



Sector Profiles of Significant Large CHP Markets

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Large CHP Sector Profiles

- EEA conducted a market assessment of the 2-50 MW combined heat and power (CHP) market and near-term opportunities for a fixed set of CHP technologies. This size range has been the biggest contributor to the traditional inside-the-fence CHP market to date. Opportunities still exist and a current understanding of the remaining prospects will help focus efforts that can accelerate near-term markets.
- The assessment utilized the IHS Energy Major Industrial Plant Database (MIPD) and Commercial Energy Profile Database (CEPD). The databases contain energy and operations data for over 160,000 large industrial and commercial facilities. The analysis considered five classes of CHP technology that are of interest to the Department of Energy (DOE) and Oak Ridge National Laboratory (ORNL):
 - Conventional Reciprocating Engine System (1MW)
 - Advanced Reciprocating Engine System (3 MW)
 - Conventional Industrial Gas Turbine System (5 MW)
 - Conventional Industrial Gas Turbine (10 MW)
 - Advanced Recuperated Gas Turbine (4.2 MW)

Large CHP Sector Profiles

- Three sectors were identified as promising sectors identified at the conclusion of market assessment.
 - Chemicals
 - Food
 - Pharmaceuticals
- The profiles are based on a literature search, review of recent CHP activity in those sectors, and telephone interviews with customer representatives in each sector.
- The profiles briefly characterize size of sector, industry trends, energy typical plant size and energy usage, historical use of CHP, growth trends, purchasing trends, geographic concentration, and potential.
- The profiles are intended to help those developing CHP projects better understand the needs and drivers of customers in these sectors.

Large CHP Sector Profiles

- All sectors have varying levels experience in CHP.
 - Chemical sector in particular is comprised of very sophisticated energy users.
 - Opportunities for non-steam CHP exist, e.g., fluid heating in the chemical sector.
- Market assessment concluded opportunities for CHP in the 2-50 MW size range remain and market is far from fully saturated.
- Recent energy price increases and natural gas price volatility are very important issues.
 - Many sites that have the potential to fuel switch.
 - Potential utilization of biomass in Food sector.
- Reliability of electric service is a growing concern.

1. Chemicals Sector

Chemicals: Sector Profile

- The chemical industry produces over 70,000 diverse products from a large number of raw materials.
- Chemicals represent 10.3% of manufacturing activity in the U.S. and 1.9% of the gross domestic product.
- There are currently over 1000 corporations involved in the chemical sector.

Top 15 U.S. Chemical Producers	
Company	2002 Sales (millions of dollars)
Dow Chemical	27,609
DuPont	26,728
ExxonMobil	16,408
General Electric	7,651
Huntsman Corp.	7,200
PPG Industries	5,996
Equistar Chemicals	5,537
Chevron Phillips	5,473
Eastman Chemical	5,320
Praair	5,128
Air Products	5,125
Rohm and Haas	5,021
Lyondell Chemical	3,262
Honeywell	3,205
Monsanto	3,088

Organic and Inorganic Chemicals: Primary Sub-sectors

Organic Chemicals

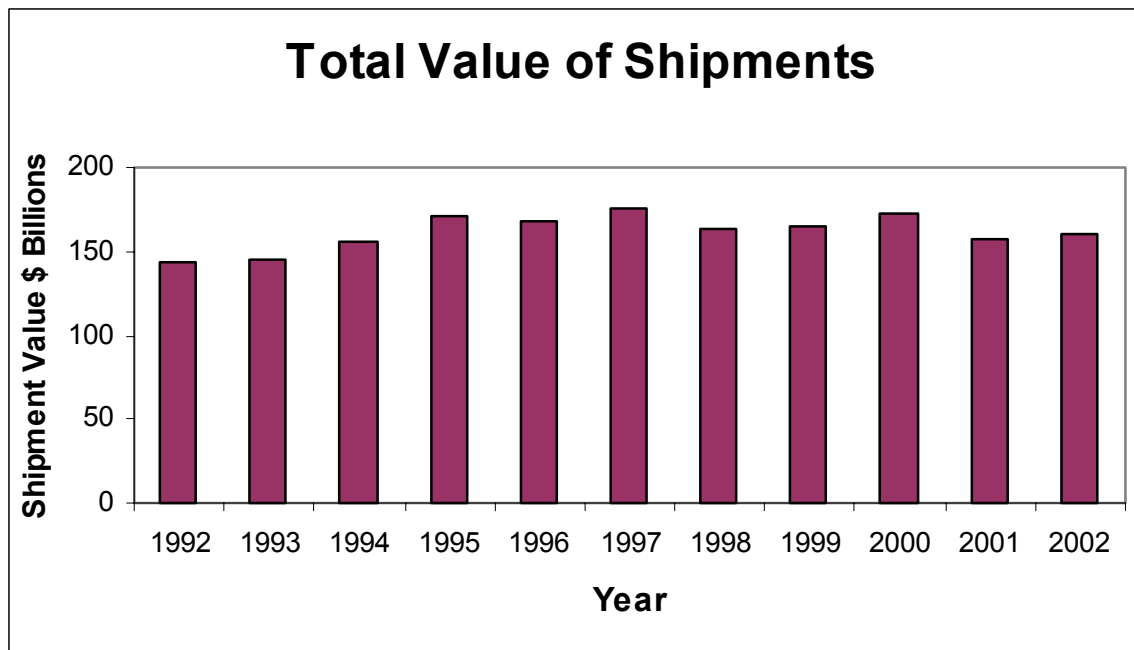
1987 SIC	SIC Description	1997 NAICS	NAICS Description
2861	Gum & wood chemicals	325191	Gum & wood chemical mfg
2865	Cyclic crudes & intermediates	325110	Petrochemical mfg
		325132	Synthetic organic dye & pigment mfg
		325192	Cyclic crude & intermediate mfg
2869	Industrial organic chemicals	325120	Industrial gas mfg
		325193	Ethyl alcohol mfg
		325199	All other basic organic chemical mfg

Inorganic Chemicals

1987 SIC	SIC Description	1997 NAICS	NAICS Description
2812	Alkalies and Chlorine	325181	Alkalies and Chlorine mfg
2813	Industrial gases	32512	Industrial gas mfg
2816	Inorganic Pigments	325131	Inorganic dye and pigment mfg
		325182	Carbon black mfg
2819	Industrial inorganic chemicals	211112	Recovering sulfur from natural gas
		325998	Misc chemical product mfg
		331311	Alumina Refining
		325188	All other inorganic chemical mfg

Value of Basic Chemical Shipments

- Both the organic and inorganic sectors posted trade deficits in 2002.
 - Organic trade deficit: \$13.5 billion
 - Inorganic trade deficit: \$461 million
- Exports have increased slightly (1%) but imports have gone down by 8%.

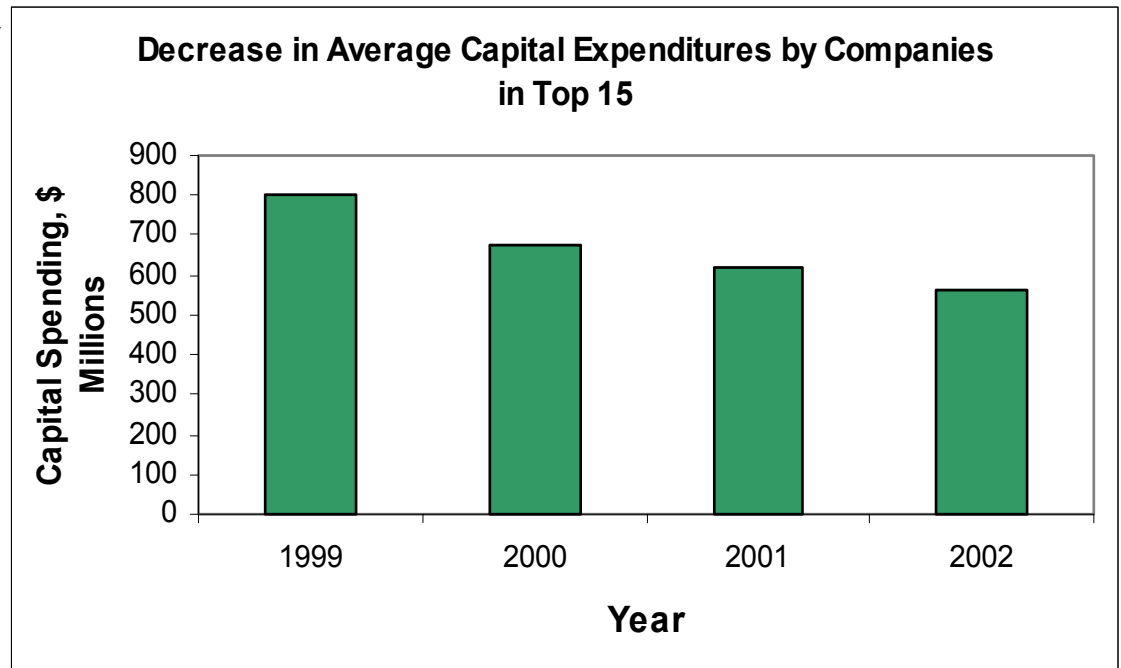


Source: Chemical and Engineering News

The total value of shipments for organic and inorganic chemicals has remained fairly level over the past decade.

Trend in Capital Expenditures

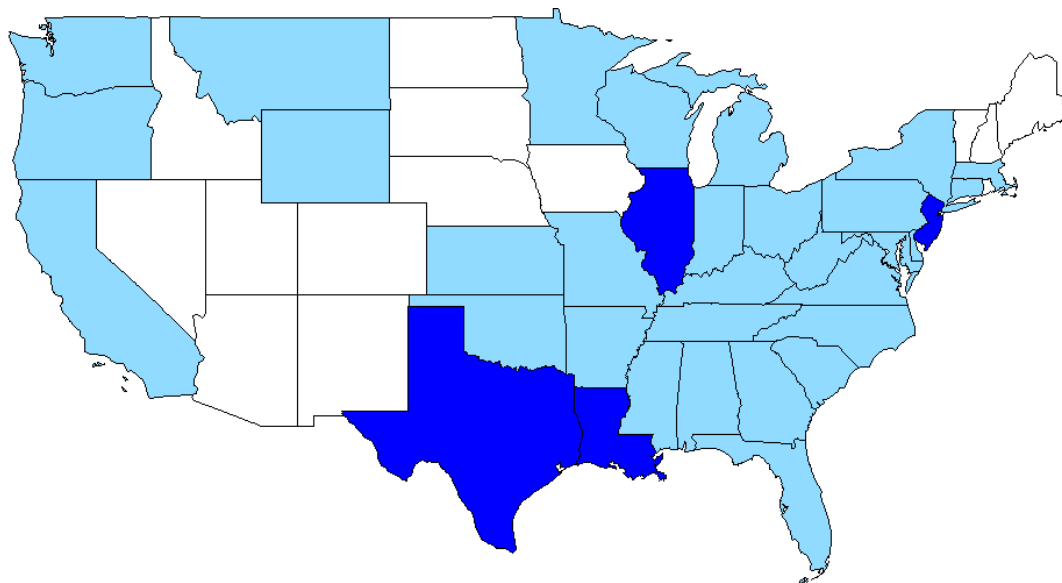
- Most chemical companies have steadily decreased their capital expenditures over the past four years.
- Dow, Chevron-Phillips, and Eastman Chemical are the only companies in the top 10 to increase capital spending.




