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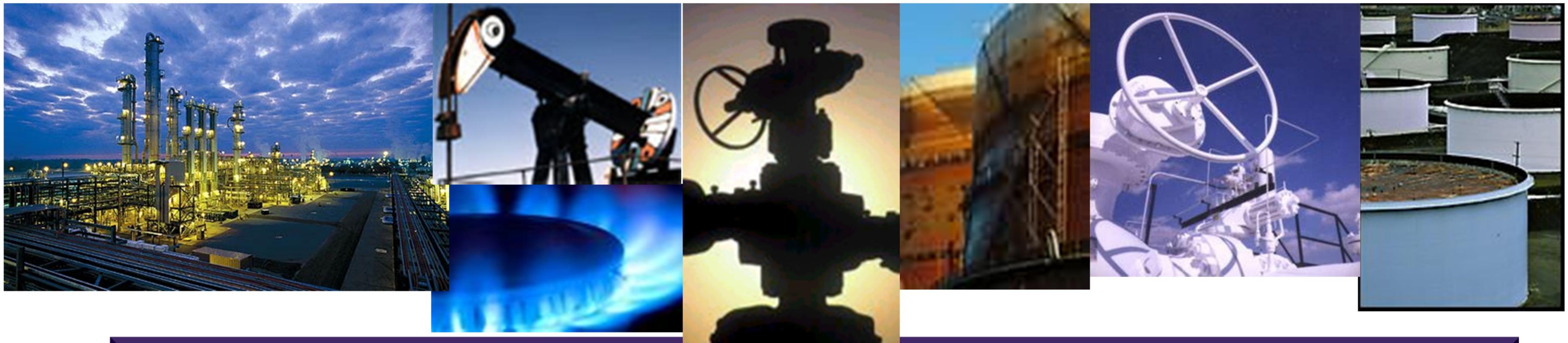

Combined Heat & Power in Louisiana: Status, Potential, and Policies.

Phase 1 Report: Resource Characterization & Database

Prepared for the Louisiana Department of Natural Resources

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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.

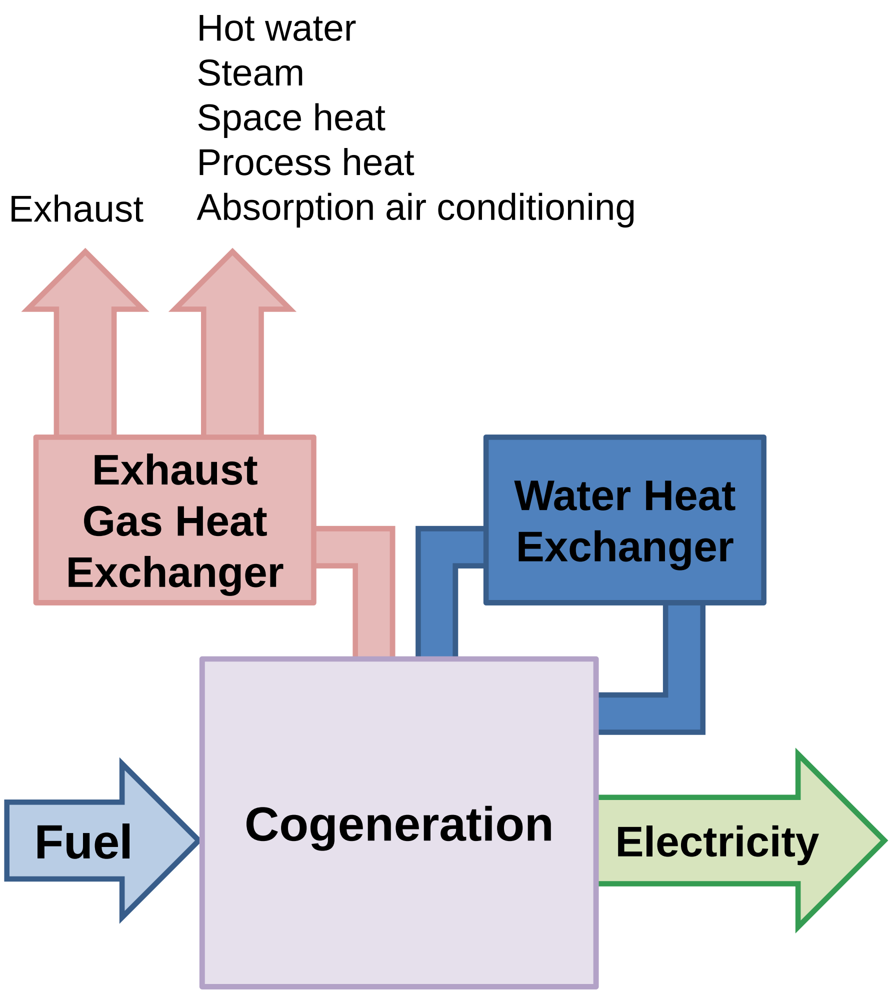
Over the past several years, independent oil and gas producers, utilizing innovative technologies, and exploiting a previously underutilized geologic resource, have unleashed trillions of cubic feet of new natural gas resources. Today's "shale revolution" has led to new, stable, abundant and affordably-price 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.[1] 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.

[1]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.

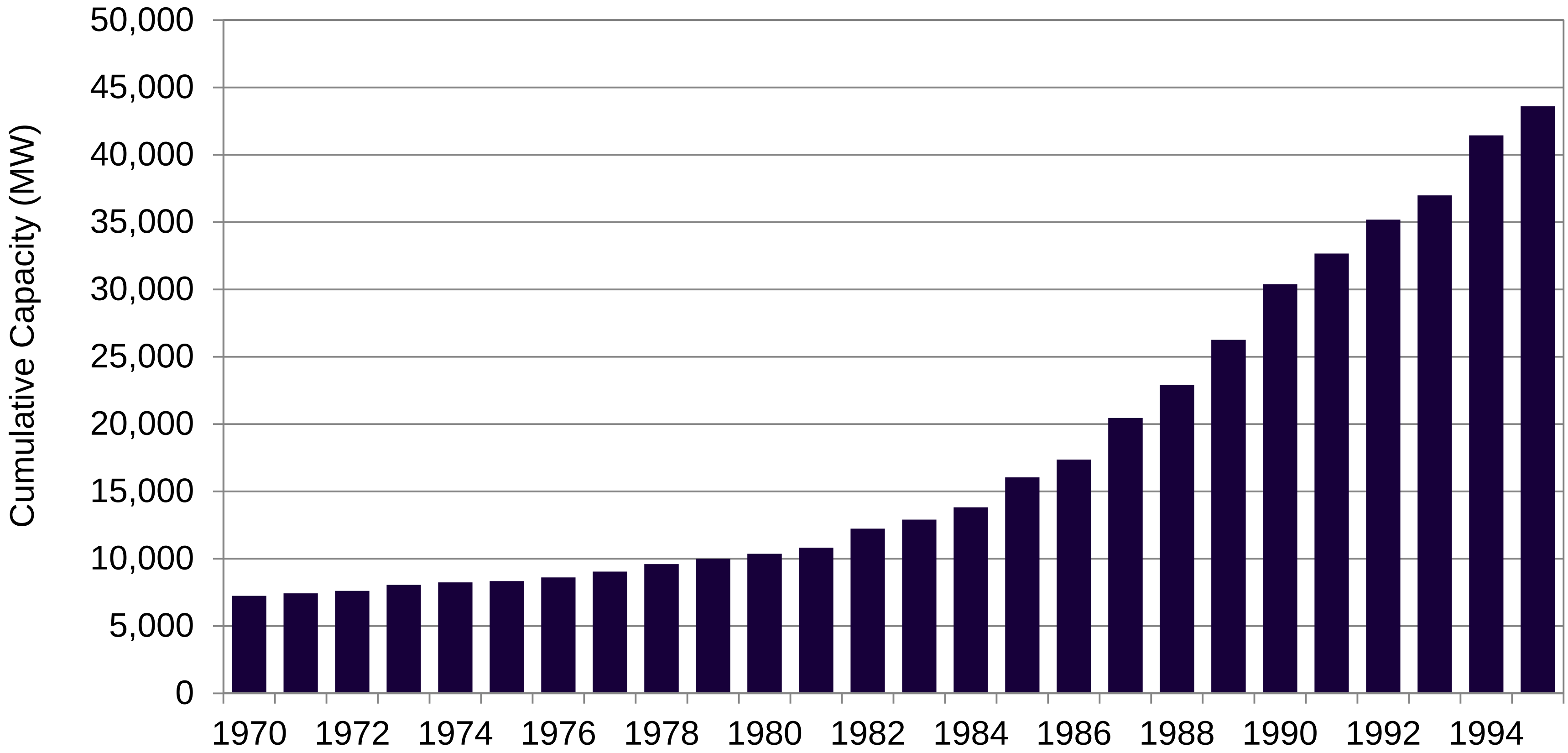
How PURPA Impacted CHP Development

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

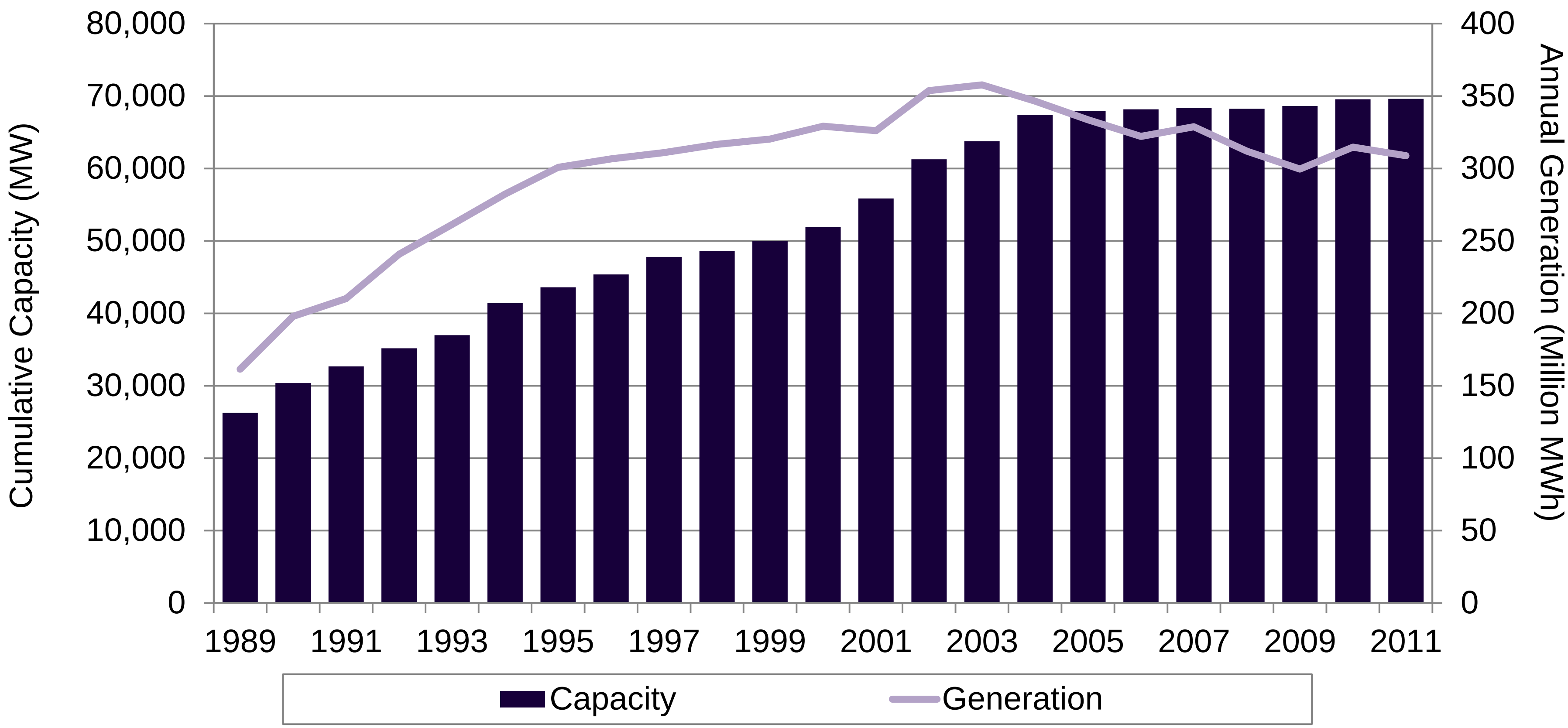
Industrial cogeneration has grown steadily and dramatically since the early 1980s.



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.



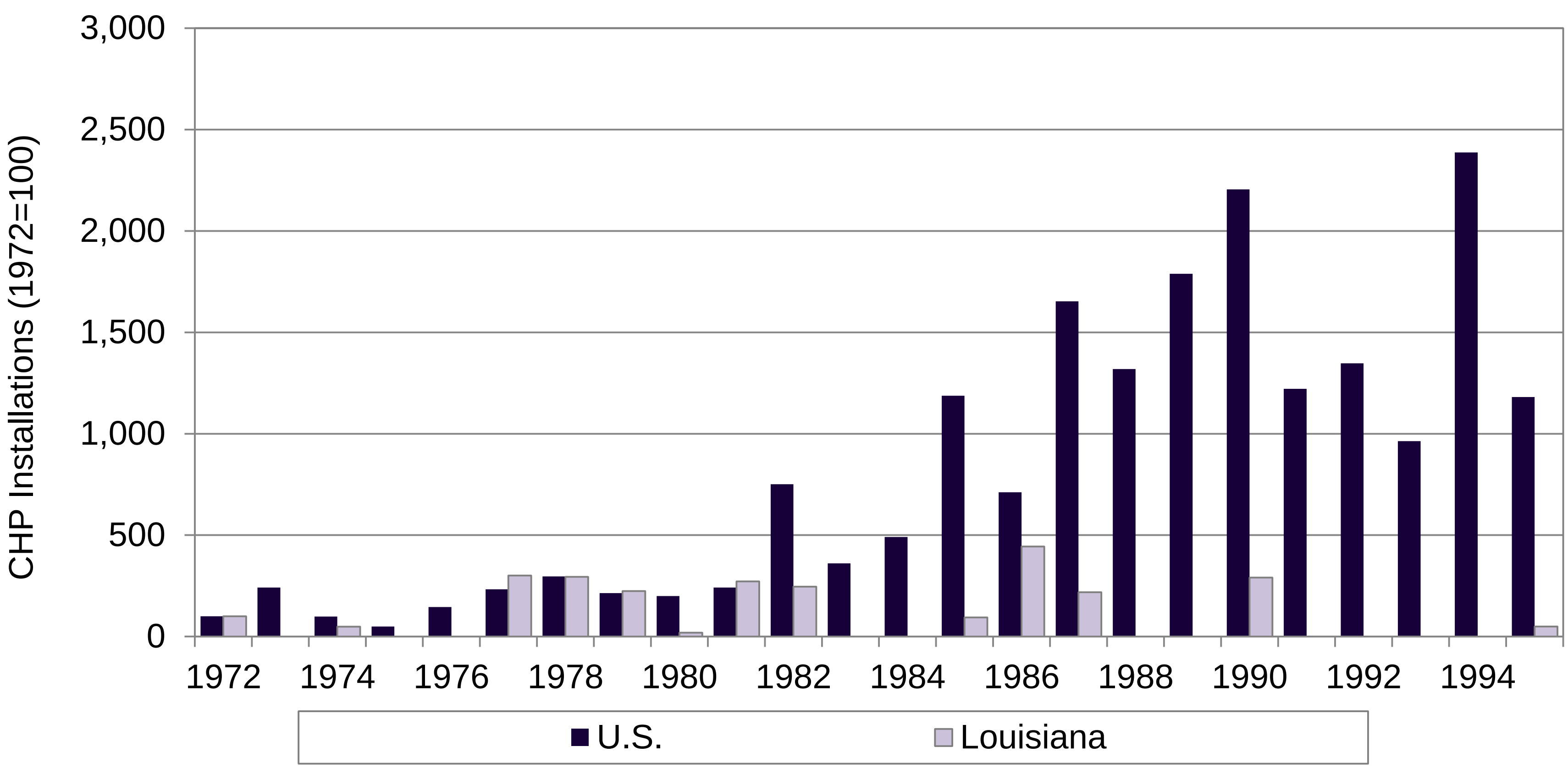
Note: Cumulative capacity is net of retirements. Includes Commercial CHP, Industrial CHP and IPP CHP as defined by the Energy Information Administration.
Source: Energy Information Administration, U.S. Department of Energy.

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.

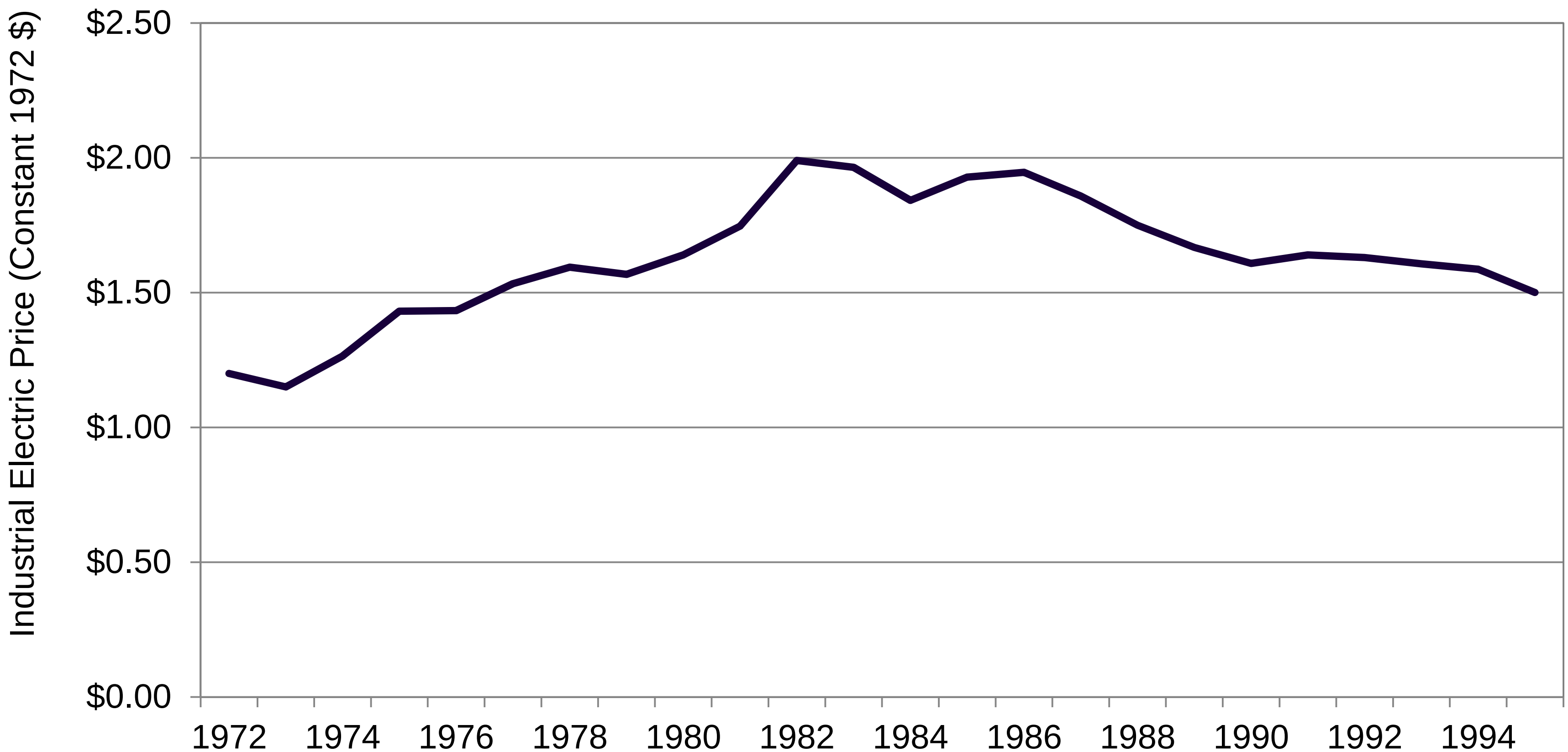
US and Louisiana CHP Development (1972=100)

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

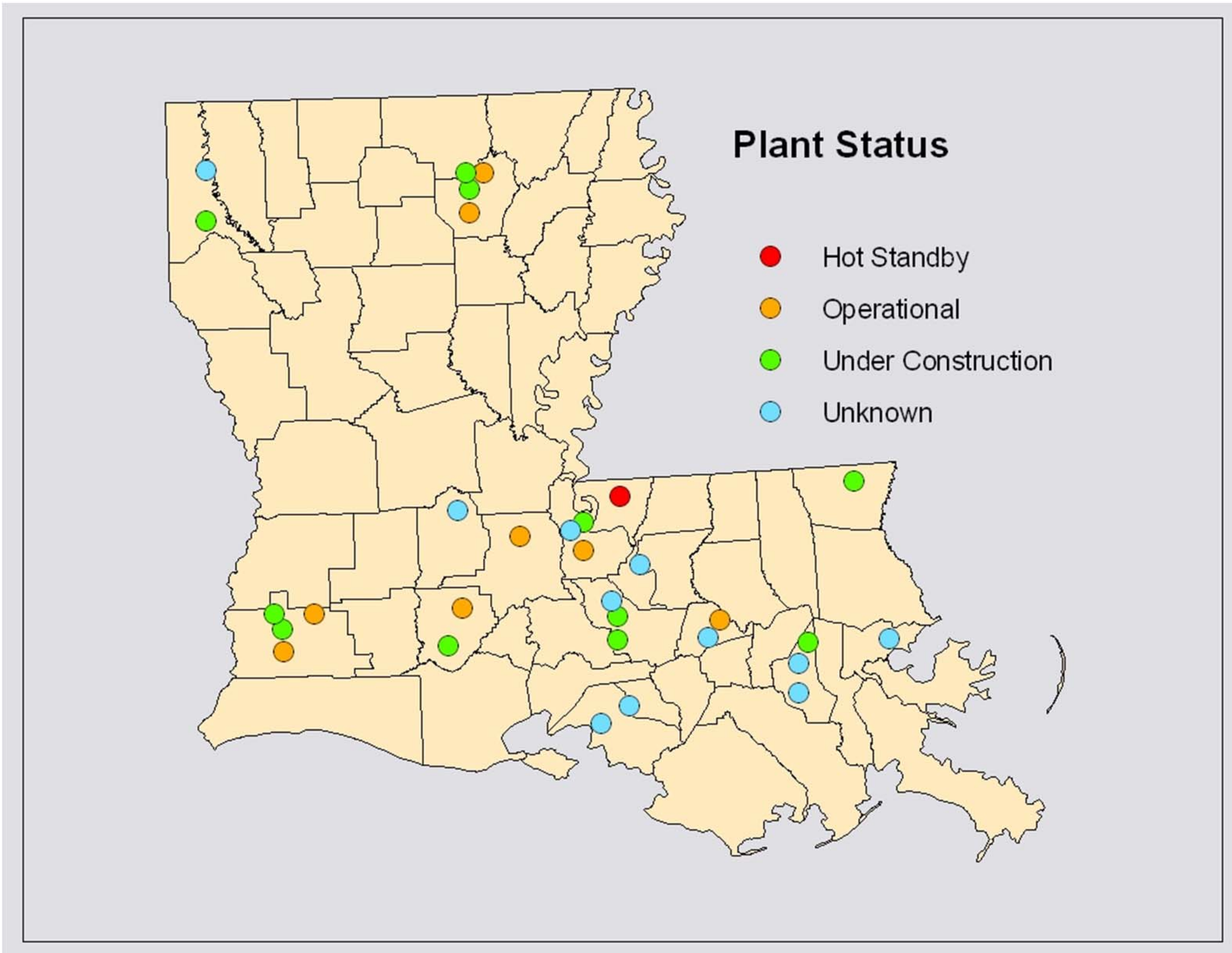
Louisiana became the epicenter of merchant power generation development in the southeastern U.S. during the late 1990s and early 2000s. A large part of this merchant development was associated with capacity additions and various repower pricings at the earlier PURPA incented industrial CHP facilities.

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)
Status of Merchant Plants		
Operational	4,013	4,343
Under Construction	564	-
Adv. Development	-	-
Early Development	2,805	-
Planned	1,200	2,400
Tabled	-	564
Cancelled	-	1,275
Status of Cogeneration Plants		
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

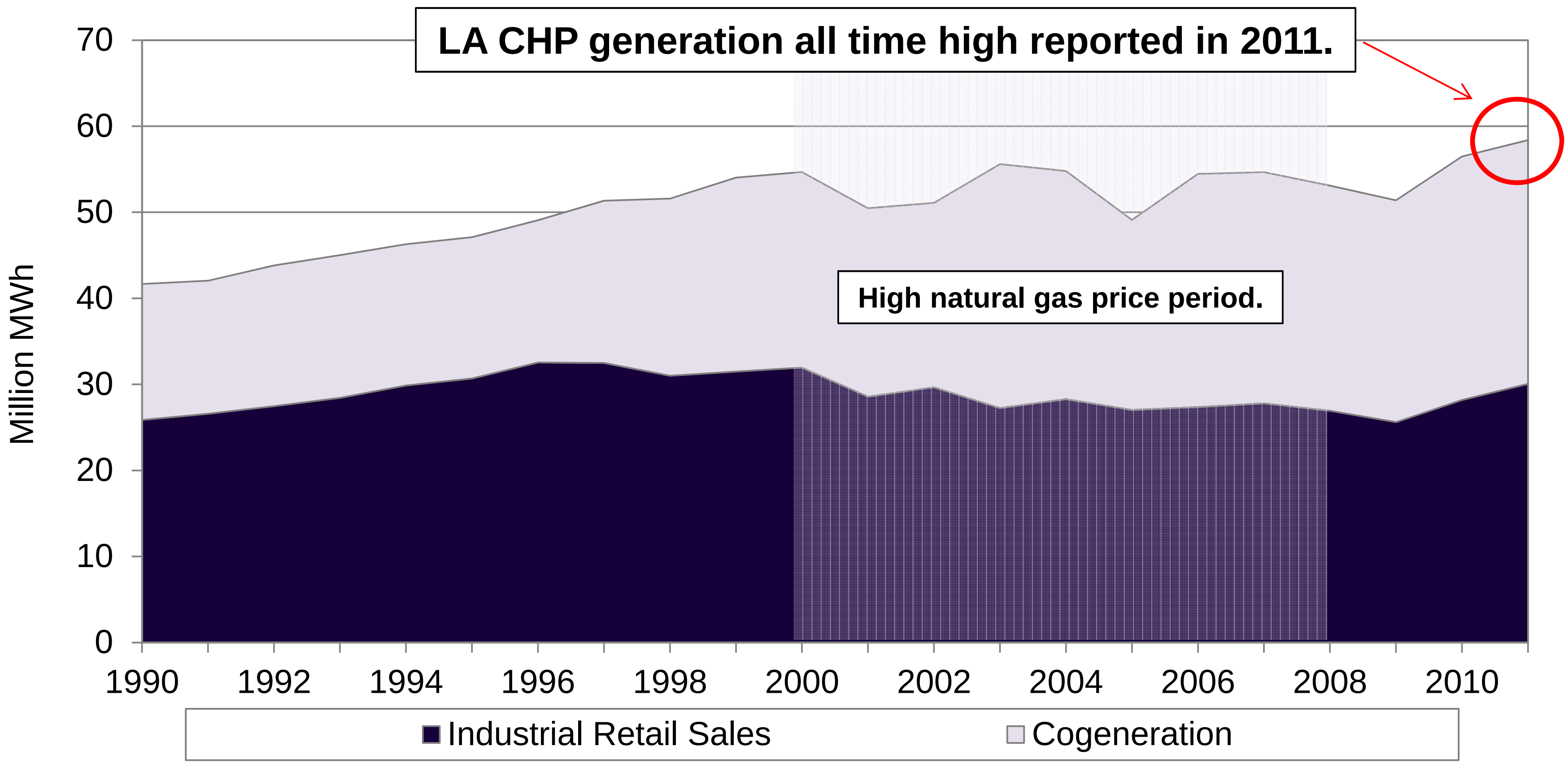
Louisiana has one of the highest concentrations of retail industrial sales in the U.S. The state also has one of the highest concentrations of industrial CHP-based generation.

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)

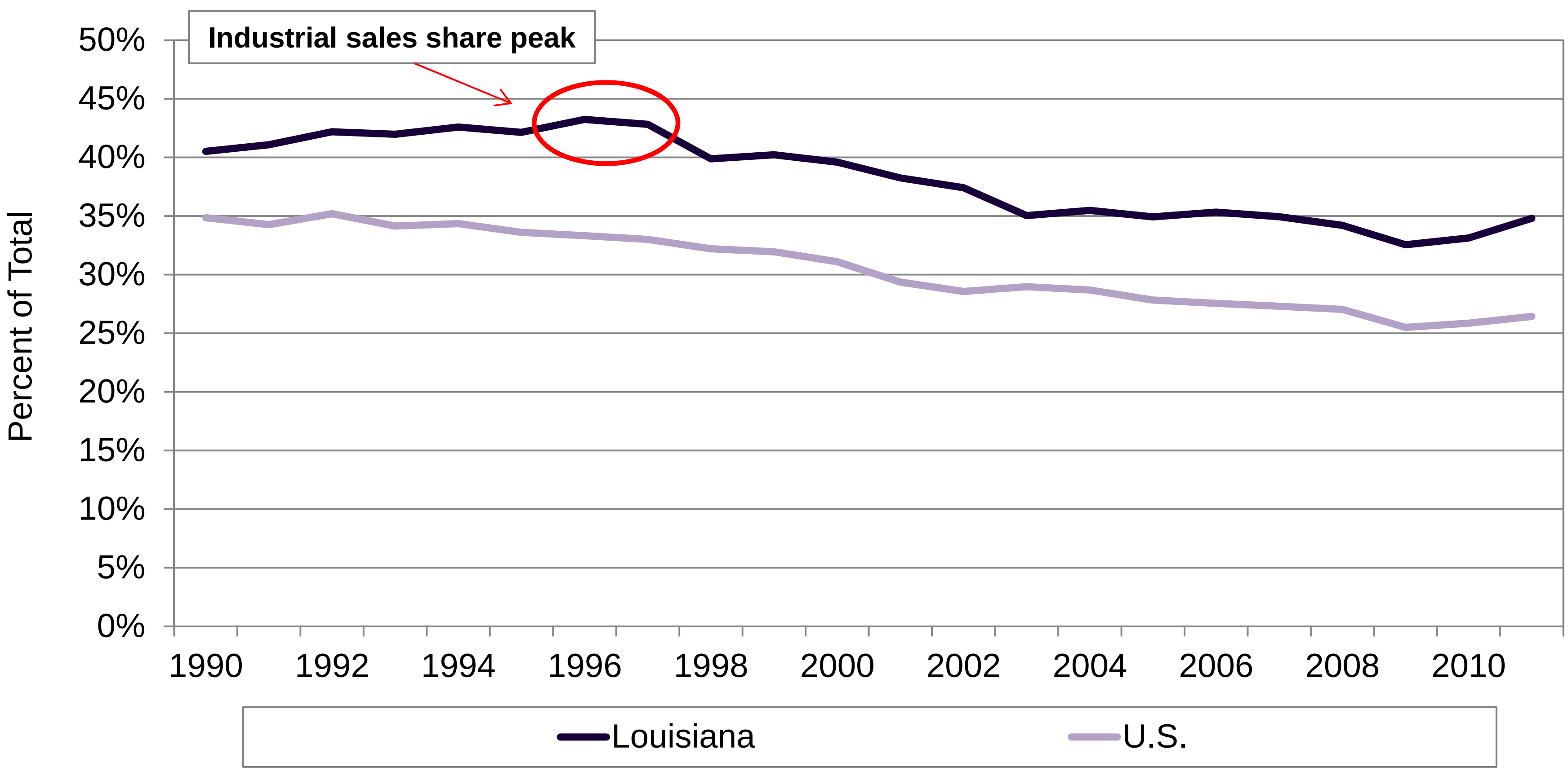
Major industrial electric users include the chemical industry (15.2 million MWh), the refining industry (9.4 million MWh) and the paper products industry (4.0 million MWh). In total, Louisiana industry used 30.1 million MWh.

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
	30,058,415	**100.0%**	**156,197**

Source: MIPD.

Industrial Electric Sales as a Percent of Total Electric Sales

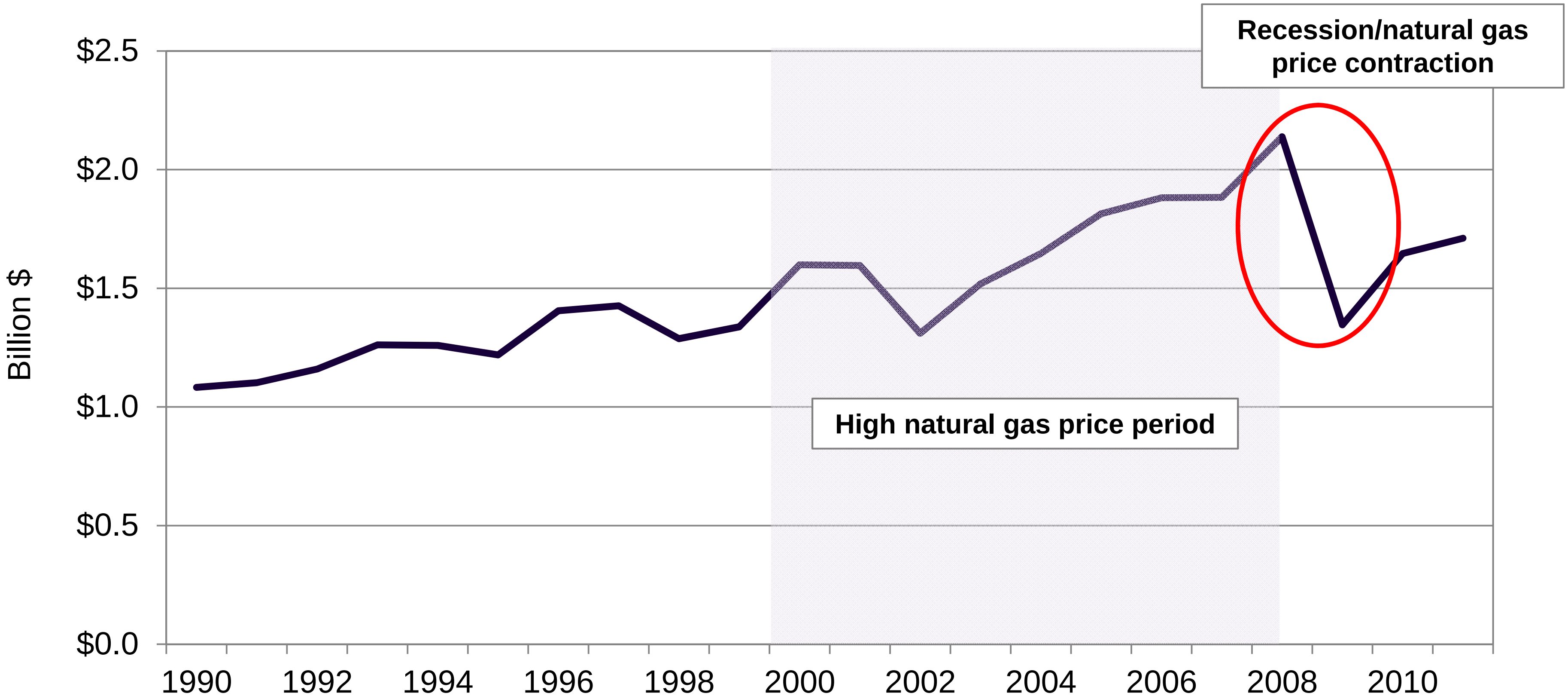
In Louisiana, industrial electric sales as a percent of total electric sales have fallen 19.5 percent since their high in 1996. Similarly, during the same period, U.S., industrial electric sales fell just over 20 percent.



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

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.



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

Estimated Industrial Average Electricity Expenditure by NAICS

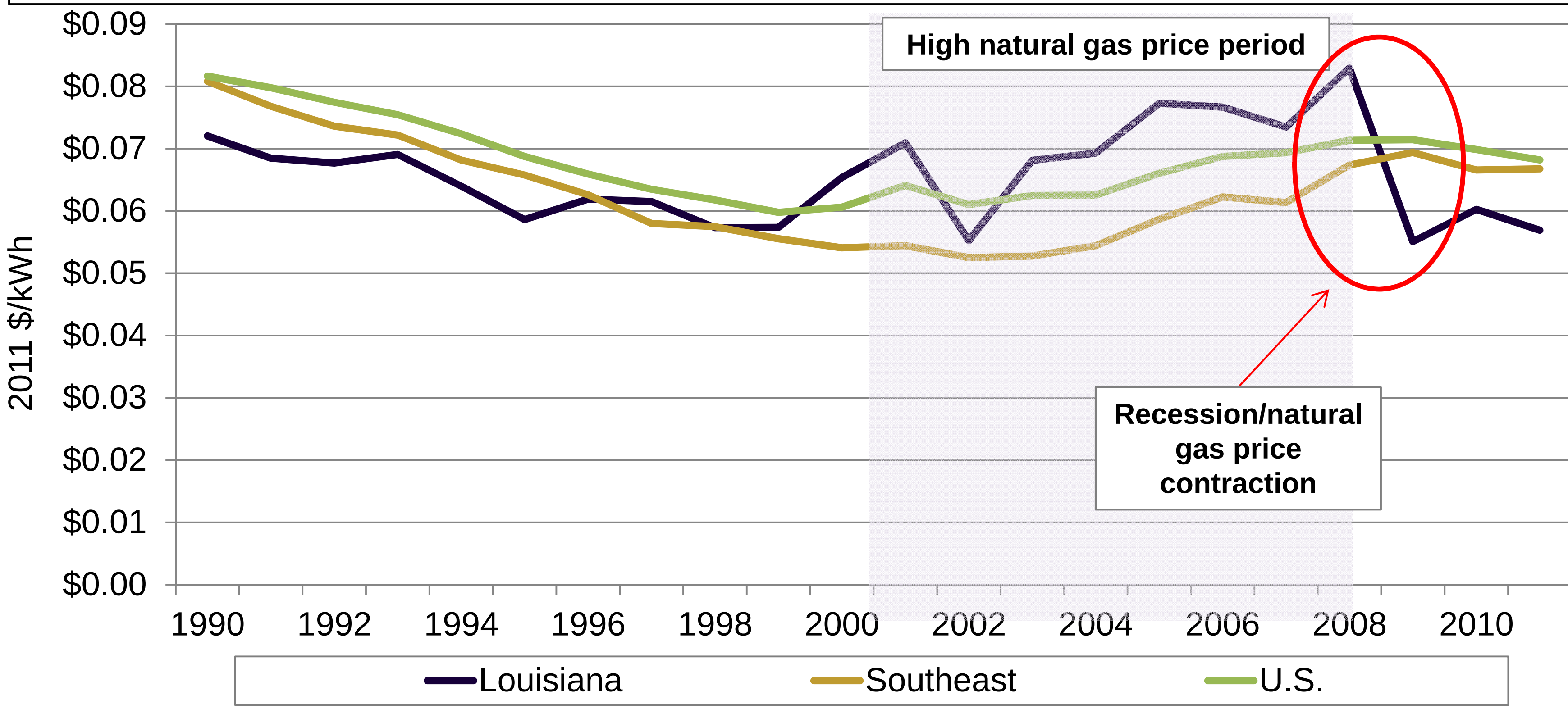
In 2011, the chemical industry spent an estimated $862.7 million, or $15.5 million per facility, on electricity purchases. Similarly, the refining industry spent about $536 million, or $34.4 million per facility. In total, Louisiana industry spent an estimated $1.71 billion.

