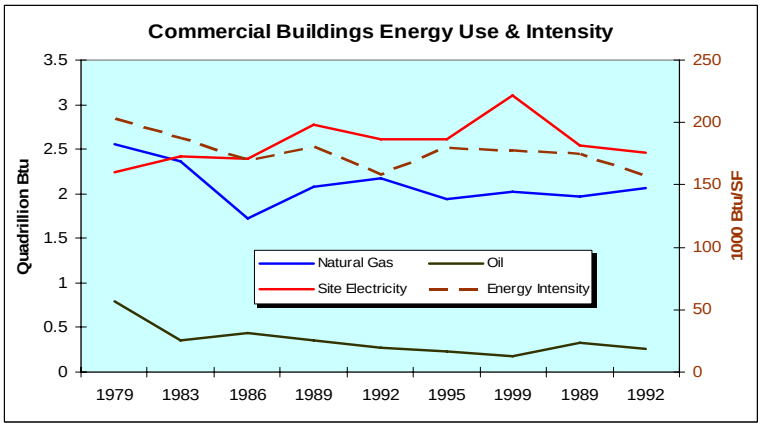
EIA Data

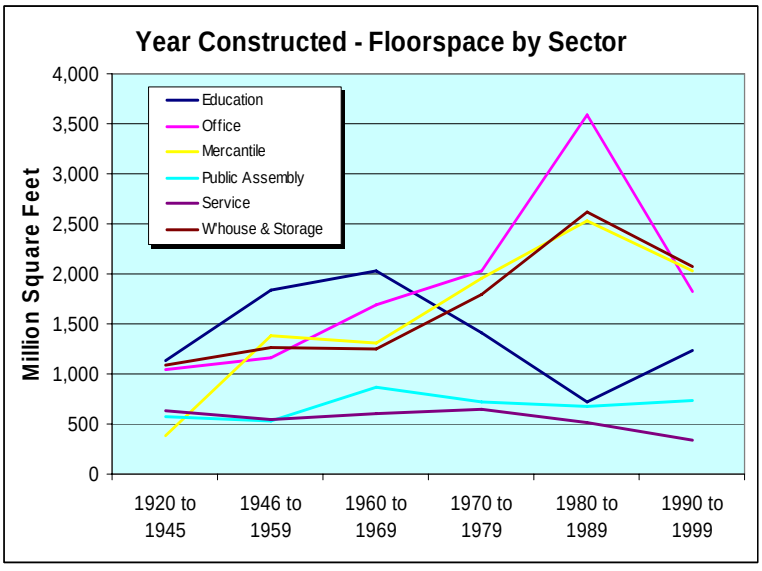
EIA data is analyzed by sector to identify trends in physical characteristics, energy use, sources and cost.

The decline in Education construction during the 70's and 80's has led to the current strength of school building and college expansion.

Trends and assumptions are based on the average building use in each sector where available.



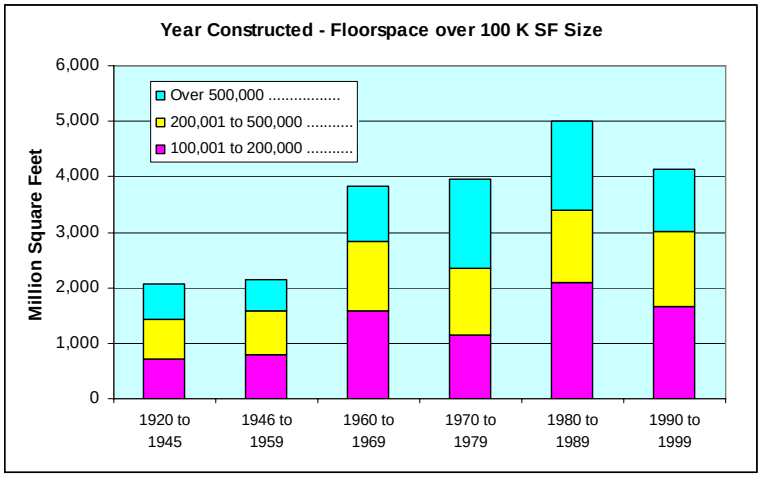




Large Commercial Buildings

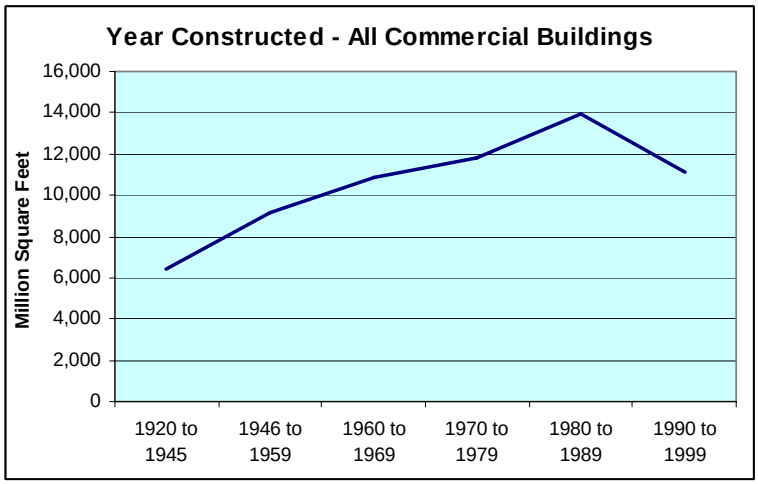
Buildings over 100,000 square feet are suitable for CHP systems. EIA data will be analyzed for all buildings as well as buildings over 100,000 square feet.

Large commercial buildings (over 100,000 square feet) have shown a similar growth trend to that for total buildings.

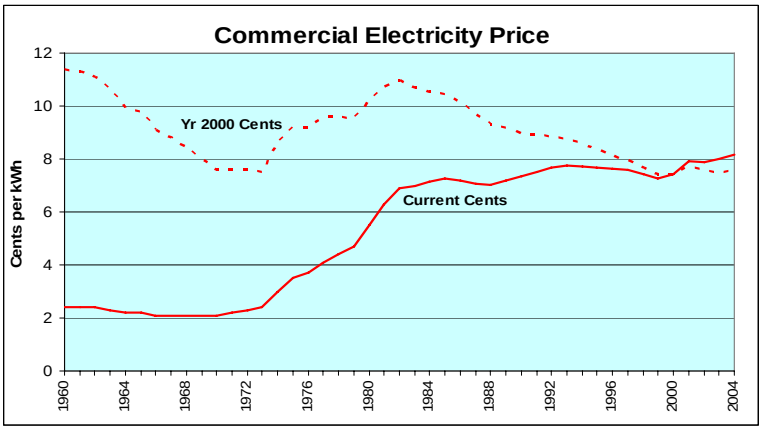


Commercial Energy Costs

Average commercial prices of electricity are calculated by dividing utility revenue by commercial sales. The resulting measurement is the cost, or average revenue per kilowatthour, of electricity sold. Electric utilities usually offer three primary classes of service: residential, commercial, and industrial. The average price per kilowatthour for residential consumers is generally higher than for any other sector due in part to higher costs associated with serving many consumers who use relatively small amounts of electricity. The industrial sector has the lowest rates due to the economies of serving a few consumers who use relatively large amounts of electricity.

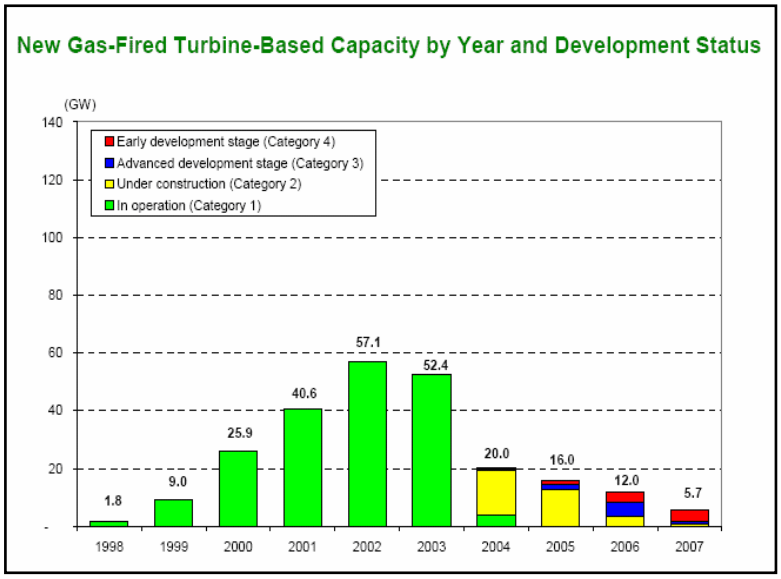


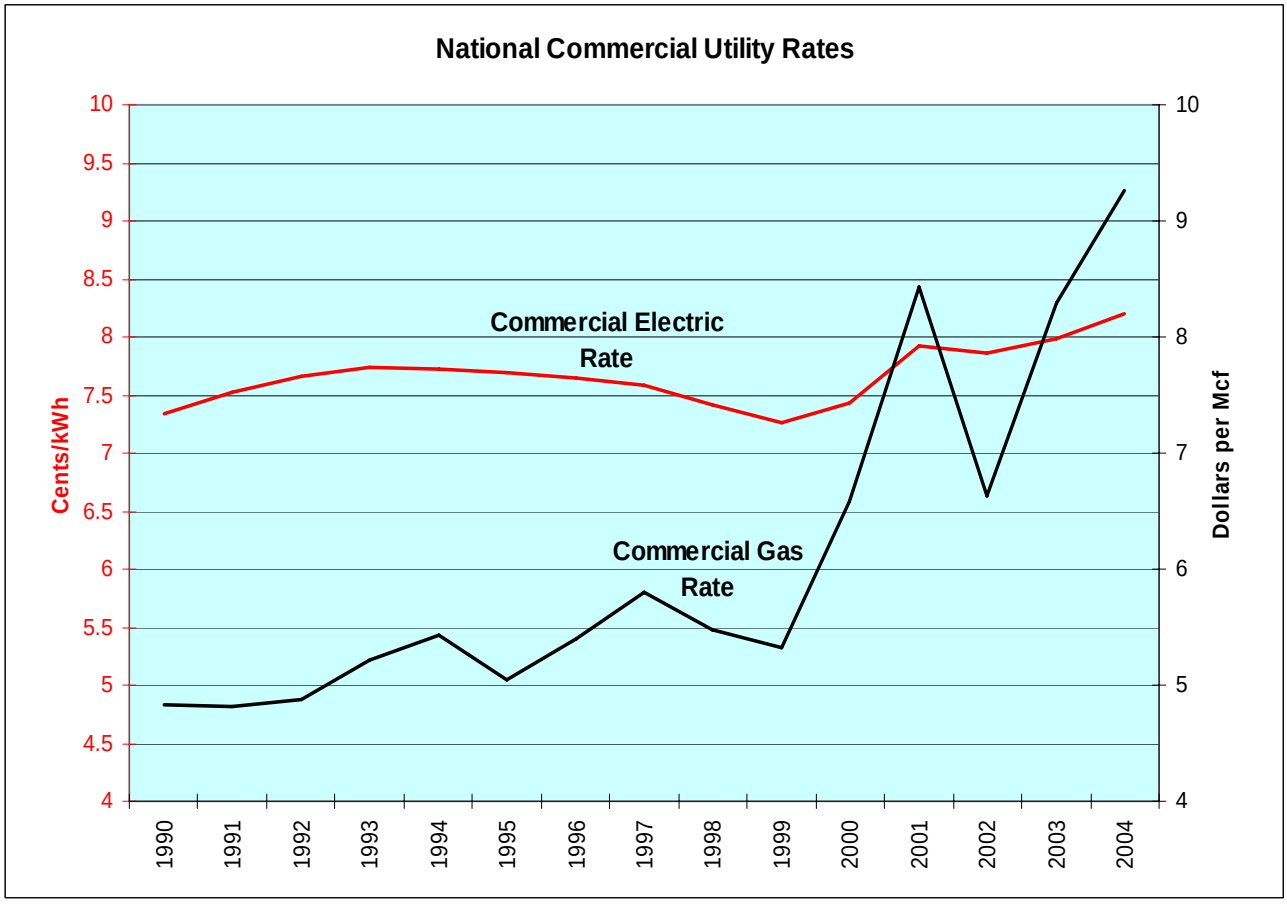
During the first half of the century, the national average price of electricity decreased as more efficient generating units were brought into service. This general trend has continued. The average real price of electricity to all sectors in 1999 (that is, the price adjusted to reflect the purchasing power of the dollar) was 22 percent below the price in 1960. However, the apparent stability in electricity prices masked fluctuations that occurred throughout the period. For example, following the oil embargo in 1973 and 1974, electricity prices increased rapidly because of escalation in the costs of fuel, labor, materials, capital, and services to electric utilities.



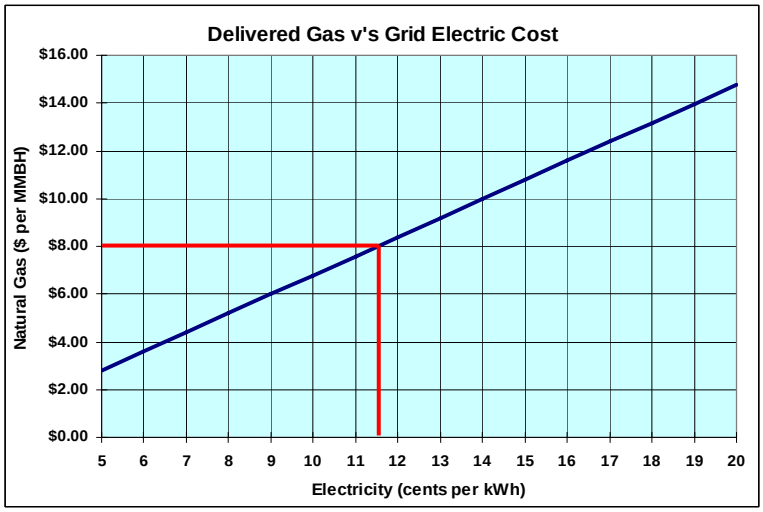
Future energy costs will be subject to supply and demand, generation technology and fossil fuel pricing. In states where there is a lot of natural gas based electricity consumption, the price will rise more quickly that coal based states if fuel pricing trends continue. Already construction of new gas fired generating plants has slowed considerably due to the high cost of gas as well as more complex financial and legislative reasons.