Location of Large Organic Chemical Plants*


State	# Sites
AL	3
AR	3
CA	6
CT	1
DE	2
FL	3
GA	6
IL	13
IN	2
KS	1
KY	6
LA	22
MA	2
MD	1
MI	7
MN	5

MO	5
MS	2
MT	1
NC	5
NJ	13
NY	8
OH	7
OK	1
OR	2
PA	9
SC	6
TN	7
TX	55
VA	2
WA	2
WI	2
WV	5
WY	1
Total	216



*Source: MIPD

 < 10 Sites

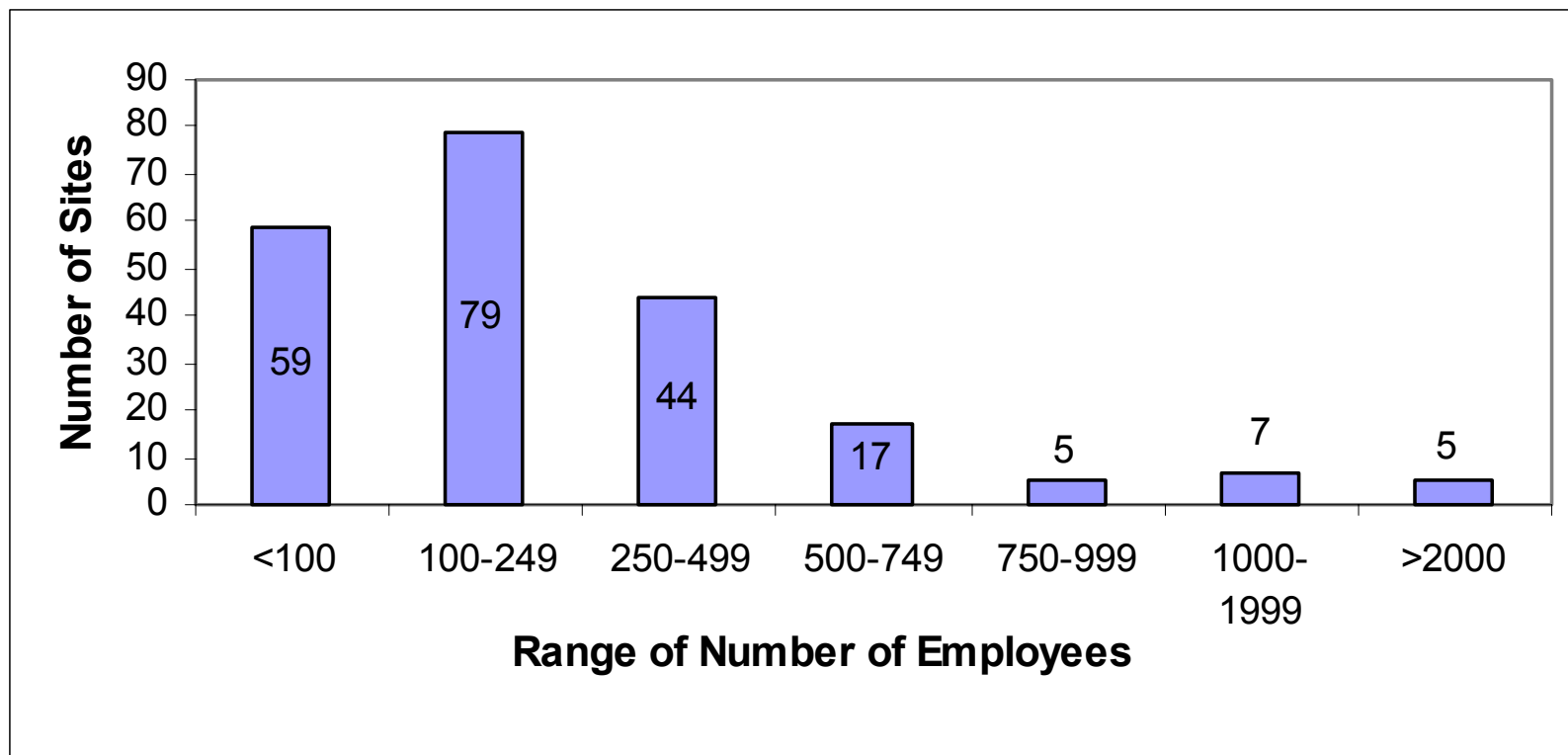
 > 10 Sites

Typical Organic Chemical Site Statistics

Site Statistics	Mean	Median
Employees	324	168
Plant Hours per Yr	8,024	8,736
Shipments	220,711	111,696
Steam Draw (lbs/hr)	154,259	30,000
Ele c Demand (kW)	18,212	2,488
Ele c Price (\$)	0.0566	0.0529

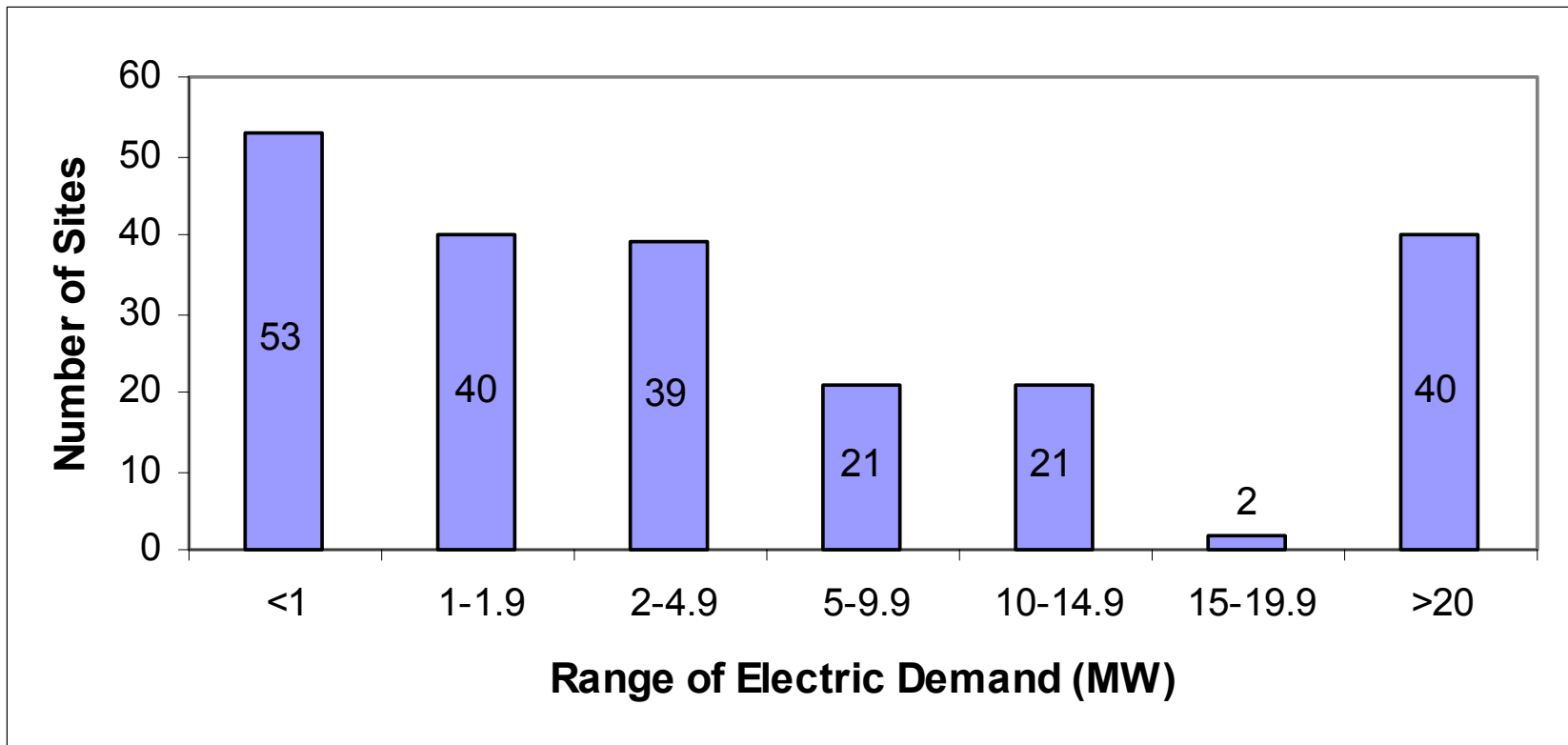
- There are 216 organic chemical sites in the Major Industrial Plant Database (MIPD) where these statistics were calculated from.
- 27 sites generate some electricity on site.
- 16 of the 27 are listed as CHP sites.

Distribution of Organic Chemical Sites by Number of Employees

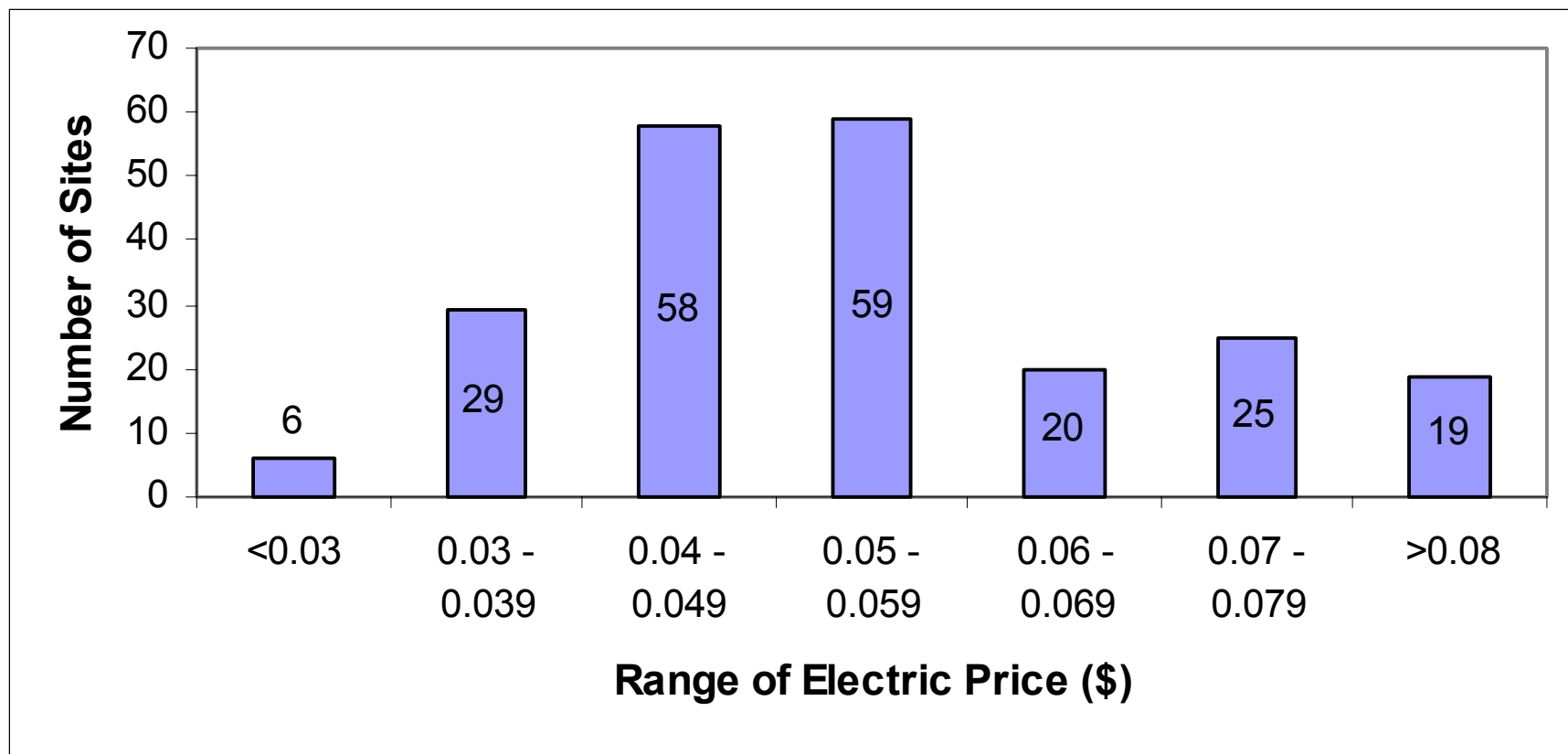


Employment in this sector has continued to fall over the past two years.

Distribution of Organic Chemical Sites by Electric Demand in MW



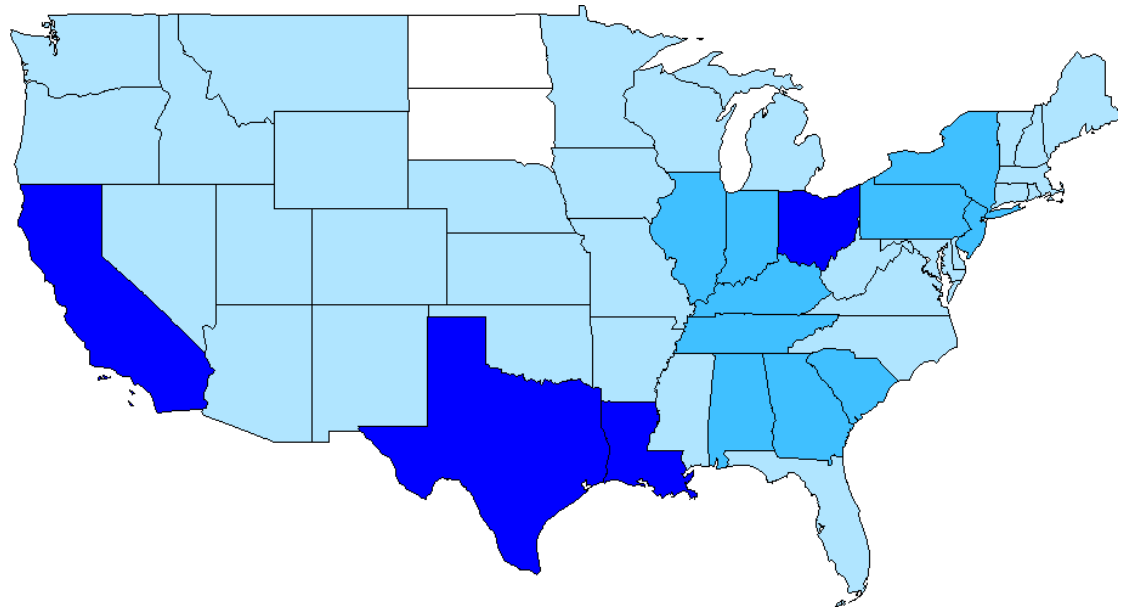
Distribution of Organic Chemical Sites by Electric Price per kWh



