



# **Combined Heat & Power in Louisiana: Status, Potential, and Policies.**

## **Phase 1 Report: Resource Characterization & Database**

*Prepared for the Louisiana Department of Natural Resources*

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August 11, 2014



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## EXECUTIVE SUMMARY – PROJECT OVERVIEW

The purpose of this report has been to characterize the current status of the state's electrical "cogeneration" or "combined heat and power" ("CHP") resources. This report is the first phase of a research project designed to estimate the technical and cost-effective opportunities for CHP in Louisiana.

Cogeneration, or CHP, is the simultaneous production of electrical and thermal energy. Historically, cogeneration has been the most common form of electricity production for larger industrial firms that have both electricity and thermal needs.

CHP is an energy efficiency application since thermal energy that is typically wasted or vented to the environment is captured for further use as second stage power generation or additional production.

Technologies, regulatory policies, and project economics have created, and continue to create opportunities for new CHP applications in the state.

Louisiana saw considerable industrial CHP development during the 1980s and early 1990s given: (a) relatively high industrial retail electricity rates offered by regulated utilities; and (b) relatively low priced and abundant natural gas supplies coming from the deepwater Gulf of Mexico.

Louisiana also saw considerable merchant power generation development during the late 1990s and early 2000s: part of that merchant development was associated with the construction of CHP capacity at many industrial facilities around the state. These facilities were much larger, and more efficient, than those developed a decade earlier.

## EXECUTIVE SUMMARY – CHP GENERATION & CAPACITY

Louisiana has one of the highest concentrations of both retail industrial electricity sales and CHP-based generation in the U.S. Louisiana CHP generation has trended between 48 million to 55 million megawatthours (“MWh”) over the past decade. While CHP generation was down during the 2008-2009 recession, both have rebounded to around 60 million MWhs.

There are 35 CHP facilities in Louisiana, with over 6,200 megawatts (“MW”) of capacity, that range in size from 3 MW to as much as 987 MW. There are 13 “large” (greater than 100 MW) CHP facilities in Louisiana.

Over 66 percent (4,171 MW) of all CHP capacity in Louisiana was developed after 1990, over 1,500 MW (24 percent) of that capacity came on-line in 2002 alone.

Louisiana’s chemical industry accounts for the largest share of CHP installations in the state with close to 5,000 MW or 91 percent of all state CHP capacity.

Louisiana’s chemical industry also accounts for some of the largest CHP facilities in the state. Eight of ten largest and most efficient facilities in the state are located at chemical plants.

The chemical industry also has the most efficient CHP generators in the state: averaging 11,000 British thermal units (“Btu”) of energy used to make one kWh of electricity.

Primary metal manufacturing and paper manufacturing have the highest CHP utilization rates in the state, at 66 percent and 80 percent, respectively.

## EXECUTIVE SUMMARY – CONCLUSIONS

Louisiana industry has done a good job in capturing on-site electrical and thermal energy efficiency opportunities.

Admittedly, new Louisiana CHP development stalled during the past decade with the combined threats created by increased tropical activity, uncertain global economic conditions, and high natural gas prices. Those concerns, however, have been alleviated, and today, new opportunities for CHP development abound.

Over the past several years, independent oil and gas producers, utilizing innovative technologies, and exploiting a previously underutilized geologic resource, have unleashed trillions of cubic feet of new natural gas resources. Today's "shale revolution" has led to new, stable, abundant and affordably-price natural gas supplies.

The "shale revolution" is also leading to a new "industrial renaissance" of billions of dollars in new manufacturing investments. Recent estimates place the industrial investment opportunities from this renaissance at over \$62 billion. With these new industrial and manufacturing facilities will come new energy end uses, and continued new CHP opportunities.

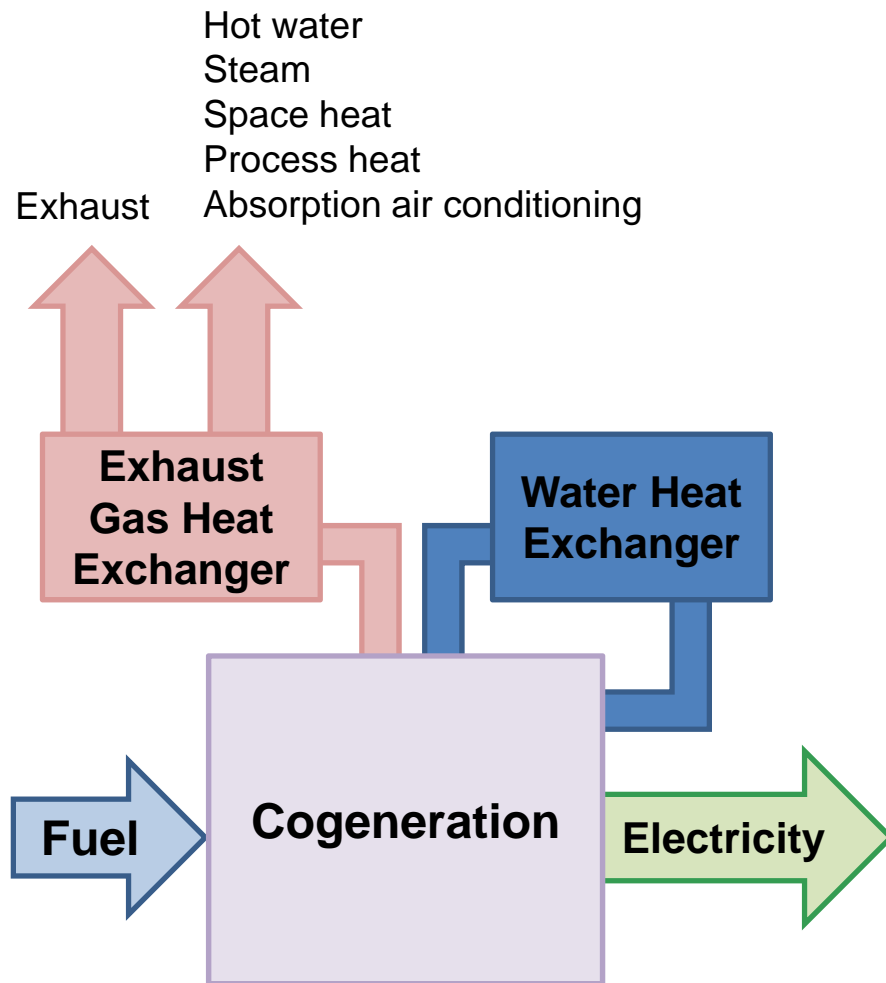
Later phases of this research will model the existing Louisiana commercial and industrial base for new incremental CHP opportunities. The role that industry trends, economic changes, and policy plays on CHP development will also be explored in these future analyses.



## **Section 2: Introduction**



Definition: Cogeneration



*Cogeneration* is the simultaneous production of electrical and thermal energy; hence the reference to “combined heat and power” (“CHP”) applications.

Cogeneration is a technical and engineering definition that describes a process of energy production. Historically, cogeneration has been the most common electricity production technique for larger industrial firms with heat and power requirements.

Technologies, regulatory policies, and project economics, however, are starting to create new opportunities for CHP applications at much smaller scales.



**Historic Evolution of Cogeneration**

Historically, cogeneration, or “combined heat and power” (“CHP”) applications in Louisiana have been relegated to large industrial facilities throughout the state. Prior to the late 1970s, industrial facilities in Louisiana (and elsewhere) tended to install CHP applications in order to reduce costs by either (a) increasing some form of process efficiency; and/or (b) utilizing a waste product, like bagasse or rice hulls, as a fuel source. The CHP capacity developed during these periods served on-site needs exclusively since off-site sales to utilities, other affiliates, or other industrial retail customers was restricted if not prohibited.





The National Energy Act and PURPA

In 1978, Congress passed the “National Energy Act” (NEA) which was composed of five different statutes.<sup>1</sup> The general purpose of the NEA was to ensure sustained economic growth during a period in which the availability and price of future energy resources was becoming increasingly uncertain. The two major themes of the legislation were to: (1) promote the use of conservation and renewable/alternative energy, and (2) reduce the country's dependence on foreign oil. While many aspects of the National Energy Act affected the electric power industry, PURPA was one of the most significant. A major policy goal of PURPA was to encourage more efficient use of energy through cogeneration.

<sup>1</sup>The Public Utilities Regulatory Policy Act (PURPA); the National Energy Tax Act; the National Energy Conservation Policy Act; the Power Plant and Industrial Fuels Act (FUA); and the Natural Gas Policy Act.



## How PURPA Impacted CHP Development

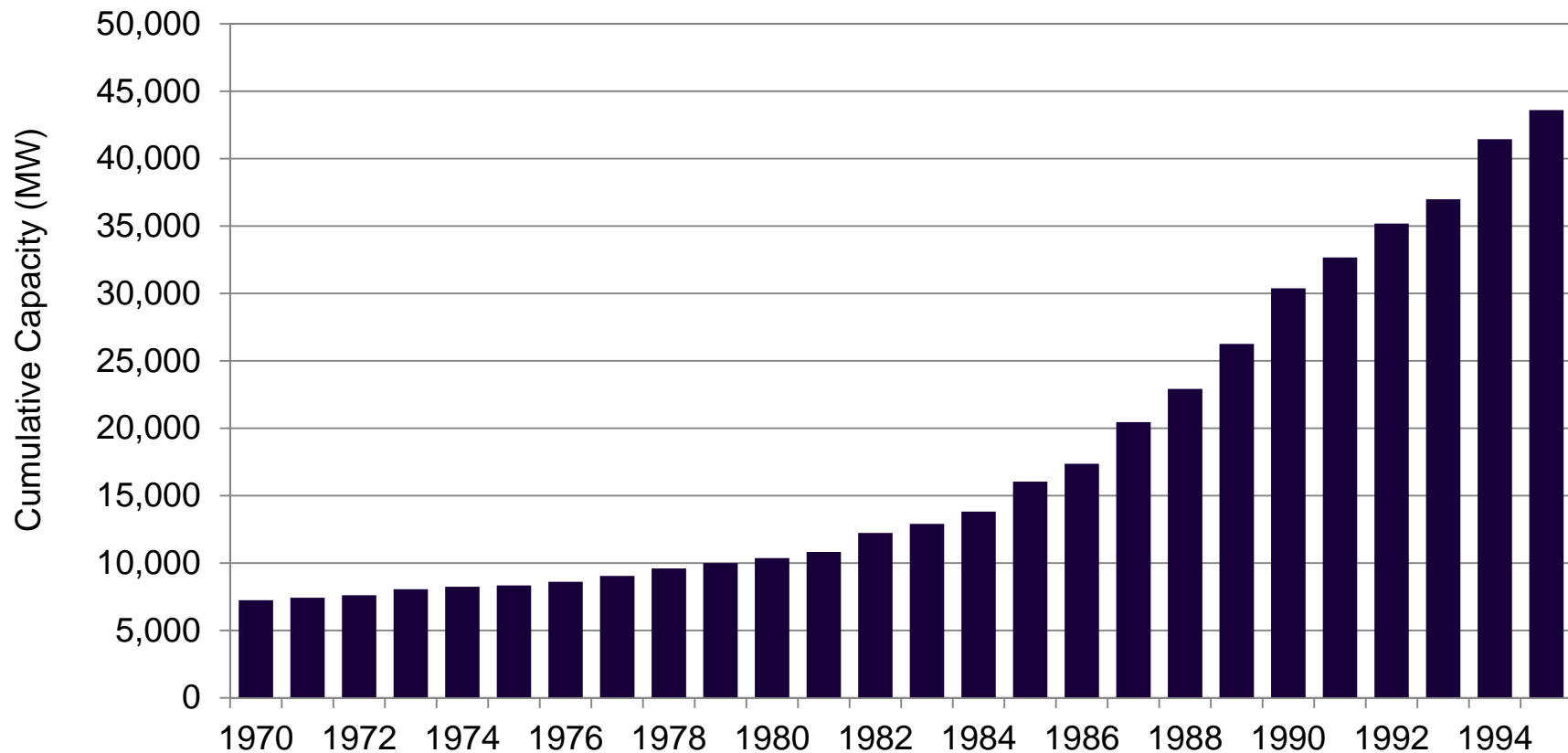
Over the past 20 years, PURPA helped to show that electricity generation is not a natural monopoly and can be opened to competition. In doing so, PURPA weakened an important justification for the regulation of electricity generation. Since the implementation of PURPA, non-utility generating capacity, most of which is cogenerated electricity from PURPA “qualifying facilities” (QFs), has more than doubled.

The growth of cogeneration created under PURPA is an important historical precedent leading to the rise of competition in the electric utility industry. In addition to PURPA, there were a number of other concurrent factors leading to the growth in cogeneration throughout the 1980s and early 1990s that include falling natural gas prices, decreases in interest rates, increased technological advances in gas turbine technologies, favorable state regulatory treatment of cogenerated electricity, and increasing wholesale competition for both natural gas and electricity.



Historic Trends in Cogeneration Capacity Development

Industrial cogeneration has grown steadily and dramatically since the early 1980s.



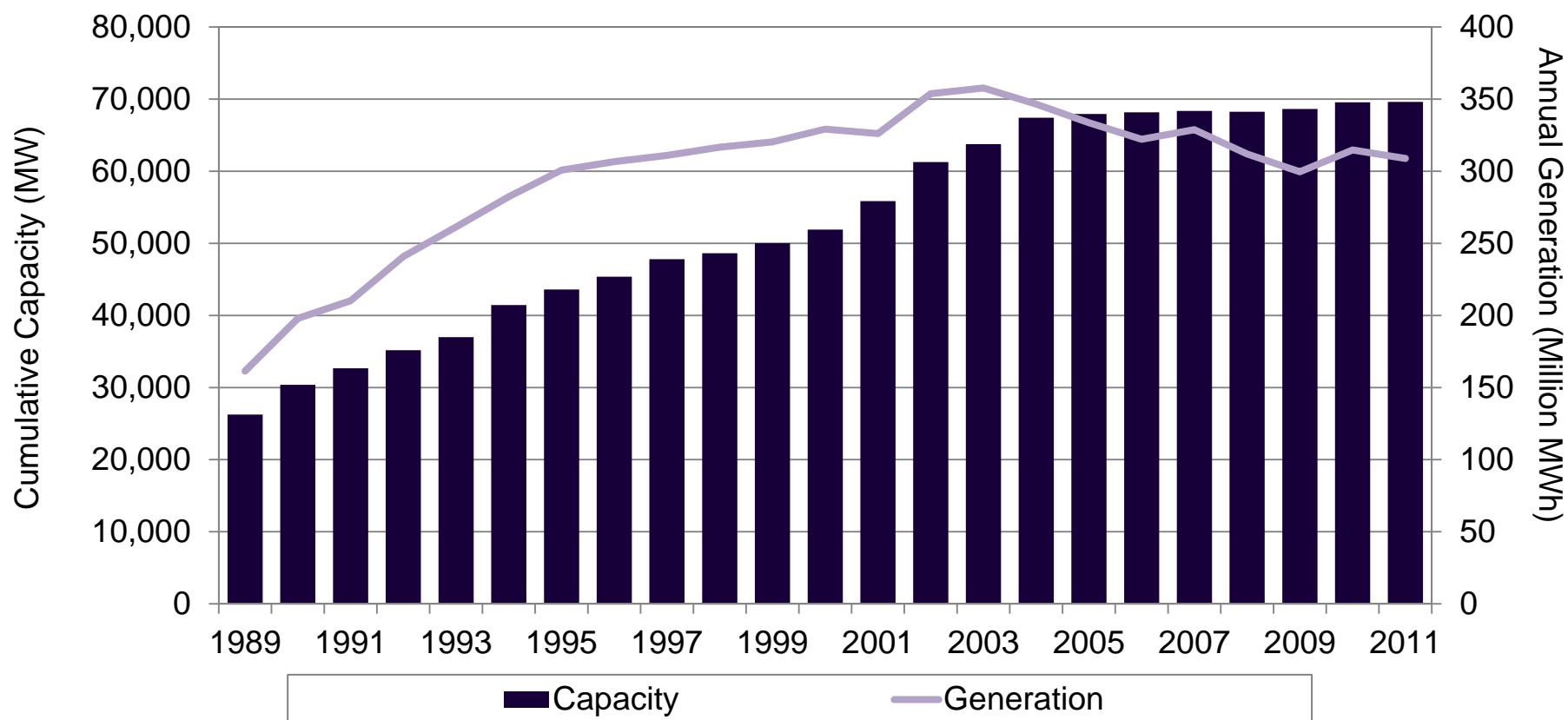
Note: Cumulative capacity is net of retirements. Includes Commercial CHP, Industrial CHP and IPP CHP as defined by the Energy Information Administration.

Source: Energy Information Administration, U.S. Department of Energy.



Cogeneration Capacity and Production

Cogeneration production grew significantly in the 1990s.



Note: Cumulative capacity is net of retirements. Includes Commercial CHP, Industrial CHP and IPP CHP as defined by the Energy Information Administration.

Source: Energy Information Administration, U.S. Department of Energy.



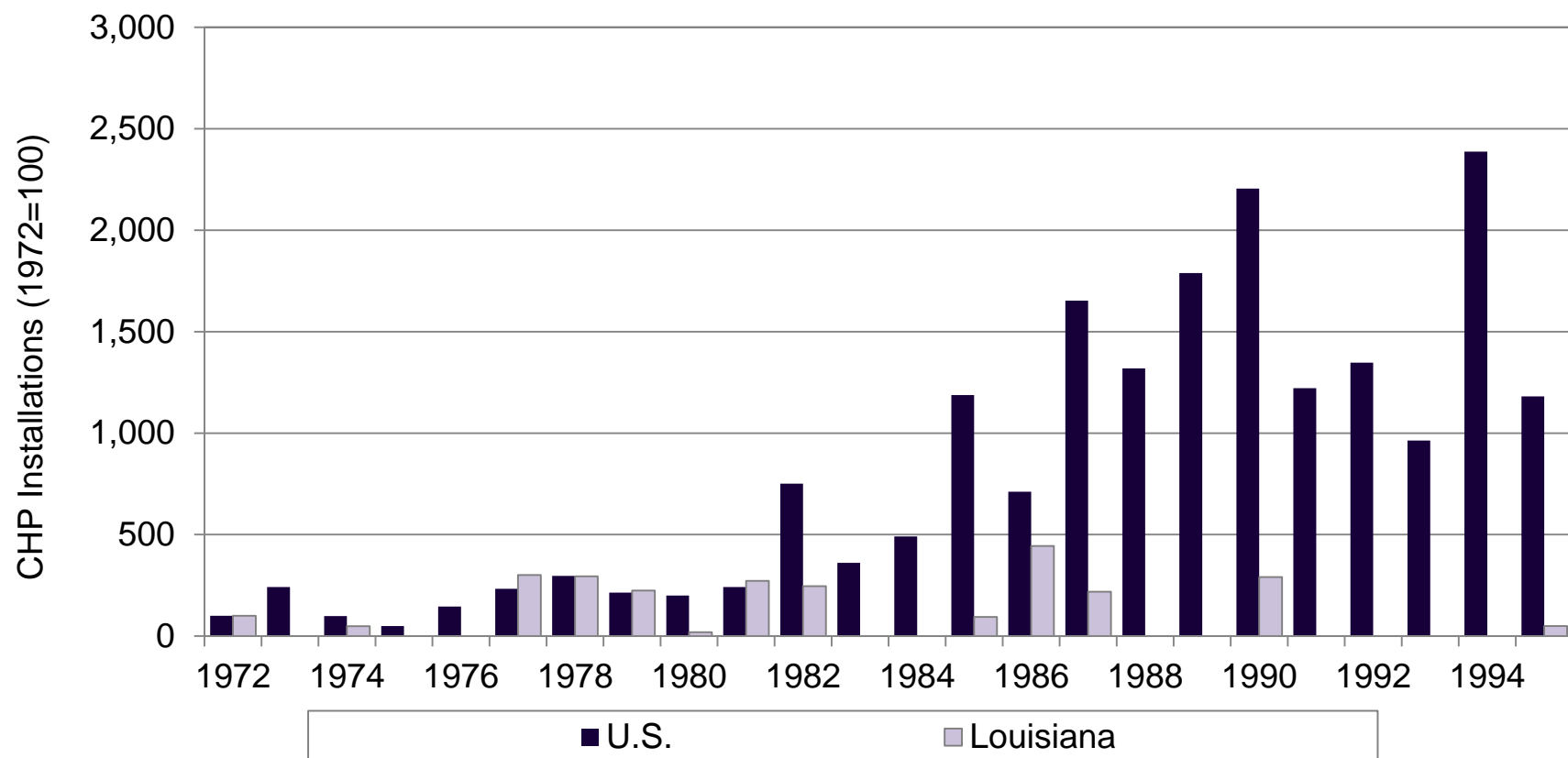
**Louisiana Industrial CHP Development**

Louisiana was a significant beneficiary of these changing federal energy policies given its large industrial base and technical potentials for CHP. Louisiana saw considerable industrial CHP development during the 1980s and early 1990s given: (a) relatively high industrial retail electricity rates offered by regulated utilities; and (b) relatively low natural gas prices and increasing supplies as producers moved into more prolific deep-water areas of the offshore Gulf of Mexico.



