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## Indicators of investment and capacity for renewable energy

First published in Renewable Energy World September-October 2004  
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Almost US\$22 billion were invested in renewable energy capacity during 2003 - nearly four times as much as in 1995, according to a new analysis by [Eric Martinot](#).

Renewable energy is becoming more and more significant in relation to conventional forms of energy: the following indicators of investment and capacity are intended to show how significant it has become. By grouping all renewable energy technologies into a single indicator, we can go beyond single-technology reporting, and by looking at investment and capacity, we can see a more aggressive and significant market presence than traditionally cited statistics of renewable energy as a fraction of global energy supply. Of course, renewables generally provide less energy per unit of capacity than fossil fuels, but capacity still reflects investment flows better than energy production does. And capacity grows more smoothly over time, allowing better year-to-year analysis.

Approximately US\$22 billion was invested in renewable energy worldwide in 2003 (see Figure 1). In comparison, total investment in the electric power sector is likely to be in the range of \$120-160 billion/year (it varies substantially from year to year). Annual investment in renewable energy has grown almost fourfold from \$6 billion in 1995, while cumulative investment since 1995 is in the order of \$110 billion. The 2003 investment shares in the renewables sector were roughly 38% for wind power, 24% for solar PV, and 21% for solar thermal hot water. Small hydro power, biomass power generation, and geothermal power and heat made up the remaining 17%.



Renewable energy on the up LEFT TO RIGHT Rooftop PV in California GE (FORMER ASTROPOWER) Solar thermal collectors at a hospital in Rome, Italy GIOVANNI ADDOLORATA/THERMOMAX Wind farm at Woolnorth, Australia VESTAS Wood-fired Irish biomass plant WÄRTSILÄ BIOPOWER

Total renewable power capacity stood at roughly 140 GW as of 2003, excluding large hydro (Table 1). This represents slightly less than 4% of the world's total electric power capacity. About 40% of total renewable power capacity is installed in developing countries. Worldwide, wind capacity increased by 26% and grid-connected solar PV capacity increased by an incredible 50% (365 MW) in 2003. These growth rates far outpace those for traditional electric power, currently 1%-3% in most countries, except China, where traditional power capacity is growing at rates of 7%-9%.

Germany has almost 40% of the world's wind power capacity, with the US and Spain on equal footing in second place. Two thirds of all of the wind power capacity in developing countries exists in India, though China is now catching up. Half of the global small hydro capacity exists in China, with the EU a distant second and the remainder distributed through many other countries. Biomass power capacity is largest in the EU, the Philippines, Brazil and China. The leading geothermal countries meanwhile are the US, the Philippines and Mexico, which together account for more than half of the capacity installed worldwide.

**TABLE 1. Grid-based renewable power capacity as of 2003**

<b>Generation type</b>		<b>Capacity in all countries (GW)</b>	<b>Capacity in developing countries<sup>a</sup> (GW)</b>
Small hydro power <sup>b</sup>		56	33
Wind power		40	3
Biomass power <sup>c</sup>		35	18
Geothermal power		9	4
Solar photovoltaic power (grid-connected)		1.1	< 0.1
Solar thermal power		0.4	0
<b>Total renewable power capacity</b>		<b>142</b>	<b>58</b>
For comparison	- large hydro power <sup>d</sup>	730	340
	- total electric power capacity	3700	1300

<sup>a</sup> Developing countries are non-OECD countries plus Mexico, South Korea and Turkey, excluding countries with economies in transition. Martinot et al. (2002) included economies in transition in these totals, reflecting all countries eligible for World Bank development assistance.

<sup>b</sup> Definitions of small hydro vary by country. They usually cover hydro up to 10 MW, although this figure is up to 25 MW in India and up to 30 MW in China - thus global totals can differ greatly depending on what is counted.

<sup>c</sup> Biomass power figures exclude municipal solid waste combustion and landfill gas.

<sup>d</sup> Published hydro power figures assumed to include both large and small hydro, except in China, where these are reported separately. Total hydro is the sum of small and large hydro.

Solar thermal capacity for domestic hot water and space heating, approaching 100 million m<sup>2</sup> as of 2003, grew by 16% worldwide in 2003 (Table 2). In China, solar thermal growth was even higher, at 30%; China now accounts for 55% of global capacity. At least 30 million households worldwide now use solar hot water. Solar thermal has become a huge market in recent years, about \$5 billion in 2003.

**TABLE 2. Solar thermal capacity as of 2003**

<b>Feature</b>	<b>Figure for all countries</b>	<b>Figure for developing countries</b>
Solar thermal collector area (million m <sup>2</sup> ) <sup>a</sup>	94	62
Number of homes with solar thermal (millions) <sup>b</sup>	29	21
For comparison - total number of homes (millions) <sup>c</sup>	1600	1200

<sup>a</sup> Figures exclude unglazed water collectors (mainly used to heat swimming pools) and all air collectors (mainly for agricultural processing). Glazed water collectors are used primarily for hot water, but a share of them are used for space heating as well.