Utility rates and electric industry data are based on current and historic EIA information and are analyzed for national trends as well as underlying characteristics at the state level.





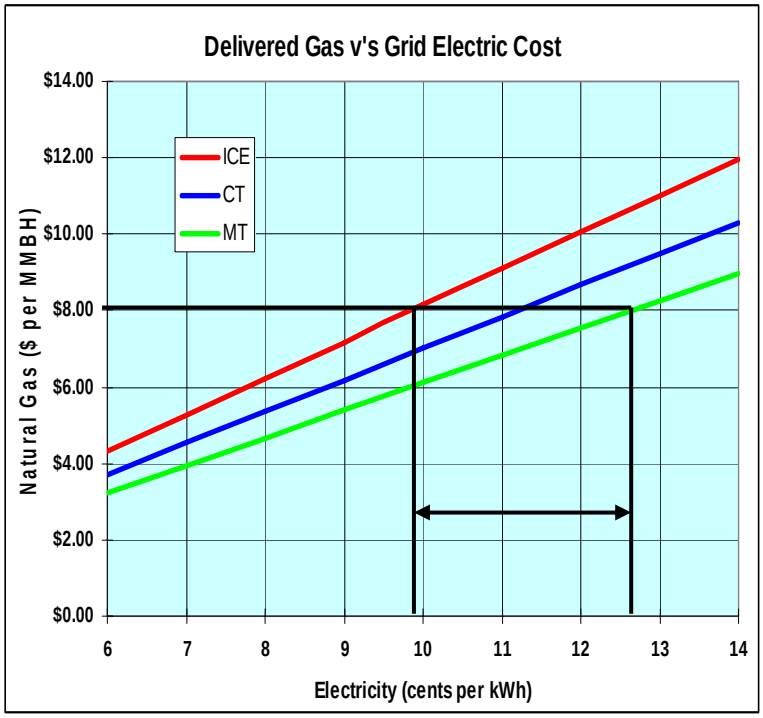
Electric Price Benchmark



The basic reason for application of a CHP system is the economic factor – does the CHP system complete with grid supplied electricity. In many applications the thermal energy is the 'profit' that pays for the equipment and so a CHP system should generate electricity plus maintenance at less than or equal to the grid cost.

There is a direct relationship between the cost of generating on-site electricity and natural gas. Assuming an average 30% LHV ISO efficiency and a maintenance cost of $0.015/kWh the graph shows the relationship. At $8.00 per MBH for natural gas, a 30% efficient generator will produce electricity at approximately 11 ½ cents per kilowatt-hour including maintenance.

Adjusting the average for different engines shows a range of cost from 9 ¾ cents for high efficiency IC Engines to 12 ½ cents per kilowatt-hour for microturbines. Simple cycle combustion turbines are in the middle at 11 ¼ cents per kilowatt-hour. The high efficiency recuperated Solar Mercury 50 at 40% efficiency will produce electricity at 9 cents per kilowatt-hour.



CHP System Characteristics

In identifying suitable sectors for CHP systems it is important to understand the outline characteristics of those systems. Efficiency, emissions, cost, physical size, maintenance, etc are all characteristics that vary from system to system. These characteristics will influence the selection of one system over another but do not determine the applicability of a specific configuration to a specific commercial sector. The two main parameters that will determine the applicability of a CHP system to a sector are electric output and the thermal-electric ratio.

The following table describes the outline characteristics for the six major configurations of cooling based CHP systems:

System Configuration			Efficiency		
Prime Mover	Thermal System	Effective Size Range	Power-Cooling Ratio (Average)	CHP Output Efficiency HHV	Heat Recovery Efficiency
Generator	Chiller	kW	T/kW	%	%
Large Combustion Turbine	Steam Turbine	2.5 - 7	0.5	77%	77%
Small Combustion Turbine	2 Effect Absorber	1 - 2.5	0.4	69%	73%
Microturbine	2 Effect Absorber	0.25 - 0.5	0.6	60%	49%
Reciprocating Engine	2 Effect Absorber	1.5 - 5	1.4	50%	34%
Reciprocating Engine	1 Effect Absorber	0.25 - 5	0.9	58%	70%
Microturbine	1 Effect Absorber	0.25 - 0.5	0.7	44%	54%

Electric Output

For most CHP applications both the generator and chiller are sized to meet only part of the load in order to create a high load factor. Typical buildings have a 100% load factor for generators that output approximately 30% to 40% of the buildings peak electric load. At this ratio the thermal output of the CHP system will typically also have a high load factor.

Systems start at 250 kW due to the smallest viable chiller being 100 tons. A 250 kW CHP system provides 1/3 of the peak electric use for a building with a peak load of 750 kW. At 5 watts per square foot this is the equivalent of a building with 150,000 square feet. Due to the variety of uses and intensities it is not possible to draw a reliable equivalent floorspace from electric load. In order to allow for variations we will set the minimum economically feasible building size for CHP at 100,000 square feet.

Power-Cooling (P/C) Ratio

An essential characteristic when applying CHP systems to a building is the ratio of electric energy to thermal energy produced by the system. In analyzing the market for chiller based CHP systems we are only interested in the power to cooling ratio. The P/C Ratio is calculated by converting the electric output in kW to MBH (thousand Btu's per hour) and dividing the result by the chiller output expressed in MBH.

CHP systems vary from 1.4 MBH_e per MBH_c (0.2 Tons/kW_e) for IC engine with exhaust only heat recovery to 0.4 (0.7 Tons/kW_e) for low efficiency combustion turbines. Buildings with P/C ratios over 1.4 will need other thermal loads to justify CHP, while buildings with P/C ratios under 0.4 can easily be accommodated through duct firing or supplemental chilling.

An Example of buildings over a 1.4 P/C Ratio are supermarkets which have a very high P/C ratio due to refrigeration. The refrigerated cases increase electric use and reduce cooling requirements. Typical supermarkets have a base load of 250 to 350 kW and a space cooling requirement of 0 to 30 tons. Chilled water produced from a CHP system may also be applied to refrigerant sub-cooling but this will provide only an additional 20 tons of load. A typical supermarket with 300 kW base electric load and 40 tons of cooling including refrigerant sub-cooling has a P/C ratio of 2.2. In addition the size of chiller required and complexity of sub-cooling make this a high cost CHP system. This is the major influencing factor on the high P/C Ratio exhibited by the Food Sales commercial sector which contains supermarkets.

Commercial Sectors

The Department of Energy keeps track of energy use, size, source, production, etc. on a state and federal level. In the Commercial Buildings Energy Consumption Survey (CBECS), buildings are classified according to principal activity, which is the primary business, commerce, or function carried on within each building. Buildings used for more than one of the activities described below are assigned to the activity occupying the most floorspace at the time of the interview. There are 14 activity classifications separating health care, hotel, retail and office market sectors as follows:

Education
Food Sales
Food Service
Health Care
- Inpatient
- Outpatient

Lodging
Mercantile
- Retail (other than mall)
- Enclosed and Strip Malls

Office
Public Assembly
Public Order and Safety
Religious Worship
Service
Warehouse and Storage
Other
Vacant

Each category is described below together with a list of subcategories.

Education Buildings; used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of "Office," dormitories are "Lodging," and libraries are "Public Assembly."

Elementary or middle school
High school
College or university
Preschool or daycare
Adult education
Career or vocational training
Religious education

Food Sales Buildings; used for retail or wholesale of food.

Grocery store or food market
Gas station with a convenience store
Convenience store

Food Service Buildings; used for preparation and sale of food and beverages for consumption.

Fast food
Restaurant or cafeteria

Health Care (Inpatient) Buildings; used as diagnostic and treatment facilities for inpatient care.

Hospital
Inpatient rehabilitation

Health Care (Outpatient) Buildings; used as diagnostic and treatment facilities for outpatient care. Medical offices are included here if they use any type of diagnostic medical equipment (if they do not, they are categorized as an office building).

Medical office (see above)
Clinic or other outpatient health care
Outpatient rehabilitation
Veterinarian

Lodging Buildings; used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.

Motel or inn
Hotel
Dormitory, fraternity, or sorority
Retirement home
Nursing home, assisted living, or other residential care
Convent or monastery
Shelter, orphanage, or children's home
Halfway house

Mercantile (Retail Other Than Mall) Buildings; used for the sale and display of goods other than food.

Retail store
Beer, wine, or liquor store
Rental center
Dealership or showroom for vehicles or boats
Studio/gallery

Mercantile (Enclosed and Strip Malls) Shopping Malls; comprised of multiple connected establishments.

Enclosed mall
Strip shopping center

Office Buildings; used for general office space, professional office, or administrative offices. Medical offices are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building).

Administrative or professional office
Government office
Mixed-use office

Bank or other financial institution
Medical office (see previous column)
Sales office
Contractor's office (e.g. Construction, plumbing, hvac)
Non-profit or social services
Research and development
City hall or city center
Religious office
Call center

Public Assembly Buildings; in which people gather for social or recreational activities, whether in private or non-private meeting halls.

Social or meeting (e.g. Community center, lodge, meeting hall, convention center, senior center)
Recreation (e.g. Gymnasium, health club, bowling alley, ice rink, field house, indoor racquet sports)
Entertainment or culture (e.g. Museum, theater, cinema, sports arena, casino, night club)
Library
Funeral home
Student activities center
Armory
Exhibition hall
Broadcasting studio
Transportation terminal

Public Order and Safety Buildings; used for the preservation of law and order or public safety.

Police station
Fire station
Jail, reformatory, or penitentiary
Courthouse or probation office

Religious Worship Buildings; in which people gather for religious activities, (such as chapels, churches, mosques, synagogues, and temples). No subcategories collected.

Service Buildings; in which some type of service is provided, other than food service or retail sales of goods vehicle service or vehicle repair shop

Vehicle storage/ maintenance (car barn)
Repair shop
Dry cleaner or laundromat
Post office or postal center
Car wash
Gas station
Photo processing shop
Beauty parlor or barber shop
Tanning salon
Copy center or printing shop
Kennel

Warehouse and Storage Buildings; used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).

Refrigerated warehouse
Non-refrigerated warehouse
Distribution or shipping center

Other Buildings; are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial/ manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category.

Airplane hangar
Crematorium
Laboratory
Telephone switching
Agricultural with some retail space
Manufacturing or industrial with some retail space
Data center or server farm

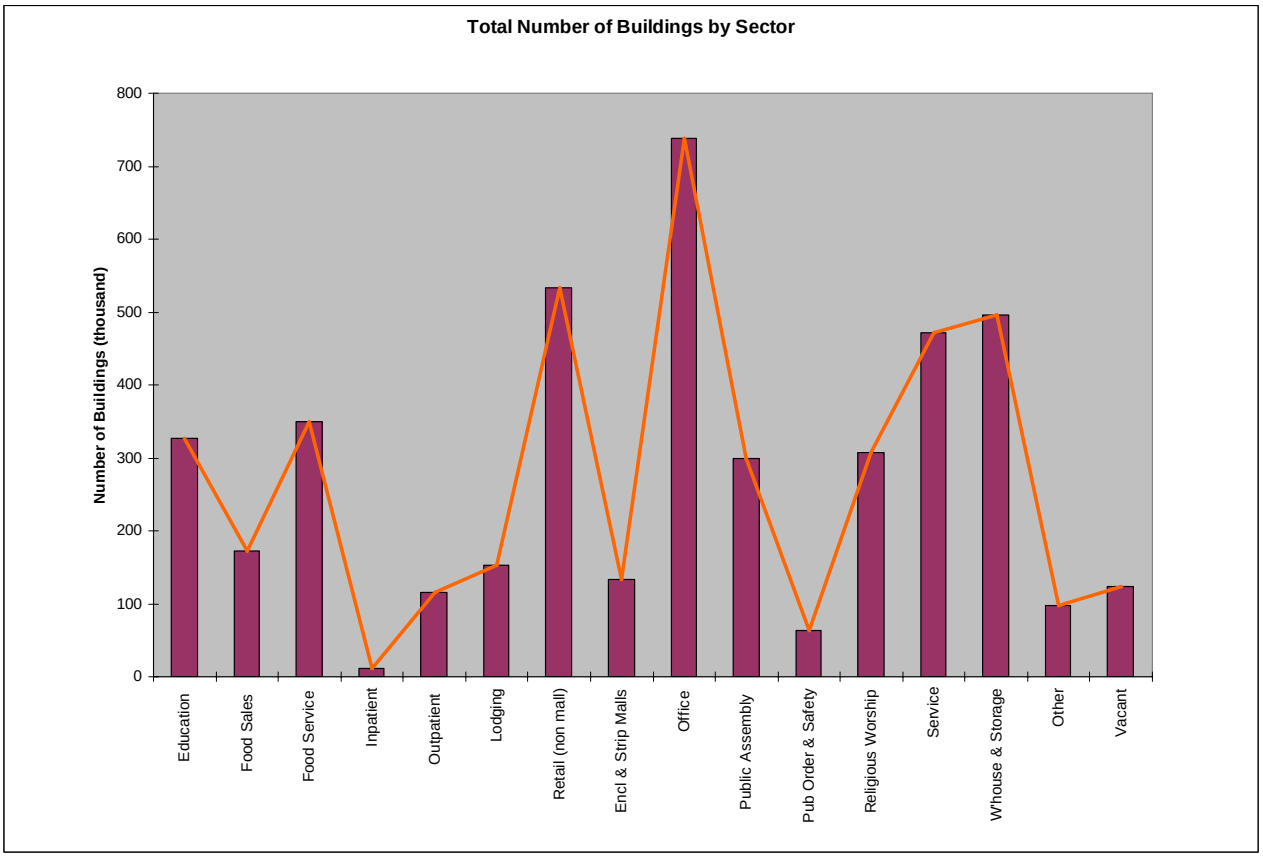
Vacant Buildings; in which more floorspace was vacant than was used for any single commercial activity at the time of interview. Therefore, a vacant building may have some occupied floorspace. No subcategories collected, but a question was asked to determine whether the building was completely vacant.