US and Louisiana CHP Development (1972=100)

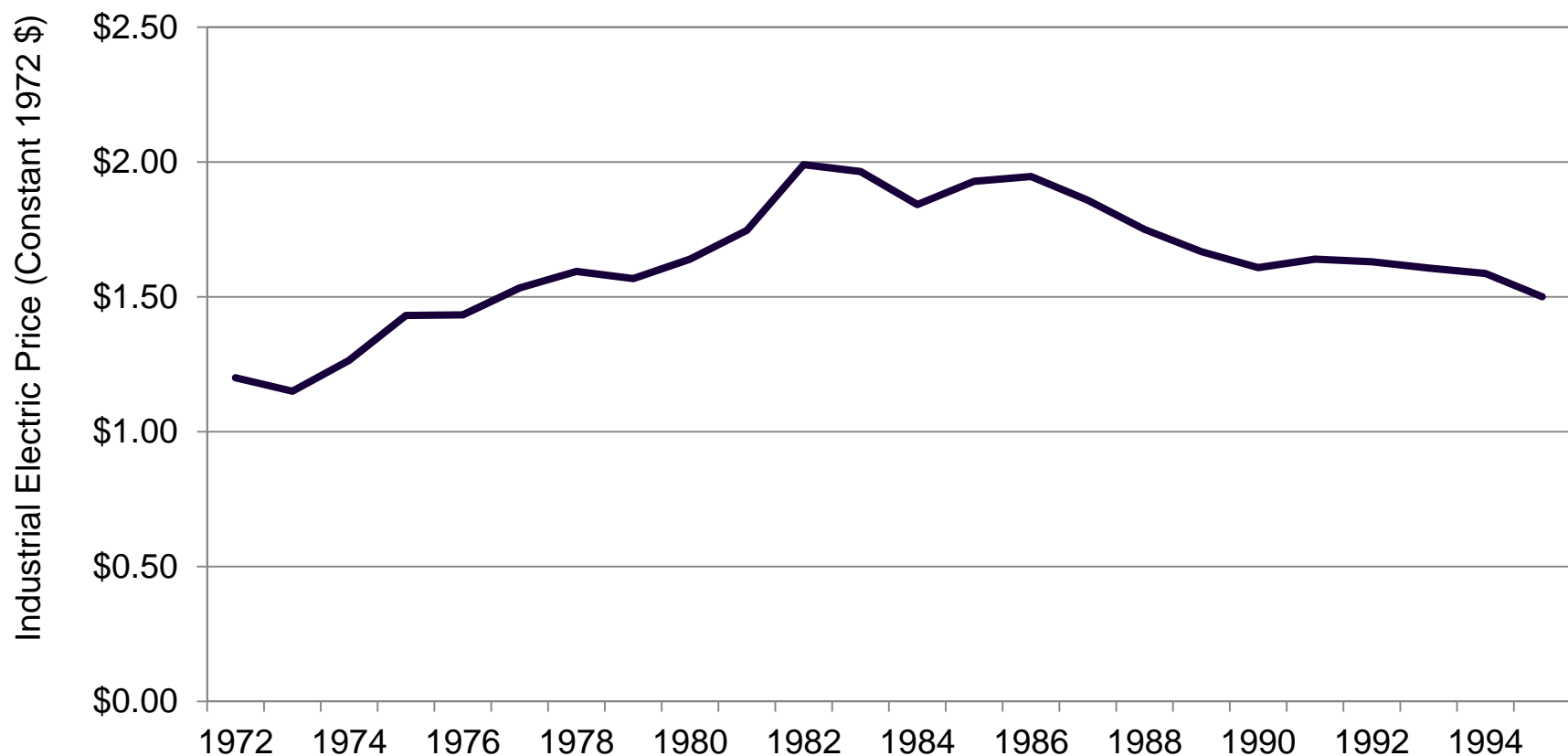
Capacity development in Louisiana was significant around, and immediately after the passage of PURPA. There was an additional surge of development in 1986, and very little throughout the 1990s.



Note: . Includes Commercial CHP, Industrial CHP and IPP CHP as defined by the Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Price of Electricity Delivered to U.S. Industrial Consumers (1972 \$)



Note: Price represents retail prices of electricity sold by electric utilities.  
Source: Energy Information Administration, U.S. Department of Energy.



EPAct and Competitive Wholesale Power Markets

PURPA was amended by the Energy Policy Act of 1992 (“EPAct”). These amendments, in part, directed the Federal Energy Regulatory Commission (“FERC”) to open wholesale markets to competition by requiring utilities to provide open access to their transmission systems on equal and non-discriminatory terms. FERC promulgated a final rule (Order 888) in 1996 opening wholesale markets to competition, thereby expanding the potential market for non-utility generated electricity including generation from CHP applications.

EPAct, coupled with the new FERC open access, low natural gas prices, and a booming economy hungry for new generation, led to a second wave of new CHP development. This development occurred in conjunction with the development of other forms of non-utility generation by entities often referred to as “independent power producers” (“IPPs”) or “merchant power generators.”





Merchant Power Development in Louisiana

Louisiana became the epicenter of merchant power generation development in the southeastern U.S. during the late 1990s and early 2000s. A large part of this merchant development was associated with capacity additions and various repower pricings at the earlier PURPA incented industrial CHP facilities.

During this period, industrial host sites partnered with new competitive generation companies to develop facilities that leveraged the thermal energy characteristics of host site. These facilities were much larger, and considerably more efficient than some of the CHP facilities developed a decade earlier.

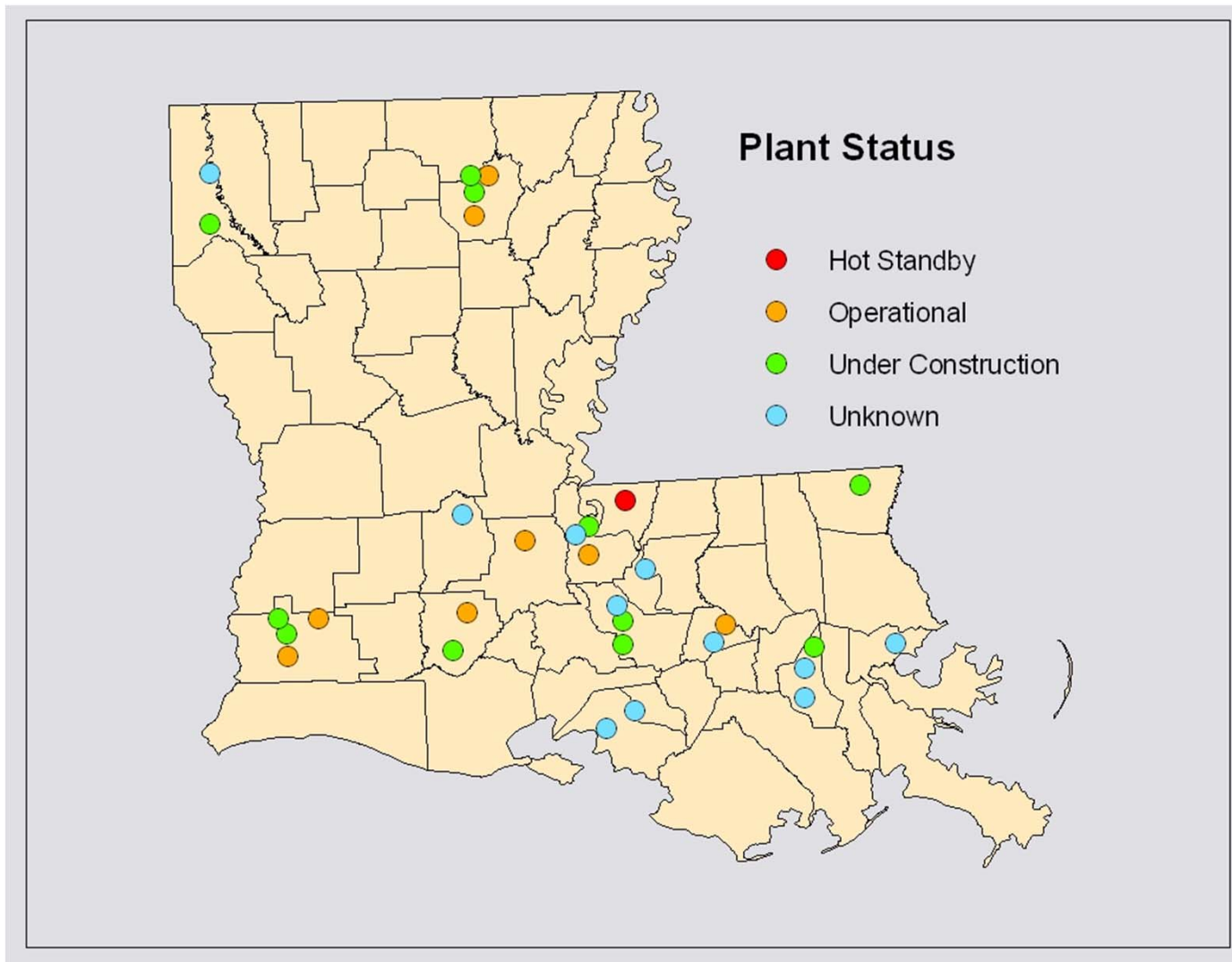


Louisiana Merchant Development (2004)

	Capacity (MW)	
	Original Status (1999)	Updated Status (2004)
<b>Status of Merchant Plants</b>		
Operational	4,013	4,343
Under Construction	564	-
Adv. Development	-	-
Early Development	2,805	-
Planned	1,200	2,400
Tabled	-	564
Cancelled	-	1,275
<b>Status of Cogeneration Plants</b>		
Operational	1,816	2,716
Under Construction	900	-
Adv. Development	685	-
Early Development	670	-
Planned	78	575
Tabled	-	670
Cancelled	-	188



Announced Independent Power Facilities in Louisiana, 2004





## **Section 3: Overview – Industrial Sales and Usage**



Overview: Louisiana Industrial Electricity Sales and Prices

Louisiana has one of the highest concentrations of retail industrial sales in the U.S. The state also has one of the highest concentrations of industrial CHP-based generation.

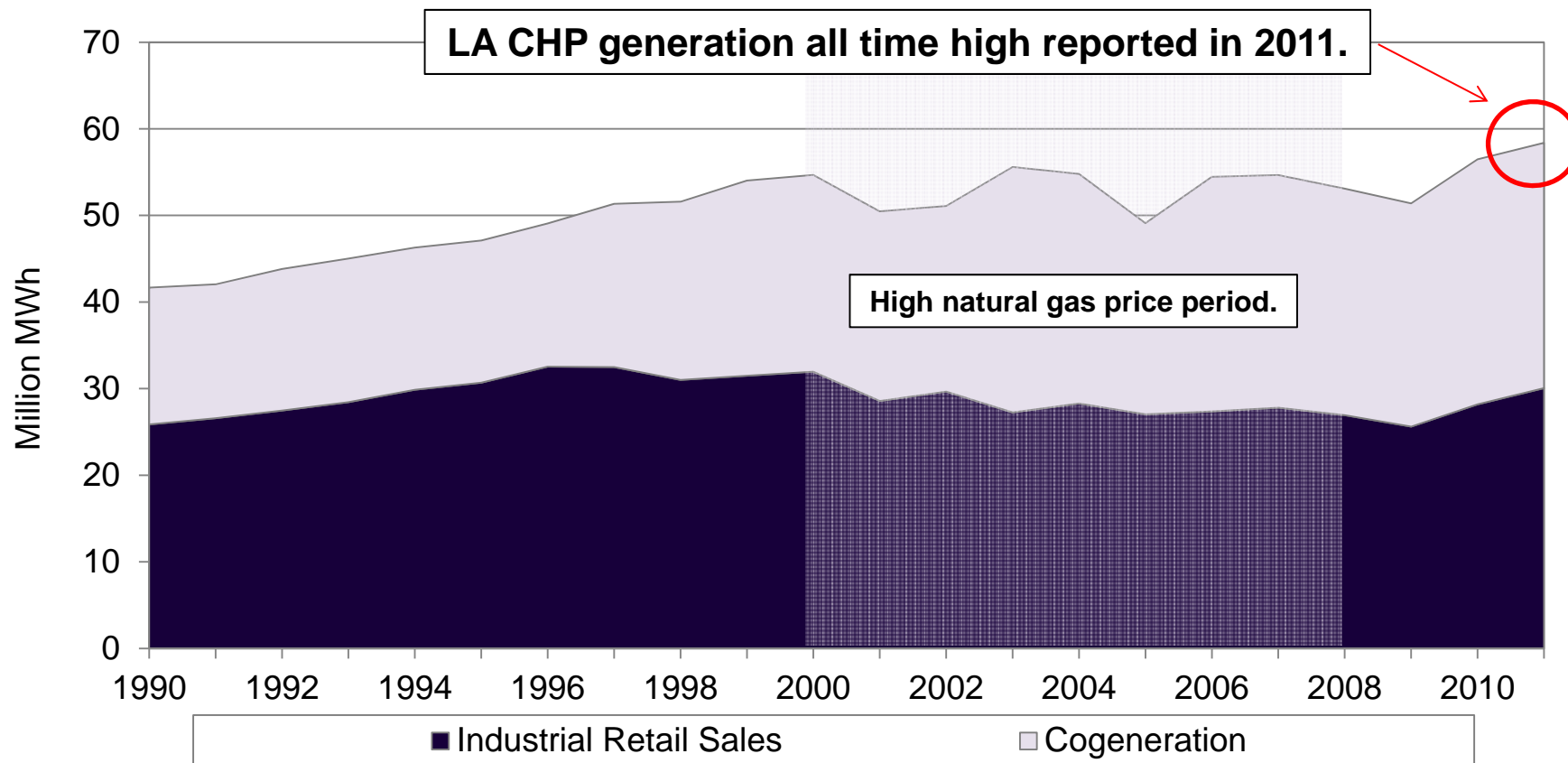
Industrial sales and CHP generation from industrial facilities grew in a similar and proportional fashion until about 1995 when on-site industrial CHP began to grow, and industrial sales started to contract. By 2000, generation from industrial CHP sites was larger than total retail industrial sales.

CHP generation moved up and down over the course of the past decade at between 48 million to 55 million MWh. While CHP generation and industrial sales both fell during the 2008-2009 recession, both have rebounded to relatively healthy levels. In fact, Louisiana CHP generation in 2011 was at all time high of almost 60 million MWh.



Historic Louisiana Industrial Retail Sales and Cogeneration

Since 2009, Louisiana's industrial retail sales have increased by five percent while industrial CHP generation has increased 29 percent, for a combined 16 percent overall increase in CHP generation and industrial use.



Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Estimated Industrial Average Usage by NAICS (2011)

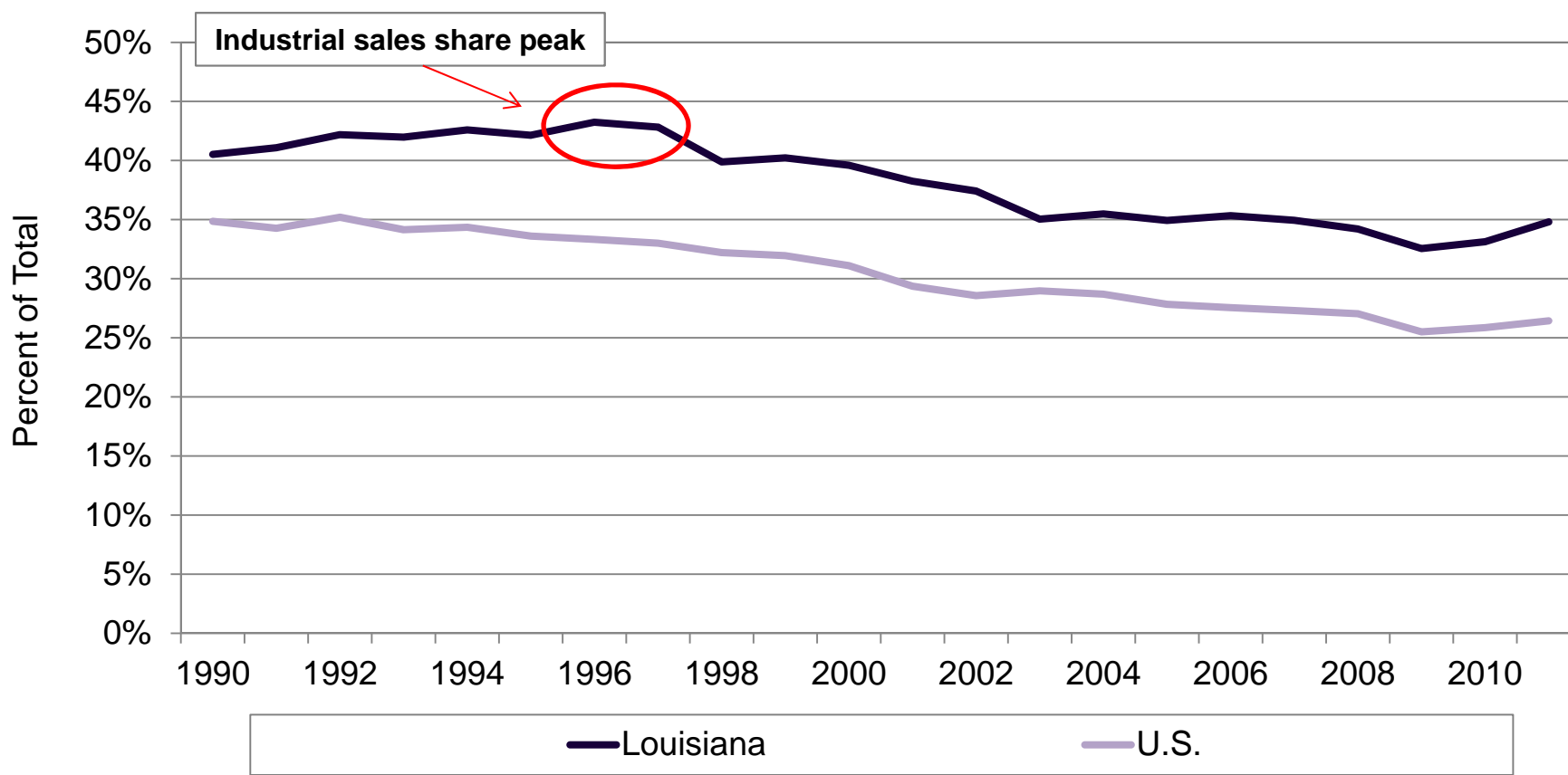
Major industrial electric users include the chemical industry (15.2 million MWh), the refining industry (9.4 million MWh) and the paper products industry (4.0 million MWh). In total, Louisiana industry used 30.1 million MWh.