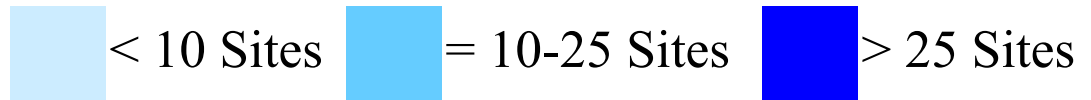
Location of Large Inorganic Chemical Plants*

State	# Sites
AK	2
AL	11
AR	6
AZ	2
CA	34
CO	3
CT	2
DE	2
FL	3
GA	15
HI	2
IA	4
ID	2
IL	17
IN	11
KS	4
KY	10
LA	31
MA	3
MD	9
ME	1
MI	8

MN	2
MO	8
MS	3
MT	3
NC	7
NE	1
NH	2
NJ	10
NM	1
NV	2
NY	13
OH	28
OK	5
OR	1
PA	18
RI	1
SC	11
TN	13
TX	49
UT	6
VA	7
VT	1
WA	8
WI	4
WV	8
WY	6
Total	400



*Source: MIPD

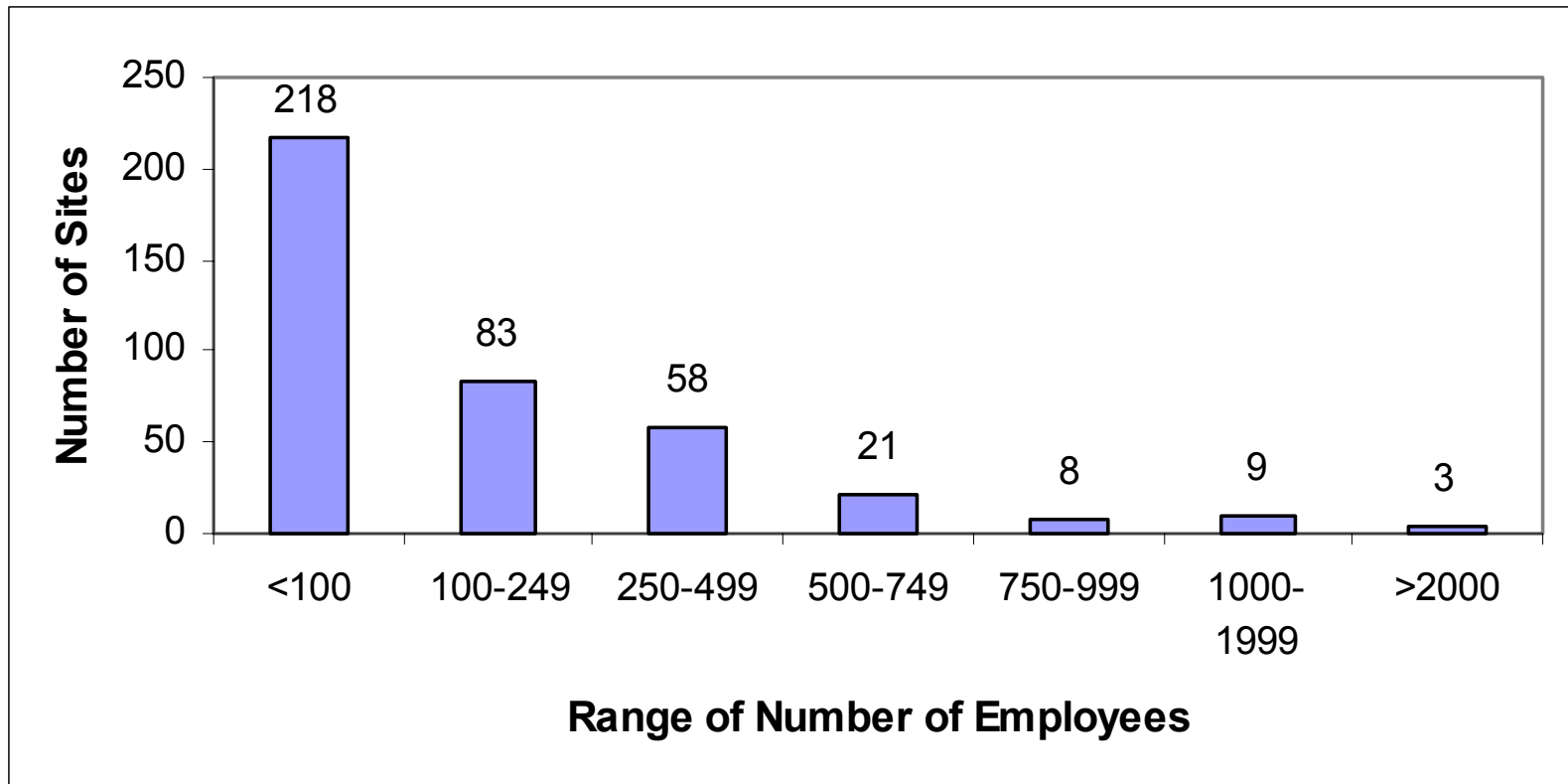


Typical Inorganic Chemical Site Statistics

Site Statistics	Me a n	Me dia n
Emp lo y e e s	268	80
Pl a n t H o u r s p e r Y r	7,826	8,736
S h i p m e n t s	1,527,064	23,895
S t e a m D r a w (l b s / h r)	84,844	1,197
Ele c D e m a n d (kW)	18,017	2,931
Ele c P r i c e (\$)	0.0560	0.0523

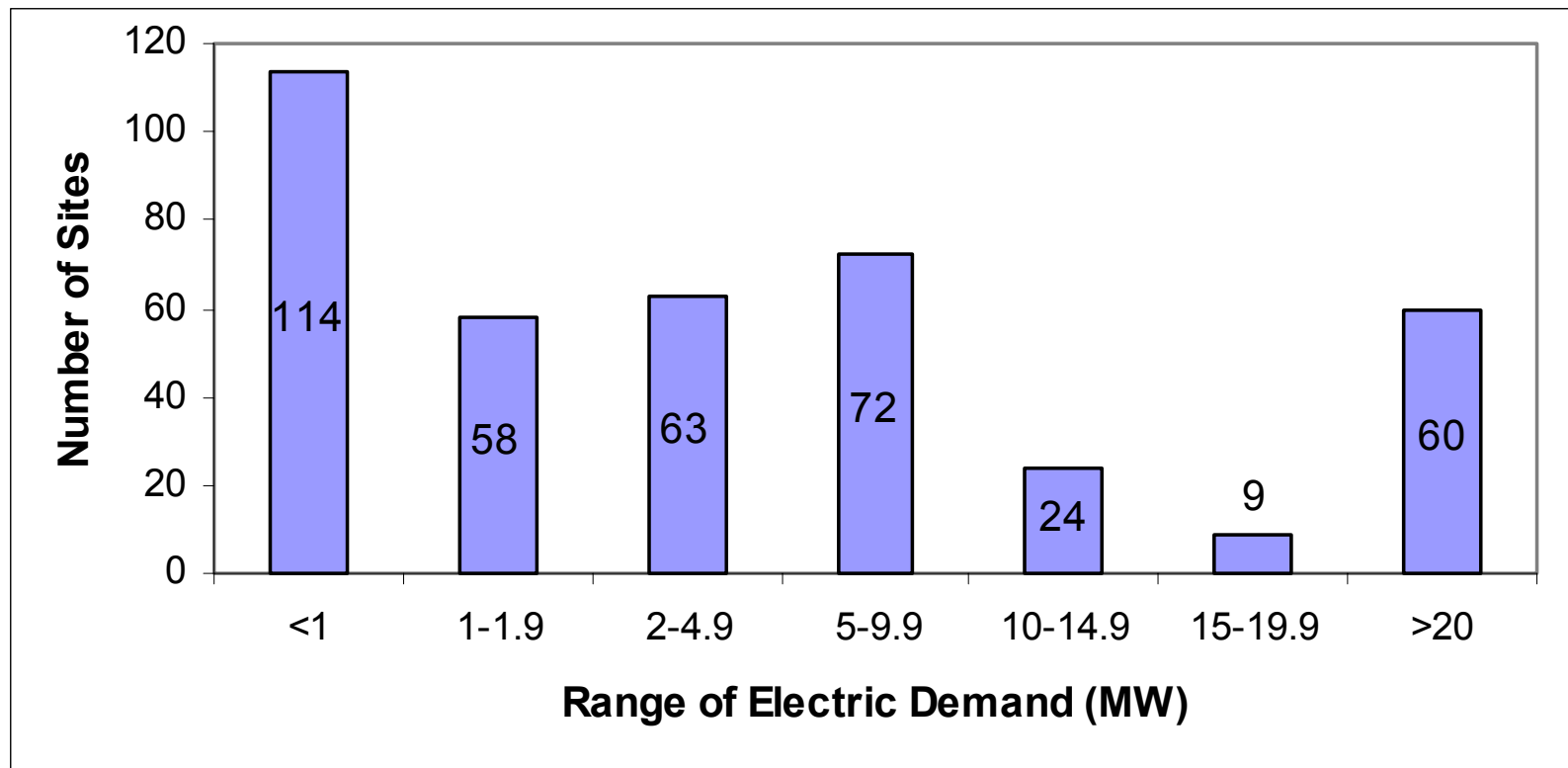
- There are 400 inorganic chemical sites in the Major Industrial Plant Database (MIPD) where these statistics were calculated from.
- 26 sites generate some electricity on site.
- 14 of the 26 are listed as CHP sites.

Distribution of Inorganic Chemical Sites by Number of Employees

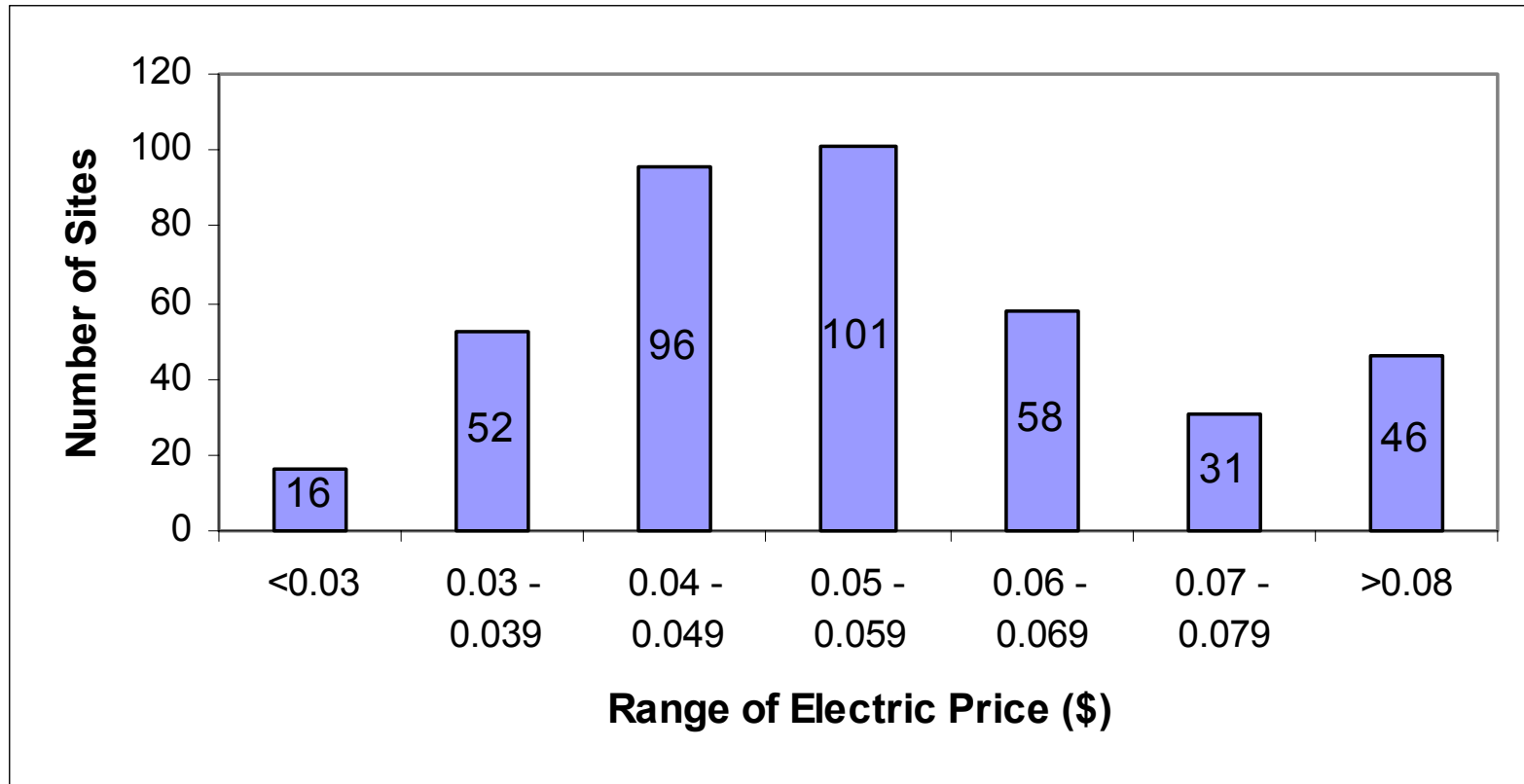


Employment in this sector has continued to decline in the past two years.