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
	Total			**1,710,595**	**100.0%**	**8,888**

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

Regional Industrial Electricity Rate Comparisons (Average Revenues)

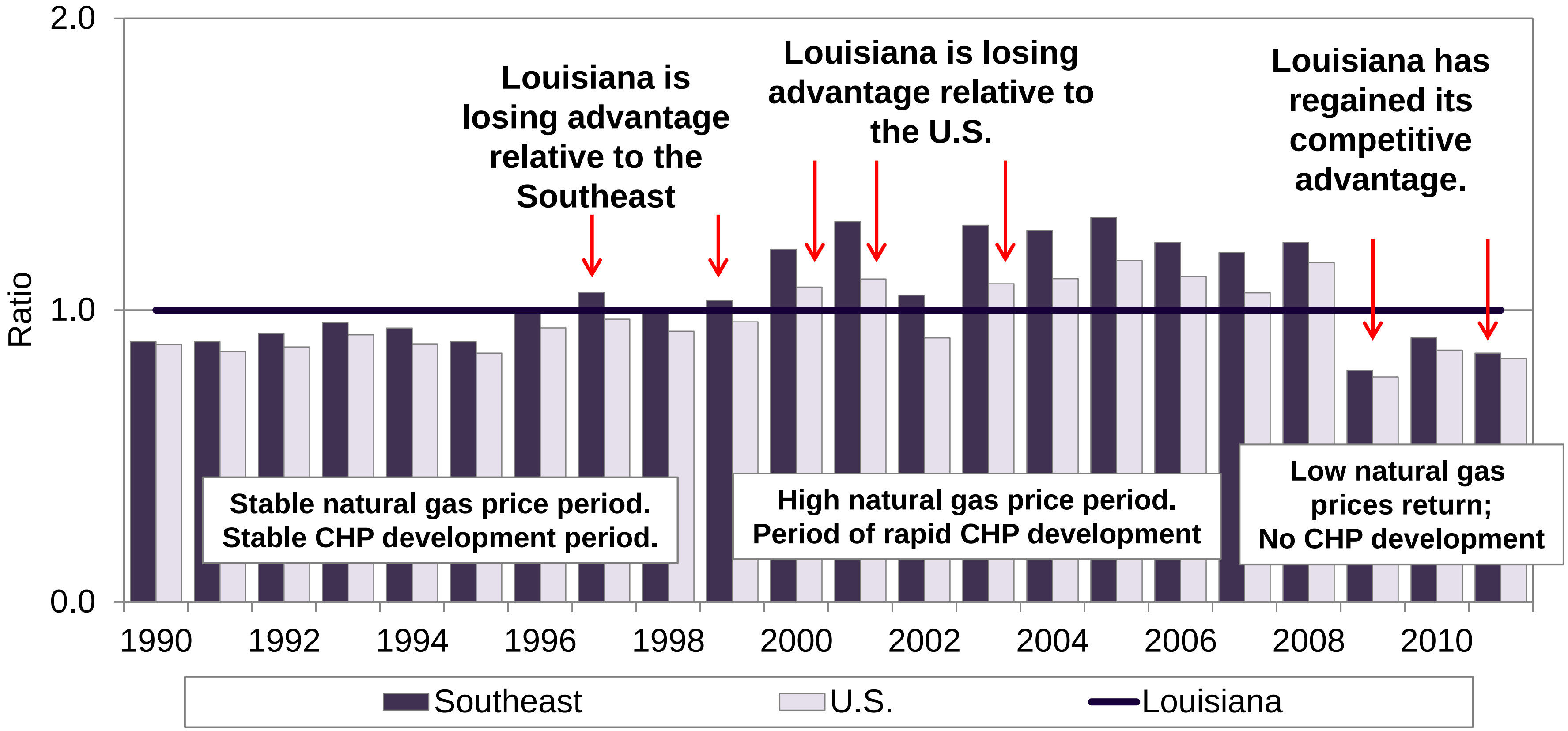
In the 1990s, Louisiana industrial electricity rates were competitive with both the Southeastern and U.S. averages. These advantages however, begin to fade relative to the Southeast in 1996 and the U.S. in 2000. In recent years however, industrial electric rates in Louisiana have fallen and regained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

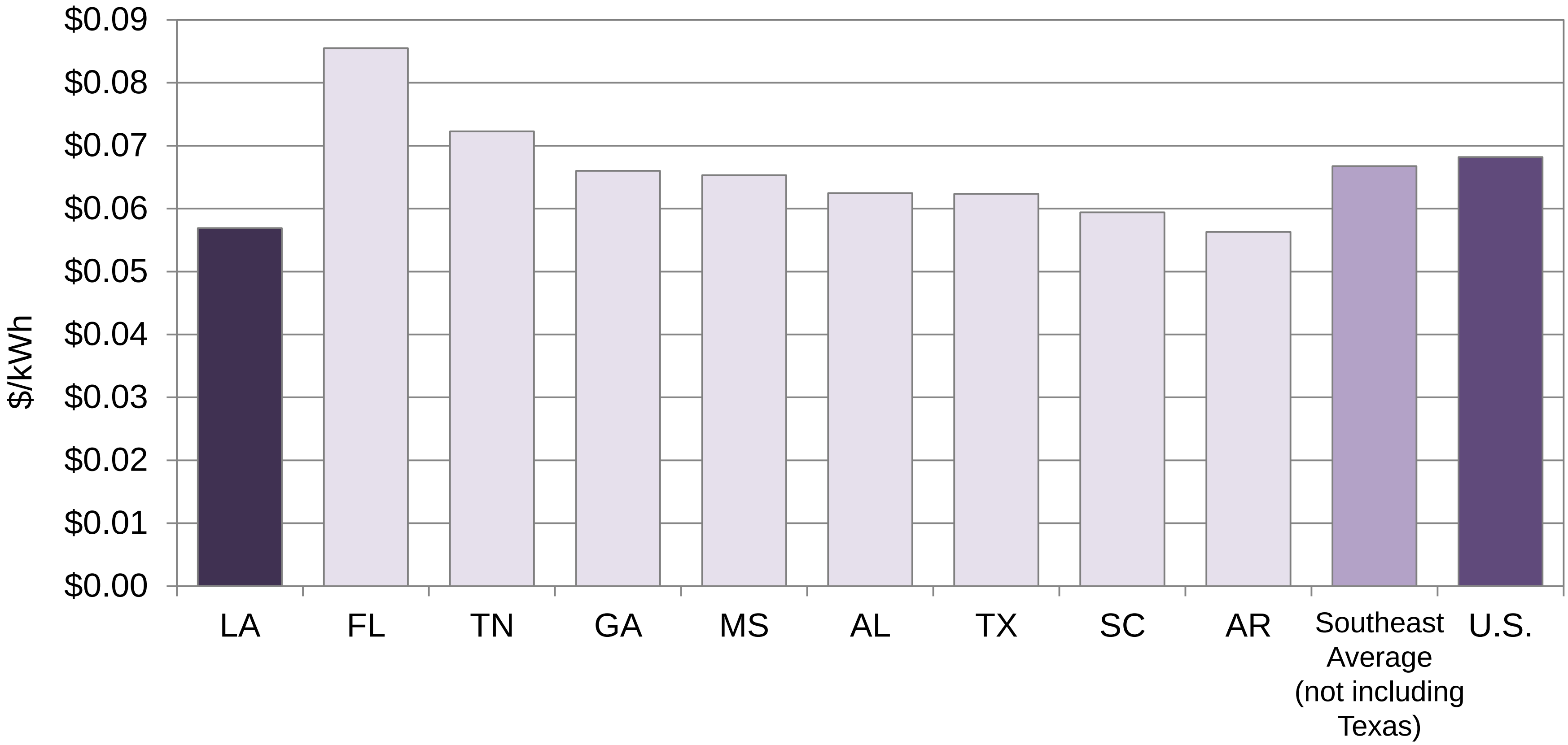
Louisiana's rates are compared as a ratio to both the Southeastern and U.S. averages. A ratio of 1.0 or less means that Louisiana's industrial rates are equal or less than the Southeastern or national average. A ratio greater than 1.0 means that Louisiana's industrial rates are higher than the Southeastern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

Southeastern Rate Competitiveness (Average Revenues)

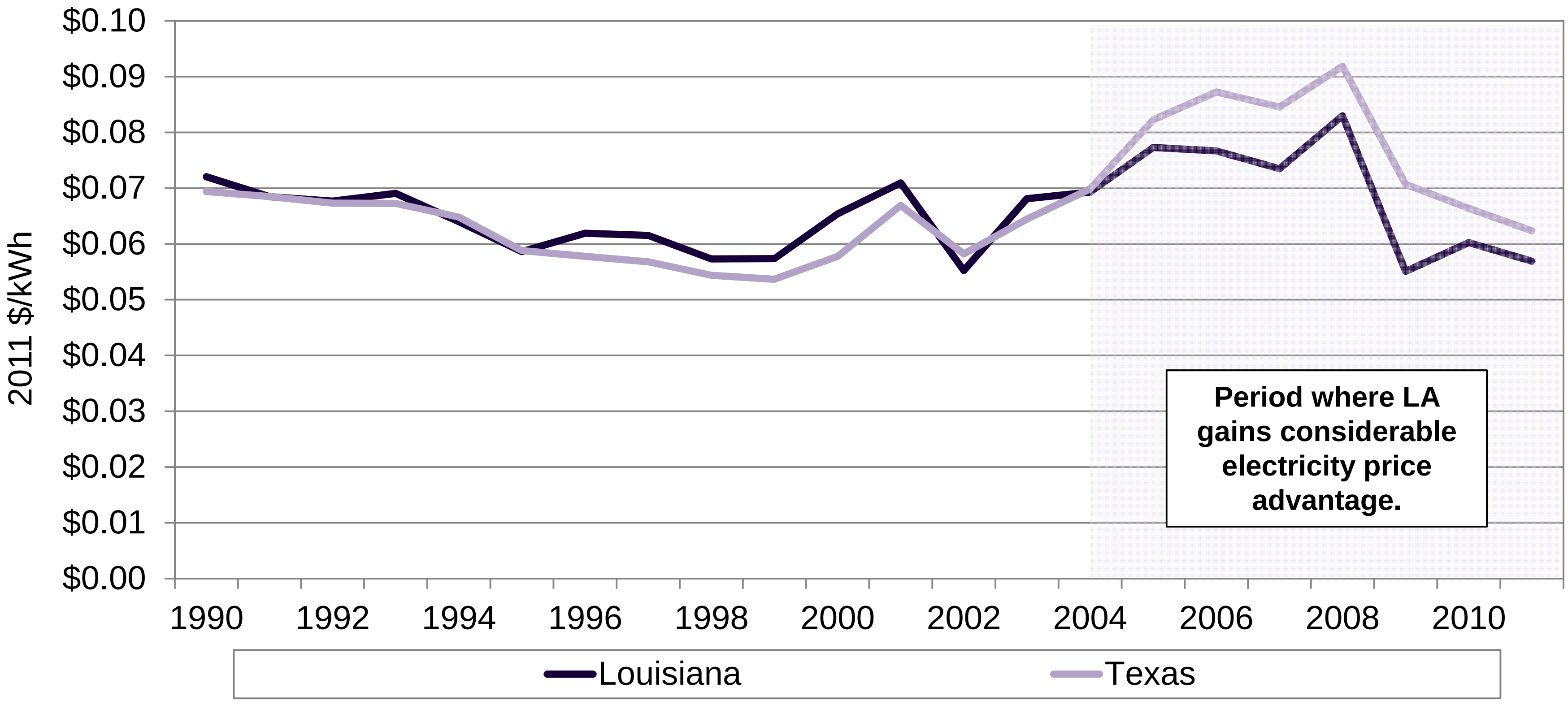
In 2011, Louisiana had the lowest retail industrial rates in the southeast; some 33 percent lower than those in Florida and nine percent lower than those in Texas.



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.



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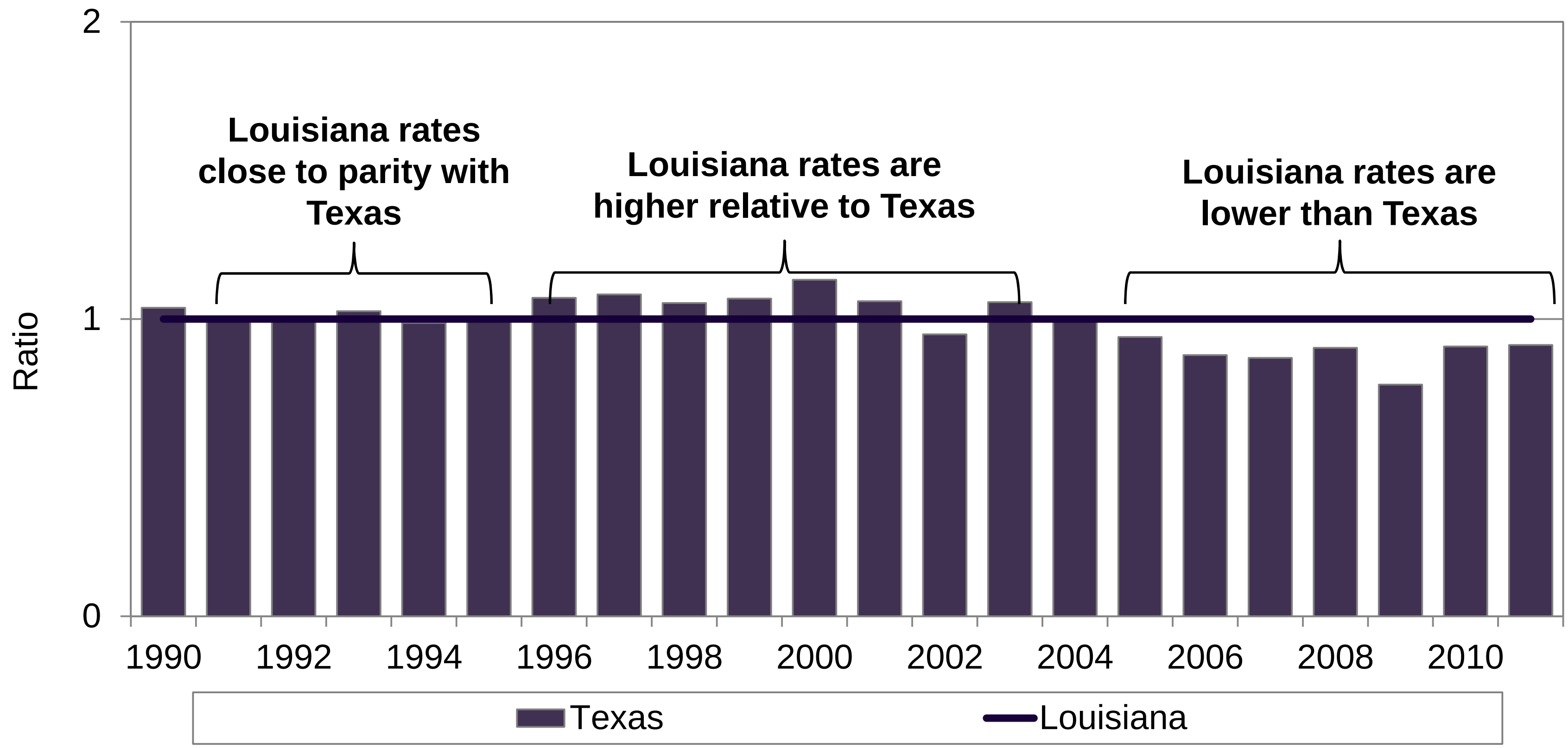
Source: Energy Information Administration, U.S. Department of Energy.

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.

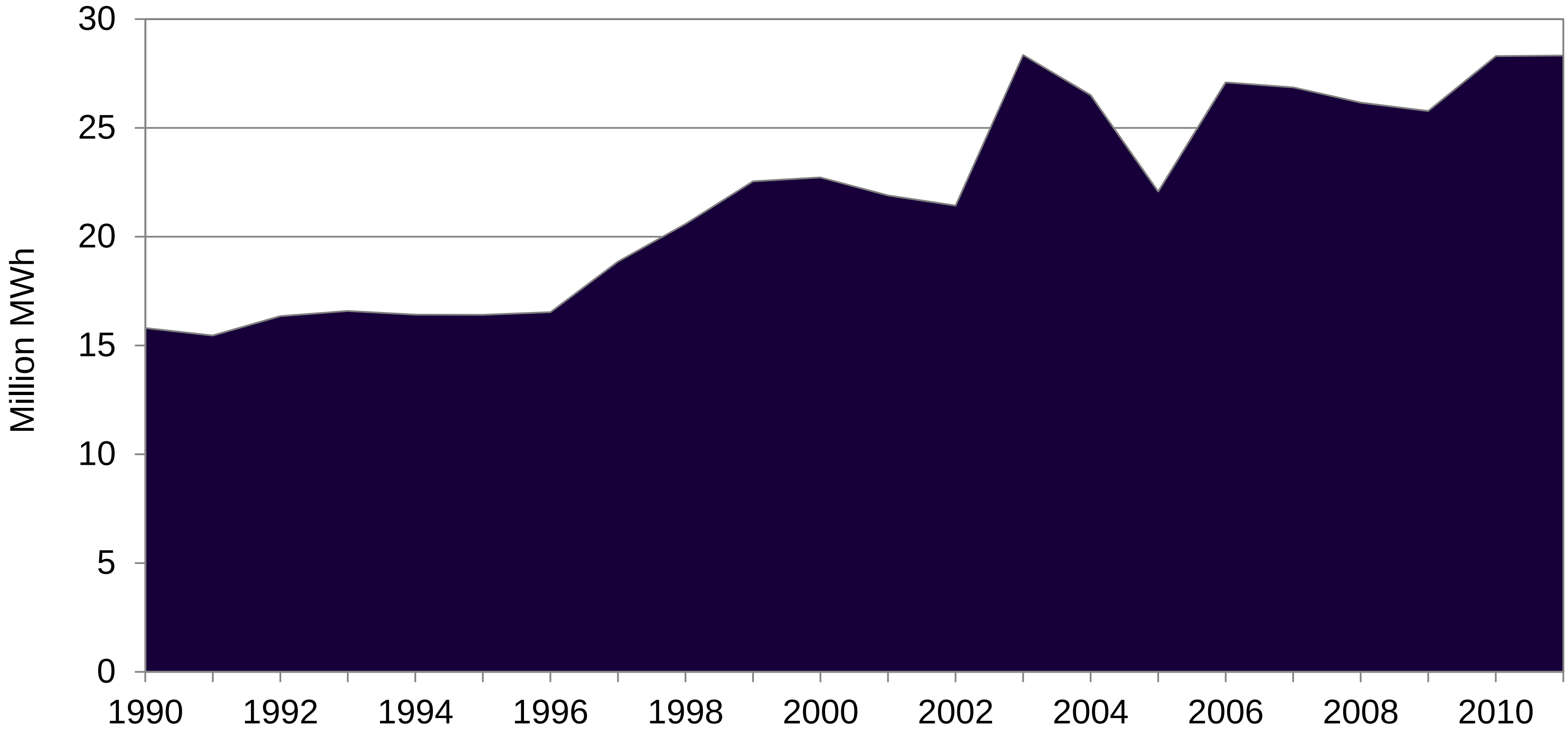


Note: Average Revenues are for the "Total Electric Industry," which includes full-service providers (i.e. bundled energy and delivery services); as well as energy-only providers; and delivery-only providers. Pursuant to Texas statutes establishing competitive electricity markets within ERCOT, all customers 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

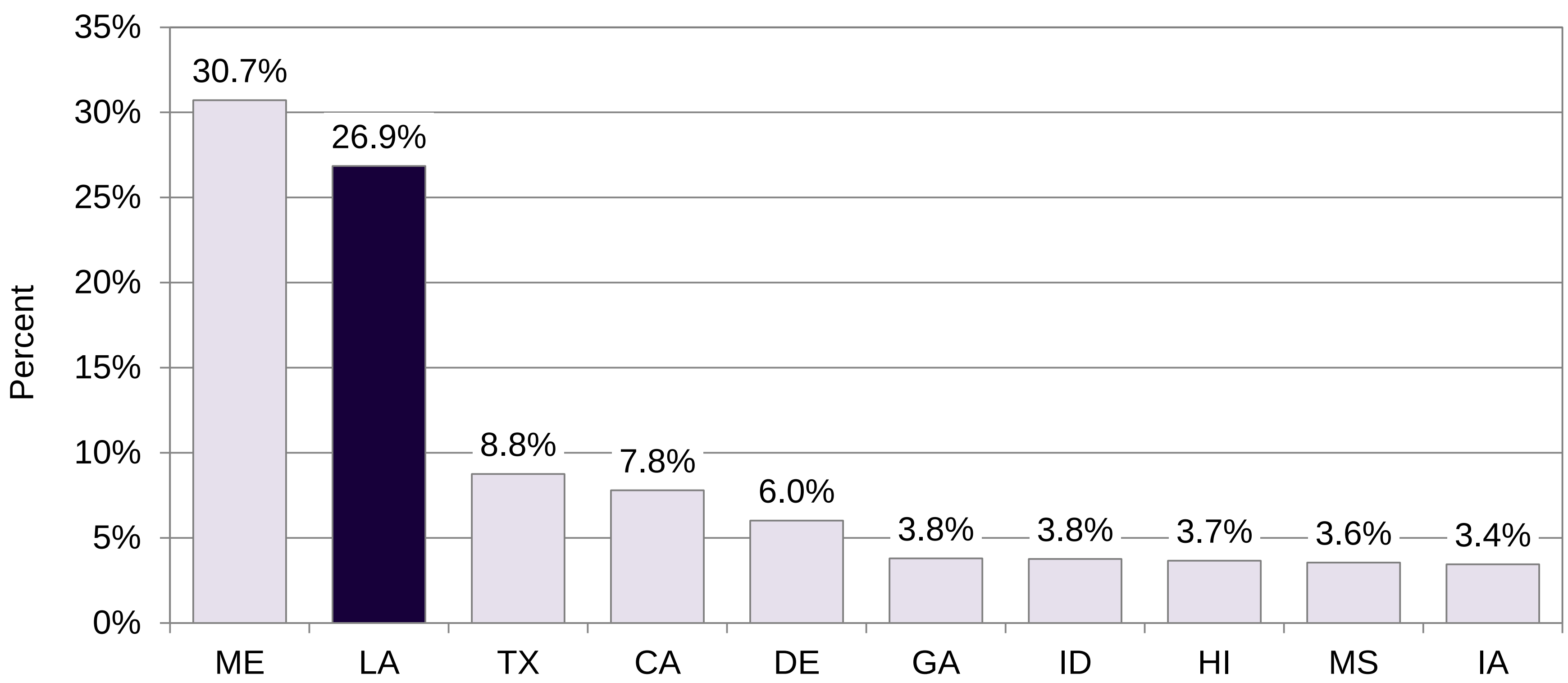
In Louisiana, generation from industrial CHP facilities has increased 71 percent since 2006.



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)

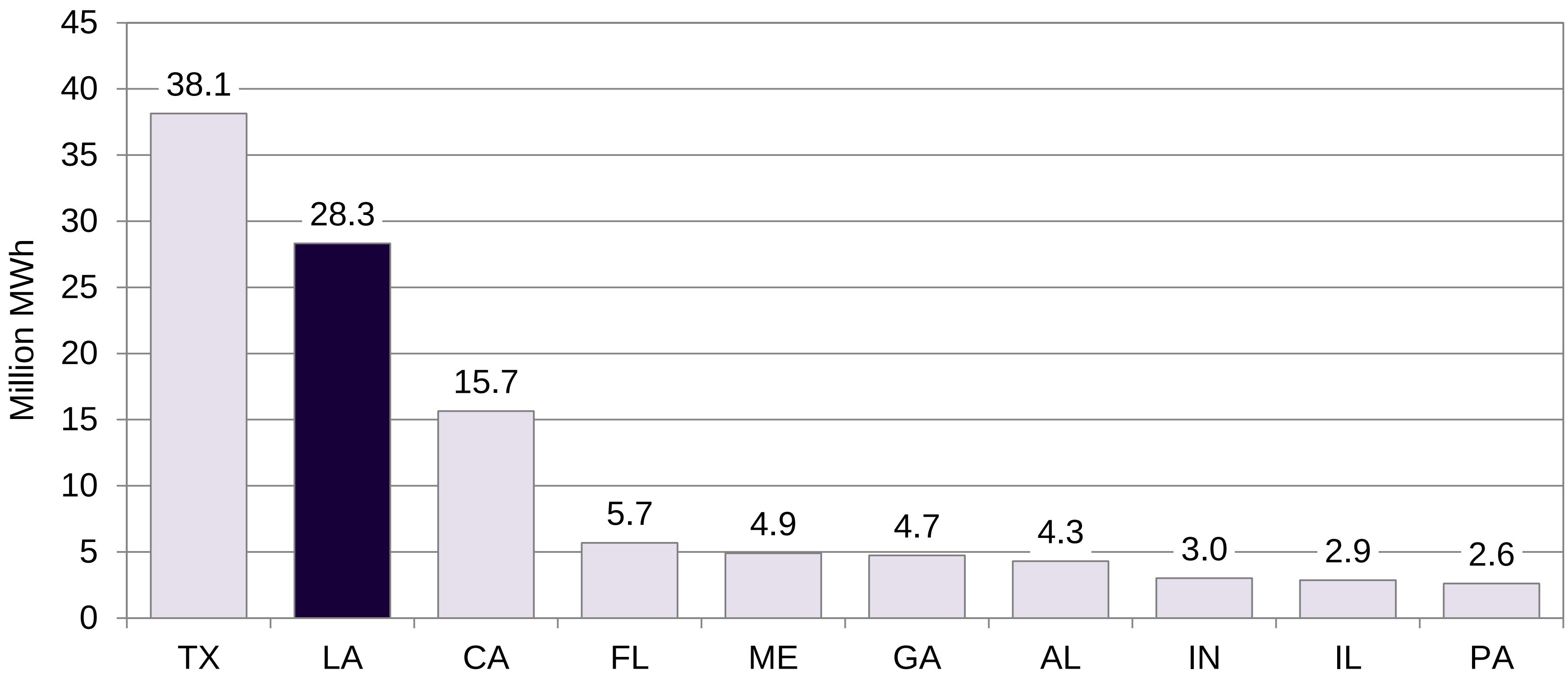
Almost 27 percent of Louisiana's electricity is generated at industrial CHP facilities: a level considerably more significant than just about any other state including Texas.



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)

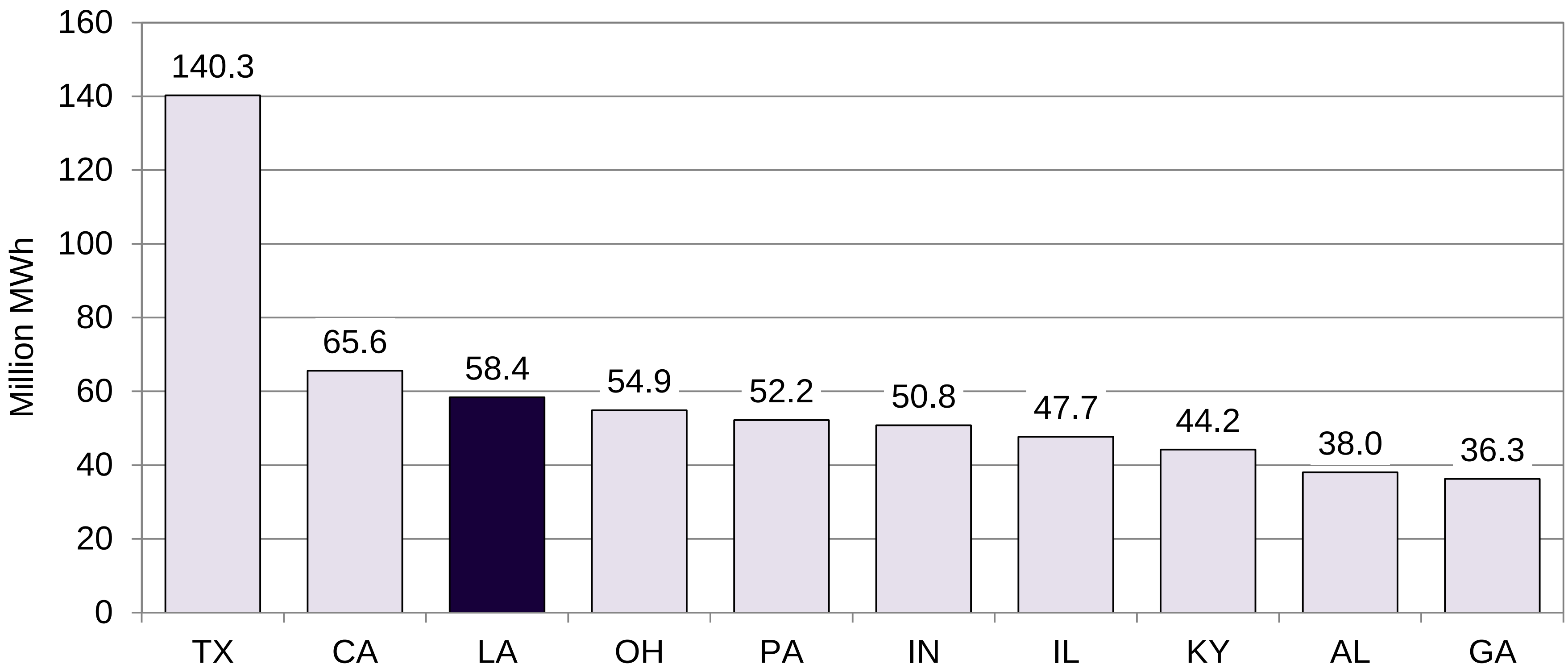
In 2011, Louisiana's industries generated over 28 million MWh of electricity, making it the second largest industrial CHP generator (in absolute terms).



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)

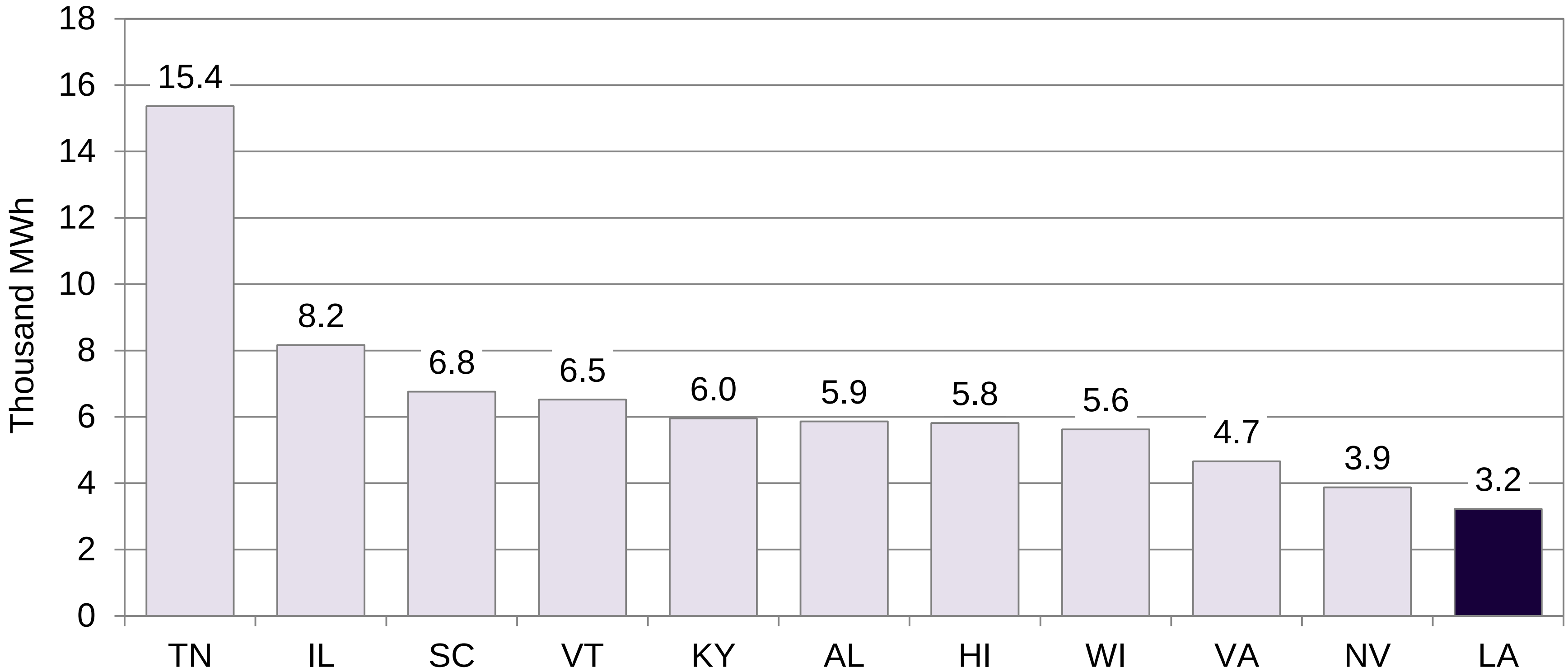
Louisiana ranks third in combined industrial usage and CHP.



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 11th in overall use per industrial customer.

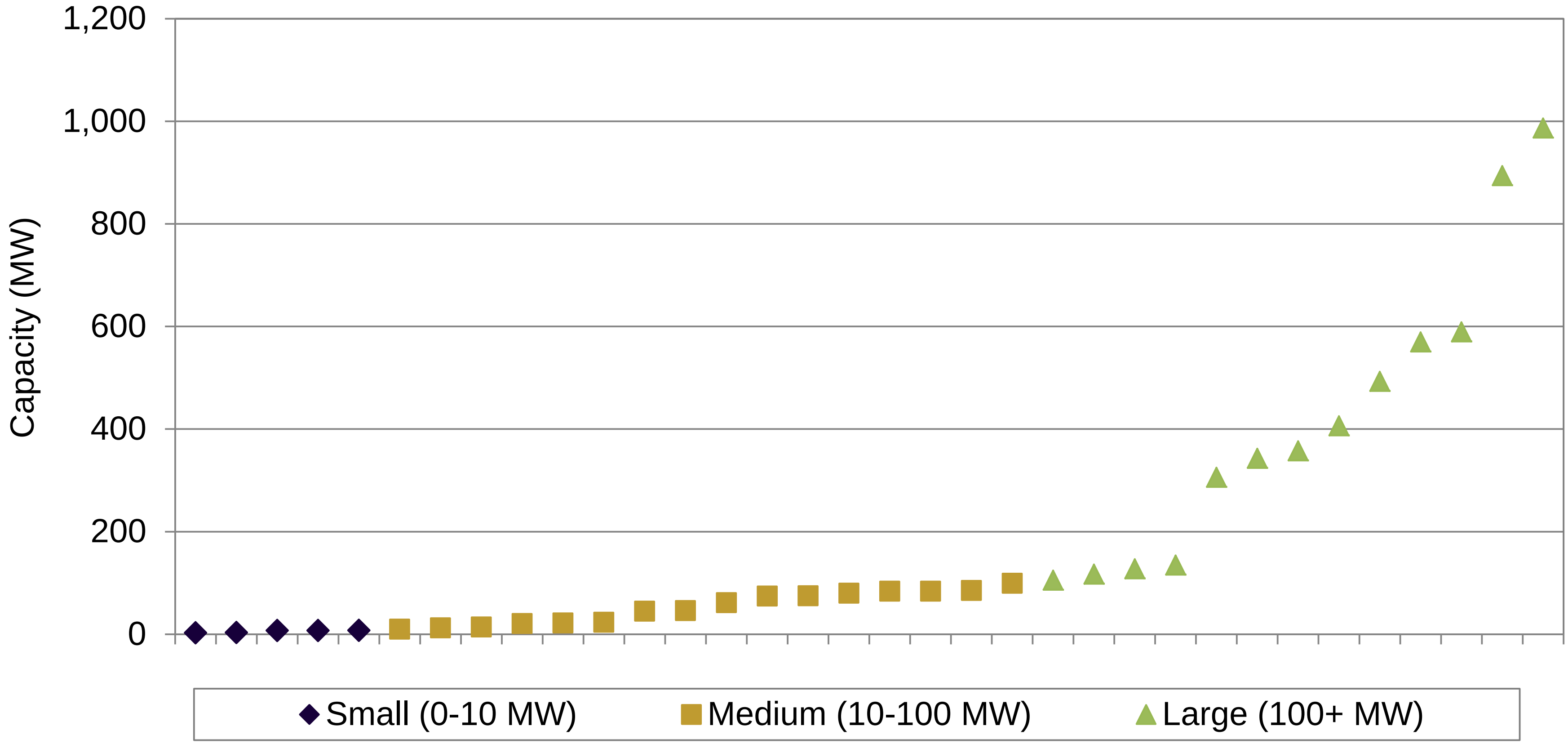


Note: Includes Industrial CHP only, as defined by Energy Information Administration.
Source: Energy Information Administration, U.S. Department of Energy.

Section 5: Unit Specific CHP Statistics and Trends

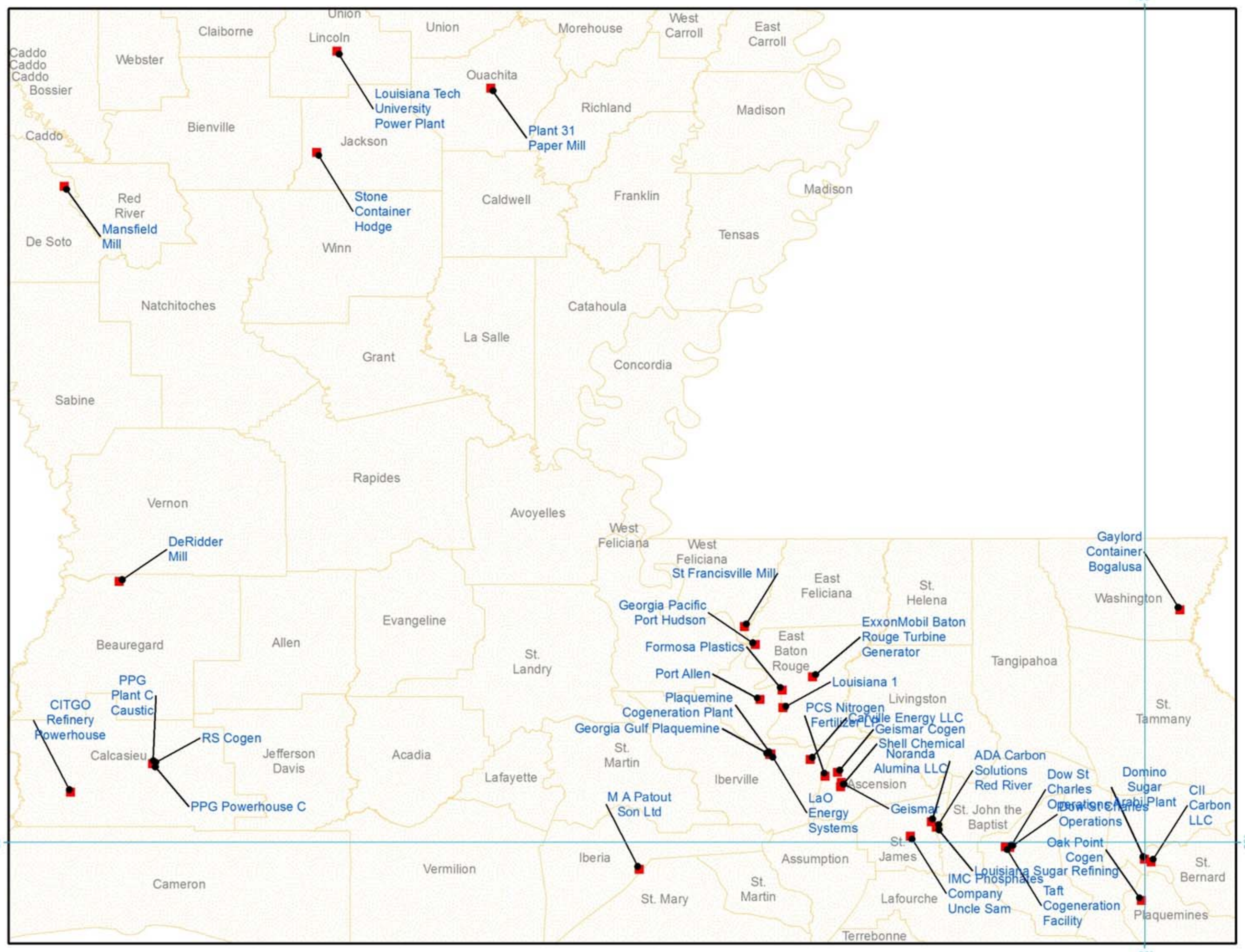
Louisiana CHP Facilities by Capacity

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.



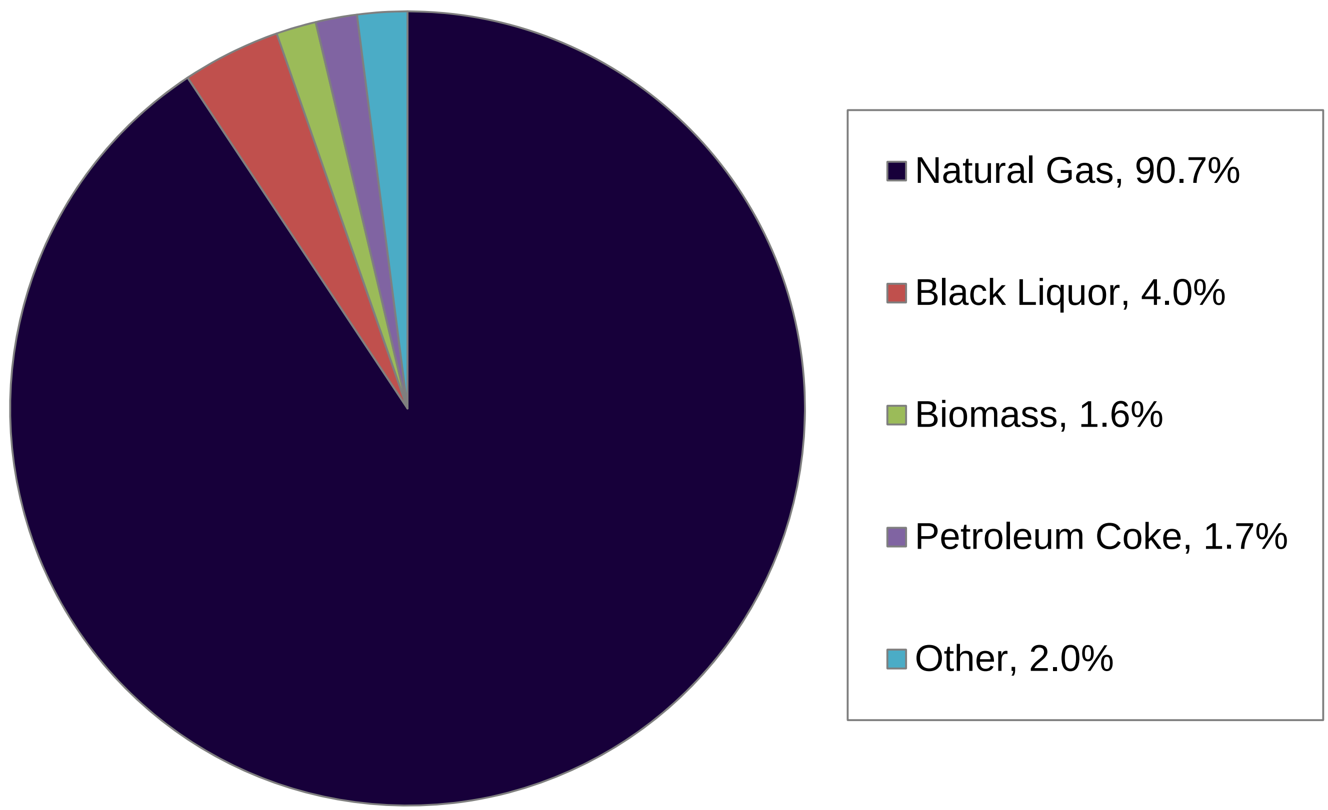
Louisiana CHP Facilities Location

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



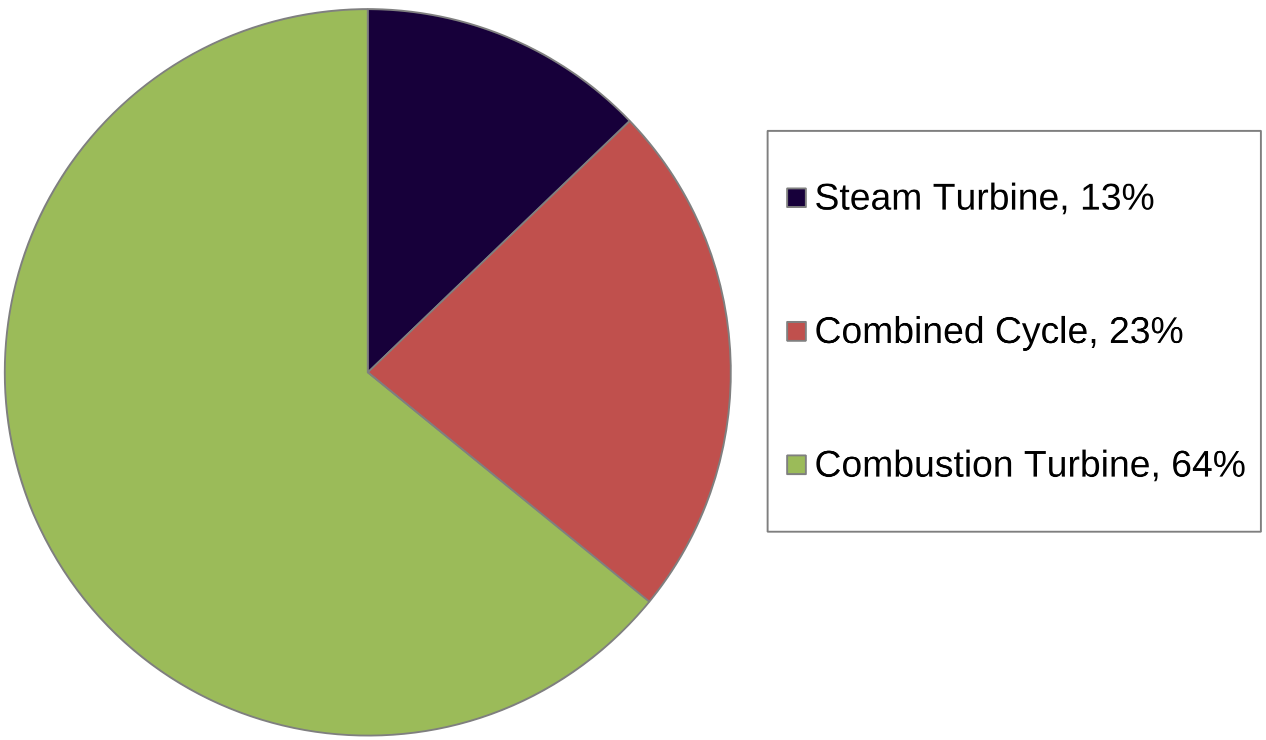
CHP Capacity by Fuel Type

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



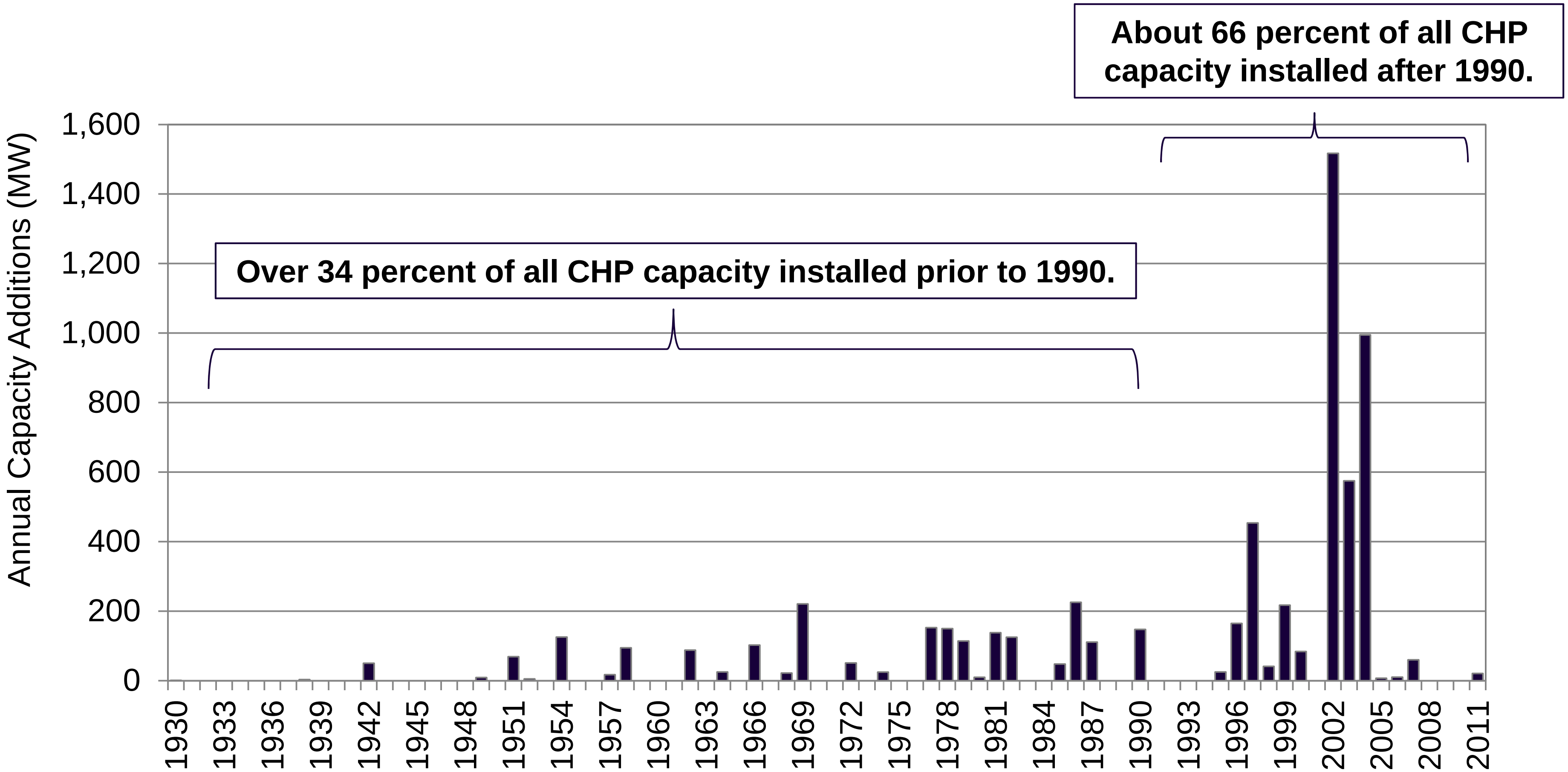
CHP Capacity by Prime Mover

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.