NAICS Category	Total Electric Use (MWh)	Percent of Total (%)	Per Customer Average Use (MWh)
311-312 Food, Beverage and Tobacco	261,667	0.9%	9,986
313 Textile Mills	4,572	0.0%	5,583
314-315 Textile Products and Apparel	1,010	0.0%	617
316 Leather and Allied Products	1,956	0.0%	1,194
321 Wood Products	165,447	0.6%	14,431
322 Paper Manufacturing	4,032,947	13.4%	378,839
323 Printing and Related Support	38,763	0.1%	3,381
324 Petroleum and Coal Products	9,416,959	31.3%	605,247
325 Chemical Manufacturing	15,159,127	50.4%	272,233
326 Plastics and Rubber	335,630	1.1%	68,310
327 Nonmetallic Minerals	93,505	0.3%	22,837
331 Primary Metal Manufacturing	319,623	1.1%	48,789
332 Fabricated Metal Products	49,419	0.2%	4,642
333 Machinery Manufacturing	107,630	0.4%	6,918
335 Electrical Equip. and Components	14,322	0.0%	17,489
336 Transportation Equipment	53,023	0.2%	6,475
337 Furniture and Related Products	917	0.0%	560
339 Miscellaneous	1,900	0.0%	349
	<b>30,058,415</b>	<b>100.0%</b>	<b>156,197</b>



Industrial Electric Sales as a Percent of Total Electric Sales

In Louisiana, industrial electric sales as a percent of total electric sales have fallen 19.5 percent since their high in 1996. Similarly, during the same period, U.S., industrial electric sales fell just over 20 percent.

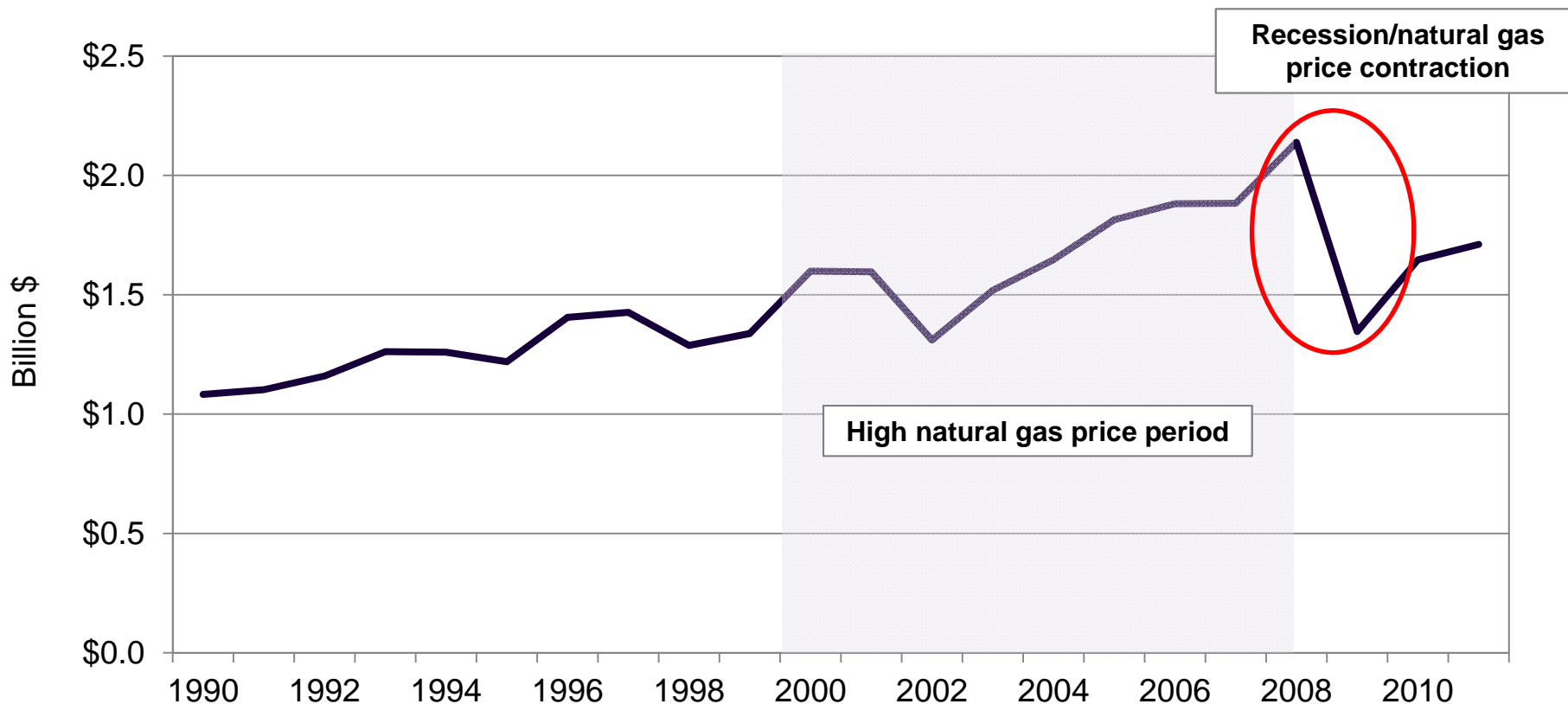






Historic Louisiana Industrial Electric Expenditures

Louisiana industrial electric expenditures increased 63 percent between 2002 and 2008 during a period of high natural gas prices, but have fallen 20 percent since the recession.





**Estimated Industrial Average Electricity Expenditure by NAICS**

**In 2011, the chemical industry spent an estimated \$862.7 million, or \$15.5 million per facility, on electricity purchases. Similarly, the refining industry spent about \$536 million, or \$34.4 million per facility. In total, Louisiana industry spent an estimated \$1.71 billion.**

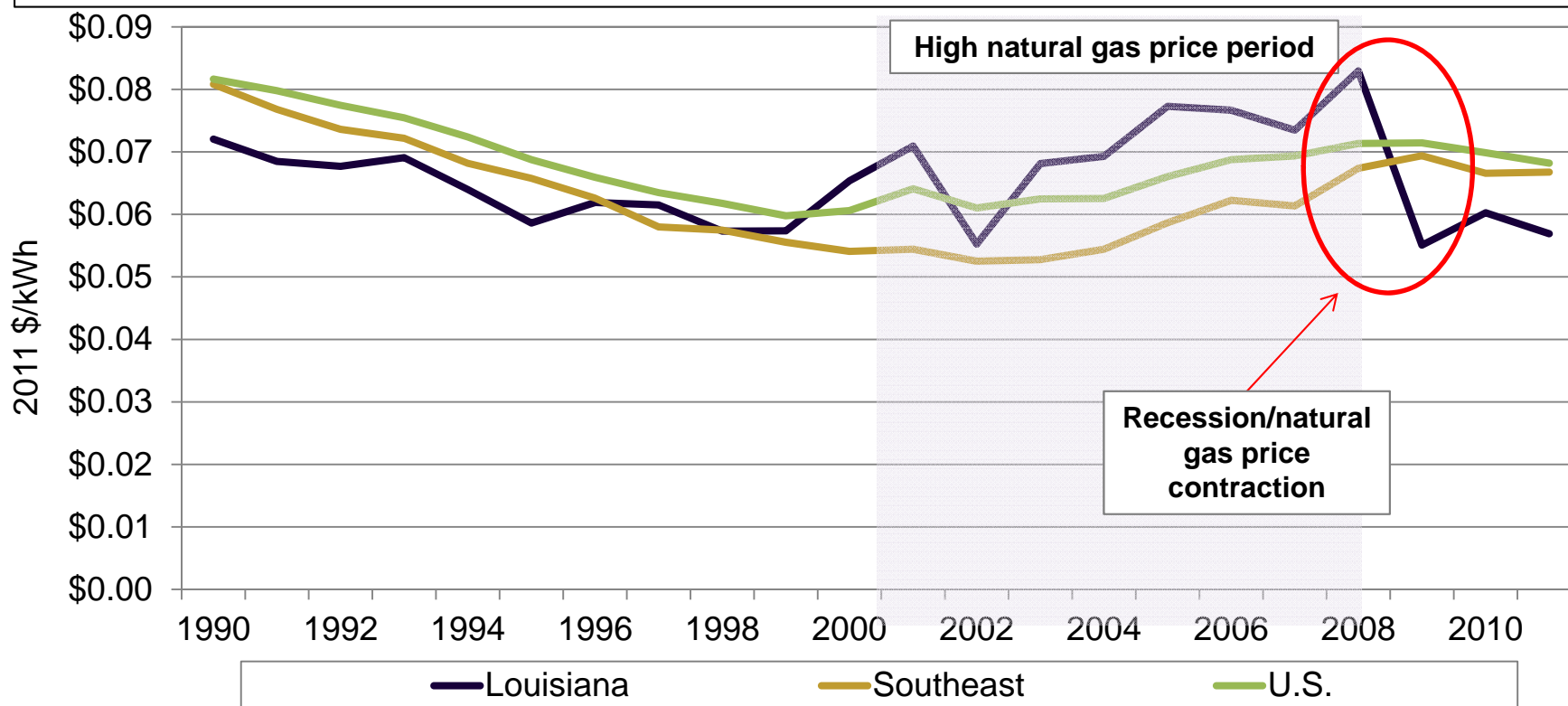
SIC Category	NAICS Category	Estimated Electric Expenditures (thousand \$)	Percent of Total (%)	Per Customer Average Expenditure (thousand \$)
20 Food and Kindred Products	311-312 Food, Beverage and Tobacco	14,891	0.9%	568
22 Textile Mill Products	313 Textile Mills	260	0.0%	318
23 Apparel & Textile Products	314-315 Textile Products and Apparel	57	0.0%	35
31 Leather & Leather Products	316 Leather and Allied Products	111	0.0%	68
24 Lumber and Wood Products	321 Wood Products	9,415	0.6%	821
26 Paper and Allied Products	322 Paper Manufacturing	229,511	13.4%	21,556
27 Printing & Publishing	323 Printing and Related Support	2,206	0.1%	192
29 Petroleum and Coal Products	324 Petroleum and Coal Products	535,910	31.3%	34,439
28 Chemicals and Allied Products	325 Chemical Manufacturing	862,691	50.4%	15,490
30 Rubber & Misc. Plastic Prods.	326 Plastics and Rubber	19,100	1.1%	3,887
32 Stone, Clay & Glass Products	327 Nonmetallic Minerals	5,321	0.3%	1,299
33 Primary Metal Industries	331 Primary Metal Manufacturing	18,189	1.1%	2,776
34 Fabricated Metal Products	332 Fabricated Metal Products	2,812	0.2%	264
35 Machinery & Computer Equip.	333 Machinery Manufacturing	6,125	0.4%	394
36 Electric & Electronic Equip.	335 Electrical Equip. and Components	815	0.0%	995
37 Transportation Equipment	336 Transportation Equipment	3,017	0.2%	368
25 Furniture & Fixtures	337 Furniture and Related Products	52	0.0%	32
39 Misc. Manufacturing Industries	339 Miscellaneous	108	0.0%	20
<b>Total</b>		<b>1,710,595</b>	<b>100.0%</b>	<b>8,888</b>

Note: Assumes a 2011 industrial average retail price of \$56.90/MWh. Source: MIPD.



Regional Industrial Electricity Rate Comparisons (Average Revenues)

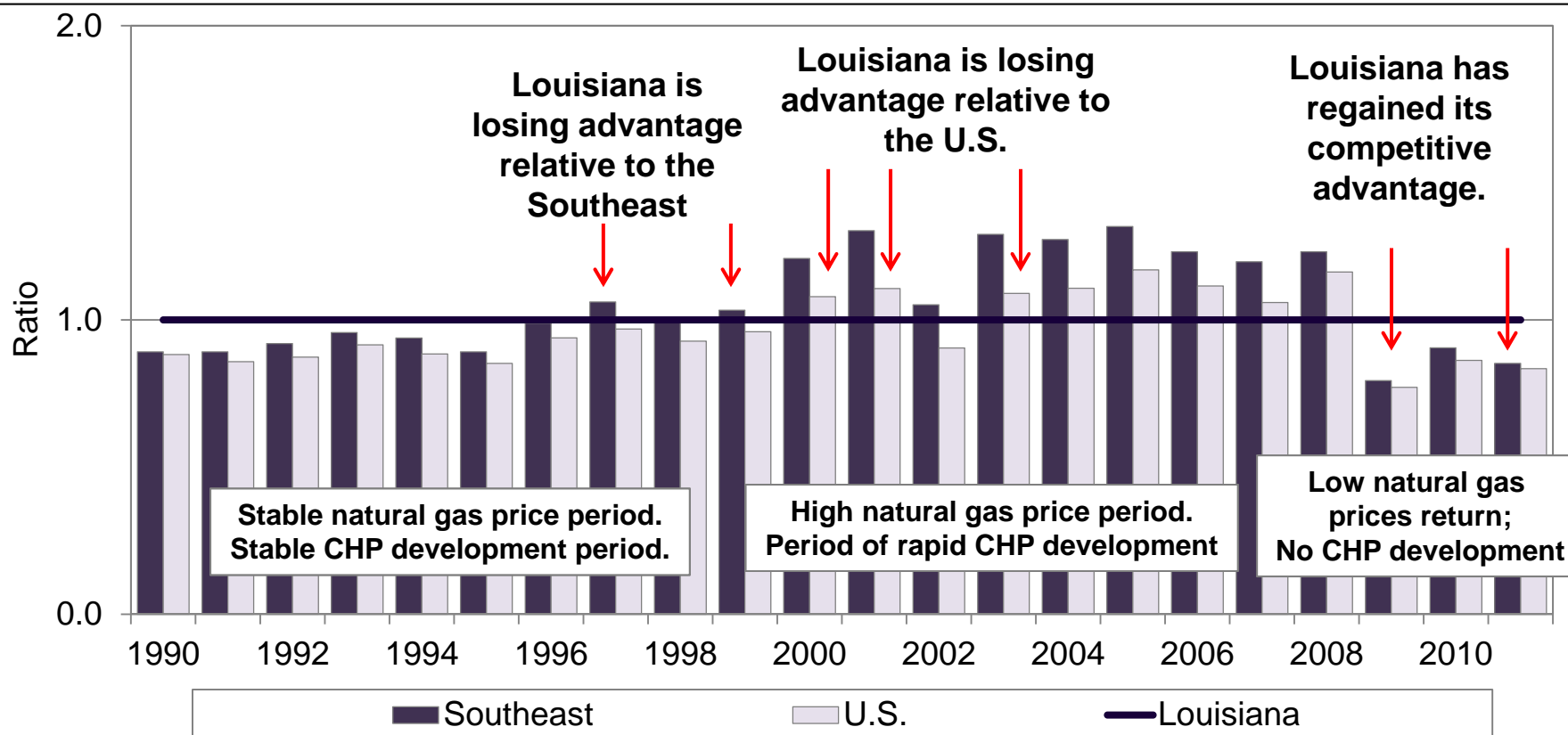
In the 1990s, Louisiana industrial electricity rates were competitive with both the Southeastern and U.S. averages. These advantages however, begin to fade relative to the Southeast in 1996 and the U.S. in 2000. In recent years however, industrial electric rates in Louisiana have fallen and regained their competitive state.



Note: Average Revenues are for the "Total Electric Industry," which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Source: Energy Information Administration, U.S. Department of Energy.

**Industrial Electricity Rate Competitiveness (Average Revenue)**

**Louisiana’s rates are compared as a ratio to both the Southeastern and U.S. averages. A ratio of 1.0 or less means that Louisiana’s industrial rates are equal or less than the Southeastern or national average. A ratio greater than 1.0 means that Louisiana’s industrial rates are higher than the Southeastern or national average.**

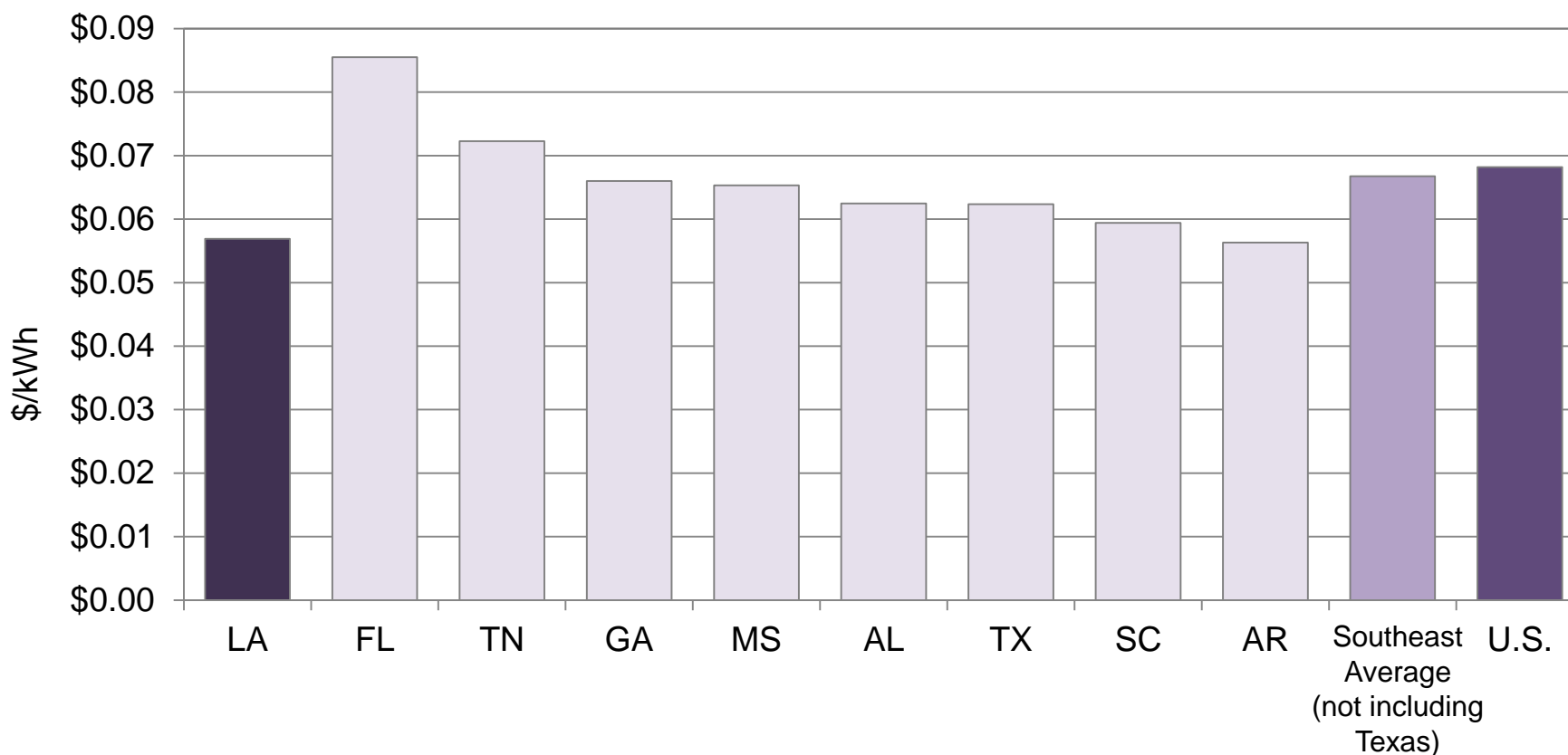


Note: Average Revenues are for the “Total Electric Industry,” which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Source: Energy Information Administration, U.S. Department of Energy. © LSU Center for Energy Studies 28



Southeastern Rate Competitiveness (Average Revenues)

In 2011, Louisiana had the lowest retail industrial rates in the southeast; some 33 percent lower than those in Florida and nine percent lower than those in Texas.