Distribution of Inorganic Chemical Sites by Electric Demand in MW



Distribution of Inorganic Chemical Sites by Electric Price per kWh



Chemical Industry Issues

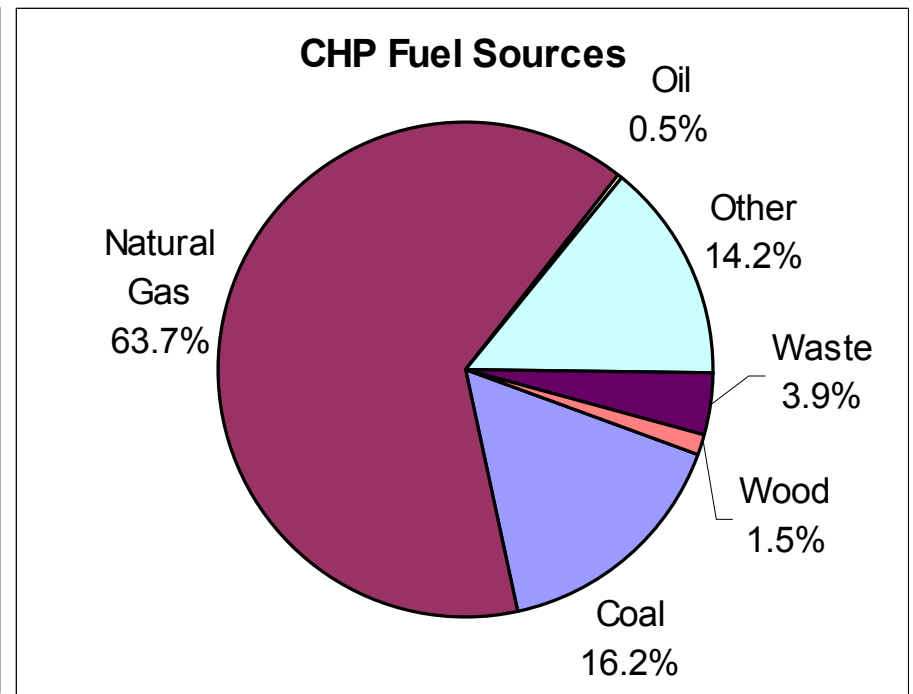
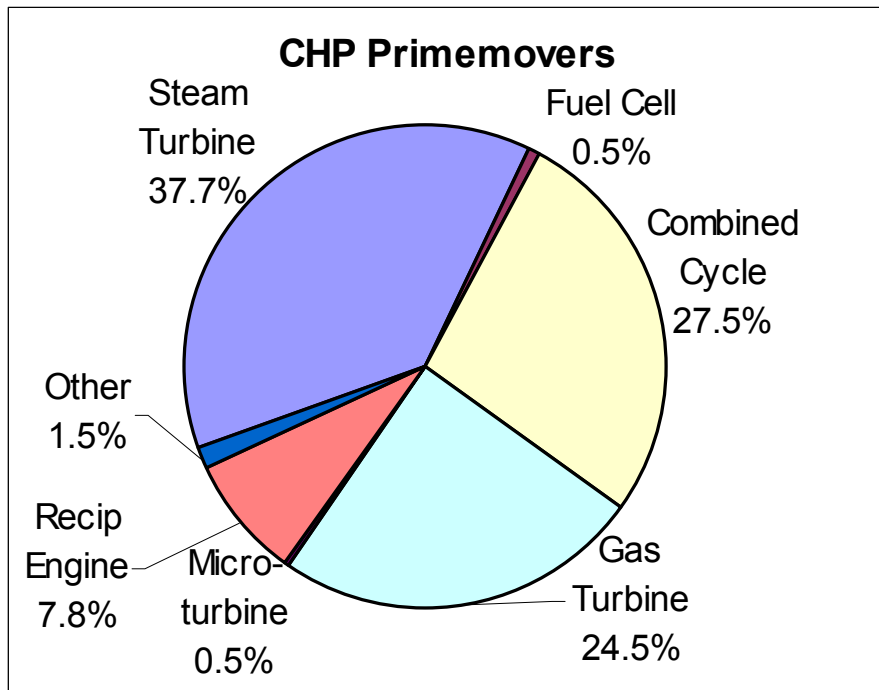
- Financial progress being made in the chemical industry is due more to cost-cutting techniques than to increased output or sales.
 - Most companies are cutting research and development as well as capital spending to save money.
- Chemical industry growth overseas, particularly in Asia, the Middle East, and Latin America, is leading to increased competition and lower exports.
- Raw material costs are increasing and fuel costs are climbing due to the high price of oil.
- Companies are shifting to producing more specific products rather than an array of items from different sub-sectors.
- There is a considerable amount of consolidation.
 - In 1999, there were \$45 billion in mergers and acquisitions.

Combined Heat and Power in the Chemical Industry

Chemical Subsectors	# Sites	Capacity (MW)	Mean Site Capacity	Median Site Capacity
SIC 2810 Inorganic Chemicals	56	5,156.2	92,075	41,600
SIC 2820 Plastics	24	2,271.6	2,822	2,821
SIC 2860 Organic Chemicals	10	970.1	2,867	2,869
SIC 2870 Fertilizers	22	890.3	2,872	2,870
SIC 2800 Chemical (sub-sector unknown)	92	14,051.6	152,735	36,715
Total	204	23,339.8		

Source: EEA CHP database

Breakdown of CHP Sites by Primemover and Fuel Source

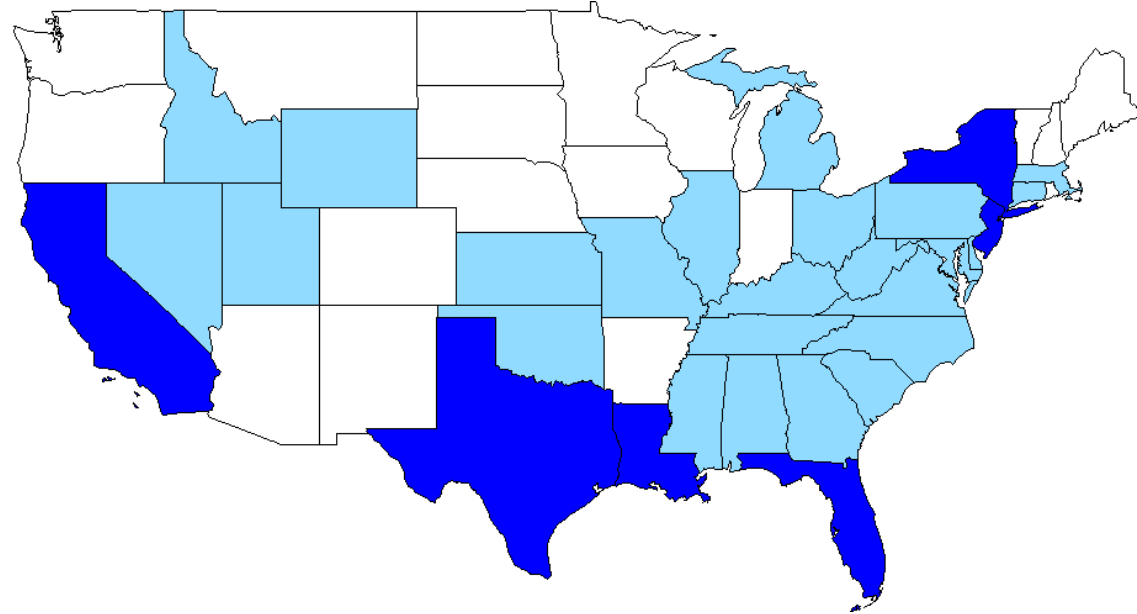


Source: EEA CHP database

Location of CHP Chemical Sites

State	# Sites
AK	2
AL	4
CA	15
CT	1
DE	1
FL	19
GA	1
HI	1
ID	1
IL	3
KS	1
KY	1
LA	25
MA	5
MD	2
MI	5
MO	1

MS	1
NC	5
NJ	14
NV	2
NY	10
OH	3
OK	2
PA	5
SC	2
TN	7
TX	51
UT	2
VA	7
WV	3
WY	2
Total	204



Source: EEA CHP database



2. Food Sector

Food: Sector Profile

- US food processing accounts for 26% of food processing output of the world.
- There are over 10,000 food processing facilities in US.
- Includes SIC 20 and NAICS 311.

Primary Subsectors

Fruit and Vegetables

Meat, Poultry, and Seafood

Beverage and Bottling

Dairy Operations

Major Companies

Campbell Soup

H.J. Heinz company

Dean Foods

Schreiber Foods

Mid-American Dairy men

Anheuser Bush

Philip Morris

Adolf Coors

The Coca-Cola Company

Pepsico

Tyson Foods

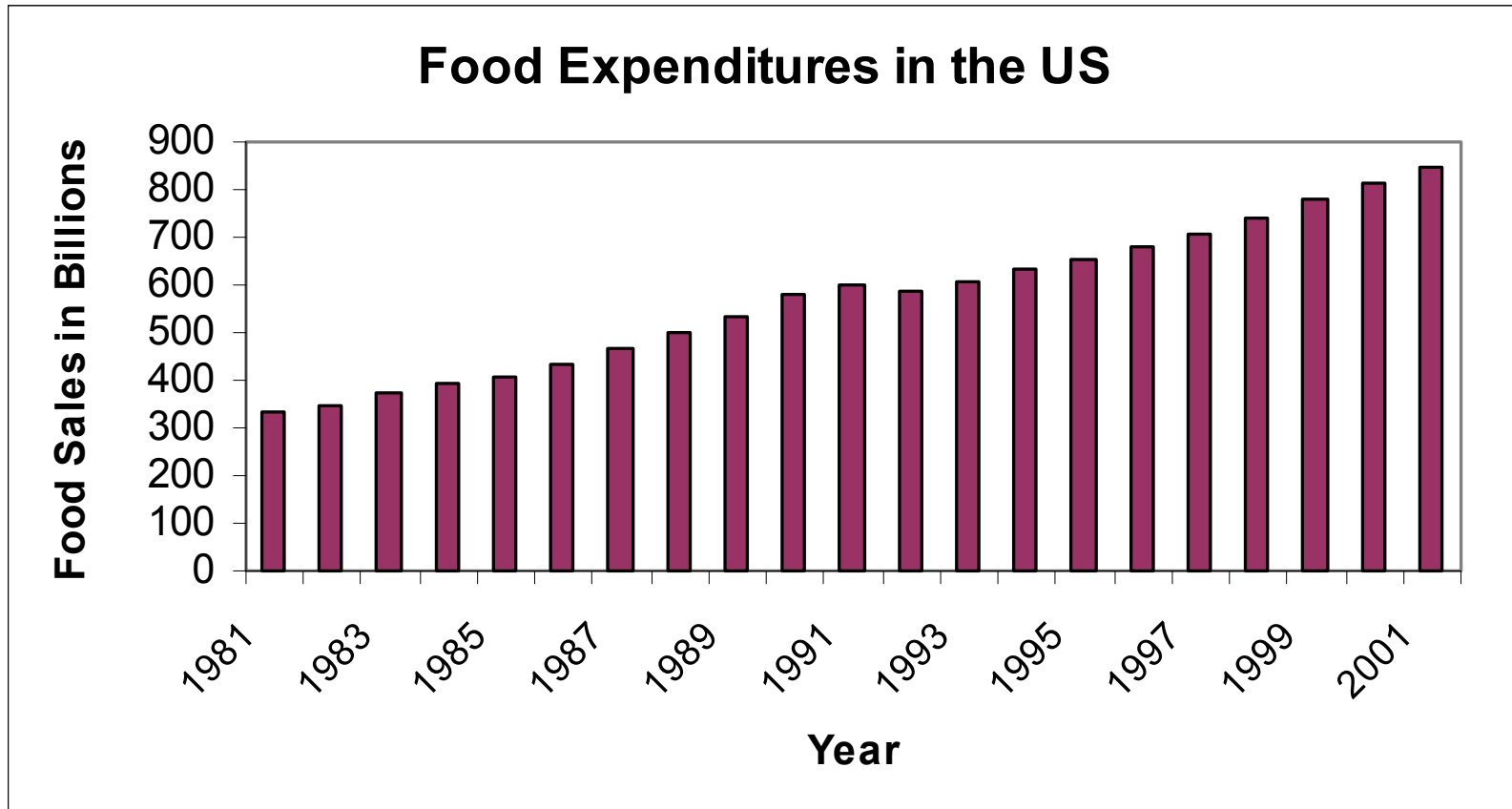
Nestle USA

RJR Nabisco

Con Agra

IBP Inc.

