RENEWABLES

GLOBAL STATUS REPORT

2006 Update

REN21 Renewable Energy Policy Network for the 21st Century

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Renewable Energy Policy Network for the 21st Century

REN21 is a global policy network in which ideas are shared and action is encouraged to promote renewable energy. It provides a forum for leadership and exchange in international policy processes. It bolsters appropriate policies that increase the wise use of renewable energies in developing and industrialized economies.

Open to a wide variety of dedicated stakeholders, REN21 connects governments, international institutions, nongovernmental organizations, industry associations, and other partnerships and initiatives. Linking actors from the energy, development, and environment communities, REN21 leverages their successes and strengthens their influence for the rapid expansion or renewable energy worldwide.

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EXECUTIVE SUMMARY

This update covers major changes since mid-2005 when the Renewables 2005 Global Status Report *was written. Background and further information is contained in the original report, available at www.ren21.net.*

Record investment in new renewable energy capacity occurred in 2005—$38 billion, up from $30 billion in 2004. Germany and China were the investment leaders, with about $7 billion each, followed by the United States, Spain, Japan, and India. Wind power registered the second highest added capacity, almost as much as large hydropower, with existing capacity growing 24 percent to reach 59 gigawatts (GW). Biomass power production saw 50–100 percent increases in annual production in several countries in 2004. High growth rates also occurred in biodiesel (85 percent increase in annual production) and grid-connected solar PV (55 percent increase in existing capacity). Solar hot water existing capacity grew by 23 percent in China and reached record levels across Europe as well. And construction began in the United States and Spain on the world's first utility-scale solar thermal power plants in 20 years.

Country leadership changed or broadened in several areas. Germany leapt ahead of Japan in grid-connected solar PV, adding 600 megawatts (MW) in one year to achieve a higher cumulative capacity. The United States was the leader in wind power additions for the first time since 1992, while at the same time India's existing capacity surpassed wind-pioneer Denmark. Ten countries added over 300 MW of wind, up from five countries that did so in 2004. India passed Japan in total renewable power capacity. In ethanol, U.S. production caught up to Brazil, long the world's leading producer, and three new European Union (EU) countries became producers. In biodiesel, nine new EU countries became producers.

The renewables industry captured investors attention, as the number of renewable energy companies or divisions with market valuations greater than $40 million increased from 60 to 85. The estimated total valuation of companies in this category was $50 billion, double the 2004 estimate, as several high-profile initial public offerings took place. The solar PV industry invested record amounts in new plant and equipment (about $6 billion), as did the biofuels industry (more than $1 billion). The wind industry continued international production expansion, including in Australia and China, where Vestas, Gamesa, Suzlon, Acciona, and GE Energy were all establishing manufacturing facilities.

Policies were extended, revised, and added. Several EU countries revised or supplemented feed-in policies. The United States extended its production tax credit through 2007. A number of countries dramatically stepped up targets for biofuels and at least 10 states/provinces and six countries added blending mandates. Several EU countries enacted new biofuels tax exemptions. New feed-in laws were enacted in four states/provinces in India and Canada. Spain became the first country to mandate solar PV in new construction and the second country (after Israel) to mandate solar hot water in new buildings as a national policy. Initiatives for grid-connected solar PV multiplied, including California's new policy for a million solar roofs by 2017 and programs in several U.S. states, Australia, China, and the EU. New city-level targets appeared, including a proposal by Tokyo to reach a 20 percent share of renewables in primary energy consumption by 2020.

Developing countries took new steps in record numbers to incorporate renewables into their energy systems, including programs and new policy developments in Brazil, Chile, Colombia, Egypt, India, Iran, Madagascar, Malaysia, Mexico, Morocco, Pakistan, the Philippines, South Africa, Thailand, Tunisia, Turkey, and Uganda.

SELECTED INDICATORS AND TOP FIVE COUNTRIES

Selected Indicators	2004		2005
Investment in new renewable capacity (annual)	$30	▸	$38 billion
Renewables power capacity (existing, excl. large hydro)	160	▸	182 GW
Renewables power capacity (existing, incl. large hydro)	895	▸	930 GW
Wind power capacity (existing)	48	▸	59 GW
Grid-connected solar PV capacity (existing)	2.0	▸	3.1 GW
Solar PV production (annual)	1150	▸	1700 MW
Solar hot water capacity (existing)	77	▸	88 GWth
Ethanol production (annual)	30.5	▸	33 billion liters
Biodiesel production (annual)	2.1	▸	3.9 billion liters
Countries with policy targets	45	▸	49
States/provinces/countries with feed-in policies	37	▸	41
States/provinces/countries with RPS policies	38	▸	38
States/provinces/countries with biofuels mandates	22	▸	38

Top Five Countries	#1	#2	#3	#4	#5
Annual amounts or capacity additions in 2005					
Annual investment	Germany/China (equal)		United States	Japan	Spain
Wind power	United States	Germany	Spain	India	China
Solar PV (grid-connected)	Germany	Japan	United States	Spain	France
Solar hot water	China	Turkey	Germany	India	Austria/Greece/ Japan/Australia
Ethanol production	Brazil/United States		China	Spain/India	
Biodiesel production	Germany	France	Italy	United States	Czech Republic
Existing capacity as of 2005					
Renewables power capacity (excl. large hydro)	China	Germany	United States	Spain	India
Large hydro	United States	China	Brazil	Canada	Japan/Russia
Small hydro	China	Japan	United States	Italy	Brazil
Wind power	Germany	Spain	United States	India	Denmark
Biomass power	United States	Brazil	Philippines	Germany/Sweden/Finland	
Geothermal power	United States	Philippines	Mexico	Indonesia/Italy	
Solar PV (grid-connected)	Germany	Japan	United States	Spain	Netherlands
Solar hot water	China	Turkey	Japan	Germany	Israel

1. GLOBAL MARKET OVERVIEW

Renewable energy markets grew robustly in 2005. (See Table 1, p. 17.) Large hydropower increased by an estimated 12–14 gigawatts (GW) in 2005, led by China (7 GW added), Brazil (2.4 GW added), and India (over 1.3 GW added).[1] Small hydro increased by 5 GW to total 66 GW worldwide, with 38.5 GW existing in China alone as the boom in small hydro investment there continued.

Wind power was second in power capacity added, with 11.5 GW added and existing capacity growing by 24 percent to reach 59 GW. (See Figures 1 and 2, and Table 2, p. 18.) More than half of global wind power additions were in three countries: the United States (2.4 GW), Germany (1.8 GW), and Spain (1.8 GW). India jumped ahead of Denmark into fourth place in terms of total installed capacity, adding 1.4 GW in 2005. Strong growth took place in China, with 0.5 GW added to the previous existing 0.8 GW. Offshore wind installations grew by at least 180 megawatts (MW).

Biomass power generation and heat supply continued to increase at both large and small scales, with an estimated 2–3 GW power capacity added in 2005, bringing existing biomass power capacity to about 44 GW. Annual increases of 50–100 percent or more in biomass power production were registered for 2004 (most recent data) in several OECD countries, including Germany, Hungary, the Netherlands, Poland, and Spain. Other increases of 10–30 percent were registered in Australia, Austria, Belgium, Denmark, Italy, South Korea, New Zealand, and Sweden.[2] There is an increasing proliferation of small projects in developing countries, such as Thailand's "small power producers" program, which resulted by 2005 in 50 biomass power projects totaling 1 GW and several small-scale biogas power projects. Bagasse power plants are under development by the sugar industry in several countries, such as the Philippines and Brazil. Geothermal power saw continued growth as well, with contracts for an additional 0.5 GW in the United States and plants under construction in 11 countries.

