



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
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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

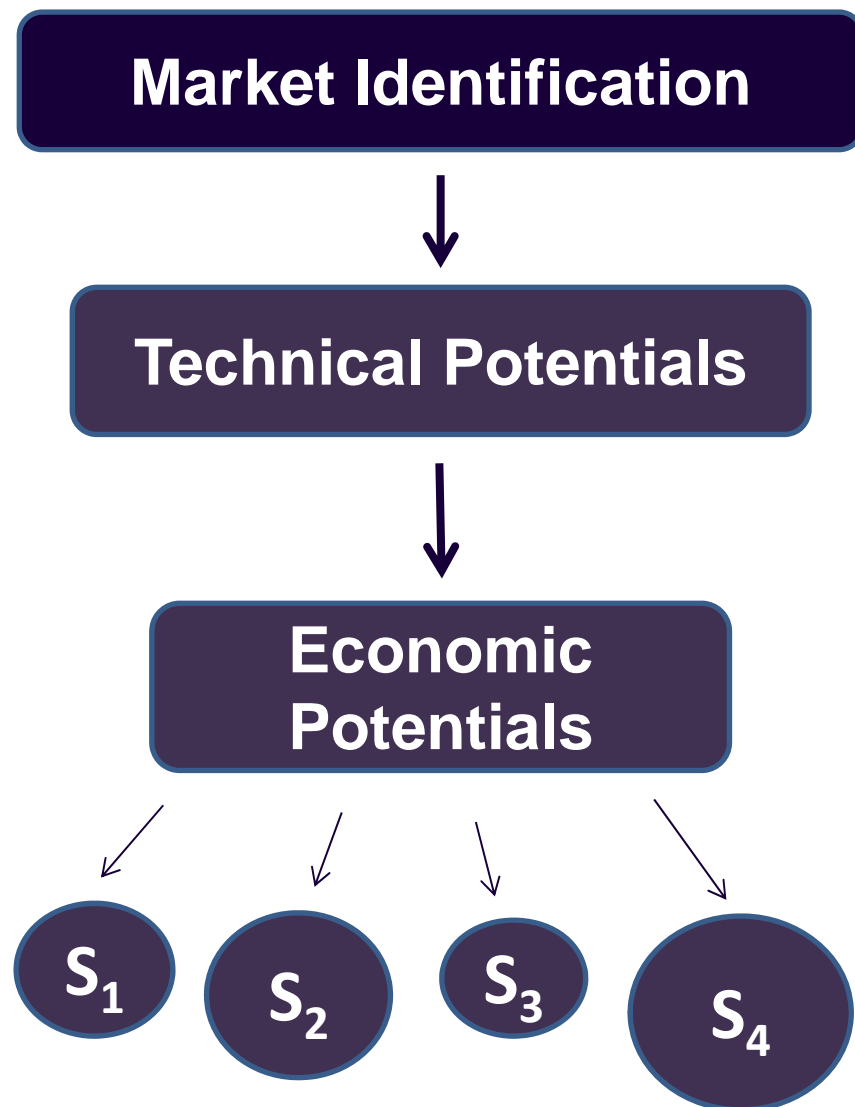
The empirical model utilized to examine the opportunities for CHP development is comprised of four primary components:

- 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

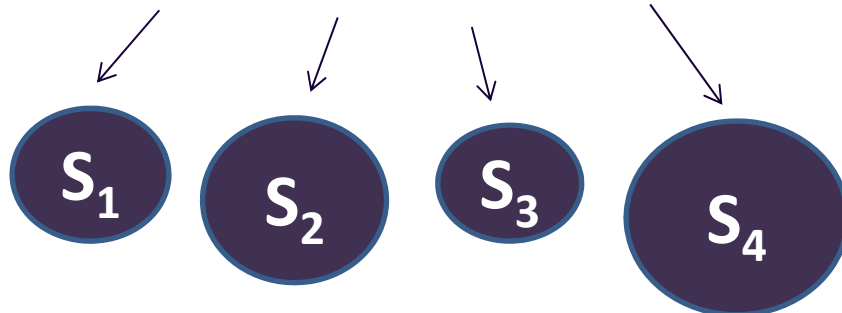
Market Identification



Technical Potentials



Economic Potentials



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

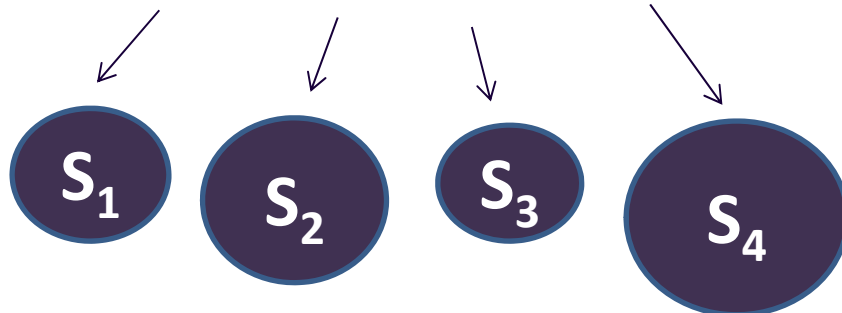
Market Identification



Technical Potentials



Economic 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

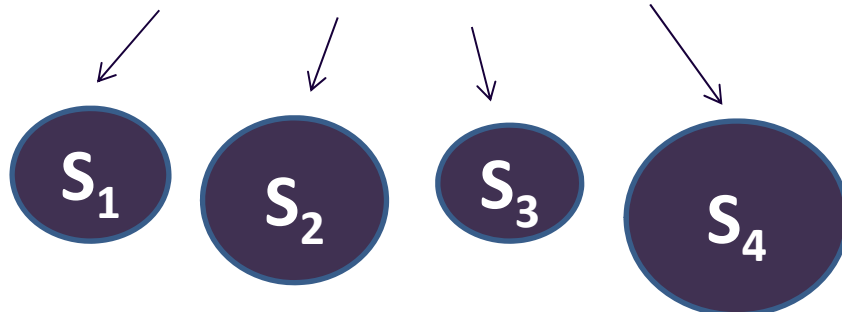
Market Identification



Technical Potentials



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

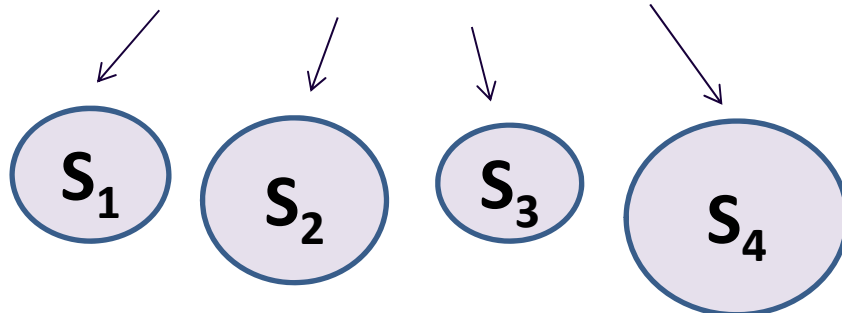
Market Identification



Technical Potentials



Economic Potentials



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

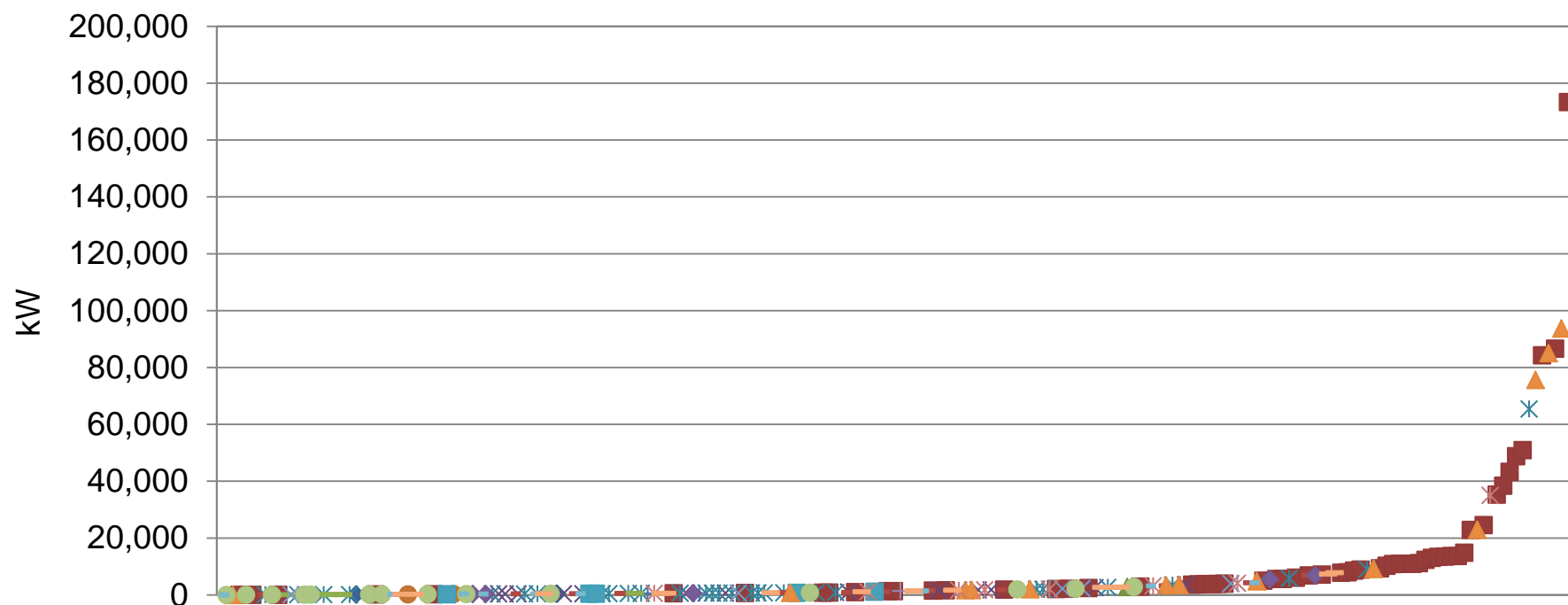
The 209 candidate facilities total 1,480 MW in demand. While the chemical and refining sectors make up just 34 percent of the number of facilities (72 out of 209), the demand for these sectors account for over 80 percent (1,198 MW out of 1,478 MW).

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.

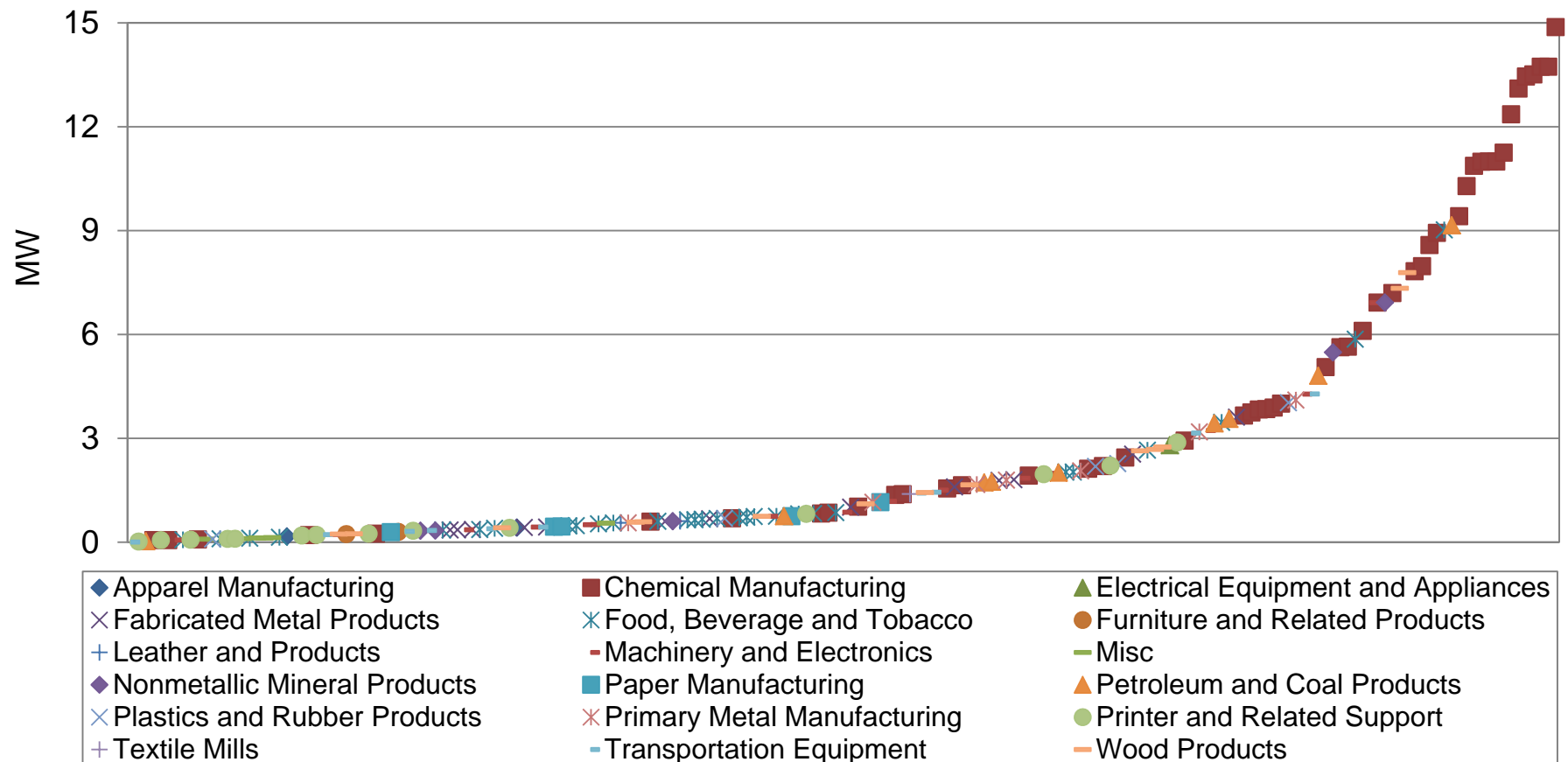


- ◆ Apparel Manufacturing
- × Fabricated Metal Products
- + Leather and Products
- ◆ Nonmetallic Mineral Products
- × Plastics and Rubber Products
- + Textile Mills
- Chemical Manufacturing
- × Food, Beverage and Tobacco
- Machinery and Electronics
- Paper Manufacturing
- × Primary Metal Manufacturing
- Transportation Equipment
- ▲ Electrical Equipment and Appliances
- Furniture and Related Products
- Misc
- ▲ Petroleum and Coal Products
- Printer and Related Support
- Wood Products