Growth in U.S. Food Sales

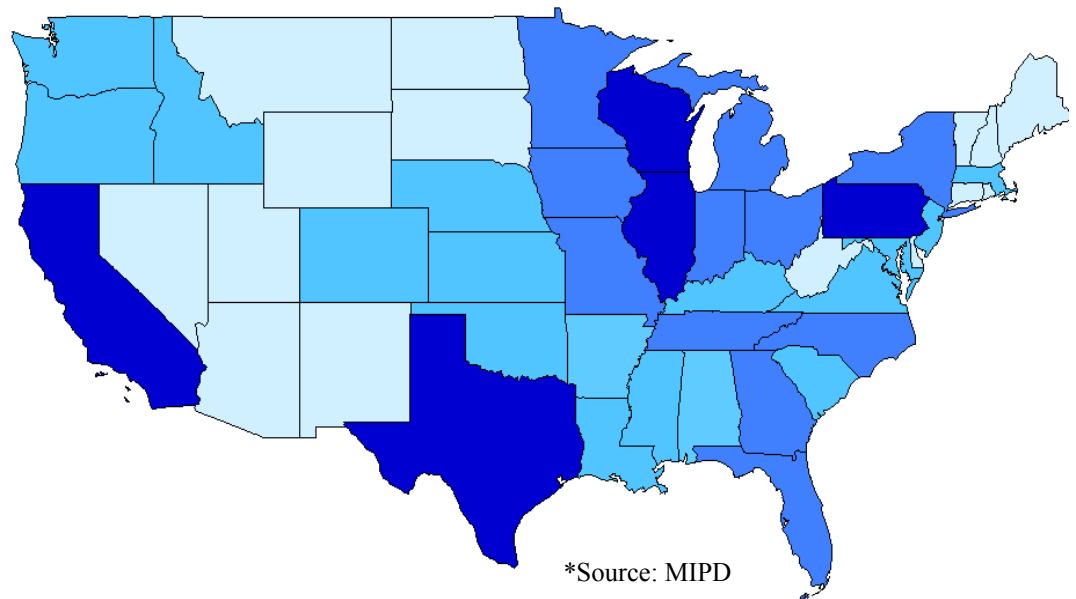


Source: US Bancorp

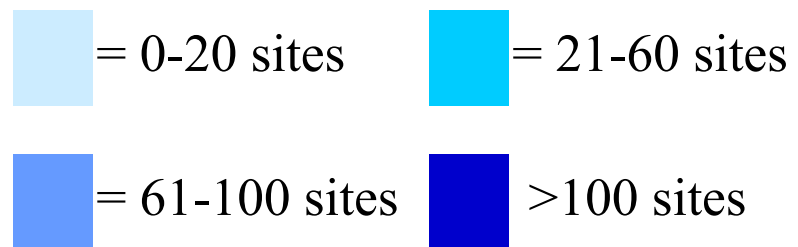
Location of Large Food Processing Plants*

State	# of Sites
AK	5
AL	50
AR	57
AZ	11
CA	202
CO	23
CT	16
DE	11
FL	71
GA	92
HI	12
IA	72
ID	22
IL	144
IN	69
KS	45
KY	42
LA	37
MA	29
MD	29
ME	6
MI	61
MN	95
MO	61
MS	29
MT	5

NC	69
ND	9
NE	28
NH	4
NJ	40
NM	2
NV	1
NY	94
OH	91
OK	28
OR	42
PA	119
RI	2
SC	22
SD	8
TN	68
TX	131
UT	16
VA	46
VT	2
WA	40
WI	115
WV	6
WY	2
Total	2281



*Source: MIPD

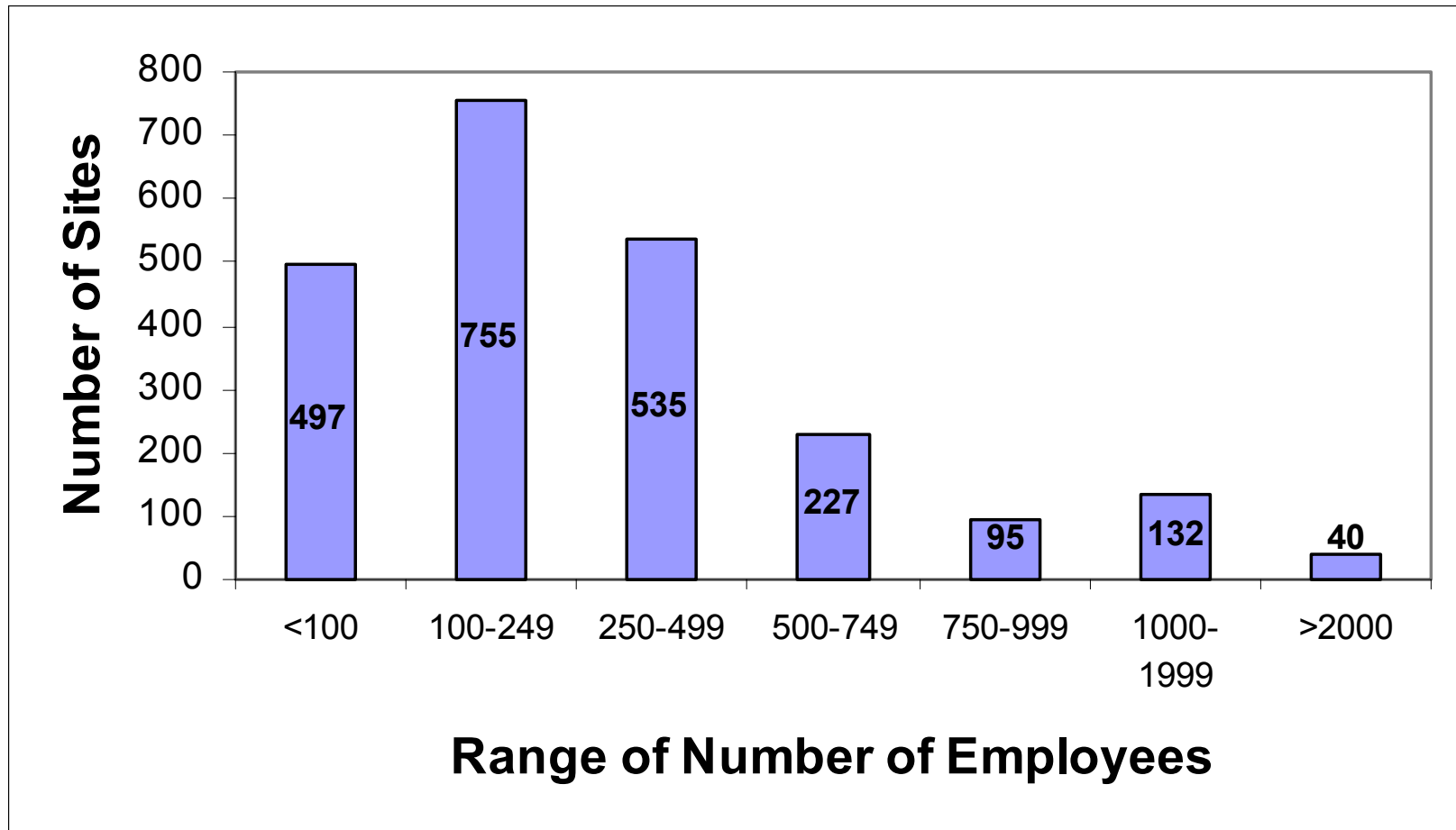


Typical Food Processing Site Statistics

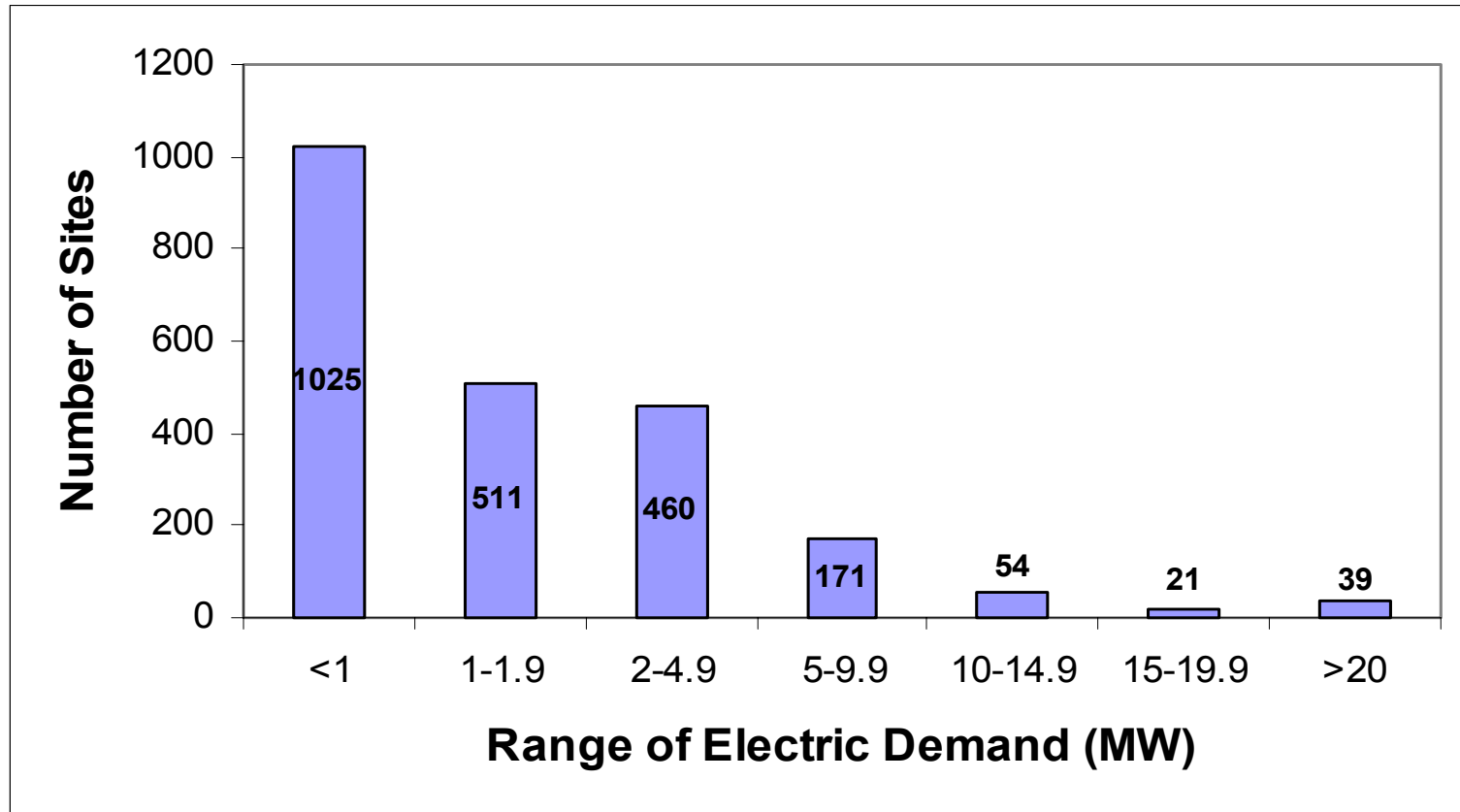
Site Statistics	Mean	Median
Employees	357	200
Plant Hours (hrs / yr)	5,785	6,120
Shipments per Year	290,780	61,600
Steam Draw (lbs / hr)	21,546	5,000
Elec Demand (kW)	3,347	1,144
Elec Price (\$)	0.0583	0.0544

- There are 2,281 food processing sites in the Major Industrial Plant Database (MIPD) where these statistics were calculated from.
- 76 sites generate some electricity on site.
- 29 of the 76 are listed as CHP sites.