Commercial Buildings Size

Number of Buildings

The total number of commercial buildings using electricity is 4,395,000. The Office sector has the highest number of buildings at 738 thousand buildings followed by Retail at 534 and Warehouse & Storage at 496 thousand buildings.

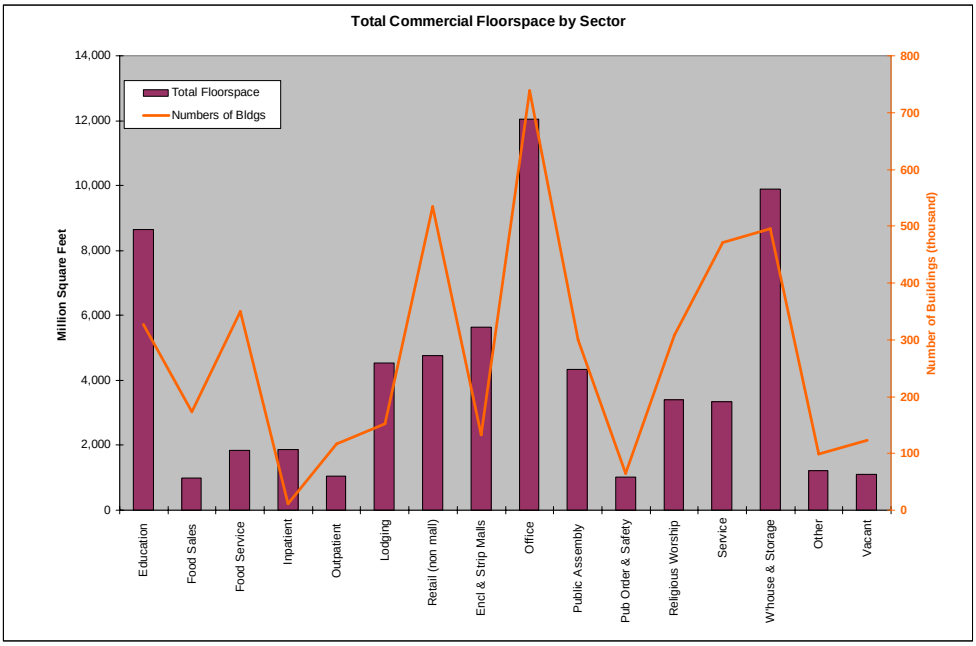
The number of buildings is an indication of market size but not a qualification for suitability for York based CHP solutions. In some cases the high number of buildings indicates a low average size as with Food Sales and Service.



Floorspace

In terms of overall floorspace the Office sector is also the largest with over 12 billion square feet followed by Warehouse & Storage with 9.89 and Education with 8.65 billion square feet.

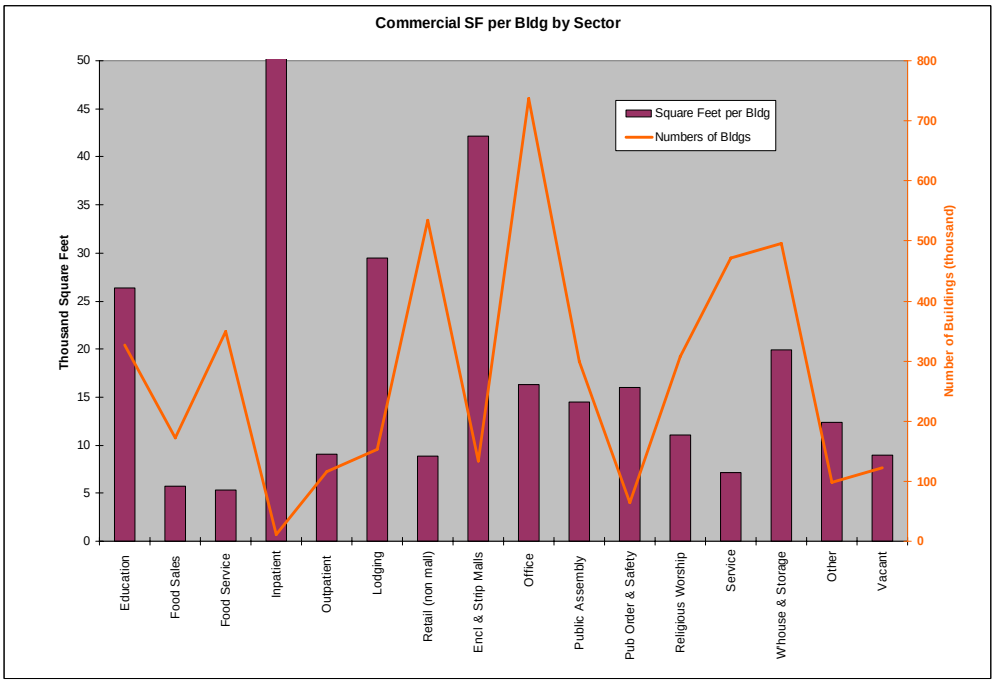
The graph of floorspace is overlaid with the number of buildings per sector.



Building Size

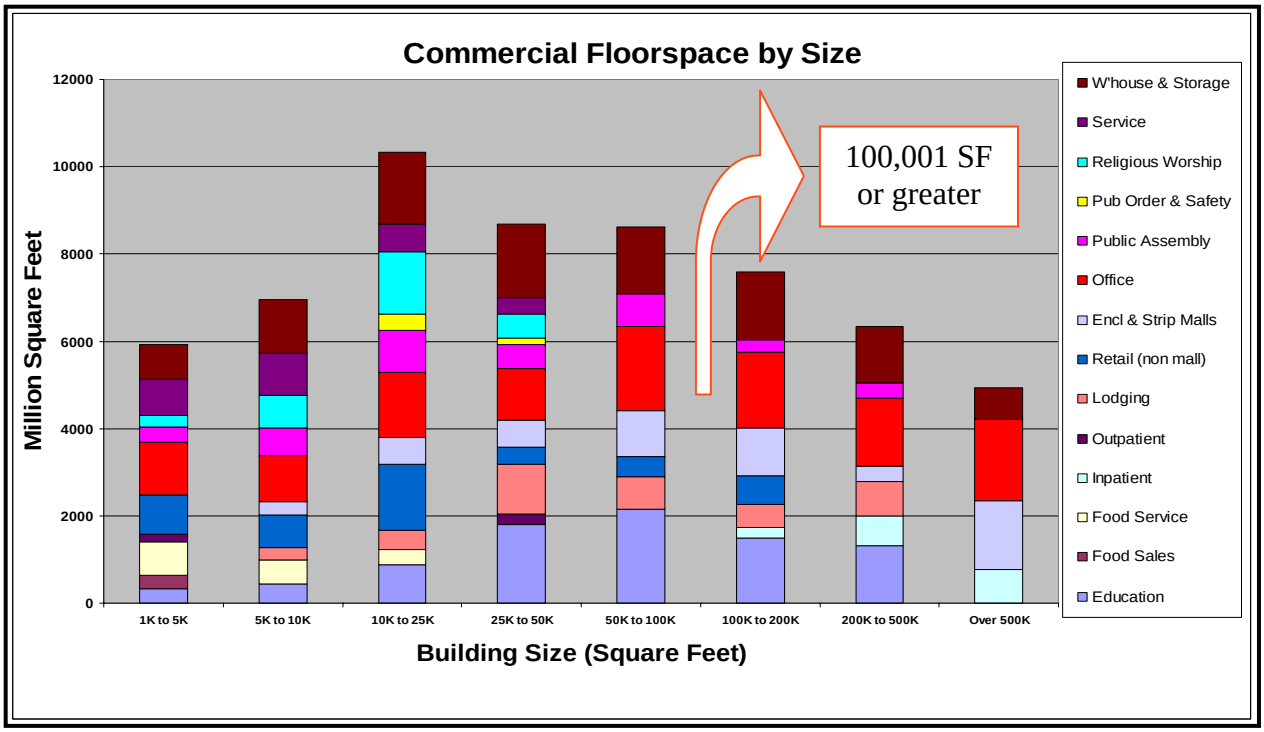
The individual building size will help identify physically suitable sites for CHP. The larger the average building the more likely that sector will suit York CHP. The left scale was reduced below the Inpatient sector average of 168,000 square feet per building.

After Inpatient facilities Malls, Education and Lodging facilities are the largest on average.

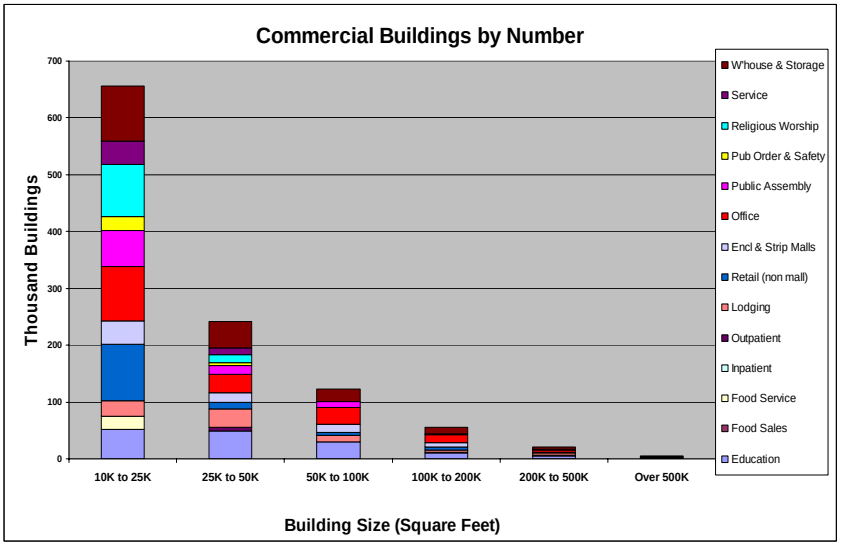


Commercial Building Size

York equipment is limited to a minimum size of 100 tons which is typically equivalent to a CHP system for a 100 thousand square foot building. Of all commercial building floorspace 68% is contained in buildings under this size while 32% is contained in buildings over 100 thousand square feet. The biggest sectors over 100 K SF are Education, Inpatient, Lodging, Mercantile, Office, Public Assembly and Warehouse and Storage.

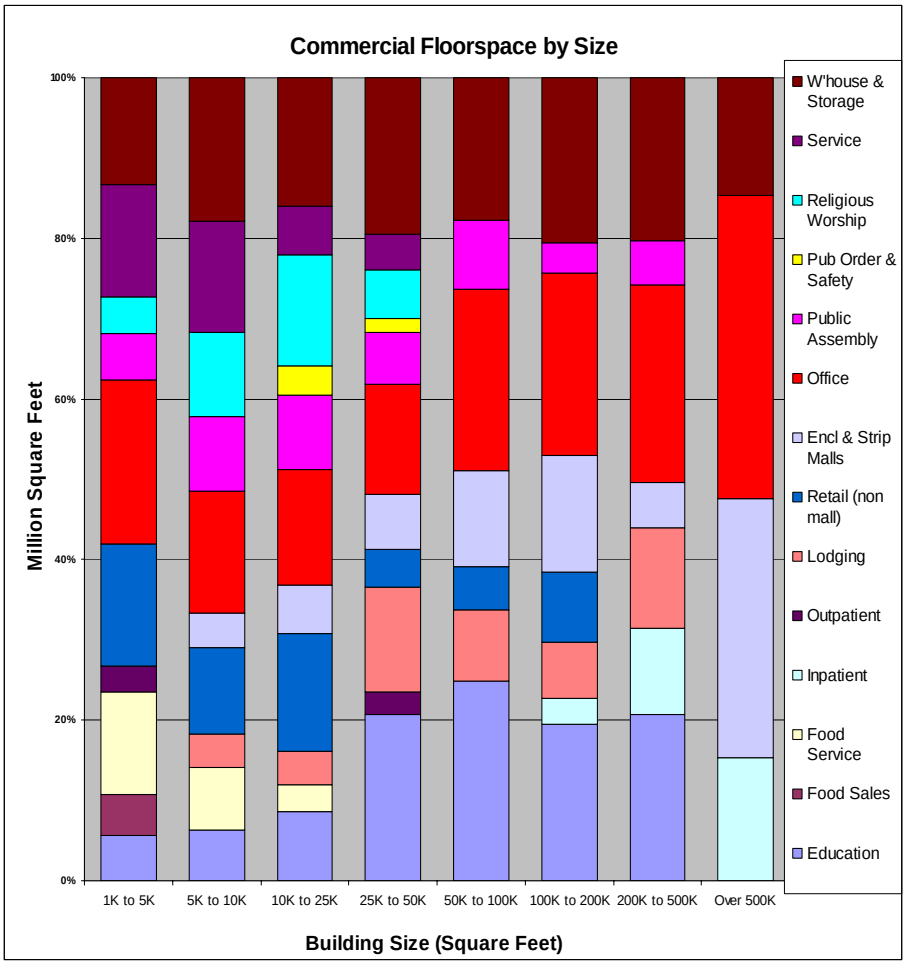


The total number of buildings drops off as the building size increases. In terms of building numbers, only approximately 81,000 or 2% are over 100 thousand square feet. Of these 25% are in the office sector.