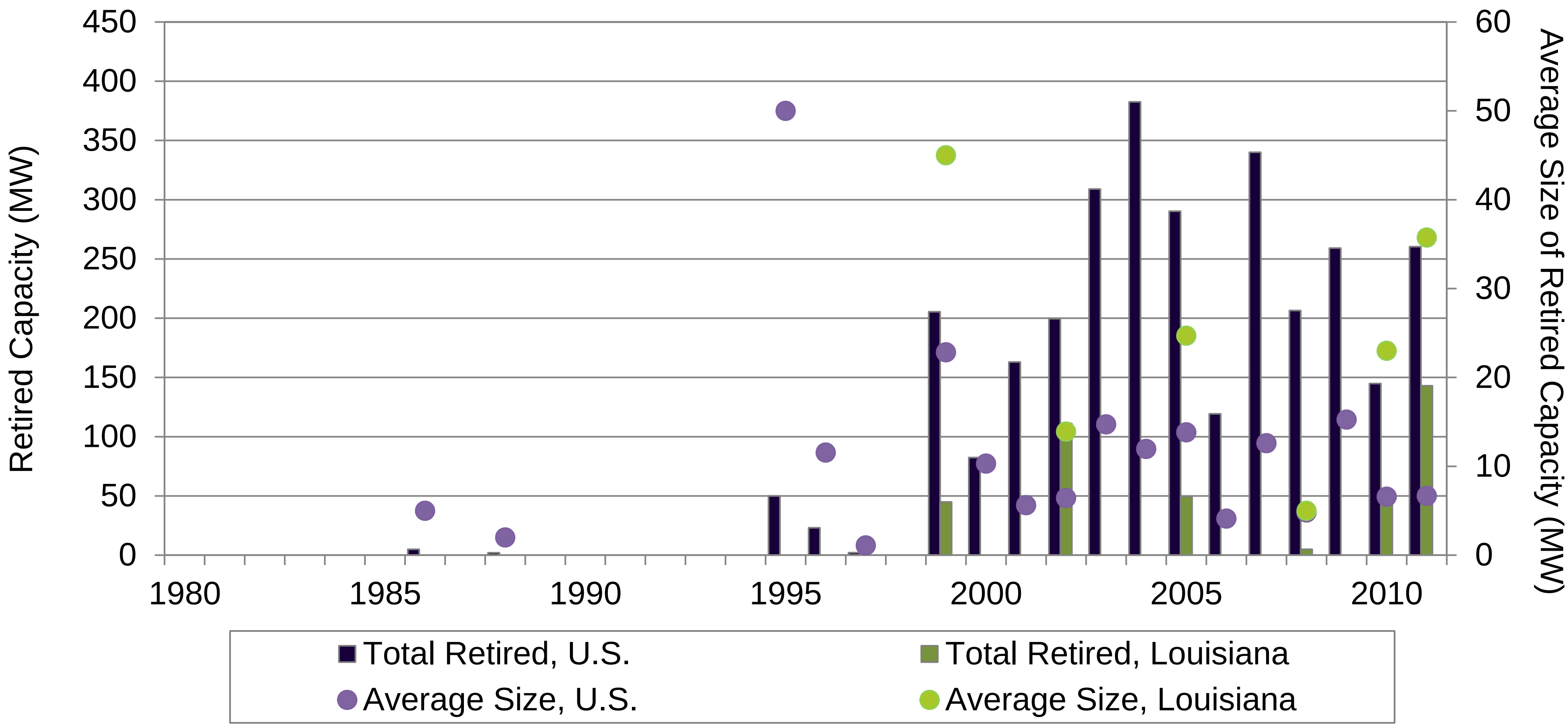
CHP Capacity by Installation Year

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



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

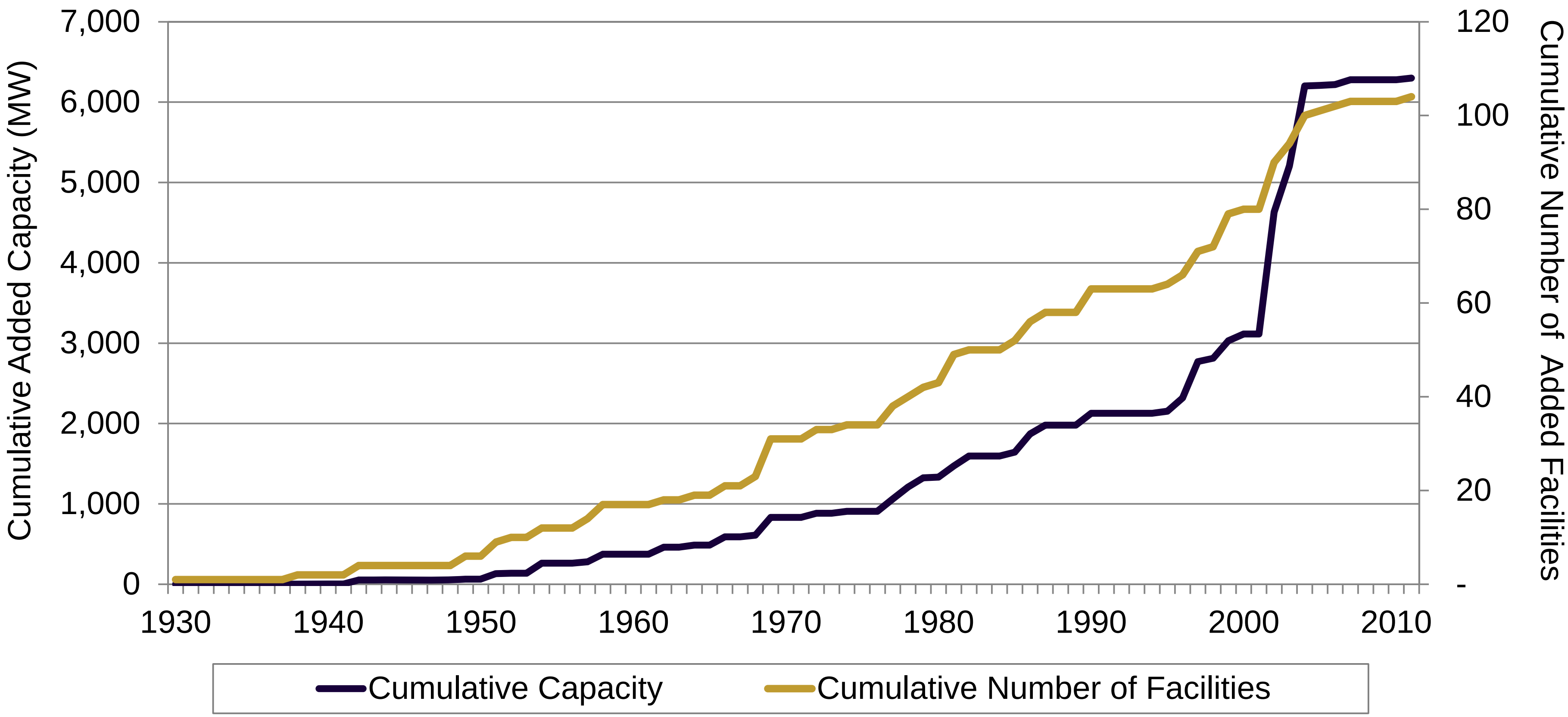
Legacy units (pre-1990) account for 34 percent of installed CHP capacity. Only chemical manufacturing units have a greater share of new capacity.

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%
	Total	**2,128**	**4,171**	**33.8%**	**66.2%**

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

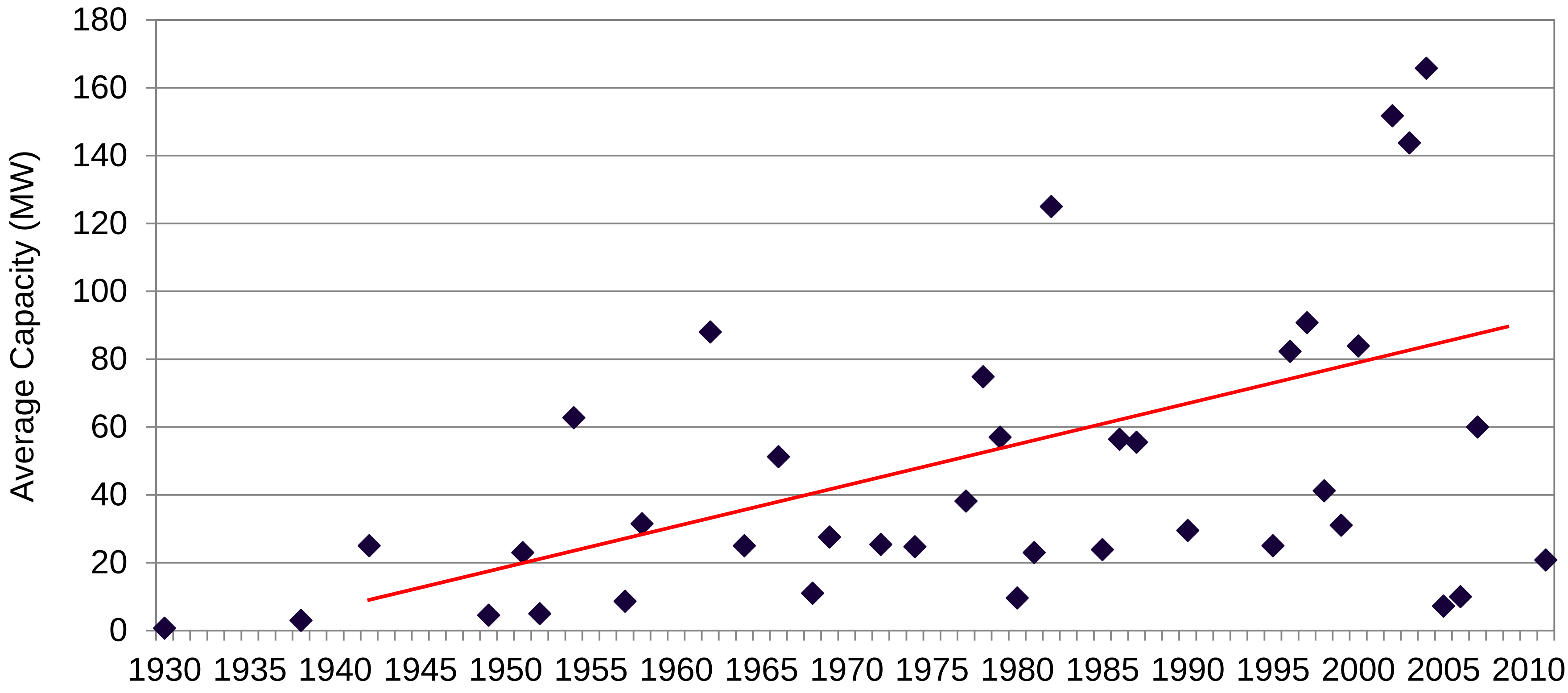
Cumulative Added CHP Capacity by Installation Year

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

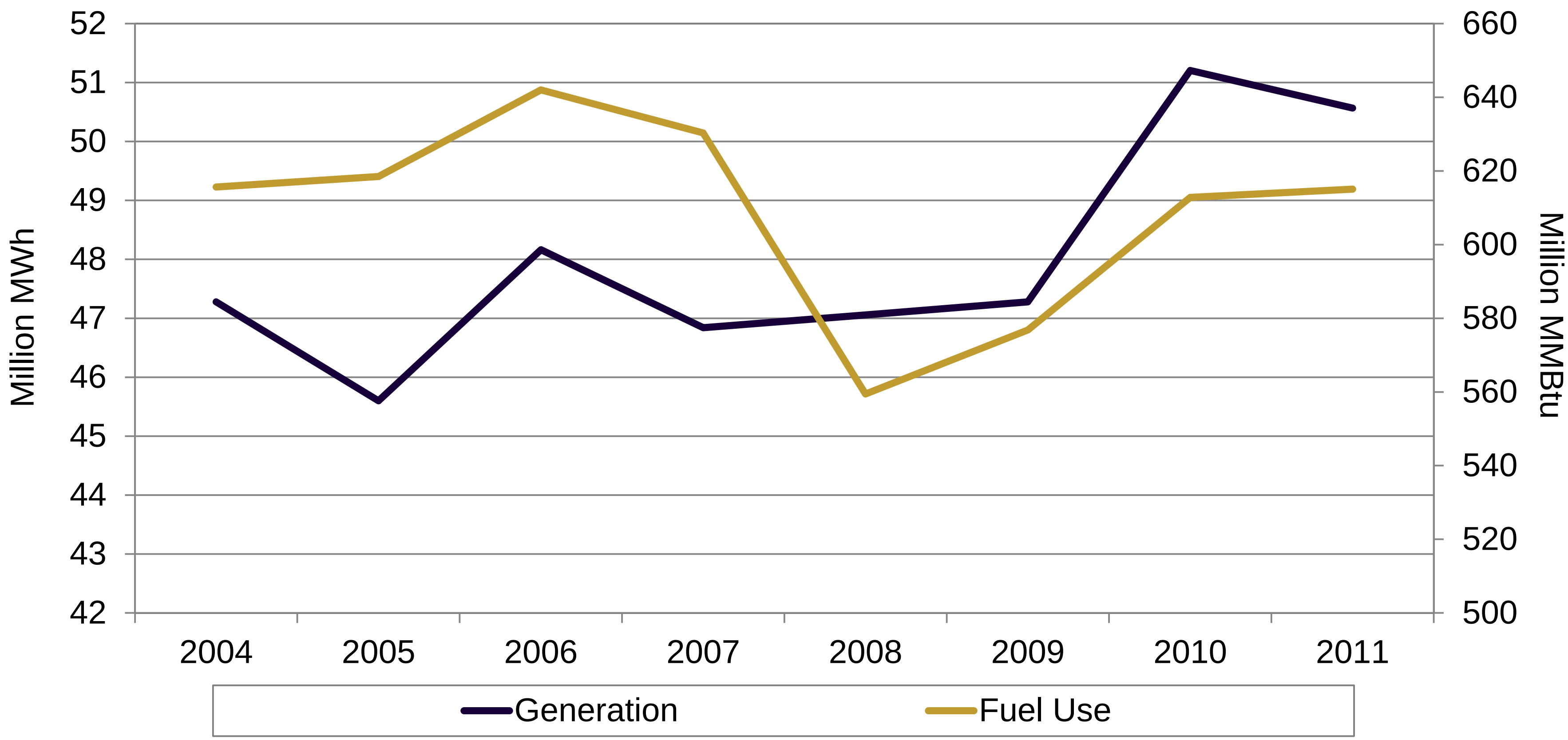
In Louisiana, CHP capacity totals 6,300 MW. Chemical manufacturing is the largest category, accounting for almost 5,000 MW, or about 80 percent of total CHP capacity. These units also tend to be the largest, averaging 91 MW per unit.

NAICS		Capacity (MW)	Percent of Total	Average Capacity (MW)
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
325	Chemical Manufacturing	4,984	79.1%	90.6
331	Primary Metal Manufacturing	84	1.3%	28.0
	Misc	8	0.1%	7.5
	Total	**6,299**	**100.0%**	**60.6**

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%
Total		**433,150,910**	**100.0%**

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

CHP Average Heat Rate by Sector

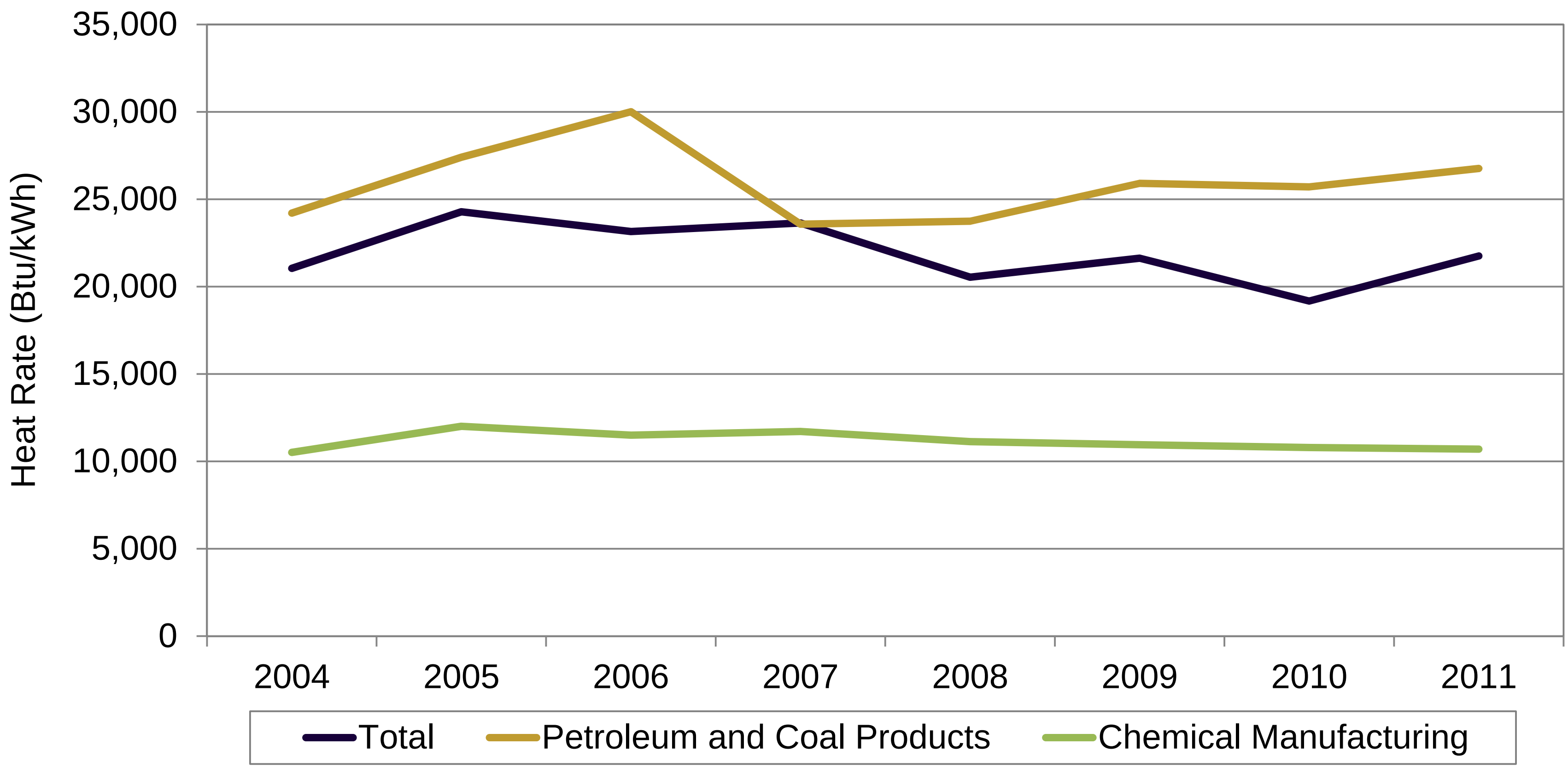
The chemical manufacturing CHP units operate the most efficiently in terms of heat rate.

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
Average		**21,749**

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

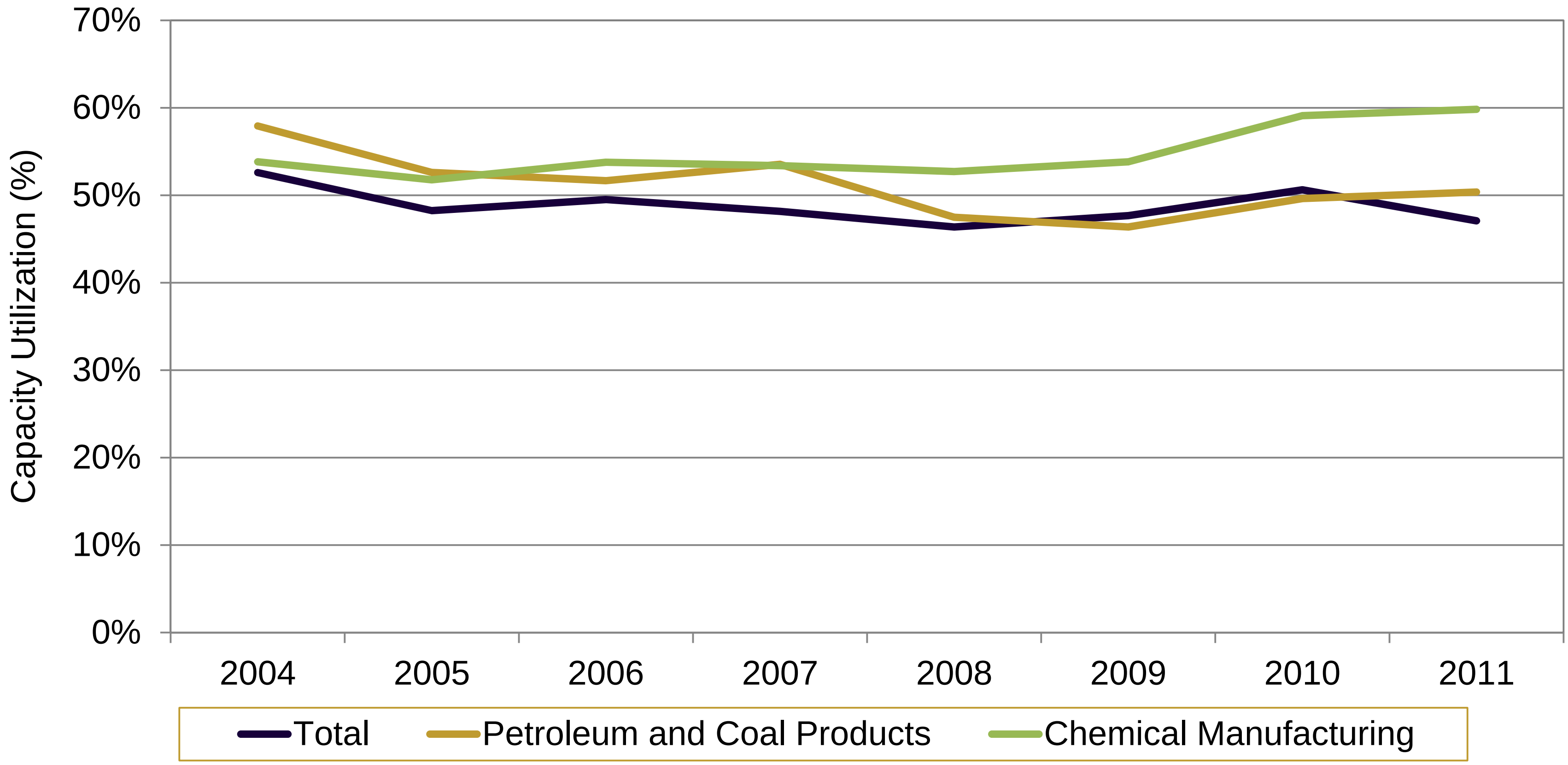
CHP production in the primary metal industries is the most utilized, as are paper manufacturing.

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%
Average		**60.1%**

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_2, SO_2 and NOx and emissions. Utility and IPPs emit significantly larger amounts of SO_2 and NOx, from a much greater share of coal use.

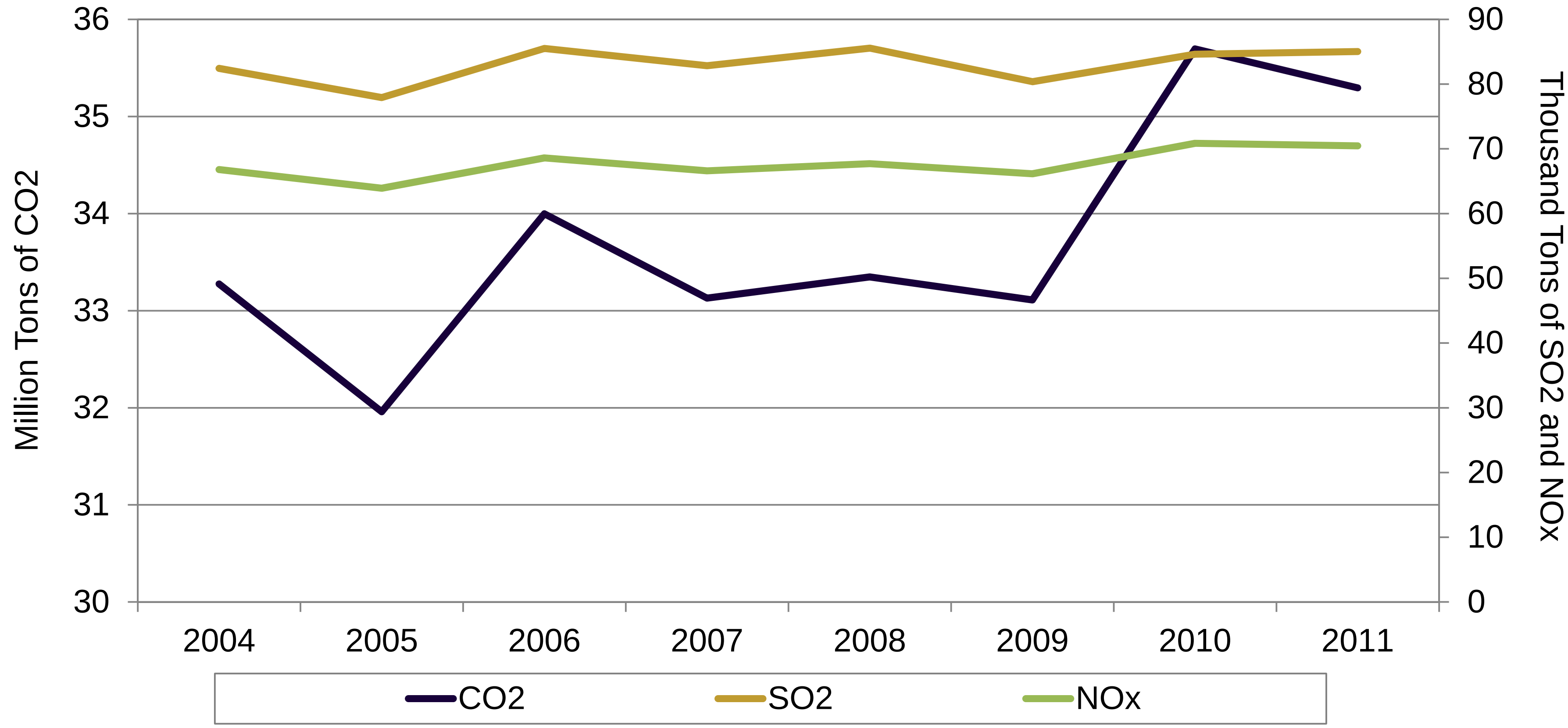
NAICS		CO2 Emissions (tons)	Percent of Total (%)	SO2 Emissions (tons)	Percent of Total (%)	NOx Emissions (tons)	Percent of Total (%)
311-312	Food, Beverage and Tobacco	20,589	0.2%	2	0.0%	55	0.4%
322	Paper Manufacturing	415,363	3.1%	6,875	75.5%	1,796	11.8%
324	Petroleum and Coal Products	1,618,487	12.0%	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%
Total CHP		**13,501,966**	**100.0%**	**9,110**	**100.0%**	**15,239**	**100.0%**

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%**
Total	**59,780,599**	**100.0%**	**96,526**	**100.0%**	**65,382**	**100.0%**

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_2, SO_2 and NOx have increased for Louisiana's CHP and industrial self-generation units. CO_2 emissions have increased 6.1 percent, SO_2 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

LSU Center for Energy Studies

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

Phase 2 Report: Technical & Cost-Effectiveness Methodologies

Prepared for the Louisiana Department of Natural Resources

David E. Dismukes, Ph.D.
Center for Energy Studies
Louisiana State University
August 11, 2014

LSU CENTER FOR ENERGY STUDIES

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EXECUTIVE SUMMARY – PROJECT OVERVIEW

The methodological goal for this project is to estimate firm/industry-specific CHP opportunities. The model is based upon four primary components including: (1) market identification; (2) technical potentials analysis; (3) economic potentials analysis; and (4) sensitivity analyses.

The market identification will select the relevant firms and industries that are potential candidates for CHP development.

The technical potentials analysis will screen all firms selected in the market identification for their technical abilities to install CHP, which are based primarily upon each firm's thermal and electrical energy use characteristics.

The economic potential analysis starts with all firms having the technical capability for CHP. Costs and benefits for each of these firms will be evaluated and only those firms with cost-effective CHP opportunities will be selected.

The economic potentials will be subjected to a variety of sensitivities in order to ascertain the robustness of the empirical results.

Section 2: Introduction

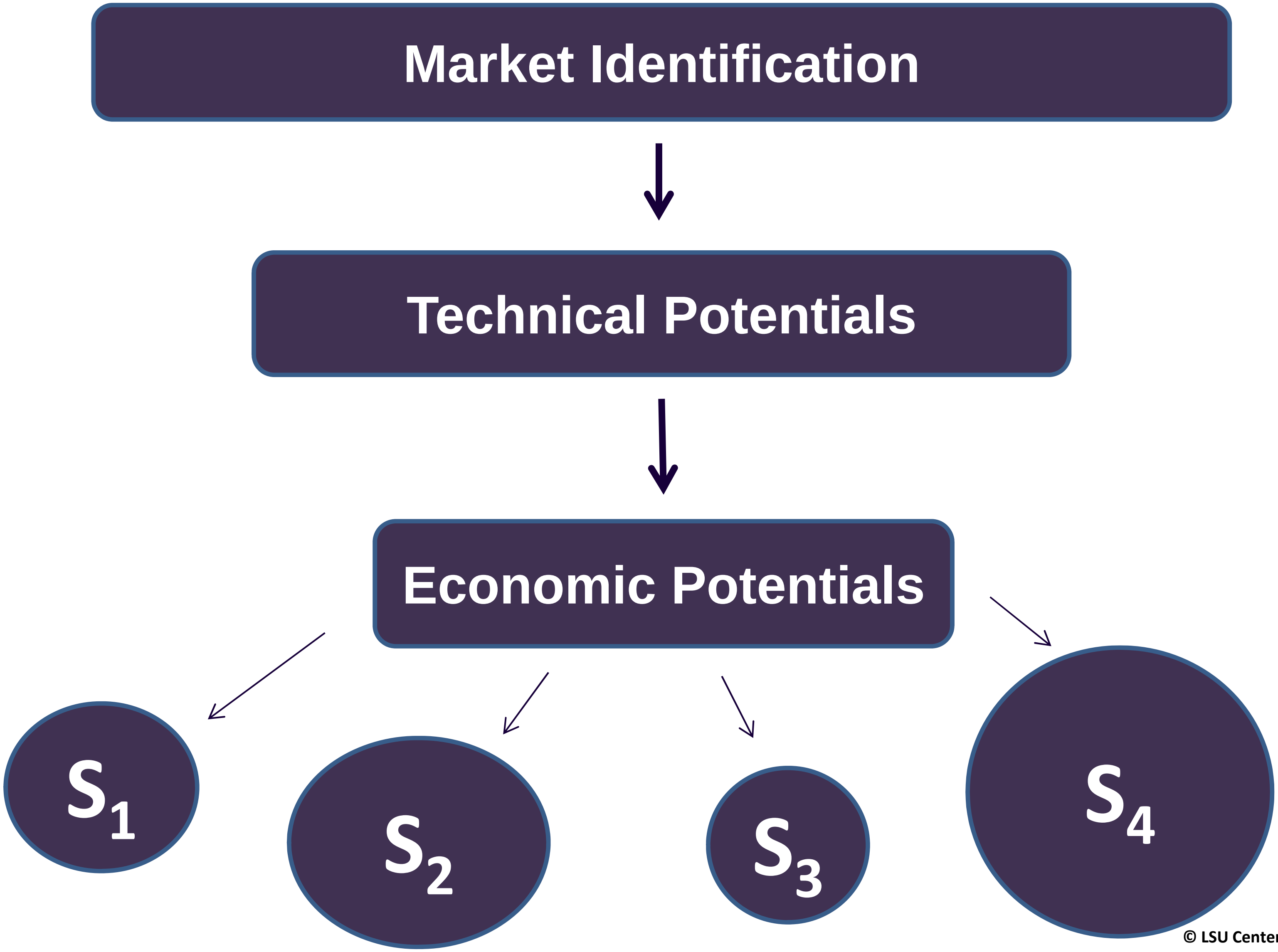
Modeling Overview

The empirical model utilized to examine the cost-effective opportunities for additional CHP development is comprised of four primary components that include:

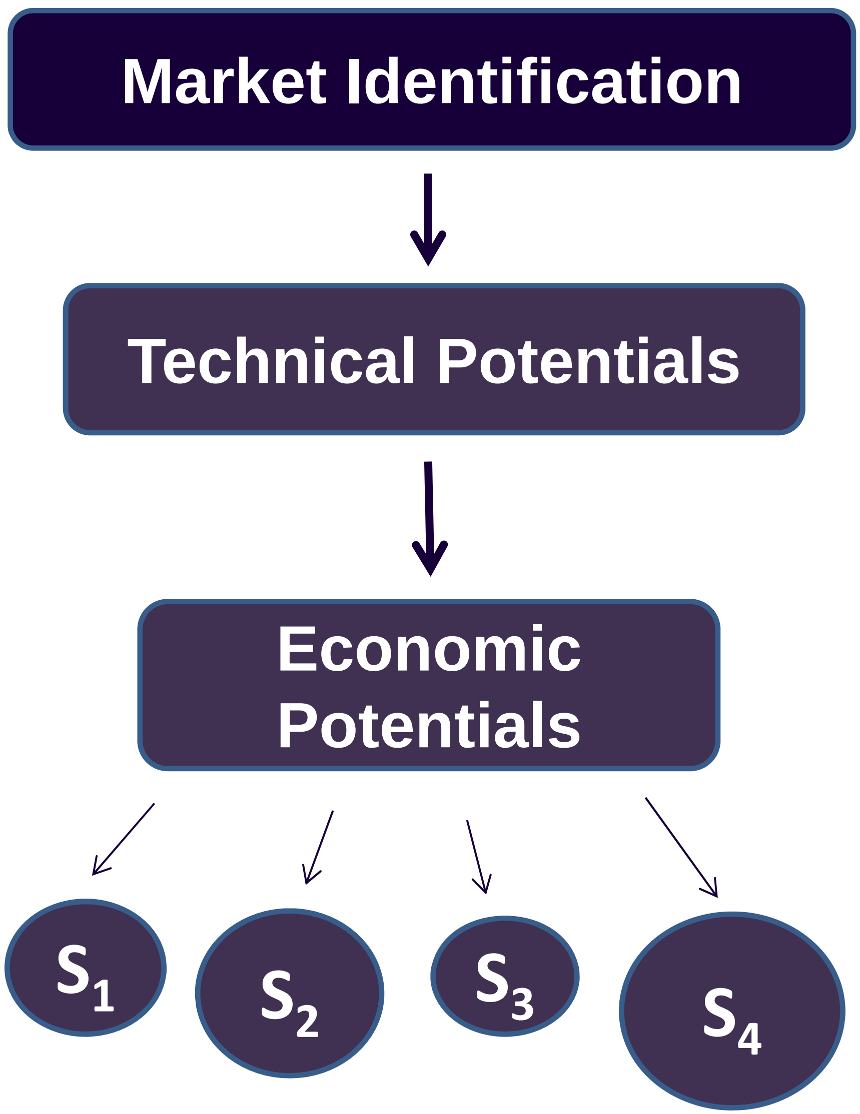
1) Market scope identification;
2) Technical potentials identification;
3) Economic potentials estimation; and
4) Sensitivity analyses.

In addition, data, as well as a number of operational assumptions are necessary in order to make each of the model components tractable. Each of the aforementioned components progress sequentially starting with market identification and working down to the sensitivity analysis.

Schematic: CHP Modeling Components



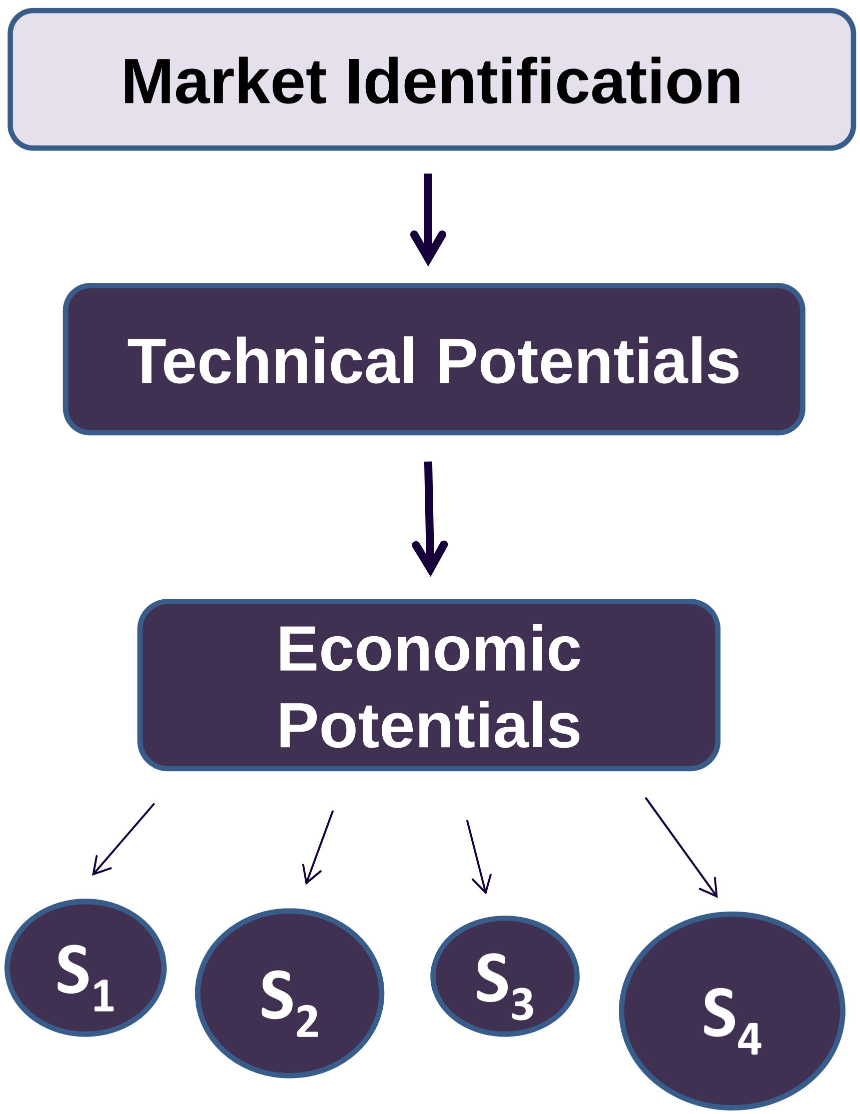
CHP Modeling Components: Market Identification



Each box decreases in size since each represents a sequential component of the modeling process starting from the highest level of aggregation to the smallest. The market is first defined, followed by the technical potentials (which is a subset of the market), followed by the economic potentials (which are a subset of the technical potentials), followed by sensitivities, impacts of which vary depending upon their nature and underlying assumptions.