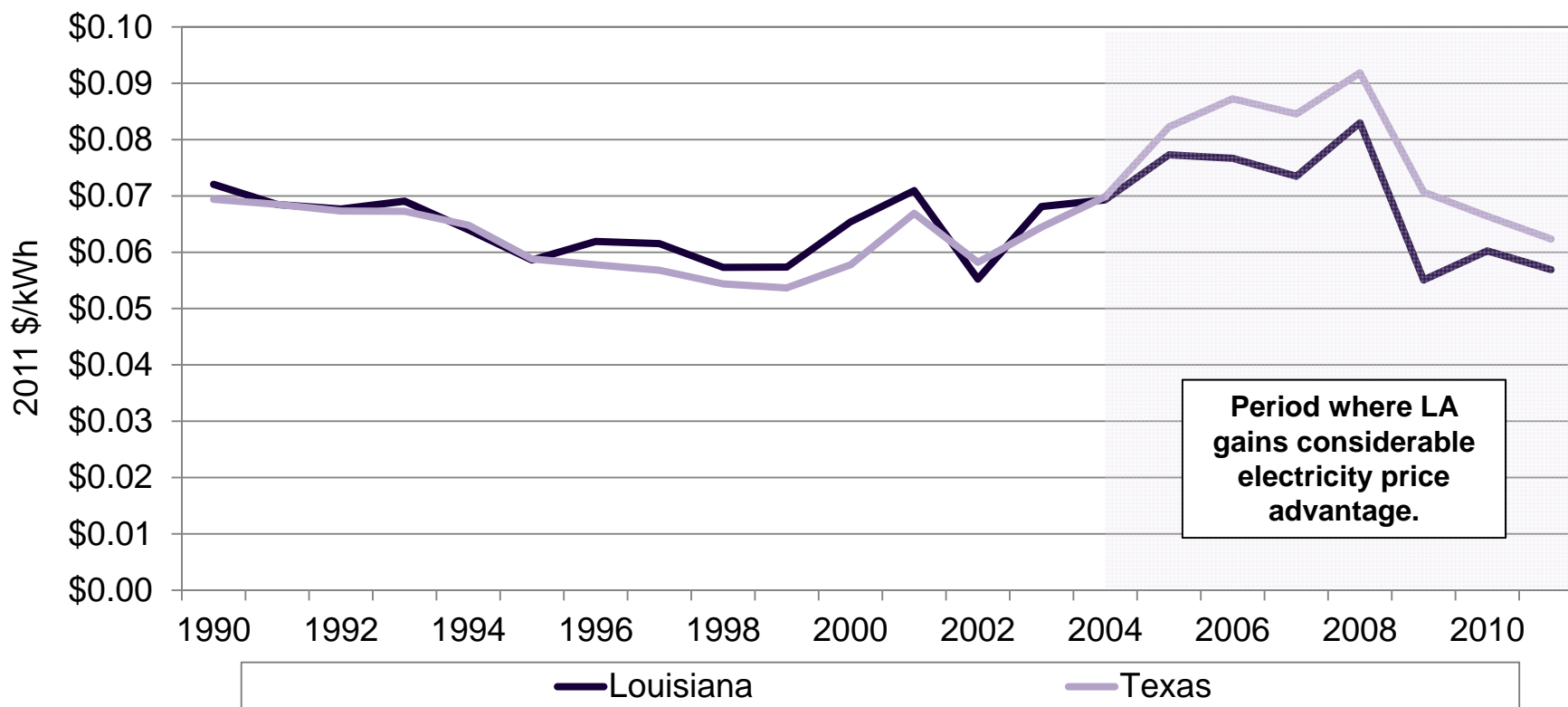
Note: Average Revenues are for the "Total Electric Industry," which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Pursuant to Texas statutes establishing competitive electricity markets within ERCOT, all customers served by Retail Energy Providers must be provided bundled energy and delivery services, so they are included under "Full-Service Providers".

Source: Energy Information Administration, U.S. Department of Energy.



Historic Louisiana and Texas Industrial Average Revenue

**Texas and Louisiana compete for many of the same types of industry (chemicals, refining). The differences between LA and TX rates tend to be less determined by natural gas prices (since both states rely heavily on natural gas) than other factors.**

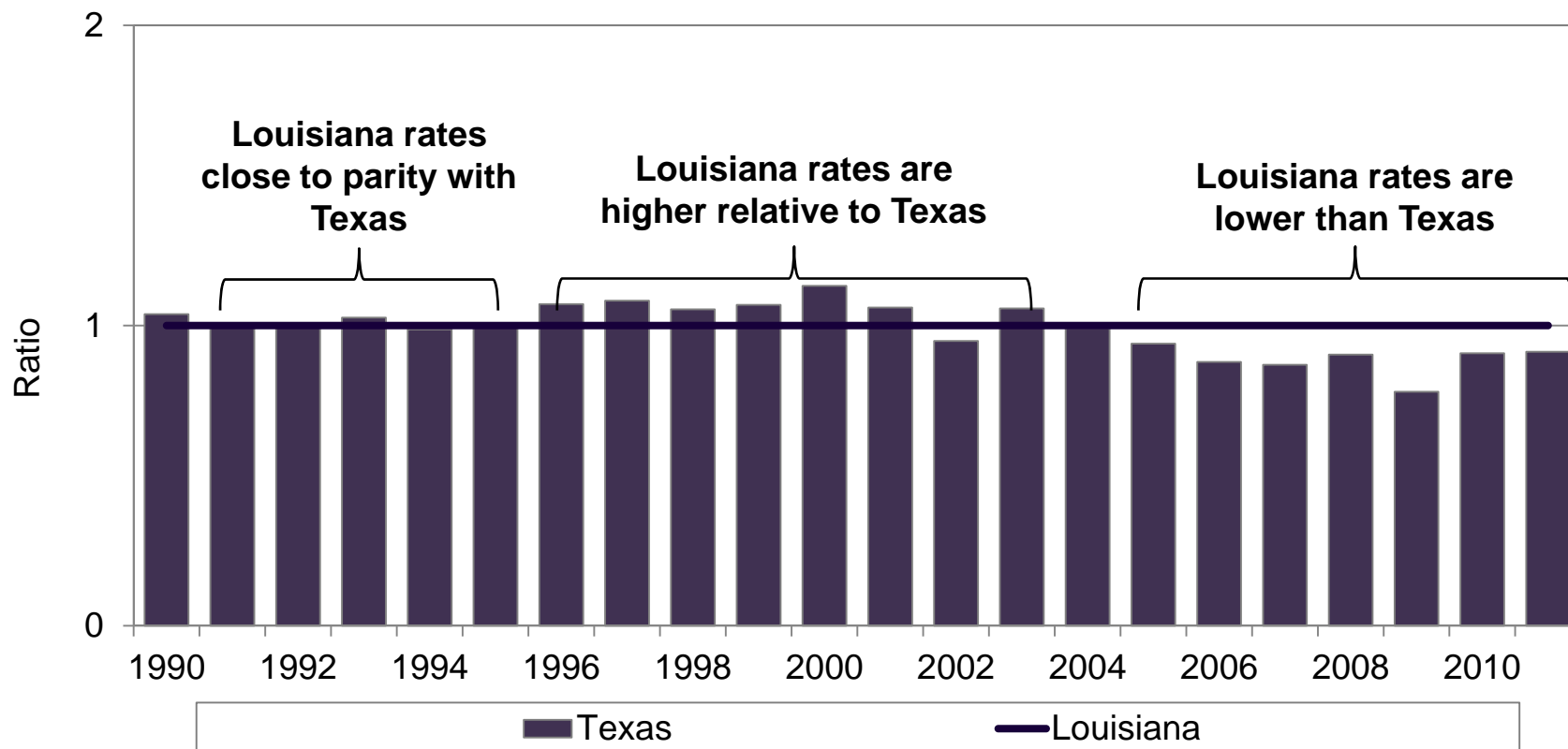


Note: Average Revenues are for the "Total Electric Industry," which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Pursuant to Texas statutes establishing competitive electricity markets within ERCOT, all customers served by Retail Energy Providers must be provided bundled energy and delivery services, so they are included under "Full-Service Providers".

Source: Energy Information Administration, U.S. Department of Energy.

**Historic Louisiana Industrial Average Revenue Relative to Texas**

**Unlike the southeastern comparisons presented earlier, Louisiana regained its competitive advantage in terms of electric cost against Texas going back to as far as 2005.**



Note: Average Revenues are for the "Total Electric Industry," which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Pursuant to Texas statutes establishing competitive electricity markets within ERCOT, all customers served by Retail Energy Providers must be provided bundled energy and delivery services, so they are included under "Full-Service Providers".  
 Source: Energy Information Administration, U.S. Department of Energy.



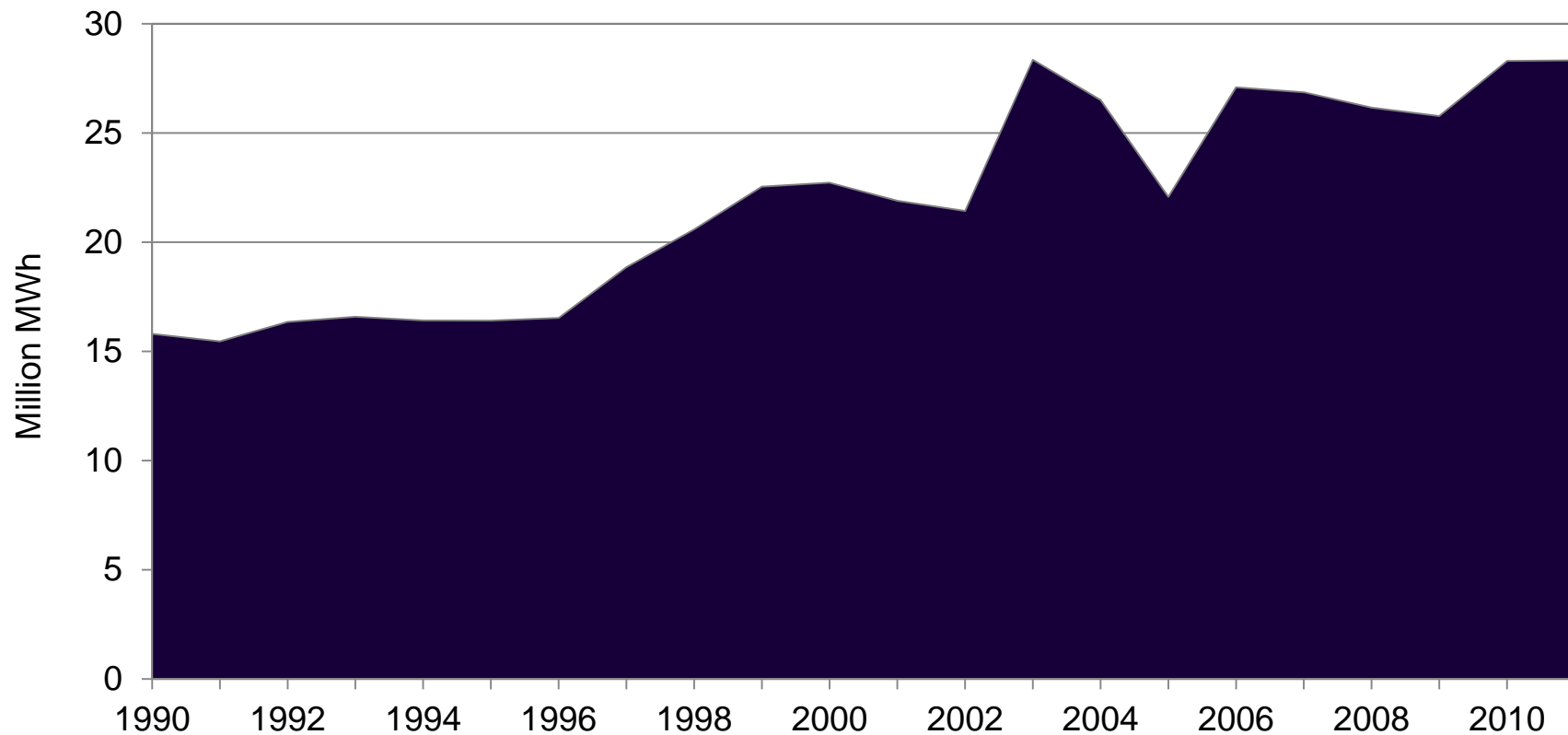
## **Section 4: Overview – Louisiana Cogeneration Trends**





Louisiana Industrial Cogeneration

In Louisiana, generation from industrial CHP facilities has increased 71 percent since 2006.

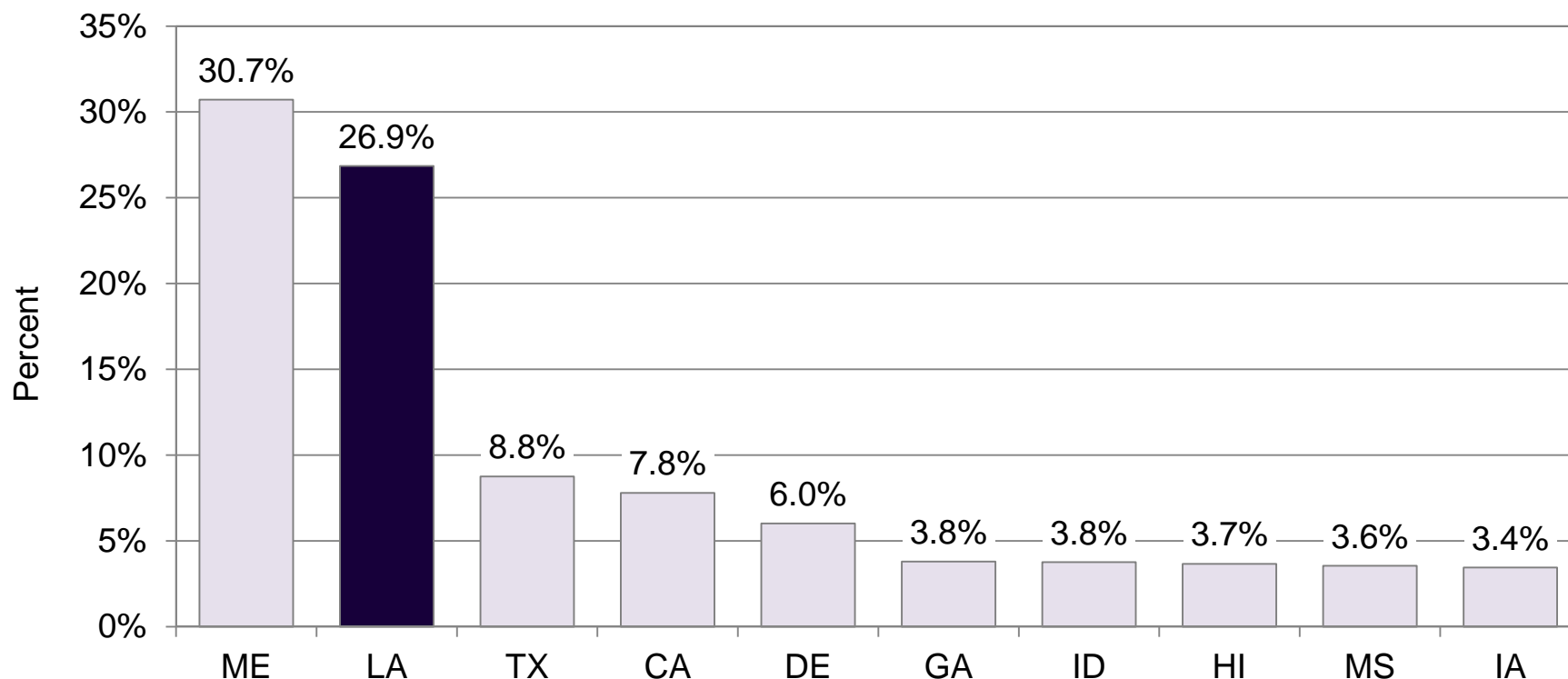


Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Industrial Cogeneration as a Percent of Total State Generation (2011)

Almost 27 percent of Louisiana's electricity is generated at industrial CHP facilities: a level considerably more significant than just about any other state including Texas.

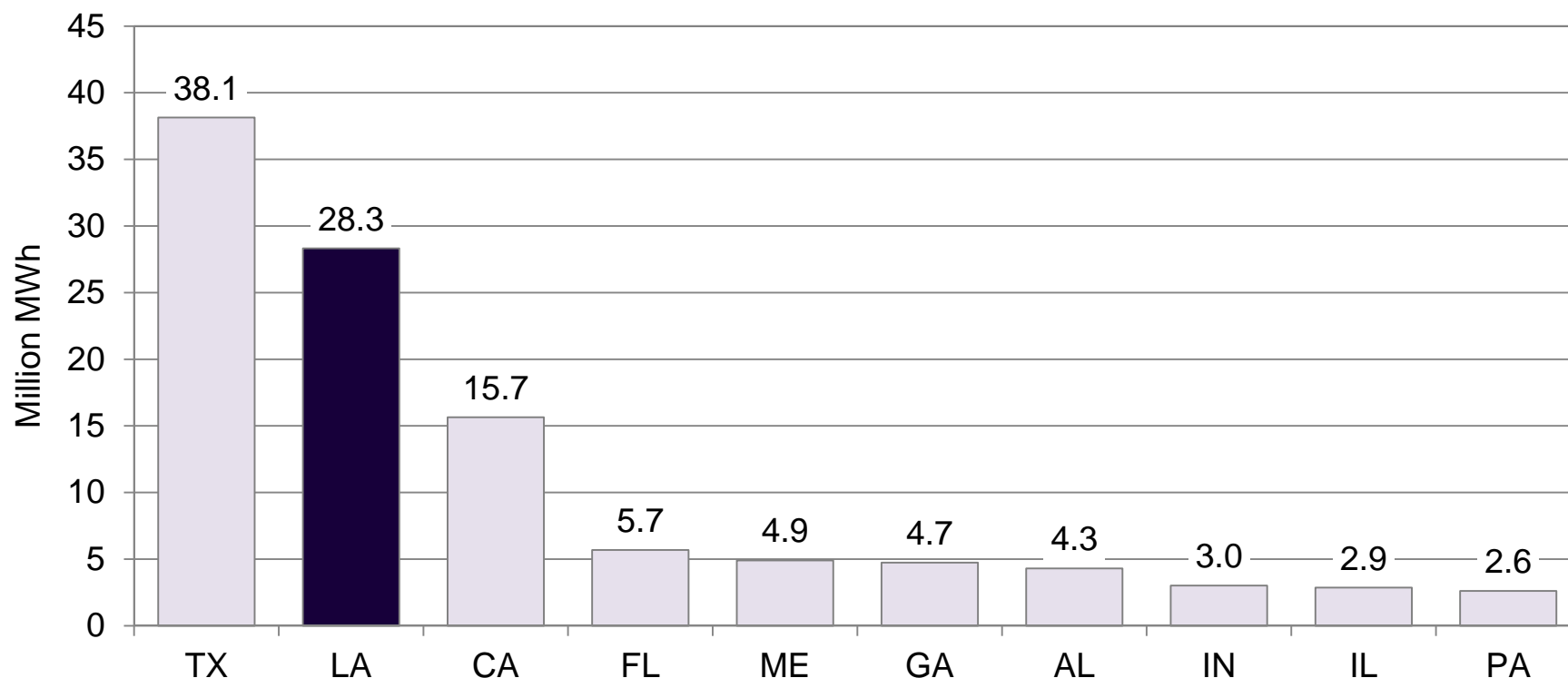


Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Industrial Cogeneration by State (2011)

In 2011, Louisiana's industries generated over 28 million MWh of electricity, making it the second largest industrial CHP generator (in absolute terms).