Sector Comparison by Size

A comparison of sector weight within each size classification shows some useful trends.



Education buildings vary widely by size since this sector includes all schools, colleges and universities.

The high electric energy intensity sectors of Food Sales and Food Service are predominantly less than 10 thousand square feet.

Outpatient facilities tend to be small while there are thousands of Inpatient facilities that are over 100 K SF.

Lodging facilities mainly range from 25 to 500 thousand square feet of floorspace. While there are considerably more facilities under 100 K SF there is also a considerably amount of floorspace in hotels above 200 K SF.

Mercantile is divided into retail which has a lot of buildings under 100 K SF while enclosed and strip malls are popular in the 50 K to 200 K SF size range as well as being a significant portion of the largest buildings.

Office facilities are prevalent in all size areas and are particularly significant in the larger building size range.

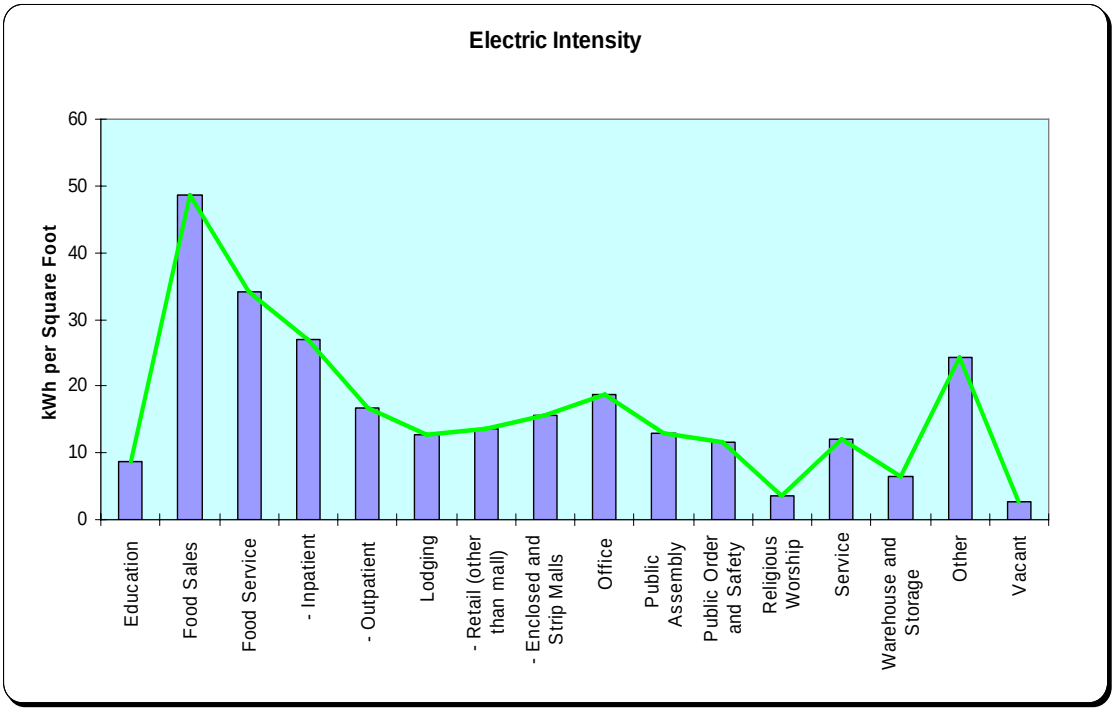
Public assembly covers significant floorspace in all but the biggest size range. Public order and safety, religious worship and service facilities are predominantly under 50 K SF.

Warehouse and storage represents considerable floorspace in all size ranges.

Commercial Building Energy Intensity

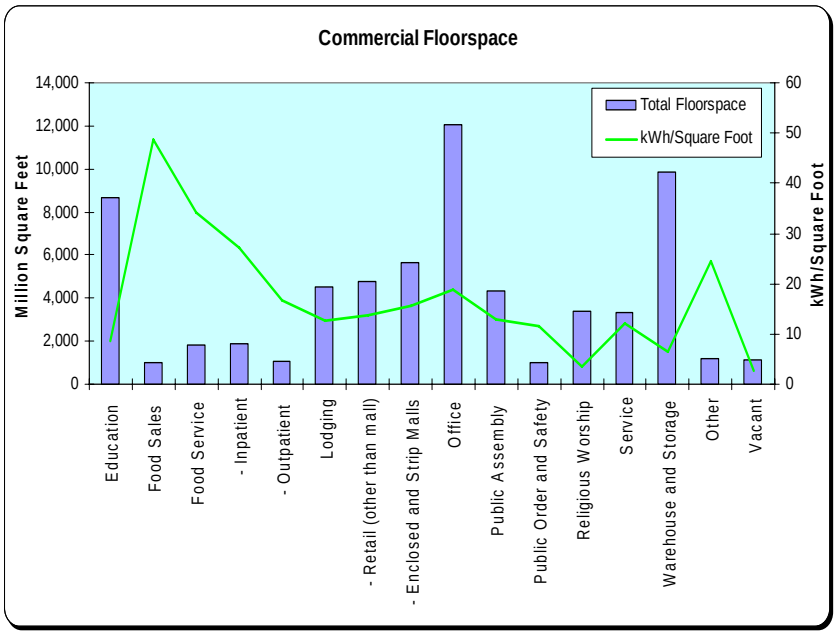
Since CHP systems generally have long run hours the economics are based more on energy use rather than peak demand. A high electric energy use per square foot indicates a high load factor and therefore suitability for CHP.

The following graph shows the average energy intensity measured in kWh/square foot per year, for each sector. This measure will be used as a reference line for other graphs in this section. Food Sales and Service and Inpatient Healthcare show the highest electric energy intensity while Religious Worship and Warehouse and Storage have the lowest intensity.



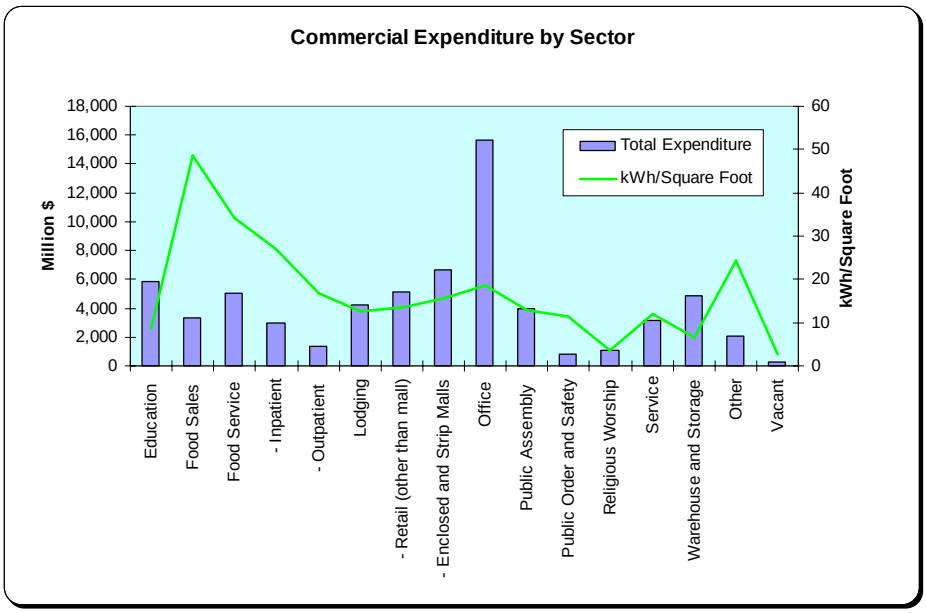
Total Floorspace

The Office sector has the most floorspace and has an electric intensity of approximately 20 kWh/SF. Warehouse and Storage has a large floorspace but with a low electric intensity. Education as the third large space occupier has an average intensity of just under 10 kWh/SF.



Total Electricity Expenditure

The Office sector spends almost $16 billion per year on electricity followed by Malls at $6.7 billion, Education at $5.8 billion and Food Service at $5 billion. Religious Worship and Public Order and Safety are lowest at $1 billion and $800 thousand respectively.

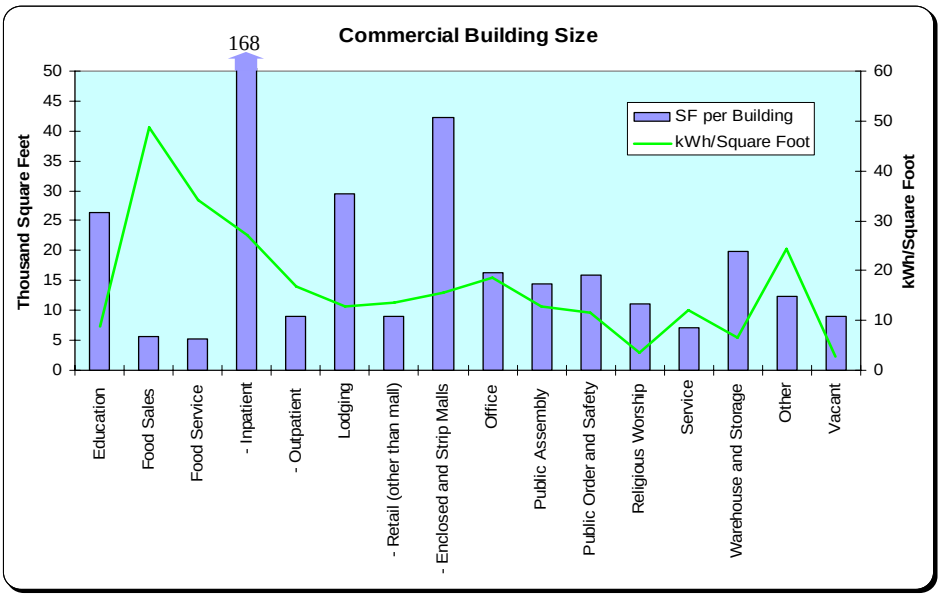


Building Size

Commercial buildings vary widely in average size. The average size does not determine the number of big buildings in a given sector.

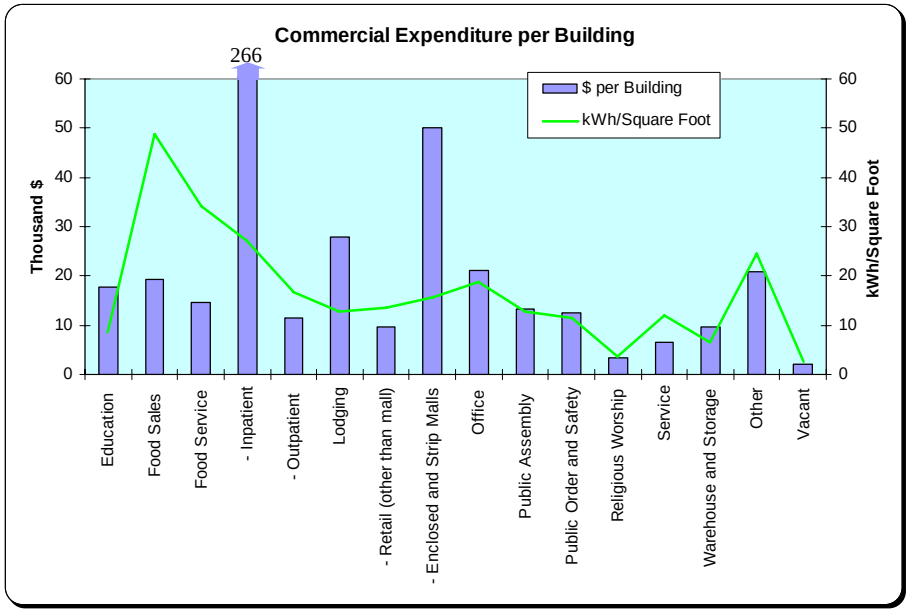
The scale is adjusted outside of the Inpatient reading of 168,000 square feet per building. The high number indicates a lack of small buildings in this sector.

The high intensity Food Sales and Service sectors have a low average building size of approximately 5,000 square feet.



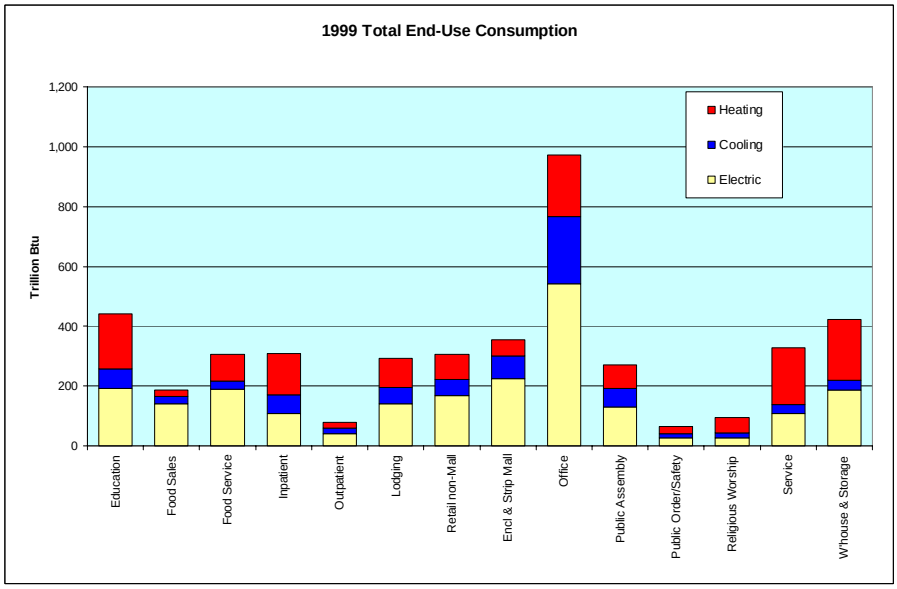
Annual Electricity Expenditure per Building

The high Inpatient expenditure per building is due to the high number of large buildings in this sector.