<sup>b</sup> Rough estimates assuming 3 m<sup>2</sup>/home average for developing countries and 4 m<sup>2</sup>/home average for developed countries, neglecting commercial use (Weiss et al. 2004, Li Hua, Renewable Energy World, July-Aug 2002). Li (2002) suggests closer to 2 m<sup>2</sup>/home in China, so the number of homes is probably larger than that shown in Table 2.

<sup>c</sup> Rough estimates based on 4.4 persons/home in developing countries and 2.5 persons/home in developed countries (Worldwatch Institute, 2004) and population data from the World Bank's World Development Indicators.

Ethanol production capacity, at over 30 billion litres/year, now exceeds 1% of worldwide gasoline production capacity (Table 3). Both ethanol production and biodiesel capacity grew by close to 20% from 2002 to 2003. Half of the world's ethanol capacity is in Brazil, with the other half mostly in the US, which has expanded capacity rapidly since 1999. Small shares of ethanol are also produced in China, Europe and Canada. Most of the biodiesel capacity exists in Germany, France and Italy, with smaller amounts in several European countries and the US.

**TABLE 3. Biofuels capacity as of 2003**

Capacity	Capacity in all countries (billion litres/year)	Capacity in developing countries (billion litres/year)
Ethanol production capacity <sup>a</sup>	> 29	> 15
Biodiesel production capacity	1.8	0
For comparison - total gasoline refinery capacity <sup>b</sup>	2300	1000

<sup>a</sup> Ethanol production figures from Fulton et al. (2004). Ethanol production figures are commonly reported, rather than capacity. In the US, the production-to-capacity ratio is about 85% (Renewable Fuels Association 2004). In Europe, it appears to be closer to two thirds (EUREC 2004). Actual worldwide ethanol capacity might be 32-35 billion litres/year.

<sup>b</sup> Calculated using British Petroleum Statistical Review of World Energy figures for refinery capacity (in barrels of oil/day) by country, assuming 75 litres of gasoline (47% of petroleum product) produced per barrel of oil.

These investment and capacity indicators clearly demonstrate that renewables are becoming big business. By any measure, the absolute gap between renewables and conventional energy is still enormous. However, by putting them on the same scale, and noting renewables' rapid growth, we can better imagine the gap closing over time - and investors and policymakers alike may come to realize more and more just how much renewables deserve their attention.

## DATA SOURCES AND NOTES

All data given in this article are approximate. The numbers presented are synthesized from a large number of statistical and country-specific sources, and for most entries, a detailed spreadsheet by country has been used. Some categories of information lack data for 2003, or even 2002, requiring estimation based on recent growth rates and trends. The supposition is that it is better to have an approximate set of numbers for a recent and consistent year (2003) than a more accurate set for an earlier year, especially since markets such as wind power are so dynamic. For some entries, such as biomass and small hydro, no consistent set of numbers exists for any year. Developing countries are the real challenge, as IEA reports only cover OECD countries.

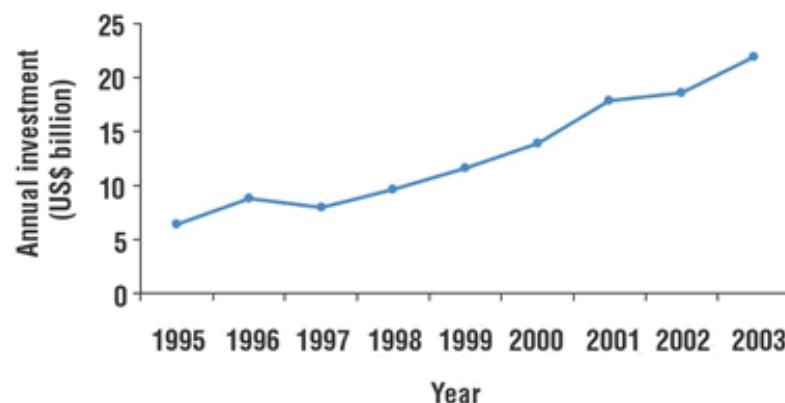


FIGURE 1. Annual investment in renewable energy, 1995-2003

Investment numbers in Figure 1 are based on analyses of annually installed capacity coupled with approximated, per-unit investment costs by technology. A previous version of Figure 1 gave \$20 billion investment for 2003. However, the availability of new data, in particular for China's booming solar hot water market and small hydro growth from 2001-2003, made the previous assumptions too low. Solar thermal may be higher than 21% of the total, but per-unit costs were estimated conservatively at \$250/m<sup>2</sup> in China and \$800/m<sup>2</sup> in developed countries. Solar PV costs were estimated at \$7/W, including balance of system.

Detailed notes, full references, and all assumptions are available at [www.martinot.info/markets.htm](http://www.martinot.info/markets.htm)

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