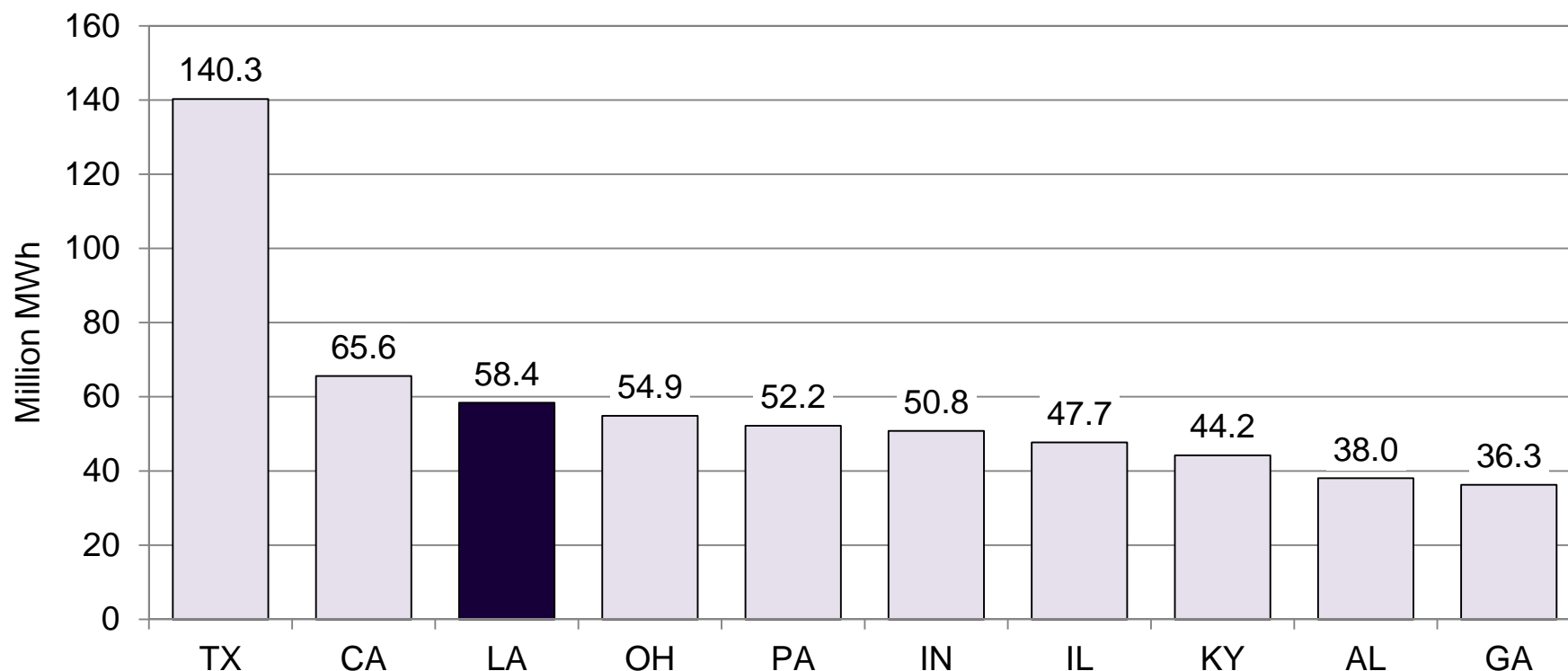


Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Combined Industrial Usage and CHP Generation Comparison (2011)

Louisiana ranks third in combined industrial usage and CHP.

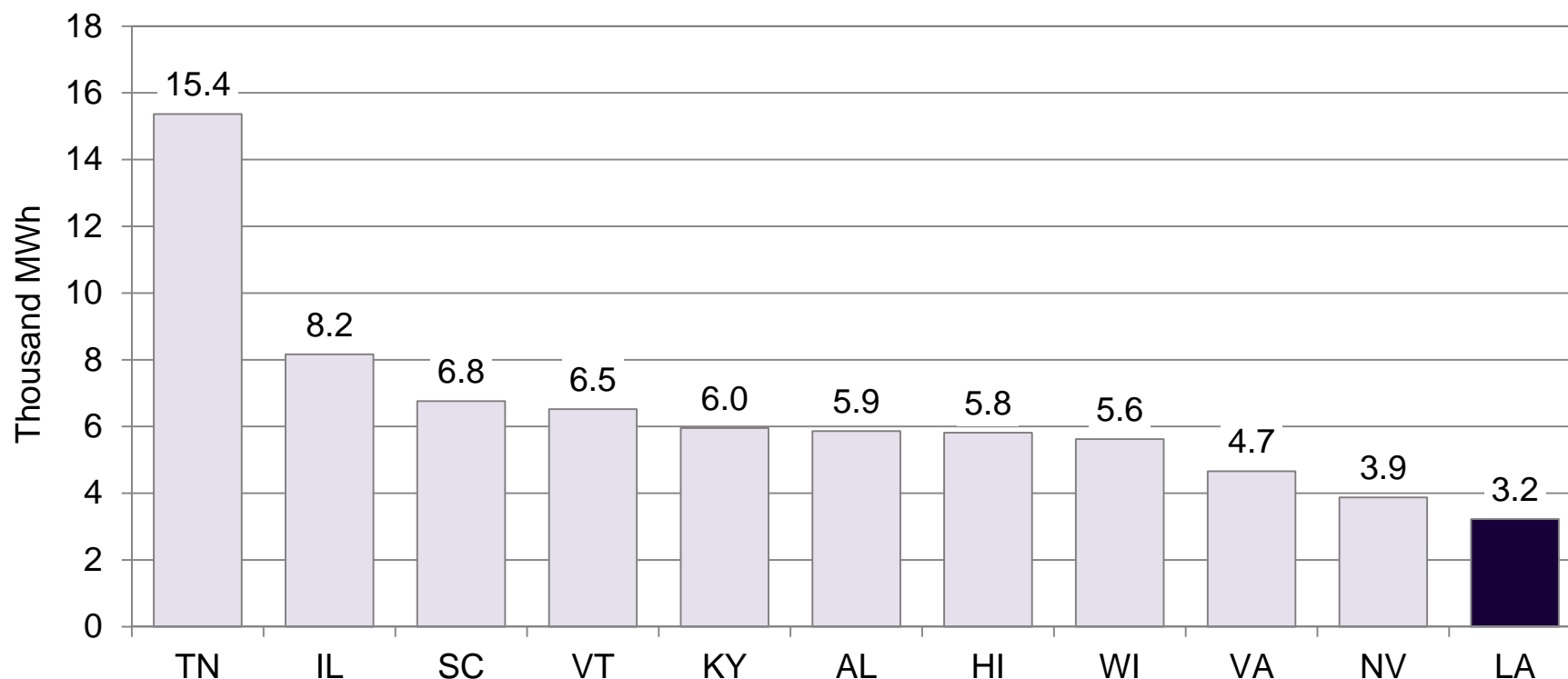


Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



Industrial Usage/CHP per Customer (2011)

Louisiana has a considerable combined usage/CHP efficiency. While the state ranks second in its shares of CHP relative to total generation, and third in overall CHP/usage, it ranks 11<sup>th</sup> in overall use per industrial customer.



Note: Includes Industrial CHP only, as defined by Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.

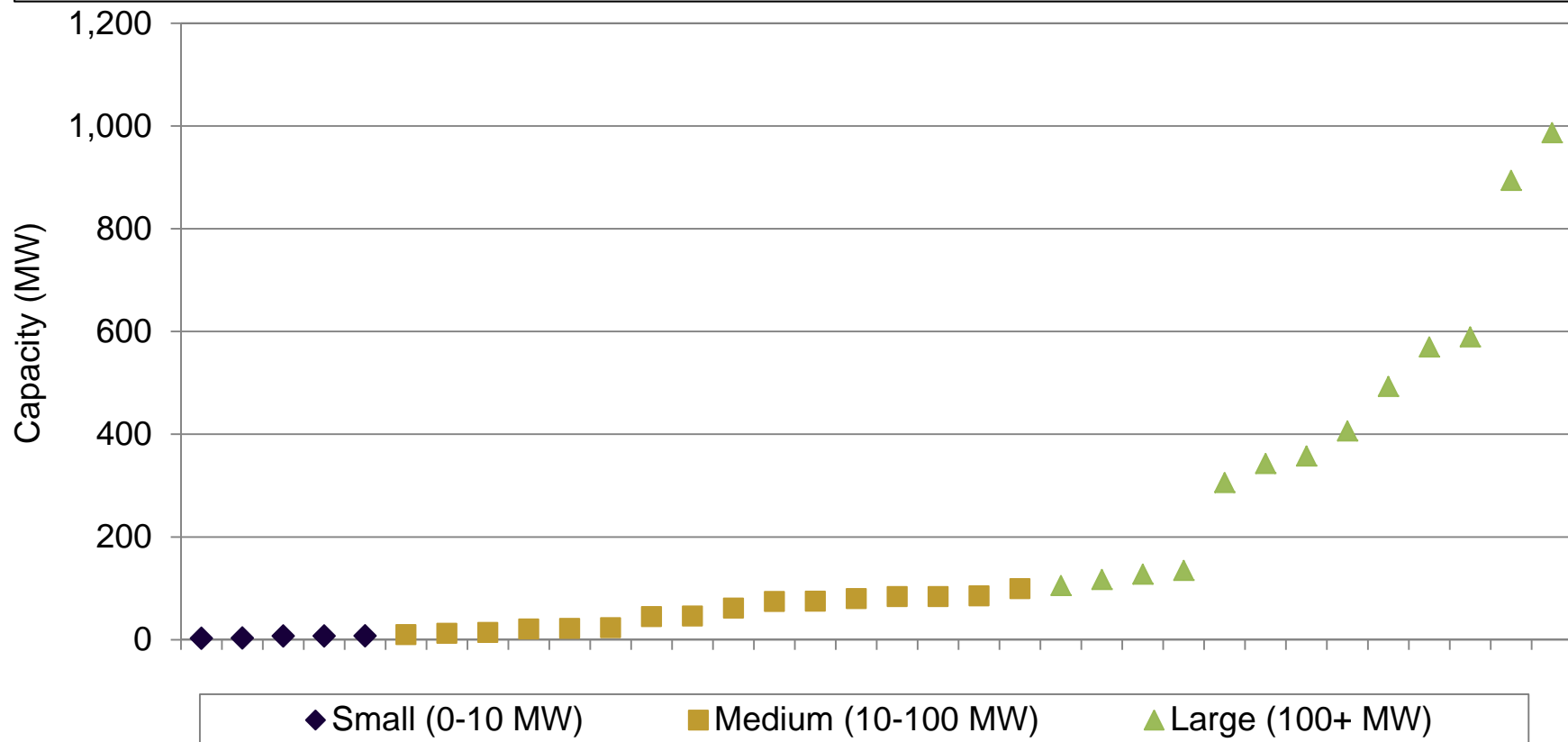


## **Section 5: Unit Specific CHP Statistics and Trends**



Louisiana CHP Facilities by Capacity

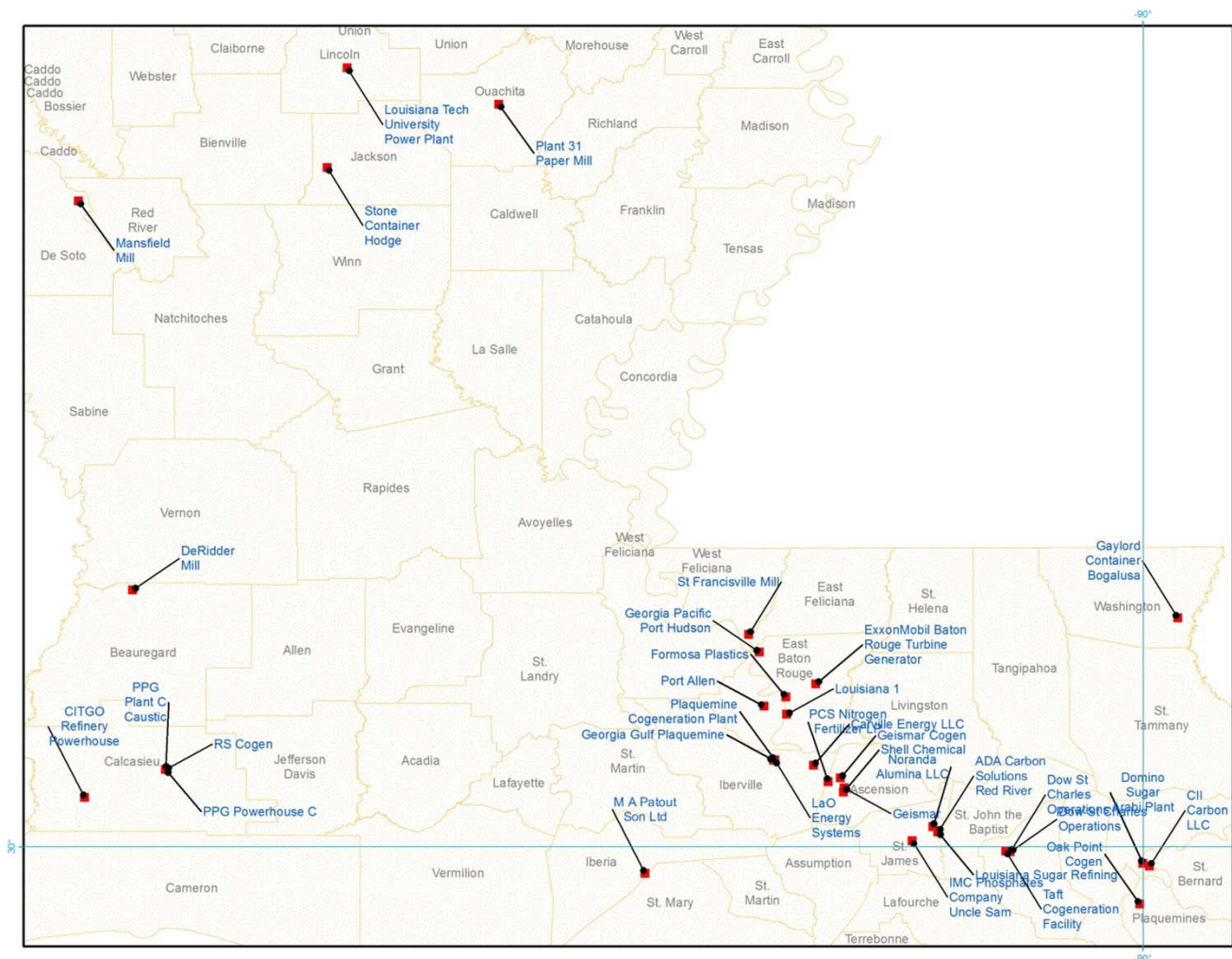
There are 35 CHP facilities in Louisiana. These facilities range in size from 3 MW to 987 MW. Five facilities are considered small, or up to 10 MW; 16 facilities are medium (between 10 and 100 MW); and 13 are large, or greater than 100 MW. The large facilities account for 86 percent of total capacity.





Louisiana CHP Facilities Location

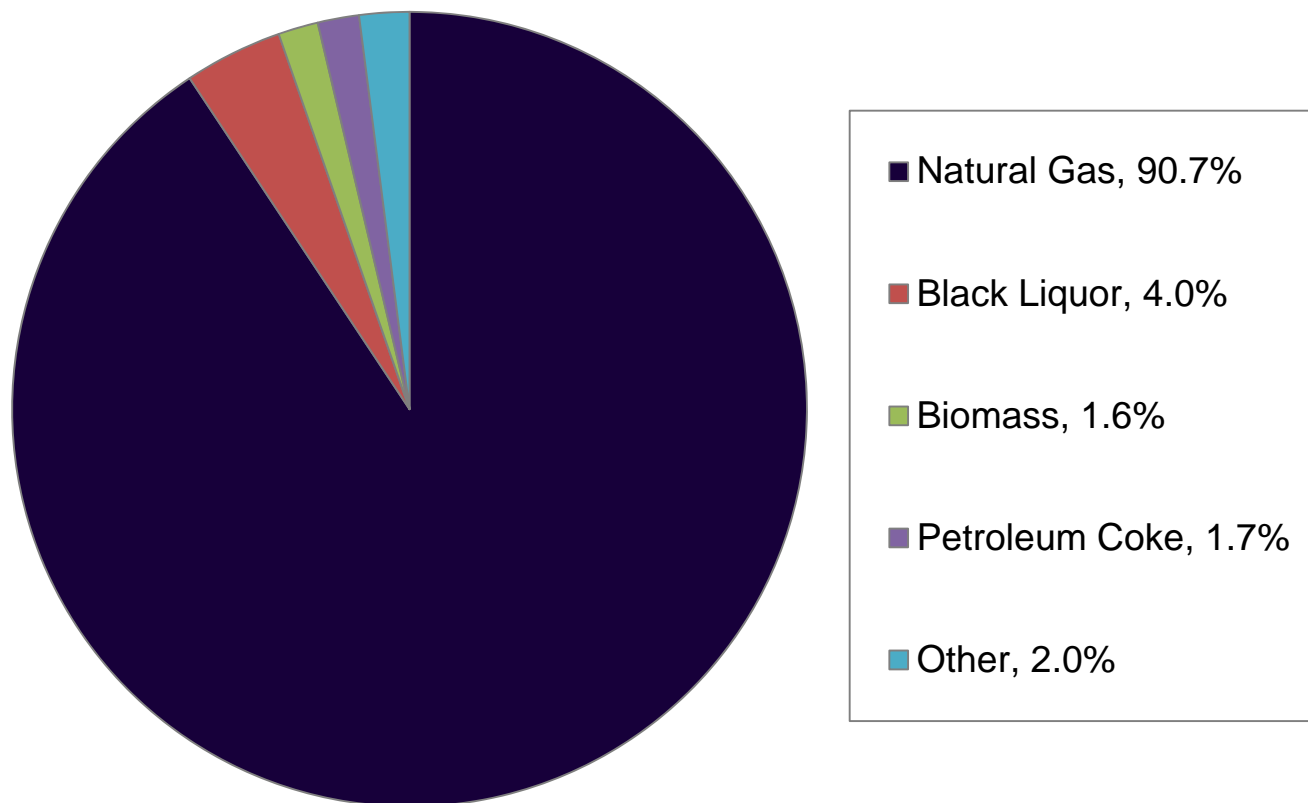
Louisiana's 35 CHP facilities are located throughout the state with a large concentration along the river corridor.