Grid-connected solar photovoltaic (PV) continued to be the fastest growing power generation technology, with a 55 percent increase in cumulative installed capacity to 3.1 GW, up from 2.0 GW in 2004. (See Figure 3, and Table 3, p. 18.) More than half of the annual global increase occurred in Germany, which saw over 600 MW of PV installed in one year. Grid-connected solar PV increased by about 300 MW in Japan and 70 MW

Figure 1. Wind Power, Existing World Capacity, 1990–2005

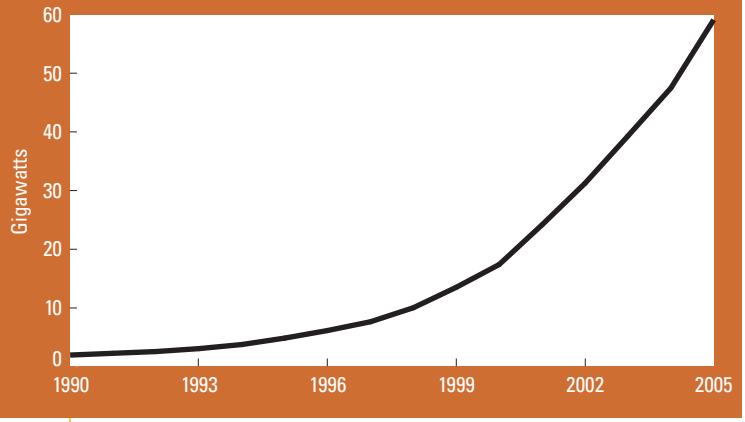


Figure 2. Wind Power Capacity, Top 10 Countries, 2005

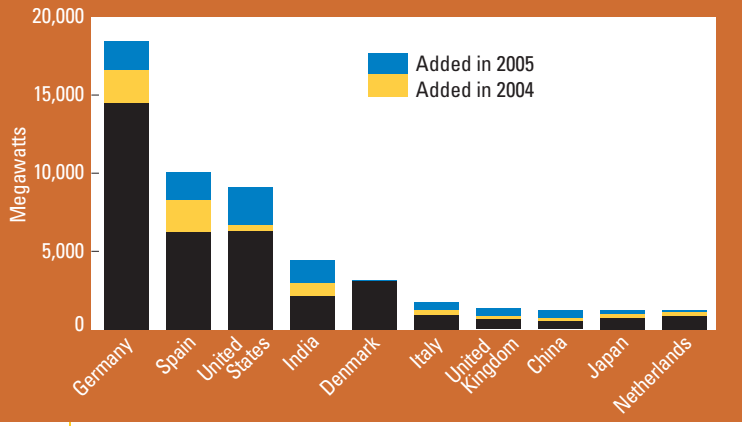


Figure 3. Solar PV, Existing World Capacity, 1990–2005

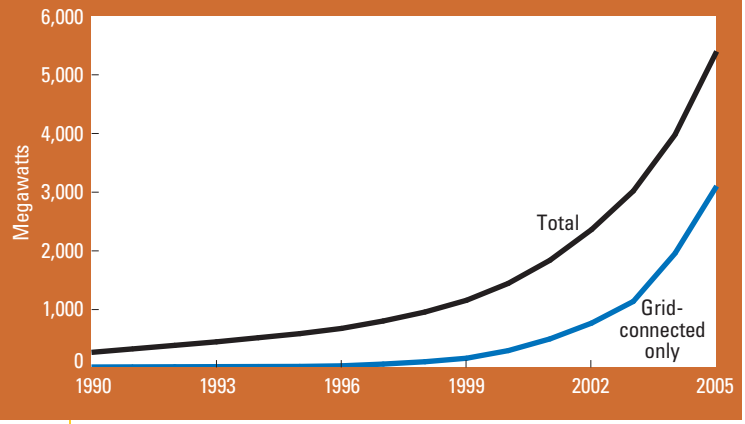


Figure 4. Renewable Power Capacities for Developing Countries, EU, and Top 6 Individual Countries, 2005

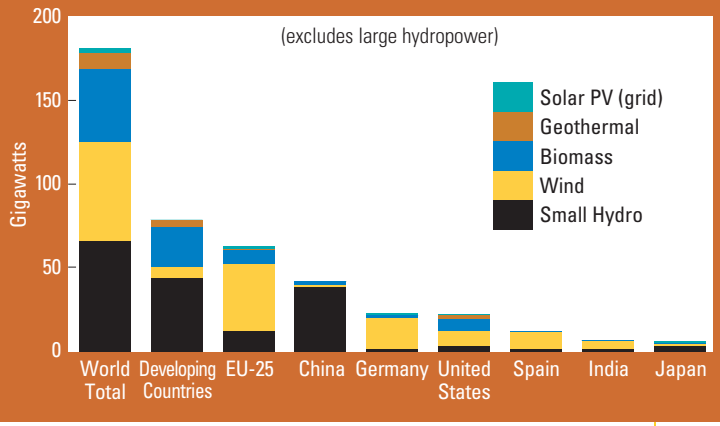


Figure 5. Solar Hot Water/Heating Capacity Added in 2005

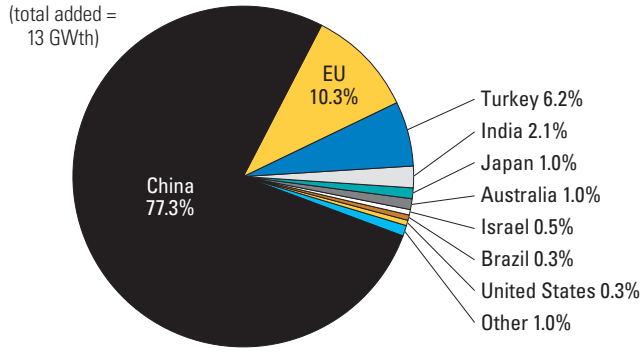
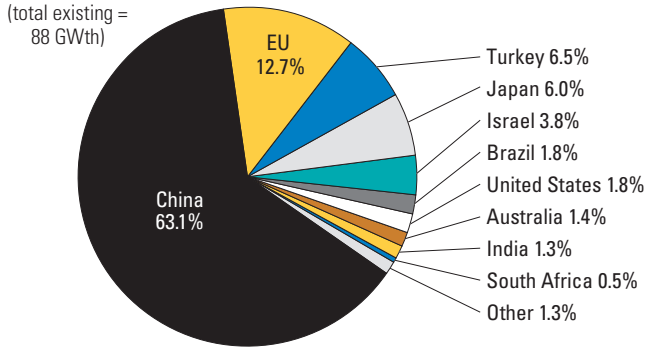


Figure 6. Solar Hot Water/Heating Capacity Existing in 2005



in the United States. Several milestones occurred in 2005, such as the commissioning of the world's largest solar PV power plant, 10 MW total, in Germany, and many large commercial installations of tens and hundreds of kilowatts (kW) each. German cumulative PV capacity exceeded Japan's for the first time. Including off-grid applications, total PV existing worldwide increased to 5.4 GW, up from 4.0 GW in 2004.[3]

Overall, renewable power capacity expanded to 182 GW, up from 160 GW in 2004, excluding large hydropower. (See Figure 4, and Table 4, p. 20.) The top six countries were China (42 GW), Germany (23 GW), the United States (23 GW), Spain (12 GW), India (7 GW), and Japan (6 GW). India's renewable power capacity exceeded Japan's for the first time. The capacity in developing countries grew from 70 GW to 80 GW, with China (small hydro) and India (wind) leading the increase. The developing-country share thus remained constant compared to 2004, at 44 percent. Including large hydropower, renewable power capacity reached 930 GW in 2005.