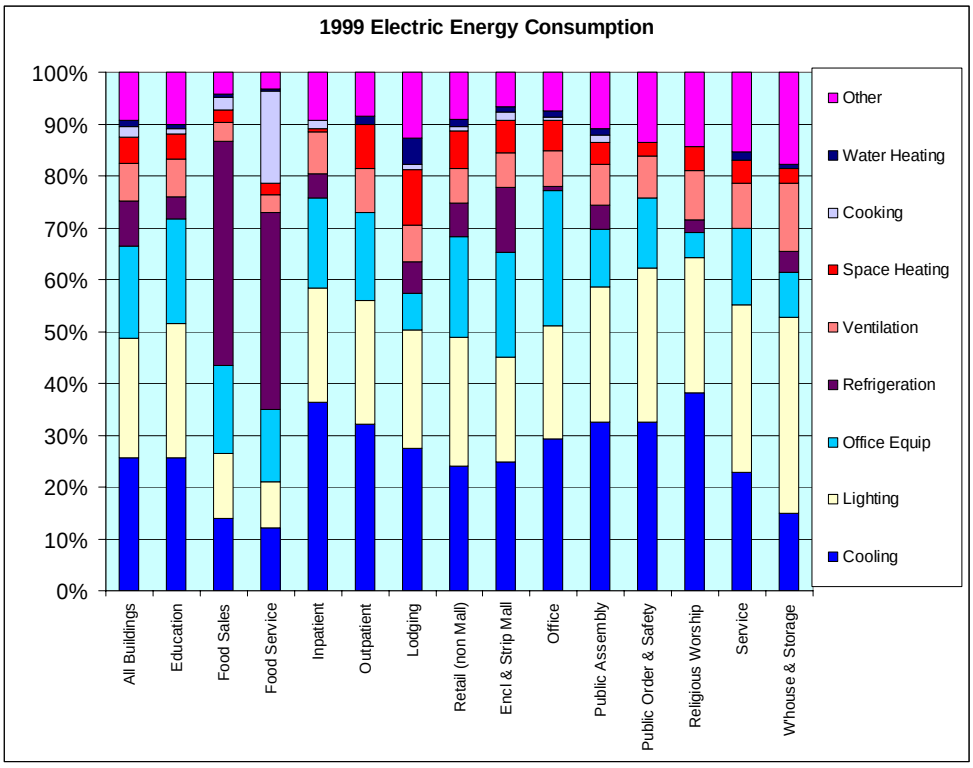
Building Energy Use

The 1999 Commercial Buildings Assessment provides some information on overall building energy consumption for each sector. The heating is based on natural gas and the cooling is based on electricity.



Electricity Use

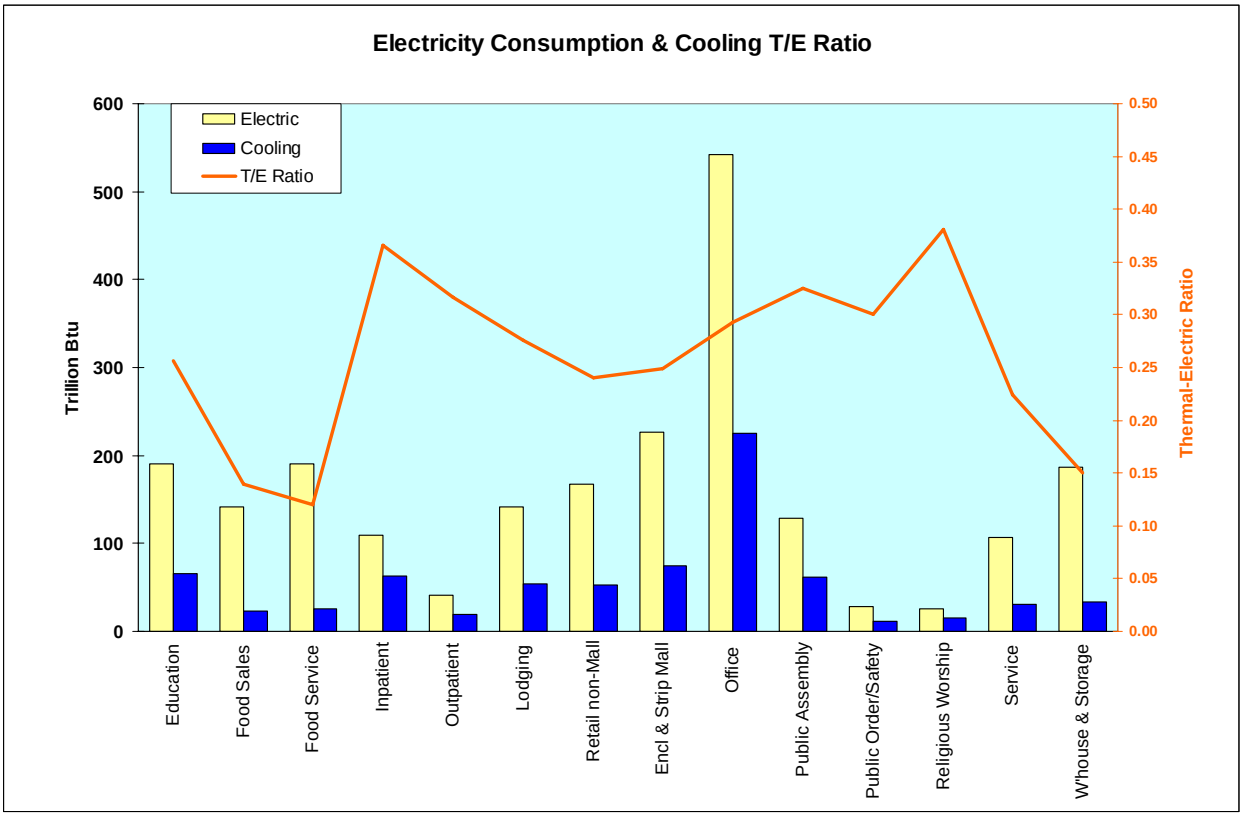
The Electric Energy Consumption by process for each sector provides a guide to the relative value of cooling.



Thermal Electric Ratio

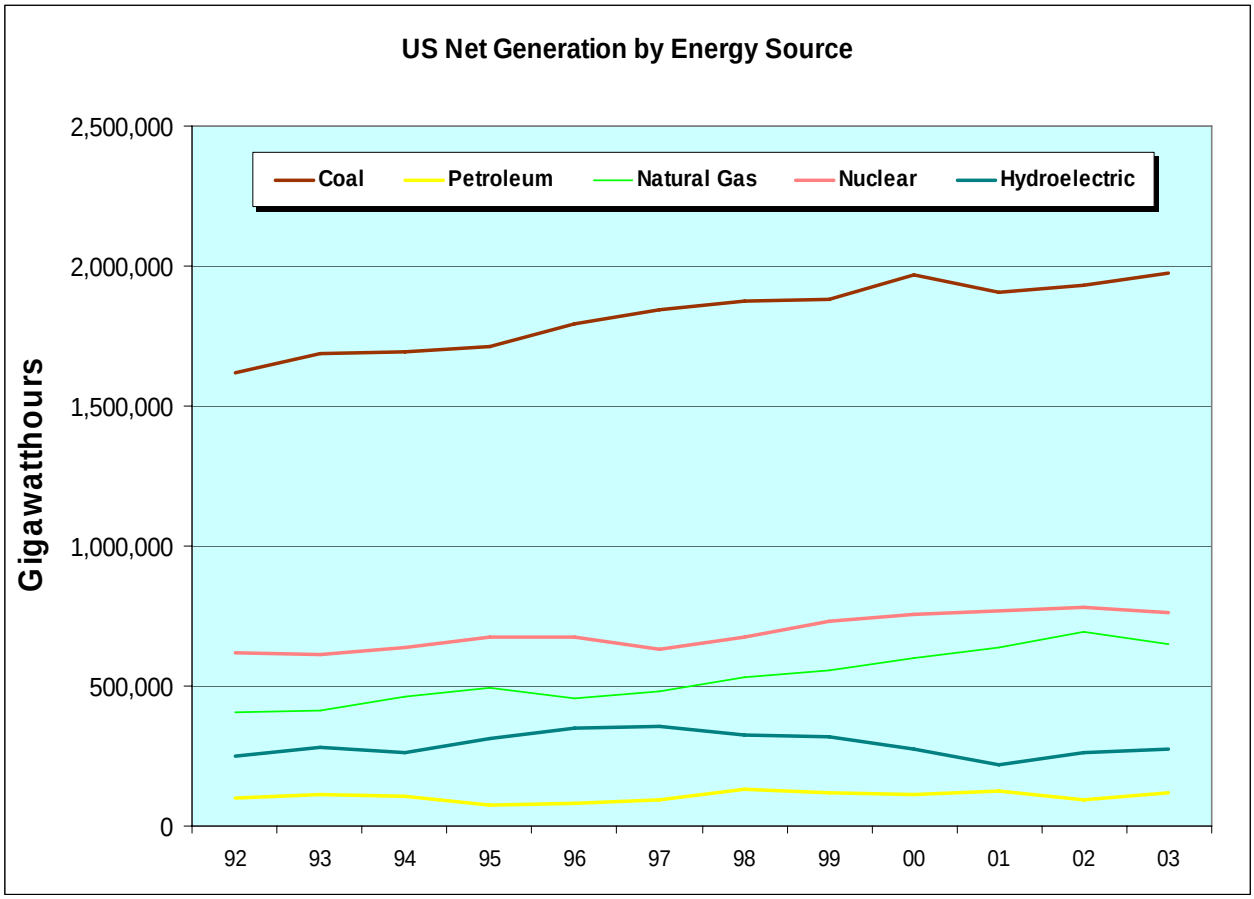
The following thermal-electric ratio is based on the total electric Btu's used for cooling divided by the total Btu's of electricity used for other purposes based on the EIA table 'Electricity End-Use Consumption by Principal Building Activity, 1999 (Preliminary Estimates)'. Building specific T/E ratios can vary widely from the average values provided. The individual building's base load T/E Ratio in Tons/kW is used in CHP design.

Food Sales and Service have a low cooling need – a lot of the thermal energy requirements are for refrigeration which is not included in cooling. Office Buildings consume the most energy and have a high T/E ratio. Inpatient Buildings have a high ratio due to high thermal consumption as with hospitals while Public Order and Religious Worship Buildings have a high T/E ratio due to low electric consumption.


Electricity Consumption & Cooling T/E Ratio
Electric
Cooling
T/E Ratio
Trillion Btu
Thermal-Electric Ratio
600
500
400
300
200
100
0
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Education
Food Sales
Food Service
Inpatient
Outpatient
Lodging
Retail non-Mall
Encl & Strip Mall
Office
Public Assembly
Public Order/Safety
Religious Worship
Service
W'house & Storage

Electric Energy Source

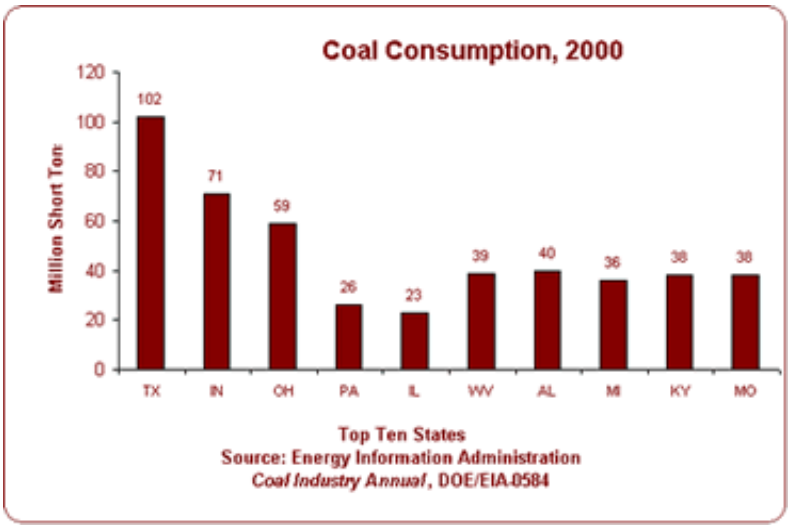
In order to understand electricity pricing it is necessary to know the sources used by the generating industry and associated costs. The following graph illustrates the dominant position of coal as well as the increasing contribution of natural gas while nuclear is squeezing more energy out of the same plants. The mix of fuel sources of new generation together with energy source cost trends will determine the future price of electricity.



The following gives a quick overview of the top three sources of fuel for electric generation.

Coal

Coal, a fossil fuel like petroleum and natural gas, is a sedimentary organic rock that contains more than 50 percent carbonaceous material by weight. It is composed largely of carbon, hydrogen, oxygen, nitrogen, and sulfur, with smaller amounts of other materials ranging from aluminum to zirconium. Coal had its beginning as plants that grew in swamps hundreds of millions of years ago, before dinosaurs and animals ever existed. Geological processes working over vast spans of time compressed and altered the plant remains, increasing the percentage of carbon present, thereby producing the different ranks of coal: lignite, subbituminous, bituminous, and anthracite.



