

July 30, 2002 Memo to WindSail Team

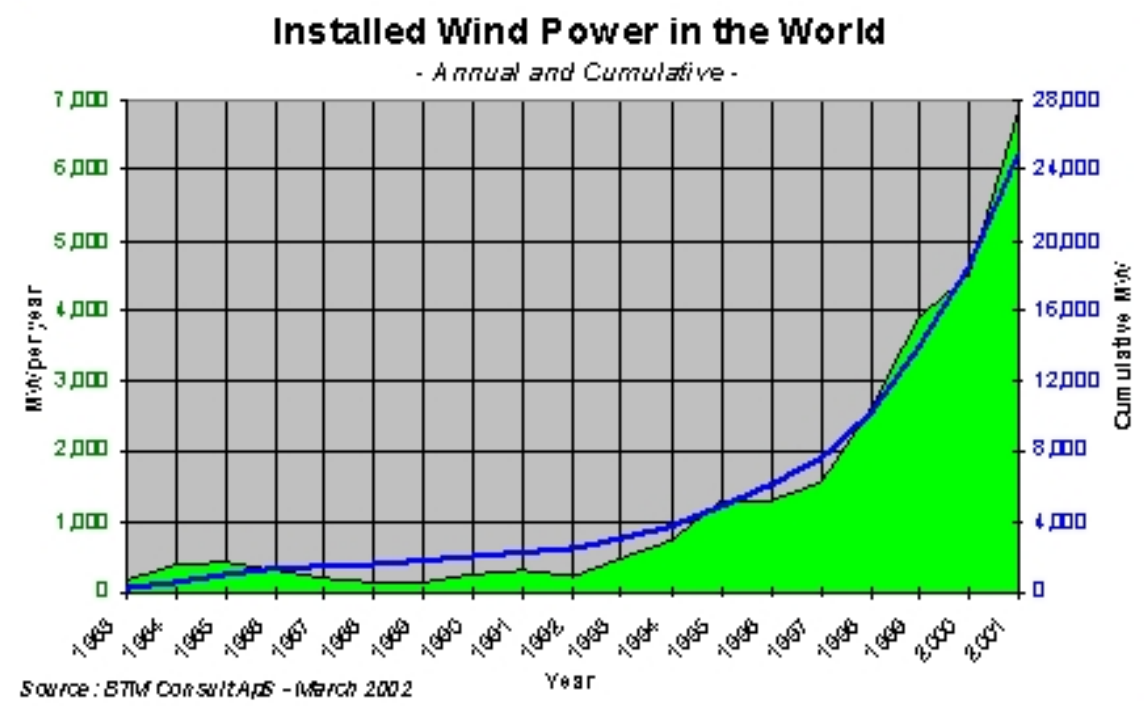
This memorandum is the first in a series that will cover the contents of the outline that was discussed with Rich McClellan and Daryl Oshatz on July 15, 2002. Specifically, this memo covers the first two sections of the outline: the first part of this memo assesses the size of the global wind power market, while the second part provides information on the U.S. wind power market. Note that the data presented here pertains almost exclusively to *utility-scale* wind turbines, as small wind turbines get lost in the noise when looking at wind development from a national or international perspective.¹

1. Assessing the Size of the Global Wind Power Market

According to BTM Consult ApS (2002), 6,824 MW of new wind capacity was installed globally in 2001, bringing total cumulative capacity to 24,900 MW. *Windpower Monthly* had slightly different numbers, with 6,765 MW of new capacity in 2001 bringing total global capacity to 24,481 MW. Note that these numbers represent grid-connected, utility-scale turbines only.

Figure 1 depicts the strong growth in the wind industry over the past decade. The shaded area indicates annual capacity additions (left scale), while the line represents cumulative capacity (right scale).

Figure 1. Global Annual and Cumulative Installed Wind Capacity



¹ Information on small wind turbines will be provided in later sections covering grid-connected/customer-sited and off-grid applications.