Section 3: Market Identification

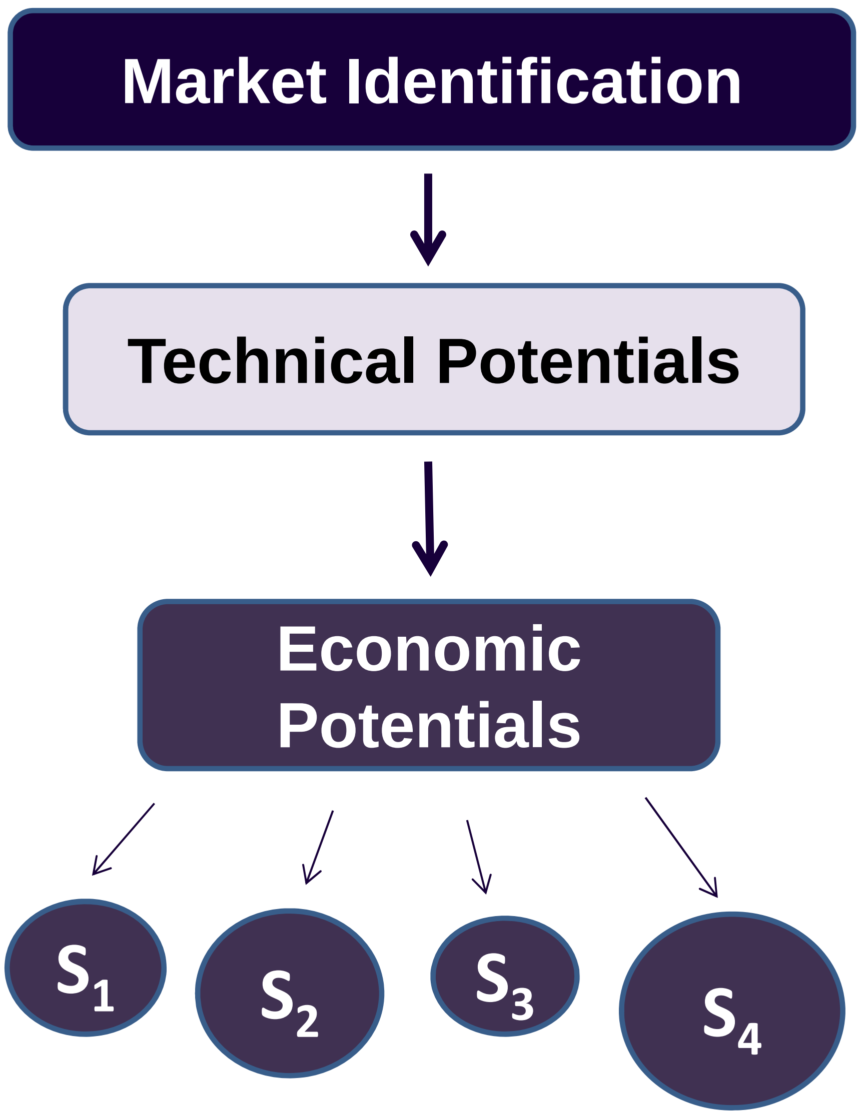
CHP Modeling Components: Market Identification



The first step in the modeling process is to identify the relevant market. For purposes of this research, the relevant market will be restricted to identifying commercial and industrial CHP applications. Thus, all Louisiana businesses and industries will be included for consideration. The unit of analysis will be at the facility level.

Section 4: Technical Potential

CHP Modeling Components: Technical Potentials



The technical potential for installing CHP is based on all candidate sites that have the technical capabilities to install CHP without regards to economics, ascetics, zoning ordinances, or other non-technical factors that would limit CHP development.

Technical Potential Screens

Three different screens were used to examine the electrical and thermal energy use for each Louisiana business and industry included in the CHP eligible market. These screens are:

1) A total thermal energy use screen (S^1)
2) A thermal energy use load factor screen (S^2)
3) An electric to thermal ("ET") energy use screen (S^3).

Business and industries that pass all three screens are considered to have the technical potential to install and operate CHP. These technical CHP candidates serve as the starting point for the subsequent economic potentials analysis.

Thermal Energy Use Screen (S[1])

Credible CHP analyses recognize that not all end users have the operational need for both electrical and thermal energy. CHP applications are capital intensive, and the on-site needs for both types of energy helps to drive down overall average development and operating costs. While recent technological innovations do allow for relatively small scale power operations, these applications often do not have large thermal requirements, or requirements scalable (proportional) with the power application and its heat output. Further, the technical and economic requirements of moving steam to a remote location for alternative use is often challenging if not (cost) prohibitive.

Thus, the first screen in the technical potential analysis is to identify and remove all candidate locations that (1) do not have a thermal load requirement or (2) have an inadequate thermal load requirement for steam that is less than 250 degrees Fahrenheit in temperature and 50 pounds per square inch gauge ("psig") in pressure.

First Screen (S^1) Formulation

The total thermal energy screen, S^1, is given by:

$$S^1{}_i = 1 \qquad if\ U_i > 0\ or$$
$$H_i \geq 100°\mathrm{F}\ \text{and}$$
$$P_i \geq 50\ psig$$

$$S^1{}_i = 0 \qquad otherwise$$

Where i indexes each individual candidate site, U_i is the candidate site's on-site thermal energy use measured in MMBtus, H_i is the candidate site's reported temperature for on-site steam use and P_i is the candidate site's reported on-site steam pressure. When S^1 = 1, the site passes the first technical screen and fails otherwise.

Load Factor Screen (S^2)

Those candidate CHP sites that pass the first total thermal use screen are subjected to a second thermal energy use screen examining their thermal energy use variation.

The load factor screen is used to ensure that thermal energy use is relatively stable and year round as opposed to seasonal and cyclical. The thermal load factor is estimated as the ratio of the candidate site's average to peak thermal energy usage. A ratio of 1.0 indicates that the site has steady year round usage with no variation between peak and average use. Lower ratios indicate higher degrees of thermal energy use variation. These ratios can be expressed in percentage terms by multiplying by 100.

The load factor screen selects only those sites with a thermal load factor greater than 50 percent (0.50)

Second Screen (S^2) Formulation

The thermal load factor screen, S^2, is given by:

$$S^2{}_i = 1 \qquad if\ \frac{A_i}{P_i} \geq 0.50$$
$$S^2{}_i = 0 \qquad otherwise$$

Where A_i is the candidate site's average on-site thermal energy use measured in MMBtus, P_i is the candidate site's reported peak on-site thermal energy use. When S^1 = 1, the site passes the first technical screen and fails otherwise.

Electricity/Thermal Ratio Screen (S^3)

The ratio of a candidate site's electric to thermal ("ET") energy use is used as the last technical potentials screen to recognize that some proportional need for steam and power is necessary in order for a CHP project to be developed. While excess power can be "put" to the host utility grid given PURPA requirements, the same is not true for steam.

The ET ratio screens out candidate sites with a ratio below 2.38 which is the thermal efficiency requirement needed to qualify for avoided cost rates under PURPA. §292.205 of PURPA identifies 42 percent as the required thermal efficiency requirement, the inverse of which, is 2.38.

Third Screen (S^3) Formulation

The ET ratio screen, S^3, is given by:

$$S^3{}_i = 1 \qquad if\ \ 2.38 \geq \frac{E_i}{U_i} \ \geq\ 0.001$$
$$S^3{}_i = 0 \qquad otherwise$$

Where E_i is the candidate site's electricity use standardized to MMBtus and U_i is the candidate site's thermal energy demand also standardized in MMBtus.

When S^3 = 1, the site passes the third technical screen and fails otherwise.

Technical Potentials Selection

Candidate sites are selected as being technically capable for a CHP installation if they pass all three screens discussed earlier. Mathematically, this overall technical potentials screen is defined as:

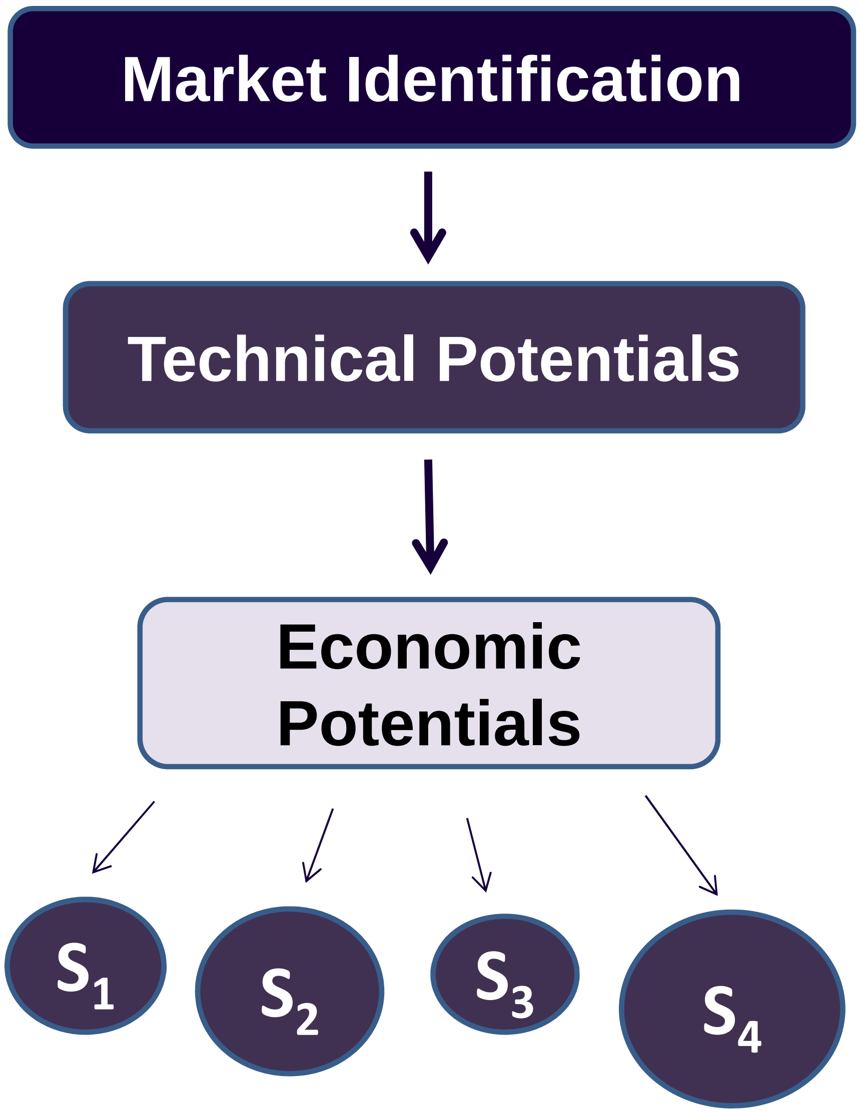
$$S^T{}_i = 1 \qquad if\ S^1{}_i = 1\ and\ S^2{}_i = 1\ and\ S^3{}_i = 1$$

$$S^T{}_i = 0 \qquad otherwise$$

When $S^T = 1$, the site is selected as having the technical potential for CHP and is further evaluated in the second part of the analysis for cost-effectiveness.

Section 5: Overview, Economic Potential

CHP Modeling Components: Economic Potentials



The economic potential is defined as those candidate sites that have the technical capabilities to install CHP and where the project life benefits of the CHP installation are greater than the project life costs on a net present value ("NPV") basis.

Economic Potentials Modeling: Overview

In general, candidate sites are identified as being cost-effective if their benefits are greater than or equal to their costs:

$$E_i = 1 \qquad iff\ G^B{}_i \geq G^C{}_i$$
$$E_i = 0 \qquad otherwise$$

Where $G^B{}_i$ are the benefits associated with the candidate site adoption of CHP and $G^C{}_i$ represents the costs of the candidate site adopting CHP. If E_i = 1, the site is identified as being a cost-effective candidate for CHP.

Economic Potentials Modeling: CHP Benefits

The economic benefits of CHP at each candidate site (${G^B}_i$) are determined by the sum of the potential projects avoided energy costs associated with electrical (${S^E}_i$) and thermal energy (${S^H}_i$) as well as any revenues (${R^E}_i$) that may be earned from excess power sales. Mathematically, this can be expressed as:

$${G^B}_i = {S^E}_i + {S^H}_i + {R^E}_i$$

Section 6: Energy Savings Benefits

CHP Benefits: Electricity Savings Determination

Electricity expenditures for most larger commercial and industrial customers are broken into three components: energy charges; demand charges; and customer/facility charges.

Facilities and customer charges are not avoidable since all CHP candidates in this study are assumed to continue to remain interconnected to the host utility grid for emergency and backup service.

Energy and demand charges are potentially avoidable. These charges are unique to each in-state electric utility and are regulated by the Louisiana Public Service Commission ("LPSC")

Electricity Savings: Avoided Energy and Demand Charges (Electricity)

Energy charges are based upon the variable cost of generating electricity which is primarily fuel by will vary in absolute value across utilities depending upon their: (1) fuel cost procurement efficiency; (2) fuel diversity; and (3) generating fleet efficiency.

Demand charges are associated with the cost recovery of capacity developed to serve peak loads and are usually assessed to large customers on a fixed price per kilowatt ("kW") basis.

[1]Technically, fuel costs are recovered under a separate volumetric charge often referred to as a "fuel adjustment clause or "FAC." For purposes of discussion in this report, the "energy charge" referenced in this report should be interpreted to include both the base rate and fuel related volumetric rates unless otherwise indicated.

Electricity Savings: Avoided Energy and Demand Charges

Total electricity savings equals the net present value of all the avoided energy and demand charges over the life (t) of the project, valued at discount rate (r):

$$S^E{}_{it} = \left(\sum_{t=1}^{T} E^s{}_{it} + D^s{}_{it}\right)e^{-rt}$$

Where $E^s{}_{it}$ is the avoided annual energy charges and $D^s{}_{it}$ is the avoided annual demand charges for each year (t) such that in each year:

$$(E^s{}_{it} + D^s{}_{it}) = (p^E{}_{it}q^E{}_{it} + p^D{}_{it}q^D{}_{it})$$

Where each p represents the energy and demand charge (or price) faced by firm i in year t and q is the annual quantity of energy and demand purchased by firm i in year t.

Avoided Thermal Energy Charges

Thermal energy savings are derived by taking the summation of all the avoided thermal energy costs over the life of the project as given by:

$$S^{H}{}_{it} = \sum_{t=1}^{T} h^{s}{}_{it}$$

Where $h^{s}{}_{it}$ represents avoided annual thermal energy costs, standardized in MMBtus, for each year (*t*) that the CHP project is operational such that:

$$(h^{s}{}_{it}) = (p^{h}{}_{it} q^{h}{}_{it})$$

Revenues from CHP Electricity Sales

Total electricity sales revenues are derived by taking the summation of all annual excess electricity sales over the life of the project as given by:

$$R^{E}{}_{it} = \sum_{t=1}^{T} p^{a}{}_{it} q^{ES}{}_{it}$$

Where p^{a} represents annual prices for excess energy sales (at avoided costs) for each unit of excess electricity sales q^{ES}.

Section 7: CHP Costs

CHP Costs

The costs associated with CHP development are generally based upon the initial capital costs of purchasing and installing the CHP equipment as well as any other supporting equipment and balance of plant investment. The return on the investment and the return of the investment, through its annual depreciation allowance, represent the annual capital costs associated with CHP development.

Other costs tend to be more variable in nature and include annual fuel costs, annual operation and maintenance (“O&M”) costs, and a variety of other miscellaneous costs.

Formulation of CHP Costs

Total CHP costs are the net present value of all the capital and variable costs associated with project development and operation over the life (t) of the project, valued at discount rate (r):

$$G^C{}_{it} = \left(\sum_{t=1}^{T} (K^G{}_{it} - D^G{}_{it}\right)(1-r)$$

$$+ d_{it} + \left(p_{it}^{f} q_{it}^{f}\right) + \left(p_{it}^{o} q_{it}^{o}\right) + \left(p_{it}^{z} q_{it}^{z}\right))e^{-rt}$$

Where K^G is the gross capital cost of the CHP investment, D^G is the accumulated depreciation, d_{it} is the annual depreciation expense, $p_{it}^{f} q_{it}^{f}$ are the annual fuel costs, $p_{it}^{o} q_{it}^{o}$ are the annual operations costs, and $p_{it}^{z} q_{it}^{z}$ are other annual costs.

Section 8: Cost Effectiveness

Cost Effectiveness Definition & Formulation

Cost effectiveness is calculated based upon a comparison of the CHP benefits and costs outlined in the earlier two sections of this report. As noted earlier, candidate sites are identified as having cost-effective CHP opportunities if their estimated CHP benefits are greater than their costs expressed as:

$$G^{B}{}_{i} \geq G^{C}{}_{i}$$

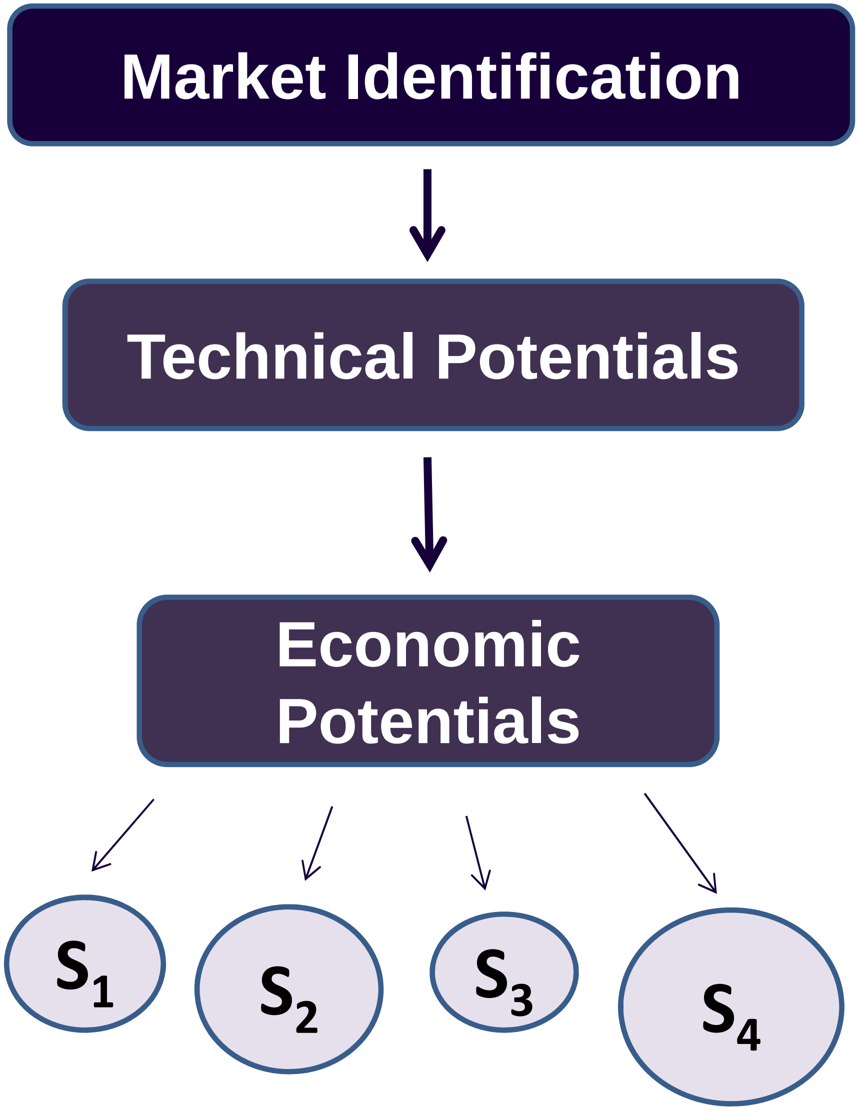
This relationship can be expressed in ratio-form as a benefit-cost ratio given by:

$$\frac{G^{B}{}_{i}}{G^{C}{}_{i}} \geq 1.0$$

A candidate site can be identified as being cost effective if the ratio given above is greater than, or equal to, a value of 1.0.

Section 9: Sensitivities

CHP Modeling Components: Sensitivities



Sensitivities are conducted to test the robustness of the empirical results. Sensitivities are based upon the relaxation of certain assumptions in both the technical and economic potentials analysis. The results of changing these assumptions will likely have differing positive and negative impacts on the size of the estimated CHP economic potentials. Specific sensitivities will be identified in the Phase 3 Report.

Section 10: Conclusions

Summary and Conclusions

The methodological goal for this project is to estimate firm/industry-specific CHP opportunities. The model is based upon four primary components including: (1) market identification; (2) technical potentials analysis; (3) economic potentials analysis; and (4) sensitivity analyses.

The market identification will select the relevant firms and industries that are potential candidates for CHP development.

The technical potentials analysis will screen all firms selected in the market identification for their technical abilities to install CHP, which are based primarily upon each firm's thermal and electrical energy use characteristics.

The economic potential analysis starts with all firms having the technical capability for CHP. Costs and benefits for each of these firms will be evaluated and only those firms with cost-effective CHP opportunities will be selected.

The economic potentials will be subjected to a variety of sensitivities in order to ascertain the robustness of the empirical results.

LSU Center for Energy Studies

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

Phase 3 Report: Empirical Results: Technical & Cost-Effectiveness Potentials

Prepared for the Louisiana Department of Natural Resources

David E. Dismukes, Ph.D.
Center for Energy Studies
Louisiana State University
August 11, 2014

LSU CENTER FOR ENERGY STUDIES

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4.0	Estimated CHP Technical Potentials
5.0	Estimated CHP Economic Potentials
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7.0	Conclusions

EXECUTIVE SUMMARY – PHASE 3 REPORT

The empirical model used to examine the opportunities for CHP development is comprised of four primary components: market scope identification; technical potentials identification; economic potentials estimation; and sensitivity analyses.

Some 209 facilities, accounting for 1,480 MW in load, were identified as having the potential for CHP installations (the market scope). These facilities are primarily large commercial sites, smaller-scale manufacturing, and large industrial facilities.

Facilities with large and relatively balanced thermal and electrical load requirements were largely those that have the technical potential for CHP installations. There are 92 facilities, which account for 1,070 MW in load, that are estimated to pass the technical screen for CHP installations. Chemicals and refineries dominate those passing this screen.

A small number of facilities were estimated to have cost-effective CHP potential. There are 28 facilities, which use around 560 MW of load, that have the cost-effective potential to install CHP. Most of these opportunities are in chemical manufacturing or refining.

The sensitivities relaxing the cost-effectiveness range and increasing market prices for excess CHP generation sales, created positive swings for CHP potential.

Section 2: Introduction

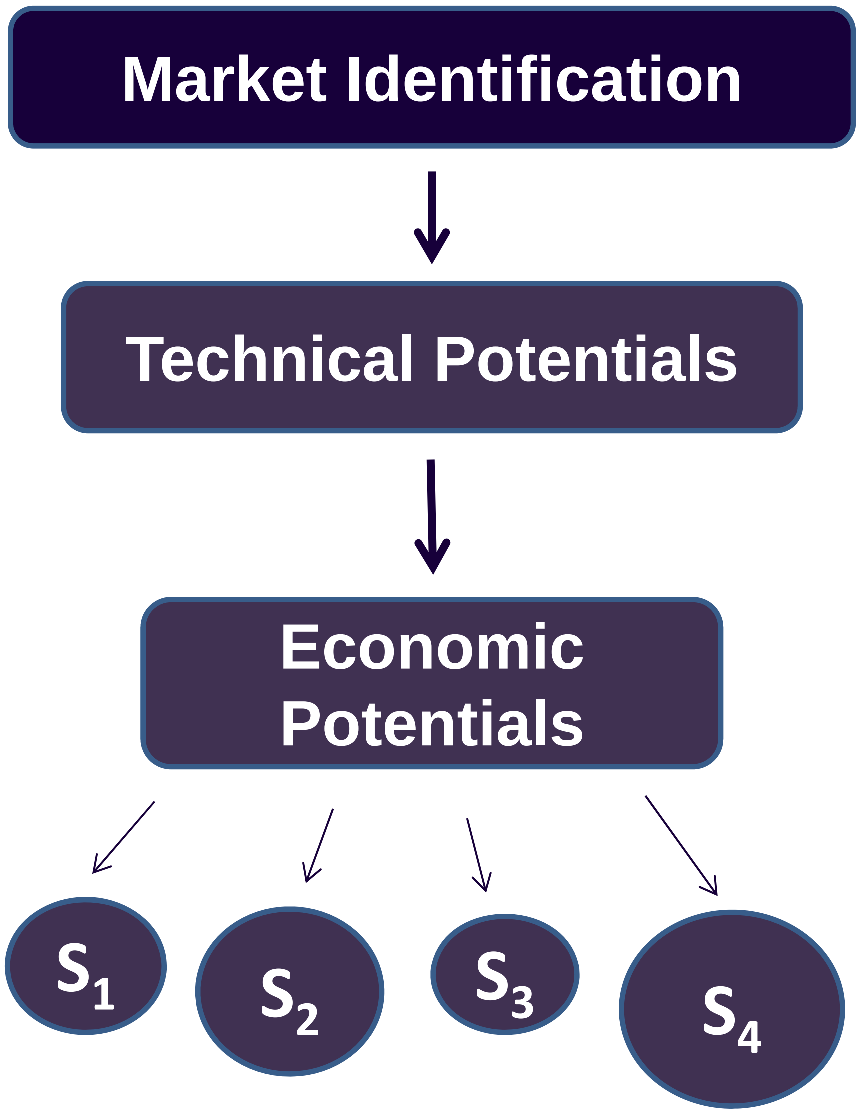
Modeling Overview

The empirical model utilized to examine the opportunities for CHP development is comprised of four primary components:

1) Market scope identification;
2) Technical potentials identification;
3) Economic potentials estimation; and
4) Sensitivity analyses.

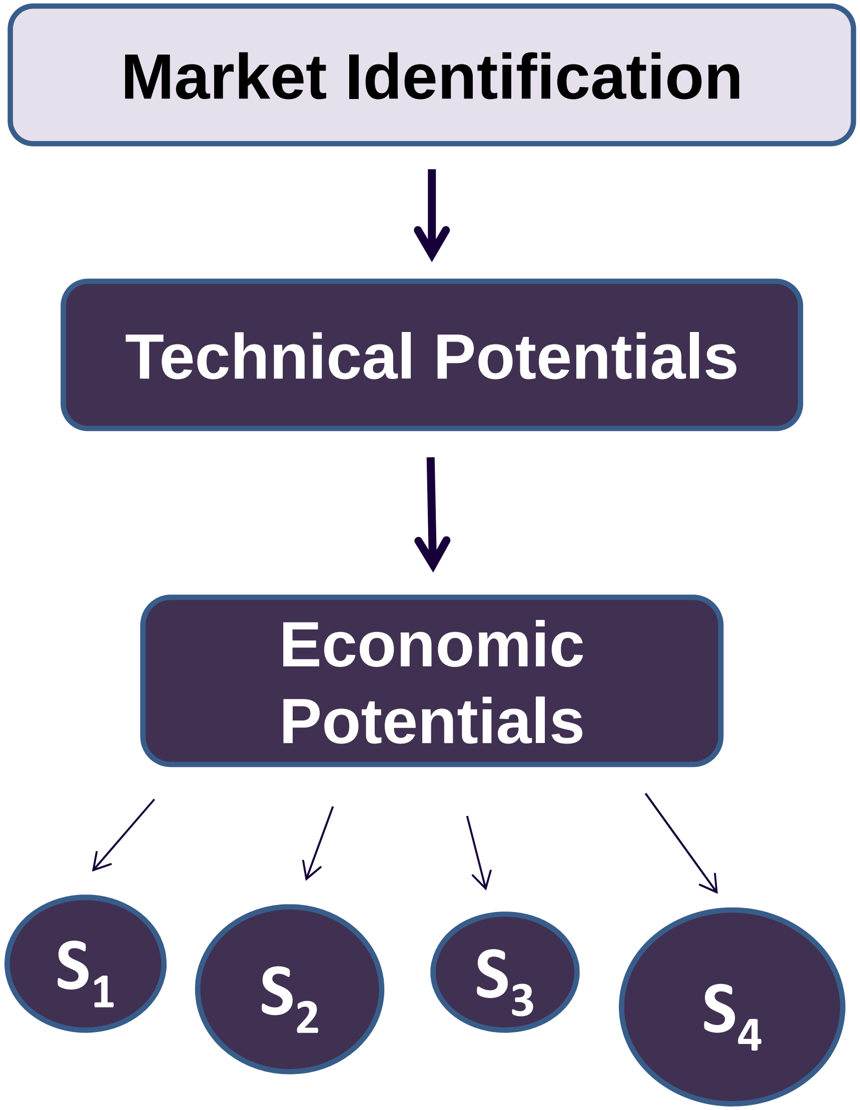
In addition, a working dataset as well as a number of operational assumptions are necessary in order to make each of the model components tractable. Each of the model components progress sequentially starting with market identification and working down to the sensitivity analysis.

CHP Modeling Components: Market Identification



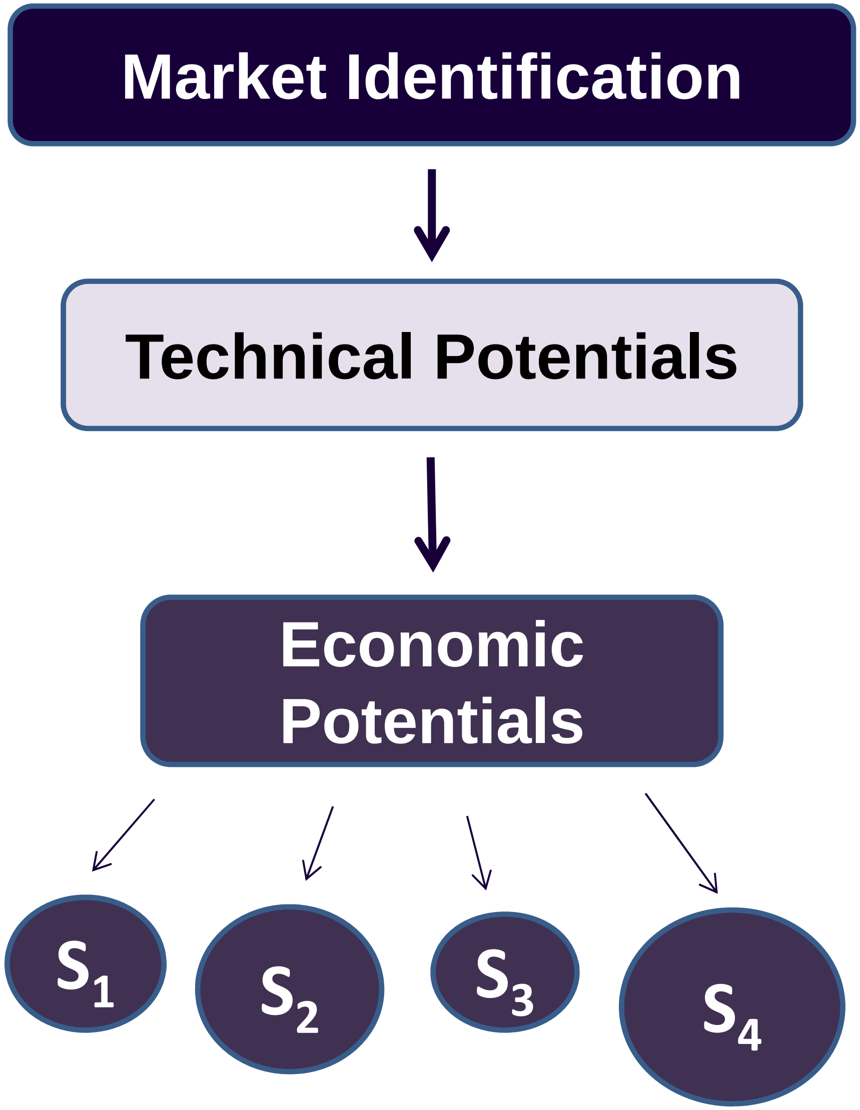
Each box decreases in size since each represents a sequential component of the modeling process starting from the highest level of aggregation to the smallest. The market is first defined, followed by the technical potentials (which is a subset of the market), followed by the economic potentials (which are a subset of the technical potentials), followed by sensitivities, impacts of which vary depending upon their nature and underlying assumptions.

CHP Modeling Components: Market Identification



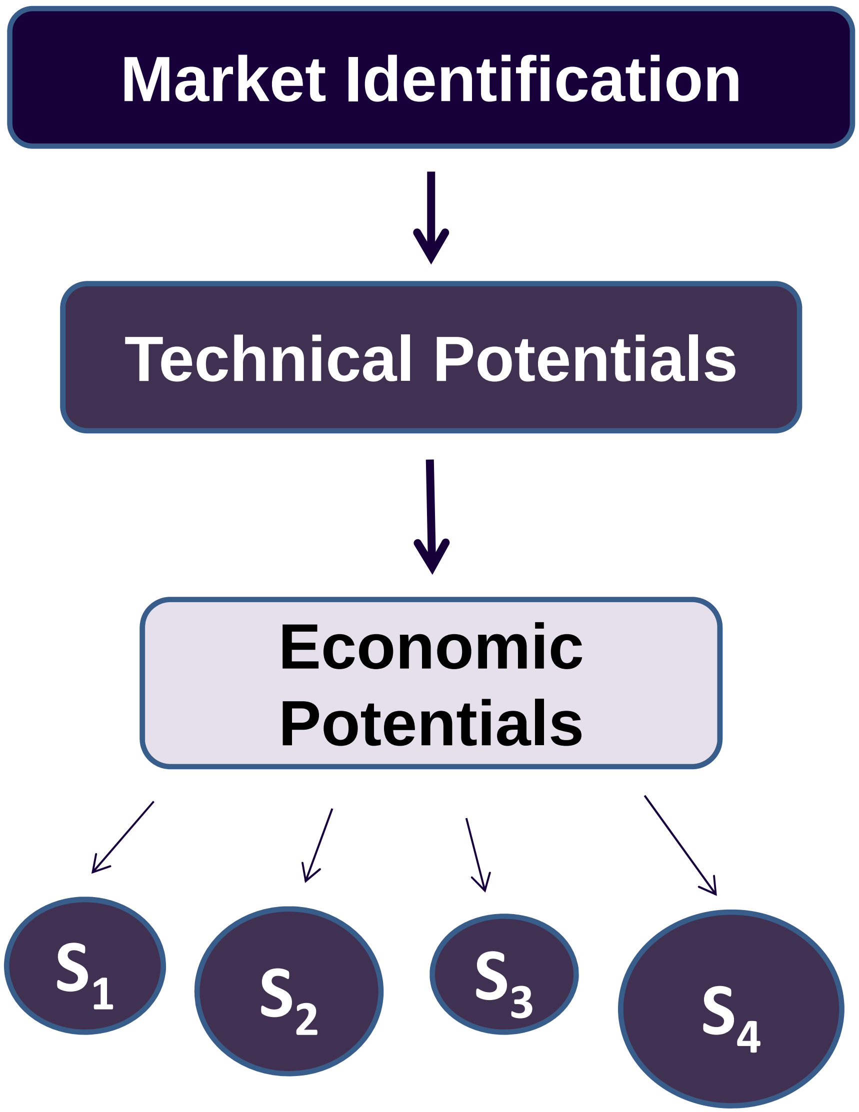
The first step in the modeling process is to identify the relevant market. For purposes of this research, the relevant market will be restricted to identifying potential commercial and industrial CHP applications. Thus, all Louisiana businesses and industries will be included for consideration. The unit of analysis will be at the facility level.

CHP Modeling Components: Technical Potentials



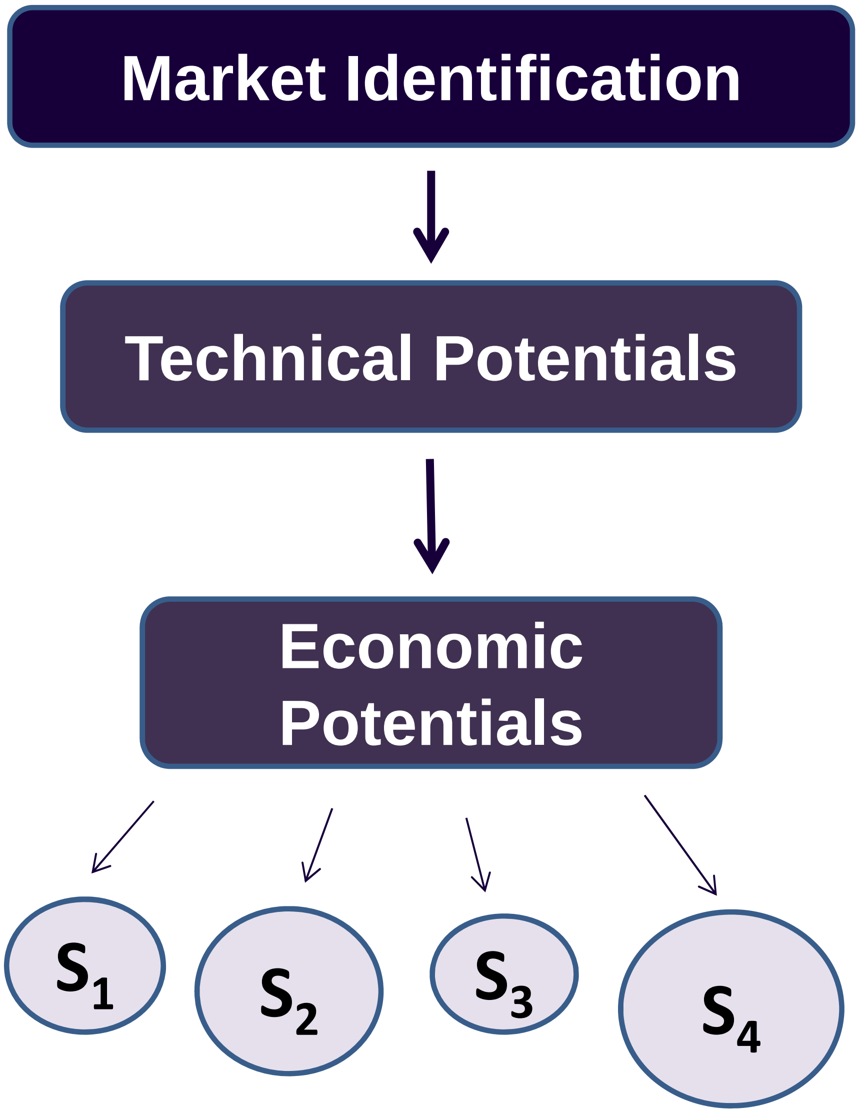
The technical potential for installing CHP is based on all candidate sites that have the technical capabilities to install CHP without consideration of economics, aesthetics, zoning ordinances, or other non-technical factors that would limit CHP development.

CHP Modeling Components: Economic Potentials



The economic potential is defined as those candidate sites that have the technical capabilities to install CHP and where the project life benefits of the CHP installation are greater than the project life costs on a net present value ("NPV") basis.

CHP Modeling Components: Sensitivities



Sensitivities are conducted to test the robustness of the empirical results. Sensitivities are based upon changes to certain assumptions in the economic potentials analysis. The results of changing these assumptions will likely have differing positive and negative impacts on the size of the estimated CHP economic potentials. These specific sensitivities are identified later in this report.

Data Utilized

This analysis uses the Major Industrial Plant Database ("MIPD") for Louisiana prepared by IHS. This database identifies industrial facilities in Louisiana and includes data elements such as:

- Plant name, location and address (including latitude and longitude);
- Plant products by SIC or NAICS code;
- Hours of production, capacity utilization and dollar value of shipments;
- Electric utility, use, demand and price;
- Plant cogeneration percentage;
- Fuel usage by type: boiler, furnace or feedstock;
- Steam demand, pressure and temperature; and
- Number and rating of boilers, including primary and secondary fuels.

Section 3: Potential CHP Market

Louisiana CHP Market Potentials

The analysis starts with a dataset of 235 Louisiana commercial and industrial facilities. Phase 1 of this project identified 24 facilities with on-site CHP generation. Thus, there are 209 candidate facilities that define the potential Louisiana CHP market. In total, the average demand of these facilities is approximately 1,480 megawatts (“MW”).

The overwhelming bulk of the potential Louisiana CHP market (in capacity terms) is in the chemical and refining sectors which require close to 1,200 MW of capacity. The food, beverage and tobacco; primary metals; and wood products sectors comprise the next three largest potential CHP markets with 103 MW, 50 MW, and 30 MW, respectively.

Summary of Potential Louisiana CHP Market by NAICS

There are 209 candidate facilities that define the potential Louisiana CHP market. The average demand of these facilities is almost 1,480 MW, the majority of which is in the chemical and refining sectors. The food, beverage and tobacco; primary metals; and wood products sectors make up the next three largest potential CHP markets.

NAICS Category		Number of Facilities	Electric Use (MWh)	Average Electric Usage (MWh)	Electric Demand (kW)	Average Electric Demand (kW)	Boiler Fuel (MMBtu)	Furnace Fuel (MMBtu)
311-312	Food, Beverage and Tobacco	30	308,027	10,268	102,736	3,425	1,782,242	912,846
313-314	Textile Mills	1	5,583	5,583	1,395	1,395	-	125,282
315	Apparel Manufacturing	2	1,233	617	592	296	-	5,382
321	Wood Products	14	202,038	14,431	30,172	2,155	1,490,389	754,301
337	Furniture and Related Products	2	1,120	560	537	269	-	2,736
322	Paper Manufacturing	5	17,361	3,472	3,114	623	33,194	65,873
323	Printer and Related Support	14	47,337	3,381	9,660	690	-	65,112
325	Chemical Manufacturing	59	7,259,477	123,042	893,533	15,145	101,440,609	128,921,300
324	Petroleum and Coal Products	13	2,633,909	202,608	304,653	23,435	19,044,294	28,160,021
326	Plastics and Rubber Products	5	59,860	11,972	9,268	1,854	-	164,345
316	Leather and Products	2	2,389	1,194	1,171	586	2,034	-
327	Nonmetallic Mineral Products	5	114,185	22,837	13,684	2,737	62,475	3,029,388
331	Primary Metal Manufacturing	8	390,313	48,789	49,543	6,193	99,942	1,861,698
332	Fabricated Metal Products	13	60,349	4,642	15,600	1,200	1,851	290,477
333-334	Machinery and Electronics	19	131,434	6,918	27,290	1,436	64,050	444,245
335	Electrical Equipment and Appliances	1	17,489	17,489	2,802	2,802	-	100,000
336	Transportation Equipment	10	64,750	6,475	11,974	1,197	158,040	15,052
339	Misc	6	2,320	387	1,112	185	-	21,745
Total		**209**	**11,319,173**	**54,159**	**1,478,836**	**7,076**	**124,179,120**	**164,939,803**

Potential Louisiana CHP Market, Facility Utilization

The 209 candidate facilities have an average utilization rate of 54 percent. The average utilization rate for the chemical and refining sectors is reported to be 91 percent and 99 percent. The leather manufacturing sector has the lowest average utilization, at 23 percent.