**CHP Capacity by Fuel Type**

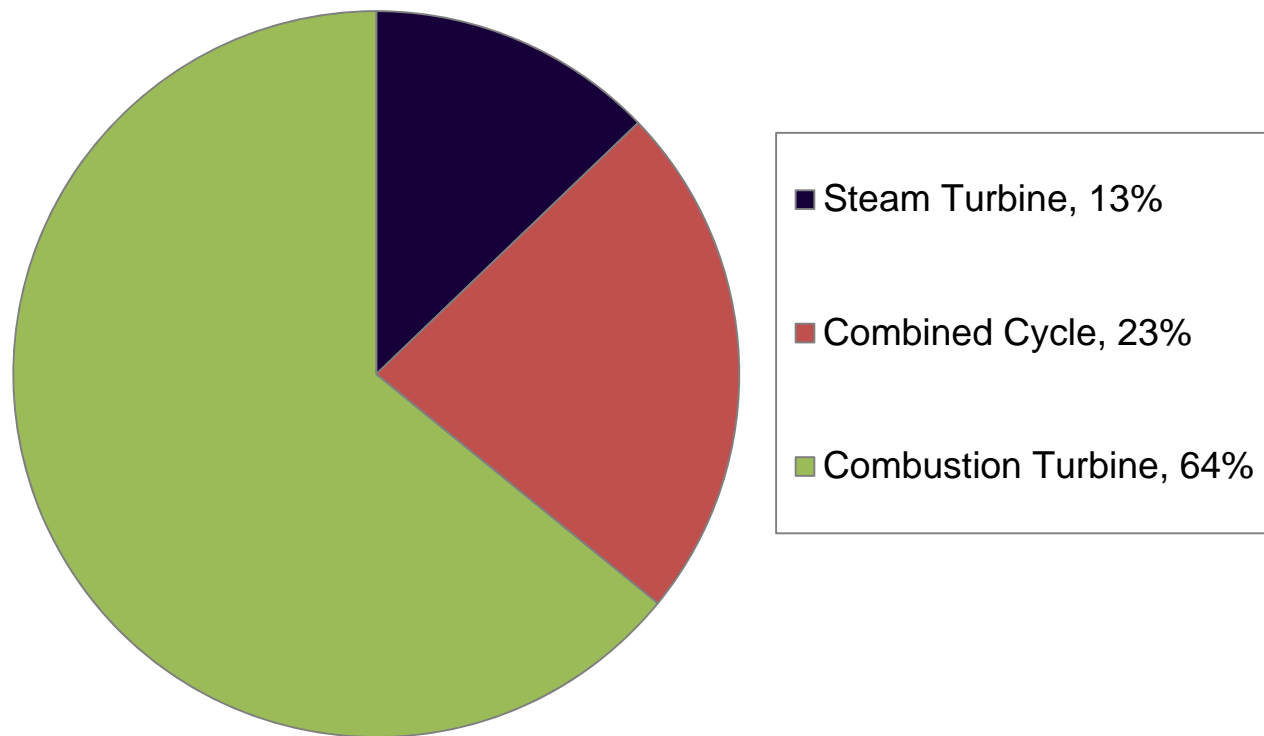
**Natural gas fuels an overwhelming share of the CHP capacity in Louisiana.**





CHP Capacity by Prime Mover

Combustion turbines are the predominant prime mover at most Louisiana CHP facilities. Older legacy steam turbines are still utilized at a number of facilities and account for 13 percent of the state's CHP capacity. Relatively newer and highly efficiency combined cycle facilities account for 23 percent of the total CHP capacity.

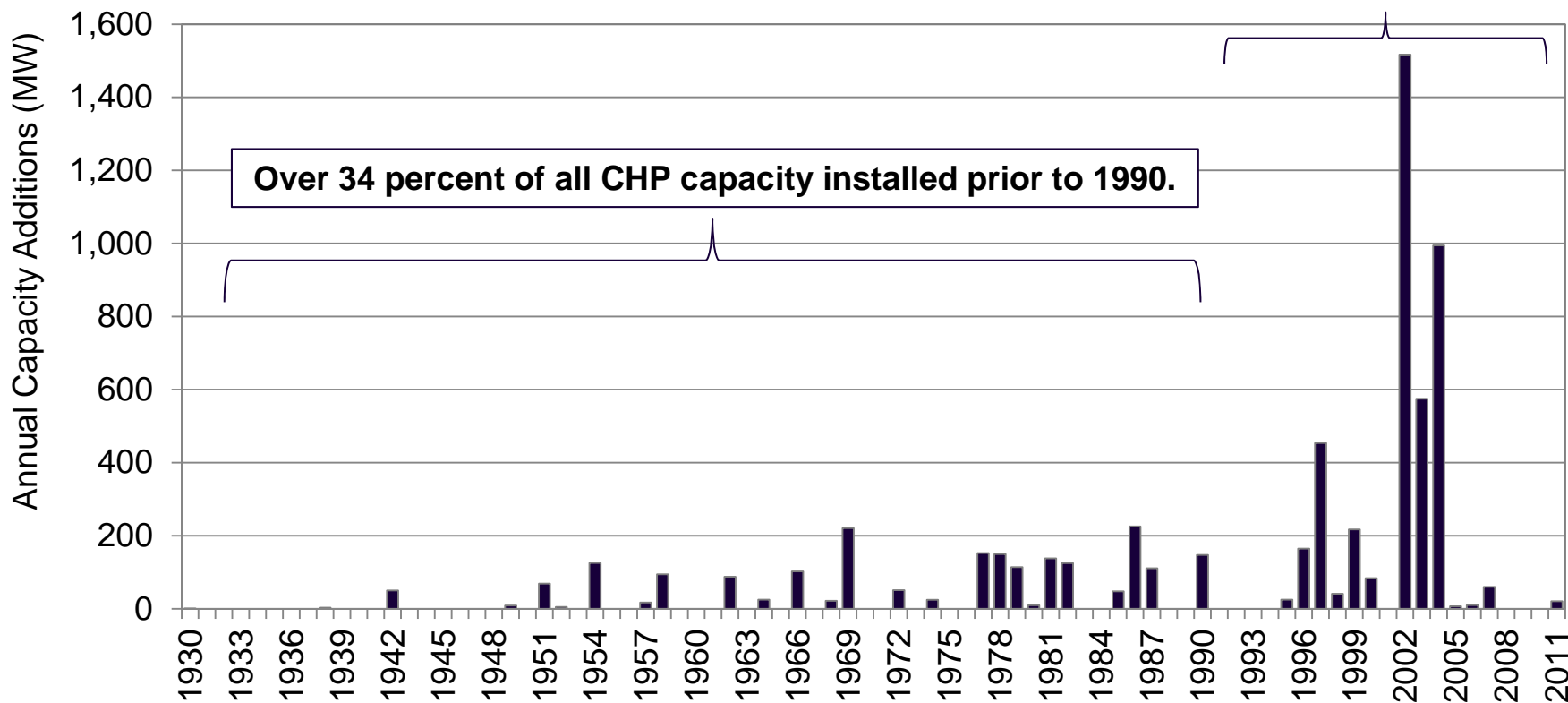




CHP Capacity by Installation Year

Over 1,500 MW (24 percent) of CHP capacity was installed in Louisiana in 2002 alone. Most capacity was developed after 1990.

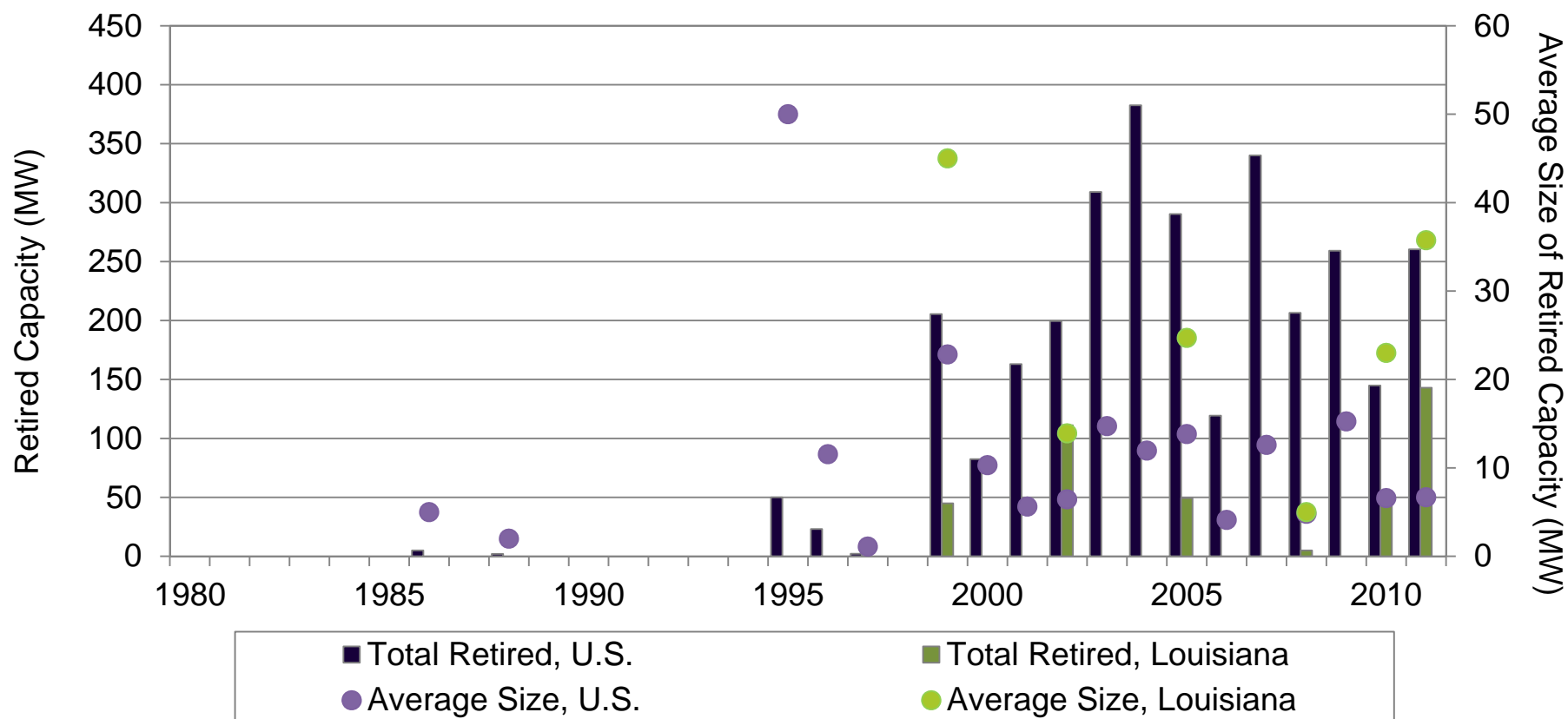
About 66 percent of all CHP capacity installed after 1990.





U.S. and Louisiana CHP Retirements

The majority of CHP retirements do not take place until post-2000 and most are less than 20 MW in size.



Note: Includes Commercial CHP, Industrial CHP and IPP CHP as defined by the Energy Information Administration.  
Source: Energy Information Administration, U.S. Department of Energy.



CHP Capacity by Vintage and Sector

Legacy units (pre-1990) account for 34 percent of installed CHP capacity. Only chemical manufacturing units have a greater share of new capacity.

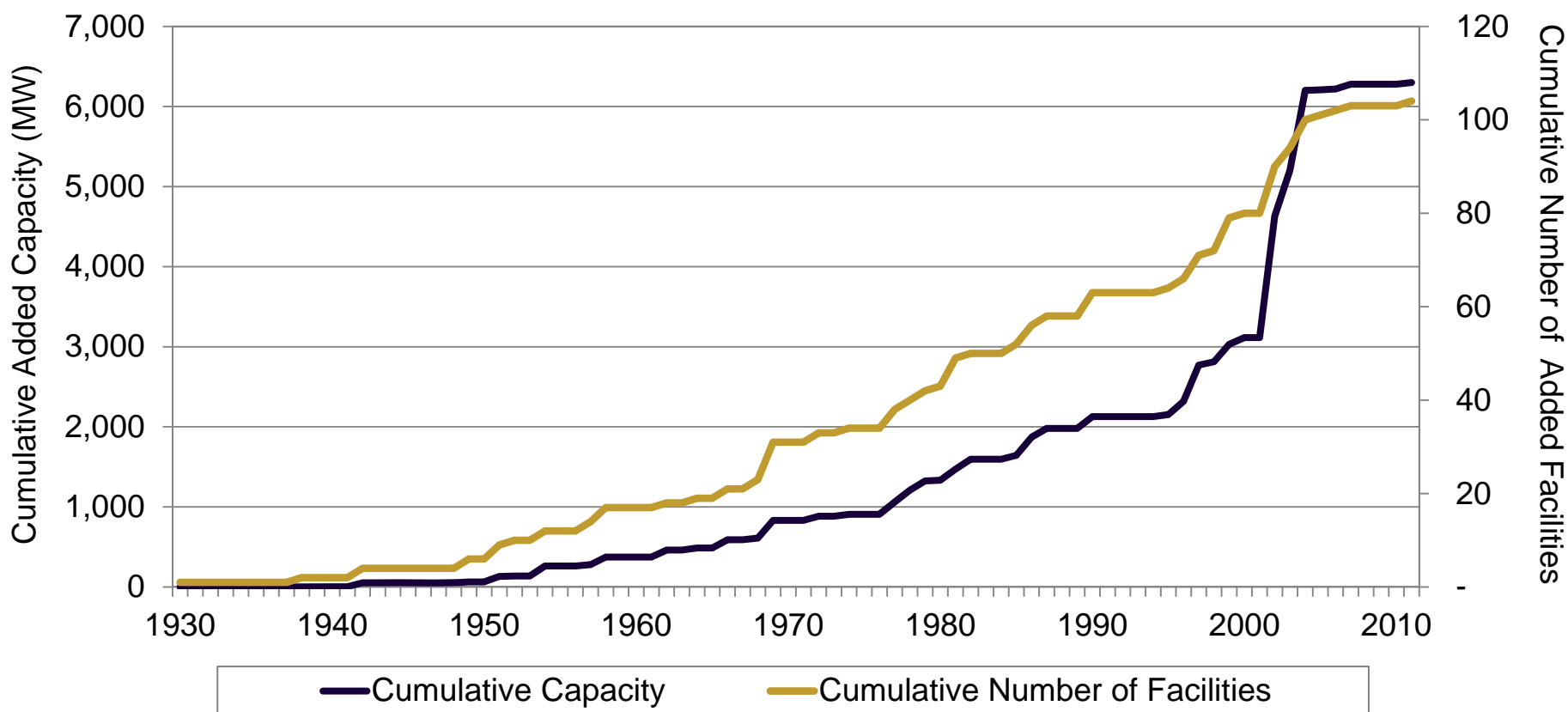
NAICS	Legacy Units (MW)	New Units (MW)	Legacy Units (%)	New Units (%)
311-312 Food, Beverage and Tobacco	19	5	79.5%	20.5%
322 Paper Manufacturing	434	122	78.0%	22.0%
324 Petroleum and Coal Products	463	180	72.0%	28.0%
325 Chemical Manufacturing	1,176	3,807	23.6%	76.4%
331 Primary Metal Manufacturing	36	48	42.4%	57.6%
Misc	-	8	0.0%	100.0%
<b>Total</b>	<b>2,128</b>	<b>4,171</b>	<b>33.8%</b>	<b>66.2%</b>

Note: The "Misc" category includes the Louisiana Tech University Power Plant in Lincoln Parish.



### Cumulative Added CHP Capacity by Installation Year

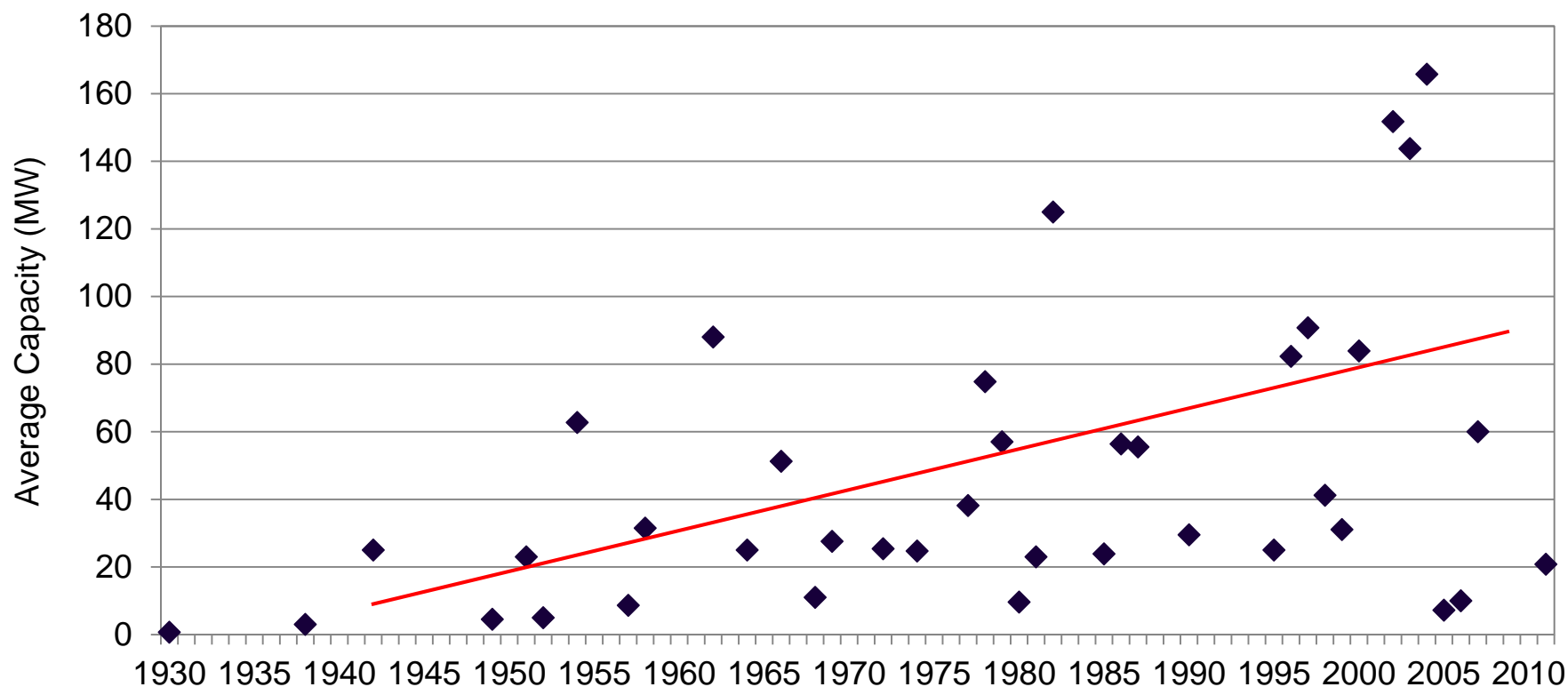
**Before 2002, just 50 percent of current CHP and self-generating capacity had been installed. These facilities however represent 77 percent of the total number of installed facilities.**





Average Installed Capacity (MWs)

The average size of CHP units has increased over time.





