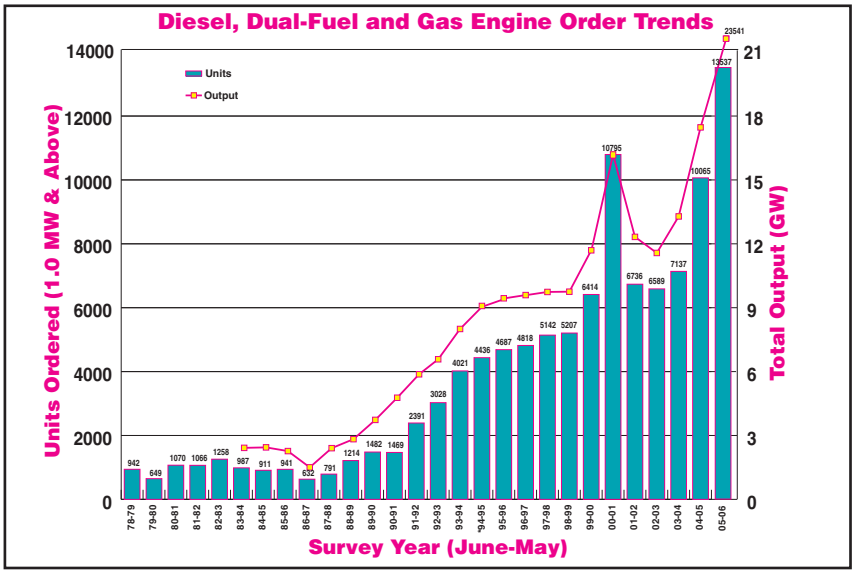
2006

30th POWER GENERATION ORDER SURVEY

DIESEL & GAS TURBINE WORLDWIDE
The Marine and Stationary Power Authority

BY MARK MCNEELY



Red Hot Recip Market

Reciprocating engine orders up by 8600 units, gas turbine order output grows to 42 GW

Editors Note: *For a second year this annual survey reports data on a smaller category of engine output (0.5 to 1.0 MW) – the range of reciprocating engines from 500 to 1000 kW. The next higher category, therefore, technically begins at 1.01 MW. The historical (graphic) representation of reciprocating engine orders and outputs will still begin at 1.0 MW. This year's survey analysis, however, will now include this new information, as we have two years of data.*

If last year's survey noted that "it's a good time to be a manufacturer of larger piston engines," then this year it has to be exclaimed that it's a great time to be a manufacturer of larger piston engines. Only one region — the Far East — showed any decline in reported engines, while the rest of the world demonstrated the resounding strength of the power generation industry. Meanwhile, the gas turbine manufacturers seem to have gained some momentum after three years of less than stellar order intake. These are the overall highlights in *Diesel & Gas Turbine Worldwide's* 30th Annual Power Generation Order Survey.

The volume of piston engines above 1.0 MW (13 537) has easily eclipsed the previous record level (10 795) set in the 1999/00 survey timeframe. The order volume for the smaller engines, 500 to 1000 kW, rose to 17 614 engines this year over last year's 12 439 units. Gas turbine engine orders (831) showed an impressive increase over last year's reported figures (697) and the aggregated output total increased by 19% from last year's level.

The geographic disposition of these engines is truly global in reach.

Diesel, dual-fuel and natural gas (including biogas) reciprocating engine orders increased almost beyond comprehension in 2006, after posting near record gains in the 2005 survey period. Of those engines greater than 500 kW, units ordered increased 38% over 2005 reports, while the total output also increased by 40%. Highlighted output categories this year include the 2.01 to 3.5 MW range, which showed a unit order increase of 79%. And while the 10 to 15 MW category declined by 51%, the next higher output range, 15 to 20 MW, demonstrated a unit volume increase of 160%. Finally, the two strongest output categories by volume, including 0.5 to 2.0 MW, reflected a combined increase of 37% over 2005. Geographically, all of the major regions in the world reported large increases, with the notable exception of the Far East, which includes Japan and China.

Gas turbine orders are up 19% this year to a total of 831 units, a welcome respite after three years of lower order volumes. Correspondingly, gas turbine output increased by 20% over 2005 to a total of over 42 GW. Several output categories showed positive gains this year, including 10 to 20 MW (up 143%), 30 to 60 MW (up 88%) 120 to 180 MW (up 21%) and 180+ MW (up 11%). When taken geographically, most of the major regions of the world showed increases in gas turbine orders, with the notable exception of North America.