NAICS Category		Number of Facilities	Average Facility Utilization	Minimum Facility Utilization	Maximum Facility Utilization
			---------- (%) ----------		
311-312	Food, Beverage and Tobacco	30	60%	23%	100%
313-314	Textile Mills	1	46%	46%	46%
315	Apparel Manufacturing	2	24%	24%	24%
321	Wood Products	14	56%	23%	100%
337	Furniture and Related Products	2	24%	24%	24%
322	Paper Manufacturing	5	65%	24%	100%
323	Printer and Related Support	14	55%	24%	100%
325	Chemical Manufacturing	59	91%	23%	100%
324	Petroleum and Coal Products	13	99%	96%	100%
326	Plastics and Rubber Products	5	53%	24%	100%
316	Leather and Products	2	23%	23%	24%
327	Nonmetallic Mineral Products	5	69%	24%	100%
331	Primary Metal Manufacturing	8	76%	30%	100%
332	Fabricated Metal Products	13	41%	23%	66%
333-334	Machinery and Electronics	19	50%	24%	100%
335	Electrical Equipment and Appliances	1	71%	71%	71%
336	Transportation Equipment	10	44%	23%	100%
339	Misc	6	24%	24%	24%
Total		**209**	**54%**	**23%**	**100%**

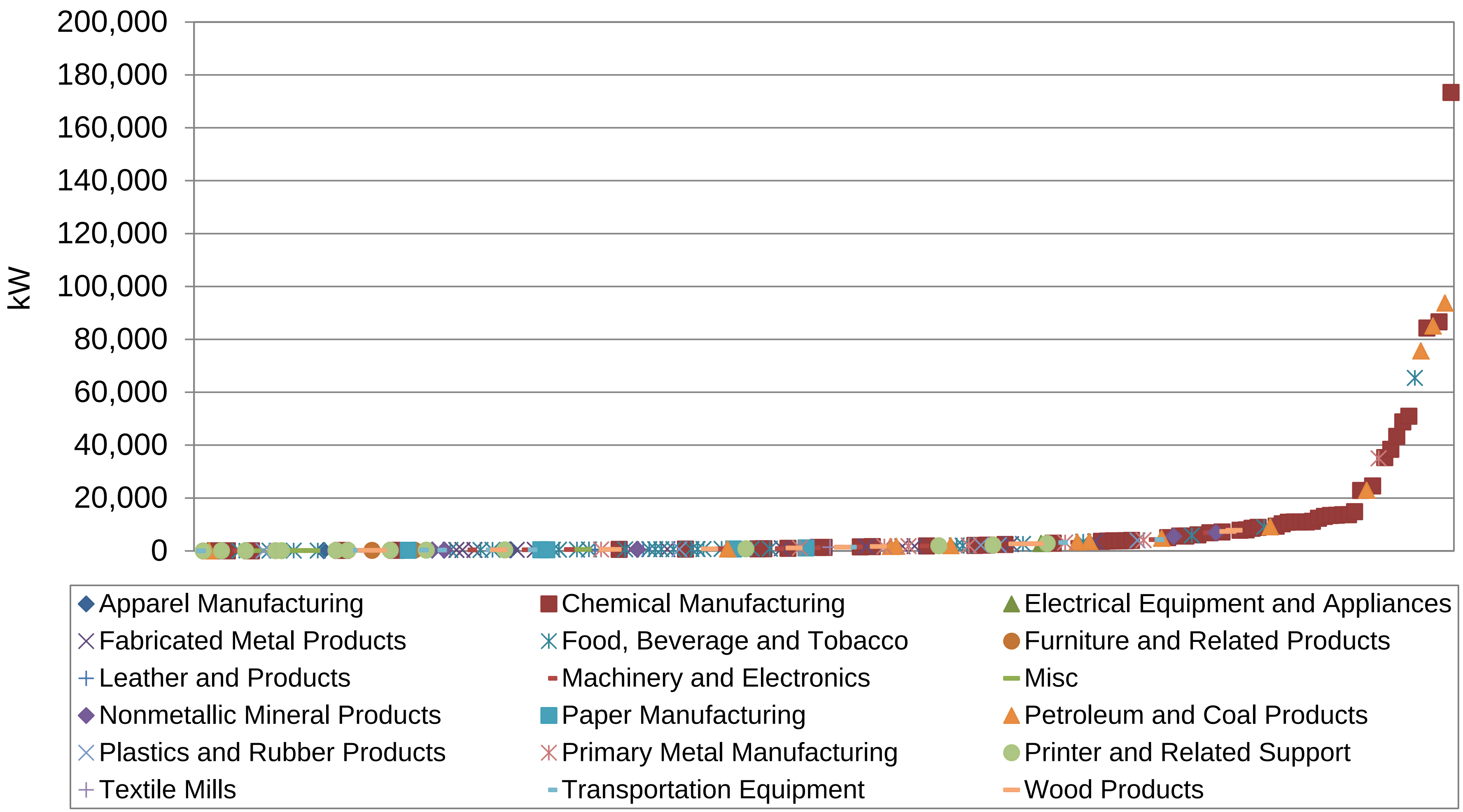
Potential Louisiana CHP Market, Electric Demand

The 209 candidate facilities total 1,480 MW in demand. While the chemical and refining sectors make up just 34 percent of the number of facilities (72 out of 209), the demand for these sectors account for over 80 percent (1,198 MW out of 1,478 MW).

NAICS Category		Number of Facilities	Electric Demand	Minimum Electric Demand	Maximum Electric Demand	Average Electric Demand
			--------------------	(kW)	--------------------	
311-312	Food, Beverage and Tobacco	30	102,736	73	65,401	3,425
313-314	Textile Mills	1	1,395	1,395	1,395	1,395
315	Apparel Manufacturing	2	592	168	424	296
321	Wood Products	14	30,172	233	7,783	2,155
337	Furniture and Related Products	2	537	235	302	269
322	Paper Manufacturing	5	3,114	292	1,160	623
323	Printer and Related Support	14	9,660	22	2,884	690
325	Chemical Manufacturing	59	893,533	62	173,400	15,145
324	Petroleum and Coal Products	13	304,653	31	93,744	23,435
326	Plastics and Rubber Products	5	9,268	93	4,027	1,854
316	Leather and Products	2	1,171	561	610	586
327	Nonmetallic Mineral Products	5	13,684	333	6,923	2,737
331	Primary Metal Manufacturing	8	49,543	562	35,014	6,193
332	Fabricated Metal Products	13	15,600	353	3,613	1,200
333-334	Machinery and Electronics	19	27,290	65	6,916	1,436
335	Electrical Equipment and Appliances	1	2,802	2,802	2,802	2,802
336	Transportation Equipment	10	11,974	3	4,280	1,197
339	Misc	6	1,112	89	549	185
Total		**209**	**1,478,836**	**3**	**173,400**	**7,076**

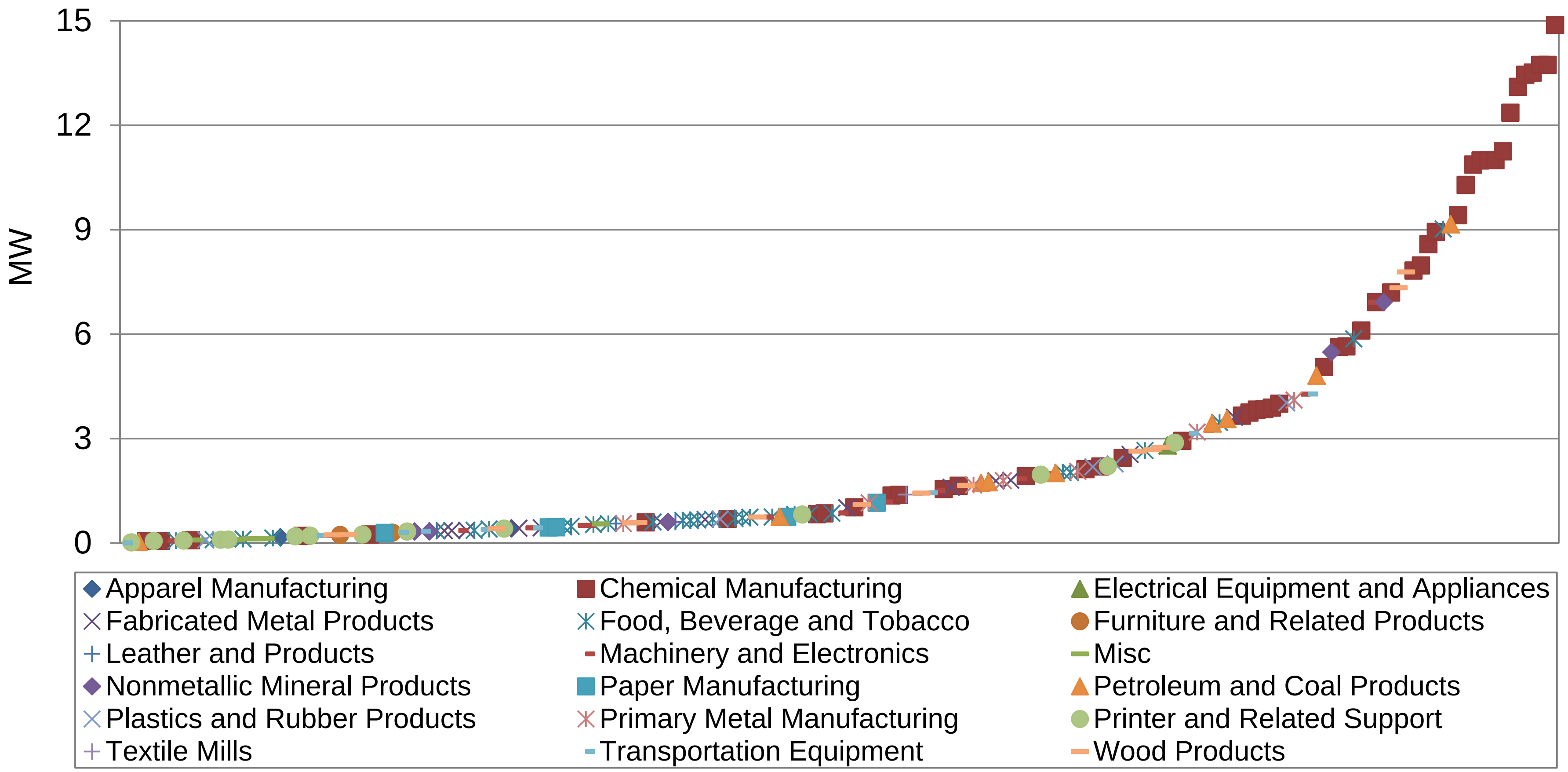
Distribution of Potential Louisiana CHP Market, Electric Demand

A distribution of the candidate facilities shows the facilities range in size from 3 kW to over 170 MW. Most of the potential candidate facilities, however, are under 20 MW.



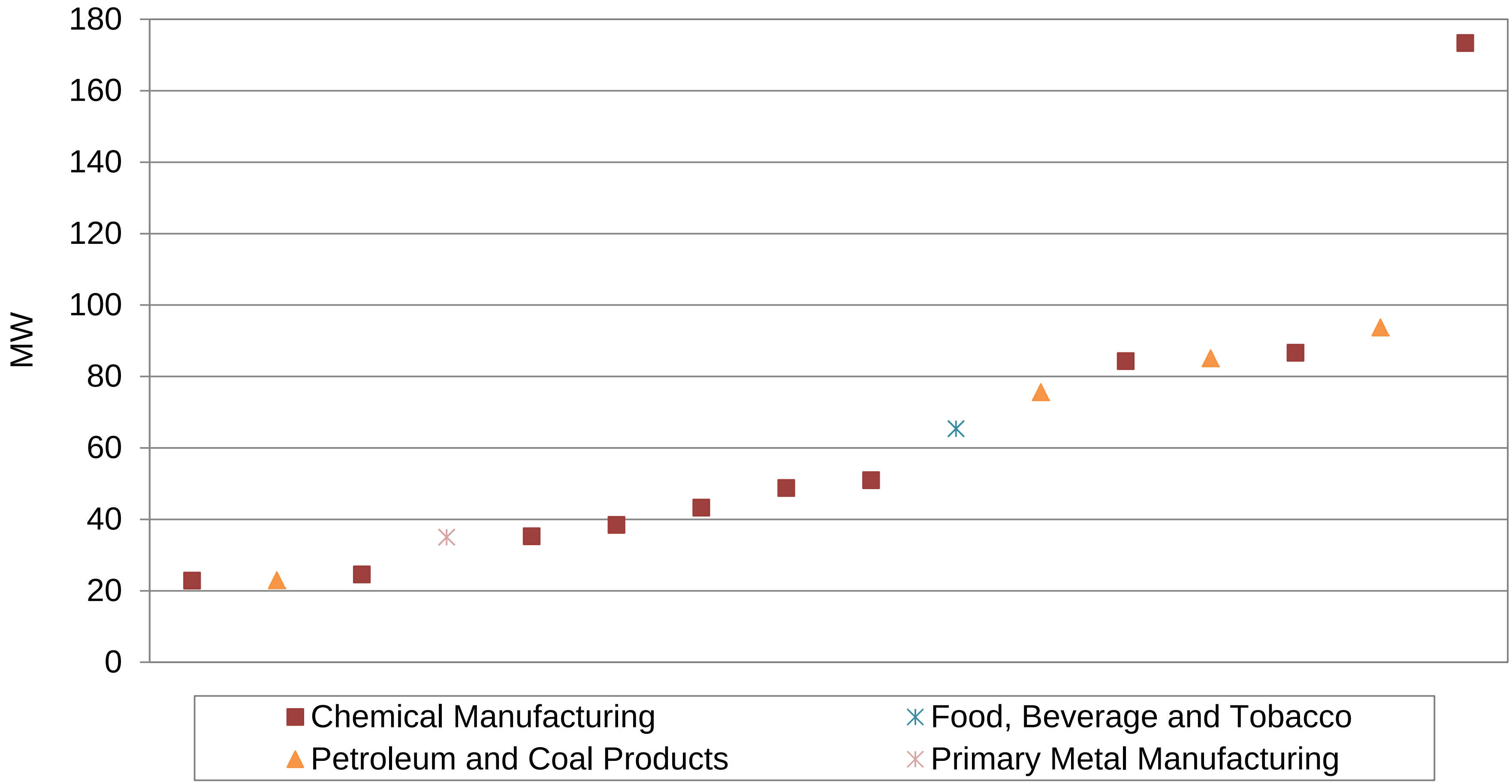
Distribution of Potential Louisiana CHP Market, Electric Demand (< 15 MW)

Limiting the analysis to small-scale CHP candidate sites (those with less than 15 MW of demand) highlights the fact that all manufacturing sectors have potential locations; and small-scale chemical manufacturing dominates these potential locations. Further, the distribution of small scale facilities is heavily-weighted to those with demands less than 6 MW.



Distribution of Potential Louisiana CHP Market, Electric Demand (> 15 MW)

The distribution of large-scale candidate facilities (those greater than 15 MW) includes just four manufacturing sectors: 10 of the 16 candidate sites are those supporting some type of chemical manufacturing.



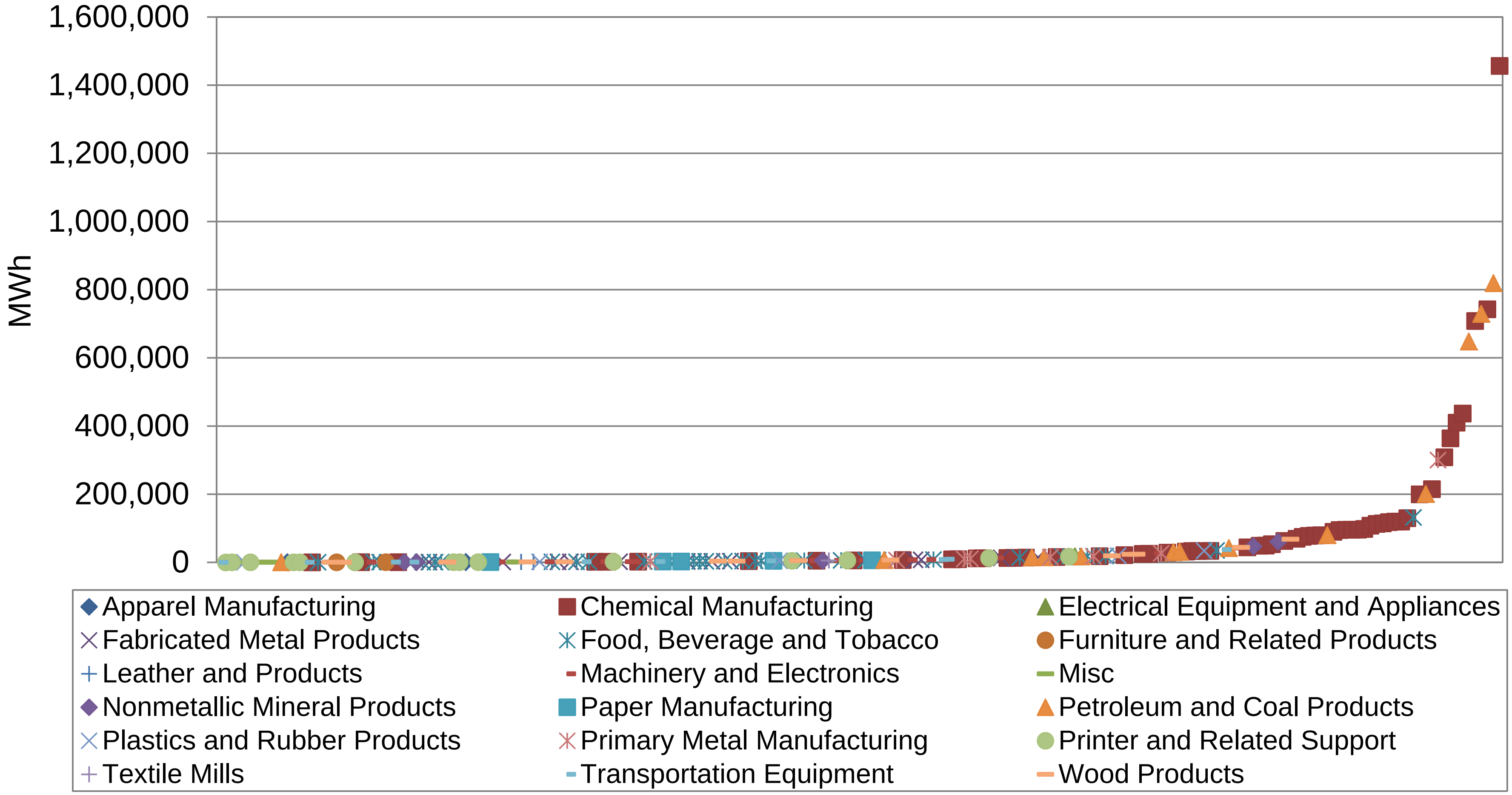
Louisiana Potential CHP Market, Electricity Usage

The 209 candidate facilities use over 11 million MWh of electric energy. The chemical and refining sectors account for 84 percent of estimated total manufacturing electric use.

NAICS Category		Number of Facilities	Electric Use	Minimum Electric Use	Maximum Electric Use	Average Electric Usage
			(MWh)	(MWh)	(MWh)	(MWh)
311-312	Food, Beverage and Tobacco	30	308,027	460	131,850	10,268
313-314	Textile Mills	1	5,583	5,583	5,583	5,583
315	Apparel Manufacturing	2	1,233	350	883	617
321	Wood Products	14	202,038	485	68,000	14,431
337	Furniture and Related Products	2	1,120	490	630	560
322	Paper Manufacturing	5	17,361	947	6,500	3,472
323	Printer and Related Support	14	47,337	134	17,182	3,381
325	Chemical Manufacturing	59	7,259,477	459	1,456,560	123,042
324	Petroleum and Coal Products	13	2,633,909	273	818,956	202,608
326	Plastics and Rubber Products	5	59,860	195	33,832	11,972
316	Leather and Products	2	2,389	1,167	1,222	1,194
327	Nonmetallic Mineral Products	5	114,185	694	60,481	22,837
331	Primary Metal Manufacturing	8	390,313	2,250	300,000	48,789
332	Fabricated Metal Products	13	60,349	735	14,743	4,642
333-334	Machinery and Electronics	19	131,434	462	42,327	6,918
335	Electrical Equipment and Appliances	1	17,489	17,489	17,489	17,489
336	Transportation Equipment	10	64,750	7	37,394	6,475
339	Misc	6	2,320	185	1,143	387
Total		**209**	**11,319,173**	**7**	**1,456,560**	**54,159**

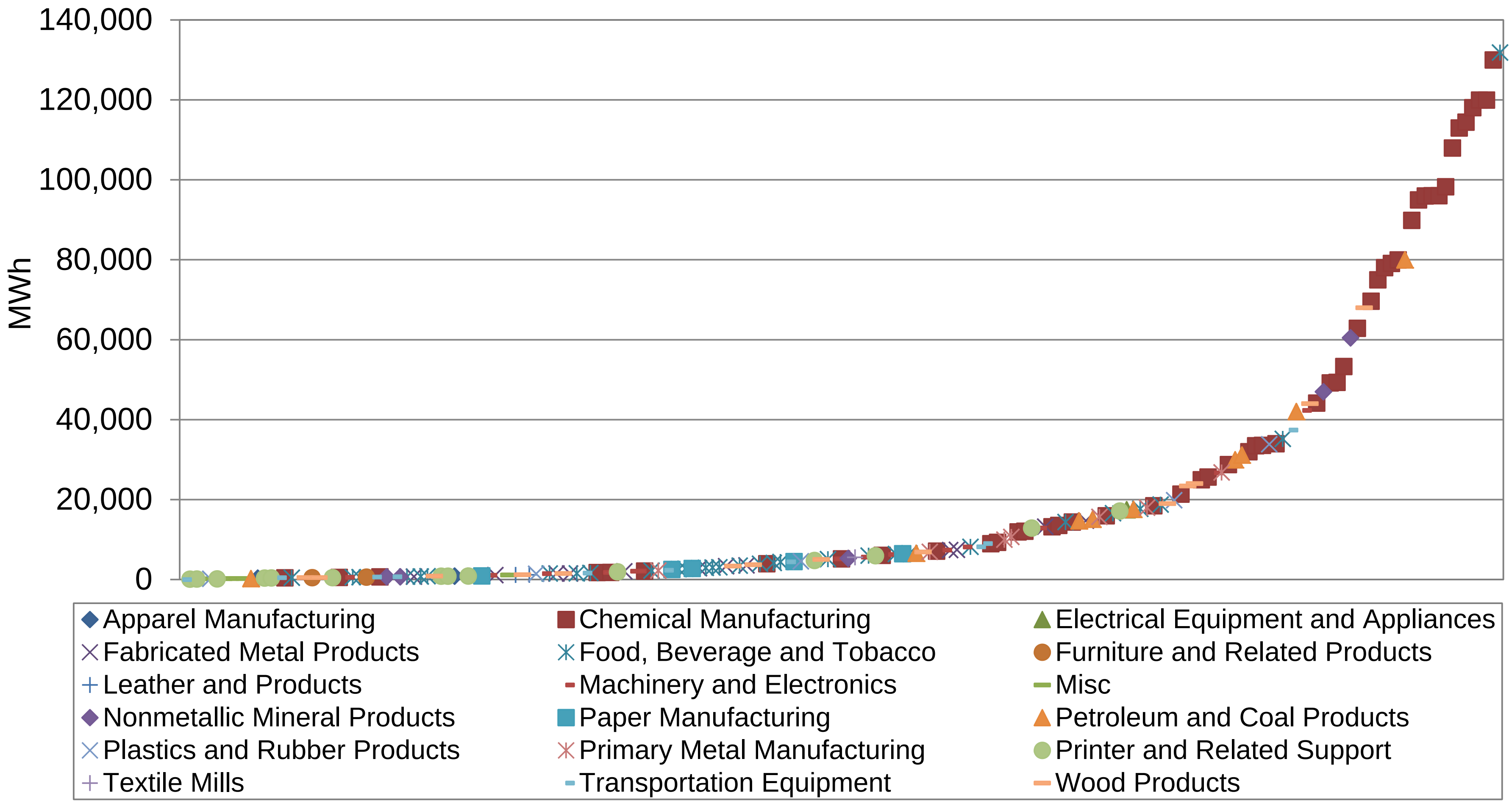
Distribution of Potential Louisiana CHP Market, Electricity Usage

The estimated electric usage from candidate CHP locations is estimated to range from 7 MWh to over 1.4 million MWh. Chemical manufacturing facilities, which dominate the CHP candidate facility estimates, range from as small as 459 MWh to almost 1.46 MWh.



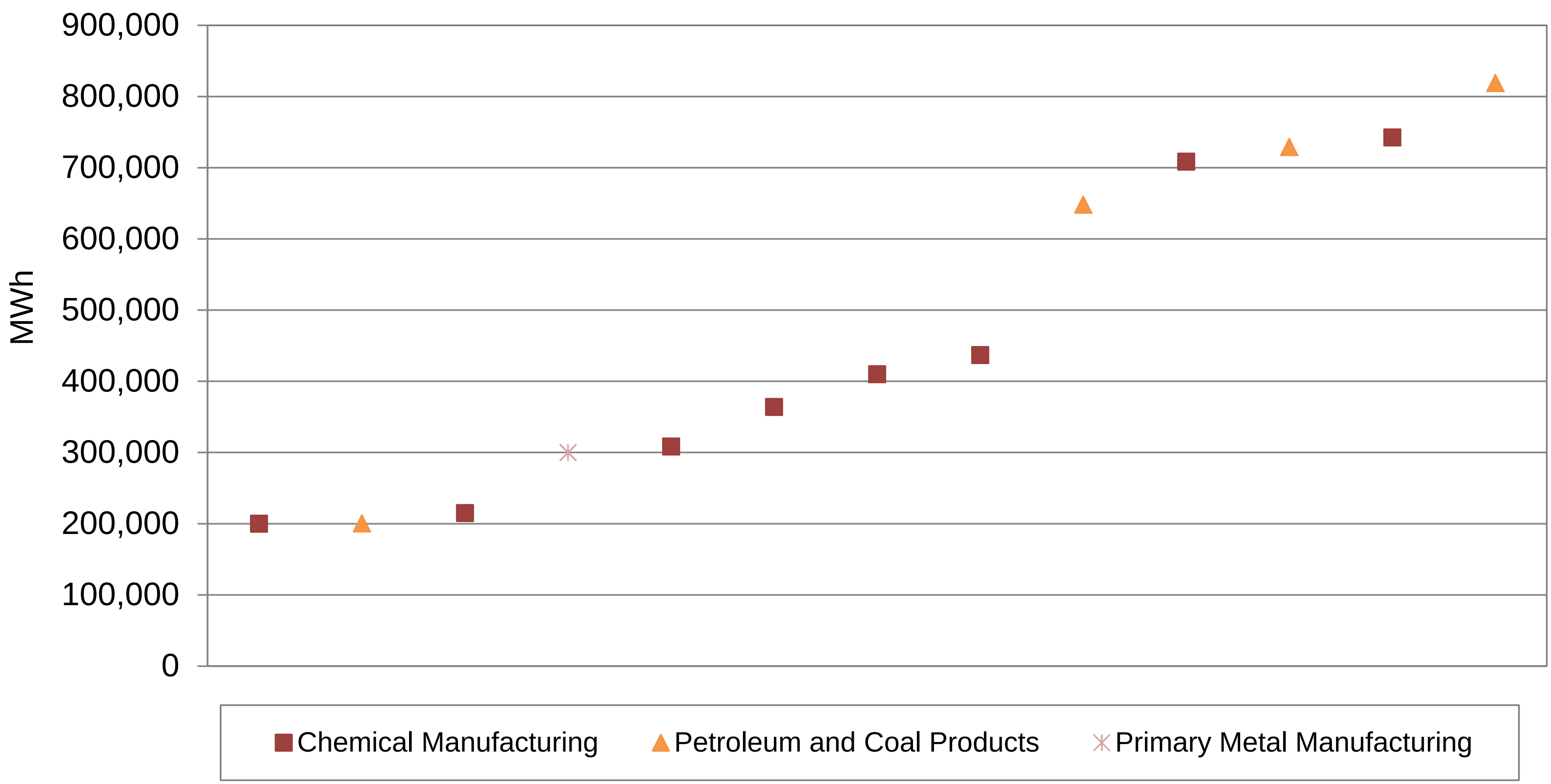
Distribution of Potential Louisiana CHP Market, Electricity Usage (< 140,000 MWh)

The majority of small-scale candidate CHP sites use less than 40,000 MWh in any given year. Small-scale chemical manufacturing CHP candidate sites range in estimated electrical usage from 40,000 MWh to 140,000 MWh.



Distribution of Potential Louisiana CHP Market, Electricity Usage (> 200,000 MWh)

Large-scale CHP candidate facilities are estimated to have average annual electrical energy usage levels in excess of 400,000 MWh per year. Chemical manufacturing facilities are the larger electrical energy users at these CHP candidate sites.



Note: There are no facilities reporting usage between 140,000 MWh and 200,000 MWh.

Louisiana Potential CHP Market, Thermal Usage

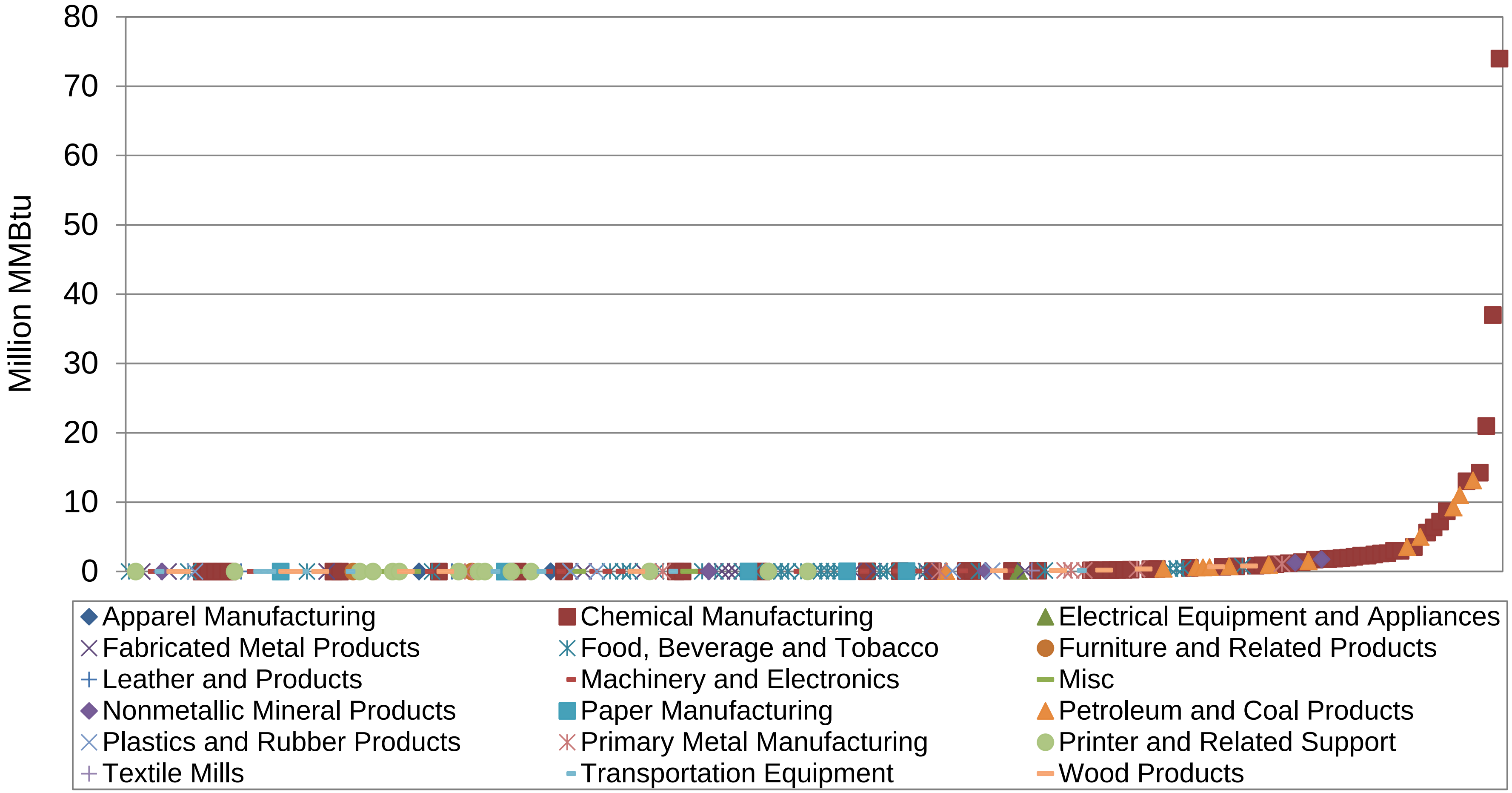
The 209 CHP candidate facilities have an estimated thermal energy use of close to 290 million MMBtus. The chemical sector accounts for 80 percent of the estimated total manufacturing thermal energy use.

NAICS Category		Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
			(MMBtu)			
311-312	Food, Beverage and Tobacco	30	2,695,088	-	770,400	89,836
313-314	Textile Mills	1	125,282	125,282	125,282	125,282
315	Apparel Manufacturing	2	5,382	1,373	4,009	2,691
321	Wood Products	14	2,244,690	-	780,000	160,335
337	Furniture and Related Products	2	2,736	400	2,336	1,368
322	Paper Manufacturing	5	99,067	-	46,897	19,813
323	Printer and Related Support	14	65,112	-	23,239	4,651
325	Chemical Manufacturing	59	230,361,908	-	74,000,000	3,904,439
324	Petroleum and Coal Products	13	47,204,315	60,769	13,133,798	3,631,101
326	Plastics and Rubber Products	5	164,345	-	83,096	32,869
316	Leather and Products	2	2,034	-	2,034	1,017
327	Nonmetallic Mineral Products	5	3,091,863	-	1,748,284	618,373
331	Primary Metal Manufacturing	8	1,961,640	2,234	1,092,500	245,205
332	Fabricated Metal Products	13	292,328	-	107,078	22,487
333-334	Machinery and Electronics	19	508,295	-	139,579	26,752
335	Electrical Equipment and Appliances	1	100,000	100,000	100,000	100,000
336	Transportation Equipment	10	173,092	-	158,040	17,309
339	Misc	6	21,745	865	10,640	3,624
Total		**209**	**289,118,924**	**-**	**74,000,000**	**1,383,344**

Note: Total thermal usage includes both furnace and boiler fuel usage.

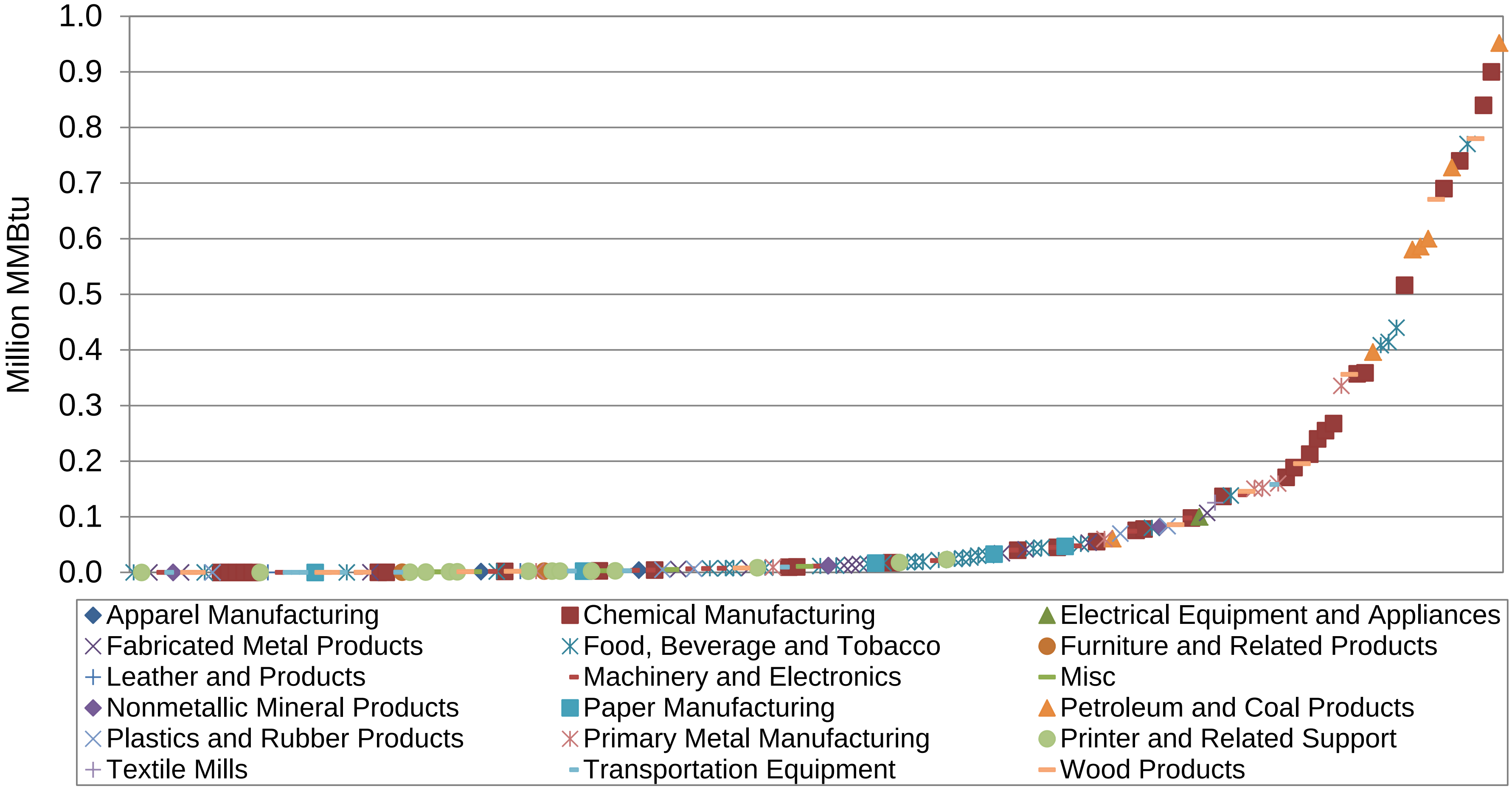
Distribution of Potential Louisiana CHP Market, Thermal Usage

Estimated thermal energy use for the candidate CHP locations ranges from zero to 74 million MMBtu. Most of the larger thermal energy users are associated with chemical and refining manufacturing.



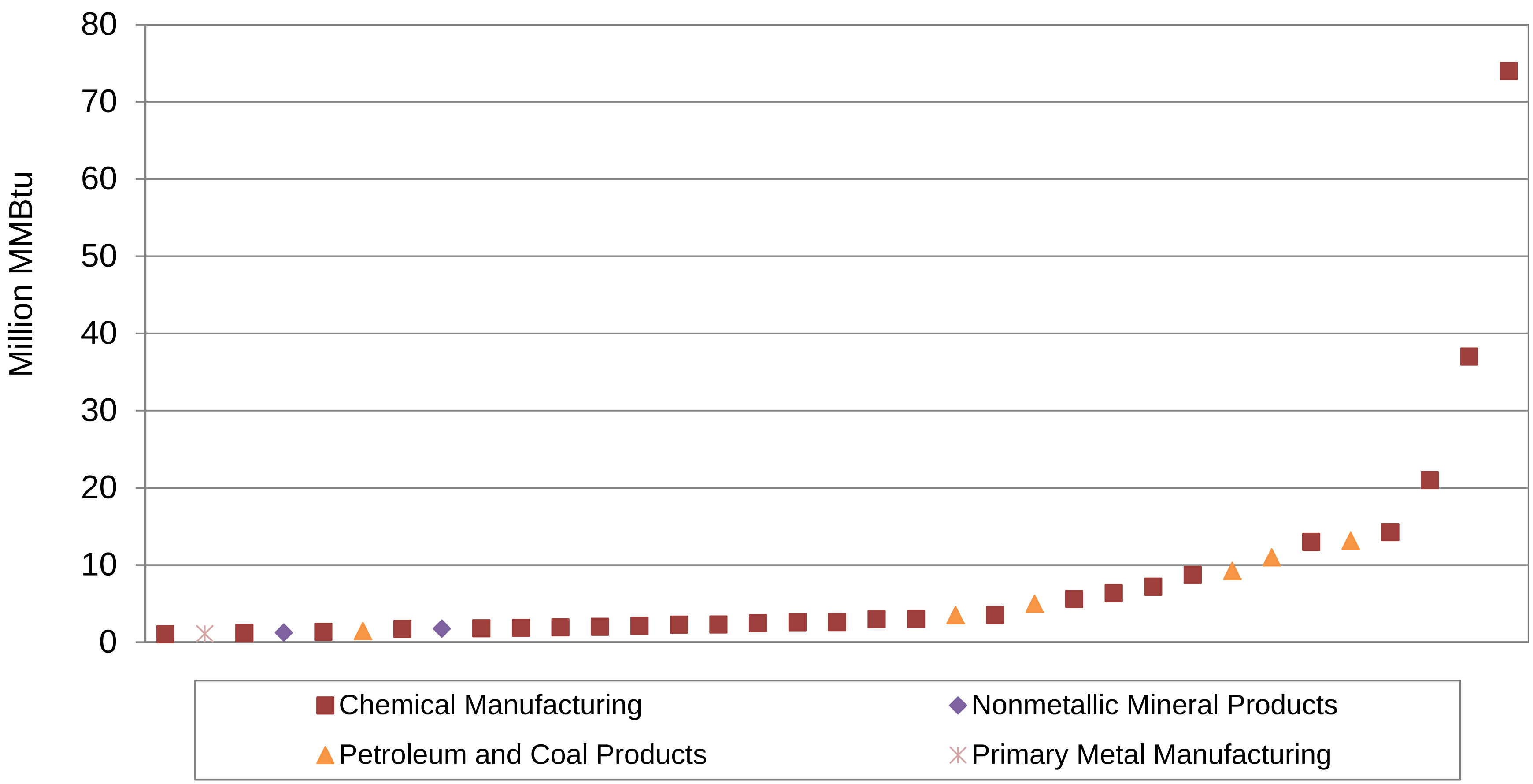
Distribution of Potential Louisiana CHP Market, Thermal Usage (< 1 Million MMBtu)

The majority of the small-scale CHP candidate sites have thermal usage well under 200,000 MMBtus per year. Chemical and refining candidate sites dominate the upper range of this small-scale thermal energy distribution.



Distribution of Potential Louisiana CHP Market, Thermal Usage (> 1 Million MMBtu)

Large CHP candidate sites tend to have estimated thermal energy uses that are less than 10 million MMBtus. Almost all of the CHP candidate sites that have high thermal energy use are associated with chemical manufacturing.



Section 4: Estimated Technical Potentials

Estimated Louisiana CHP Technical Potentials: Summary

Most of the technical potentials identified for the Louisiana CHP market comes from the chemical and petroleum refining sectors with a combined total of 960 MW of load, representing about 90 percent of the CHP technical potential estimates. The food and beverage sector is estimated to have the technical potential for as much as 15 MW of CHP-avoidable load; and the wood products sector is estimated to have a technical CHP installation potential of 17 MW.