The July 2002 issue of *Windpower Monthly* provides a mid-year estimate of installed global wind capacity (25,824 MW), as well as a country breakdown. Table 1 shows this breakout (first column), as well as the amount of capacity added in each country in the past year-and-a-half (8,118 MW in aggregate).

Table 1. Global Installed Wind Capacity Through June 2002 (MW)

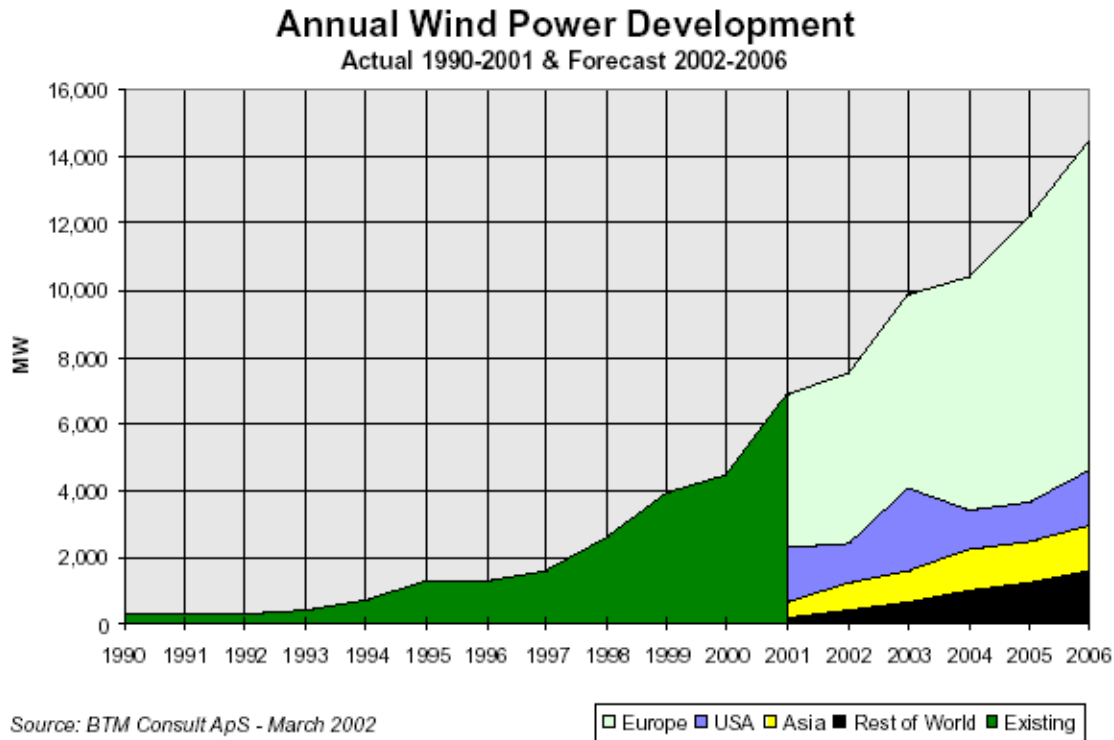
	Cumulative Installed Capacity Through June 2002 (MW)	Installed Capacity Since 12/31/2000 (MW)			
			Ukraine	40	35
			New Zealand	37	0
			Belgium	31	22
			Poland	28	21
Germany	9,500	3,387	Argentina	24	10
USA	4,251	1,696	Czech Republic	23	16
Spain	3,712	1,310	Brazil	20	0
Denmark	2,456	159	Turkey	19	0
India	1,627	407	Norway	17	4
Italy	700	311	Luxembourg	15	5
Netherlands	501	53	Caribbean	13	0
UK	498	89	Iran	11	0
China	399	59	South Korea	8	0
Japan	300	150	Israel	8	0
Sweden	280	49	Russia	5	0
Greece	272	83	Switzerland	5	2
Canada	207	67	Mexico	5	0
Portugal	127	27	Sri Lanka	3	0
Ireland	125	7	Taiwan	3	0
Egypt	125	62	Africa	3	0
Austria	95	17	Chile	2	2
France	85	6	Jordan	2	0
Australia	73	39	Hungary	1	1
Costa Rica	71	20	Latvia	1	0
Morocco	54	0	Romania	1	0
Finland	41	3			
			Total	25,824	8,118