Distribution of Food Processing Sites by Number of Employees

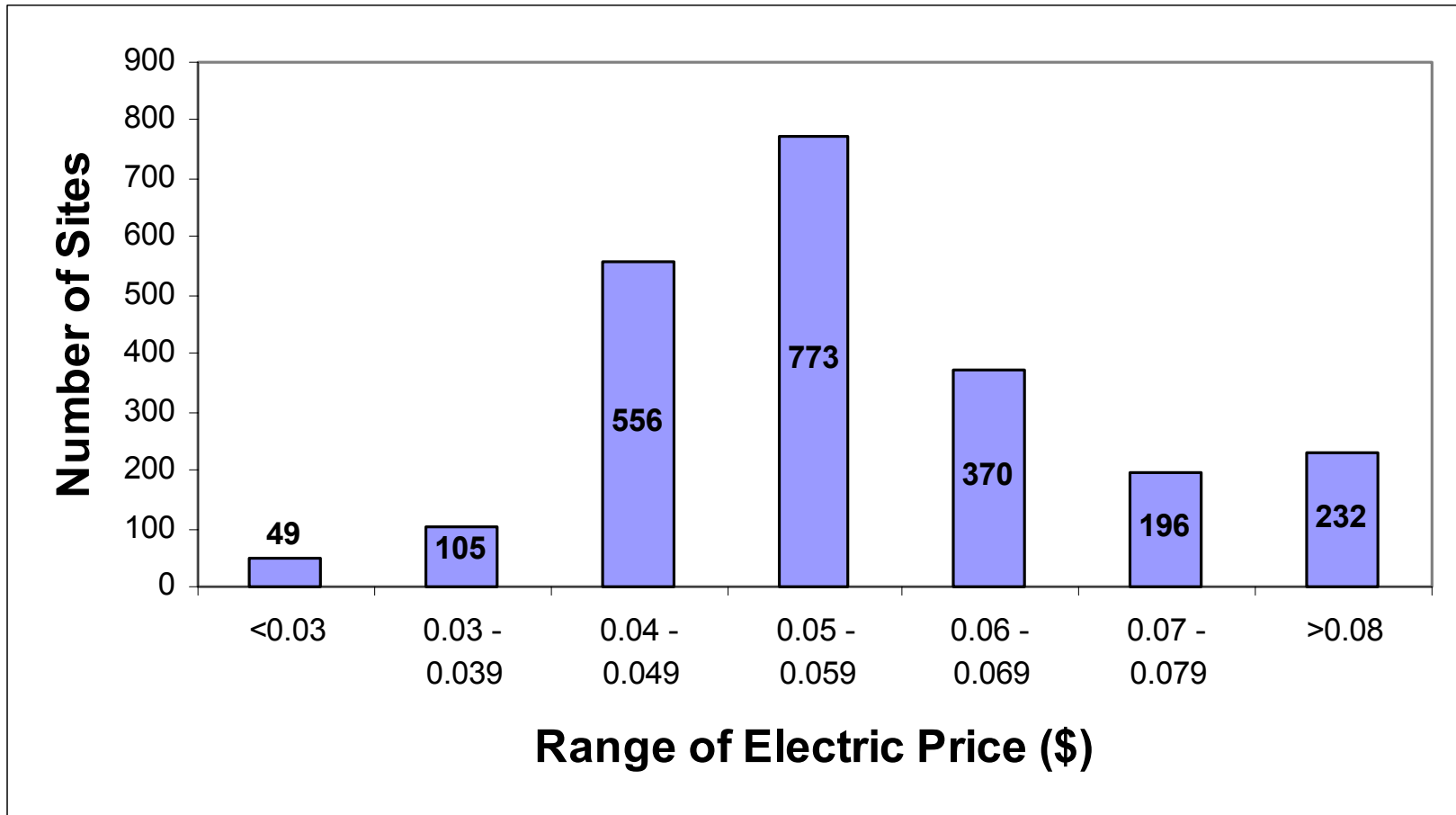


Distribution of Food Processing Sites by Electric Demand



The food industry is not as energy intensive as many other industries, causing many processing plants to buy electricity from the local utility, however some facilities have natural gas boilers for steam.

Distribution of Food Processing Sites by Electric Price per kWh



Food Industry Issues

- There is a need to increase the energy efficiency of industry processes while decreasing the greenhouse gas emissions that they produce.
- It is becoming necessary to create better methods of wastewater treatment and disposal in efforts to make the industry cleaner.
- There is an increased focus on water conservation and solid waste reduction.
- There is an industry trend toward the use of electricity instead of steam for many processes, including heating, cooling, drying, debacterisation, and pre-cooking.

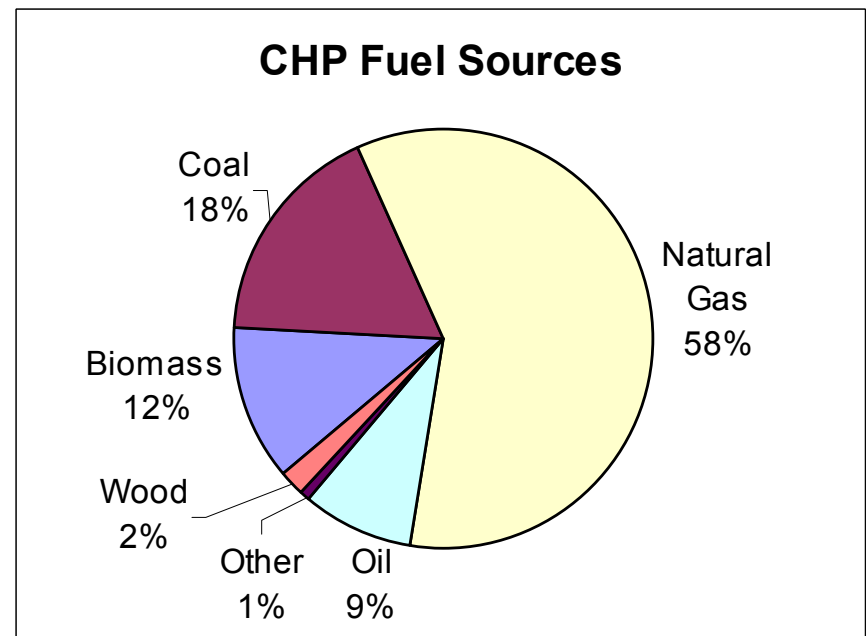
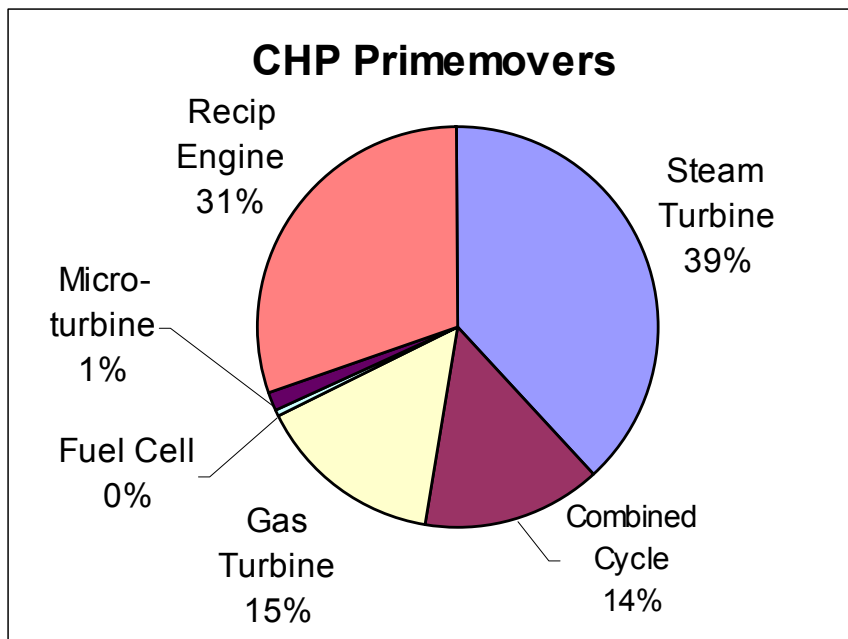
Combined Heat and Power in the Food Sector

Installed CHP Capacity by Sub-sector

Food Subsector	# Sites	Capacity (MW)	Mean Site Capacity	Median Site Capacity
SIC 201 Meat, Poultry, Sausage	7	50.5	7.2	6.5
SIC 202 Dairy Products	22	165.2	7.5	0.5
SIC 203 Fruits and Vegetables	25	2767.4	110.7	49.2
SIC 204 Grain and Corn processing	26	783.7	30.1	9.5
SIC 205 Bakery Products	13	24.8	38.3	3.6
SIC 206 Sugar, Candy, Gum, Nuts	47	699.1	14.9	6.0
SIC 207 Oils	14	116.6	8.3	3.4
SIC 208 Beverages	21	340.3	16.2	5.5
SIC 209 Seafood, Ice, Prepared foods	15	490.5	32.7	6.1
SIC 200 Misc.	20	608.2	30.4	6.8
Total	210	6046.3		

Source: EEA CHP database

Breakdown of CHP Sites by Primemover and Fuel Source

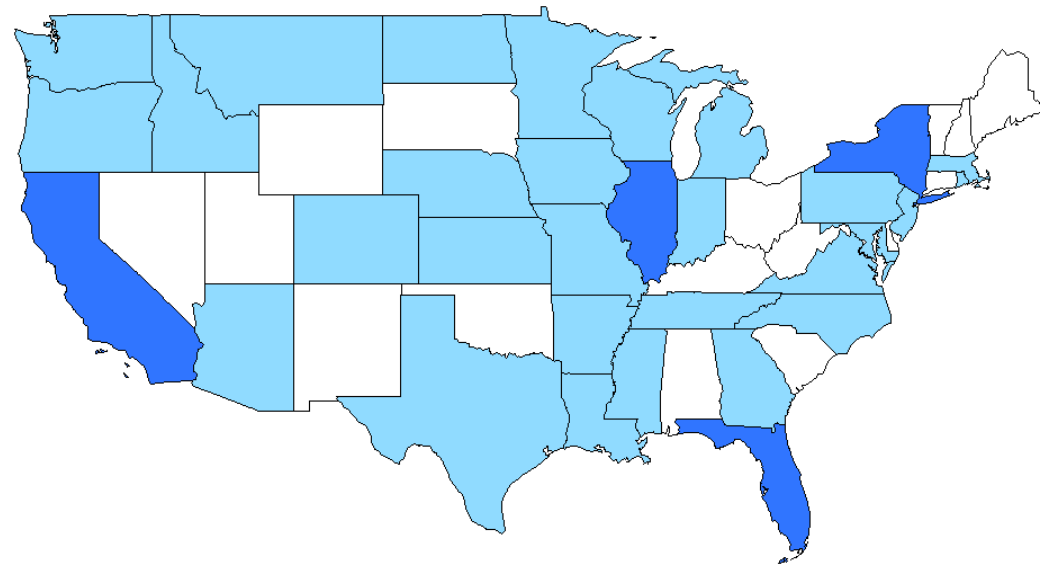


Source: EEA CHP database

Location of CHP Food Processing Sites

State	# Sites
AK	7
AR	3
AZ	1
CA	42
CO	1
DE	1
FL	15
GA	5
HI	10
IA	6
ID	5
IL	19
IN	3
KS	2
LA	8
MA	4

MD	1
MI	5
MN	4
MO	1
MS	2
MT	1
NC	6
ND	3
NE	2
NJ	8
NY	21
OR	4
PA	5
RI	1
TN	1
TX	6
VA	2
WA	1
WI	4
Total	210



Source: EEA CHP database

= 1-10 sites
 >10 sites

3. Pharmaceuticals Sector

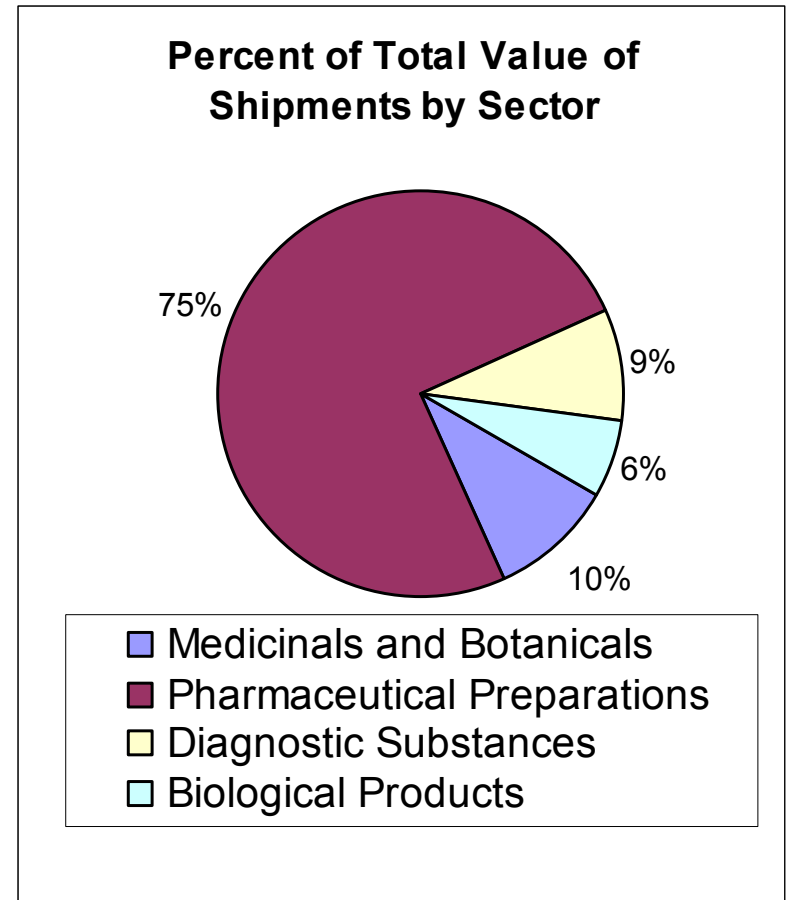
Pharmaceuticals: Sector Profile

- The Pharmaceutical industry had sales of \$192 billion in 2002.
- This shows a growth of 11.8%. However the growth rate is down from 17% in 2001.
- The US represents the largest worldwide market for pharmaceuticals, taking 50% of the world market in 2002 compared with 34% in 1992.
- Includes SIC 283 and NAICS 3254.