Summary of Estimated Louisiana Technical CHP Potentials by NAICS

The technical potentials analysis identifies 92 CHP locations, as opposed to the broader market analysis that identified as many as 209 CHP locations. Most of those facilities with the technical capabilities for CHP are located in the chemical (42) and refining (11) manufacturing sectors.

NAICS Category		Number of Facilities	Electric Use (MWh)	Average Electric Usage (MWh)	Electric Demand (kW)	Average Electric Demand (kW)	Boiler Fuel (MMBtu)	Furnace Fuel (MMBtu)
311-312	Food, Beverage and Tobacco	12	101,133	8,428	15,144	1,262	763,682	481,637
313-314	Textile Mills	-	-	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-	-	-
321	Wood Products	5	141,319	28,264	16,954	3,391	704,101	749,489
337	Furniture and Related Products	-	-	-	-	-	-	-
322	Paper Manufacturing	3	13,595	4,532	2,208	736	33,194	63,397
323	Printer and Related Support	4	6,784	1,696	1,049	262	-	23,663
325	Chemical Manufacturing	42	6,322,795	150,543	741,598	17,657	100,566,995	127,951,718
324	Petroleum and Coal Products	11	1,904,636	-	219,538	-	17,793,514	25,173,321
326	Plastics and Rubber Products	2	53,679	26,840	6,298	3,149	-	152,982
316	Leather and Products	-	-	-	-	-	-	-
327	Nonmetallic Mineral Products	2	65,791	-	7,530	-	-	1,830,284
331	Primary Metal Manufacturing	4	360,461	-	42,056	-	39,942	1,699,779
332	Fabricated Metal Products	1	3,533	3,533	606	606	-	8,000
333-334	Machinery and Electronics	4	56,355	14,089	9,013	2,253	-	146,905
335	Electrical Equipment and Appliances	1	17,489	-	2,802	-	-	100,000
336	Transportation Equipment	1	37,394	37,394	4,280	4,280	158,040	-
339	Misc	-	-	-	-	-	-	-
Total		**92**	**9,084,963**	**98,750**	**1,069,076**	**11,620**	**120,059,468**	**158,381,176**

Estimated Louisiana CHP Technical Potentials, Facility Utilization

The 92 facilities passing the technical potentials screen have an average utilization rate of 88 percent. The average utilization rate for the chemical and refining sectors is reported to be 97 percent and 99 percent. The lowest utilization rate is in the paper manufacturing sector, at 64 percent.

NAICS Category		Number of Facilities	Average Facility Utilization	Minimum Facility Utilization	Maximum Facility Utilization
			---------------------- (%)	----------------------	
311-312	Food, Beverage and Tobacco	12	78%	68%	100%
313-314	Textile Mills	-	-	-	-
315	Apparel Manufacturing	-	-	-	-
321	Wood Products	5	91%	71%	100%
337	Furniture and Related Products	-	-	-	-
322	Paper Manufacturing	3	77%	64%	100%
323	Printer and Related Support	4	91%	66%	100%
325	Chemical Manufacturing	42	97%	71%	100%
324	Petroleum and Coal Products	11	99%	96%	100%
326	Plastics and Rubber Products	2	98%	96%	100%
316	Leather and Products	-	-	-	-
327	Nonmetallic Mineral Products	2	100%	100%	100%
331	Primary Metal Manufacturing	4	98%	96%	100%
332	Fabricated Metal Products	1	66%	66%	66%
333-334	Machinery and Electronics	4	74%	70%	85%
335	Electrical Equipment and Appliances	1	71%	71%	71%
336	Transportation Equipment	1	100%	100%	100%
339	Misc	-	-	-	-
Total		**92**	**88%**	**64%**	**100%**

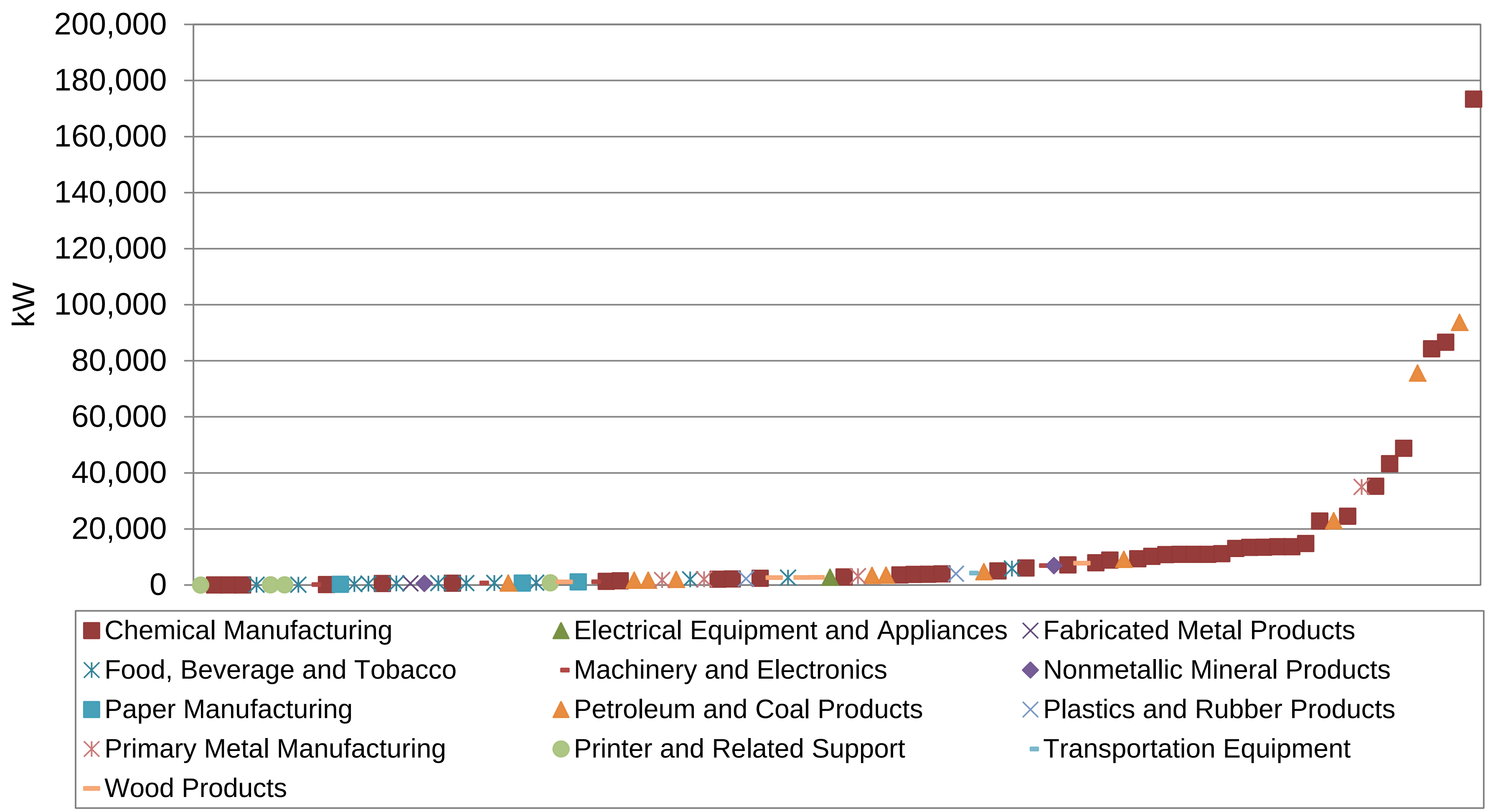
Estimated Louisiana CHP Technical Potentials, Electric Demand

The 92 locations estimated to have the technical potential for CHP installation are estimated to utilize 1,069 MW in capacity. The chemical and refining sectors comprise 58 percent of facilities with the technical capability of installing CHP, but 90 percent of the overall load.

NAICS Category		Number of Facilities	Electric Demand	Minimum Electric Demand	Maximum Electric Demand	Average Electric Demand
			---------------------- (kW) --------------------------			
311-312	Food, Beverage and Tobacco	12	15,144	98	5,866	1,262
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	5	16,954	1,107	7,783	3,391
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	3	2,208	292	1,160	736
323	Printer and Related Support	4	1,049	22	825	262
325	Chemical Manufacturing	42	741,598	62	173,400	17,657
324	Petroleum and Coal Products	11	219,538	756	93,744	-
326	Plastics and Rubber Products	2	6,298	2,271	4,027	3,149
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	7,530	607	6,923	-
331	Primary Metal Manufacturing	4	42,056	1,794	35,014	-
332	Fabricated Metal Products	1	606	606	606	606
333-334	Machinery and Electronics	4	9,013	170	6,916	2,253
335	Electrical Equipment and Appliances	1	2,802	2,802	2,802	-
336	Transportation Equipment	1	4,280	4,280	4,280	4,280
339	Misc	-	-	-	-	-
Total		**92**	**1,069,076**	**22**	**173,400**	**11,620**

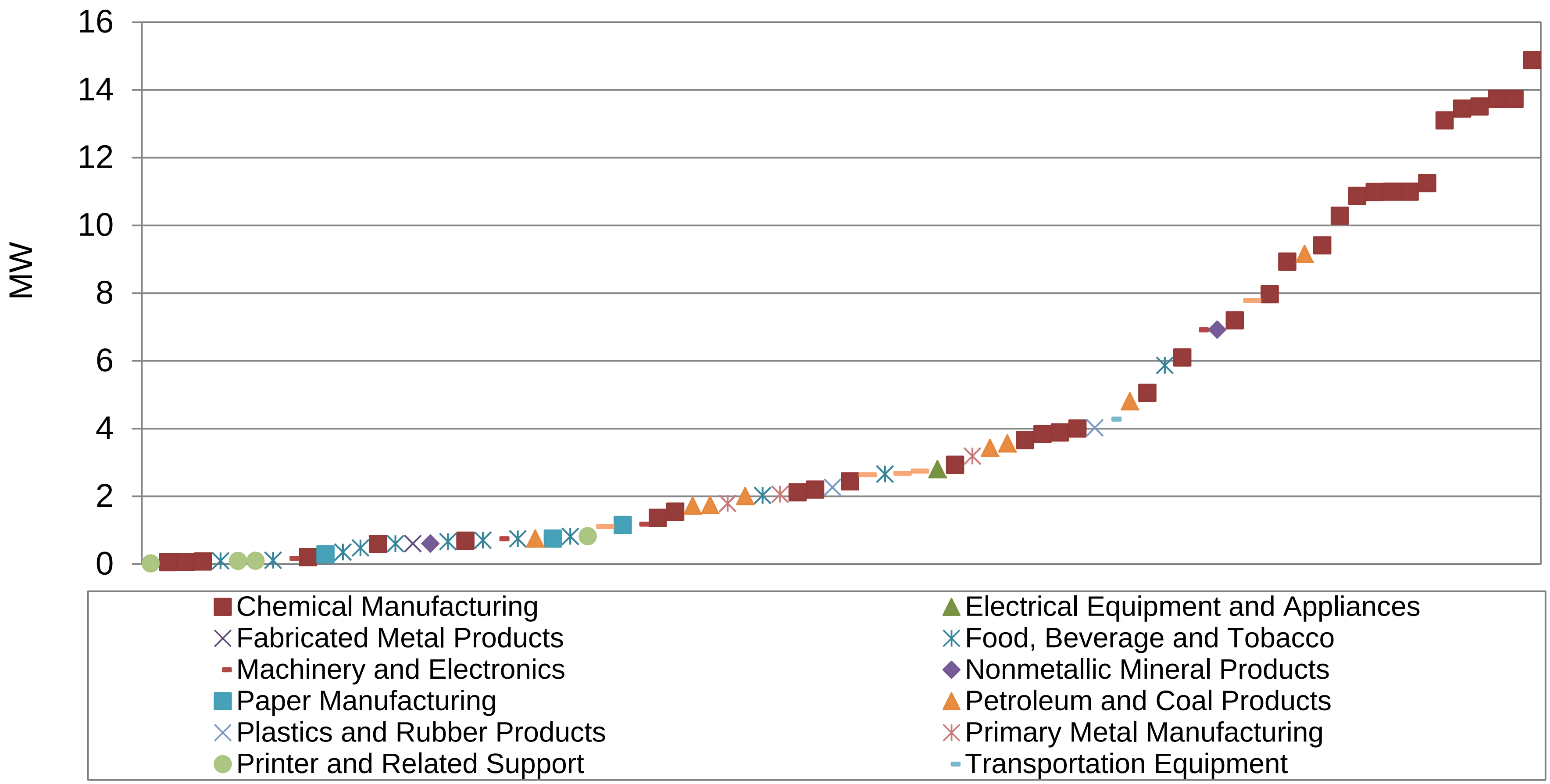
Distribution of Louisiana CHP Technical Potentials, Electric Demand

The electrical loads for the facilities with CHP technical potential ranges in size from 22 kW to over 170 MW with the larger loads being associated with chemical manufacturing plants.



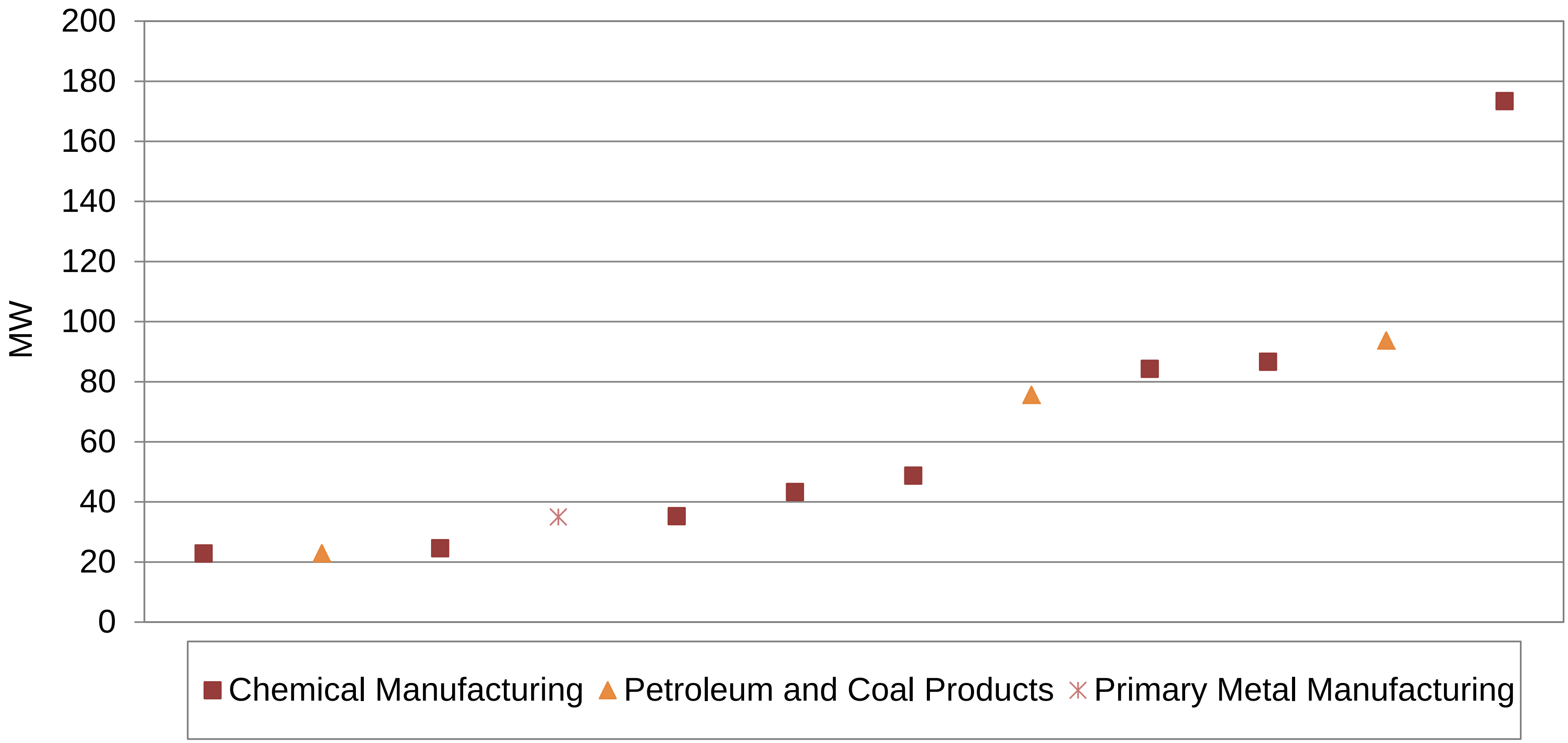
Distribution of Louisiana CHP Technical Potentials, Electric Demand (< 15 MW)

Small-scale CHP facilities (particularly those with less than 10 MW of demand) include those from a wide range of manufacturing sectors. Chemical manufacturing facilities dominate the small-scale technical potentials in the 6 MW to 15 MW range.



Distribution of Estimated Louisiana CHP Technical Potentials, Electric Demand (> 15 MW)

Larger electric use facilities passing the technical potentials screen are primarily in the chemical sector.



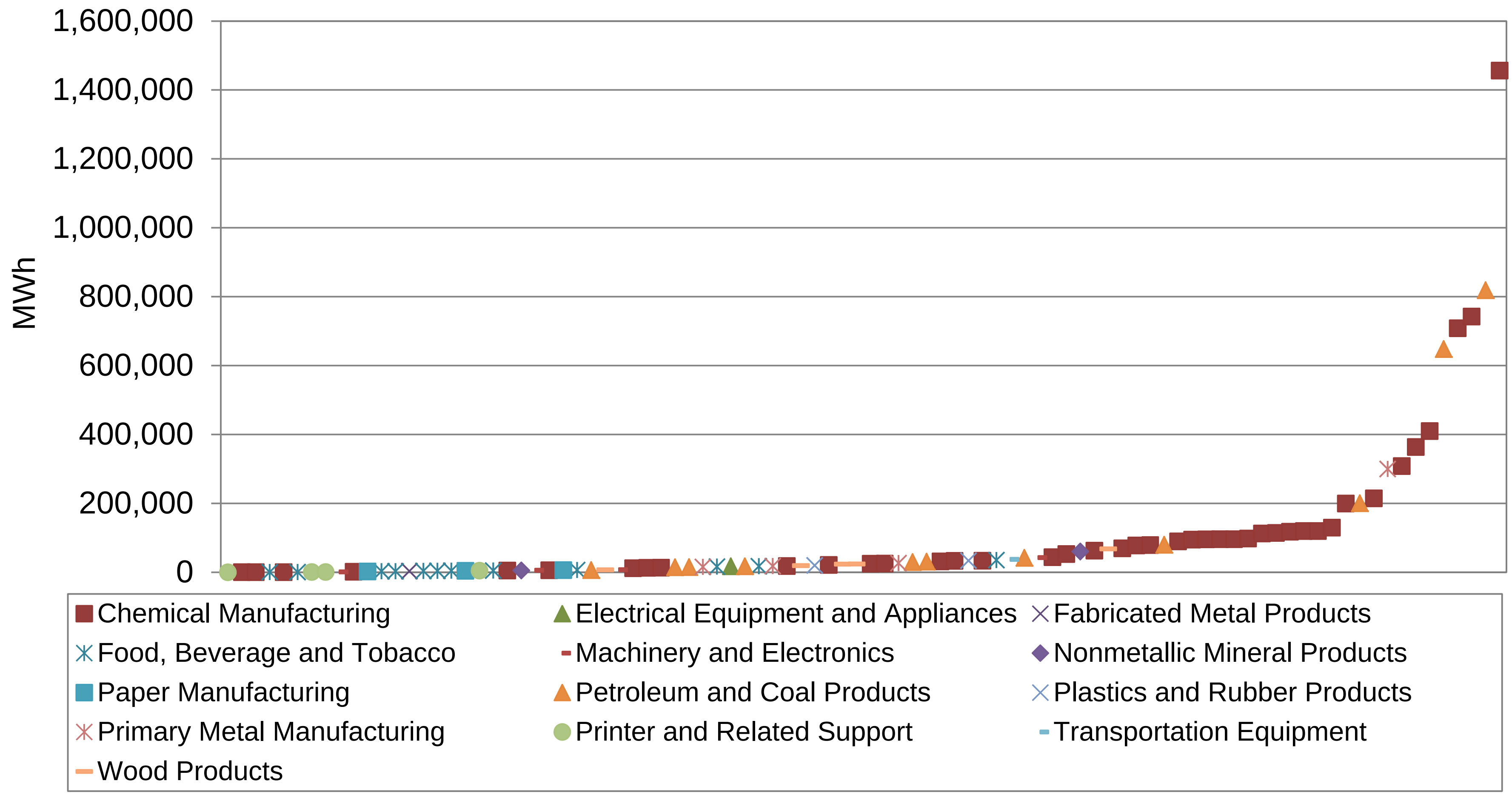
Estimated Louisiana CHP Technical Potentials, Electricity Usage

The 92 facilities passing the technical potentials screen are estimated to use over 9 million MWh. The chemical and refining sectors account for 91 percent of total electric use for the facilities passing the technical potentials screen.

NAICS Category		Number of Facilities	Electric Use	Minimum Electric Use	Maximum Electric Use	Average Electric Usage
			---------------------- (MWh) ------------------------			
311-312	Food, Beverage and Tobacco	12	101,133	617	35,200	8,428
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	5	141,319	6,913	68,000	28,264
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	3	13,595	2,554	6,500	4,532
323	Printer and Related Support	4	6,784	200	4,807	1,696
325	Chemical Manufacturing	42	6,322,795	459	1,456,560	150,543
324	Petroleum and Coal Products	11	1,904,636	6,605	818,956	-
326	Plastics and Rubber Products	2	53,679	19,847	33,832	26,840
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	65,791	5,310	60,481	-
331	Primary Metal Manufacturing	4	360,461	15,677	300,000	-
332	Fabricated Metal Products	1	3,533	3,533	3,533	3,533
333-334	Machinery and Electronics	4	56,355	1,062	42,327	14,089
335	Electrical Equipment and Appliances	1	17,489	17,489	17,489	-
336	Transportation Equipment	1	37,394	37,394	37,394	37,394
339	Misc	-	-	-	-	-
Total		**92**	**9,084,963**	**200**	**1,456,560**	**98,750**

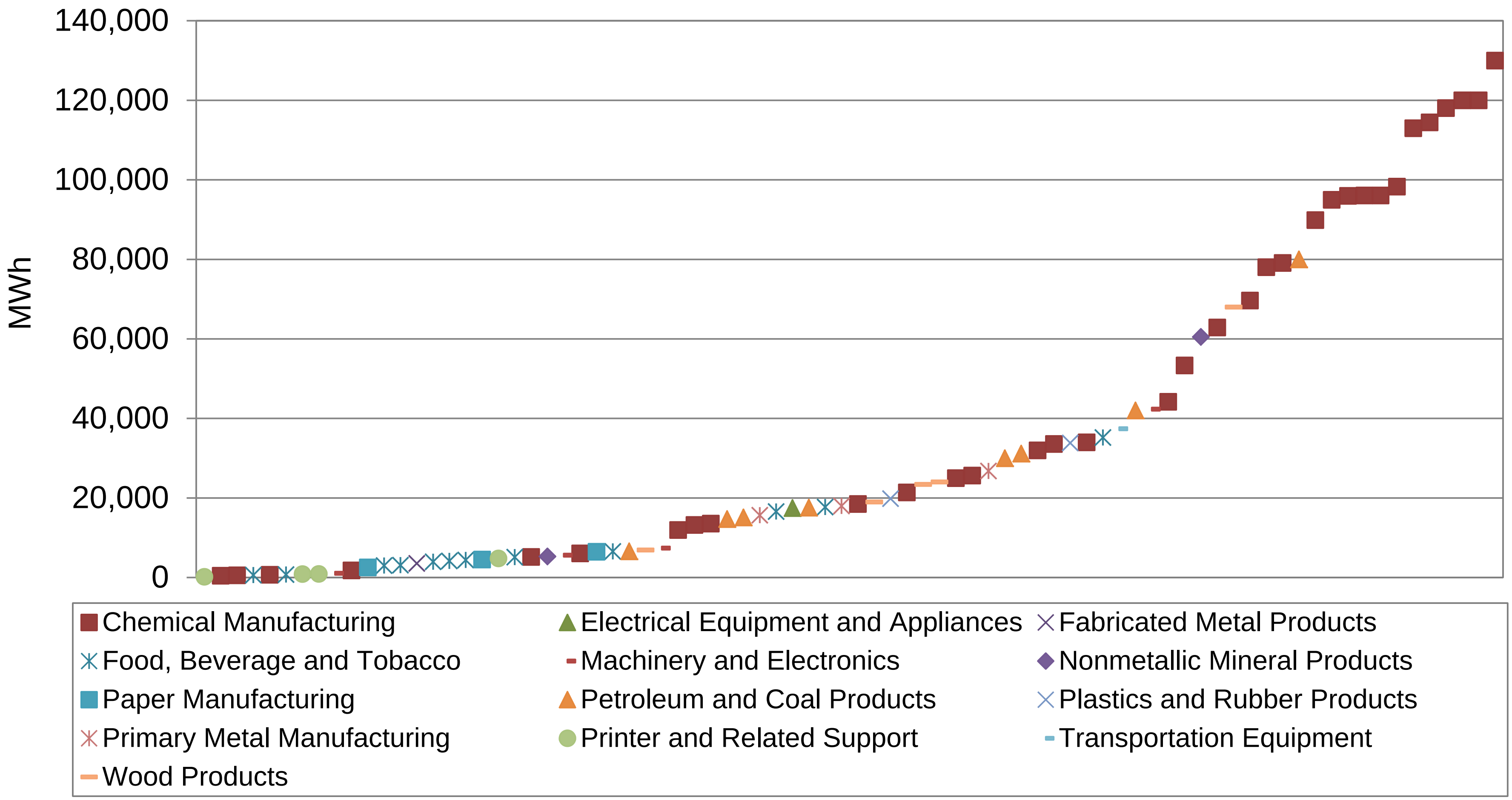
Distribution of Estimated Louisiana CHP Technical Potentials, Electricity Usage

Facilities that pass the technical potentials screen are estimated to use from 200 MWh to 1.4 million MWh in electricity. Most of the larger electrical energy users passing the technical screen are in the chemical sector.



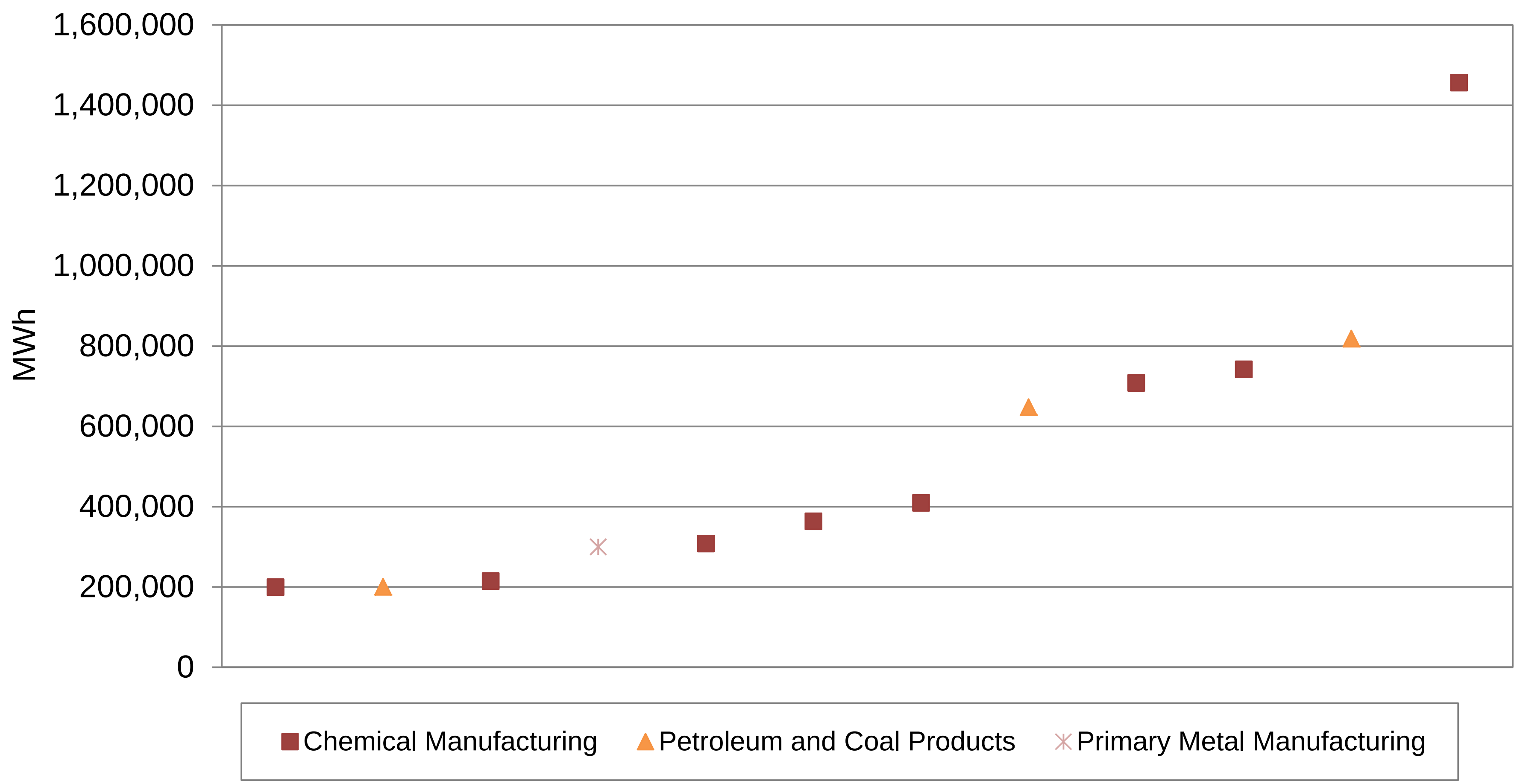
Distribution of Estimated Louisiana CHP Technical Potentials, Electrical Usage (< 140,000 MWh)

Limiting the distribution to facilities with less than 140,000 MWh shows that all of the remaining sectors are represented, with the majority of facilities using less than 40,000 MWh. Chemical manufacturing facilities dominate the facilities from 40,000 MWh to 140,000 MWh.



Distribution of Estimated Louisiana CHP Technical Potentials, Electrical Usage (> 200,000 MWh)

The larger energy use facilities passing the technical potentials screen are primarily in the chemical sector.



Note: There are no facilities reporting usage between 140,000 MWh and 200,000 MWh.

Estimated Louisiana CHP Technical Potentials, Thermal Usage

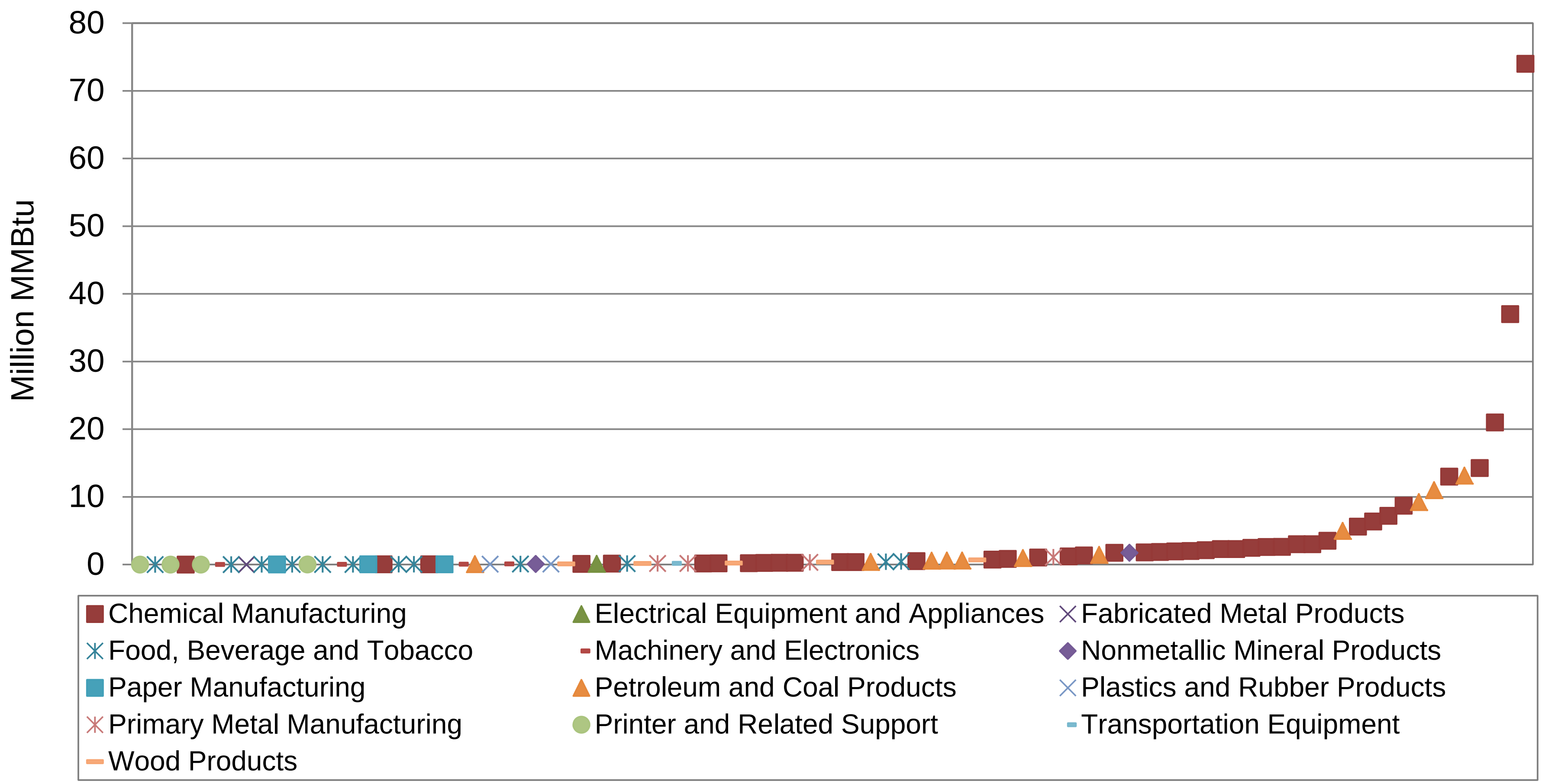
Estimated thermal energy use for the facilities passing the technical potentials screen totals almost 280 million MMBtu. The chemical sector accounts 80 percent of the estimated total thermal usage and has the highest average usage at 5.4 million MMBtu.

NAICS Category		Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
			------------------- (MMBtu) -------------------			
311-312	Food, Beverage and Tobacco	12	1,245,319	1,725	440,000	103,777
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	5	1,453,590	85,780	670,742	290,718
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	3	96,591	16,694	46,897	32,197
323	Printer and Related Support	4	23,663	444	17,857	5,916
325	Chemical Manufacturing	42	228,518,712	2,849	74,000,000	5,440,922
324	Petroleum and Coal Products	11	42,966,835	60,769	13,133,798	3,906,076
326	Plastics and Rubber Products	2	152,982	69,886	83,096	76,491
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	1,830,284	82,000	1,748,284	915,142
331	Primary Metal Manufacturing	4	1,739,721	152,000	1,092,500	434,930
332	Fabricated Metal Products	1	8,000	8,000	8,000	8,000
333-334	Machinery and Electronics	4	146,905	4,144	74,106	36,726
335	Electrical Equipment and Appliances	1	100,000	100,000	100,000	100,000
336	Transportation Equipment	1	158,040	158,040	158,040	158,040
339	Misc	-	-	-	-	-
Total		**92**	**278,440,644**	**444**	**74,000,000**	**1,392,203**

Note: Total thermal usage includes both furnace and boiler fuel usage.

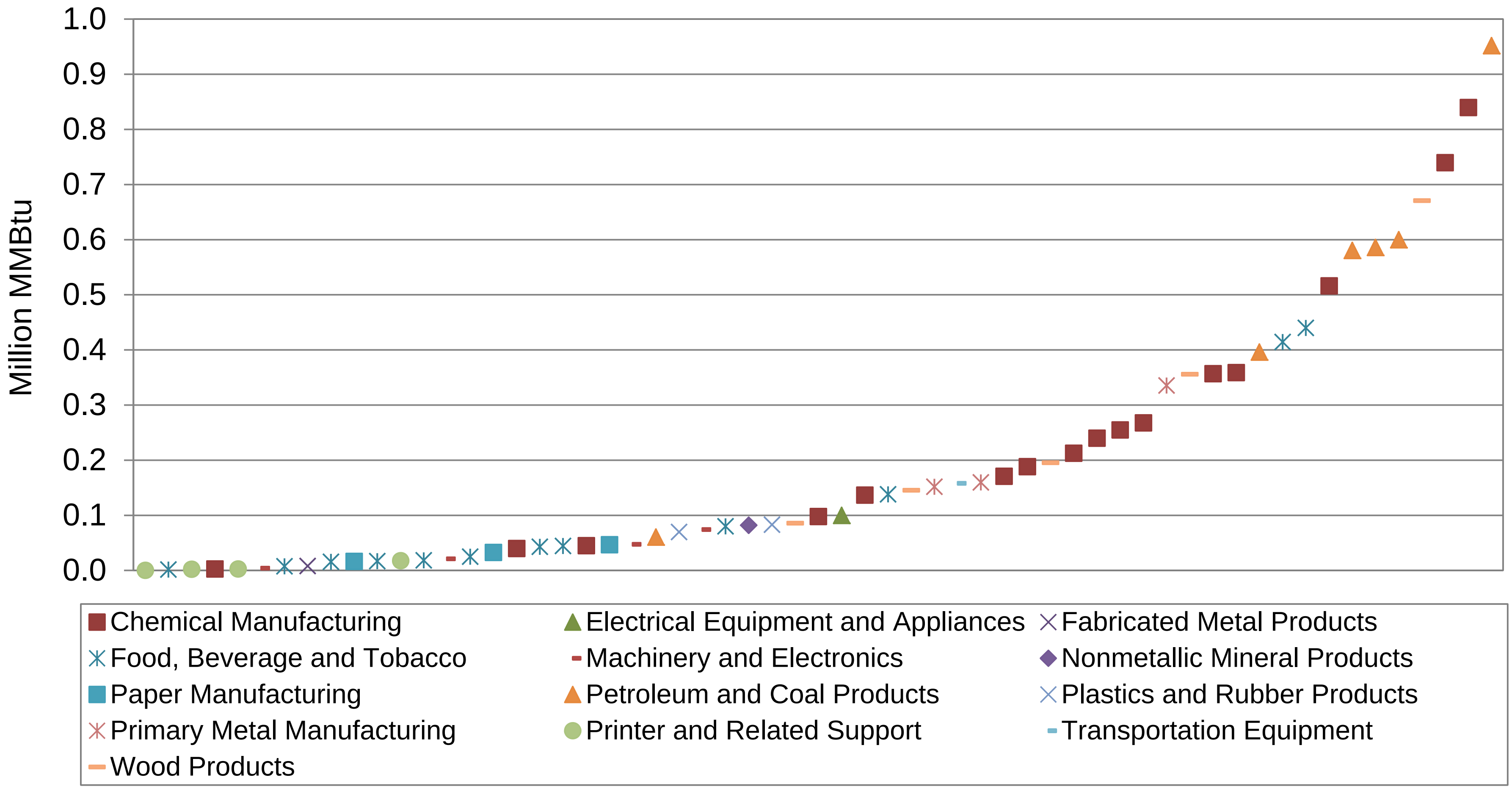
Distribution of Estimated Louisiana CHP Technical Potentials, Thermal Usage

Estimated thermal energy use for facilities passing the technical potentials screen ranges from 444 MMBtu to 74 million MMBtu. The larger thermal users are chemical and refining facilities.



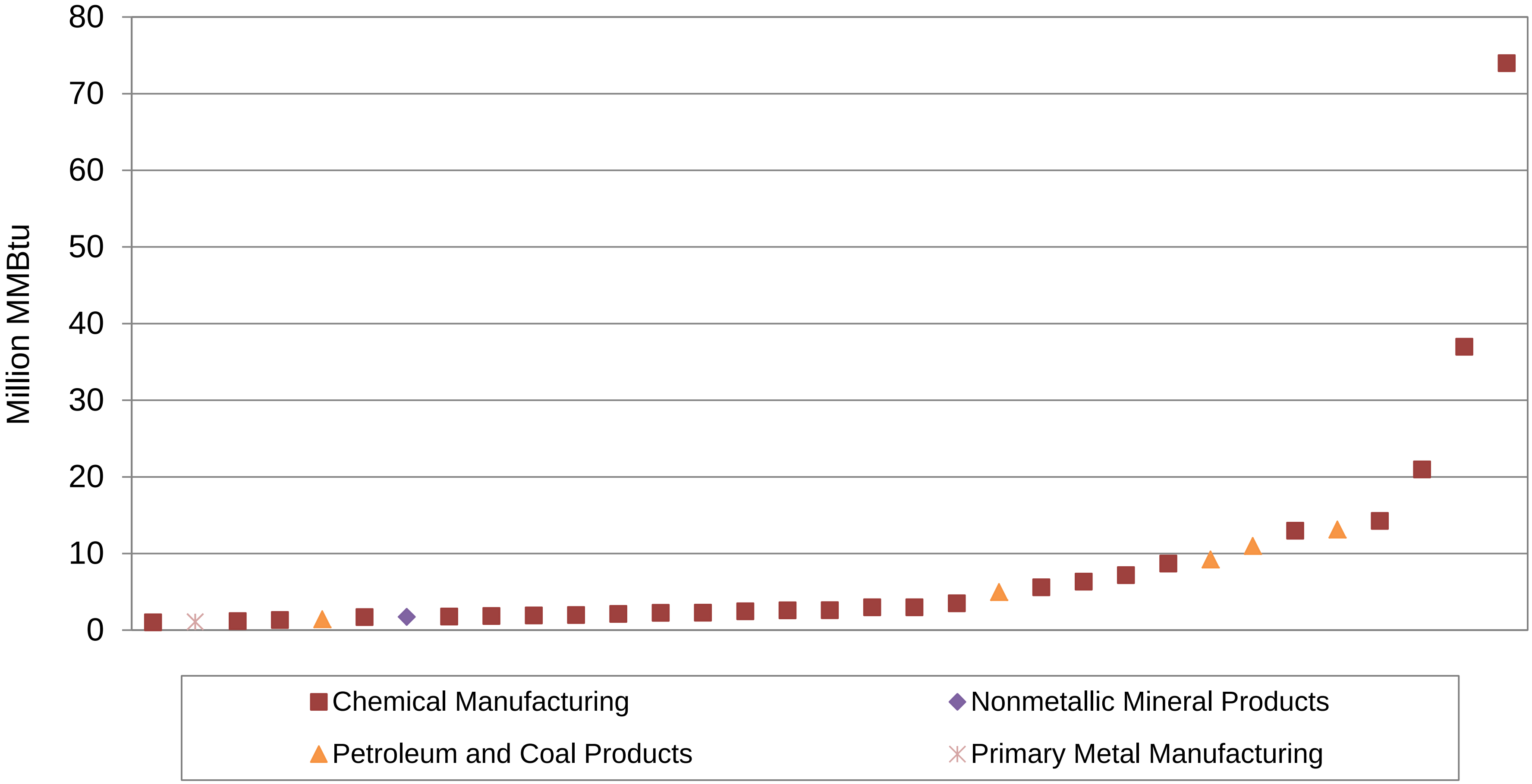
Distribution of Estimated Louisiana CHP Technical Potentials, Thermal Usage (< 1 Million MMBtu)

Paper, printer and food, beverage and tobacco facilities dominate the estimated thermal energy use distribution for smaller-sized facilities passing the technical potentials screen.