Source: WINDPOWER MONTHLY, July 2002

Figure 2 shows BTM's (2002) estimate of actual annual global wind power development through 2001, plus a forecast of annual global development through 2006. At this predicted pace of growth, global cumulative wind capacity will reach nearly 80,000 MW by 2006 – a tripling of installed capacity in just 5 years. Note that the lion's share of forecast development is in Europe, where the EC has set a goal of 40,000 MW of wind power by 2010 in Europe alone (EWEA is targeting 60,000 MW of wind in Europe by 2010). The spike in the U.S. in 2003 is related to the scheduled expiration of the federal production tax credit for wind in December 2003.

While the optimism inherent in this forecast could easily lead one to view it with skepticism, we note that among the many different forecasts of installed wind capacity that are available, BTM's forecasts are considered to be fairly reliable. BTM's annual *World Market Update* is one of the most often cited documents in the realm of forecasting.

Figure 2. Annual Global Wind Power Development, Actual and Forecast (MW)



BTM (2001) also presents this 5-year forecast at the country level. Countries that are expected to be major contributors from 2002-2005 include Spain (6,800 MW from 2002-2005), Germany (6,500 MW), the U.S. (3,400 MW), France (1,900 MW), India (1,450 MW), the UK (1,350 MW), Denmark (1,250 MW), Italy (1,200 MW), and China (1,100 MW). Potentially of interest to WindSail, BTM’s forecast for the former Soviet Union is 380 MW from 2002-2005.

Over the longer term, BTM (2002) predicts that by 2010, cumulative global wind capacity will reach 144,000 MW, which translates into a growth rate of 26%/year until 2005 and then 20%/year from 2005-2010. Note that this *prediction* is considerably more uncertain than BTM’s 5-year *forecast* due to the extended time horizon, as well as uncertainty over what types of policy and economic drivers will exist over more than the next few years.

For example, as part of market liberalization, the European Union hopes to see its member countries’ incentive policies for renewable energy converge within a few years, but at this time it is not clear which of the competing policies in Europe will win out – aggressive feed-in tariffs which have driven the bulk of European wind installations to date (e.g., Germany), or renewables portfolio standards (RPS) that are currently being launched in the UK, Denmark, the Netherlands, and a few other countries. To underscore this point, the Dutch consulting firm ECOFYS estimates that with a continuation of *current* policy through 2010, installed wind capacity in Europe will reach 54,000 MW (ECOFYS 2002). If, however, all approved policies (as of 9/1/2001) are enacted as scheduled, installed wind capacity in Europe will grow to only 37,000 MW by 2010. This difference reflects a shift away from lucrative feed-in tariffs towards more market-based policies that will likely not be as favorable to wind developers.

The pace of offshore development will be a key factor in determining whether forecasts of installed capacity are met, particularly in Europe. Many large (i.e., hundreds of MW) offshore projects are currently in the planning stages for Europe (and a few in the US), but few are actually under construction at this point, and it remains to be seen whether legal and permitting hurdles can be overcome in time for the offshore market to be a major contributor to capacity targets for 2010.

Finally, by 2010 wind power may become economical without incentives in many cases, yet this driver is difficult to predict. Another wildcard is climate policy – Kyoto Protocol targets are currently driving some of the stated wind development goals in Europe, and the establishment of more binding policies such as a carbon tax could also be a major driver for wind power.