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

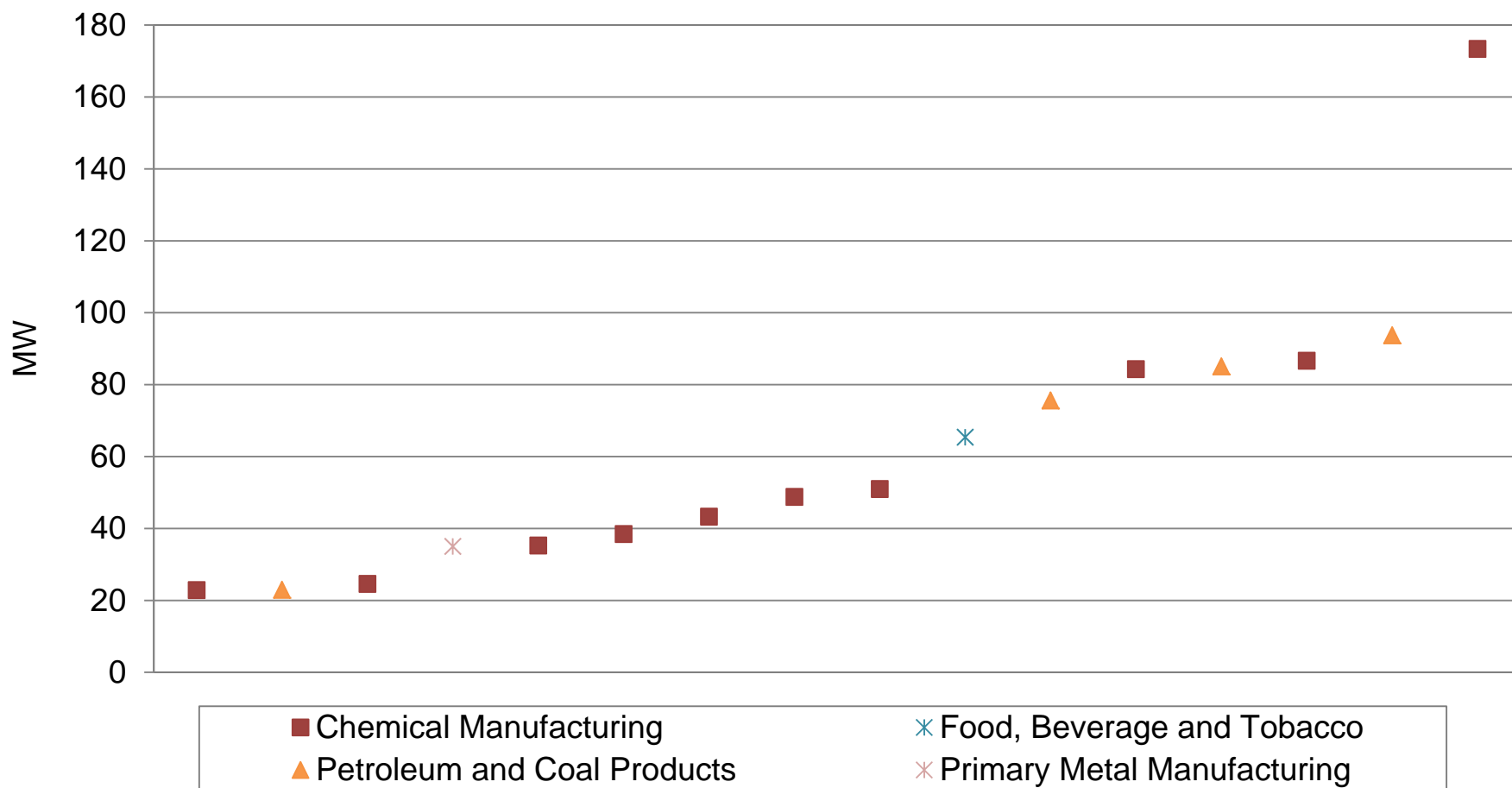
Limiting the analysis to small-scale CHP candidate sites (those with less than 15 MW of demand) highlights the fact that all manufacturing sectors have potential locations; and small-scale chemical manufacturing dominates these potential locations. Further, the distribution of small scale facilities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

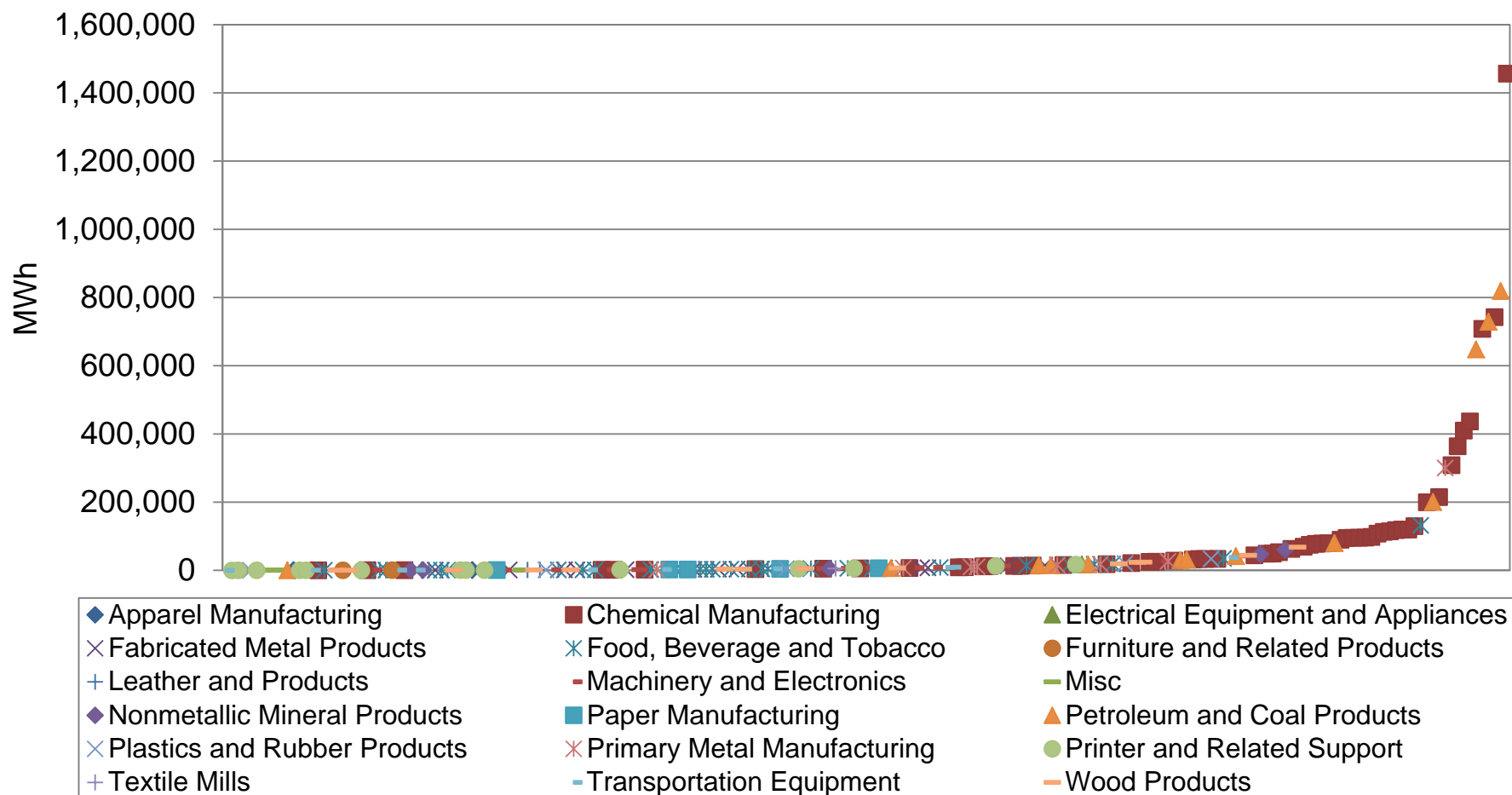
The 209 candidate facilities use over 11 million MWh of electric energy. The chemical and refining sectors account for 84 percent of estimated total manufacturing electric use.

NAICS Category	Number of Facilities	Electric Use	Minimum Electric Use (MWh)	Maximum Electric Use	Average Electric Usage
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

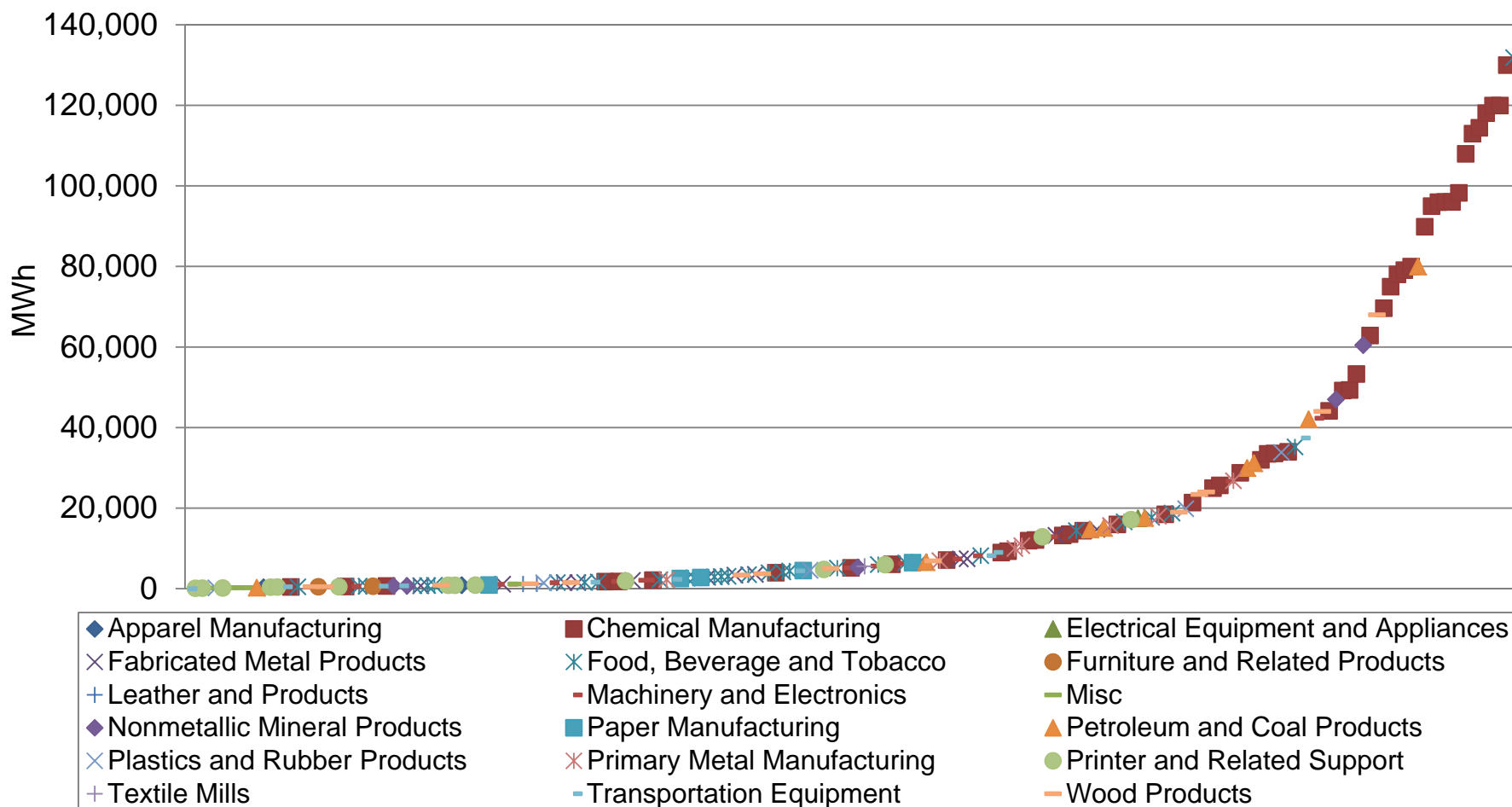
The estimated electric usage from candidate CHP locations is estimated to range from 7 MWh to over 1.4 million MWh. Chemical manufacturing facilities, which dominate the CHP candidate facility estimates, range from as small as 459 MWh to almost 1.46 MWh.