Procedures

This survey's coverage again includes reciprocating engines starting at 500 kW. Gas turbine orders received for power generation remain rated 1.0 MW and above. This survey encompasses a one-year period from June 1, 2005, through May 31, 2006. Also shown in the data tables are the previous year's survey results for reference and comparison purposes.

As in previous years, our report on orders for marine mechanical propulsion, marine auxiliary generation and diesel-electric marine propulsion systems will be featured in our forthcoming November issue. Also, an inaugural Mechanical Drive Order Survey will be featured in the December issue, as well as in our sister publication COMPRESSORTechTwo.

The accompanying list of participants contributing to this worldwide survey is much the same as in the recent past, including contributed data for the 500 to 1000 kW category. In the absence of any significant changes from the 2005 survey, these 2006 survey results are comparable on a year-to-year basis for various analyses.

Recip Engines off the Charts

Engine orders for diesel, dual-fuel and natural gas engine generating systems totaled 31 151 units, a 38% increase in activity over the 22 504

DIESEL, DUAL-FUEL AND GAS ENGINE ORDERS, June 2005 – May 2006

Output Range (MW)	Units Ordered	Total Engine Output (MW)	Type of Generating service			Fuel				Western Europe	Eastern Europe & Russia	Middle East	Far East	Southeast Asia / Australia	Central Asia	North Africa	Central, W., E., and S. Africa	North America	Central America and Caribbean	South America
			Stand-by	Peak-ing	Contin-uous Duty	Diesel Fuel	Heavy Fuel	Dual-Fuel	Nat. Gas											
0.50-1.0	17 614	11 840	11 315	1490	4809	16 608	13	12	981	3735	312	2378	2026	1341	2163	5	344	4466	570	274
1.01 to 2.0	11 257	15 403	6298	1280	3679	9765	285	0	1207	2430	180	1016	1610	1181	616	11	182	2827	1075	129
2.01 to 3.5	1778	4226	810	155	813	1269	209	1	298	433	60	150	77	91	29	1	35	659	220	23
3.51 to 5.0	147	574	4	1	142	43	67	3	34	35	9	3	13	24	6	1	5	3	47	1
5.01 to 7.5	129	758	4	10	115	35	15	4	75	22	6	10	51	15	10	4	3	1	5	3
7.51 to 10	151	1303	0	0	151	1	70	0	80	4	58	30	4	5	11	0	4	0	34	1
10.01 to 15	14	167	2	0	12	4	10	0	0	2	0	10	0	0	0	0	0	0	2	0
15.01 to 20	60	1067	1	0	59	13	43	4	0	13	0	9	0	2	1	0	8	0	12	15
20.01 to 30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.01 & above	1	43	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Totals	**31 151**	**35 381**	**18 434**	**2936**	**9781**	**27 751**	**713**	**24**	**2675**	**6674**	**625**	**3608**	**3781**	**2659**	**2837**	**22**	**581**	**7956**	**1965**	**446**

DIESEL, DUAL-FUEL & GAS ENGINE ORDERS, June 2004 – May 2005

Output Range (MW)	Units Ordered	Total Engine Output (MW)	Type of Generating Service (Units)			Fuel (Units)				Western Europe	Eastern Europe & Russia	Middle East	Far East	Southeast Asia/ Australia	Central Asia	North Africa	Central, W., E., & S. Africa	North America	Central America	South America
			Stand-by	Peak-ing	Contin-uous	Diesel Fuel	Heavy Fuel	Dual-Fuel	Nat. Gas											
0.50-1.0	12 439	8307	9144	348	2947	11 711	6	6	716	2397	124	1177	2733	1126	1235	4	82	2923	393	245
1.01-2.0	8662	11 465	6174	230	2258	7612	22	0	1028	1421	267	721	1800	870	874	14	55	2138	411	91
2.01-3.5	991	2320	616	12	363	751	25	1	214	182	54	45	93	33	33	0	34	485	20	12
3.51-5.0	86	362	9	3	74	40	6	0	40	21	8	6	19	7	4	5	0	9	7	0
5.01-7.5	136	796	9	7	120	29	33	4	70	14	5	8	36	13	18	0	26	15	1	0
7.51-10	137	1155	3	2	132	16	57	0	64	15	3	27	10	14	19	11	11	15	5	7
10.01-15	29	354	0	0	29	0	29	0	0	3	0	15	4	0	3	0	1	0	3	0
15.01-20	23	411	0	0	23	0	20	3	0	1	0	6	0	0	0	0	3	0	13	0
20.01-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.01 & above	1	43	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Totals	**22 504**	**25 213**	**15 955**	**602**	**5947**	**20 159**	**199**	**14**	**2132**	**4054**	**461**	**2005**	**4695**	**2063**	**2186**	**34**	**212**	**5585**	**854**	**355**