Existing solar hot water capacity increased by 14 percent to reach 88 gigawatts-thermal (GWth), up from 77 GWth in 2004, excluding unglazed swimming pool heating. (See Table 5, p. 21.) Accounting for retirements, 13 GWth of new capacity was added in 2005. China installed 80 percent of that new capacity (10.5 GWth) and remained the world leader, with over 60 percent of the global installed capacity. (See Figures 5 and 6.) Solar hot water in Europe increased by more than 1.3 GWth. India and several other countries saw an acceleration of solar hot water installations.

Ethanol production increased to 33 billion liters in 2005, up from 30.5 billion liters in 2004—an 8 percent increase, with most of this in the United States. Fuel ethanol production in the United States caught up to Brazil's for the first time, growing by 15 percent in 2005, as both remained the dominant producers. (See Figure 7, page 6.) Fuel ethanol consumption in Brazil was fairly stable, supplying 41 percent of all motor-vehicle fuel (non-diesel) sold, about the same as in 2004.[4] Brazil's vehicle market saw the continuing growth of "flex-fuel" vehicles, which attained a 70 percent share of the (non-diesel) vehicle market by 2005. The EU increased fuel ethanol production by 70 percent, although still at low levels relative to Brazil and the United States. Three new EU countries began to produce ethanol for the first time.[5]

Biodiesel growth far outpaced that of ethanol. Global production of biodiesel reached 3.9 billion liters, up from 2.1 billion liters in 2004. (See Figure 8, p. 6, and Table 6,

p. 22.) Biodiesel production increased by 75 percent in the EU, led by increases in Germany, France, Italy, and Poland, and tripled in the United States. Germany alone accounted for half of global biodiesel production in 2005. Nine EU countries began producing biodiesel for the first time in 2005, bringing to 20 the number of EU biodiesel producers.[6]

2. INVESTMENT FLOWS

An estimated $38 billion was invested in new renewable energy capacity worldwide in 2005, up from $30 billion in 2004.* (See Figure 9, p. 7.) Almost all the increase was due to increased investment in solar PV and wind power. Technology shares of the $38 billion annual investment were wind power (37 percent), solar PV (26 percent), solar hot water (11 percent), small hydropower (11 percent), biomass power and heat (7 percent), and geothermal power and heat (7 percent). An additional $15–20 billion was invested in large hydropower.

The largest country shares of annual investment were by Germany, China, the United States, Spain, Japan, and India. Investment in Germany and China increased from $6 billion each in 2004 to $7 billion each in 2005, mostly for wind and solar PV in Germany and for small hydro and solar hot water in China. The United States was number three, with about $3.5 billion, followed by Spain and Japan, with more than $2 billion each, and then India. (These figures do not include large hydropower; investment in large hydropower in China was an additional $10 billion in 2005, with 7 GW of new capacity installed. Thus, counting large hydropower, China's investment was about $17 billion.)

In addition to renewable energy capacity investment, the solar PV and biofuels industries made substantial capital investments in new manufacturing plant and equipment in 2005. Investment by the solar PV industry in 2005 was an estimated $6 billion and was expected to reach $8–9 billion in 2006. Investment in new biofuels production capacity worldwide exceeded $1 billion in 2005 and may reach $2 billion in 2006. The value of biofuels production plants under construction and announced construction plans through 2008 exceeded $2.5 billion in the United States, $3 billion in Brazil, and $1.5 billion in France.[7]

Development assistance for renewables investments in developing countries continued at a slightly faster pace in 2005, as increased commitments and special funds came into play. KfW committed €137 million ($170 million) to renewables in developing countries in 2005. The World Bank Group committed $150 million to renewables (excluding GEF funds and carbon finance) plus $420 million for large hydropower, both increases from 2004.[8] The Global Environment Facility continued as in 2004, with $100 million committed, about half of that for World Bank projects and the rest for other agencies. In addition, the "Special Facility for Renewable Energies and Energy Efficiency" announced at the "Renewables 2004" conference by the German government was launched in 2005 with funding of €500 million ($625 million). Established by KfW, this facility will provide concessional loans to public agencies through 2009 for investments in countries that form part of Germany's program of development cooperation. In 2005, the German government made financing commitments of €170 million ($210 million) under this facility.

Figure 7. World Fuel Ethanol Production, 2000 and 2005

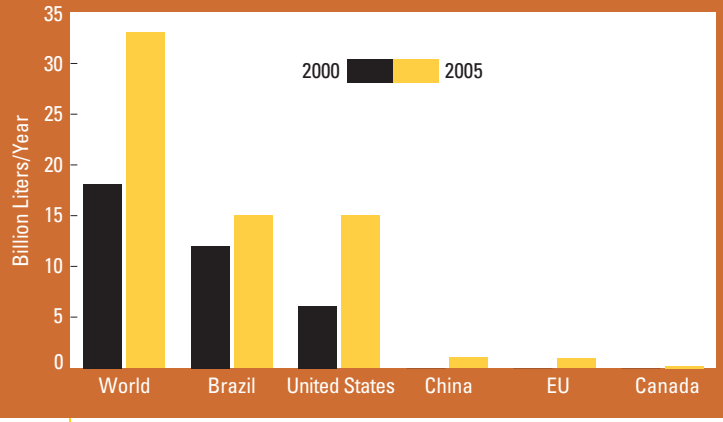
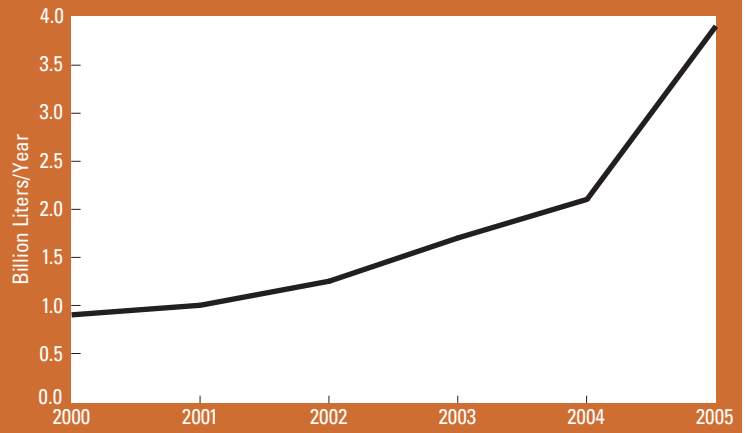
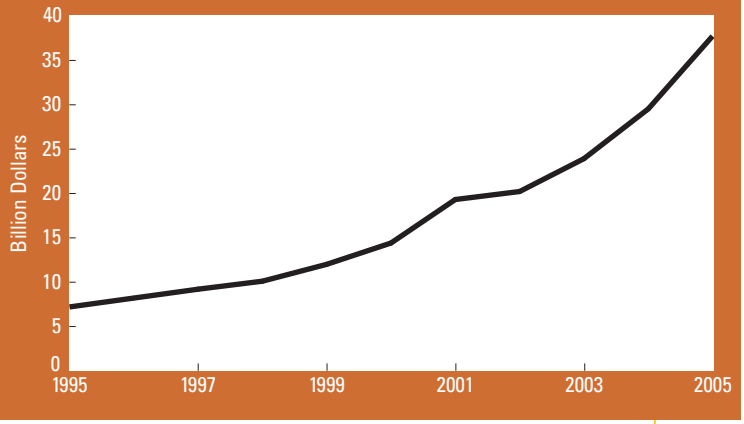