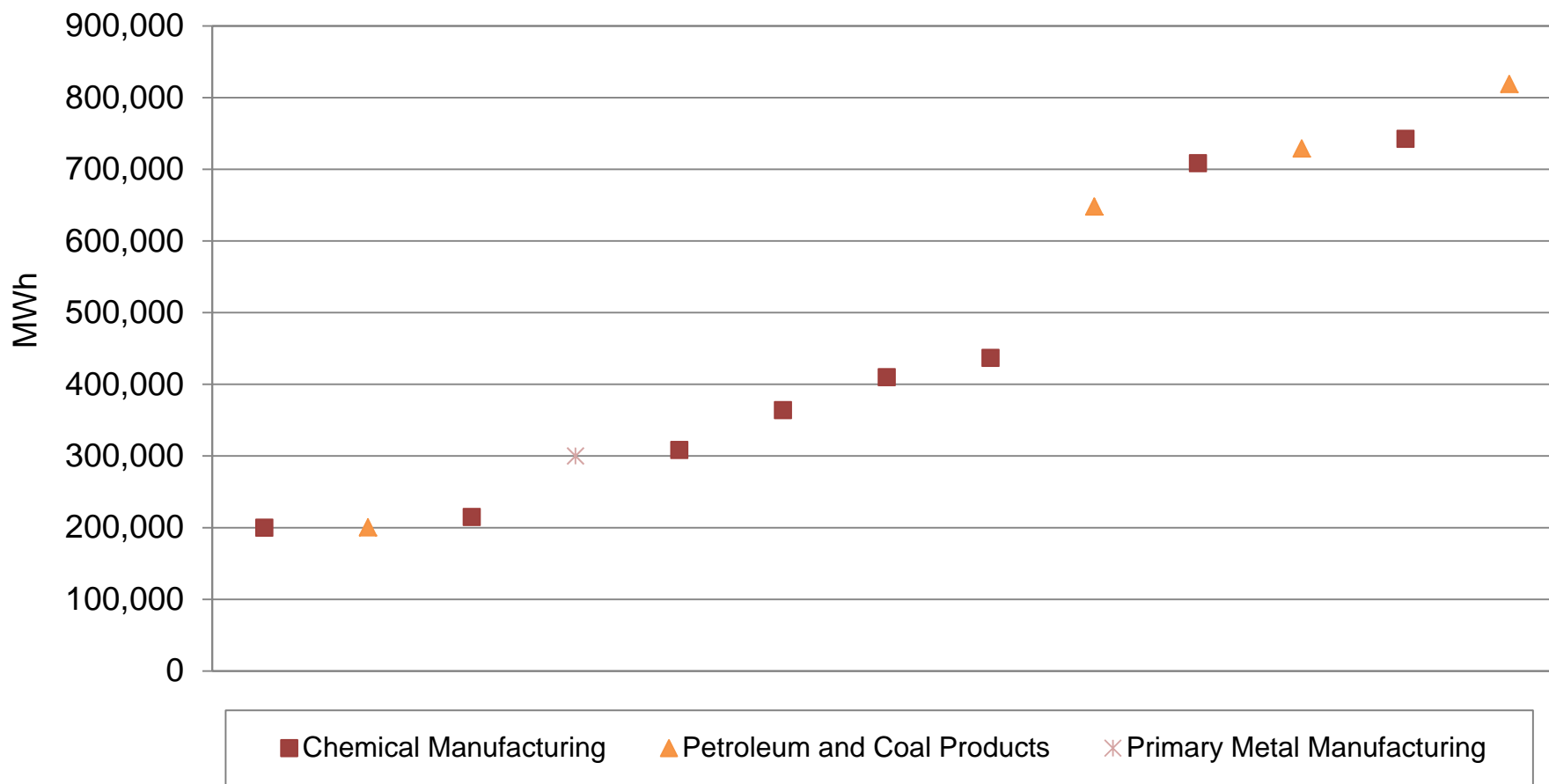
Distribution of Potential Louisiana CHP Market, Electricity Usage (< 140,000 MWh)

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.

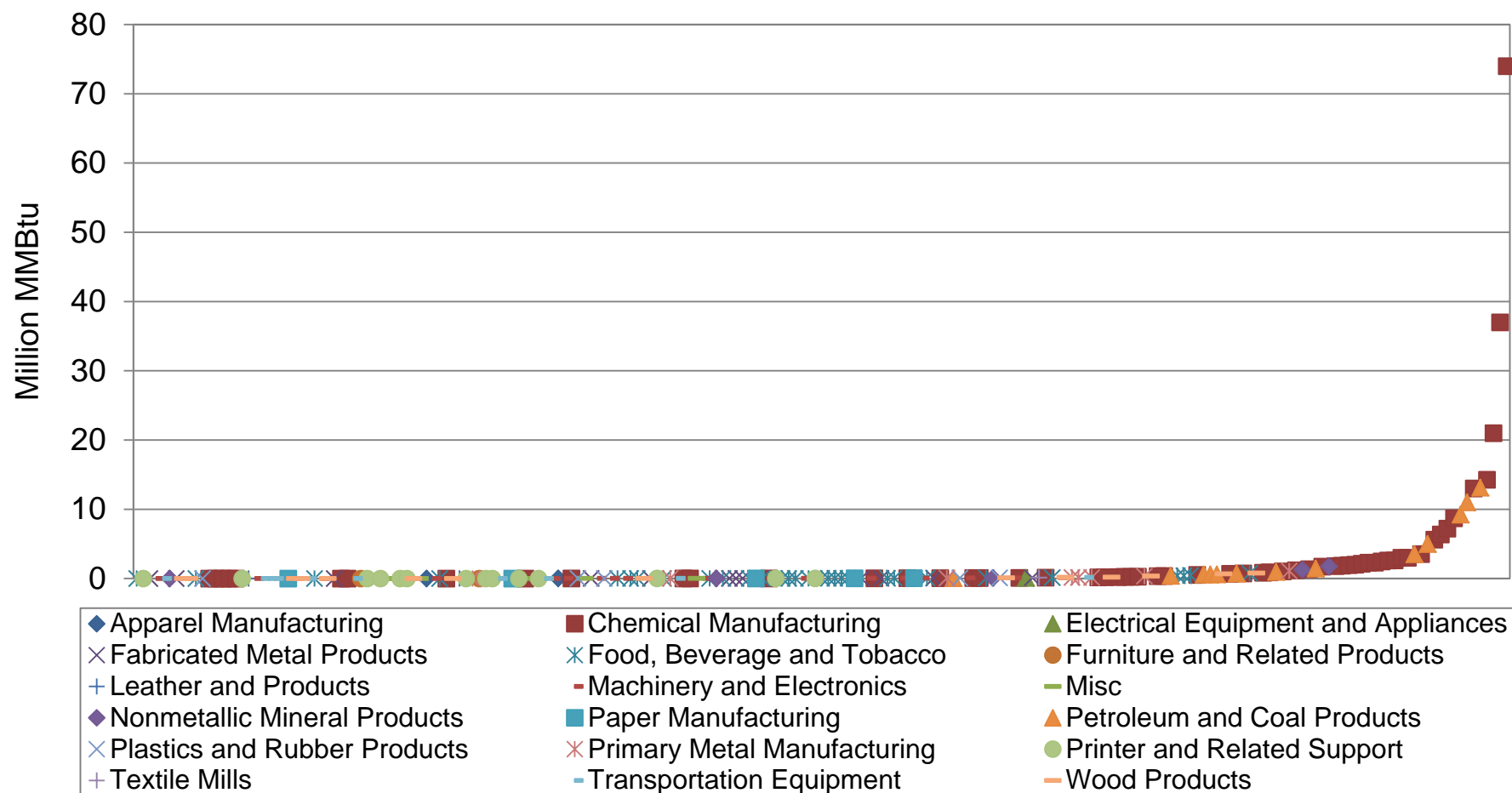
NAICS Category	Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
----- (MMBtu) -----					
311-312 Food, Beverage and Tobacco	30	2,695,088	-	770,400	89,836
313-314 Textile Mills	1	125,282	125,282	125,282	125,282
315 Apparel Manufacturing	2	5,382	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

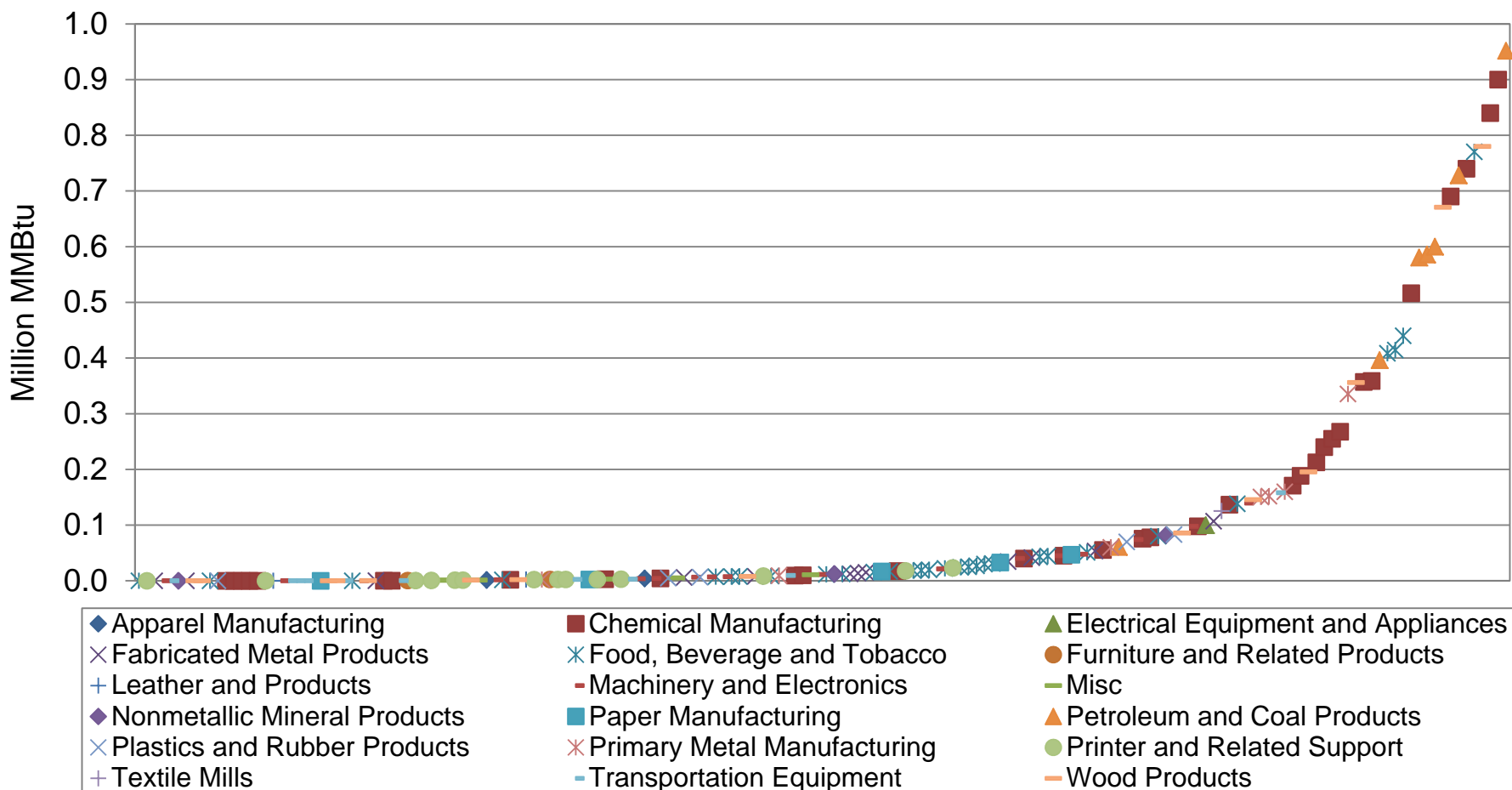
Estimated thermal energy use for the candidate CHP locations ranges from zero to 74 million MMBtu. Most of the larger thermal energy users are associated with chemical and refining manufacturing.