DIESEL, DUAL-FUEL & GAS ENGINE SPEEDS

Output Range (MW)	June 2004 - May 2005				June 2005 - May 2006			
	Speed Range (r/min)				Speed Range (r/min)			
	under 300	300-600	720-1000	above 1000	under 300	300-600	720-1000	above 1000
0.50-1.00	0	2	51	12 386	0	12	34	17 568
1.00-2.00	0	2	170	8490	0	0	324	10 933
2.01-3.50	0	9	103	879	0	16	222	1540
3.51-5.00	0	1	84	1	0	7	139	1
5.01-7.50	0	1	134	1	0	4	117	8
7.51-10.0	0	8	129	0	0	0	151	0
10.01-15.0	1	28	0	0	0	14	0	0
15.01-20.0	0	23	0	0	1	59	0	0
20.01-30.0	0	0	0	0	0	0	0	0
30.01 & above	1	0	0	0	1	0	0	0
Totals	**2**	**74**	**671**	**21 757**	**2**	**112**	**987**	**30 050**

units ordered the previous year. Total output — at 35 381 MW — increased roughly 40% over the 25 213 MW in 2005. Again, this year the analysis includes all engines above 500 kW.

The largest volume increases were in the two smaller categories, from 0.5 to 2.0 MW, and this is to be expected. The 0.5 to 1.0 MW range increased by 42% to 17 614 units and the 1.01 to 2.0 MW category increased 30% to 11 257 units. Combined output for the two output categories rose by 38% over 2005 levels. The 2.01 to 3.5 MW range also reflected a large gain in 2006, increasing by 79% to 1778 units and increasing total output by 82% to 4226 MW. Another significant increase was in the range from 15 to 20 MW, which increased in units by 160% to 60 units and increased in total output by 159% to 1067 MW. It is interesting to note that the total number of engines reported in the range of 3.5 to 10 MW remained relatively flat from 2005 to 2006.

In the type of generating service area, engines headed for standby service did not reflect a proportionate increase as those categorized as peaking or continuous-duty units. Standby units with outputs over 1.0 MW increased by only 4.5% (7119 vs. 6811 in 2005). For all output categories (500 kW and above), peaking service units increased by 387% (2936 units) over 2005, while continuous-duty machines rose by 64% (9781

GAS TURBINE POWER GENERATION ORDERS, June 2005 – May 2006

Output Range (MW)	Units Ordered	Total Engine Output (MW)	Type of Generating Service			Fuel				Western Europe	Eastern Europe & Russia	Middle East	Far East	Southeast Asia / Australia	Central Asia	North Africa	Central, W., E., and S. Africa	North America	Central America and Caribbean	South America
			Stand-by	Peak-ing	Contin-uous	Diesel Fuel	Heavy Fuel	Dual-Fuel	Nat. Gas											
1.00 to 2.00	118	162	89	0	29	46	40	11	21	4	11	0	98	0	0	2	0	1	2	0
2.01 to 3.50	36	96	31	0	5	16	15	4	1	0	4	0	32	0	0	0	0	0	0	0
3.51 to 5.00	39	161	0	0	39	3	5	8	23	10	0	0	13	1	2	1	4	4	0	4
5.01 to 7.50	76	443	1	1	74	2	0	40	34	7	2	3	11	14	11	0	7	12	0	9
7.51 to 10.00	34	263	0	0	34	2	0	8	24	12	3	1	10	2	1	0	1	3	0	1
10.01 to 15.00	119	1561	0	1	118	1	0	25	93	14	11	19	13	6	11	0	9	6	3	27
15.01 to 20.00	9	161	0	0	9	3	0	2	4	0	4	3	2	0	0	0	0	0	0	0
20.01 to 30.00	97	2436	4	11	82	17	1	20	59	5	24	37	14	1	0	5	4	3	0	4
30.01 to 60.00	124	4873	0	20	104	0	7	40	77	7	21	14	14	14	2	0	21	4	17	10
60.01 to 120.00	18	1567	0	2	16	2	5	2	9	4	3	5	3	0	0	0	0	1	0	2
120.01 to 180.00	99	14 395	0	16	83	0	0	31	68	4	3	31	7	5	6	1	29	9	0	4
180.01 and above	62	15 902	0	0	62	0	0	12	50	16	0	16	10	5	4	0	0	5	0	6
Totals	**831**	**42 020**	**125**	**51**	**655**	**92**	**73**	**203**	**463**	**83**	**86**	**129**	**227**	**48**	**37**	**9**	**75**	**48**	**22**	**67**