Figure 8. World Biodiesel Production, 2000–2005



* All dollar amounts in this report are in U.S. dollars unless otherwise indicated.

Figure 9. Annual Investment in Renewable Energy, 1995–2005



3. INDUSTRY TRENDS[9]

By 2006, at least 85 publicly traded renewable energy companies worldwide (or renewable energy divisions of major companies) had a market capitalization greater than $40 million. The number of companies in this category expanded significantly, from around 60 in 2005. The estimated total market capitalization of these companies and divisions in mid-2006 was more than $50 billion. Major additions during 2005–06 included Suntech Power (China), Suzlon (India), REC (Norway), and Q-cells (Germany), all with high-profile initial public offerings (IPOs). After their IPOs, the market capitalization of Suzlon, REC, and Suntech was over $5 billion each, although declines set in by mid-2006 for all of them.[10]

The largest number of companies is in the solar PV industry, which is becoming one of the world's fastest growing, most profitable industries. Global production increased from 1150 MW in 2004 to over 1700 MW in 2005. Japan was the leader in cell production (830 MW), followed by Europe (470 MW), China (200 MW), and the United States (150 MW). As in recent years, shortages of silicon continued to affect production. Capacity expansion plans by the solar PV industry for 2006–08 total at least several hundred megawatts and potentially two gigawatts.

The top European producer, Q-Cells, more than doubled production in 2005. The top Japanese companies increased production significantly in 2005: Sharp and Kyocera increased by more than 30 percent and Sanyo jumped to fourth place from seventh. In China, solar PV cell manufacturing more than tripled, from 65 MW to 200 MW, with manufacturing capacity of about 300 MW by year-end. Module production more than doubled, from 100 MW to over 250 MW, with production capacity approaching 400 MW by year-end. Three Chinese PV manufacturers announced plans to expand PV production by more than 1500 MW by 2008–10 (Nanjing CEEG PV Tech, Yingli Solar, and Suntech Power).

The wind industry expanded international production on several fronts. Vestas of Denmark, the leading manufacturer with 30 percent of the global market, opened a blade factory in Australia and planned a factory in China by 2007 to assemble nacelles and hubs. Nordex of Germany began to produce blades in China. Gamesa of Spain was investing $30 million to open three new manufacturing facilities in the United States. Gamesa, Acciona of Spain, Suzlon of India, and GE Energy of the United States were all opening new manufacturing facilities in China, with Acciona and Suzlon each investing more than $30 million.[11]

Two new domestic Chinese wind turbine manufacturers entered the market in 2005–06. Harbin Electric Machinery Co., one of the biggest producers of electrical generators in China, completed design and testing of a 1.2 MW turbine and was working towards production. Harbin's turbine was entirely its own design, to which it claimed full intellectual property rights, the first such instance by a Chinese manufacturer. Dongfang Steam Turbine Works began producing a 1.5 MW turbine and installed four of these in 2005. These two companies bring to four the number of existing Chinese manufacturers, who together produced 29 percent of the turbines installed in China in 2005.[12]

The wind industry saw demand exceed supply in 2005, as the U.S. market jumped from 390 MW in 2004 to over 2400 MW in 2005 due to renewal of the production tax credit (PTC) in late 2004 after expiration in 2003. This dramatic jump in demand helped push up turbine prices (along with other factors like high commodity prices). According to some industry observers, the global wind industry has been reluctant to increase production capacity to accommodate a permanent increase in the U.S. market, as the production tax credit will again expire in 2007 unless renewed, but such reluctance may be changing as other markets grow.

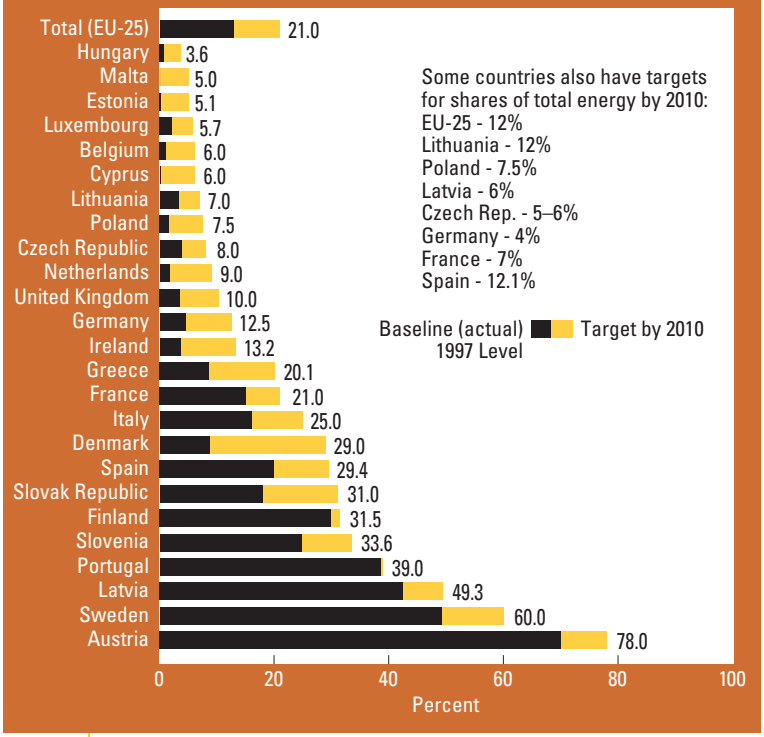
The geothermal heat pump industry has become quite dynamic in recent years. There are several dozen European manufacturers, the largest of which are found in the principal markets of Sweden, Germany, Switzerland, and France. The market is becoming controlled more and more by large industrial groups that are buying out specialized geothermal heat pump companies.[13]

The concentrating solar thermal power (CSP) industry saw construction began on a 64 MW trough plant in the U.S. state of Nevada and a 10 MW central receiver plant in Spain, the first utility-scale projects since the 1980s. Other plants in Spain were scheduled to begin construction in 2006.[14]

The ethanol industry expanded in North America and

Europe. By the end of 2005, there were 95 operating ethanol plants in the United States, with total capacity of 16.4 billion liters/year. In mid-2006, an additional 35 plants were under construction and 9 plants were being expanded, representing an added capacity of eight billion liters/year. And six new ethanol plants with capacity of 0.7 billion liters/year were under construction in Canada. Brazil had over 300 plants operating, and 80 new distillers were licensed in 2005. The Brazilian ethanol industry was poised for a major jump during 2006–08, as part of a new national plan to increase sugar cane production by 40 percent by 2009.[15] The biodiesel industry similarly expanded. The EU had operating capacity of over 6 billion liters/year by mid-2006. There were 53 operating plants in the United States, with a capacity of 1.3 billion liters/year, and an additional 44 plants under construction that would double capacity. Canada had two operating plants with capacity of 0.1 billion liters/year.