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.





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
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
324 Petroleum and Coal Products	11	1,904,636	-	219,538	-	17,793,514	25,173,321
325 Chemical Manufacturing	42	6,322,795	150,543	741,598	17,657	100,566,995	127,951,718
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

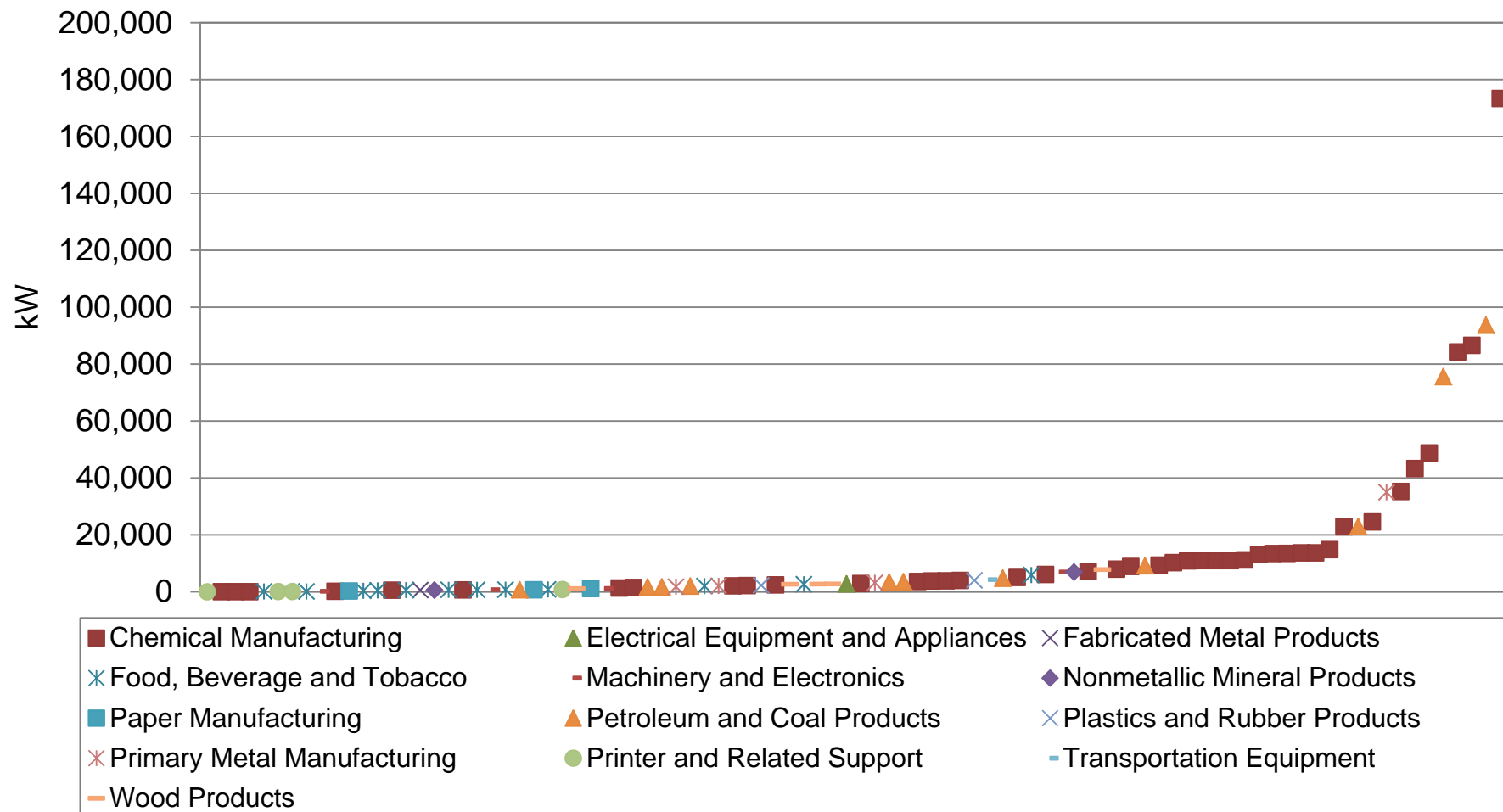
The 92 locations estimated to have the technical potential for CHP installation are estimated to utilize 1,069 MW in capacity. The chemical and refining sectors comprise 58 percent of facilities with the technical capability of installing CHP, but 90 percent of the overall load.

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

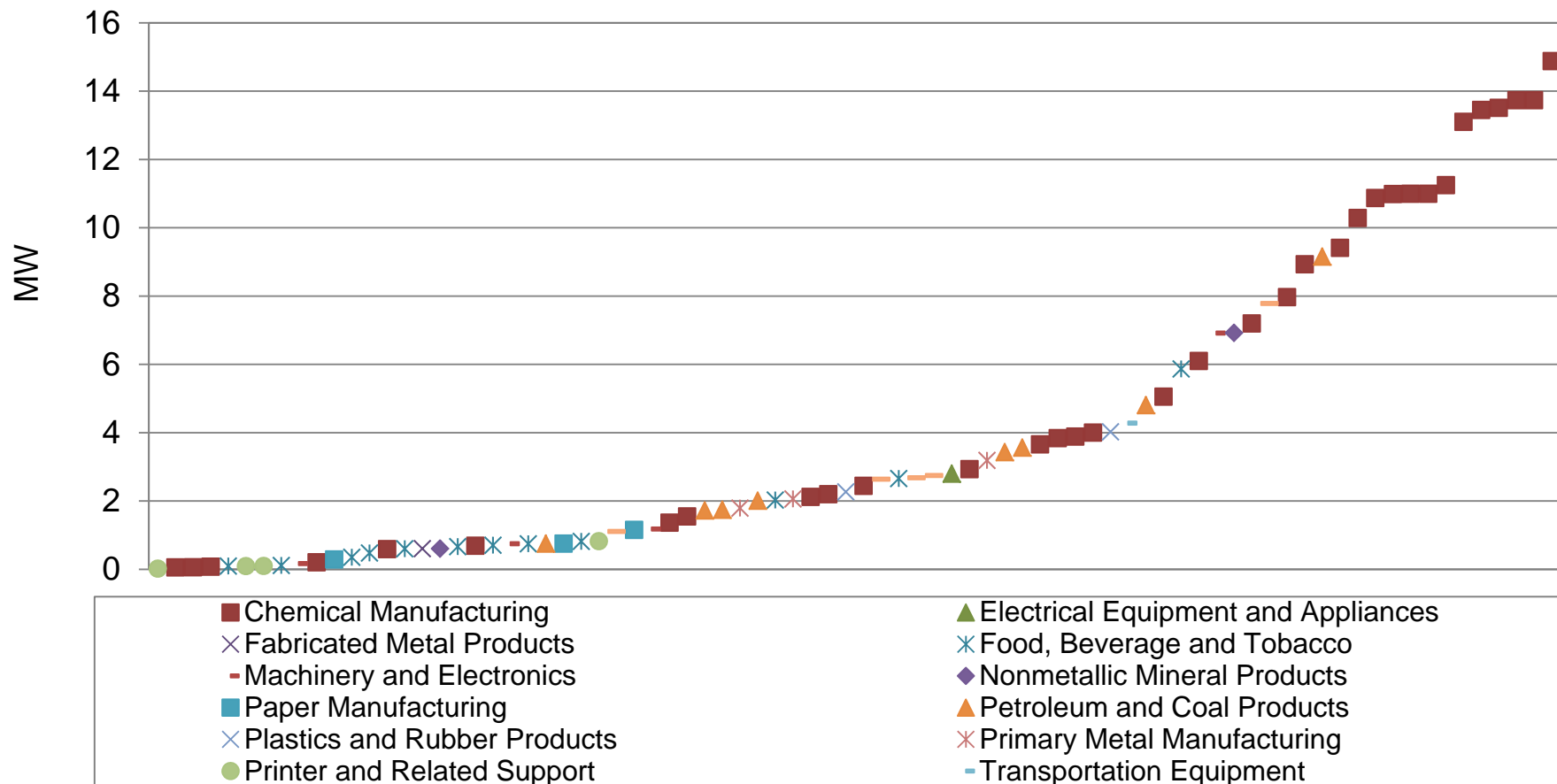
The electrical loads for the facilities with CHP technical potential ranges in size from 22 kW to over 170 MW with the larger loads being associated with chemical manufacturing plants.





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

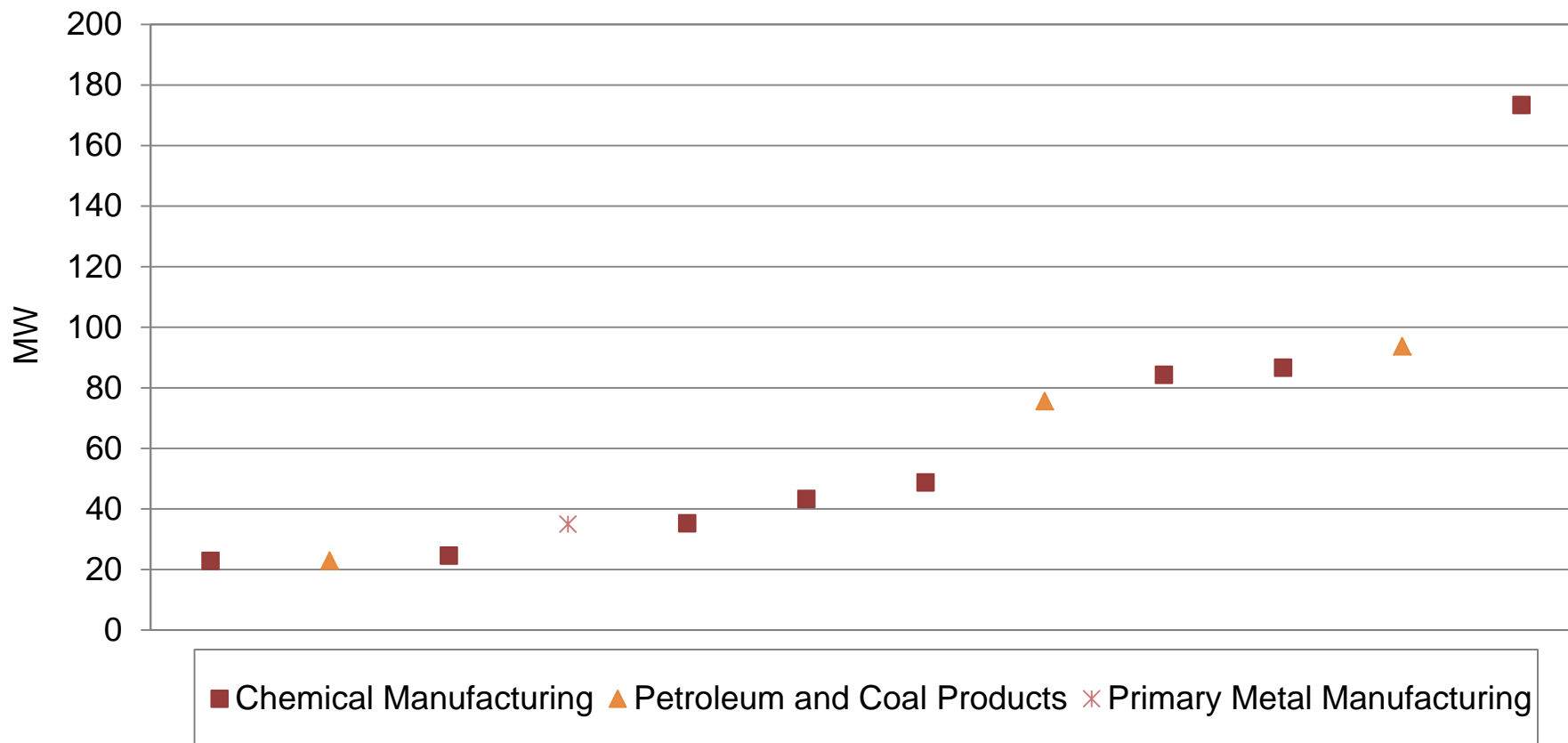
Small-scale CHP facilities (particularly those with less than 10 MW of demand) include those from a wide range of manufacturing sectors. Chemical manufacturing facilities dominate the small-scale technical potentials in the 6 MW to 15 MW range.