GAS TURBINE ORDERS, June 2004 – May 2005

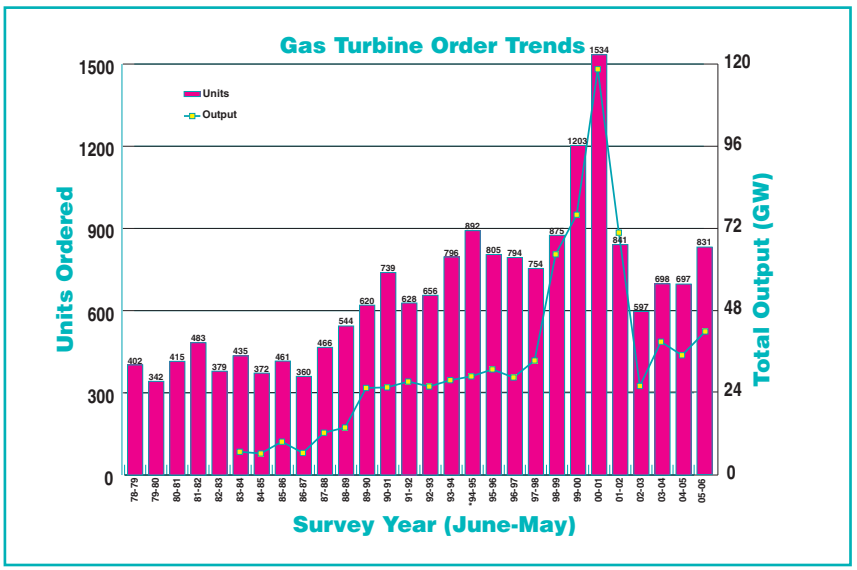
Output Range (MW)	Units Ordered	Total Engine Output (MW)	Type of Generating Service (Units)			Fuel (Units)				zWestern Europe	zzEastern Europe & Russia	Middle East	Far East	Southeast Asia/ Australia	Central Asia	North Africa	Central, W., E., & S. Africa	North America	Central America	South America
			Stand-by	Peak-ing	Contin-uous	Diesel Fuel	Heavy Fuel	Dual-Fuel	Nat. Gas											
1.01-2.0	119	157	84	0	35	47	41	12	19	2	6	0	95	4	0	1	4	4	0	3
2.01-3.5	45	120	33	0	12	15	19	2	9	0	8	0	37	0	0	0	0	0	0	0
3.51-5.0	51	194	16	1	34	13	3	5	30	5	0	1	18	5	0	4	0	4	12	2
5.01-7.5	65	375	8	0	57	1	0	23	41	10	3	8	11	5	3	0	5	7	6	7
7.51-10	42	333	2	0	40	2	0	11	29	6	1	12	9	6	0	0	0	3	4	1
10.01-15	49	637	1	0	48	0	1	24	24	13	4	6	9	4	0	0	0	4	1	8
15.01-20	7	124	0	0	7	0	0	1	6	0	1	0	4	0	0	2	0	0	0	0
20.01-30	99	2672	3	25	71	7	8	49	35	8	25	11	8	4	0	6	9	23	1	4
30.01-60	66	2809	6	21	39	8	0	19	39	5	7	18	4	10	0	2	1	14	0	5
60.01-120	16	1387	0	11	5	13	0	1	2	4	0	9	0	0	0	0	0	3	0	0
120.01-180	82	12 135	0	13	69	2	10	27	43	4	3	20	26	9	2	0	3	9	6	0
180.01 & above	56	14 000	0	0	56	0	0	18	38	12	0	12	13	11	0	1	0	2	0	5
Totals	**697**	**34 943**	**153**	**71**	**473**	**108**	**82**	**192**	**315**	**69**	**58**	**97**	**234**	**58**	**5**	**16**	**22**	**73**	**30**	**35**

units) over 2005. As in previous surveys, the bulk of the engines ordered above 3.5 MW were destined for continuous-duty operation. Engine orders by speed range showed little change in the various categories, with proportionate increases of 43% and 38% in the speed ranges of 720 to 1000 r/min and 1000+ r/min, respectively. As in previous surveys, it also follows that almost all of the higher speed units were in the smaller output ranges from 500 kW to 3.5 MW.