Figure 10. EU Renewable Energy Targets—Share of Electricity by 2010



4. POLICY LANDSCAPE

Policy Targets for Renewable Energy

Policy targets for renewable energy were supplemented, revised, or clarified in a number of countries in 2005–06. France, in addition to its existing target of 21 percent of electricity by 2010, announced new targets of 7 percent primary energy by 2010 and 10 percent by 2015. The Netherlands announced an additional target of 10 percent of primary energy by 2020. Spain set new targets in 2005 to increase the share of primary energy from renewables from 6.9 percent in 2004 to 12.1 percent in 2010, with specific capacity targets for each technology.[16] Three EU countries have revised electricity-share targets from those shown in the *Renewables 2005 Global Status Report* (see Figure 10): Finland's target is now 31.5 percent (shown as 35 percent in the 2005 report); Portugal's target is now 39 percent (shown as 45.6 percent); and the Netherlands' target is now 9 percent (shown as 12 percent). Thailand clarified its target for 8 percent of primary energy by 2011, which could add more than a gigawatt of new power capacity.[17]

China announced and was finalizing a revised target for 16 percent of primary energy from renewables by 2020, including large hydro, up from a 7.5 percent actual share in 2005. Development planning includes technology targets by 2020 of 300 GW of hydro, 30 GW of wind power, 30 GW of biomass power, 1.8 GW of solar PV, and smaller amounts of solar thermal power and geothermal. For solar hot water, a previous target was revised to 300 million square meters (m^2) by 2020. Biofuels would increase to 15 billion liters by 2020.

India, in addition to its short-term target of 10 percent of added power capacity by 2012, has proposed long-term targets by the year 2032 in several categories, including 15 percent of power capacity; 10 percent of oil consumption substituted by biofuels, synthetic fuels, and hydrogen; and 100 percent use of solar hot water in all possible applications (with full coverage of users like hotels and hospitals by 2022). New short-term targets by 2012 include full use of cogeneration in the sugar and other biomass-based industries.

Four new countries with renewable energy targets or goals were identified, bringing to 49 the total number of countries worldwide with policy targets. Croatia established a goal of 400 MW from renewables; Jordan announced a strategy to achieve 15 percent renewable energy by 2020; Nigeria plans to expand renewables to 7 percent of power generation by 2025; and Pakistan has a target of 5 percent of power generation by 2030, including 1100 MW of wind power as a short-term goal.[18]

Two U.S. states set policy targets in 2005: Vermont and Illinois. Vermont requires utilities in the state to meet all new load growth through 2012 with renewable energy and energy efficiency. Illinois targets 2 percent by 2006 and 8 percent by 2013. This increases the number of states/provinces in the U.S. and Canada with policy targets to 31 (including 22 states/provinces with renewable portfolio standards, or RPS, policies).[19]

A 2006 report by EurObserv'ER analyzed progress with EU renewable energy targets for 2010. According to the report, the EU share of primary energy from renewables grew from 5.1 percent in 2002 to 5.6 percent in 2004 (against a target of 12 percent by 2010), and the European Commission (EC) now anticipates a level of 9 percent by 2010. The share of power generation from renewables actually fell, from 14.9 percent in 2003 to 14.2 percent in 2004 (against a target of 21 percent by 2010), and the EC now anticipates a level of 18 percent by 2010. Three countries—Slovenia, Finland, and Denmark—are close to meeting their targets, and one country—Latvia—has already exceeded its target, although hydropower output in some countries can make for significant year-to-year fluctuations.

Power Generation Promotion Policies

Several EU countries revised or supplemented their feed-in laws in 2005–06, including Austria, the Czech Republic, France, Greece, Ireland, the Netherlands, and Portugal. Austria supplemented its feed-in tariffs with additional support of over €190 million ($240 million) in investment subsidies through 2012. The Czech Republic adopted a new feed-in law that establishes tariffs for all renewables technologies. France extended its feed-in law to cover re-powered and renovated facilities exceeding €800–1000 ($1000–1250) per kW of new investment, which now qualify for higher tariffs. Greece reduced permit requirements, set new tariffs, added solar thermal power, and provided subsidies and tax credits. Ireland replaced its competitive tendering system with a new feed-in policy and established new tariffs. The Netherlands revised feed-in tariffs through to 2007. Portugal adopted a new tariff calculation formula that accounts for technology, environmental impacts, and inflation. And Italy's new national feed-in tariff for solar PV, established in 2004, became operational in 2005, with a first 100 MW of allocations subscribed quickly and expectations for at least 60 MW in 2006.[20]

In 2006, Ontario became the second province in Canada, after Prince Edward Island, to enact a feed-in tariff.[21] The Indian states of Karnataka, Uttaranchal, and Uttar Pradesh also adopted feed-in tariffs in 2005, bringing to six the number of Indian states with feed-in policies. The state of Maharashtra also updated its 2003 wind-power feed-in policy to include biomass, bagasse, and small hydropower generation. These new policies in Canada and India increased the numbers of states/provinces/countries worldwide with feed-in policies from 37 to 41. (See Table 7, p. 23.) New production incentives, called limited feed-in tariffs by some, were also appearing in several U.S. states, including Minnesota, New Mexico, and Wisconsin.[22]

Although the number of states/provinces with RPS polices remained constant, four U.S. states updated their policies in 2005. (See Table 8, p. 23.) New Jersey raised its target to 22.5 percent. Nevada extended its portfolio standard by two years and increased the final requirement by 5 percent (to 20 percent by 2010) while allowing for partial compliance using energy efficiency measures. Connecticut now requires 1 percent of utility supply from distributed generation, increasing to 4 percent by 2010. And Wisconsin now requires 10 percent from renewables by 2015. Arizona planned to revise its requirement later in 2006 to 15 percent by 2020, from an original 1.1 percent by 2007.