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

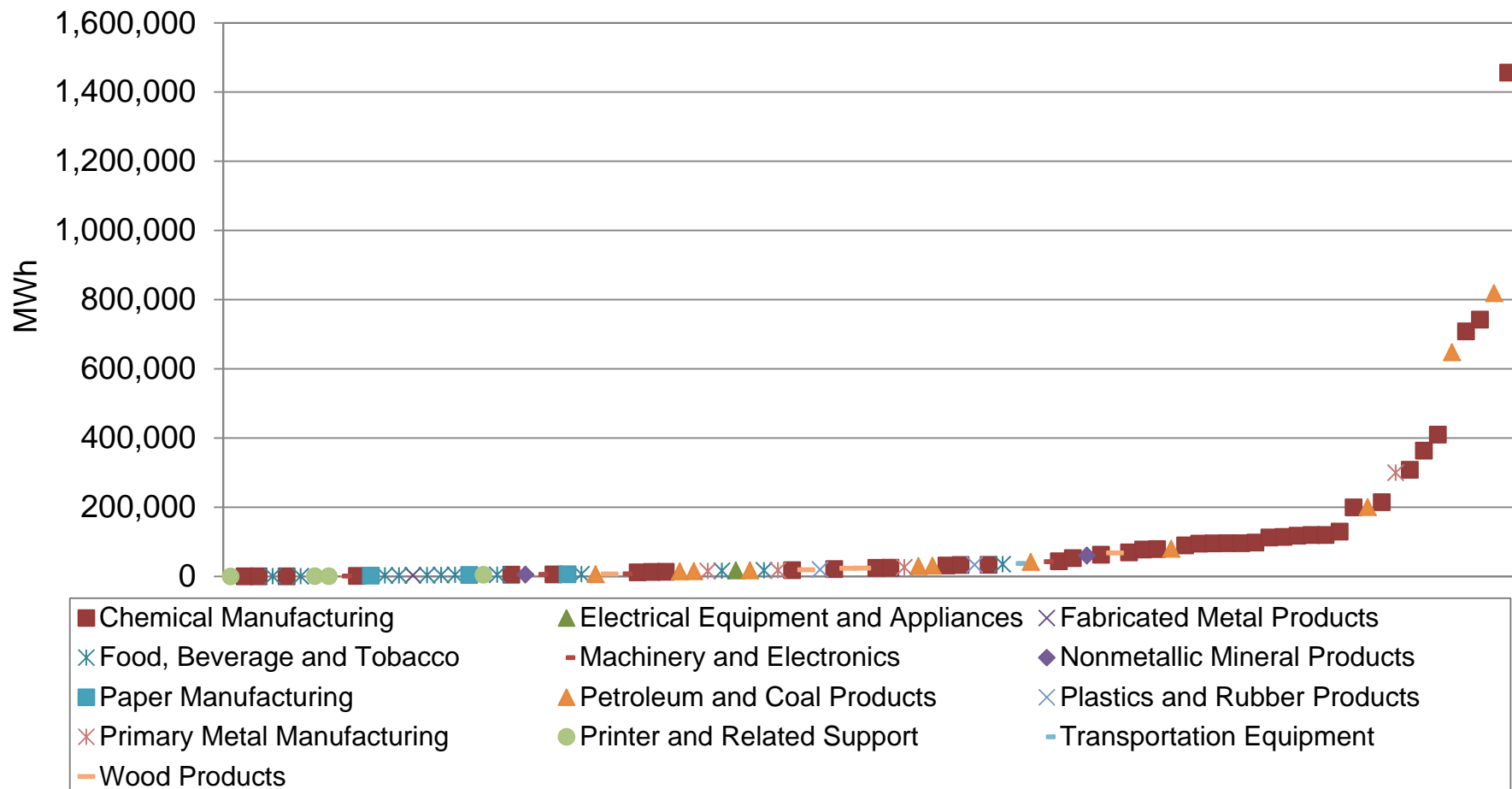
The 92 facilities passing the technical potentials screen are estimated to use over 9 million MWh. The chemical and refining sectors account for 91 percent of total electric use for the facilities passing the technical potentials screen.

NAICS Category	Number of Facilities	Electric Use	Minimum Electric Use (MWh)	Maximum Electric Use	Average Electric Usage
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

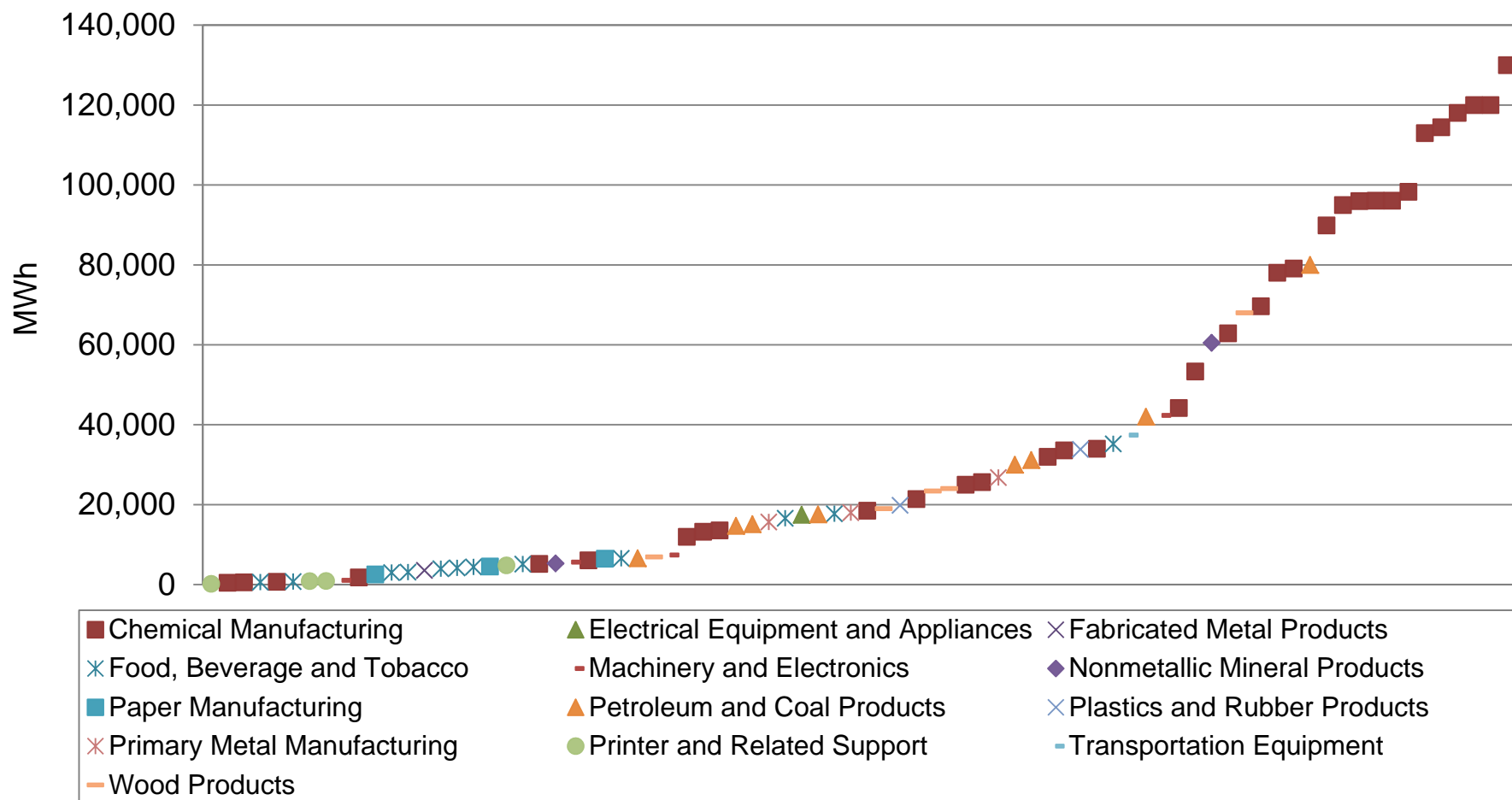
Facilities that pass the technical potentials screen are estimated to use from 200 MWh to 1.4 million MWh in electricity. Most of the larger electrical energy users passing the technical screen are in the chemical sector.





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

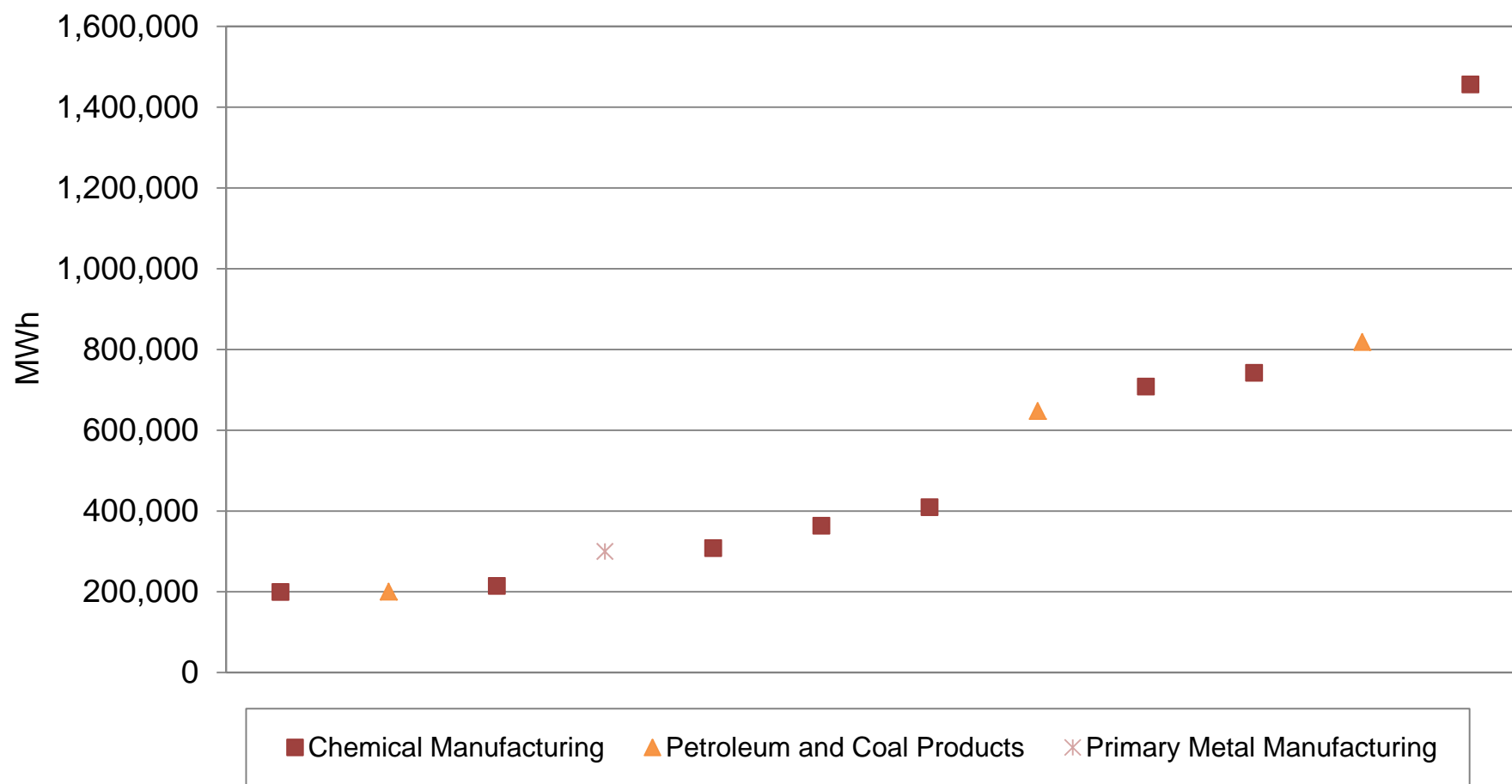
Limiting the distribution to facilities with less than 140,000 MWh shows that all of the remaining sectors are represented, with the majority of facilities using less than 40,000 MWh. Chemical manufacturing facilities dominate the facilities from 40,000 MWh to 140,000 MWh.





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.