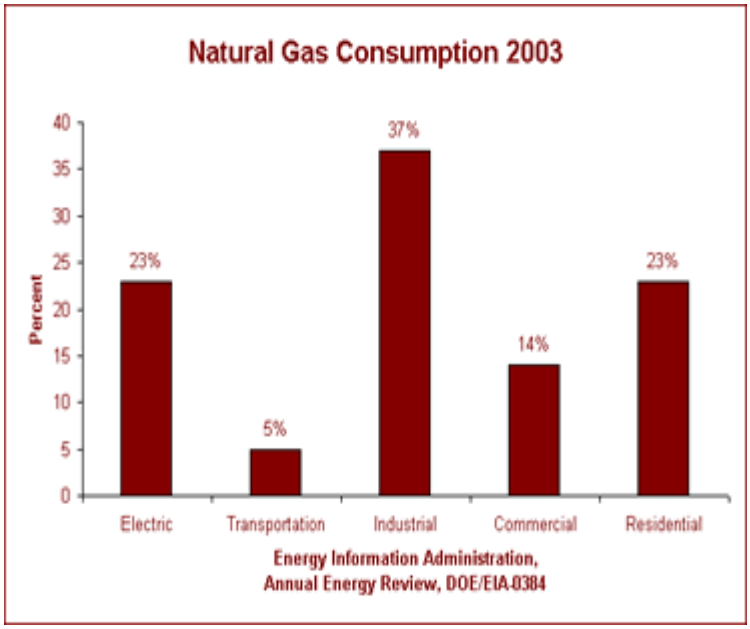
During 2000, 1.08 billion short tons of coal were consumed in the United States. The greatest demand for coal was by electricity generating plants that burn coal to produce electricity. Some 982.6 million short tons, 91.0 percent of the total, were used by the electric power sector to produce more than half (51.8) percent) of all electricity generated. Each ton of coal consumed at an electric power plant produces about 2,000 kilowatthours of electricity. Texas led all States in coal consumption in 2000, using 102 million short tons. Indiana and Ohio were second and third, respectively. These three States accounted for over 21 percent of the total U.S. coal consumption for the year. North Dakota, which ranked tenth in coal use, is the site of one coal gasification plant that uses 6.3 million tons of lignite per year to produce about 54 billion cubic feet per year of synthetic natural gas.

In 2002, Wyoming was the Nation's leading coal-producing State with production of 373.2 million short tons, which was about 30.5 percent of the national total. Wyoming's coal production level in 2002 was just 5.3 million short tons less than the total produced by the rest of the 22 coal-producing States. West Virginia ranked second, with 150.1 million short tons, and Kentucky was third, with 124.1 million short tons. Together, these three States accounted for 58 percent of total U.S. coal production - the same percentage as in 1998.

Natural Gas

For centuries, natural gas has been used in various parts of the world. The Chinese, 2,000 years ago, piped natural gas through bamboo poles from shallow wells. They then burned the gas to heat large pans to evaporate sea water for salt. It is believed that the first commercial use of natural gas in the western world was for street lighting in Genoa, Italy, in 1802.

In 2003, U.S. natural gas consumption reached an historical peak at 22.3 trillion cubic feet (Tcf), 2.8 percent more than in 2002. Residential natural gas consumption in 2003 was 5.1 trillion cubic feet. Commercial natural gas consumption in 2003 was 3.2 trillion cubic feet. Industrial consumption in 2000 was 7.1 trillion cubic feet, 4.9 percent lower than in 2002. Electric utilities consumed 5.1 trillion cubic feet of natural gas in 2003, which was 9.4 percent less than in 2002. By the year 2025, U.S. natural gas consumption is projected to range between 27 Tcf and 33 Tcf, with most of the increase being used for electricity generation.

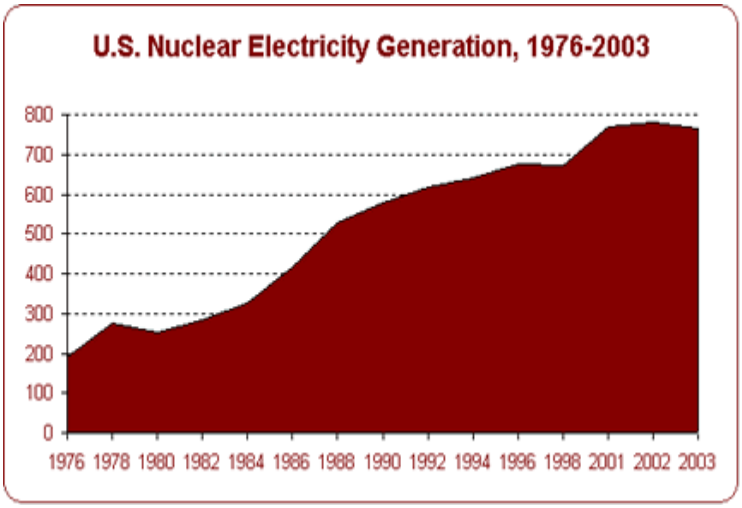


In 2003, world natural gas consumption was 95.5 Tcf. Russia, which consumed 15.3 Tcf, and the United States, which consumed 22.4 Tcf, accounted for 47 percent of the total. Consumption of natural gas is projected to increase by nearly 70 percent between 2001 and 2025, with the most robust growth in demand expected among the developing nations. By the year 2025, total world consumption of natural gas is expected to be 151 trillion cubic feet

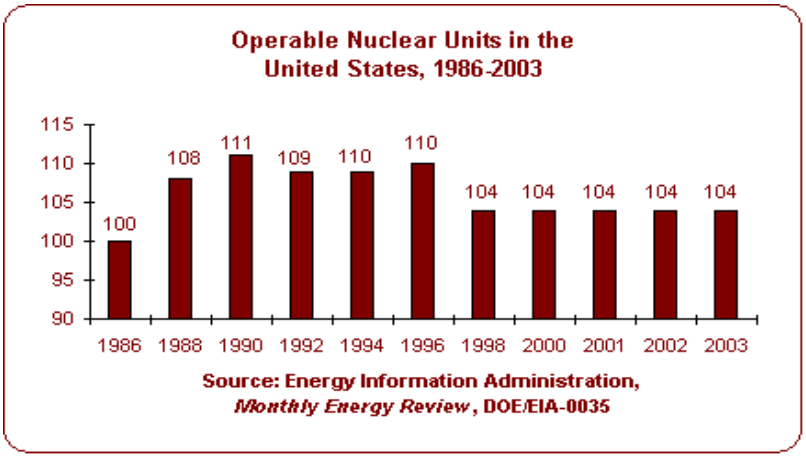
Nuclear

The burning of fossil fuels (coal, oil, and gas) has been used to generate electricity since before the turn of the twentieth century. For over three decades, however, a non-fossil fuel, uranium, also has been used to produce electricity. The first U.S. nuclear power plant went into commercial operation in 1957 at Shippingport, Pennsylvania. Since then, the use of nuclear-generated electricity has grown substantially in the United States.

The U.S. nuclear power industry achieved its fourth consecutive year of record power generation levels during 2002. Total nuclear output was 780.1 billion kilowatt hours, about 1.5 percent above the previous record of 768.8 billion kilowatt hours set in 2001. This represents continued growth in an industry that was producing less than 600 billion kilowatt hours per year prior to 1991. The record was achieved despite the fact that the total number of commercial reactors has dropped from 111 reactors (in 1990) to 104 reactors now. The record was attained through increased use of existing nuclear capacity. The estimated annual net capacity factor was 90.7 percent during 2002 compared to 89.4 percent in 2001 and 66 percent in 1990.



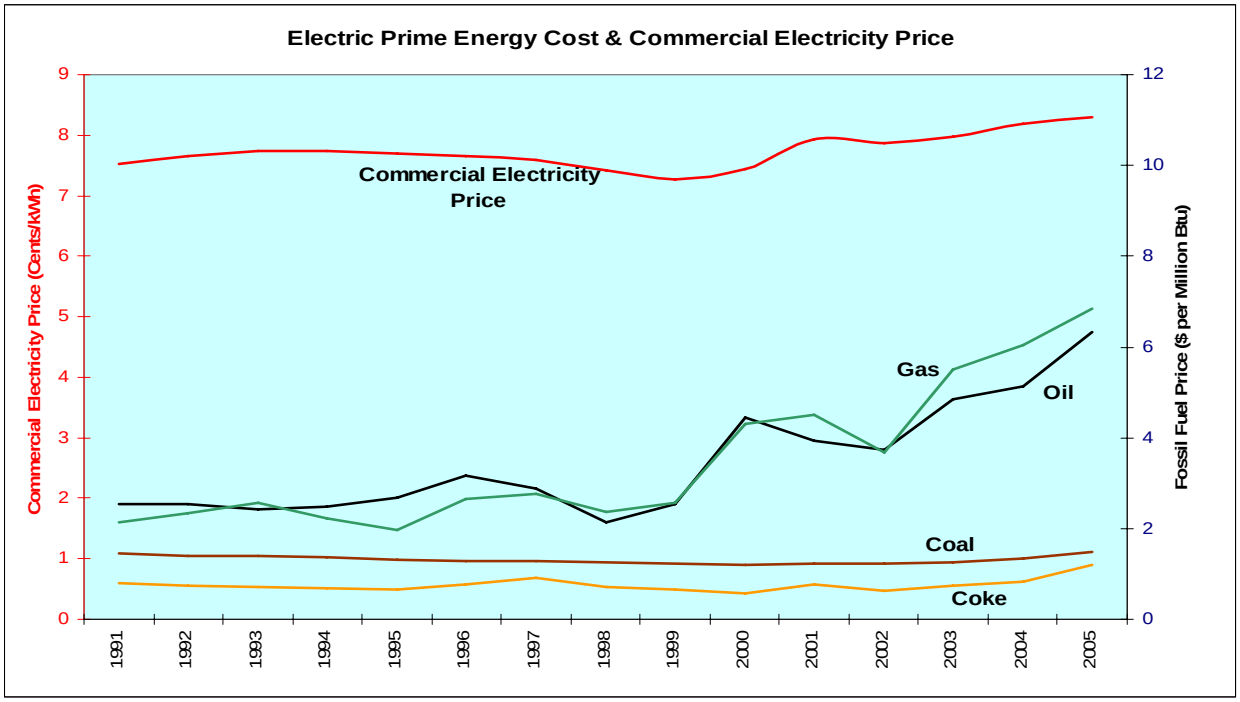
The United States has 98.2 million kilowatts of nuclear capacity, more than any other nation in the world. France ranks second, third is Japan, and fourth is Germany. International growth in commercial nuclear power has slowed, but several countries have ambitious nuclear construction programs. While no nuclear reactors have been ordered in the United States since 1978, China, India, Russia, and South Korea and other countries have brought new reactors into service during the current century.



National Energy Price Trends

In the early 1900s, coal was the Nation's major fuel source, supplying almost 90 percent of its energy needs. Later, coal's importance declined, mainly because petroleum and natural gas were cleaner, more cost effective, and more efficient. However, at the present time, coal is the primary source used for electricity generation because it is now far cheaper than other fossil fuels, and because it is also more abundant in the United States than any other fossil fuel. In 2000, coal receipts by the electric power industry totaled a record 983 million short tons. Of the total coal consumed in the United States, 91 percent was used for generating electricity -- accounting for over half of the total electricity produced.

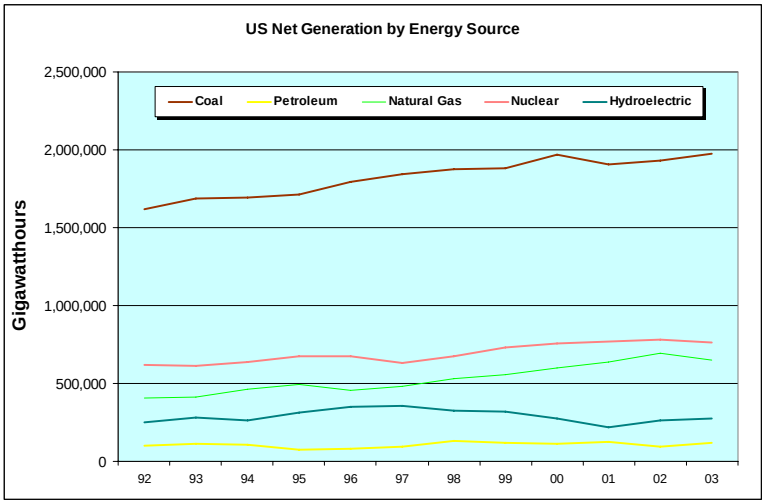
During the early 1970s, natural gas was the least expensive fuel used to generate electricity. In 1970 electric utilities paid on the average, about 28 cents per million Btu of natural gas, 31 cents per million Btu of coal, and 42 cents per million Btu of petroleum. Since 1976, however, coal has been the least expensive fossil fuel used to generate electricity. In 1999, on a dollars-per-million-Btu basis, natural gas was the most expensive fossil fuel ($2.59), petroleum was second ($2.56), and coal was least expensive ($1.22). Although, these figures show that the cost of generating electricity from coal has increased significantly, it is still lower than the cost of generating electricity from either natural gas or petroleum. The average price for coal delivered to electric utilities was $24.28 per short ton in 2000, with the spot-market price being only slightly higher at $24.85.



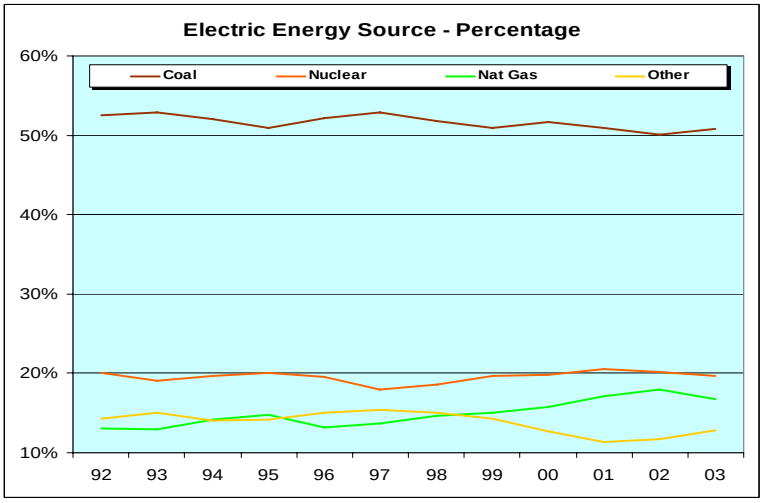
Source Energy

Coal continues to be the predominant energy source for electricity while use of natural gas for electric generation has steadily grown and is expected to continue to grow through the next decade.