New solar PV promotion programs continued to appear around the world, at national, state/provincial, and local levels. The U.S. government enacted a 30 percent federal tax credit for solar PV, valid through 2007.[23] California extended its solar PV subsidy program to 2011 and enacted a $3.2 billion, 11-year plan to install 3 GW of solar PV by 2017 for homes, schools, businesses, and farms—the "California Solar Initiative."[24] Three other U.S. states also enacted new investment subsidies and tax credits for solar PV: Connecticut ($0.20–0.50/watt), Maine ($1–3/watt), and New Mexico (30 percent tax credit). Australia extended its solar PV subsidy program through 2006, providing Aus$4/watt ($3/watt) subsidies.[25] Sweden earmarked SEK 100 million ($12 million) to subsidize solar PV on public buildings under a three-year program. Shanghai launched an initiative to install PV systems on 100,000 rooftops.[26] And Spain became the first country in the world to require solar PV on new buildings as a national policy, with a new building code enacted in early 2006 that requires solar PV in new construction and renovation of certain types of buildings, including shopping centers, office buildings, warehouses, hotels, and hospitals exceeding certain size limits.[27]

A number of developing countries were working on enacting or strengthening renewable energy promotion policies and programs. Egypt was working to develop wind power; Madagascar established a new program for hydropower; Turkey passed a new renewable energy promotion law in 2005; Uganda wrote and was expected to approve a new renewable energy policy in 2006; Iran was developing a new promotion law and also started to allow independent power producers; India announced a new national tariff policy in early 2006 that aims to promote renewable power generation, including quotas, preferential tariffs, and guidelines for pricing 'non-firm' power; And Thailand was working on a feed-in policy for very small power producers. Public bidding in Brazil for future electricity supply was ongoing for small hydro, wind, and biomass (bagasse) power as part of the PROINFA program. Pakistan initiated a limited feed-in tariff to boost wind power development, with a 9.5 cents/kWh tariff established for approved projects and competitive selection of project developers underway for two 50 MW projects.* Pakistan also waived import duties for wind turbines and was con-

* All cent amounts in this report are in U.S. cents unless otherwise indicated.

sidering a broader renewable energy promotion law.[28]

In Mexico, an anticipated renewable energy promotion law was sanctioned by one chamber of the national congress in 2005 and passage was expected in 2006. An accelerated depreciation allowance for renewable energy investments was enacted, and an existing "self-supply" law from 2001 was clarified with new regulations, allowing self-generation to be wheeled to the point of consumption—a form of net metering.

The widely anticipated China feed-in law enacted in 2005 took effect at the start of 2006 as part of the broader renewable energy promotion law. Contrary to expectations, the feed-in tariff did not apply to wind power, only to biomass. Biomass power tariffs are set at province-specific average coal prices plus a premium of RMB 0.25/kWh (3 cents/kWh). Wind power tariffs are established through the ongoing process of competitive bidding (concessions). A third round of wind power concession bidding took place in 2005, following rounds in 2003 and 2004, with four projects awarded an additional 450–650 MW, and a fourth round was to take place in 2006 for an additional 700 MW.[29]

Other countries boosted or extended policy support. Public competitive bidding policies continued in Quebec, Canada, when Hydro-Quebec issued a second solicitation for 2000 MW of wind power in 2005, following the first solicitation for 1000 MW in 2004.[30] The United States extended its production tax credit (PTC) through the end of 2007, and extended the credit to other renewables technologies besides wind. Ireland announced 265 million ($330 million) in extra subsidies to support renewables over the next five years, including 65 million ($80 million) funding for renewable energy investments. Sweden enacted a 30 percent tax credit for household solar PV and investments to replace heating oil with biofuels. Overall, Sweden allocated SEK 500 ($70 million) each for 2007 and 2008 for energy efficiency and renewable energy.[31]

Solar Hot Water/Heating Policies

Solar hot water policies continued to be enacted in Spain. In early 2006, the Barcelona city government approved a new solar hot water ordinance, upgrading the existing one by eliminating the minimum energy demand threshold—meaning all new buildings are now subject to the ordinance.[32] By early 2006, more than 70 municipalities and cities throughout Spain had adopted similar municipal solar ordinances. In March 2006, inspired by these ordinances, a new national building code was enacted that requires minimum levels of solar hot water and solar PV in new construction and renovation. Solar hot water must meet 30–70 percent of hot water energy needs, depending on climatic zone, consumption level, and back-up fuel.[33]

Beyond Spain, a number of cities were working on solar hot water policies during 2005, such as Cape Town, South Africa, and Rome, Italy (with a requirement for 30–50 percent of energy for new buildings). Other states and countries added or modified subsidies for solar hot water. The U.S. state of Maine introduced a 25 percent investment subsidy.[34] California will begin a pilot program to support solar hot water. The United States also enacted a federal 30 percent tax credit for solar hot water through 2007. A number of countries in North Africa and the Middle East were continuing to develop solar hot water policies, building codes, and/or promotion programs, including Tunisia, Morocco, Egypt, Jordan, and Syria.

Biofuels Policies

A turning point for biofuels policies occurred in 2005–06, when several countries dramatically stepped up targets and mandates for biofuels. In the EU, several countries took new measures. France established an ambitious biofuels plan, with goals of 5.75 percent by 2008 (two years earlier than the EU target), 7 percent by 2010, and 10 percent by 2015. Belgium set a 5.75 percent target for 2010. Germany mandated biofuels blending for the first time, requiring 4.4 percent biodiesel blending and 2 percent ethanol blending starting in 2007, increasing biodiesel blending to 5.75 percent by 2010.[35] Italy mandated 1 percent blending for both ethanol and biodiesel. As part of a strategic energy review by the Commission of European Communities, the EU presidency voiced a proposal to set a new EU-wide biofuels target of 8 percent by 2015.

EU countries have also been enacting biofuels tax exemptions. Such exemptions now exist in at least 8 EU countries, most of these enacted during 2005–06, including France, Germany, Greece, Ireland, Italy, Spain, Sweden, and the United Kingdom. Ireland announced 265 million ($330 million) in extra subsides to support renewables over the next five years, including 200 million in excise tax relief for biofuels.

In the United States, a renewable fuel standard was enacted in 2005 that requires fuel distributors to increase the annual volume of biofuels blended up to 7.5 billion gallons (28 billion liters) by 2012 (although this target was expected to be met anyway through tax incentives). The federal government also extended a 43 cents/gallon (12 cents/liter) biodiesel tax credit for blenders through 2008. The state of Wisconsin mandated partial biofuels blending for government vehicles.[36] Washington state now mandates B2 blending. Several other states now offer production incentives and sales tax reductions or exemptions.

Besides the EU and United States, new blending mandates have appeared in Brazil, Canada, Colombia, Malaysia, and Thailand. In Canada, the province of Saskatchewan began mandating E7 in 2005, while Ontario will mandate E5 (average) blending by 2007. National blending mandates appeared for large cities in Columbia (E10). Malaysia will require B5 by 2008. Four provinces in China added man-

dates for blending in major cities, bringing to nine the number of provinces with blending mandates. The Dominican Republic will require E15 and B2 by 2015. Brazil started to allow B2 blending in 2005 and will require it starting in 2008, increasing to B5 by 2013. Thailand is phasing in a national E10 blend by 2007 and also established a 3 percent biodiesel target by 2011, to be achieved by promoting biodiesel in specific regions through 2010.[37] The Philippines was considering E10 and B1 blending, with a proposed goal of 25 percent E10 fuel by 2010.[38] The result of recent policy activity is that biofuels blending mandates now exist at the national level in at least eight countries and at the sub-national level in at least 30 states and provinces.[39]