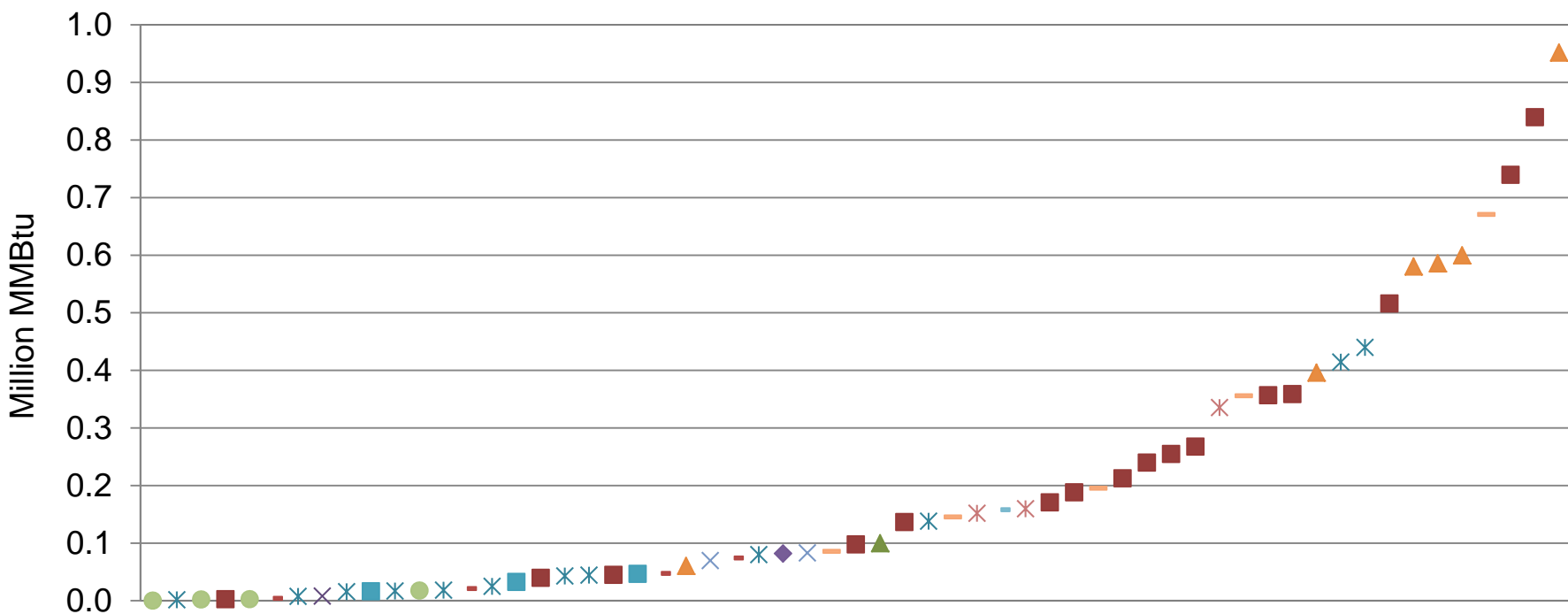
NAICS Category	Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
		----- (MMBtu) -----			
311-312 Food, Beverage and Tobacco	12	1,245,319	1,725	440,000	103,777
313-314 Textile Mills	-	-	-	-	-
315 Apparel Manufacturing	-	-	-	-	-
321 Wood Products	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 (< 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.



- Chemical Manufacturing
- ▲ Electrical Equipment and Appliances
- ✕ Fabricated Metal Products
- ✕ Food, Beverage and Tobacco
- Machinery and Electronics
- ◆ Nonmetallic Mineral Products
- Paper Manufacturing
- ▲ Petroleum and Coal Products
- ✕ Plastics and Rubber Products
- ✕ Primary Metal Manufacturing
- Printer and Related Support
- Transportation Equipment
- Wood Products



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%



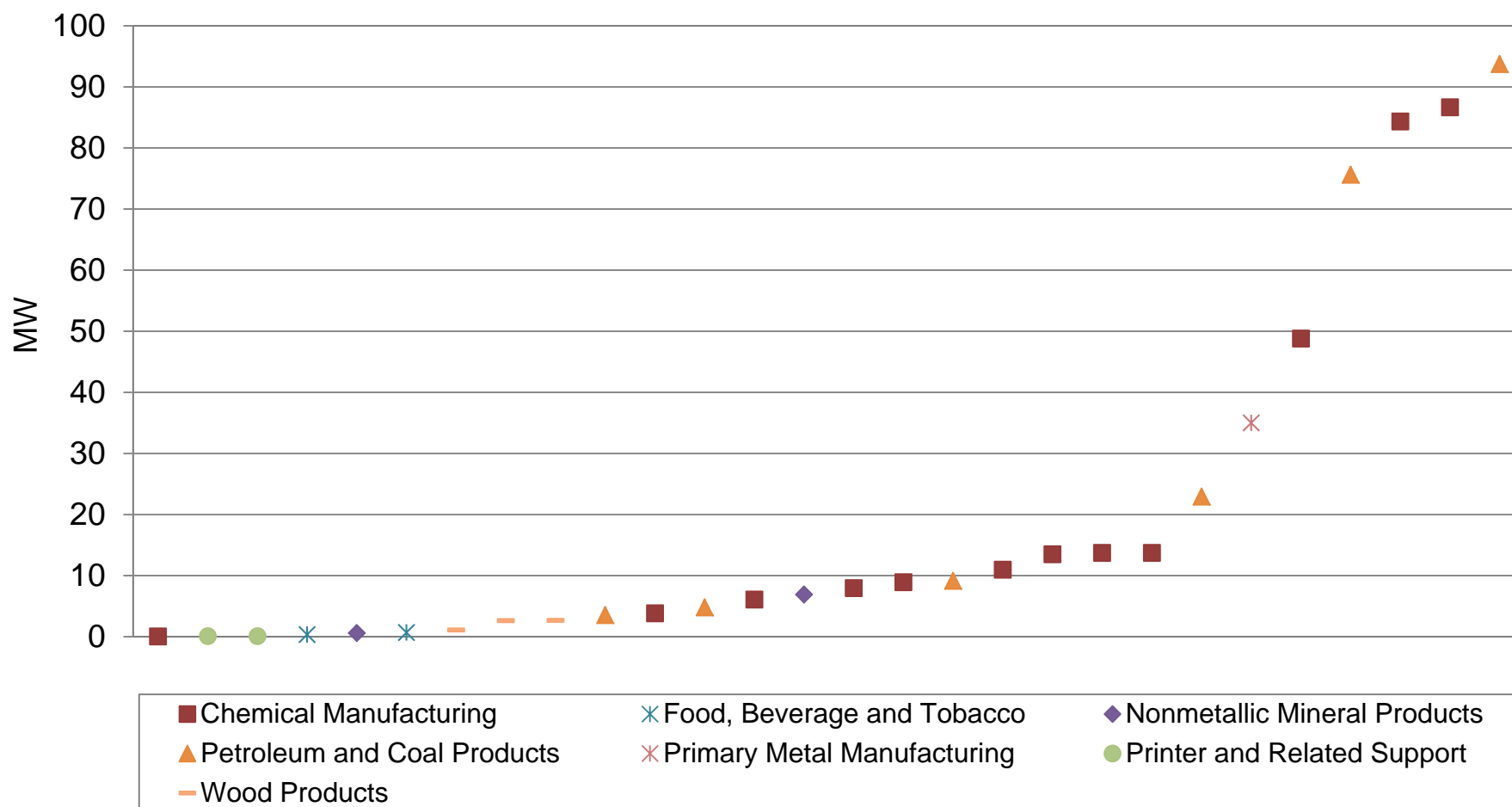
Estimated Louisiana CHP Economic Potentials, Electric Demand

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

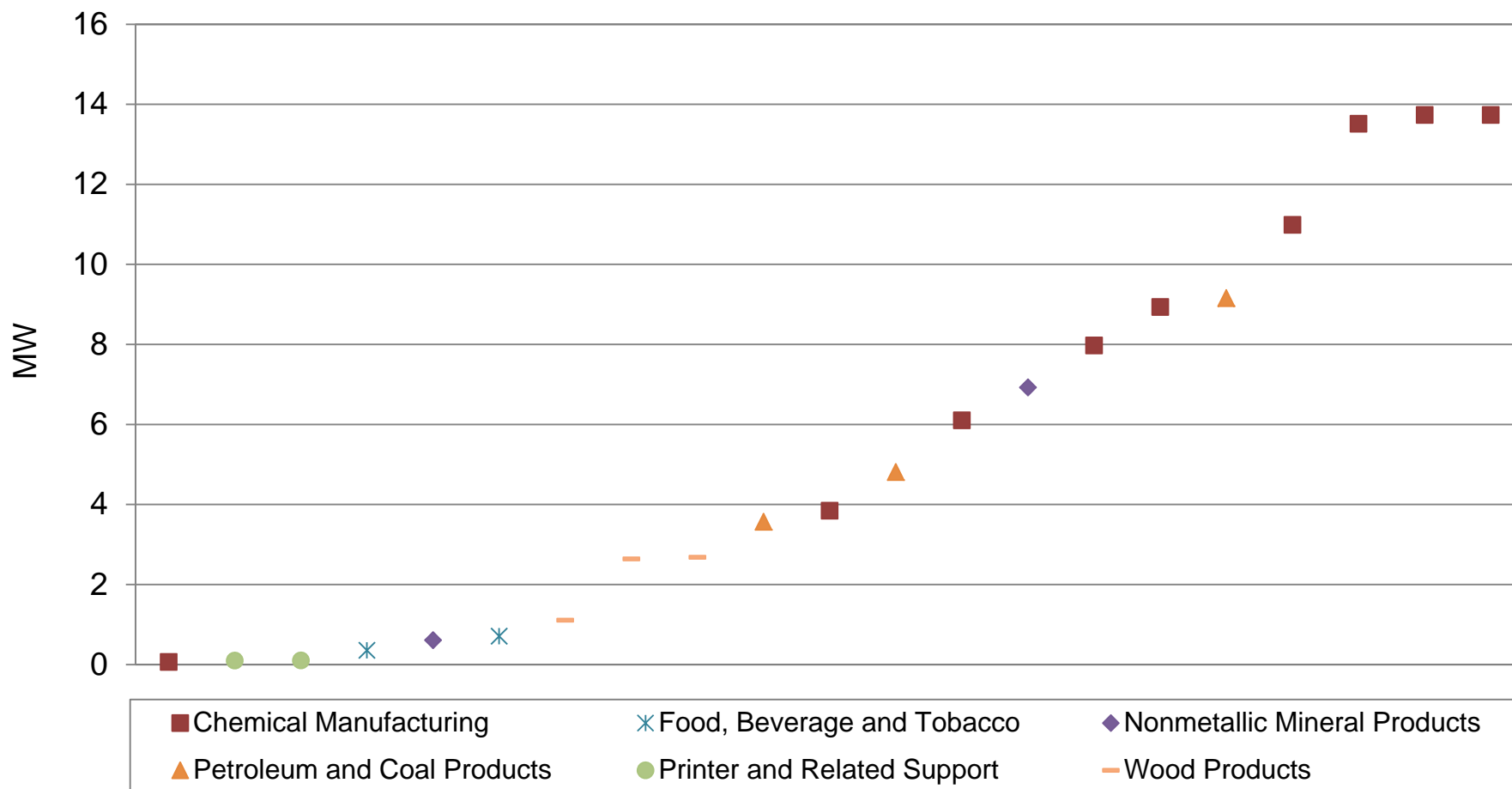
The load associated with facilities with cost-effective CHP potential ranges from 65 kW to 94 MW. With the exception of one primary metals facility, all of the facilities over 7 MW are from the chemical and refinery sectors.





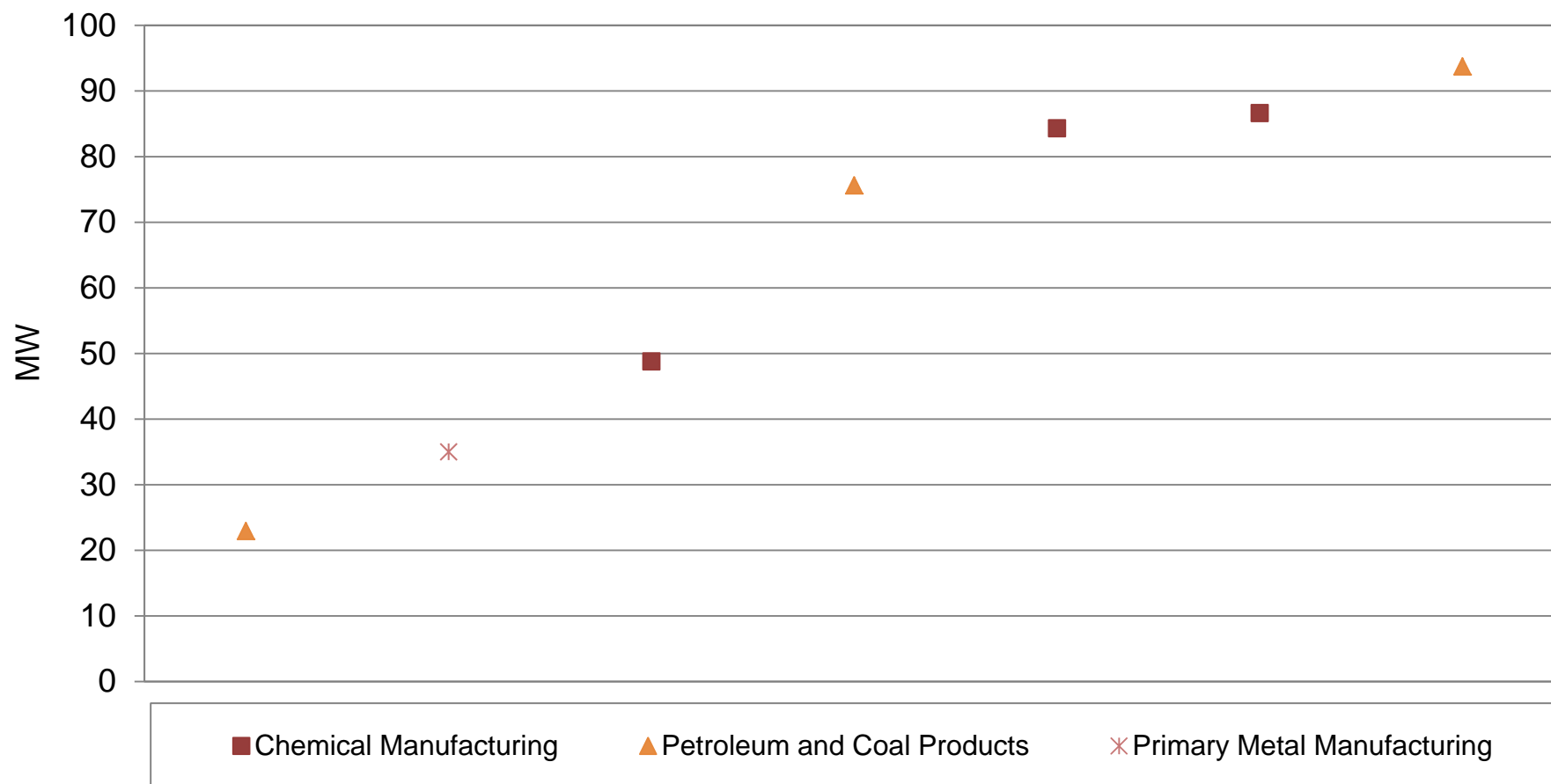
Distribution of Estimated Louisiana CHP Economic Potentials, Electric Demand (< 15 MW)