**CHP Capacity and Average Capacity by Sector**

**In Louisiana, CHP capacity totals 6,300 MW. Chemical manufacturing is the largest category, accounting for almost 5,000 MW, or about 80 percent of total CHP capacity. These units also tend to be the largest, averaging 91 MW per unit.**

<b>NAICS</b>	<b>Capacity (MW)</b>	<b>Percent of Total</b>	<b>Average Capacity (MW)</b>
311-312 Food, Beverage and Tobacco	24	0.4%	2.7
322 Paper Manufacturing	556	8.8%	30.9
324 Petroleum and Coal Products	644	10.2%	35.8
<b>325 Chemical Manufacturing</b>	<b>4,984</b>	<b>79.1%</b>	<b>90.6</b>
331 Primary Metal Manufacturing	84	1.3%	28.0
Misc	8	0.1%	7.5
<b>Total</b>	<b>6,299</b>	<b>100.0%</b>	<b>60.6</b>

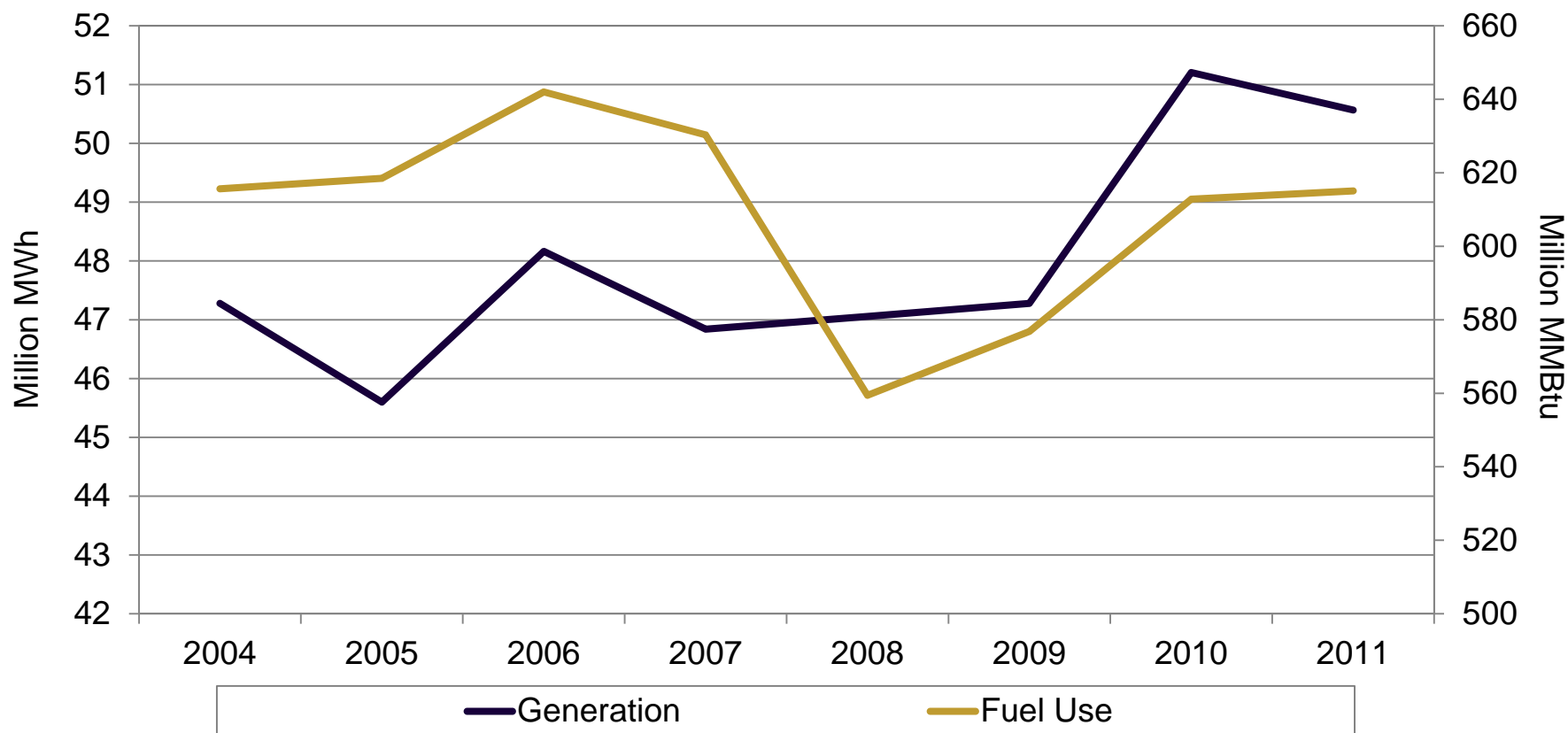
Note: The "Misc" category includes the Louisiana Tech University Power Plant in Lincoln Parish.





CHP Generation

In Louisiana, CHP generation has increased 7 percent since 2004.





CHP Fuel Use by Sector

Similar to generation, chemical manufacturing consumes the largest amount of fuel (mostly natural gas), followed by paper manufacturing.

NAICS	Fuel Use (MMBtu)	Percent of Total (%)
311-312 Food, Beverage and Tobacco	2,191,009	0.5%
322 Paper Manufacturing	88,335,571	20.4%
324 Petroleum and Coal Products	28,028,960	6.5%
325 Chemical Manufacturing	302,281,272	69.8%
331 Primary Metal Manufacturing	11,734,935	2.7%
Misc	579,163	0.1%
<b>Total</b>	<b>433,150,910</b>	<b>100.0%</b>

Note: The "Misc" category includes the Louisiana Tech University Power Plant in Lincoln Parish.



CHP Average Heat Rate by Sector

The chemical manufacturing CHP units operate the most efficiently in terms of heat rate.

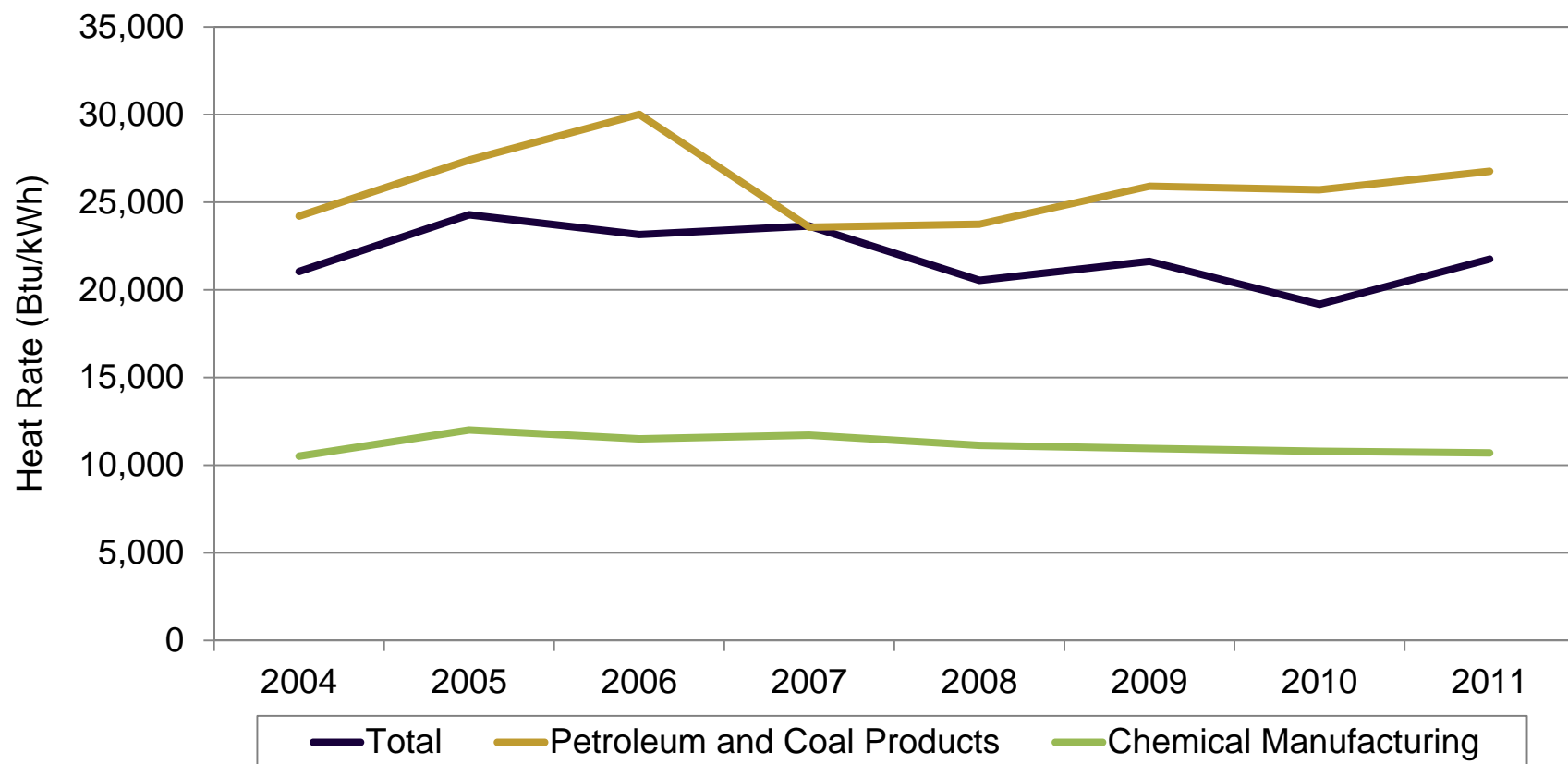
NAICS	Average Heat Rate (Btu/kWh)
311-312 Food, Beverage and Tobacco	54,858
322 Paper Manufacturing	27,590
324 Petroleum and Coal Products	26,758
325 Chemical Manufacturing	10,700
331 Primary Metal Manufacturing	19,871
Misc	12,315
<b>Average</b>	<b>21,749</b>

Note: The "Misc" category includes the Louisiana Tech University Power Plant in Lincoln Parish.



CHP Average Heat Rate

The average heat rates (efficiency measures) have stayed about the same over the past several years, improving somewhat for the chemical sector.





Ten Most Efficient CHP Facilities (2011)

Eight of the ten most efficient facilities operate in the chemical manufacturing industry.

Company	Facility	NAICS	Capacity (MW)	Average Heat Rate (Btu/kWh)
Occidental Chemical Corporation	Taft Cogeneration Facility	325 Chemical Manufacturing	894	7,480
PPG Industries Inc	RS Cogen	325 Chemical Manufacturing	493	8,254
Carville Energy LLC	Carville Energy LLC	325 Chemical Manufacturing	570	8,414
Dow Chemical Co	LaO Energy Systems	325 Chemical Manufacturing	590	8,505
Mosaic Phosphates Co.	IMC Phosphates Company Uncle Sam	325 Chemical Manufacturing	22	9,716
ADA Carbon Solutions LLC	ADA Carbon Solutions Red River	325 Chemical Manufacturing	21	9,716
IPC-Mansfield Mill	Mansfield Mill	322 Paper Manufacturing	135	9,927
Formosa Plastics Corp	Formosa Plastics	325 Chemical Manufacturing	106	11,205
Dow Chemical Co	Plaquemine Cogeneration Plant	325 Chemical Manufacturing	987	11,774
Exxon Mobil Baton Rouge Refinery	ExxonMobil Baton Rouge	324 Petroleum and Coal Prod	85	12,053



CHP Capacity Utilization

CHP production in the primary metal industries is the most utilized, as are paper manufacturing.

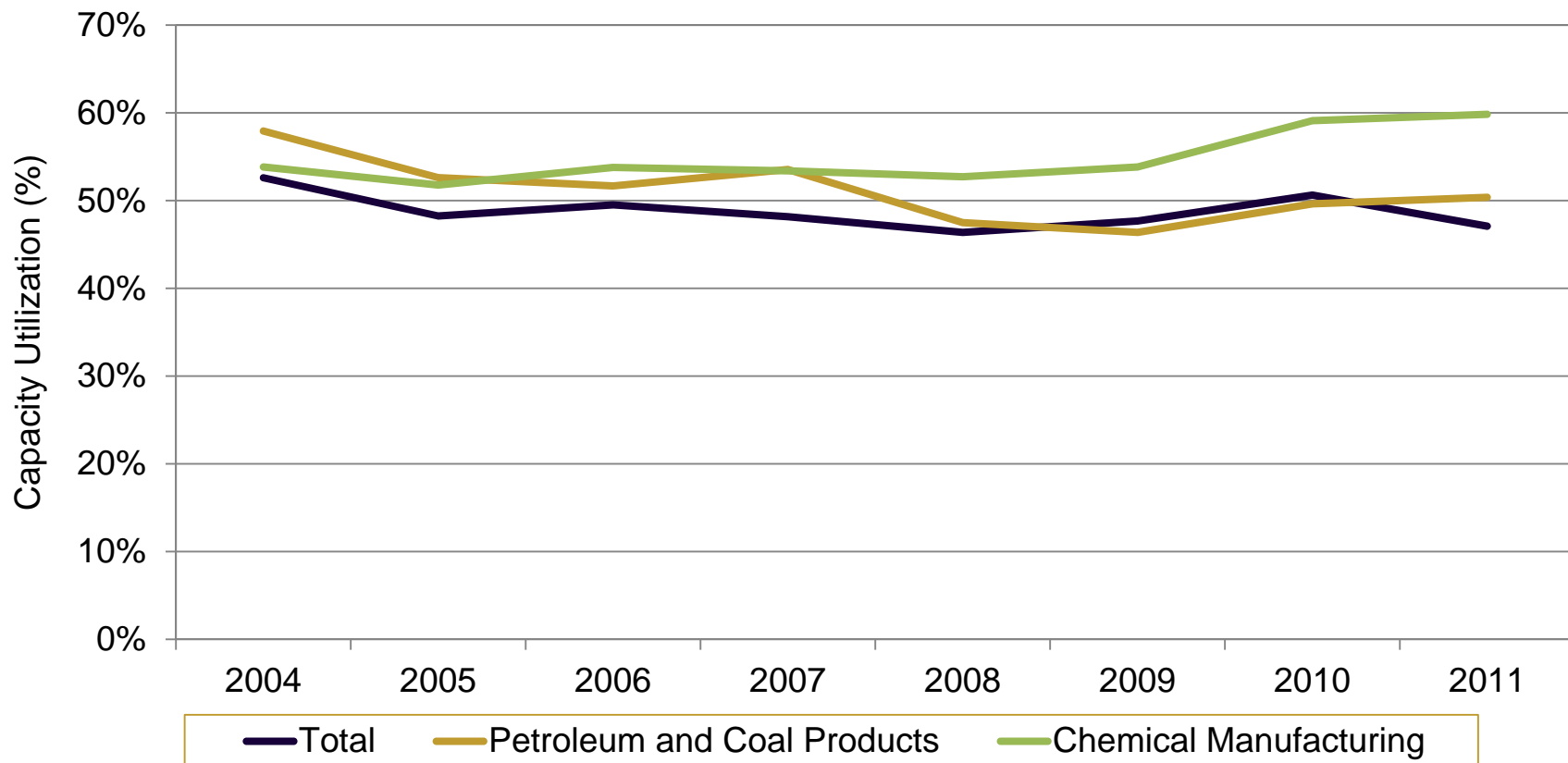
NAICS	Capacity Utilization (%)
311-312 Food, Beverage and Tobacco	18.7%
322 Paper Manufacturing	65.8%
324 Petroleum and Coal Products	18.6%
325 Chemical Manufacturing	64.7%
331 Primary Metal Manufacturing	80.2%
Misc	71.6%
<b>Average</b>	<b>60.1%</b>

Note: The “Misc” category includes the Louisiana Tech University Power Plant in Lincoln Parish.



### CHP Capacity Utilization

Capacity utilization has fallen over 10 percent since 2004 for all industries. Chemical industry utilization, however, on average has seen a mild increase, over the past decade.





Ten Highest Capacity Utilization Factors, CHP Facilities (2011)

The ten most utilized facilities come from each of the Louisiana manufacturing categories: chemicals, paper, primary metals and refineries.

Company	Facility	NAICS	Capacity (MW)	Capacity Utilization (%)
Exxon Mobil Baton Rouge Refinery	ExxonMobil Baton Rouge	324 Petroleum and Coal Products	85	86.3%
Air Liquide America Corp	Shell Chemical	325 Chemical Manufacturing	80	83.9%
Entergy Gulf States - LA LLC	Louisiana 1	325 Chemical Manufacturing	406	79.3%
BASF Corporation	Geismar	331 Primary Metal Manufacturing	84	77.1%
Placid Refining Co LLC	Port Allen	324 Petroleum and Coal Products	8	76.4%
Georgia Pacific Corp - Port Hudson	Georgia Pacific Port Hudson	322 Paper Manufacturing	128	76.2%
Stone Container Corp	Stone Container Hodge	322 Paper Manufacturing	74	74.8%
Graphic Packaging International	Plant 31 Paper Mill	322 Paper Manufacturing	45	73.9%
Air Liquide Large Industries U.S. LP	Geismar Cogen	325 Chemical Manufacturing	84	71.9%
Louisiana Tech University	Louisiana Tech University Power Plant	Misc	8	71.6%





CHP Emissions by Sector

Chemical manufacturing is responsible for the greatest share of CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> and emissions. Utility and IPPs emit significantly larger amounts of SO<sub>2</sub> and NO<sub>x</sub>, from a much greater share of coal use.