Total electricity generated from natural gas rose by 61% while coal was up by 22%, nuclear by 23% and hydroelectric by 9% over the 12 years studied.

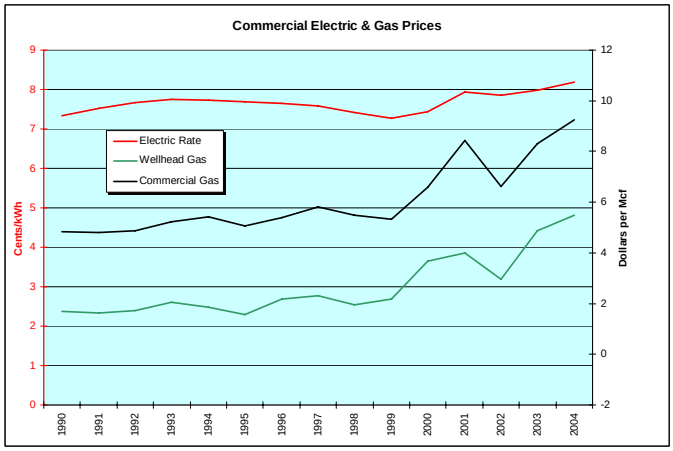


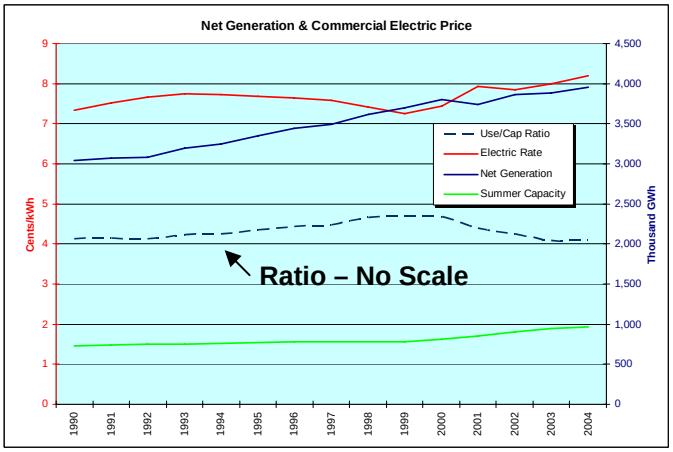
Coal and Nuclear have maintained their share of generation of 51% and 20% respectively while the share of electricity produced by Natural Gas grew from 13% to 18% in the same period for a 38% increase.



Electricity & Natural Gas

Electric costs have been rising since 1999 but at a slower pace than natural gas. Both have continued their upward trend through the three quarters of 2005.

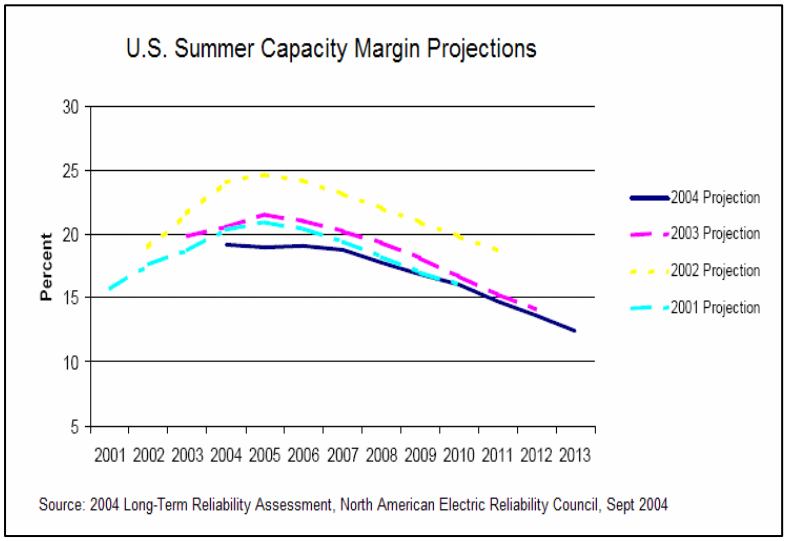




Generating Capacity

The use/capacity ratio has lowered in the last number of years as new generation capacity has been added.

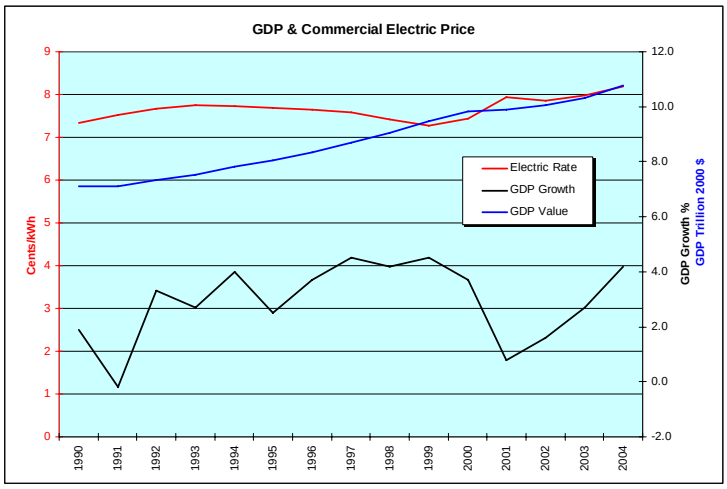
A lot of new capacity is gas fired which causes the price of electricity to increase



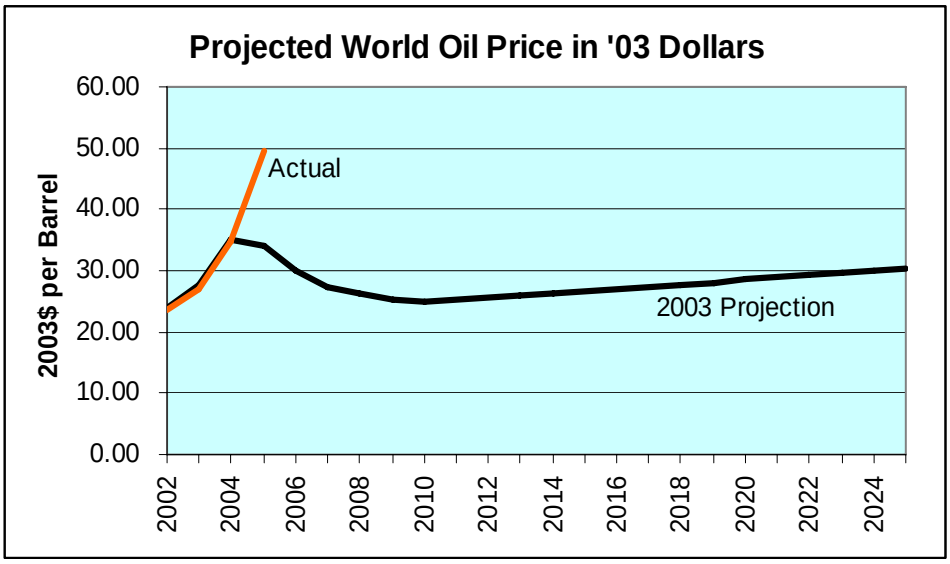
The US Capacity Margin – the amount of spare generation capacity on a peak load day has been growing with the completion of many new plants that were planned in the late '90's. There are few plants currently being planned resulting in the projection of a considerable decline in capacity margin.

GDP Growth

GDP growth has been variable but positive over the last 15 years. A slowdown in the economy and increase in energy prices were evident in 2000/2001.



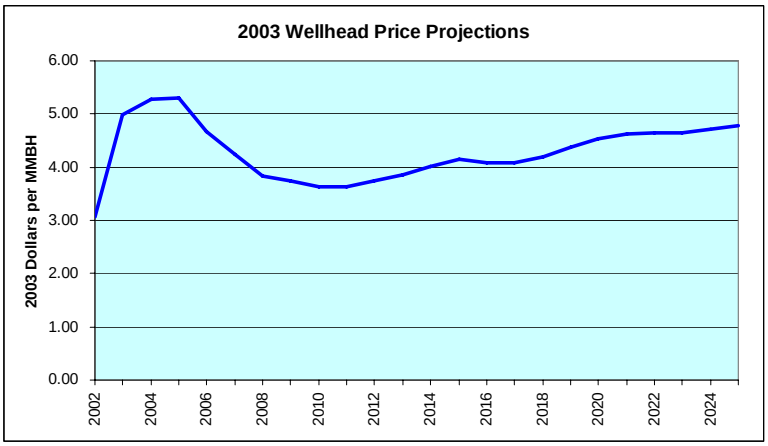
Future Trends

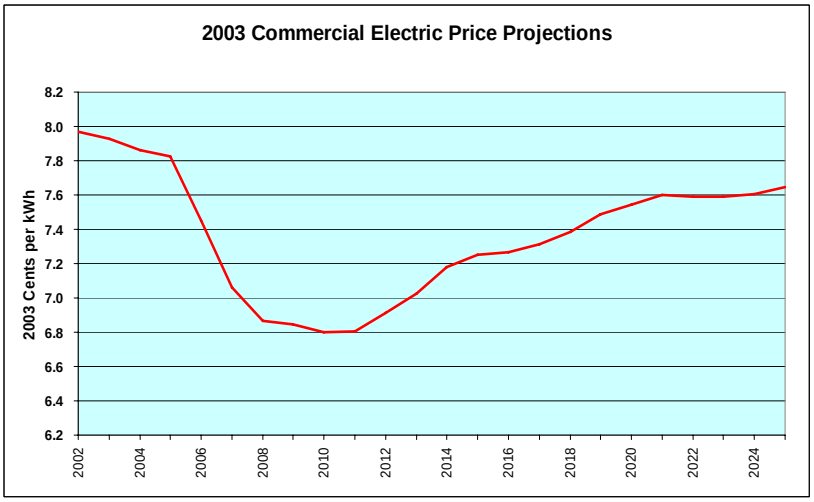


The latest EIA projections available are from the 2003 assessment which is based on 2002 data. At that time gas prices were rising but expected to stabilize and electric costs were stable and projected to drop.

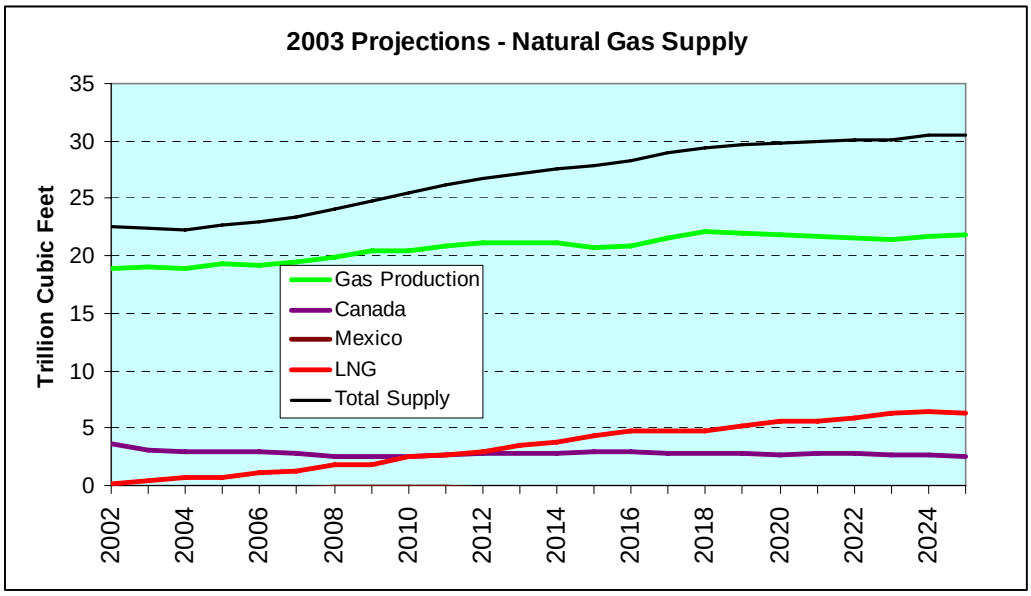
In the interval much of the planned additional capacity was cancelled while demand has grown slowly. Gas and Oil prices continued to increase at a rapid rate through the first three quarters of 2005. Electric costs did not come down as predicted but have also continued to rise nationally while having wide local variances. The assumptions based on planned capacity increases have not come true and so the capacity margin is expected to lower more rapidly than projected in 2003.

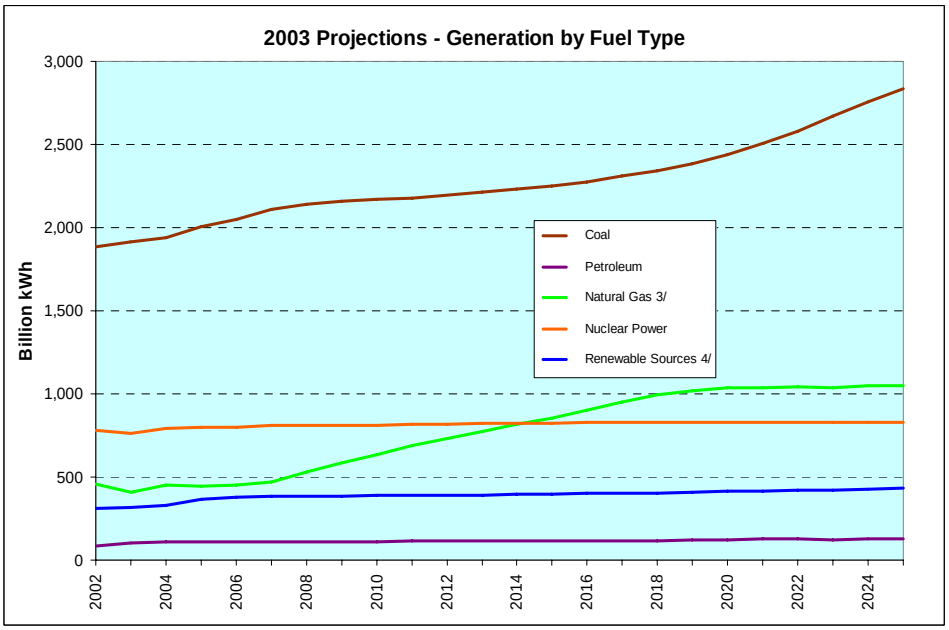
Since the 2003 projections are no longer valid we will not review this data in depth.