Wind Turbines are Rapidly Increasing in Size

Globally, the average size of all wind turbines installed in 2001 was 915 kW (BTM 2002) – a 14% increase from 800 kW in 2000. Data on average size of annual wind turbine installations in select countries is provided in Table 2 (BTM 2001).

Table 2. Average Size of Wind Turbine Generators Installed Each Year

	China	Denmark	Germany	India	Spain	Sweden	UK	US
1995	326	493	473	208	297	448	534	327
1996	400	531	530	301	420	459	562	511
1997	472	560	623	279	422	550	514	707
1998	636	687	783	283	504	590	615	723
1999	610	750	919	283	589	775	617	720
2000	600	931	1,101	401	648	802	795	686

Source: BTM Consult, “International Wind Energy Development: World Market Update 2000”, March 2001

On a cumulative basis, the average size of all wind turbines globally in 2000 was 375 kW. Data on average turbine size of cumulative installations for select countries is provided in Table 3.

Table 3. Average Size of Wind Turbine Generators of Cumulative Installations

	China	Denmark	Germany	India	Spain	Sweden	UK	US
1995	147	148	310	199	177	311	360	118
1996	209	181	358	222	258	345	398	120
1997	281	235	402	228	323	364	425	125
1998	362	271	465	233	367	412	442	132
1999	441	303	562	232	455	453	450	153
2000	479	366	646	258	510	489	484	161

Source: BTM Consult, “International Wind Energy Development: World Market Update 2000”, March 2001

Table 4 segments installed capacity in 2000 into three product size categories. While medium-sized turbines held 59% market share in 2000, MW-class turbines were closing in at 39% market share, a trend that likely continued in 2001.

Table 4. Segmentation of Installed Turbines by Size in 2000

	Number of Turbines	Installed Capacity	Market Share (by capacity)	Avg Turbine Size	Current Trend
<500 kW	311	84 MW	1.8%	270 kW	Fast decreasing
500-999 kW	4,087	2,685 MW	59.0%	657 kW	Slightly decreasing
>1 MW	1,293	1,779 MW	39.1%	1,376 kW	Increasing
Total	5,691	4,548 MW	100%	800 kW	

Source: BTM Consult, "International Wind Energy Development: World Market Update 2000", March 2001