Top 10 Companies
P fize r
Gla xo S mithKline
John son & John son
Me rck & Co
As tra Ze ne ca
Bris to l-Mye rs Squibb
No va rtis
Wye th
Lilly
Ave ntis

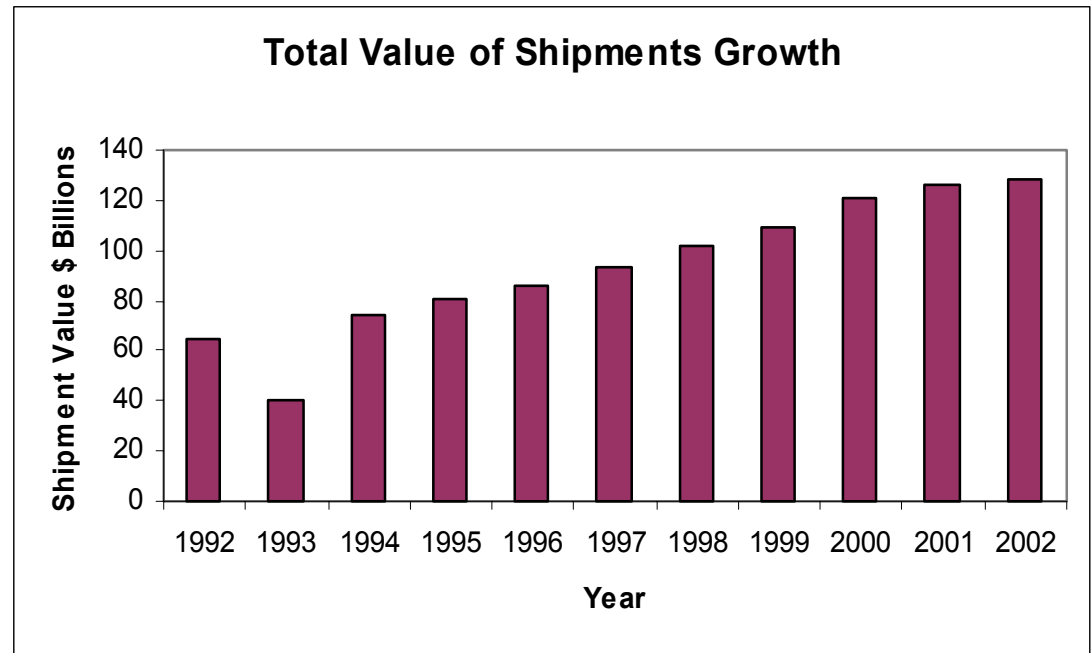
Pharmaceuticals: Sector Profile

- Primary Sub-sectors
 - Medicinals and Botanicals
 - Hormonal products, vitamins, herbs
 - Pharmaceutical Preparations
 - Prescription and Over-the-Counter drugs
 - In Vivo and In Vitro Diagnostic Substances
 - Chemical, biological, and radioactive substances used in diagnosing
 - Biological Products
 - Bacterial and virus vaccines, serums, and plasmas



Growth in Pharmaceutical Shipment Values

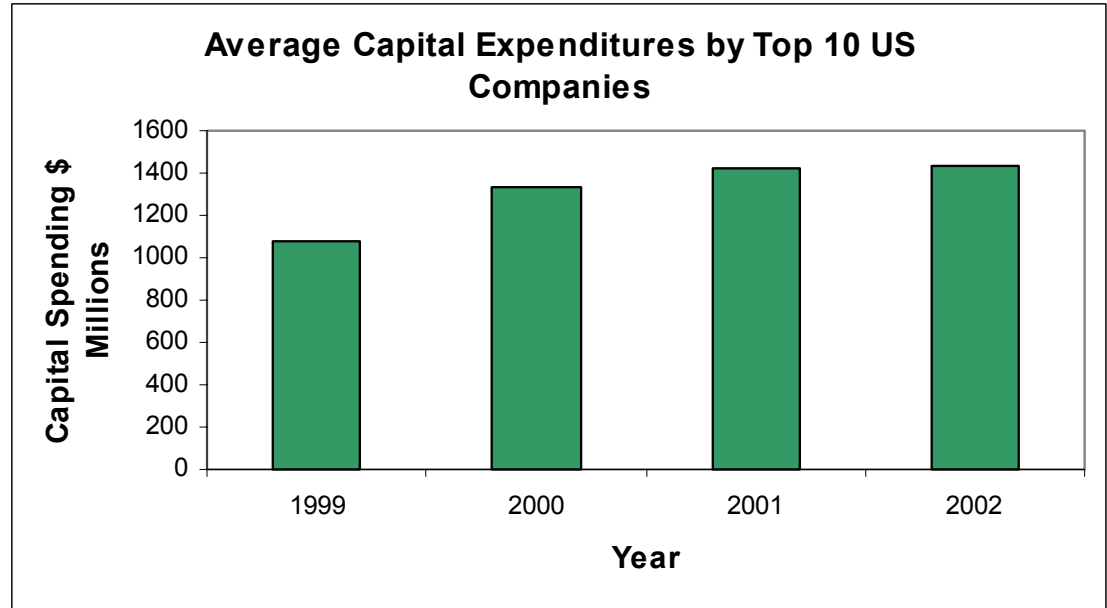
- Basic Costs
 - Raw Materials costs increasing
 - Processing costs
 - Labor costs (avg. hourly wage in 2002 was \$18.12)
- “Energy is a variable cost that the pharmaceutical industry often overlooks.” (International Society of Pharmaceutical Engineering)



Source: Chemical and Engineering News

Trend in Capital Expenditures

- Most pharmaceutical companies in the U.S. continued to increase capital spending over the last four years despite the decrease in the chemical industry as a whole.



Top 10 US Companies	Capital Spending (\$ millions)
Merck	2,370
Johnson & Johnson	2,099
Wye th	1,932
P fize r	1,758
Abbott La bora torie s	1,296

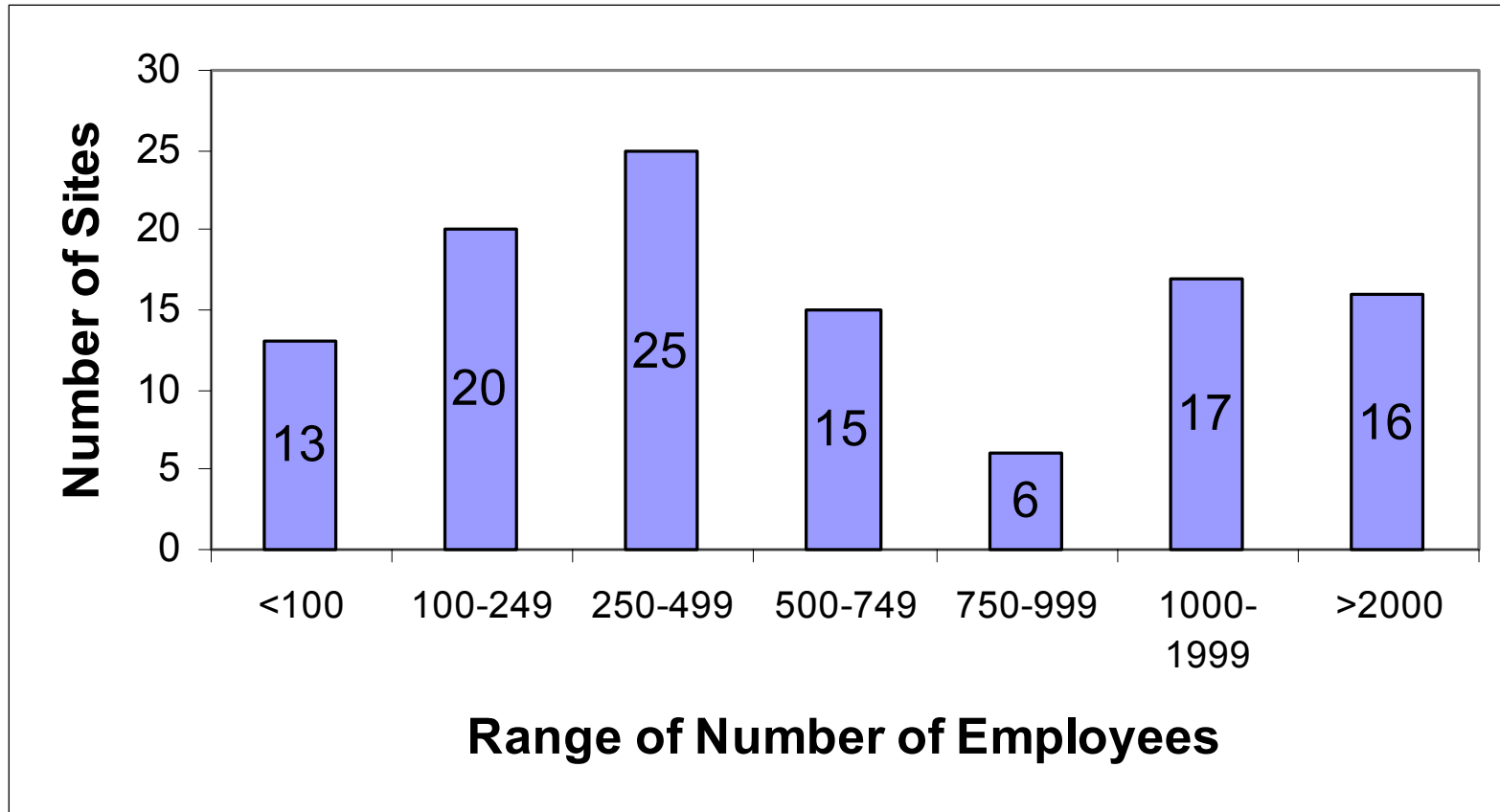
Pha rma cia	1,142
Eli Lilly	1,131
Bris to l-Me ye rs Squibb	997
Ba xte r Inte ma tio na l	848
Sche ring -P lough	770

Typical Pharmaceutical Site Statistics

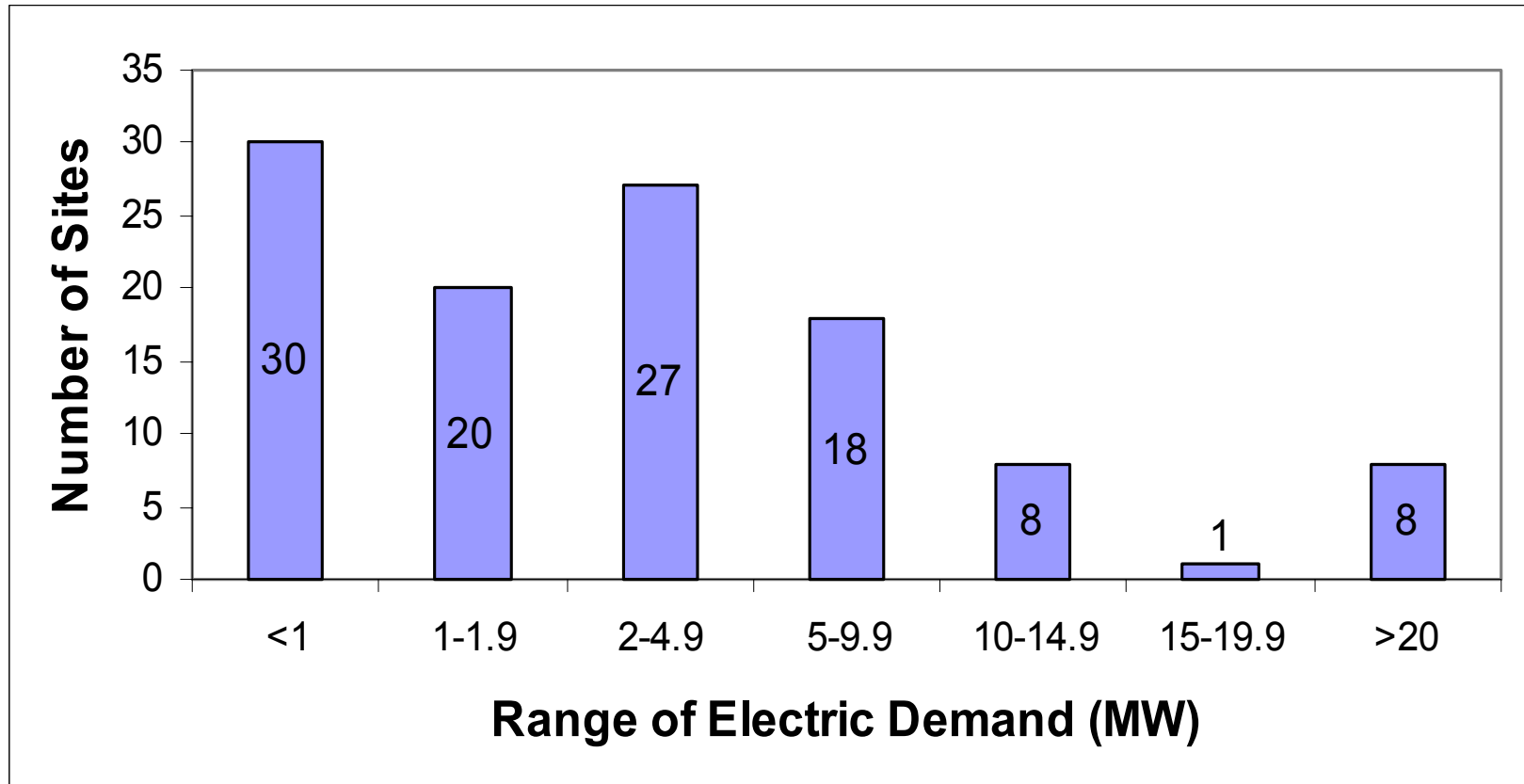
Site Statistics	Mean	Median
Employees	866	455
Plant Hours	6,437	6,439
Shipments	5,733,900	5,785,130
Steam Draw (lbs/hr)	35,186	35,503
Ele c Demand (kW)	5,457	5,505
Ele c Price (\$)	0.06288	0.06303

- There are 112 pharmaceutical sites in the Major Industrial Plant Database (MIPD) where these statistics were calculated from.
- 10 sites generate some electricity on site.
- 6 of the 10 are listed as CHP sites.