Distribution of Estimated Louisiana CHP Technical Potentials, Thermal Usage (> 1 Million MMBtu)

The thermal energy use distribution for those larger facilities passing the technical potentials screen is dominated by chemical manufacturing.



Section 5: Estimated Economic Potentials

Louisiana CHP Economic Potentials

Most of the economic potentials identified for the Louisiana CHP market comes from the chemical and petroleum refining sectors with a combined total of over 510 MW of load, or 90 percent of the overall market not already supplied by CHP. Of the remaining sectors, the food and beverage sector is estimated to have just over 1 MW of CHP-avoidable load. The wood products sector is estimated to have 6 MW of potentially CHP-avoidable load and the primary metals sector is estimated to have as much as 35 MW of CHP-avoidable load.

Summary of Estimated Louisiana CHP Economic Potentials by NAICS

Of the 92 facilities identified as having the technical potential for CHP, only 28 are estimated to have a potential for cost-effective installation. These cost-effective potentials are limited primarily to the chemical and refining manufacturing sectors.

NAICS Category		Number of Facilities	Electric Use (MWh)	Average Electric Usage (MWh)	Electric Demand (kW)	Average Electric Demand (kW)	Boiler Fuel (MMBtu)	Furnace Fuel (MMBtu)
311-312	Food, Beverage and Tobacco	2	7,496	3,748	1,059	530	43,072	44,395
313-314	Textile Mills	-	-	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-	-	-
321	Wood Products	3	49,319	16,440	6,424	2,141	261,730	165,118
337	Furniture and Related Products	-	-	-	-	-	-	-
322	Paper Manufacturing	-	-	-	-	-	-	-
323	Printer and Related Support	2	1,777	889	202	101	-	5,362
325	Chemical Manufacturing	12	2,550,214	212,518	298,704	24,892	28,411,835	34,271,393
324	Petroleum and Coal Products	6	1,820,658	303,443	209,860	34,977	17,422,593	12,549,190
326	Plastics and Rubber Products	-	-	-	-	-	-	-
316	Leather and Products	-	-	-	-	-	-	-
327	Nonmetallic Mineral Products	2	65,791	32,896	7,530	3,765	-	1,830,284
331	Primary Metal Manufacturing	1	300,000	300,000	35,014	35,014	-	1,092,500
332	Fabricated Metal Products	-	-	-	-	-	-	-
333-334	Machinery and Electronics	-	-	-	-	-	-	-
335	Electrical Equipment and Appliances	-	-	-	-	-	-	-
336	Transportation Equipment	-	-	-	-	-	-	-
339	Misc	-	-	-	-	-	-	-
Total		**28**	**4,795,256**	**171,259**	**558,793**	**19,957**	**46,139,230**	**49,958,242**

Estimated Louisiana CHP Economic Potentials, Facility Utilization

The 28 facilities that are estimated to be cost-effective CHP potentials, run at very high utilization rates (on average, at 95 percent).

NAICS Category		Number of Facilities	Average Facility Utilization	Minimum Facility Utilization	Maximum Facility Utilization
			---------- (%) ----------		
311-312	Food, Beverage and Tobacco	2	85.5%	71.2%	99.7%
313-314	Textile Mills	-	-	-	-
315	Apparel Manufacturing	-	-	-	-
321	Wood Products	3	84.4%	71.2%	99.7%
337	Furniture and Related Products	-	-	-	-
322	Paper Manufacturing	-	-	-	-
323	Printer and Related Support	2	99.7%	99.7%	99.7%
325	Chemical Manufacturing	12	98.9%	95.9%	99.7%
324	Petroleum and Coal Products	6	99.4%	97.8%	99.7%
326	Plastics and Rubber Products	-	-	-	-
316	Leather and Products	-	-	-	-
327	Nonmetallic Mineral Products	2	99.7%	99.7%	99.7%
331	Primary Metal Manufacturing	1	97.8%	97.8%	97.8%
332	Fabricated Metal Products	-	-	-	-
333-334	Machinery and Electronics	-	-	-	-
335	Electrical Equipment and Appliances	-	-	-	-
336	Transportation Equipment	-	-	-	-
339	Misc	-	-	-	-
Total		**28**	**95.1%**	**71.2%**	**99.7%**

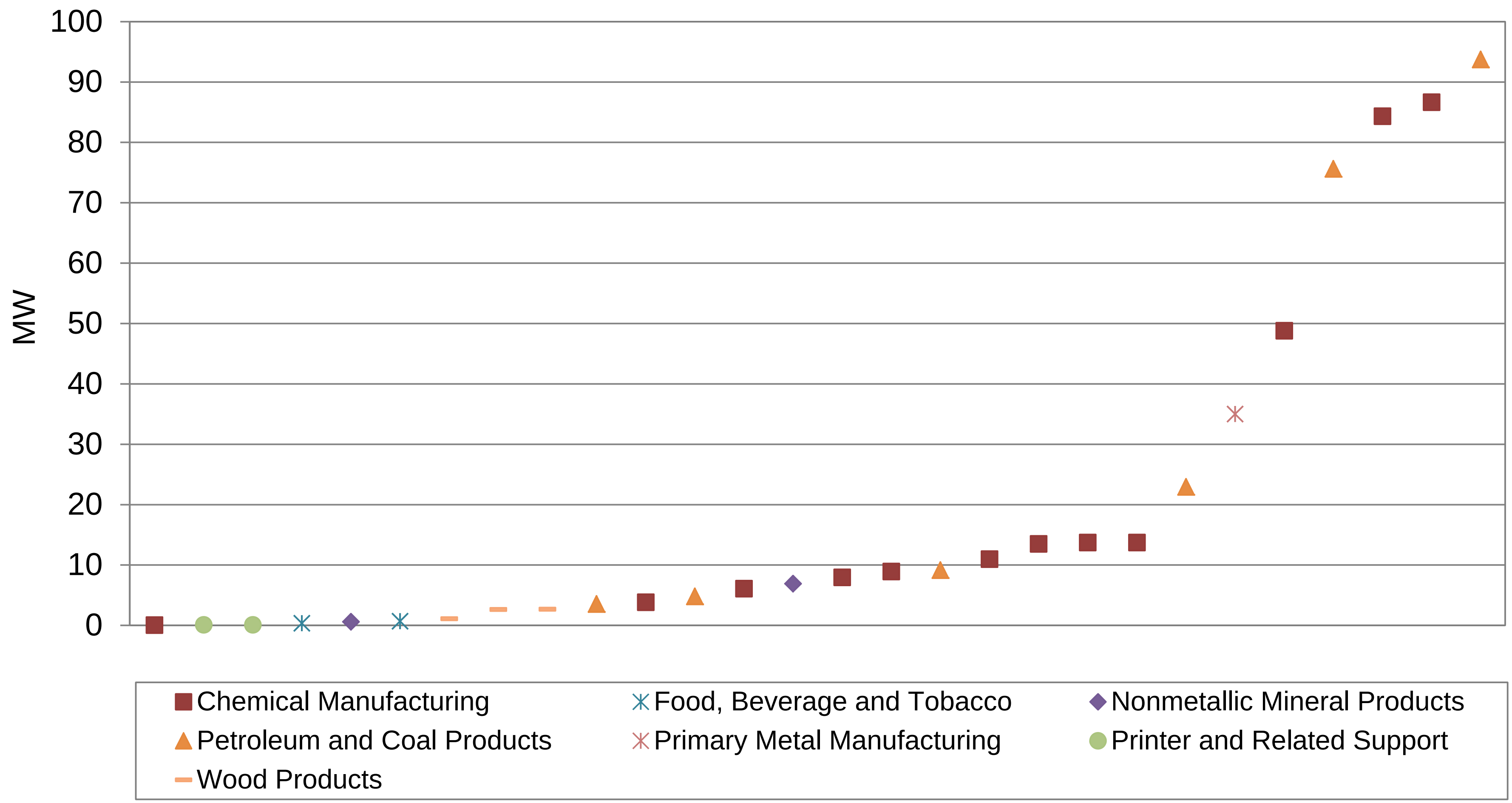
Estimated Louisiana CHP Economic Potentials, Electric Demand

There is approximately 560 MW of load associated with facilities that have cost-effective CHP installation potential. While the chemical and refining sectors are estimated to make up just 64 percent of the number of facilities (18 out of 28), the demand for these sectors account for 91 percent (509,000 kW out of 558,000 kW) of the total cost-effective potentials.

NAICS Category		Number of Facilities	Electric Demand	Minimum Electric Demand	Maximum Electric Demand	Average Electric Demand
			---- (kW) ----			
311-312	Food, Beverage and Tobacco	2	1,059	353	706	530
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	3	6,424	1,107	2,679	2,141
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	-	-	-	-	-
323	Printer and Related Support	2	202	99	103	101
325	Chemical Manufacturing	12	298,704	65	86,659	24,892
324	Petroleum and Coal Products	6	209,860	3,566	93,744	34,977
326	Plastics and Rubber Products	-	-	-	-	-
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	7,530	607	6,923	3,765
331	Primary Metal Manufacturing	1	35,014	35,014	35,014	35,014
332	Fabricated Metal Products	-	-	-	-	-
333-334	Machinery and Electronics	-	-	-	-	-
335	Electrical Equipment and Appliances	-	-	-	-	-
336	Transportation Equipment	-	-	-	-	-
339	Misc	-	-	-	-	-
Total		**28**	**558,793**	**65**	**93,744**	**19,957**

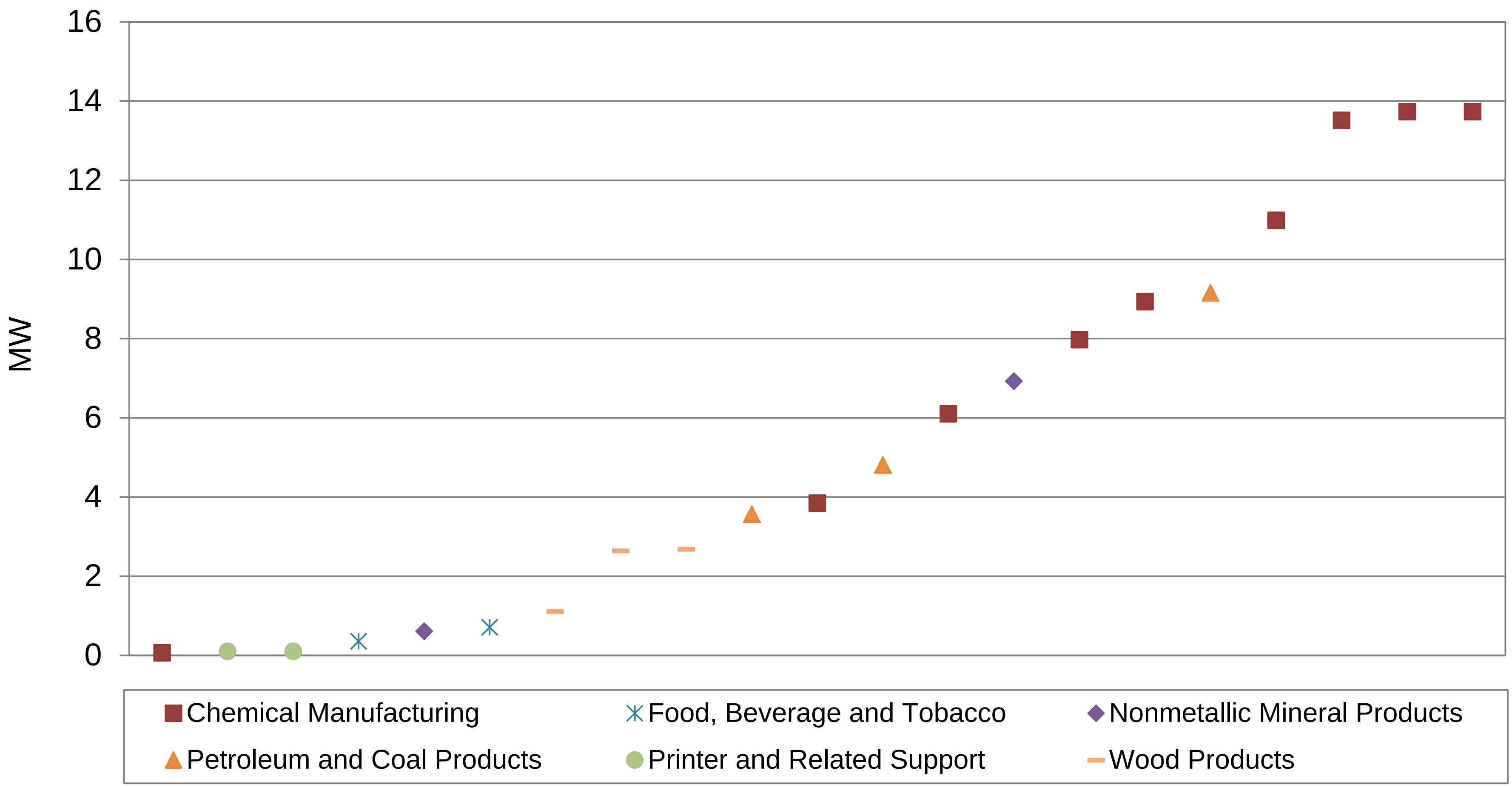
Distribution of Estimated Louisiana CHP Economic Potentials, Electric Demand

The load associated with facilities with cost-effective CHP potential ranges from 65 kW to 94 MW. With the exception of one primary metals facility, all of the facilities over 7 MW are from the chemical and refinery sectors.



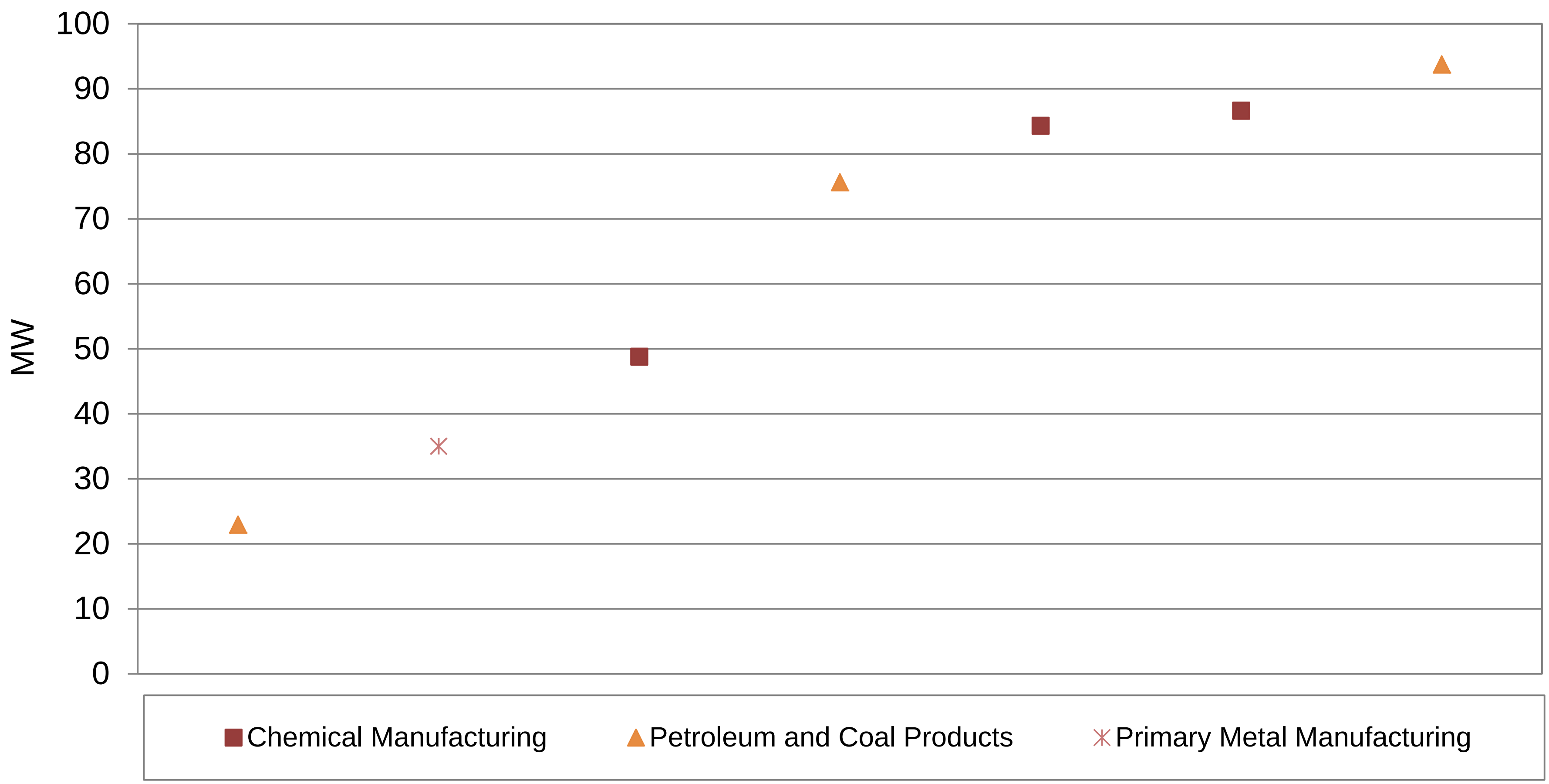
Distribution of Estimated Louisiana CHP Economic Potentials, Electric Demand (< 15 MW)

The distribution of small-load facilities passing the CHP cost-effectiveness screen spans a restricted number of economic sectors being dominated primarily by chemical manufacturing.



Distribution of Estimated Louisiana CHP Economic Potentials, Electric Demand (> 15 MW)

The large electric load facilities passing the cost-effectiveness screen are limited to seven locations associated with chemicals, refinery and primary metal manufacturing.



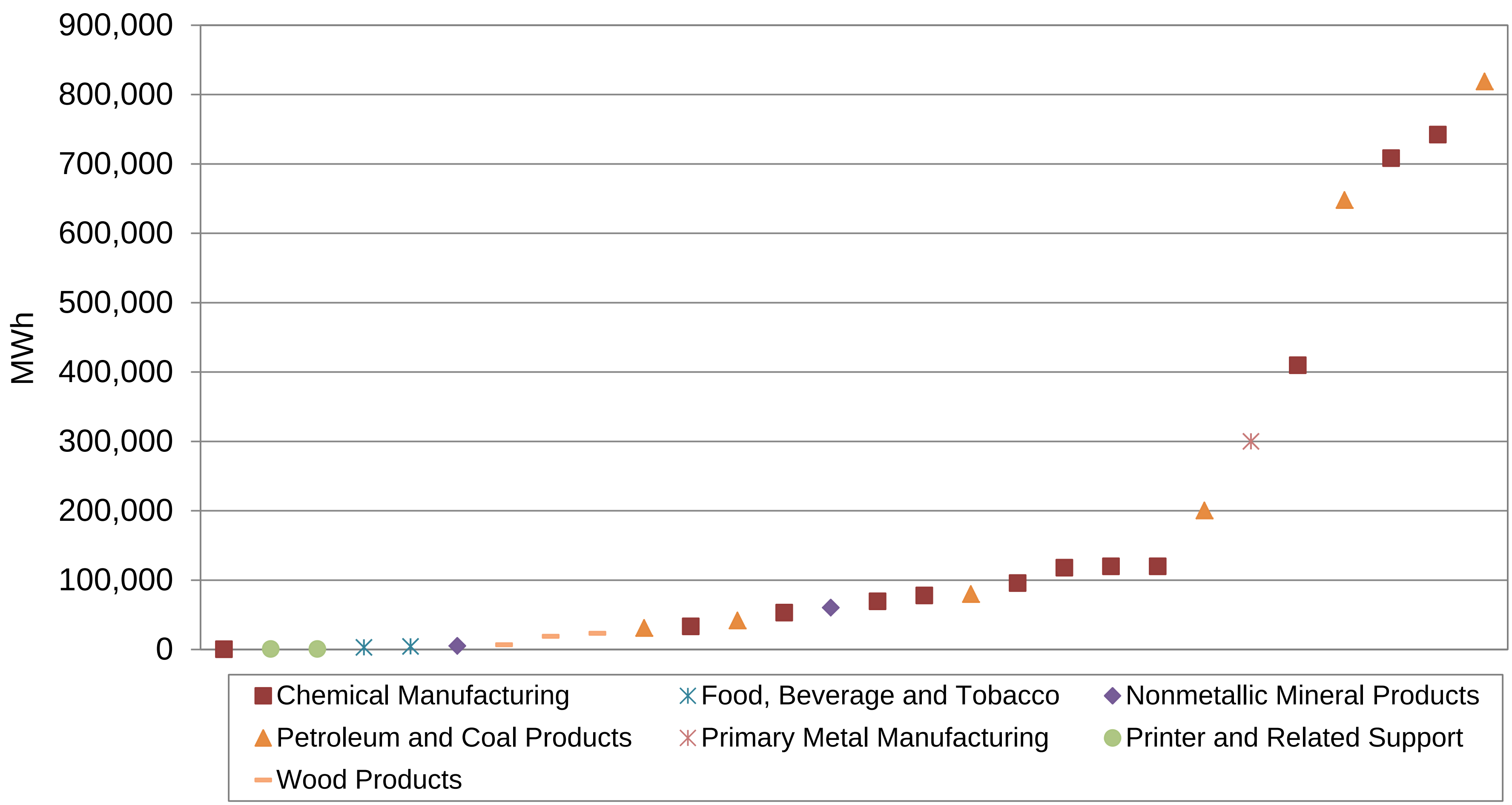
Estimated Louisiana CHP Economic Potentials, Electricity Usage

The 92 facilities estimated to have cost-effectiveness potential are estimated to use almost 4.8 million MWh. The chemical and refining sectors account for 91 percent of total electric use.

NAICS Category		Number of Facilities	Electric Use	Minimum Electric Use	Maximum Electric Use	Average Electric Usage
			(MWh)	(MWh)	(MWh)	(MWh)
311-312	Food, Beverage and Tobacco	2	7,496	3,089	4,407	3,748
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	3	49,319	6,913	23,406	16,440
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	-	-	-	-	-
323	Printer and Related Support	2	1,777	873	904	889
325	Chemical Manufacturing	12	2,550,214	571	742,500	212,518
324	Petroleum and Coal Products	6	1,820,658	31,158	818,956	303,443
326	Plastics and Rubber Products	-	-	-	-	-
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	65,791	5,310	60,481	32,896
331	Primary Metal Manufacturing	1	300,000	300,000	300,000	300,000
332	Fabricated Metal Products	-	-	-	-	-
333-334	Machinery and Electronics	-	-	-	-	-
335	Electrical Equipment and Appliances	-	-	-	-	-
336	Transportation Equipment	-	-	-	-	-
339	Misc	-	-	-	-	-
Total		**28**	**4,795,256**	**571**	**818,956**	**171,259**

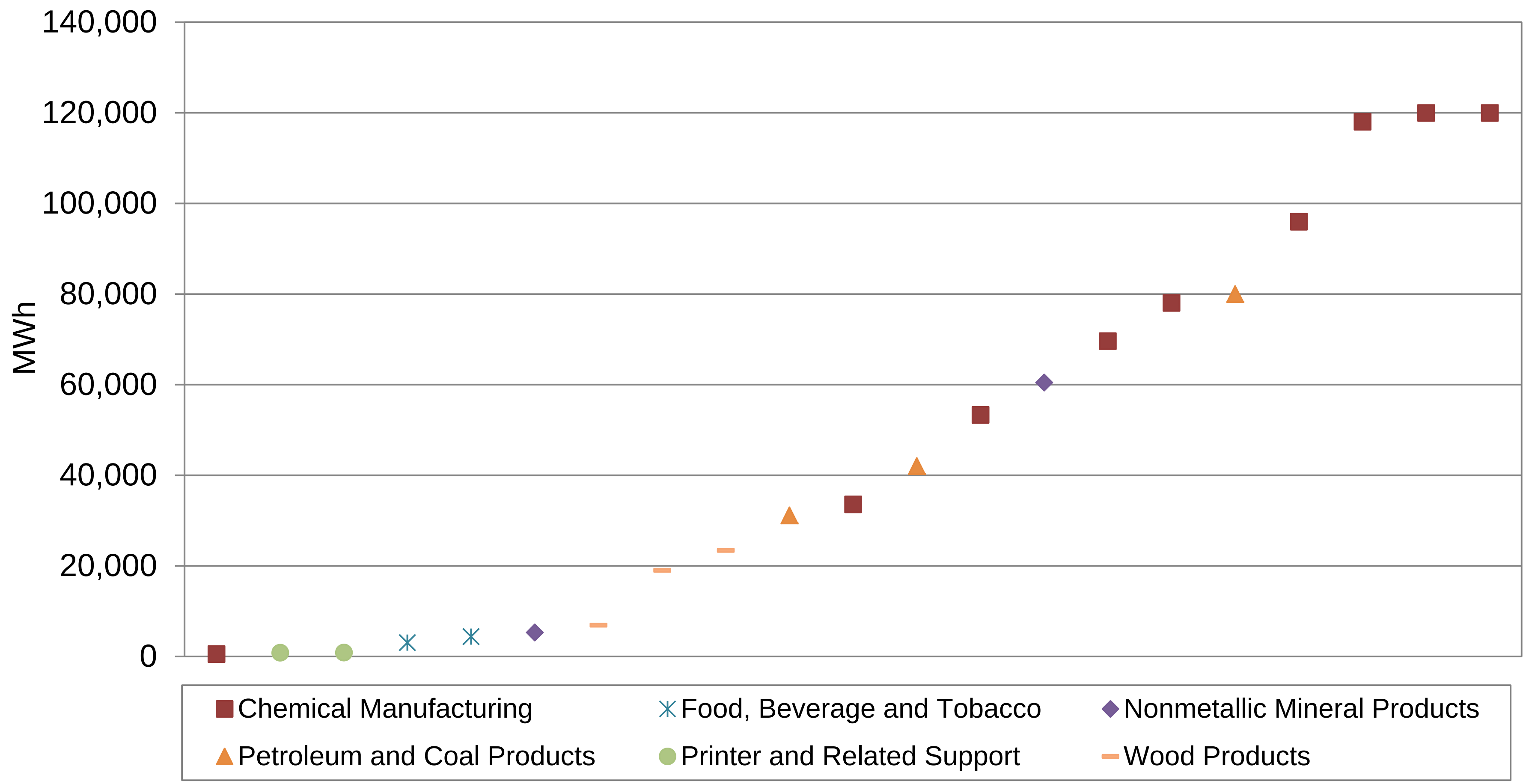
Distribution of Estimated Louisiana CHP Economic Potentials, Electricity Usage

Electricity usage at facilities estimated to have cost-effective CHP potential are also estimated to use from between 571 MWh to almost 820 million MWh of electricity.



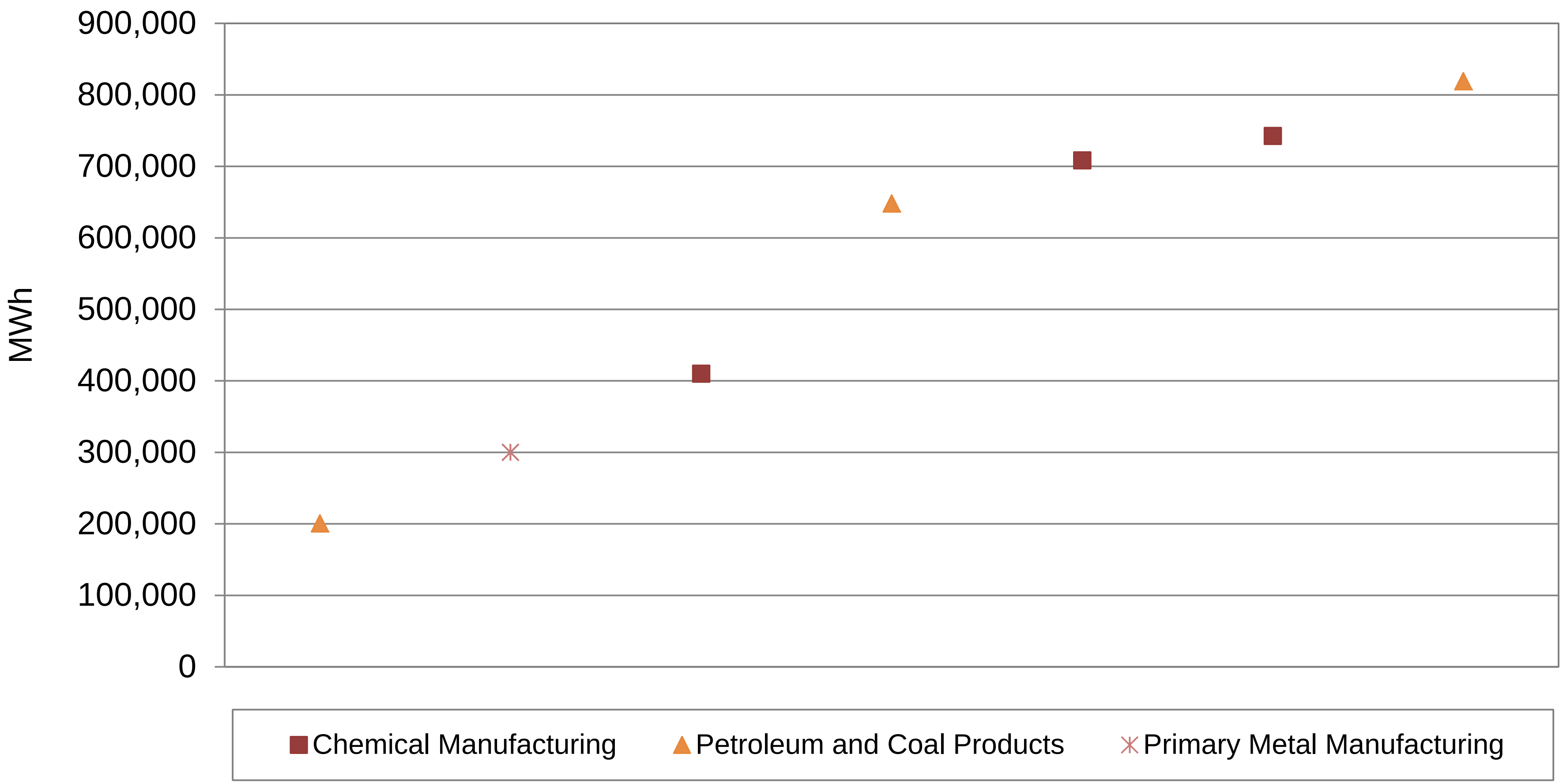
Distribution of Estimated Louisiana CHP Economic Potentials, Electricity Usage (≤ 120,000 MWh)

Smaller electric use facilities with CHP cost-effectiveness potentials span a number of industrial sectors but are heavily dominated by the chemical manufacturing sector.



Distribution of Estimated Louisiana CHP Economic Potentials, Electricity Usage (> 200,000 MWh)

Large electrical users that pass the cost-effectiveness screen are dominated by chemicals, refining, and metals manufacturing industries.



Note: There are no facilities reporting usage between 120,000 MWh and 200,000 MWh.

Estimated Louisiana CHP Economic Potentials, Thermal Usage

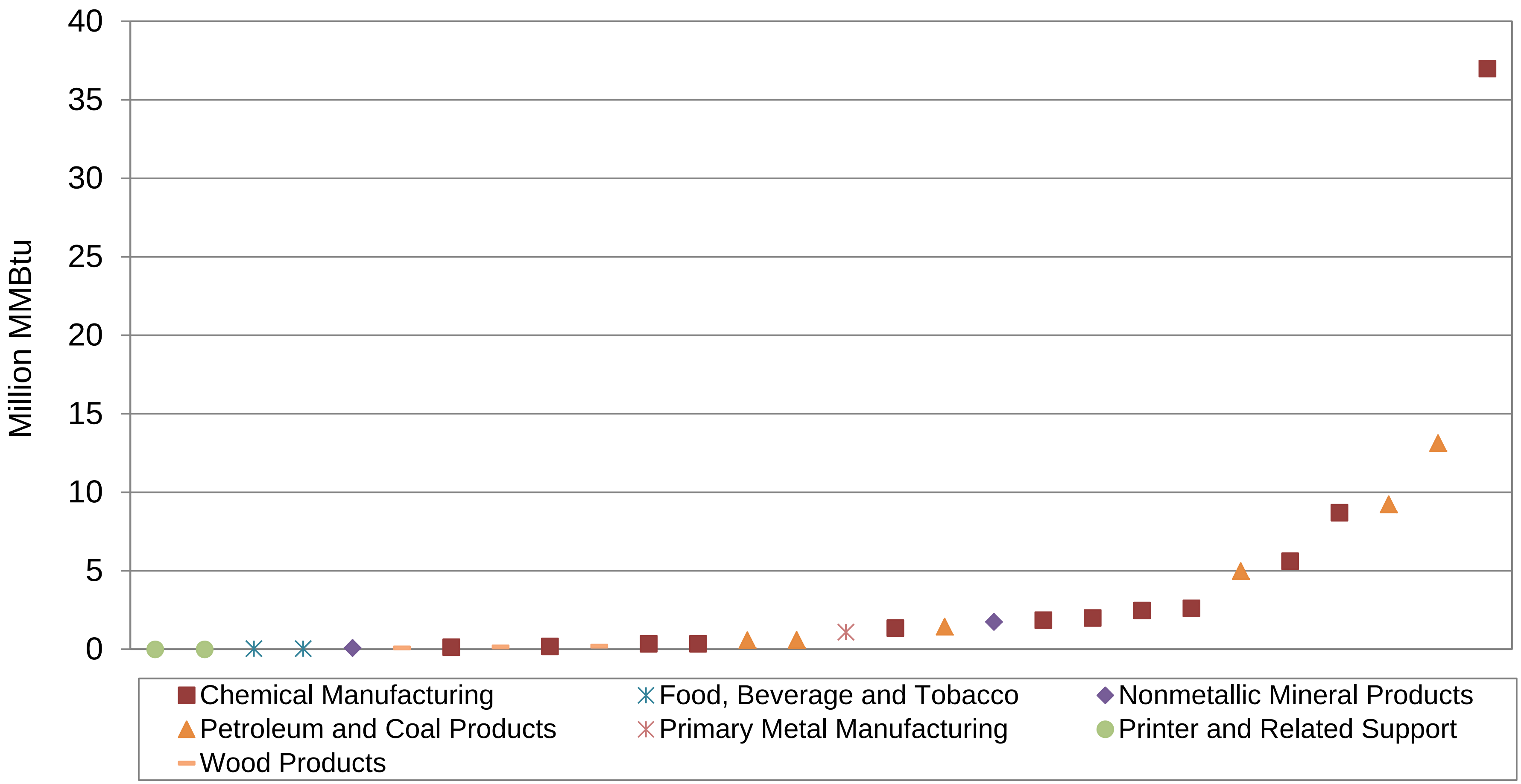
The 28 facilities passing the cost-effectiveness screen have a thermal usage that totals 96 million MMBtu. The chemical sector accounts 65 percent of the total thermal usage. The refining, nonmetallic minerals and primary metals sectors also have significant thermal usage.

NAICS Category		Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
			------------------------ (MMBtu) ------------------------			
311-312	Food, Beverage and Tobacco	2	87,467	43,072	44,395	43,733
313-314	Textile Mills	-	-	-	-	-
315	Apparel Manufacturing	-	-	-	-	-
321	Wood Products	3	426,848	85,780	195,500	142,283
337	Furniture and Related Products	-	-	-	-	-
322	Paper Manufacturing	-	-	-	-	-
323	Printer and Related Support	2	5,362	2,397	2,965	2,681
325	Chemical Manufacturing	12	62,683,228	136,800	37,000,000	5,223,602
324	Petroleum and Coal Products	6	29,971,783	580,600	13,133,798	4,995,297
326	Plastics and Rubber Products	-	-	-	-	-
316	Leather and Products	-	-	-	-	-
327	Nonmetallic Mineral Products	2	1,830,284	82,000	1,748,284	915,142
331	Primary Metal Manufacturing	1	1,092,500	1,092,500	1,092,500	1,092,500
332	Fabricated Metal Products	-	-	-	-	-
333-334	Machinery and Electronics	-	-	-	-	-
335	Electrical Equipment and Appliances	-	-	-	-	-
336	Transportation Equipment	-	-	-	-	-
339	Misc	-	-	-	-	-
Total		**28**	**96,097,472**	**2,397**	**37,000,000**	**168,297**

Note: Total thermal usage includes both furnace and boiler fuel usage.

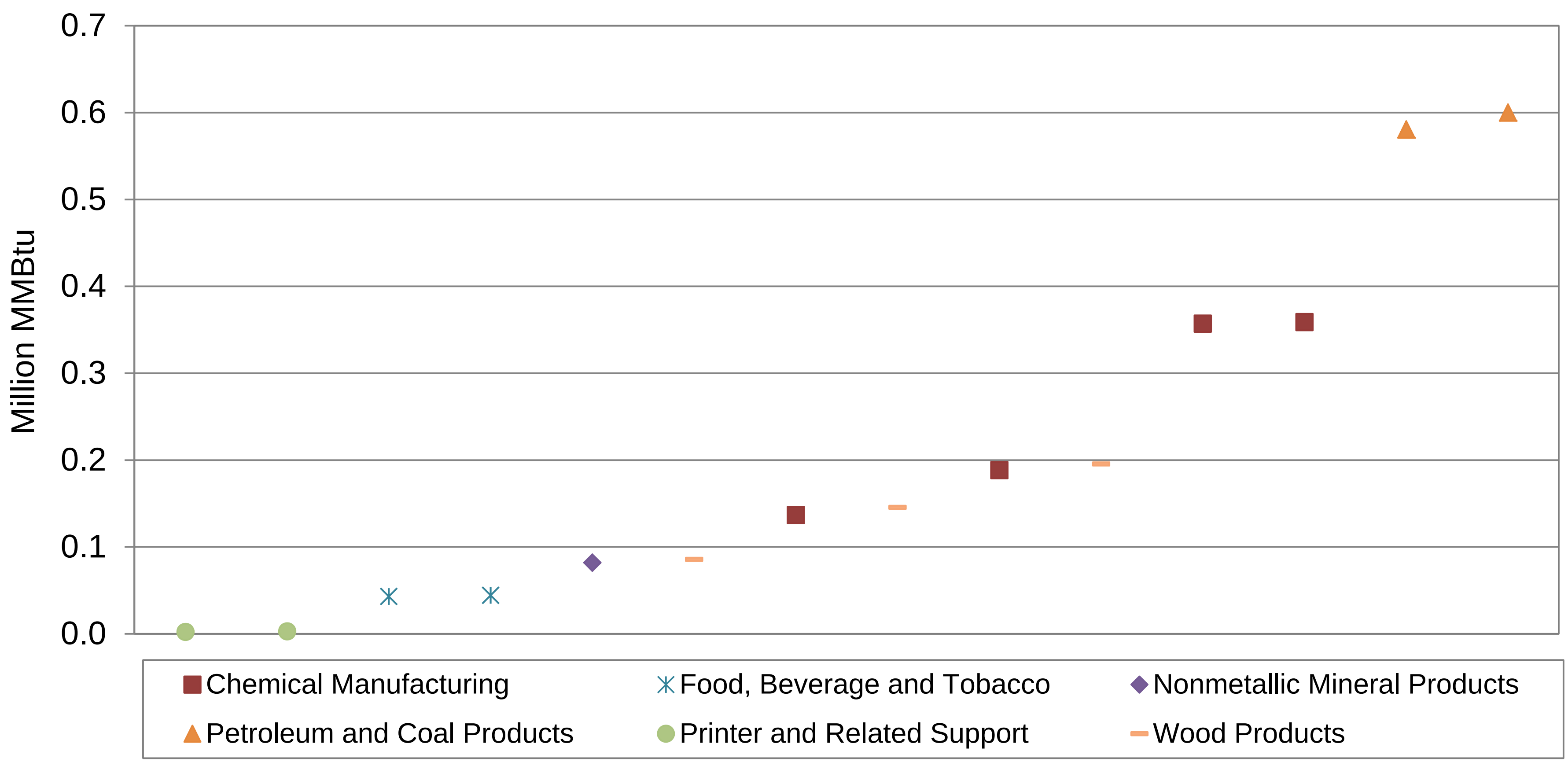
Distribution of Estimated Louisiana CHP Economic Potentials, Thermal Usage

The facilities estimated to have cost-effective CHP installation potential are estimated to utilize thermal energy ranging between 2,400 MMBtu and 37 million MMBtu.



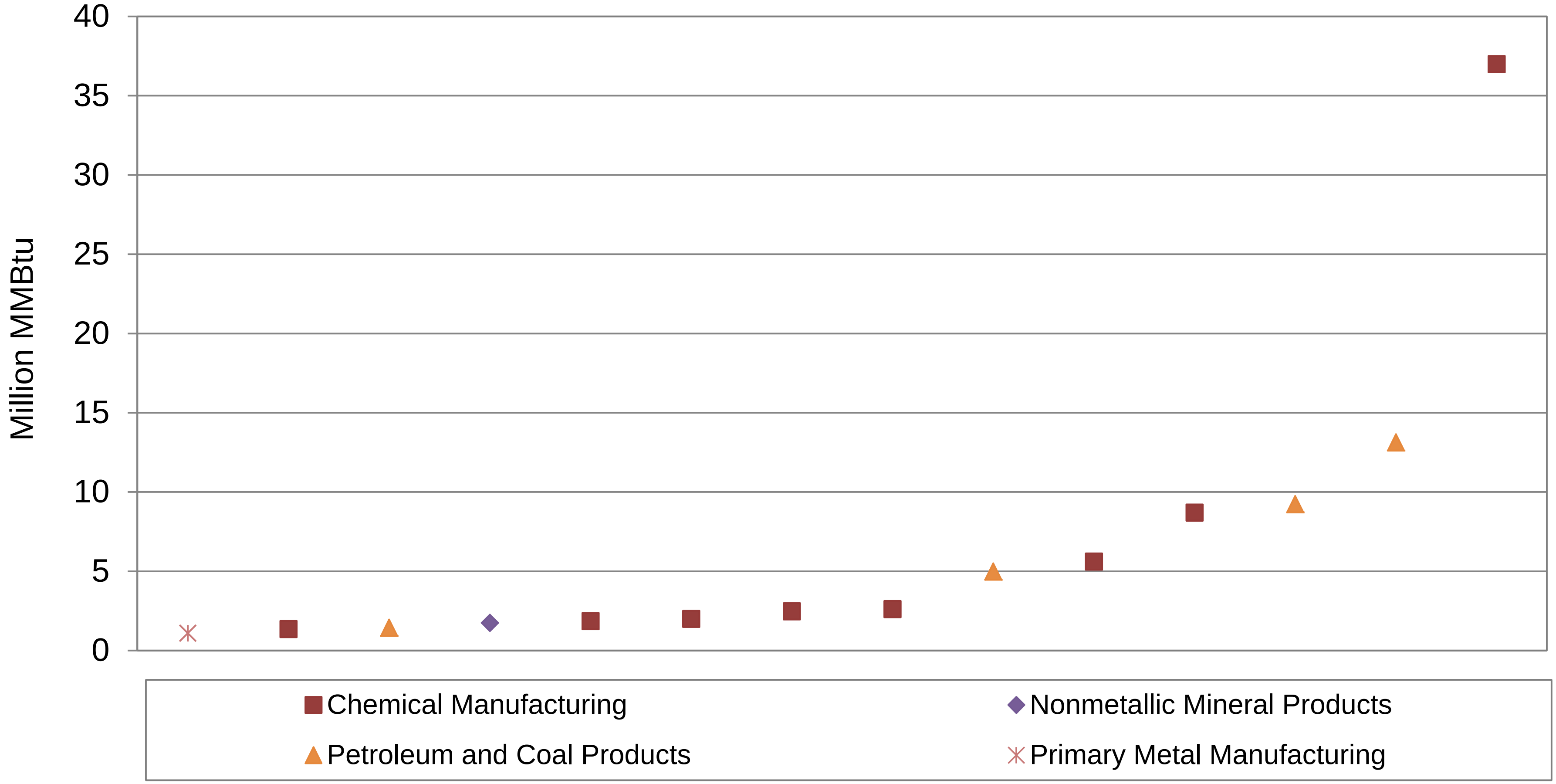
Distribution of Estimated Louisiana CHP Economic Potentials, Thermal Usage (< 1 Million MMBtu)

The smaller thermal energy users with estimated cost-effectiveness potential represent six different manufacturing sectors.