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

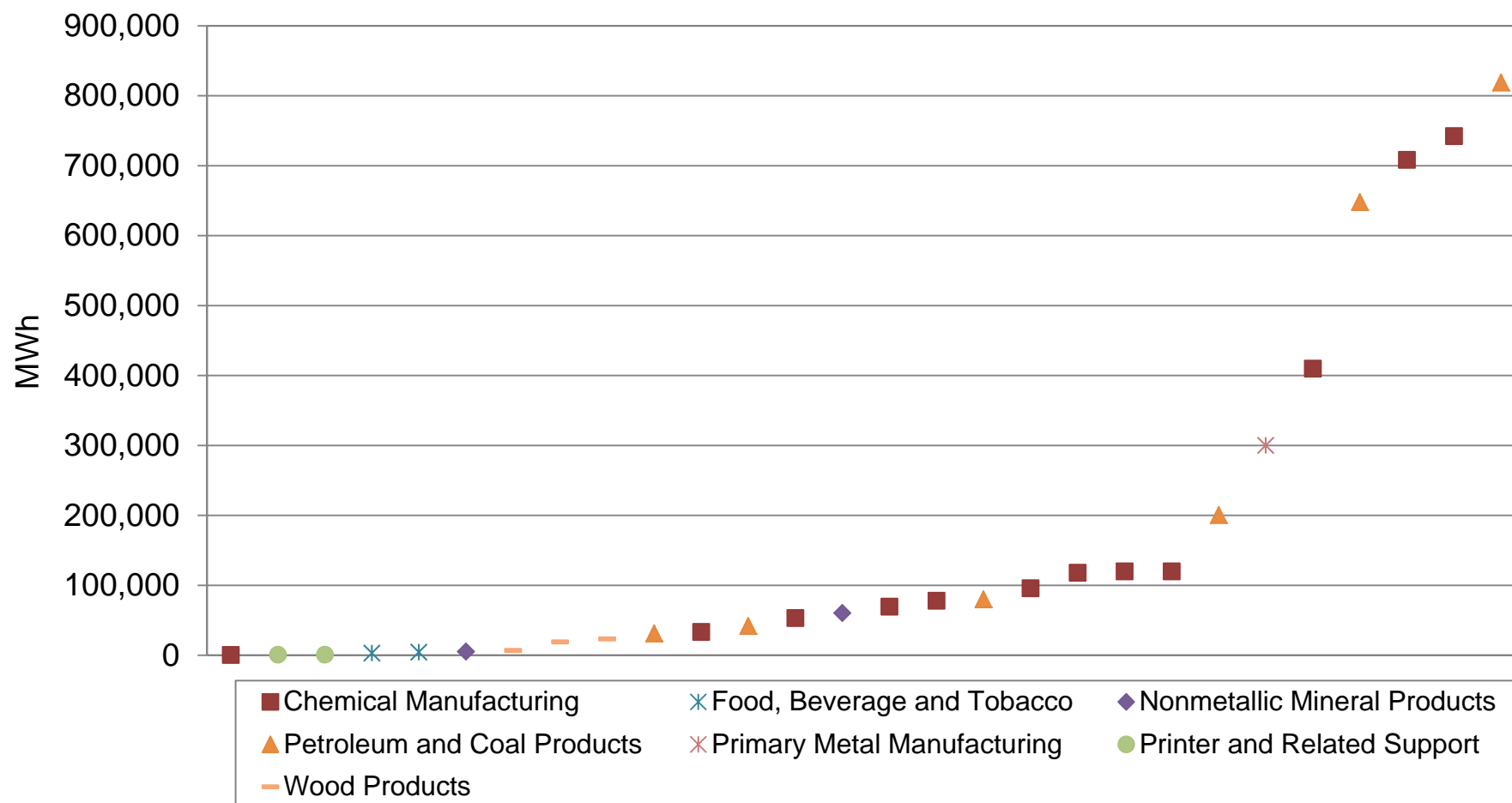
The 92 facilities estimated to have cost-effectiveness potential are estimated to use almost 4.8 million MWh. The chemical and refining sectors account for 91 percent of total electric use.

NAICS Category	Number of Facilities	Electric Use	Minimum Electric Use	Maximum Electric Use	Average Electric Usage
		----- (MWh) -----			
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

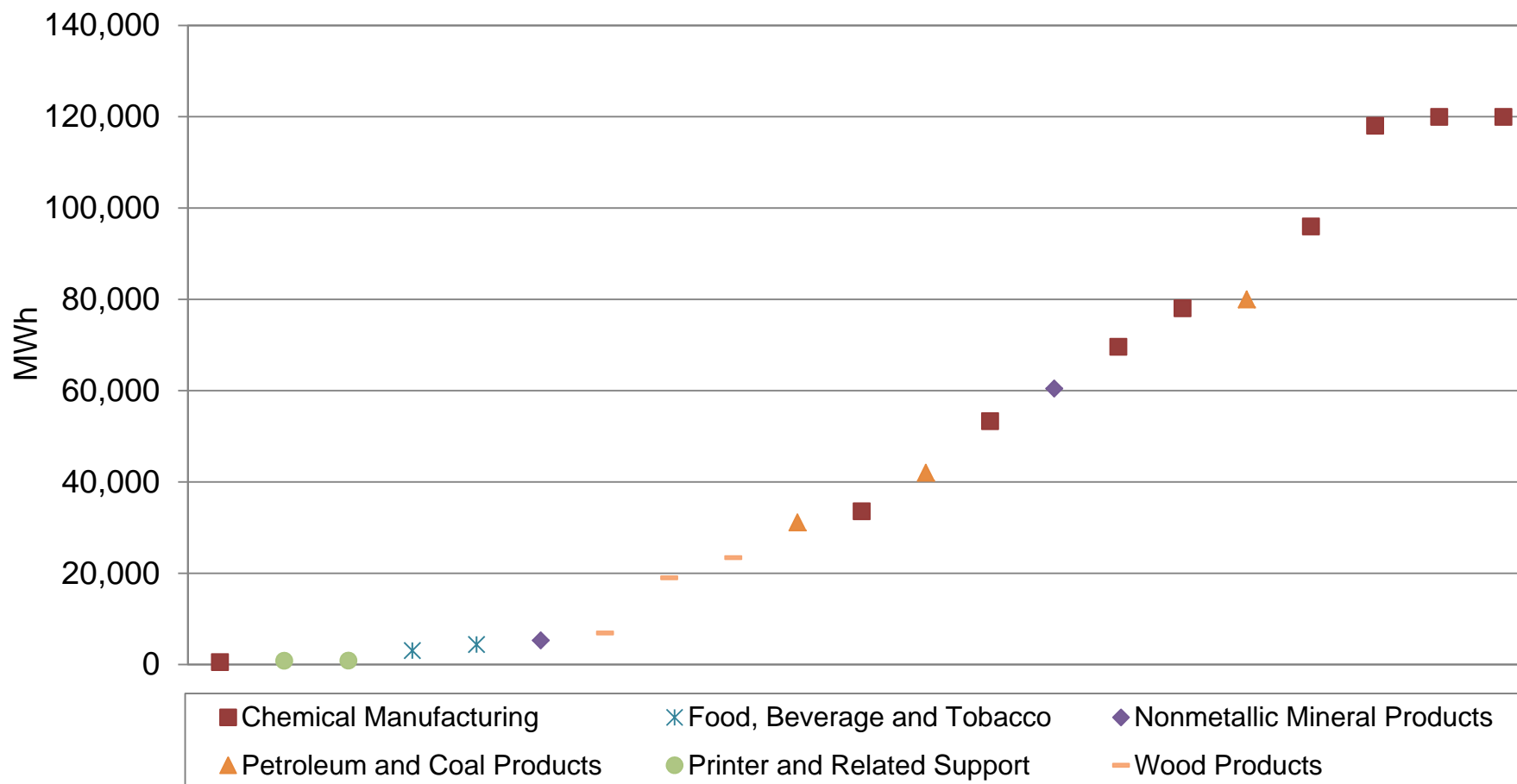
Electricity usage at facilities estimated to have cost-effective CHP potential are also estimated to use from between 571 MWh to almost 820 million MWh of electricity.





Distribution of Estimated Louisiana CHP Economic Potentials, Electricity Usage ($\leq 120,000$ MWh)

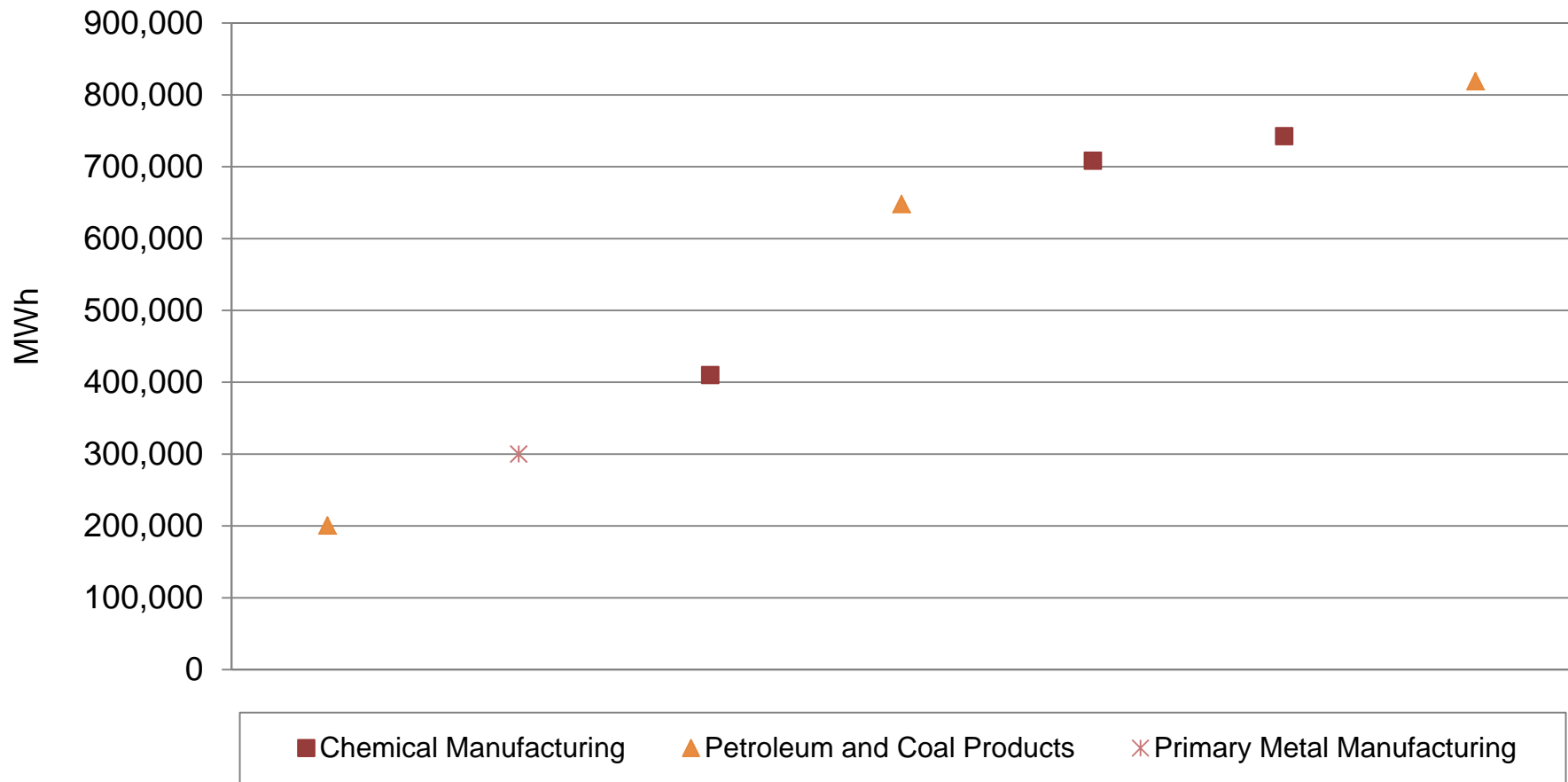
Smaller electric use facilities with CHP cost-effectiveness potentials span a number of industrial sectors but are heavily dominated by the chemical manufacturing sector.