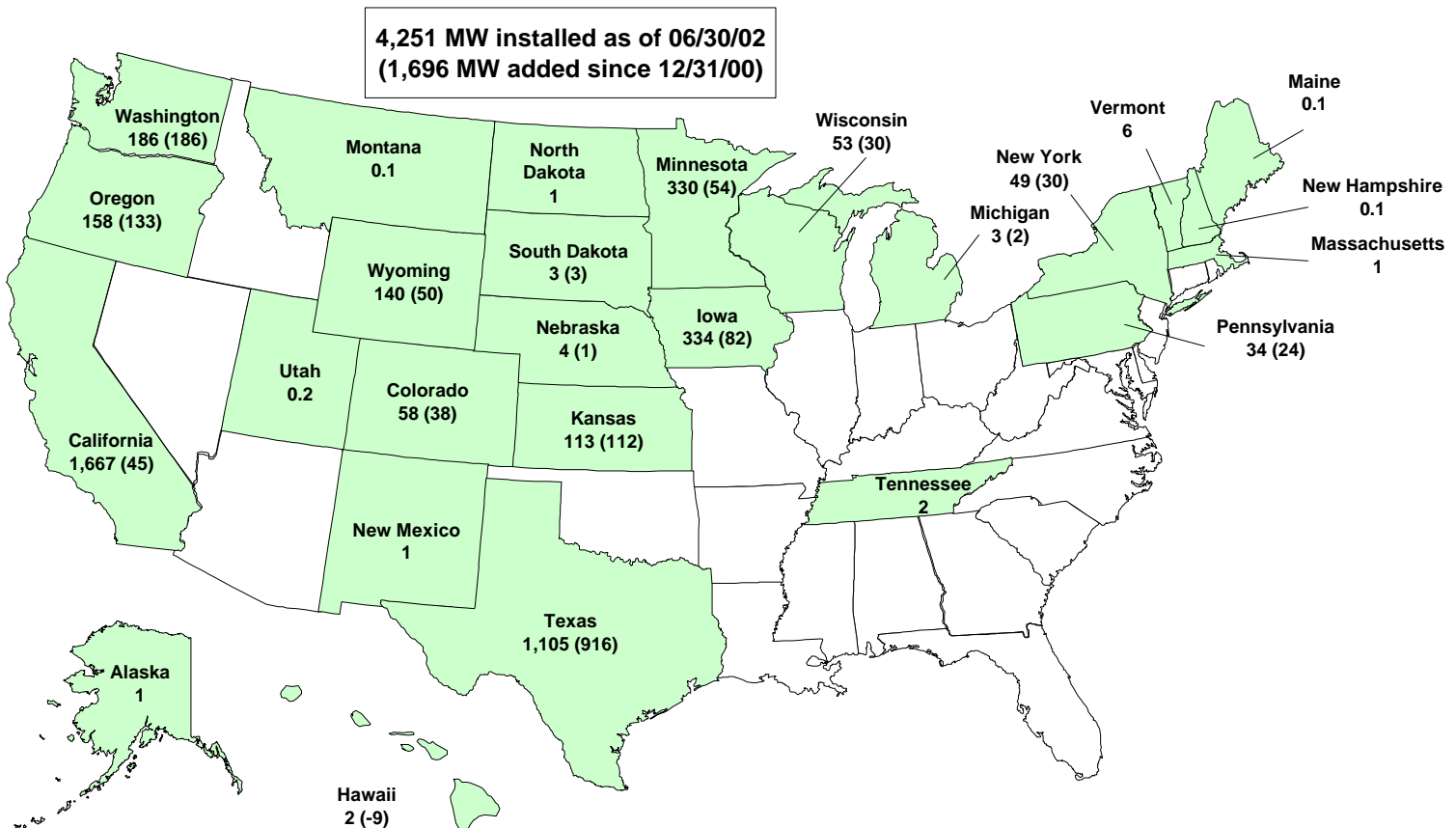
In summary, the global wind power sector as a whole has been growing at a phenomenal pace, and strong growth is predicted to continue well into the future. Turbine size has been growing rapidly, to the point where megawatt-class machines are now considered the norm, and the industry is developing 3+ MW machines for offshore use.

2. Aggregate Size of the U.S. Wind Power Market

According to the July 2002 issue of *Windpower Monthly*, there were 4,251 MW of installed *utility-scale* wind capacity in the U.S. as of the end of June 2002. For comparison purposes, AWEA estimates that there are roughly 15 MW of installed *small wind* capacity in the U.S.

Figure 3 shows installed *utility-scale* capacity by state, as well as incremental installed capacity since the end of 2000 (in parentheses). Despite little new wind development having occurred in California since the 1980's, that state continues to rank first in terms of installed capacity, with Texas close behind and likely to clinch the lead in the near future. Iowa and Minnesota rank 3rd and 4th respectively, followed by Washington and Oregon (who share the 263 MW Stateline wind project straddling the Columbia River).

Figure 3. Installed Wind Capacity (MW) in the U.S. (parentheses indicate incremental capacity since 12/31/00)



Source: *Windpower Monthly News Magazine*

Growth (and the timing of growth) in the US wind power market is heavily driven by the federal production tax credit (PTC) and its expiration or reauthorization schedule. The PTC is a 1.5¢/kWh (adjusted for inflation, stands at 1.8¢/kWh in 2002) tax credit available for the first 10 years of a commercial wind project. The PTC expired at the end of 2001, and in March 2002

was reinstated retroactively for 2 years (i.e., wind projects online before 12/31/03 will be eligible for the 10-year credit). Unless the PTC is extended well in advance of its scheduled expiration, 2003 will likely be a strong year for US wind development, as developers rush to complete their projects before the year's end.