Distribution of Pharmaceutical Sites by Number of Employees

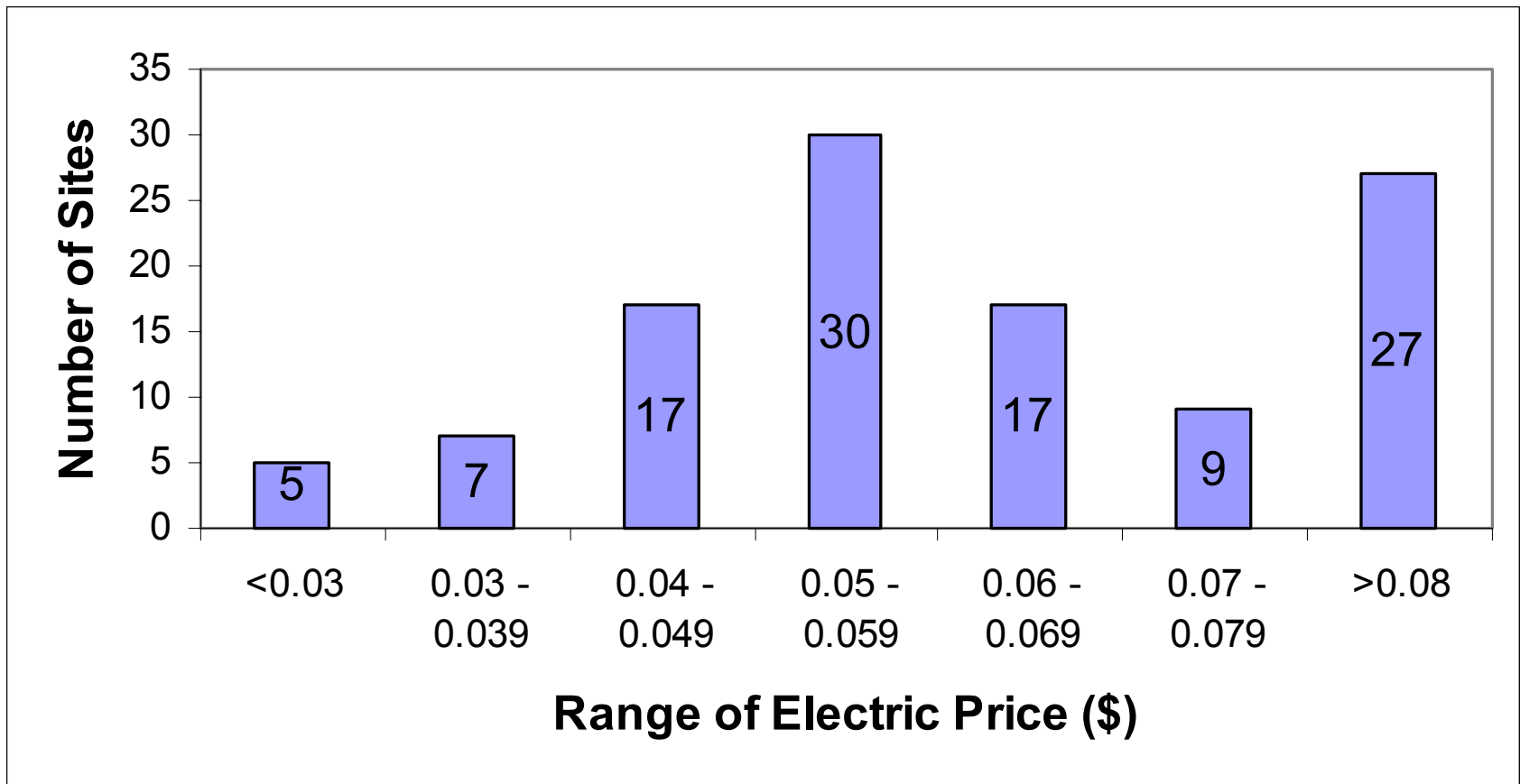


Distribution of Pharmaceutical Sites by Electric Demand



Traditionally, efforts to reduce energy use are avoided because of increased initial cost. Most pharmaceutical companies operate with payback periods of 3 years or less.

Distribution of Pharmaceutical Sites by Electric Price per kWh



Pharmaceutical Industry Issues

- New drug approvals are going slower which limits the number of new products that companies can bring to the market.
 - In 2002 the FDA approved the fewest number of molecular entities since 1983.
- Sales are being dampened by personal importation of drugs from outside the country.
- The introduction of generic drugs are hurting sales of brand name medications as companies are losing their exclusive production of patented drugs.

Combined Heat and Power in the Pharmaceutical Sector

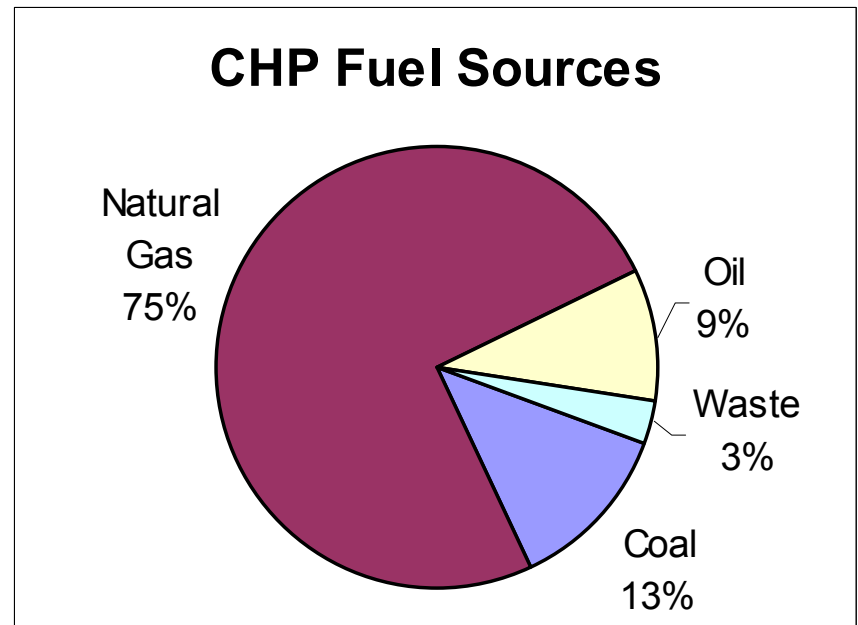
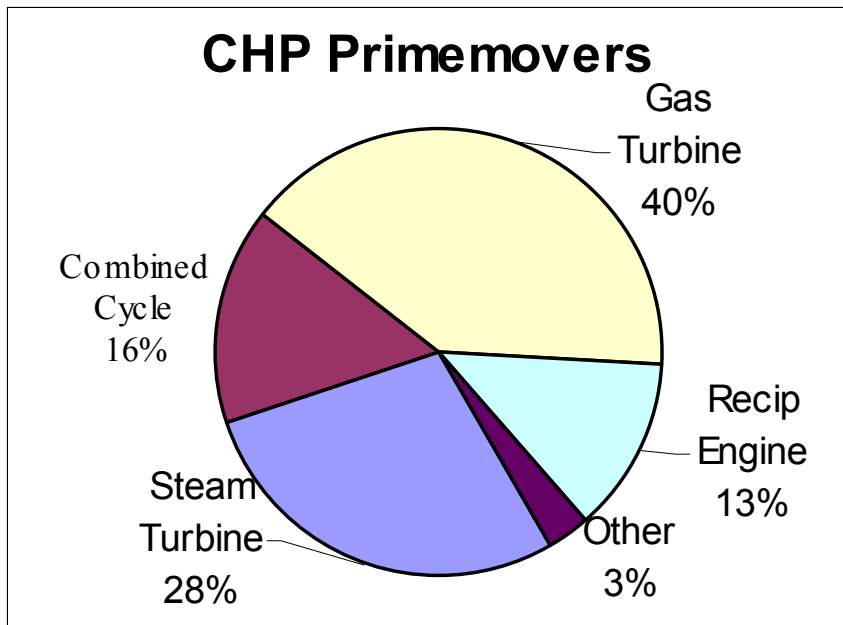
Installed CHP Capacity by Sub-sector

Pharmaceutical Subsector	# Sites	Capacity (MW)	Mean Site Capacity	Median Site Capacity
SIC 2833 Medicinals and Botanicals	6	309.8	51.6	34.8
SIC 2834 Pharmaceutical Preparations	26	430.4	16.5	4.2
Total	32	740.2		

Source: EEA CHP database

Onsite generation can save pharmaceutical companies money while providing higher reliability for critical processes that require a constant power supply. However, energy use issues usually come after safety, aesthetic, and initial capital cost issues.

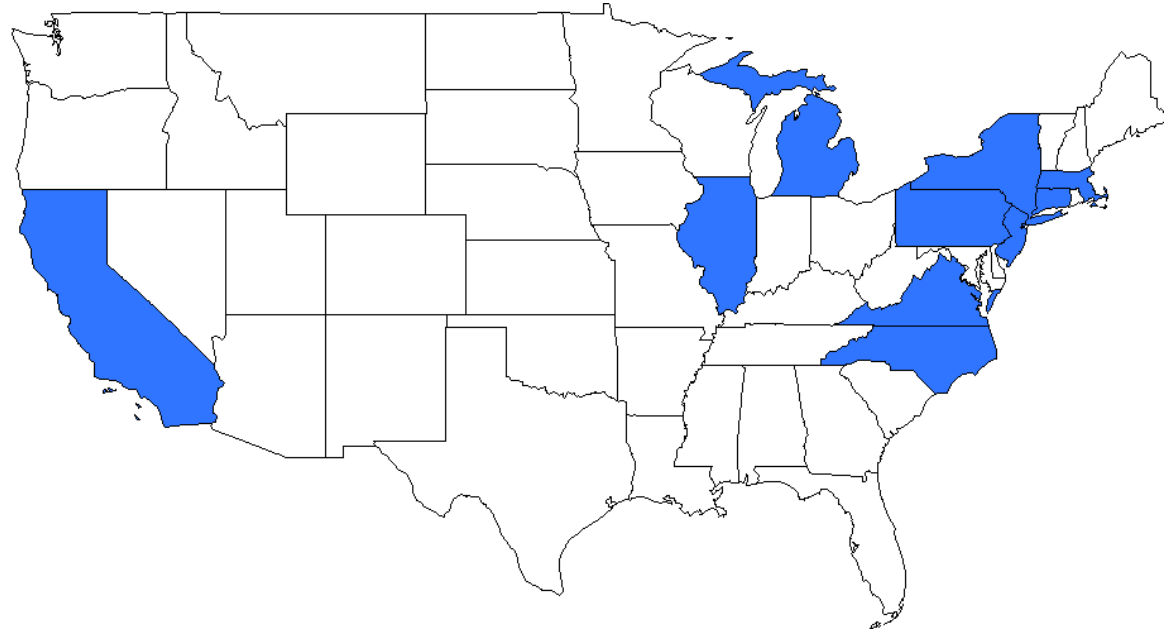
Breakdown of CHP Sites by Primemover and Fuel Source




Source: EEA CHP database

Location of CHP Pharmaceutical Sites

State	# Sites
CA	2
CT	2
IL	3
MA	1
MI	2
NC	5
NJ	9
NY	2
PA	5
VA	1
Total	32



Source: EEA CHP database

 States with CHP
Pharmaceutical sites