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.

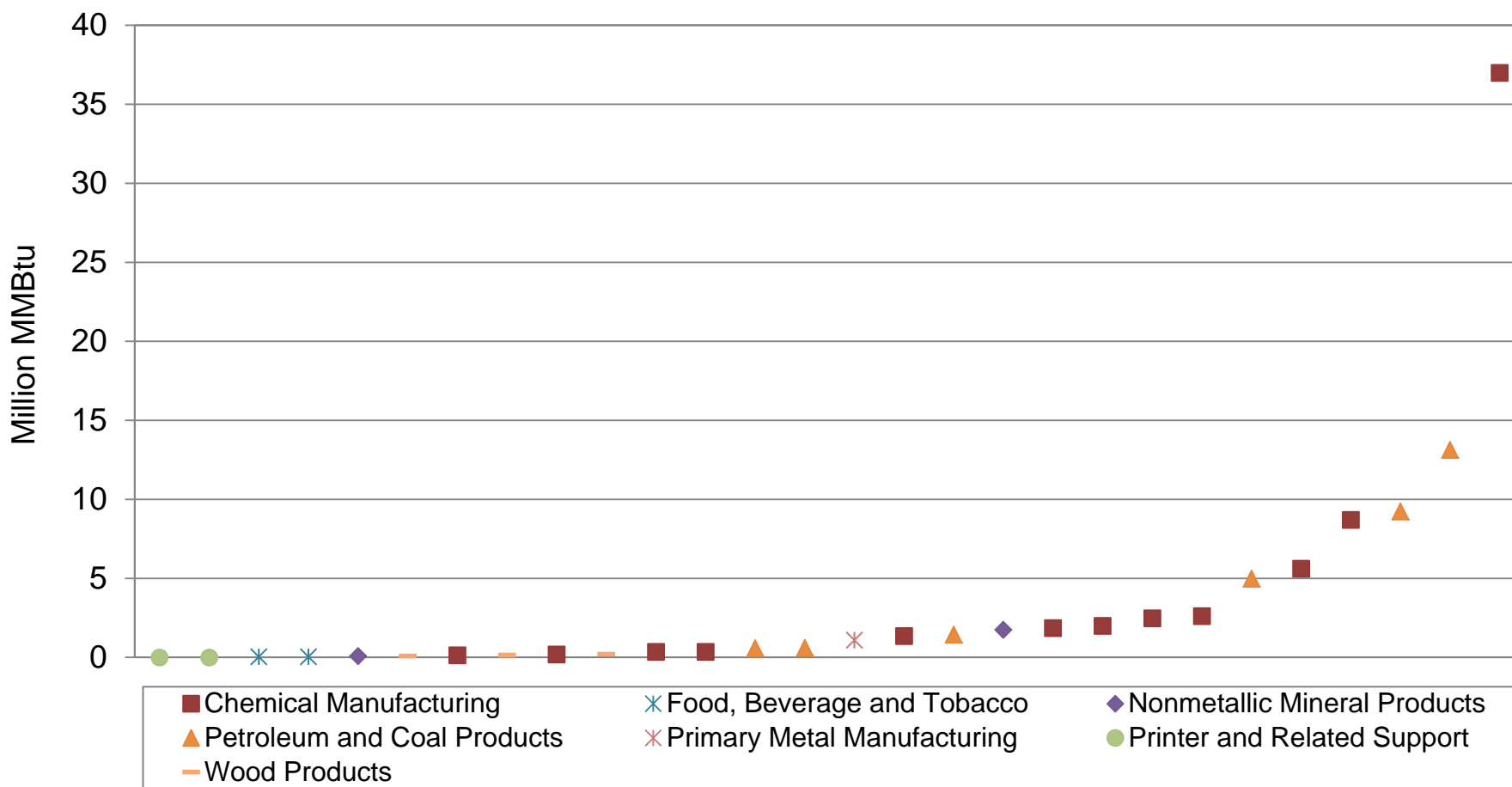
NAICS Category	Number of Facilities	Total Thermal Usage	Minimum Thermal Usage	Maximum Thermal Usage	Average Thermal Usage
		----- (MMBtu) -----			
311-312 Food, Beverage and Tobacco	2	87,467	43,072	44,395	43,733
313-314 Textile Mills	-	-	-	-	-
315 Apparel Manufacturing	-	-	-	-	-
321 Wood Products	3	426,848	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

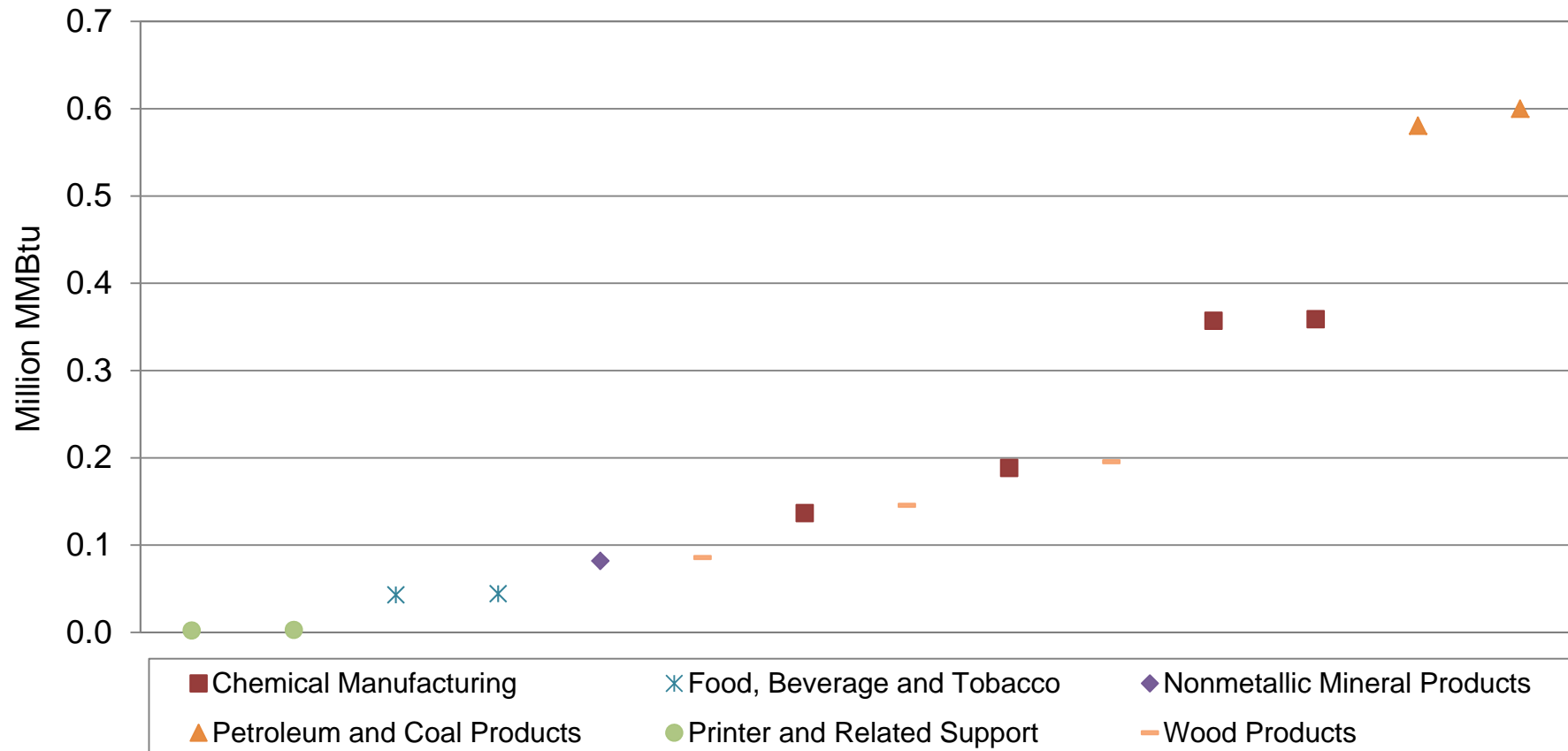
The facilities estimated to have cost-effective CHP installation potential are estimated to utilize thermal energy ranging between 2,400 MMBtu and 37 million MMBtu.





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

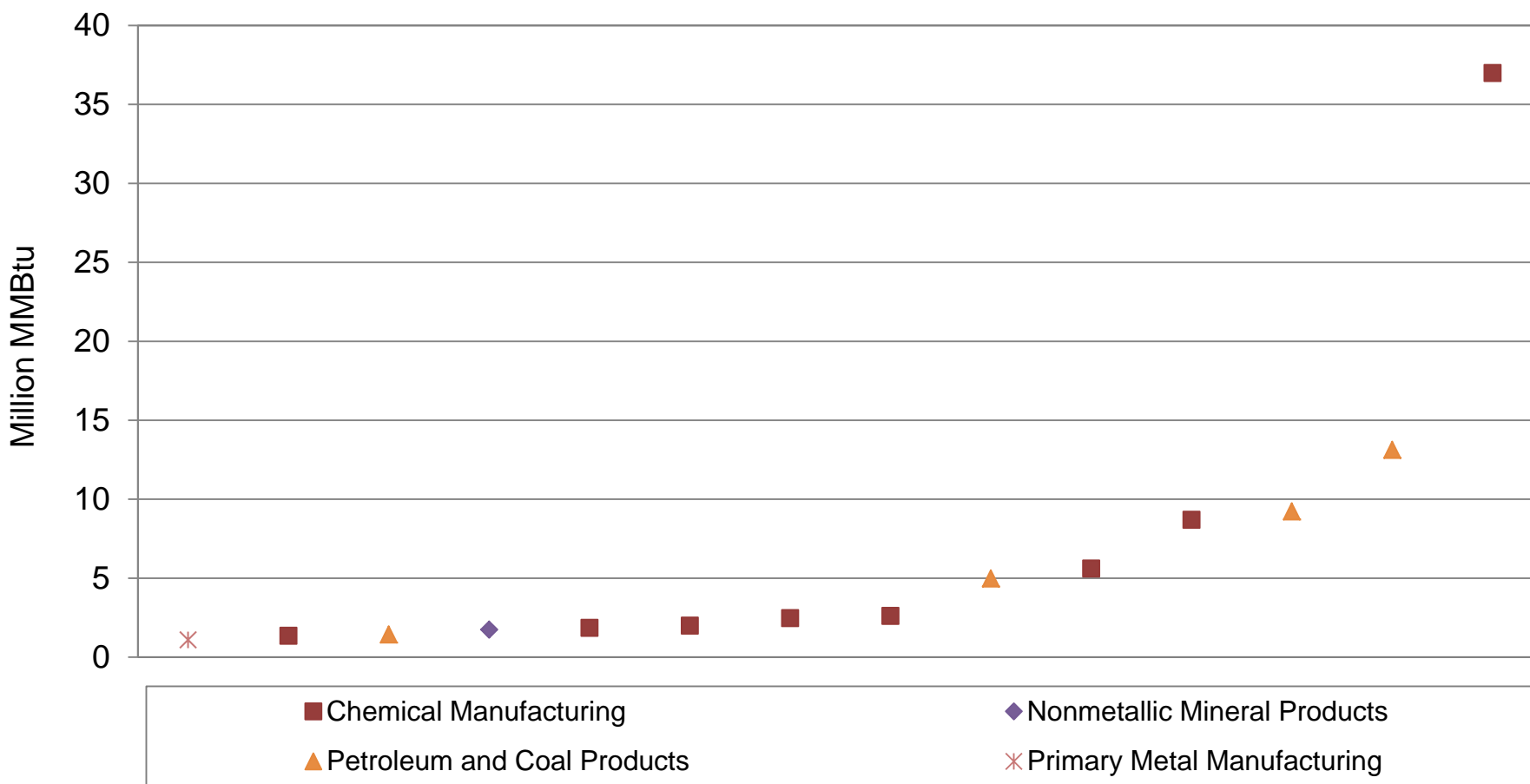
The smaller thermal energy users with estimated cost-effectiveness potential represent six different manufacturing sectors.





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)							
	Existing	Market Identification	Technical Potential	Baseline	Cost Effective			
					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 (%)							
	Existing	Market Identification	Technical Potential	Baseline	Cost Effective			
					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.