Table 5 shows two independent forecasts of annual wind power growth in the US through 2005.

Table 5. Forecast of Annual US Wind Capacity Growth (MW)

	EIA Reference Case*	BTM (2001)
2002	970	800
2003	560	1,000
2004	450	800
2005	550	800
Total	2,530	3,400

*The EIA's AEO 2002 Reference Case assumes no PTC extension beyond 2001.

The EIA reference case in Annual Energy Outlook 2002 (AEO 2002) forecasts 9,060 MW of installed wind capacity in the U.S. by 2020, an annualized growth rate of 6.8% from 2000-2020 (again, this assumes no PTC extension beyond 2001). Assuming the PTC is extended through 2006, AEO 2002 forecasts 13,000 MW by 2020 (an increase of 4,000 MW due solely to the PTC extension). In a separate "High Renewable Energy Case," AEO 2002 forecasts 8,720 MW of installed wind by 2010 and 25,270 MW by 2020. This represents a 12.4% annualized growth rate from 2000-2020.

As shown earlier in Table 2, the average size of turbines installed in the U.S. in 2000 was 686 kW, up from 327 kW in 1995. Because much of the installed wind capacity in the US (and California in particular) is from the 1980s, and relatively little capacity was installed during the late 1990s, the cumulative average turbine size has only increased from 118 kW in 1995 to 161 kW in 2000 (as shown in Table 3). However, with a banner development year in 2001 featuring large MW-class turbines, this average likely jumped significantly in 2001.

The Competition for Small Wind Turbines: Data on the PV and Diesel Markets in the US and Abroad

Although virtually all of the data presented above pertains to utility-scale turbines, WindSail is likely to develop small wind turbines that will need to compete against small distributed generation options, including PV and diesel generators. In this section, we provide some estimates of installed capacity of PV and diesel installations in the US and globally.

Photovoltaics (PV)

A May 2002 NREL report estimates total installed PV capacity in the US. NREL pegs on-grid capacity at 26.6 MW, and cites other studies that have estimated off-grid capacity to be anywhere in the range from 100-150 MW. (Note: For comparison purposes, around 15 MW of small wind capacity is reportedly installed in the US).

Table 6. Cumulative PV Capacity in the US through 2000 (MW)

Source	On-Grid (MW)	Off-Grid (MW)	Years Included
Paul Maycock	40.1	98.7	1992-2000
EIA	30.6	150.4	1982-2000
NREL	26.6	#N/A	through 2000

Source: Price et al, "U.S. On-Grid Photovoltaic Capacity: A Baseline for the National Energy Modeling System", NREL/CP-620-32104, May 2002

Of the 26.6 MW of on-grid capacity, NREL estimates that 55% is serving the commercial sector, 28% is central station, while 17% serves the residential market (see Table 7).

Table 7. Sector Breakdown of On-Grid PV Capacity in the US through 2000 (MW)

Residential	4.6
Commercial	14.6
Central Station	7.4
Total	26.6

Source: Price et al, "U.S. On-Grid Photovoltaic Capacity: A Baseline for the National Energy Modeling System", NREL/CP-620-32104, May 2002

Globally, roughly 300 MW of PV was installed in the year 2000, bringing total installed capacity worldwide to more than 1,000 MW. Japan, home to the world's largest PV market, installed almost 110 MW in 2000, bringing cumulative PV capacity in that country to nearly 320 MW. Germany, on track to surpass the US as the world's second largest market, installed 45 MW in 2000, bringing total installed PV capacity to more than 110 MW.

Diesel Generators

Data on the installed capacity of diesel generators in the US and abroad has been difficult to come by. Further exacerbating data collection efforts is the fact that only certain diesel applications (e.g., baseload power) using certain size generators (e.g. <100 kW) are likely to be relevant competitors to WindSail. Data on generators used for backup, standby, or emergency power, as well as data that includes large generators, is likely to not be very useful. With these caveats in mind, what follows is the best information we could find (without spending an inordinate amount of time searching).