While projected pricing trends have not met expectations there has been continued growth in electricity use as had been predicted. The continued growth in electricity demand and the resultant efforts to fuel that need will have a large impact on future gas and electric pricing trends. EIA's 2003 projections were for coal and natural gas to meet most of the additional demand growth. LNG imported from overseas would provide most of the additional gas supply.

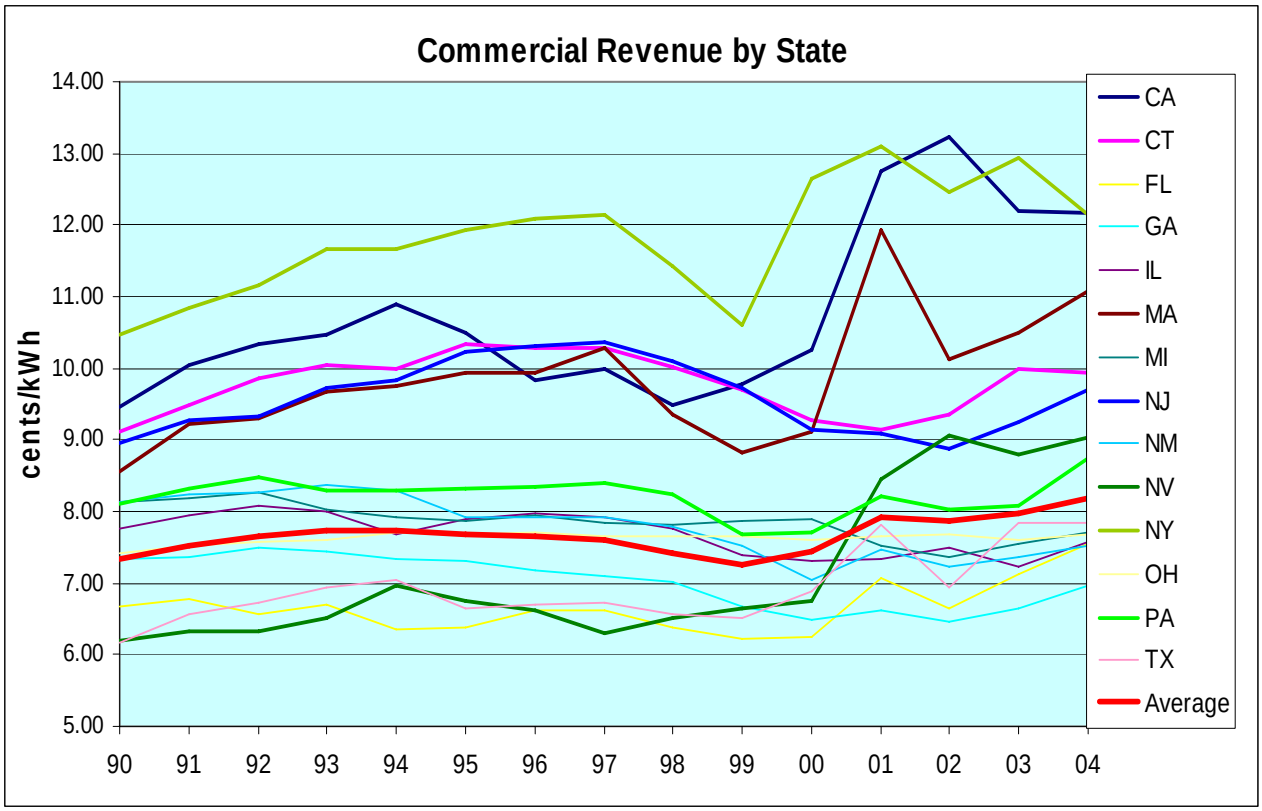




State Utility Pricing Trends

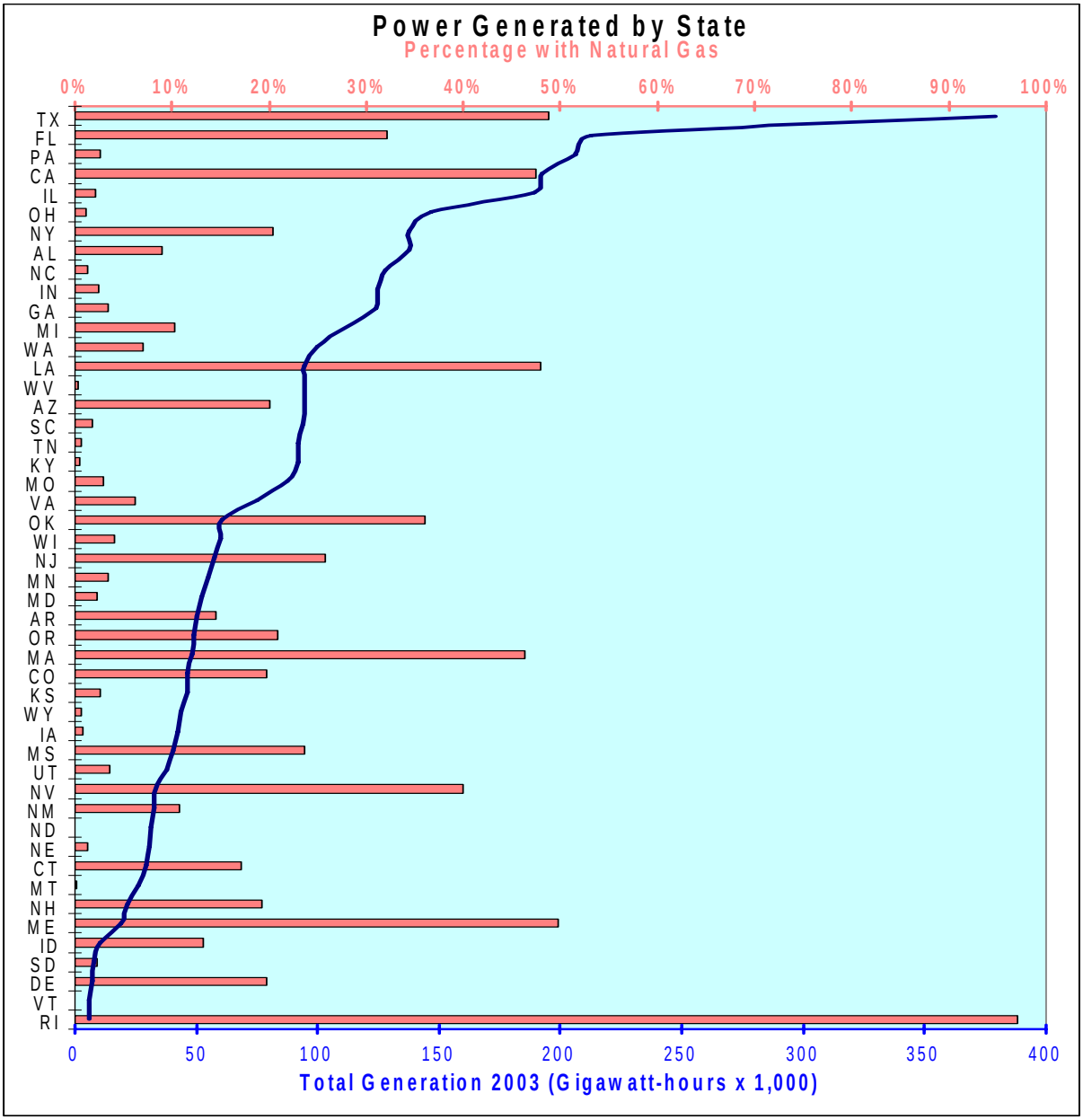
While rates differ from utility to utility, the average state cost gives a clear indication of the high cost regions. The rate costs are based on EIA commercial buildings revenue divided by kilowatt-hours consumed. California, New York and Massachusetts are the most expensive states for commercial electricity. New York and Massachusetts are somewhat distorted due to the high concentration of population in one area. Individual state price charts are given in the State Report.

Low cost states are typically linked to a large coal source for generation and have sufficient transmission and distribution capability. Higher cost states generally have dense populations, an old T&D infrastructure and lower NO_X and CO_2 emissions requirements.



The following chart shows share of electricity generated with gas and the total in-state electricity generated. Electricity exporting states using a lot of natural gas like Texas and Louisiana will not see local price increases if gas prices rise. Pennsylvania will be unaffected by rising gas prices as it primarily uses coal. Florida consumes most of its own generation output which is over 30% natural gas causing the local price to increase relative to the national average.

The percentage of electric power generated from gas varies widely and can be influenced by other than environmental reasons. In gulf coast states like Texas and Louisiana there are a lot of gas fired merchant plants supplying electricity to the interstate transmission lines. Other states have little in-state generation and import coal based electricity to keep costs low or have a very small market that is easily distorted by a few plants. The total kWh generated in Rhode Island during 2004 was less than ¼ of one per cent of total generated in the US or the equivalent of a single 750 MW plant.



2004 State Electric Pricing

The following table lists the average electric revenue per kWh for residential, commercial and industrial customers by state. Typically the spread between rates is a reflection of local politics and the relative size and influence of the group. In states such as California the commercial rate exceeds the residential and industrial rates. In New Hampshire the spreads are close where as in Texas industrial customers have much lower rates than others.

State	Avg Revenue All Sectors (¢/KwH)	Avg Revenue Residential (¢/KwH)	Avg Revenue Commercial (¢/KwH)	Avg Revenue Industrial (¢/KwH)	State	Avg Revenue All Sectors (¢/KwH)	Avg Revenue Residential (¢/KwH)	Avg Revenue Commercial (¢/KwH)	Avg Revenue Industrial (¢/KwH)
AK	10.83	12.41	10.71	8.15	MT	6.09	7.85	7.17	4.15
AL	6.13	7.60	7.17	4.25	NC	7.00	8.48	6.76	4.90
AR	5.79	7.47	5.85	4.21	ND	5.79	6.83	6.14	4.21
AZ	7.62	8.52	7.51	5.52	NE	5.70	7.00	5.89	4.27
CA	11.31	11.77	12.18	8.60	NH	11.41	12.57	11.02	10.02
CO	6.99	8.39	6.89	5.28	NJ	10.16	11.35	9.71	8.72
CT	10.40	11.79	9.93	8.22	NM	7.22	8.84	7.53	5.13
DC	7.41	8.25	7.46	5.47	NV	8.59	9.67	9.05	7.34
DE	7.29	8.83	7.57	4.98	NY	11.99	14.60	12.14	6.22
FL	8.13	8.96	7.55	5.87	OH	6.83	8.52	7.69	4.76
GA	6.67	8.02	6.95	4.42	OK	6.58	7.75	6.69	4.73
HI	15.61	17.89	16.33	13.15	OR	6.08	7.12	6.39	4.27
IA	6.49	9.08	6.84	4.41	PA	8.11	9.70	8.75	5.86
ID	4.97	6.11	5.36	3.86	RI	10.83	12.07	10.67	8.48
IL	6.94	8.60	7.56	4.73	SC	6.22	8.08	6.96	4.14
IN	5.59	7.35	6.30	4.14	SD	6.63	7.69	6.66	4.63
KS	6.47	7.88	6.66	4.61	TN	6.14	6.88	7.03	4.51
KY	4.60	6.08	5.59	3.32	TX	7.76	9.62	7.84	5.55
LA	7.13	8.09	7.53	5.80	UT	5.76	7.27	5.95	4.12
MA	10.83	11.80	11.07	8.45	VA	6.46	8.05	5.89	4.30
MD	7.15	8.05	9.00	4.53	VT	11.09	13.12	11.45	7.91
ME	9.43	12.64	11.20	3.48	WA	5.56	6.36	6.02	3.85
MI	7.04	8.56	7.71	4.88	WI	6.90	9.13	7.25	4.92
MN	6.30	8.07	6.35	4.68	WV	5.13	6.25	5.47	3.84
MO	6.11	7.15	5.91	4.45	WY	4.96	7.14	6.03	3.90
MS	7.00	8.19	7.92	4.82	US	7.59	8.97	8.20	5.12

State Interconnection Policy

The following chart indicates the existence of interconnection standards and which agency has them. This information is taken from an October 2003 report on CHP activities conducted by ACEEE for DOE. There are currently 26 states with some type of interconnection standards for on-site generation either completed or in progress.

P = Public Utility Commission, U = Utility, S = State

State	Agency	Status
AZ	P/U	PUC standards are in progress
AK	P	
CA	S	
CT	P/U	PUC standards are in progress
DE	P/U	Offers standards on a limited size
FL	S/U	Offers standards on a limited size
GA	S/U	Offers standards on a limited size
HI	U	
IL	P/U	PUC standards are in progress
IN	P/U	PUC standards are in progress
KY	P/U	Offers standards on a limited size
ME	P/U	PUC standards are in progress
MA	P/U	PUC standards are in progress
MI	S	
MN	P/U	PUC standards are in progress
NH	U	
NM	P/U	PUC standards are in progress on a limited size
NY	P	
NC	U	
ND	U	
OH	P	
PA	P	
TX	P	
VA	P/U	PUC standards are in progress
WV	P	
WI	P/U	PUC standards are in progress