Municipal-Level Policies

Cities around the world, both large and small, continued to set targets for renewable energy shares and enact policies promoting renewable energy. London announced a target to reduce carbon dioxide emissions by 20 percent by 2010, relative to 1990 levels, and by 60 percent by 2050. New York City had set a target in 2002 for 20 percent reduction by 2010 from 1995 levels; this was supplemented by a "U.S. Mayor's Climate Protection Agreement" in 2005 targeting 7 percent reduction from 1990 levels by 2012. During 2005 and 2006, New York City was joined by more than 200 other U.S. cities, representing a combined population of 41 million people, in making the same agreement. In 2006, Tokyo proposed an ambitious target of 20 percent of total energy consumption in the city by 2020. Currently, renewables supply about 2.7 percent of Tokyo's total energy demand. The target was to be formally adopted by 2008 as part of Tokyo's "Environment Basic Plan," and a number of policies were to be considered for achieving the target. In Japanese towns, local cooperatives for renewables gained in 2006, with 7 MW of citizen-owned wind farms commissioned at four sites.[40]

5. RURAL (OFF-GRID) ENERGY

Progress with rural use of renewable energy is difficult to track comprehensively on a year-by-year basis, particularly traditional and modern biomass use, which continues to dominate rural energy consumption. A comprehensive update of the rural energy section of the Renewables 2005 Global Status Report *will await future editions and an expanded network of regional correspondents. Below are some highlights.*

Rural electrification policies and programs using renewable energy continued to emerge and progress. The China Township Electrification Program finished in 2005 after electrifying about 1.3 million rural people in 1,000 townships (about 200,000 households) with solar PV, small hydro, and a small amount of wind power. During 2006, China was planning the next program, which will focus on villages, with plans to electrify 10,000 villages and 3.5 million rural households with renewables by 2010, including small hydro and up to 270 MW of solar PV. Full rural electrification is planned by 2015. In Brazil, the "Luz para todos" program had electrified half a million households out of its goal of 2.5 million, but was focusing first on grid connections, with the 200,000 households targeted for renewable energy to come later.[41] (This apparent trend, to focus on renewables in later phases of rural electrification programs, was visible in other Latin American countries as well.) The Thailand rural electrification program using solar home systems continued in 2005 and 2006, with 190,000 cumulative households, and was to finish in 2006 with 200,000 households. In Sri Lanka during 2005, another 900 off-grid households were electrified with small hydro and 20,000 with solar PV.

New rural electrification programs using renewables were launched or announced in a few additional countries, including Bolivia, which targets 50 percent access by 2015 and full access by 2025. Bolivia plans 20,000 solar home systems as part of the program by 2008. Honduras and Ethiopia both announced new universal access goals, with a share of households to be served with renewables, joining the ranks of Argentina, Bolivia, Brazil, Chile, China, and Thailand, among others. Ethiopia's goal is to increase access from 15 percent to 50 percent within five years. Pakistan now plans electrification of 8,000 villages with renewable energy under a program beginning in 2006. A pilot was completed for 400 households in four villages using 90-watt solar PV systems, and a $19 million development plan was approved for a first phase of 400 villages.[42]

India's Integrated Rural Energy Program using renewable energy had served 300 districts and 2,200 villages by early 2006. More than 250 remote villages in seven states were electrified under the program during 2005, with additional projects under implementation in over 800 villages and 700 hamlets in 13 states and federal territories. Rural applications of solar PV had increased to 340,000 home lighting systems, 540,000 solar lanterns, and 7,000 solar-power water pumps. There were 600,000 solar cookers in use. India has recently proposed to augment cooking, lighting, and motive power with renewables in 600,000 villages by 2032, starting with 10,000 remote un-electrified villages by 2012. India also has achieved 70 MW of small-scale biomass gasification systems for rural (off-grid) power generation.

The number of biogas users continued to increase in China, India, and Nepal. China reported 17 million existing biogas users in 2005, up from previous reports of 12 million. Biogas remains a priority in India, with about 3.8 million household-scale biogas plants now reported installed, up from prior reports of 3.7 million, and 66,000 new plants were expected to be installed from early April 2005 to April 2006. Nepal was providing 75 percent subsidies for family-

scale biogas plants.

Anecdotal evidence continues to accumulate about a variety of applications. In the Philippines, there are now some 130 PV-powered drinking water systems and 120 telecommunications systems, with average capacity of about 1 kW each. The Philippines also commissioned a 28 kW solar PV village power plant for 200 households. Nepal was providing 75 percent subsidies for solar-powering drinking water pumping in addition to the family-scale biogas plants. Uganda and Kenya, among others, continued with programs for solar lighting in rural classrooms and clinics. Cambodia conducted its first village electrification project using biomass gasification, with 7 kW installed, a further 27 kW approved, and planning for 3,000 villages.

The number of solar home systems added in 2005 was more than 270,000 in 2005, bringing the world total to around 2.4 million households. This includes over 120,000 added in China (where a World Bank/GEF project had cumulatively installed 350,000 systems by 2005); more than 90,000 added in Thailand; more than 20,000 each added in India, Sri Lanka, and Bangladesh; and smaller numbers added in other countries.[43]

Many household stove programs are currently under way around the world, and new commitments are being made. Improved biomass stove programs continue in Africa, with 150,000 new stoves in Uganda, 40,000 in Malawi, and 60,000 in Ethiopia reported in recent years through international assistance programs. Several African countries committed to provide access to modern cooking energy at the Bonn "Renewables 2004" conference, such as Morocco for one million improved stoves by 2015 and Uganda for 10,000 improved stoves by 2008. More recently, the Forum of Energy Ministers of Africa, founded in 2005, committed to having 50 percent of Africans living in rural areas and using traditional biomass for cooking gain access to modern energy services such as improved cook stoves within 10 years. The UN Millennium Project proposed that countries reduce the number of people without effective access to modern cooking fuels by 50 percent, and make improved cook stoves widely available by 2015. The Economic Community of West African States committed to providing modern cooking energy to 100 percent of the rural population, or over 300 million people.

SPECIAL SUPPLEMENT: PRIVATE FINANCE AND INVESTMENT TRENDS

The purpose of this special supplement is to trace the types of financing flows for renewable energy and to gauge trends in attitudes and perceptions of financiers with regard to renewable energy investments. This supplement complements and supports the factual information presented above with greater insight into trends and ideas about the future. It is based on review of articles, reports, and publications, as well as direct interviews with a number of leading experts from the international finance and renewable energy business communities, primarily in Europe and the United States.

This supplement represents the preliminary step of an evolving process by the UNEP/BASE Sustainable Energy Finance Initiative (SEFI), in collaboration with REN21, to provide a regular source of quantitative and qualitative information on financing flows for renewable energy designed to serve both the policy and finance communities. SEFI invites experts in renewable energy finance to contribute insights, ideas, and information to make this type of investment report a comprehensive, reliable, and useful service.

The year 2005 witnessed record investment in new renewable energy capacity. In interviews with major renewable energy investors, entrepreneurs, and technology developers, some attributed growth to domestic policy environments, some to Kyoto Protocol ratification, and others to local market drivers.[44] Investors in North America emphasized the importance of consumer preferences, while Asian investors noted political support globally. There was consensus, however, that increasing technological maturity, growing staff expertise, and better understanding of technology risk were key drivers behind the growth. Katherine Brass from GE Energy put it simply: "We've got the experts, we know the risks, we understand the technology and we know [how the technology needs to progress] if we want to see a greater percentage of the power portfolio from wind."[45]

A look at renewable energy finance and investment reveals 10 key trends, elaborated below: (1) global investment is growing in all regions, but emerging markets are expected to become the core; (2) sector preferences reflect the maturity and potential of the technology; (3) private investors are becoming more bullish due to policies and political factors; (4) investment banking firms are showing interest; (5) venture capital favors clean energy; (6) the bond market is starting to finance wind farms; (7) private equity investments slowed in 2006; (8) renewable energy company valuations have skyrocketed; (9) mergers and acquisitions remain buoyant; and (10) market growth looks set to remain sturdy.