With regard to fuels, it continues to be noteworthy to look at the number of natural gas engine orders. Overall, natural gas engine orders increased over 25%, from 2132 in 2005 to 2675 in 2006. This year's overall increases are somewhat proportional to the increase in orders in general, although the largest output ranges tend to be split among diesel, heavy fuel and natural gas as they have been in years past. One interesting set of outputs to note is from 3.5 to 10 MW, where nearly one-half of the engines ordered are using natural gas. Also, the number of heavy fuel engines reported this year increased by 258% to 713 units and over two-thirds of those engines are in the 1.01 to 3.5 MW output range. Dual-fuel engines increased slightly in 2006, but the total number (24) is still very small.

In analyzing the geographic location for orders, just about all of the major regions saw strong increases. The two regions with the highest volume of engines, North America and Western Europe, saw engine orders increase by 42% and 64%, respectively. Interestingly, this year's only decrease in a major region was in the Far East, which includes both China and Japan. Engine orders for the Far East decreased by 20% (3781 units vs. 4695 in 2005). Other major regions reflecting substantial increases this year include the Middle East at 80%, Central America at 130%, South America at 26% and Central/South Africa at 174%.

The overall picture is that the power generation market for reciprocating engines is continuing at a record-setting pace, which of course has positive con-



sequences for all of the ancillary systems suppliers including manufacturers of generators, controls and instrumentation, switchgear, heat exchangers, silencers and packagers. Given the geographically dispersed nature of the engines reported, it is difficult to pinpoint one single indicator driving demand. Two leading indicators for this activity, it would seem, are the continued high worldwide demand for both raw materials and energy resources. Other factors — including stronger global economies in general, specific regional infrastructure development and natural disasters (and preparedness) — have also fed demand.

Gas Turbine Order Revival

Gas turbine orders are continuing their slow ascent toward more "normal" levels, although there is great speculation as to what constitutes a normal annual order volume for gas turbines. Units ordered reached 831 in 2006, a 19% increase over last year's 697 units. Total output also increased accordingly, raising 20% to 42 020 MW, representing the highest level of total output since orders began a steep decline in the 2001/02 timeframe. This year most of the higher output categories increased in volume, thus there has been an increase of total output of 7077 MW over 2005.

With regard to the individual output categories, the results were mostly positive. Several key ranges — 10 to 15 MW, 30 to 60 MW, 120 to 180 MW, and 180+ MW — reflected increases this year. Other ranges — 2.0 to 3.5 MW, 3.5 to 5.0 MW and 7.5 to 10 MW — offered decreases. The remaining output ranges remained virtually unchanged.

The two categories demonstrating the greatest increases were 10 to 15 MW (increased by 143%) and 30 to 60 MW (increased by 88%). The 10 to 15 MW range rose 199 units this year, vs. 49 units in 2005, while the 30 to 60 MW range rose to 124 units from 66 machines last year. In the 30 to 60 MW category there is obviously a mix of aeroderivative and medium-sized industrial engines. Another "high volume" category for the aero engines is 20 to 30 MW, which this year remained relatively unchanged (97 units in 2006 vs. 99 in 2005). Meanwhile, the two largest output categories — above 120 MW — showed a combined increase of 17% over 2005. This increase bodes well for the four manufacturers of the largest gas turbines.

When analyzing the gas turbine orders by geographic location, the results indicate that most of the major regions increased orders this year, except North America. Two notable regions posted tremendous increases by percentage of orders, although the overall volumes were small. Central Asia jumped from 5 units to 37, which was an increase of 640%, while Central/South Africa rose from 22 machines to 75, an increase of 241%. Other positively oriented regions include Western Europe (+20%), Eastern Europe/Russia (+48%), the Middle East (+33%) and South America (91%). One interesting fact is that of the 124 turbines ordered in the 30 to 60 MW range, roughly 39% were to be located in Africa or Central and South America. Orders for North America fell by 25 units, a decrease of 34%. This decrease can accounted for with fewer midsized units.