Distribution of Estimated Louisiana CHP Economic Potentials, Thermal Usage (> 1 Million MMBtu)

Larger thermal energy users passing the cost-effectiveness screen are associated with metals, minerals, refining and chemical manufacturing.



Section 6: Sensitivities

Sensitivity Analyses

Four sensitivities were performed to ascertain the robustness of the empirical results. The following scenarios were applied to facilities deemed as economic potentials:

- Scenario 1: The Benefit-Cost ratio is reduced from 1.0 to 0.9.
- Scenario 2: A carbon cost is added to the cost of generation, assuming an average emission rate of 1,135 lbs/MWh and a cost of $40/ton.
- Scenario 3: The cost of natural gas is increased 107 percent, from an average spot price of $3.86/Mcf to $8.00/Mcf.
- Scenario 4: The market clearing heat rate is increased from 10,816 Btu/kWh to 20,000 Btu/kWh, thereby increasing the wholesale price of electricity by 85 percent.

Summary of Cost-Effectiveness Sensitivities

Sensitivity analyses show that reducing the benefit-cost ratio almost doubles the amount of cost effective CHP capacity. It also shows that cost-effectiveness is sensitive to carbon restrictions as well as changes in natural gas and electric power prices.

NAICS Category		CHP Capacity (MW)							
					Cost Effective				
		Existing	Market Identification	Technical Potential	Baseline	Scenario 1 - Relax Benefit-Cost Ratio	Scenario 2 - Add Carbon Restriction	Scenario 3 - High Natural Gas Prices	Scenario 4 - High Capacity Prices
311-312	Food, Beverage and Tobacco	24.4	104.6	102.7	1.1	1.5	0.4	0.4	1.1
313-314	Textile Mills	-	1.4	1.4	-	-	-	-	-
315	Apparel Manufacturing	-	0.6	0.6	-	-	-	-	-
321	Wood Products	-	30.2	30.2	6.4	14.2	2.6	-	6.4
337	Furniture and Related Products	-	0.5	0.5	-	-	-	-	-
322	Paper Manufacturing	555.6	566.3	3.1	-	-	-	-	-
323	Printer and Related Support	-	9.7	9.7	0.2	0.2	0.1	0.1	0.2
325	Chemical Manufacturing	4,983.5	2,181.6	893.5	298.7	641.2	39.4	39.4	519.1
324	Petroleum and Coal Products	643.7	1,319.5	304.7	209.9	209.9	-	9.2	209.9
326	Plastics and Rubber Products	-	49.3	9.3	-	-	-	-	-
316	Leather and Products	-	1.2	1.2	-	-	-	-	-
327	Nonmetallic Mineral Products	-	13.7	13.7	7.5	7.5	-	-	7.5
331	Primary Metal Manufacturing	84.1	49.5	49.5	35.0	40.3	-	-	35.0
332	Fabricated Metal Products	-	15.6	15.6	-	-	-	-	-
333-334	Machinery and Electronics	-	27.3	27.3	-	-	-	-	-
335	Electrical Equipment and Appliances	-	2.8	2.8	-	-	-	-	-
336	Transportation Equipment	-	12.0	12.0	-	-	-	-	-
	Misc	7.5	1.1	1.1	-	-	-	-	-
	Total	**6,298.8**	**4,386.8**	**1,478.8**	**558.8**	**914.8**	**42.5**	**49.0**	**779.2**

Cost-Effectiveness Sensitivities as a Percent of Louisiana Generation

Cost-effective facilities would make up just two percent of Louisiana's current electric power generation. Relaxing the cost-benefit ration increases this percentage to 3.5 percent.

NAICS Category		Share of Total LA Generation Capacity (%)							
					Cost Effective				
		Existing	Market Identification	Technical Potential	Baseline	Scenario 1 - Relax Benefit-Cost Ratio	Scenario 2 - Add Carbon Restriction	Scenario 3 - High Natural Gas Prices	Scenario 4 - High Capacity Prices
311-312	Food, Beverage and Tobacco	0.09%	0.40%	0.39%	0.00%	0.01%	0.00%	0.00%	0.00%
313-314	Textile Mills	-	0.01%	0.01%	-	-	-	-	-
315	Apparel Manufacturing	-	0.00%	0.00%	-	-	-	-	-
321	Wood Products	-	0.12%	0.12%	0.02%	0.05%	0.01%	-	0.02%
337	Furniture and Related Products	-	0.00%	0.00%	-	-	-	-	-
322	Paper Manufacturing	2.12%	2.16%	0.01%	-	-	-	-	-
323	Printer and Related Support	-	0.04%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%
325	Chemical Manufacturing	19.02%	8.33%	3.41%	1.14%	2.45%	0.15%	0.15%	1.98%
324	Petroleum and Coal Products	2.46%	5.04%	1.16%	0.80%	0.80%	-	0.03%	0.80%
326	Plastics and Rubber Products	-	0.19%	0.04%	-	-	-	-	-
316	Leather and Products	-	0.00%	0.00%	-	-	-	-	-
327	Nonmetallic Mineral Products	-	0.05%	0.05%	0.03%	0.03%	-	-	0.03%
331	Primary Metal Manufacturing	0.32%	0.19%	0.19%	0.13%	0.15%	-	-	0.13%
332	Fabricated Metal Products	-	0.06%	0.06%	-	-	-	-	-
333-334	Machinery and Electronics	-	0.10%	0.10%	-	-	-	-	-
335	Electrical Equipment and Appliances	-	0.01%	0.01%	-	-	-	-	-
336	Transportation Equipment	-	0.05%	0.05%	-	-	-	-	-
	Misc	0.03%	0.00%	0.00%	-	-	-	-	-
	Total	**24.0%**	**16.7%**	**5.6%**	**2.1%**	**3.5%**	**0.2%**	**0.2%**	**3.0%**

Section 7: Conclusions

Summary and Conclusions

- The Market Identification phase identifies 209 candidate facilities that define the potential Louisiana CHP market. These facilities have a combined total of 1,480 MW, with the overwhelming majority in the chemical and refining sectors.
- The Technical Potential phase reduces the number of candidate facilities to 92 eligible facilities, totaling 1,070 MW. The chemical and petroleum refining facilities have a combined total of 960 MW of load.
- The Economic Potential identifies 28 facilities (560 MW) that have the technical capability to install CHP and have project life benefits that are greater than project life costs on a NPV basis. Again, most of these are from the chemical and petroleum refining (510 MW).
- The Sensitivities Analyses show that the candidate facilities are significantly impacted by changes in each of the four assumptions.

LSU Center for Energy Studies

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

Phase 4 Report: Policy and Market Opportunity and Challenges for CHP Development

Prepared for the Louisiana Department of Natural Resources

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Center for Energy Studies
Louisiana State University

August 11, 2014

LSU CENTER FOR ENERGY STUDIES

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1.0 Policy Issues

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Section 1: Policy Issues

CHP Policy Issues

CHP developers and utilities have considerable differences of opinion in CHP policy issues that became more prominent during the period of increased merchant power development experienced over the past decade.

From a developer's perspective, past policy and market barriers have historically centered around the same three primary problems:

(1) lack of price transparency (on CHP market/utility sales);

(2) having an open and objective transmission operations, planning, and longer-run development process; and

(3) lack of market institutions to support expanded sales of CHP output into wholesale markets.

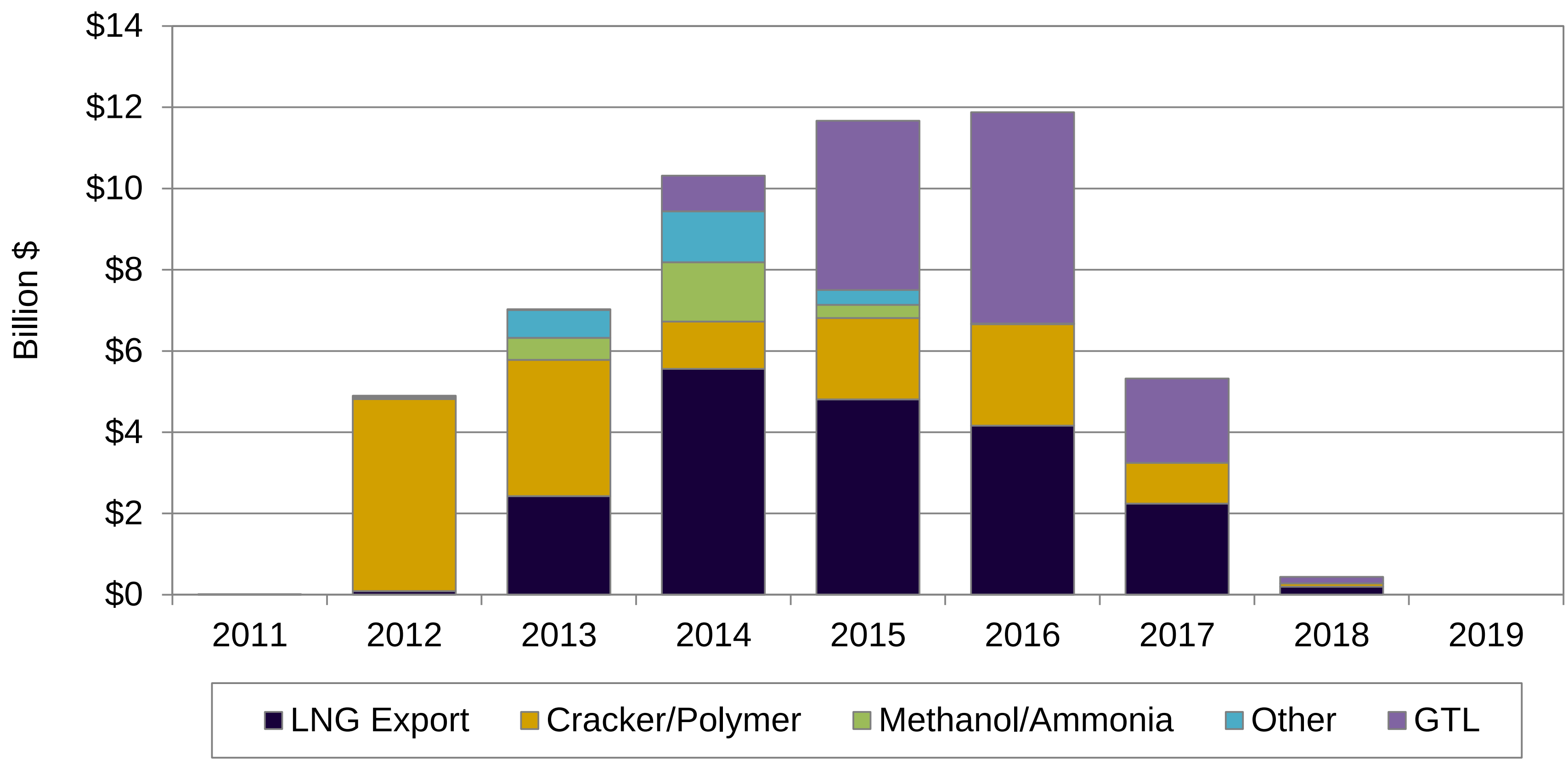
CHP Outlook

The current Louisiana “industrial renaissance,” coupled with Entergy’s recent move to the Mid-continent Independent System Operator (“MISO”), should help to alleviate many of the developers’ perceived problems associated with in-state CHP expansion.

- Over $61 billion in industrial, energy-intensive capital expenditures (“capex”), will result in the need for considerable new generation capacity, some of which will likely be CHP-oriented.
- Having the main Louisiana industrial corridor included in the MISO footprint will help to provide:
  (1) price discovery and transparency;
  (2) open access transmission operations and planning; and
  (3) greatly expanded market scope for all suppliers.

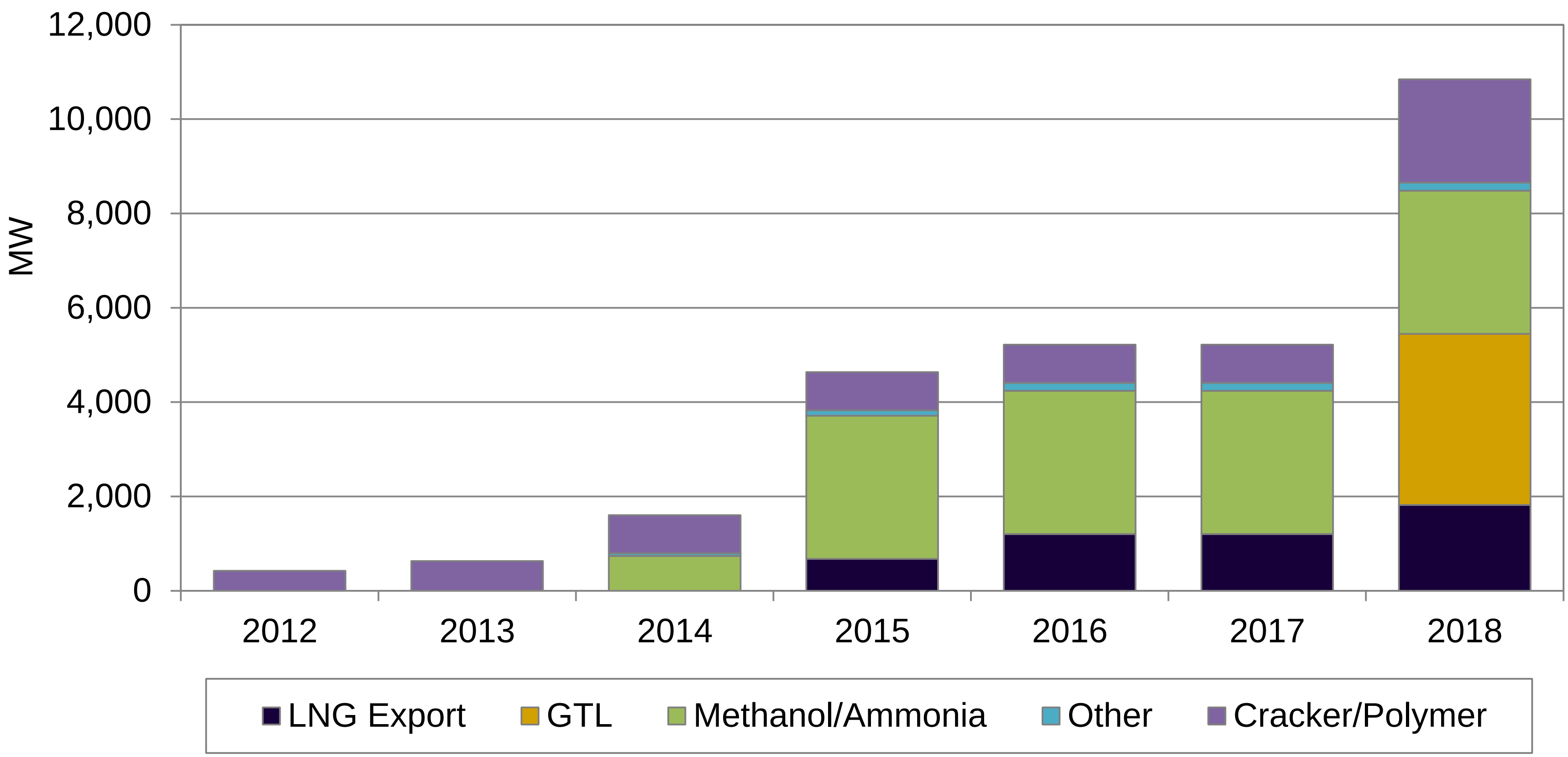
Total Capital Expenditures by Sector

The total capital investment associated with all announced natural gas-driven manufacturing investments in Louisiana totals over $61 billion. Most of the investment is anticipated to occur between 2014 and 2017.



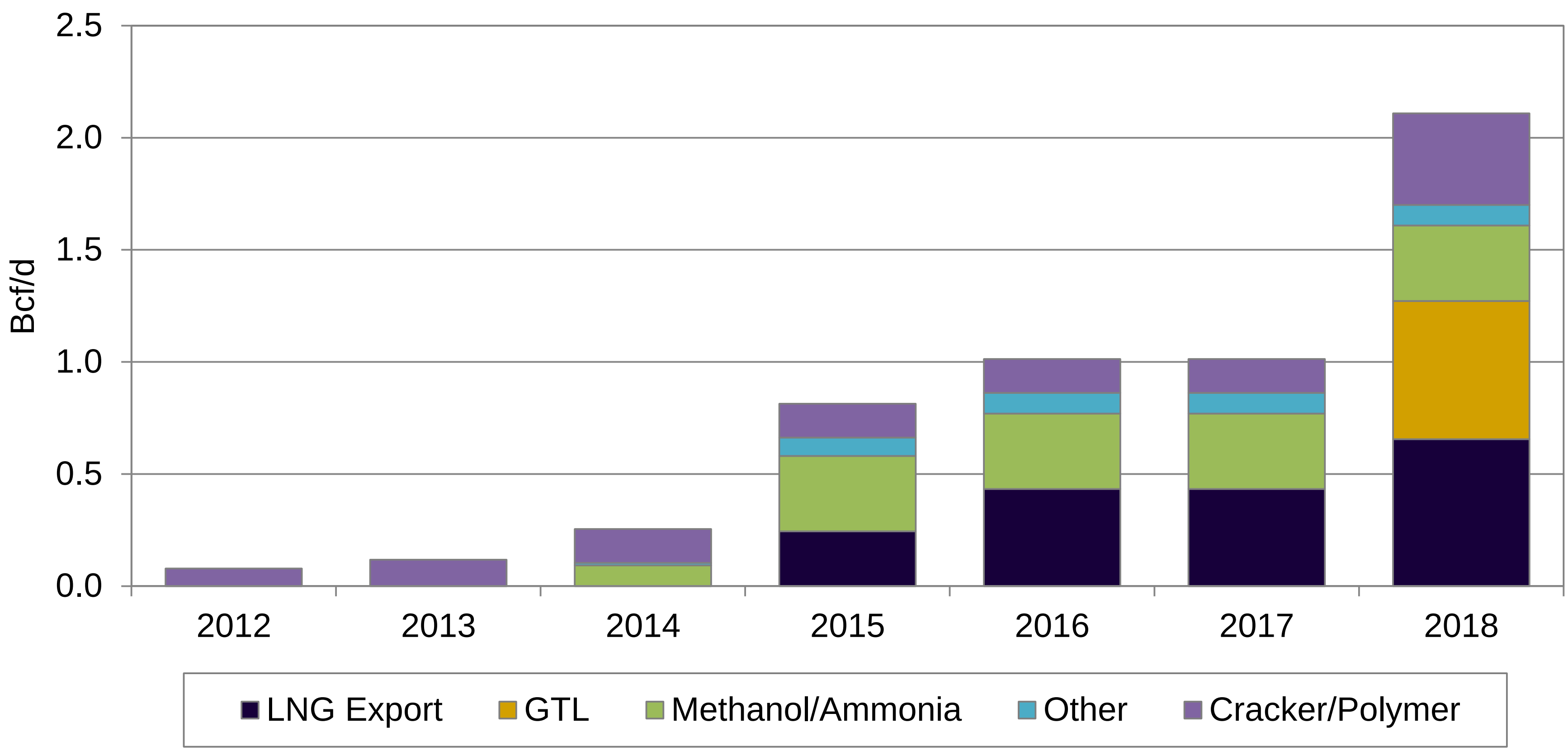
Electric Capacity by Sector and Online Date

Capacity requirements associated with all currently-announced projects would come close to doubling in-state generation capacity. All of this capacity has the technical capabilities for CHP development. The extent of CHP development will be a function of final project development, which is unknown at this time.



Total Natural Gas Capacity by Sector and Online Date

Industrial gas demand could also double given current project announcements.

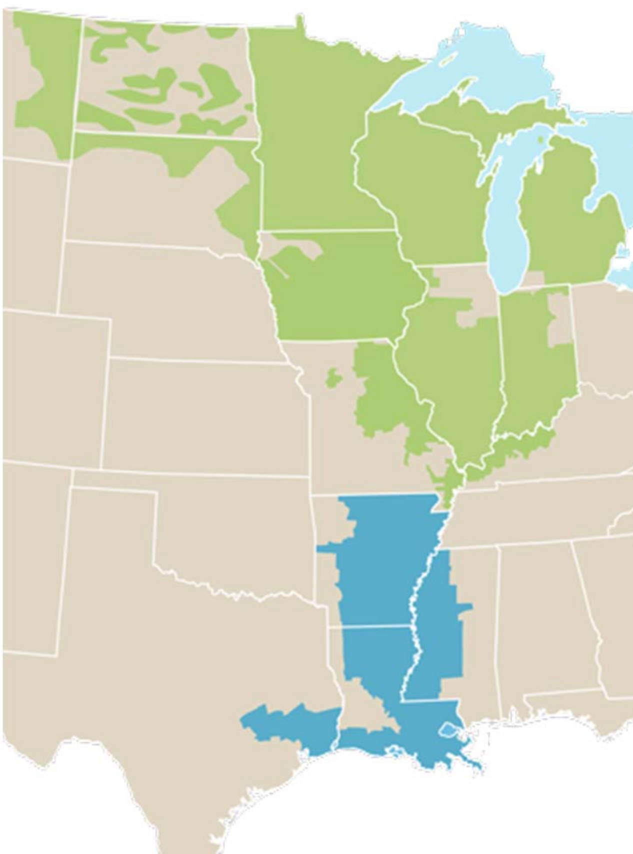


Potential Economic Impacts/Benefit: Construction, State

Not quite as clear will be the additional power/gas requirements for new residential and commercial activities supporting development/operation. This should elevate regional usage trends relative to national averages and provide for additional opportunities to sell currently-underutilized CHP capacity to host utilities.

	Construction Impacts									
	Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
Output (million $)										
Direct	$ 17,080.2	$ 4.4	$ 1,715.4	$ 2,458.1	$ 3,535.5	$ 3,765.0	$ 3,764.9	$ 1,696.2	$ 140.7	$ -
Indirect	$ 2,742.2	$ 0.7	$ 275.4	$ 394.6	$ 567.6	$ 604.5	$ 604.4	$ 272.3	$ 22.6	$ -
Induced	$ 5,315.3	$ 1.4	$ 533.8	$ 765.0	$ 1,100.2	$ 1,171.7	$ 1,171.6	$ 527.9	$ 43.8	$ -
Total	**$ 25,137.6**	**$ 6.4**	**$ 2,524.6**	**$ 3,617.7**	**$ 5,203.3**	**$ 5,541.1**	**$ 5,540.9**	**$ 2,496.4**	**$ 207.0**	**$ -**
Employment (jobs)										
Direct	115,726	30	11,623	16,655	23,955	25,510	25,509	11,493	953	-
Indirect	18,500	5	1,858	2,662	3,829	4,078	4,078	1,837	152	-
Induced	47,241	12	4,745	6,799	9,779	10,414	10,413	4,692	389	-
Total	**181,468**	**47**	**18,225**	**26,116**	**37,563**	**40,001**	**40,000**	**18,022**	**1,495**	**-**
Wages (million $)										
Direct	$ 5,566.6	$ 1.4	$ 559.1	$ 801.1	$ 1,152.3	$ 1,227.1	$ 1,227.0	$ 552.8	$ 45.8	$ -
Indirect	$ 804.7	$ 0.2	$ 80.8	$ 115.8	$ 166.6	$ 177.4	$ 177.4	$ 79.9	$ 6.6	$ -
Induced	$ 1,493.1	$ 0.4	$ 150.0	$ 214.9	$ 309.1	$ 329.1	$ 329.1	$ 148.3	$ 12.3	$ -
Total	**$ 7,864.5**	**$ 2.0**	**$ 789.8**	**$ 1,131.8**	**$ 1,627.9**	**$ 1,733.6**	**$ 1,733.5**	**$ 781.0**	**$ 64.8**	**$ -**

MISO Integration: Competitive Wholesale Market Changes/Benefits



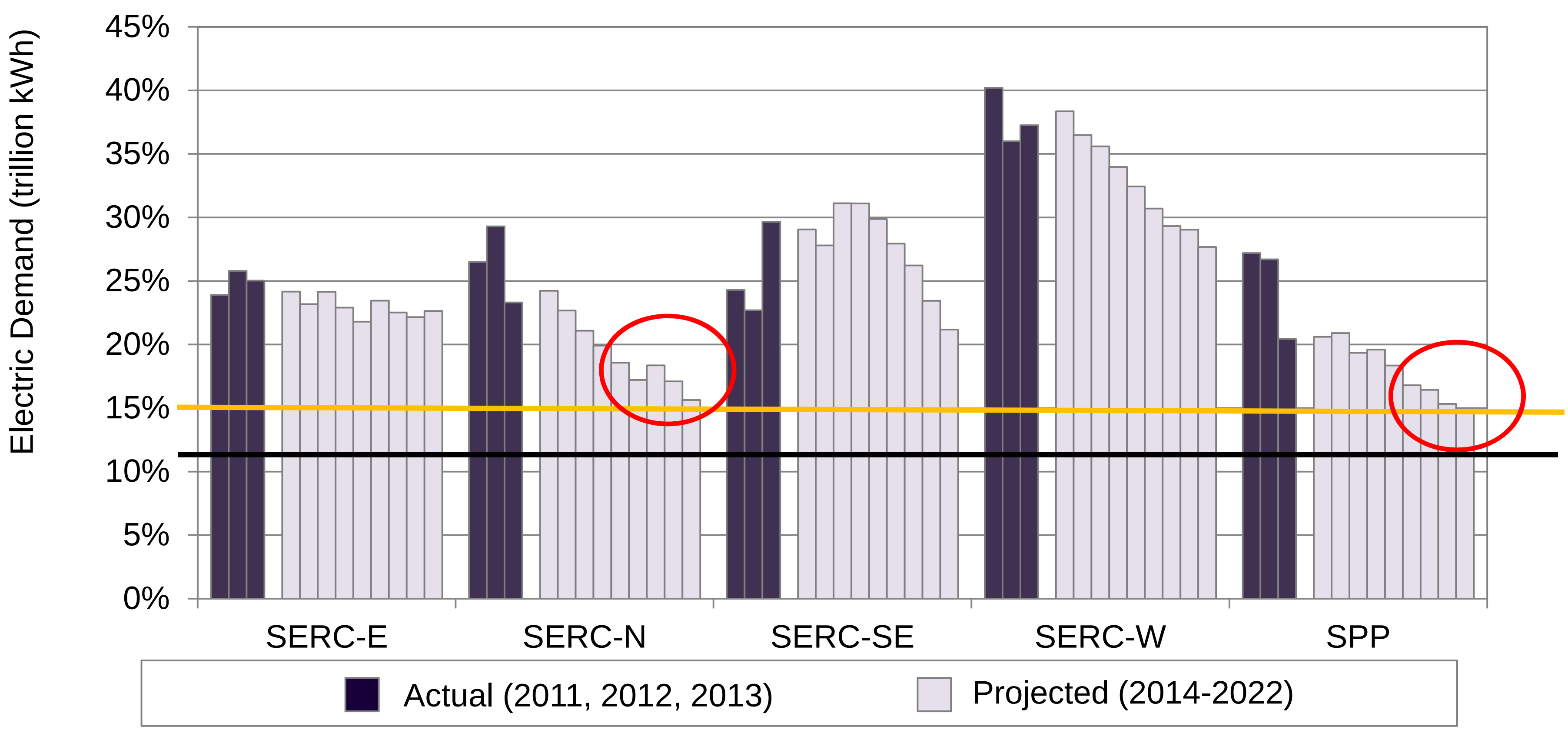
There are a number of wholesale market benefits that can arise from the expansion of MISO to the Gulf Coast that include:

- Greater power generation market efficiencies.
- The ability to move highly-efficient and environmentally-friendly natural gas fired generation into an area historically dominated by coal-fired generation.
- Greater market scope opportunities by providing lower-cost, highly efficient natural gas generators easier access to quickly growing mid-western electric power markets.

Source: Entergy.

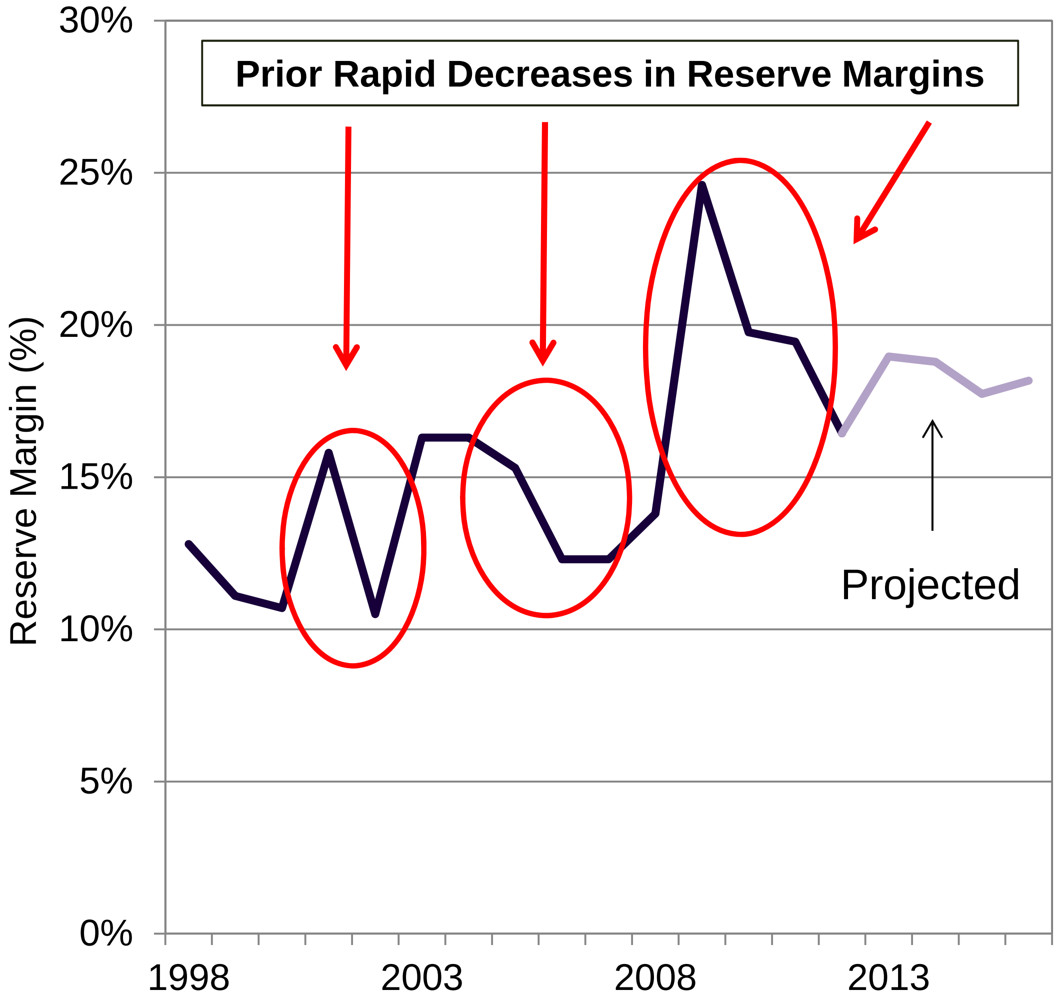
SERC/SPP Historic and Projected Reserve Margins

While margins are anticipated to fall, conventional wisdom is that this decline will be slow. It does not appear these forecasts include the exceptional increases in power generation requirements that will be needed from new industrial expansions.



Source: NERC; SERC planning standard line at 15 percent; SPP planning standard line at 13.6 percent.

Historic and Projected Reserve Margin Changes



Have seen examples in the past where excess generation can be burnt off relatively quickly.

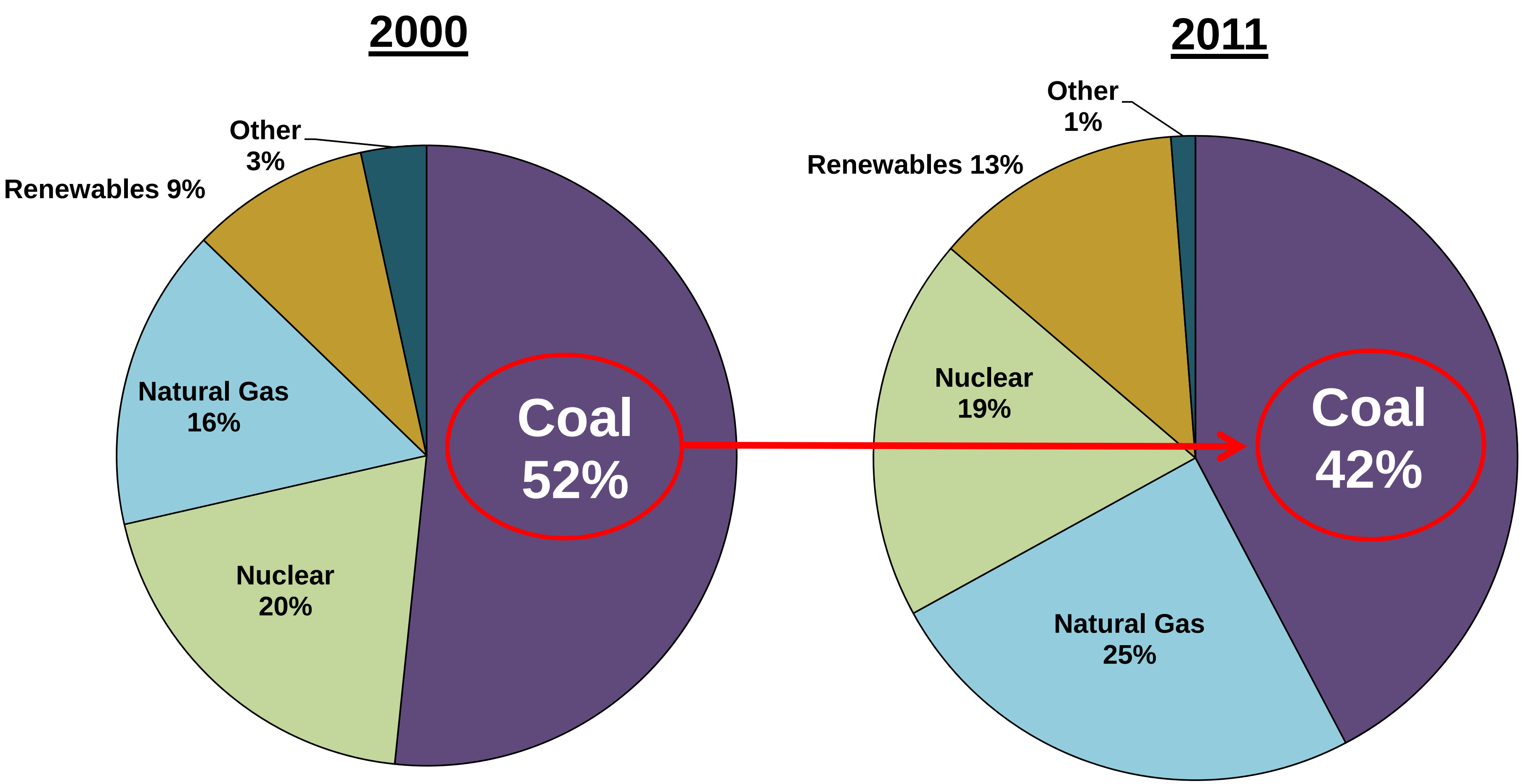
Source: Energy Information Administration, U.S. Department of Energy.

EPA Regulatory Rulemakings Discouraging Coal Generation

- Over the past several years, the EPA has entered into a number of different rulemaking proceedings that will have the net effect of discouraging coal-fired generation.
- These new EPA regulations come onto of a series of regulatory changes that arose during the 1990s that discouraged coal fired generation by increasing a number of acid rain-based regulations.
- Collectively, these new regulations, governing air emissions, water emissions, and waste materials, will impact both new and existing coal-fired power generation.
- More recently, EPA has proposed a series of new rules on carbon emissions that will likely eliminate traditional coal-fired power generation as a future resource to meet utility electricity requirements.

U.S. Power Generation Fuel Mix

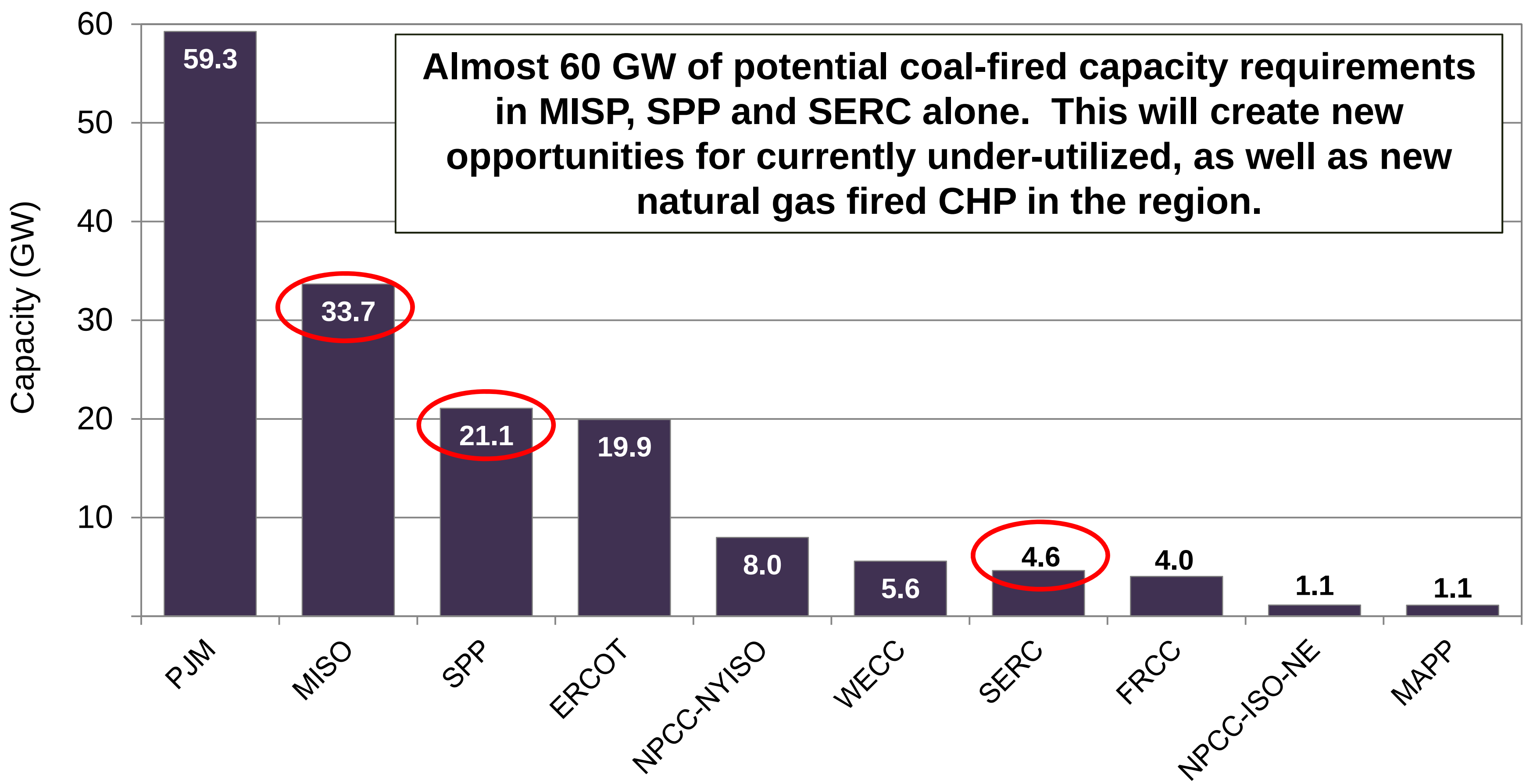
Over 250,000 MWs of natural gas and renewable power generation capacity has been added over the past decade at the expense of coal-fired power generation.



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

Estimated Environmental Retirements by NERC Region

NERC estimates that 160 GWs (339 units) will need retrofits by 2016. NERC also estimates that MISO will need to control over 33 GW of fossil-fueled generation to comply with new EPA regulations.



Source: NERC.

Policy Summary

- Projected industrial development is large and unprecedented and will create new opportunities for CHP.
- The "multiplier" impacts associated with this economic activity and its impacts on electricity use are not often considered but could move what has been flat to decreasing power and gas use upward for smaller use customer classes (increasing the opportunities for CHP off-system sales).
- Environmental regulations will preference more gas: movement to MISO will facilitate the movement of gas-by-wire, including (new/existing) CHP-based gas-by-wire.
- MISO will provide better price and transmission planning transparency and will likely lead to a considerable re-investment in transmission assets opening up historic bottlenecks that have restricted past CHP output flows.
- History shows how quickly reserve/capacity margins can evaporate: new economic growth could result in the need for capacity quickly.

Conclusions

Conclusions

- Louisiana has a long historic with CHP development. Over 24 percent of all in-state generation capacity is CHP-based.
- Some additional industrial plants have the technical capability for CHP (~1,500 MW), while a smaller number of plants have the ability to cost-effectively generate CHP-based electricity (~600 MW), but for some reason, are not employing this potential efficiency opportunity. Thus, most of those facilities that can cogenerate, do.
- Considerable future CHP opportunities given $61 billion in new industrial capex: results in estimated power requirement of close to 10 GW (assuming all is developed).
- MISO integration will likely eliminate decades-old issues associated with price discovery; transmission operations/planning transparency; and market scope.
- The future looks bright for the operation of existing CHP, and the development of new CHP, in Louisiana.