NAICS	CO2 Emissions (tons)	Percent of Total (%)	SO2 Emissions (tons)	Percent of Total (%)	NOx Emissions (tons)	Percent of Total (%)
311-312 Food, Beverage and Tobacco	20,589	0.2%	2	0.0%	55	0.4%
322 Paper Manufacturing	415,363	3.1%	6,875	75.5%	1,796	11.8%
324 Petroleum and Coal Products	1,618,487	12.0%	2,059	22.6%	1,967	12.9%
325 Chemical Manufacturing	11,262,500	83.4%	165	1.8%	10,985	72.1%
331 Primary Metal Manufacturing	169,365	1.3%	8	0.1%	400	2.6%
Misc	15,662	0.1%	0	0.0%	37	0.2%
<b>Total CHP</b>	<b>13,501,966</b>	<b>100.0%</b>	<b>9,110</b>	<b>100.0%</b>	<b>15,239</b>	<b>100.0%</b>

Facility Category	CO2 Emissions (tons)	Percent of Total State (%)	SO2 Emissions (tons)	Percent of Total State (%)	NOx Emissions (tons)	Percent of Total State (%)
Total CHP	13,501,966	22.6%	9,110	9.4%	15,239	23.3%
Utility	30,858,611	51.6%	49,402	51.2%	37,368	57.2%
IPP and Industrial Non-CHP	15,420,021	25.8%	38,015	39.4%	12,776	19.5%
<b>Total</b>	<b>59,780,599</b>	<b>100.0%</b>	<b>96,526</b>	<b>100.0%</b>	<b>65,382</b>	<b>100.0%</b>

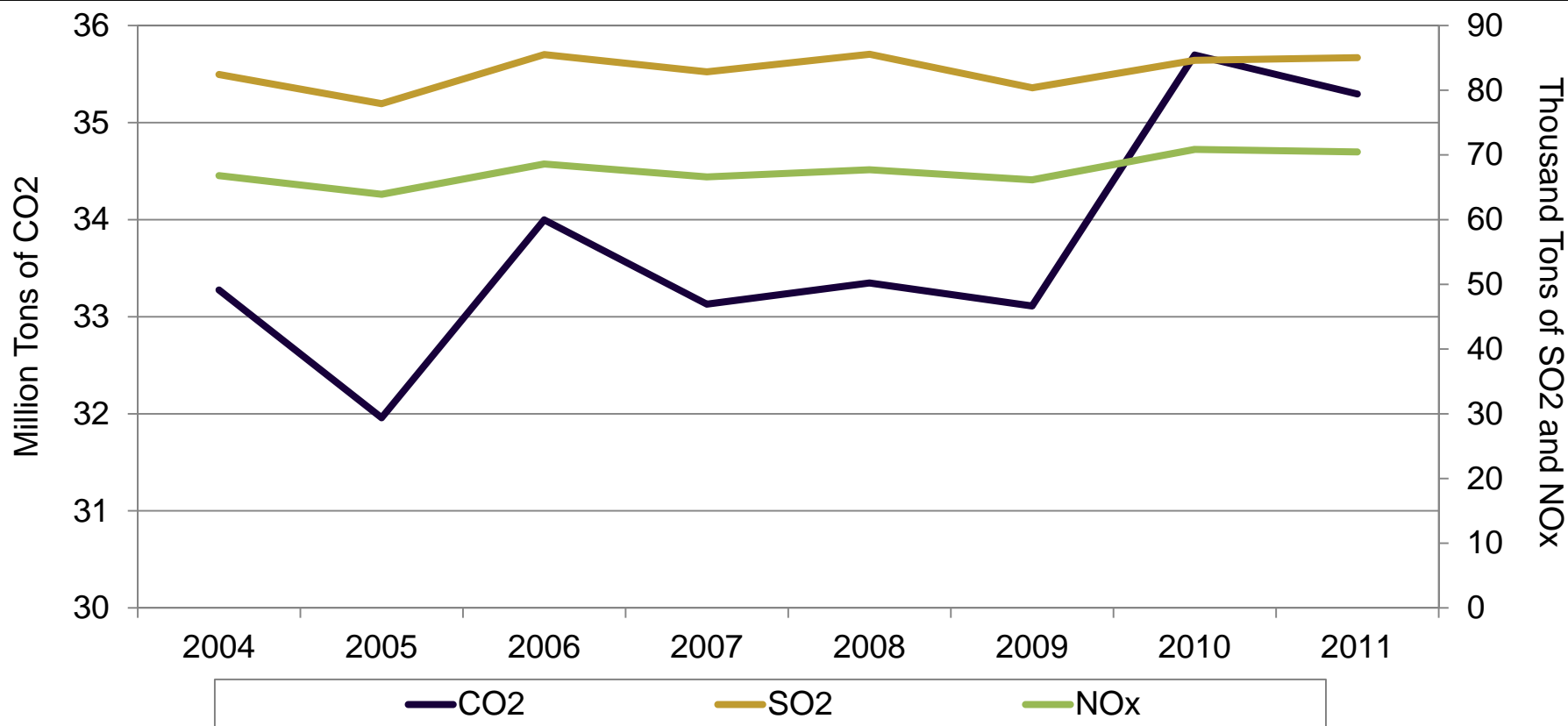
Note: The "Misc" category includes the Louisiana Tech University Power Plant in Lincoln Parish.

Source: U.S. Environmental Protection Agency; and Energy Information Administration, U.S. Department of Energy.



CHP Historic Emissions

Emissions of CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> have increased for Louisiana's CHP and industrial self-generation units. CO<sub>2</sub> emissions have increased 6.1 percent, SO<sub>2</sub> emissions have increased 3.2 percent and Nox emissions have increased 5.5 percent





## **Appendix 1: CHP Installations Database**

**Appendix 1: CHP Installations Database**

Company	Facility	Unit ID	Parish	Nameplate Capacity (MW)	Prime Mover	Primary Fuel	Year Online	NAICS Category
Air Liquide Large Industries U.S. LP	Geismar Cogen	GTG	Ascension	83.9	GT	Natural Gas	2000	325 Chemical Manufacturing
American Sugar Refining Inc.	Domino Sugar Arabi Plant	TG1	St Bernard	5.0	ST	Natural Gas	1949	311-312 Food, Beverage and Tobacco
American Sugar Refining Inc.	Domino Sugar Arabi Plant	TG2	St Bernard	5.0	ST	Natural Gas	2003	311-312 Food, Beverage and Tobacco
American Sugar Refining Inc.	Domino Sugar Arabi Plant	TG3	St Bernard	4.0	ST	Natural Gas	1949	311-312 Food, Beverage and Tobacco
BASF Corporation	Geismar	GEN1	Ascension	35.7	GT	Natural Gas	1985	331 Primary Metal Manufacturing
BASF Corporation	Geismar	GEN2	Ascension	41.2	GT	Natural Gas	1998	331 Primary Metal Manufacturing
BASF Corporation	Geismar	GEN3	Ascension	7.2	ST	Natural Gas	2005	331 Primary Metal Manufacturing
Boise Packaging & Newsprint LLC	DeRidder Mill	TG	Beauregard	61.5	ST	Black Liquor	1969	322 Paper Manufacturing
Chevron Oronite Co LLC	Oak Point Cogen	5121	Plaquemines	4.7	GT	Natural Gas	1999	324 Petroleum and Coal Products
Chevron Oronite Co LLC	Oak Point Cogen	5131	Plaquemines	4.7	GT	Natural Gas	1999	324 Petroleum and Coal Products
Chevron Oronite Co LLC	Oak Point Cogen	5141	Plaquemines	4.7	GT	Natural Gas	1999	324 Petroleum and Coal Products
Chevron Oronite Co LLC	Oak Point Cogen	5151	Plaquemines	4.7	GT	Natural Gas	1999	324 Petroleum and Coal Products
Chevron Oronite Co LLC	Oak Point Cogen	5161	Plaquemines	4.7	GT	Natural Gas	1999	324 Petroleum and Coal Products
CII Carbon LLC	CII Carbon LLC	TG-2	St Bernard	23.0	ST	Petroleum Coke	1951	324 Petroleum and Coal Products
CII Carbon LLC	CII Carbon LLC	TG-3	St Bernard	23.0	ST	Petroleum Coke	1951	324 Petroleum and Coal Products
Dow Chemical Co	LaO Energy Systems	GEN1	Iberville	57.0	CA	Natural Gas	1958	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN2	Iberville	88.0	CA	Natural Gas	1962	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN3	Iberville	90.0	CA	Natural Gas	1966	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN4	Iberville	76.5	CA	Natural Gas	1969	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN5	Iberville	76.5	CT	Natural Gas	1978	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN6	Iberville	76.5	CT	Natural Gas	1979	325 Chemical Manufacturing
Dow Chemical Co	LaO Energy Systems	GEN7	Iberville	125.0	CT	Natural Gas	1982	325 Chemical Manufacturing
Dow Chemical Co	Plaquemine Cogeneration Plant	G500	Iberville	198.0	CT	Natural Gas	2004	325 Chemical Manufacturing
Dow Chemical Co	Plaquemine Cogeneration Plant	G600	Iberville	198.0	CT	Natural Gas	2004	325 Chemical Manufacturing
Dow Chemical Co	Plaquemine Cogeneration Plant	G700	Iberville	198.0	CT	Natural Gas	2004	325 Chemical Manufacturing
Dow Chemical Co	Plaquemine Cogeneration Plant	G800	Iberville	198.0	CT	Natural Gas	2004	325 Chemical Manufacturing
Dow Chemical Co	Plaquemine Cogeneration Plant	ST5	Iberville	195.0	CA	Natural Gas	2004	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	CGN1	St Charles	125.8	CT	Natural Gas	1996	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	CGN2	St Charles	125.8	CT	Natural Gas	1997	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	CSTG	St Charles	50.0	CA	Natural Gas	2002	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	CTG	St Charles	10.0	CA	Natural Gas	1987	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	IGT	St Charles	9.6	CT	Natural Gas	1980	325 Chemical Manufacturing
Dow Chemical Co - St Charles	Dow St Charles Operations	STG	St Charles	22.0	CA	Natural Gas	1997	325 Chemical Manufacturing
Exxon Mobil Baton Rouge Refinery	ExxonMobil Baton Rouge Turbine Gen.	CTG1	East Baton Rouge	85.3	GT	Natural Gas	1990	324 Petroleum and Coal Products
Formosa Plastics Corp	Formosa Plastics	GT2	East Baton Rouge	42.7	GT	Natural Gas	1990	325 Chemical Manufacturing
Formosa Plastics Corp	Formosa Plastics	GT3	East Baton Rouge	38.8	GT	Natural Gas	1996	325 Chemical Manufacturing
Formosa Plastics Corp	Formosa Plastics	ST1	East Baton Rouge	12.0	ST	Natural Gas	1985	325 Chemical Manufacturing
Formosa Plastics Corp	Formosa Plastics	ST2	East Baton Rouge	12.0	ST	Natural Gas	1990	325 Chemical Manufacturing
Temple-Inland Corp	Gaylord Container Bogalusa	NO10	Washington	37.0	ST	Wood/Wood Waste	1999	322 Paper Manufacturing
Temple-Inland Corp	Gaylord Container Bogalusa	NO8	Washington	25.0	ST	Wood/Wood Waste	1981	322 Paper Manufacturing
Temple-Inland Corp	Gaylord Container Bogalusa	NO9	Washington	37.5	ST	Wood/Wood Waste	1979	322 Paper Manufacturing
CITGO Petroleum Corp	CITGO Refinery Powerhouse	GEN1	Calcasieu	25.0	ST	Other Gas	1942	324 Petroleum and Coal Products
CITGO Petroleum Corp	CITGO Refinery Powerhouse	GEN2	Calcasieu	25.0	ST	Other Gas	1942	324 Petroleum and Coal Products
CITGO Petroleum Corp	CITGO Refinery Powerhouse	GEN3	Calcasieu	25.0	ST	Other Gas	1969	324 Petroleum and Coal Products
Georgia Gulf Corp	Georgia Gulf Plaquemine	X773	Iberville	102.0	GT	Natural Gas	1997	325 Chemical Manufacturing
Georgia Gulf Corp	Georgia Gulf Plaquemine	X774	Iberville	102.0	GT	Natural Gas	1997	325 Chemical Manufacturing

Company	Facility	Unit ID	Parish	Nameplate Capacity (MW)	Prime Mover	Primary Fuel	Year Online	NAICS Category
Georgia Gulf Corp	Georgia Gulf Plaquemine	X775	Iberville	102.0	GT	Natural Gas	1997	325 Chemical Manufacturing
IPC-Mansfield Mill	Mansfield Mill	GEN1	De Soto	40.0	ST	Black Liquor	1981	322 Paper Manufacturing
IPC-Mansfield Mill	Mansfield Mill	GEN2	De Soto	40.0	ST	Black Liquor	1981	322 Paper Manufacturing
IPC-Mansfield Mill	Mansfield Mill	GEN3	De Soto	30.0	ST	Black Liquor	1981	322 Paper Manufacturing
IPC-Mansfield Mill	Mansfield Mill	GEN4	De Soto	25.0	GT	Natural Gas	1995	322 Paper Manufacturing
Mosaic Phosphates Co.	IMC Phosphates Company Uncle Sam	GEN1	St James	11.0	ST	Other	1968	325 Chemical Manufacturing
Mosaic Phosphates Co.	IMC Phosphates Company Uncle Sam	GEN2	St James	11.0	ST	Other	1968	325 Chemical Manufacturing
M A Patout & Sons Ltd	M A Patout Son Ltd	1000	Iberia	1.0	ST	Agric. Byproducts	1981	311-312 Food, Beverage and Tobacco
M A Patout & Sons Ltd	M A Patout Son Ltd	2000	Iberia	2.0	ST	Agric. Byproducts	1981	311-312 Food, Beverage and Tobacco
Occidental Chemical Corporation	Taft Cogeneration Facility	CT1	St Charles	178.5	CT	Natural Gas	2002	325 Chemical Manufacturing
Occidental Chemical Corporation	Taft Cogeneration Facility	CT2	St Charles	178.5	CT	Natural Gas	2002	325 Chemical Manufacturing
Occidental Chemical Corporation	Taft Cogeneration Facility	CT3	St Charles	178.5	CT	Natural Gas	2002	325 Chemical Manufacturing
Occidental Chemical Corporation	Taft Cogeneration Facility	ST1	St Charles	358.7	CA	Natural Gas	2002	325 Chemical Manufacturing
PPG Industries Inc	PPG Powerhouse C	C1	Calcasieu	73.1	CT	Natural Gas	1977	325 Chemical Manufacturing
PPG Industries Inc	PPG Powerhouse C	C2	Calcasieu	73.1	CT	Natural Gas	1978	325 Chemical Manufacturing
PPG Industries Inc	PPG Powerhouse C	C3	Calcasieu	57.1	CA	Natural Gas	1977	325 Chemical Manufacturing
PPG Industries Inc	PPG Powerhouse C	C4	Calcasieu	77.2	CT	Natural Gas	1986	325 Chemical Manufacturing
PPG Industries Inc	PPG Powerhouse C	C5	Calcasieu	77.2	CT	Natural Gas	1986	325 Chemical Manufacturing
PPG Industries Inc	PPG Plant C Caustic	TE	Calcasieu	3.4	ST	Natural Gas	1986	325 Chemical Manufacturing
PPG Industries Inc	RS Cogen	RS-4	Calcasieu	103.0	CA	Natural Gas	2002	325 Chemical Manufacturing
PPG Industries Inc	RS Cogen	RS-5	Calcasieu	195.0	CT	Natural Gas	2002	325 Chemical Manufacturing
PPG Industries Inc	RS Cogen	RS-6	Calcasieu	195.0	CT	Natural Gas	2002	325 Chemical Manufacturing
Placid Refining Co LLC	Port Allen	GEN1	West Baton Rouge	3.8	GT	Natural Gas	1990	324 Petroleum and Coal Products
Placid Refining Co LLC	Port Allen	GEN2	West Baton Rouge	3.8	GT	Natural Gas	1990	324 Petroleum and Coal Products
PCS Nitrogen LP	PCS Nitrogen Fertilizer LP	GEN2	Iberville	10.0	ST	Waste Heat	2006	325 Chemical Manufacturing
Graphic Packaging International	Plant 31 Paper Mill	GEN5	Ouachita	25.0	ST	Natural Gas	1964	322 Paper Manufacturing
Graphic Packaging International	Plant 31 Paper Mill	GEN6	Ouachita	20.0	ST	Natural Gas	1977	322 Paper Manufacturing
Stone Container Corp	Stone Container Hodge	NO 4	Jackson	3.0	ST	Natural Gas	1938	322 Paper Manufacturing
Stone Container Corp	Stone Container Hodge	NO 6	Jackson	5.0	ST	Natural Gas	1952	322 Paper Manufacturing
Stone Container Corp	Stone Container Hodge	NO 7	Jackson	15.6	ST	Natural Gas	1957	322 Paper Manufacturing
Stone Container Corp	Stone Container Hodge	NO 8	Jackson	27.5	ST	Natural Gas	1972	322 Paper Manufacturing
Stone Container Corp	Stone Container Hodge	NO 9	Jackson	23.3	ST	Natural Gas	1972	322 Paper Manufacturing
Air Liquide America Corp	Shell Chemical	101G	Ascension	40.0	GT	Natural Gas	2002	325 Chemical Manufacturing
Air Liquide America Corp	Shell Chemical	201G	Ascension	40.0	GT	Natural Gas	2002	325 Chemical Manufacturing
Georgia Pacific Corp - Port Hudson	Georgia Pacific Port Hudson	GEN1	East Baton Rouge	67.7	ST	Black Liquor	1986	322 Paper Manufacturing
Georgia Pacific Corp - Port Hudson	Georgia Pacific Port Hudson	GEN2	East Baton Rouge	60.0	ST	Petroleum Coke	2007	322 Paper Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	GT1	St James	16.0	GT	Natural Gas	1969	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	GT2	St James	16.0	GT	Natural Gas	1969	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	GT3	St James	16.0	GT	Natural Gas	1969	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	GT4	St James	24.7	GT	Natural Gas	1974	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	ST1	St James	18.7	ST	Natural Gas	1958	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	ST2	St James	18.7	ST	Natural Gas	1958	325 Chemical Manufacturing
Noranda Alumina LLC	Noranda Alumina LLC	ST3	St James	7.2	ST	Natural Gas	1969	325 Chemical Manufacturing
Renew Paper LLC	St Francisville Mill	GEN2	West Feliciana	12.5	ST	Black Liquor	1966	322 Paper Manufacturing
Louisiana Sugar Refining LLC	Louisiana Sugar Refining	GEN1	St James	0.7	ST	Natural Gas	1930	311-312 Food, Beverage and Tobacco
Louisiana Sugar Refining LLC	Louisiana Sugar Refining	GEN2	St James	2.5	ST	Natural Gas	1977	311-312 Food, Beverage and Tobacco
Louisiana Sugar Refining LLC	Louisiana Sugar Refining	GEN3	St James	1.7	ST	Natural Gas	1957	311-312 Food, Beverage and Tobacco
Louisiana Sugar Refining LLC	Louisiana Sugar Refining	GEN4	St James	2.5	ST	Natural Gas	1969	311-312 Food, Beverage and Tobacco

Company	Facility	Unit ID	Parish	Nameplate Capacity (MW)	Prime Mover	Primary Fuel	Year Online	NAICS Category
ADA Carbon Solutions LLC	ADA Carbon Solutions Red River	GEN1	Red River	20.8	ST	Waste Heat	2011	325 Chemical Manufacturing
Carville Energy LLC	Carville Energy LLC	CTG1	Iberville	187.0	CT	Natural Gas	2003	325 Chemical Manufacturing
Carville Energy LLC	Carville Energy LLC	CTG2	Iberville	187.0	CT	Natural Gas	2003	325 Chemical Manufacturing
Carville Energy LLC	Carville Energy LLC	STG	Iberville	196.0	CA	Natural Gas	2003	325 Chemical Manufacturing
Entergy Gulf States - LA LLC	Louisiana 1	1A	East Baton Rouge	23.0	CA	Natural Gas	1951	324 Petroleum and Coal Products
Entergy Gulf States - LA LLC	Louisiana 1	2A	East Baton Rouge	62.5	CA	Natural Gas	1954	324 Petroleum and Coal Products
Entergy Gulf States - LA LLC	Louisiana 1	3A	East Baton Rouge	63.0	CA	Natural Gas	1954	324 Petroleum and Coal Products
Entergy Gulf States - LA LLC	Louisiana 1	4A	East Baton Rouge	101.0	CT	Natural Gas	1987	324 Petroleum and Coal Products
Entergy Gulf States - LA LLC	Louisiana 1	5A	East Baton Rouge	156.8	CT	Natural Gas	1999	324 Petroleum and Coal Products
Louisiana Tech University	Louisiana Tech University Power Plant	TG3	Lincoln	7.5	GT	Natural Gas	2004	Misc