Whereas last year the type of service reflected a 20% increase in standby units, in 2006 the data show a 38% increase in continuous-duty machines (655 units vs. 473 in 2005). Both the standby and peaking categories reflected decreases of 18% and 28%, respectively. With regard to type of fuel, the most interesting category is natural gas, which increased by 47%, from 315 units in 2005 to 463 units in 2006. Along with a slight 6% increase in dual-fuel engines, natural gas reflects the predominance of continuous-duty machines this year. Both categories of liquid fuels — diesel and heavy fuel oil — decreased in 2006. This year's gas versus liquid fuel data is almost the direct opposite of last year's figures.

Power Generation Trends

These order surveys try to convey an accurate count of engines destined for power generating applications. It is important to note that the gas compression industry continues on a healthy order pace, which adds to the gas turbine and gas engine manufacturers' total order volumes. As noted earlier, the inaugural Mechanical Drive Order Survey will be published in the December issue of *Diesel & Gas Turbine Worldwide*, as well as the December issue of our sister publication **COMPRESSORTech**^{Two}. This Mechanical Drive survey will complete the "third leg of the stool" for our engine surveys — Power Generation, Marine Propulsion and Mechanical Drive.

Reciprocating engine orders no doubt remain healthy — especially in several key markets including marine propulsion, power generation, mechanical drivers and rail traction.

This year's remarkable, record-setting power generation order figures for piston engines reflect broad increases in both diesel and natural gas fuels, peaking and

continuous service, as well as ample dispersal throughout the major geographic regions. It is particularly interesting to note the increases in reciprocating engine orders in Africa and the Americas. Two likely drivers for this activity include oil and gas production and continued strong worldwide demand for raw materials. Moreover, natural gas engines, always a high interest area, reflect continued growth in applications with either traditional oilfield gas or biogas.

Last year in this space it was indicated that near-term gas turbine orders will total something closer to 40 000 MW on a yearly basis. This would seem to have been borne out with this year's 42 000 MW total. With gas prices coming off of record highs, decision-makers are again turning their sights toward gas turbines for power generation. There is, however, continued attention focused on coal resources and fuel diversification, such as gasification. There also continues to be, however, new markets opening up due to natural gas infrastructure development. The potential of LNG will also play a role in gas turbine orders as regional production facilities — and subsequent receiving terminals — come online.

Almost every major region in the world has benefited from this combined increase in reciprocating and gas turbine engine orders. It would be almost unthinkable to predict a similar 20 to 40% increase for 2007, but that could have been said about 2006, too. Absent any major geopolitical upheaval in the coming year, it should not be surprising to see engine orders in all categories reflect a robustness in worldwide demand for power.

Once more, our most sincere thanks go to all of the engine manufacturers who invested time and energy to participate in this survey. We deeply appreciate the support of the engine industry and are grateful that power generation buying influences and customers throughout the world continue to find this annual power generation survey useful and informative.

Diesel, Dual-Fuel and Gas Engine Manufacturers Participating and Reporting Orders in this Power Generation Survey

- BEZ Motory
- Caterpillar Engine Div. (including Caterpillar Motoren)
- Cummins Engine
- Daihatsu Diesel Mfg.
- Deutz Power Systems
- Electro-Motive Diesel
- GE Jenbacher
- GE Transportation
- Hyundai
- Isotta Fraschini
- MAN B&W Diesel Group (including MAN B&W Ltd., Copenhagen, Holeby, Augsburg and licensee Navantia, Spain)
- MTU Friedrichshafen (including Detroit Diesel)
- Mitsubishi Heavy Industries
- Niigata Power Systems
- PervomayskDieselMash
- Rolls-Royce Bergen
- Wärtsilä
- Waukesha Engine, Dresser, Inc.
- Yanmar Diesel Engine

Gas Turbine Manufacturers Participating and Reporting Orders in this Power Generation Survey

- ALSTOM Power
- Ansaldo Energia
- Daihatsu Diesel Mfg.
- GE Energy (including GE Oil & Gas)
- Hitachi Ltd.
- IHI
- Kawasaki Heavy Industries
- MAN Turbo
- Mitsubishi Heavy Industries
- NPO Saturn
- Niigata Power Systems
- OPRA
- Perm Engine Company
- Pratt & Whitney Power Systems
- Rolls-Royce Energy
- Siemens Power Generation
- Solar Turbines
- Yanmar
- Zorya-Mashproekt