A database of *backup* generators in California compiled by Arthur D Little (ADL) in 2001 from interviews with Air Quality Management Districts estimates that there are over 4,000 diesel generators in the state with a total installed capacity in excess of 3,200 MW. Data quality issues (e.g., only generators in excess of 300 kW are included) lead ADL to think that these numbers are conservative. Furthermore, much of this data was collected in early 2001; expectations of frequent rolling blackouts during the summer of 2001 may have substantially boosted backup diesel generator installations in California since then.

A different industry survey implies a far higher number of generators in California: >24,000 units in excess of 300 kW. These higher numbers may in fact be closer to reality, as many units may have been installed without notifying the local air permitting authority. In addition, Table 8 from this survey shows a far greater number of smaller diesel generators (i.e., <300 kW).

Table 8. California Engine Generator Sets

Nameplate kW	Units Installed as of January 1997	Units Installed as of April 2001
50-75	22,405	27,233
71-150	23,558	28,635
151-300	14,373	17,470
301-700	7,062	8,584
701-1200	5,259	6,392
1201-2000	5,257	6,390
2001-	1,968	2,392
Total Installed	79,882	97,097

Source: Celerity Energy, LLC

On a national level, using 1996 data obtained from the EPA, Table 9 breaks out total installed diesel generator capacity in the US by size. 51% of the generators represented by this data are believed to be stationary, rather than mobile. Note that this data is relatively old, and more recent nationwide estimates could not be found.

Table 9. Total Installed Diesel Generator Capacity in the United States, 1996

Size	Installed Units	Average Kilowatts	Installed Capacity
2.2 – 4.5 kW	6,235	4.2	26.4
4.5 kW – 8.2 kW	34,543	6.2	212.9
8.2 kW – 11.9 kW	40,262	10.4	417.5
11.9 – 29.8 kW	104,448	19.3	1,898.2
29.8 – 74.6 kW	153,705	53.6	8,104.9
74.6 – 130.6 kW	108,415	100.7	10,918.5
130.6 – 223.8 kW	72,434	183.5	13,292.8
223.8 – 447.6 kW	49,690	320	15,902.5
447.6 – 746 kW	38,318	560.2	21,467.4
Over 746 kW	24,674	1,208.5	29,819.5
Total	626,489	166 kW	102,061 MW

Note: Totals do not match due to rounding.

Source: Virinder Singh, “Blending Wind and Solar into the Diesel Generator Market”, Renewable Energy Policy Project, Winter 2001

A 1994 business plan for a new (then) joint venture between Bechtel and Pacificorp contains some indication of worldwide shipments of *baseload* diesel generators, broken out by size. Table 10 is compiled from this data. Note that this data is old, and that the projections to 2005 were made back in 1994 (not in 2002). Also note that projected growth rates are low, indicative of the mature nature of diesel gen-set technology. Data on larger generators is available, but is excluded from this table. Country-specific data is also available by sector, though not by generator size.

Table 10. Worldwide Baseload Gen-Set Shipments and Average Growth Rates

Sector	Size Range	1990	1995	2000	2005	Avg. Growth (%)
Consumer	<50 kW	75	100	123	150	4.7
	51-300 kW	153	208	257	315	4.9
Commercial	<50 kW	70	82	86	88	1.5
	51-300 kW	344	441	514	584	3.6
Agricultural	<50 kW	18	23	27	30	3.5
	51-300 kW	81	107	128	149	4.2
Industrial	<50 kW	59	75	86	98	3.4
	51-300 kW	583	704	769	833	2.4
Institutional and Utility	<50 kW	15	15	14	13	-0.7
	51-300 kW	189	199	187	176	-0.5

Source: EnergyWorks business plan, October 17, 1994