(1) Global investment is growing in all regions, but emerging markets are expected to become the core.

The majority of firms interviewed agreed that China, Brazil, and India will eventually be the largest renewable markets, but they were still focusing their activity in Europe and the United States. Dexia, HVB, GE Energy, and Ormat Technologies were concentrating on core markets in industrialized countries.[46] Some investors focused exclusively on specific markets, such as wind power in Central Europe, because, "while that may not be the biggest market, it is the market we know." This suggests that expert knowledge, company contacts, and understanding of local circumstances can keep investors in familiar markets. Still, many foresee turning their attention to Asia in the near future. According to one industry analyst, "The emerging markets won't be emerging any more; they'll be core markets." China is perceived as the top investor in renewable energy worldwide. Ernst & Young's Renewable Energy Country Attractiveness Indices highlights the progress made in India.[47] India has replaced the United Kingdom in fourth place in the Long-Term ALL Renewables Index and Germany in third place in both the Long-Term and Near-Term Wind Indices. The Ernst & Young report also suggests that India will exceed its 5,000 MW wind capacity target in 2006.

(2) Sector preferences reflect the maturity and potential of the technology.

Clean Edge, a U.S.-based market tracker, projects that markets for solar PV and wind will each grow from their current level of $11–12 billion to $50 billion by 2015. The solar PV industry has been receiving the most attention, probably because it is growing the fastest, with wind right behind. Overall, projections for solar and wind power varied: investors acknowledged that intermittent power sources have inherently capped growth potential, yet at the same time, wind power was cited as the most promising area for growth in emerging markets such as Eastern Europe and North Africa. North American investors also emphasized growing interest in wind, due to improved technology and expertise.[48] In 2005, there was new interest in the biofuels market worldwide. Many investors speculated that biofuels would emerge as a major market player in the coming decades, because "it's a steady, not intermittent source of fuel. The problem with solar is that it's intermittent, so until we can store it, the market will never capture more than 20 percent of grid needs. But biofuels can really expand, and that's their appeal."[49] Biofuels sales reached $16 billion globally in 2005, achieving a 15-percent increase over 2004.[50] Overall, interviewees concurred that solar PV and biofuels were the highest growth markets—solar because of its maturity and biofuels due to its potential.[51]

(3) Private investors are becoming more bullish due to policies and political factors.

Private-sector players are adopting a more bullish approach within increasingly favorable political environments. Investors frequently note that policy framework conditions are an important determinant of future decisions to invest. According to a 2005 prognosis by *CleanEdgeNews*, markets for biofuels, solar PV, wind energy, and fuel cells are poised to expand four-fold, to $170 billion in global revenues by 2015.[52] Not only an increasing array of supporting policies, but also long-term political priorities are attracting attention. Christian Unger, Head of Energy at Bank of Austria, uses International Energy Agency data to arrive at "the breathtaking figure of $16 trillion [that] will be invested in the energy sector until 2030." He cites oil prices, national security considerations, and the need for increased fuel autonomy as the driving factors.[53]

(4) Investment banking firms are showing interest.

Steven Greenwald, head of project finance with Credit Suisse First Boston's Energy Group, notes that "capital markets are starting to get comfortable with this space."[54] Examples include Goldman Sachs, which invested $10 million in a waste-to-energy biotechnology company in 2005, following its purchase the previous year of Horizon Wind Energy (formerly Zilkha Renewable Energy), a U.S. wind farm developer.[55] Citigroup's Sustainable Development Investment Program in 2005 invested in Balrampur Chini Mills Ltd., one of the largest sugar producers in India, a company that intends to expand its ethanol manufacturing capacity.[56] In addition, investment bank UBS AG and Diapason Commodities Management S.A. launched the first-ever biological fuels global index in the first quarter of 2006, which covers commodities used in the production of ethanol and biodiesel.[57]

(5) Venture capital investments are favoring clean energy.

Venture capital investments are favoring clean energy over fossil fuels, because clean energy technology is more in line with the venture capital risk/reward profile than conventional energy. Typically, returns in clean energy technology are in the 20 percent or higher range. Three of the hottest initial public offerings in 2005 were in the solar PV industry. The 'European Liquidity Report' from Dow Jones Venture One, which details trends in venture-backed IPOs, notes that the largest such IPO in 2005 was the German renewable energy company Q-Cells, which was valued over 1 billion after its initial public offering, with current market capitalization approaching 2 billion.[58]

Smaller companies for other technologies, including wind and biofuels, are receiving venture capital investments in anticipation of similar gains in going public. John Doerr of Kleiner Perkins Caufield and Byer, a venture capitalist recognized for astutely investing in Google before it went public, said at a recent conference that the single largest economic opportunity of this century would be the clean technology sector. According to the *2006 Cleantech Venture Capital Report* on North American venture capital investing, devotion to the clean technology segment is on the upswing.[59] During the dot-com bubble era of 1999–2001, up to 3 percent of all venture capital was carved out for clean tech investments. That commitment inched up to 5–6 percent from 2002 to 2005. By 2009, the report suggests it will jump to 10 percent of all venture capital investment activity, which could amount to $6–9 billion.

(6) The bond market is starting to finance wind farms.

A noticeable trend is the financing of wind farms through the bond market, as this provides longer term and less expensive financing than conventional loans that mature in 12–14 years. Banks are also financing projects by bundling assets from several wind farms to provide collateral for bonds. Alex Moss, senior credit analyst at Insight Investment Management, says, "The trend now is to pool different projects together" so that "it doesn't matter if one wind farm doesn't work." Italian Bank UniCredit's HVB Group, for example, sold nearly $600 million in bonds in May 2006 to pay for 39 wind farms in France and Germany. Dagmar Buhl of HVB believes the market may grow to 5 billion ($6 billion) in coming years. Alte Liebe, which owns eight German wind farms, sold 102 million ($120 million) of bonds due in 2025.[60]

(7) Private equity investments slowed in 2006.

In contrast to banks or venture capitalists or bond investors, private equity investors appear to have lost some interest in renewable energy, as it fits less well with their investment strategy. Private equity investors acquire controlling stakes in companies using high levels of debt and look for companies with strong cash flow. Analysis by New Energy Finance suggests that private equity investments in clean energy slowed in the first half of 2006, whereas venture capital investments were over 60 percent higher than in 2005. However, this is likely a temporary phenomenon, due to the surge of activity in late 2005 and supply bottlenecks in the solar and wind sectors. Vincenzo La Ruffa of the private equity firm NGP Energy Technology Partners believes that the slowdown in private equity is likely to be short-lived and anticipates that, "by the end of the year, you're going to see more funds at least partially devoted to energy technology…. I think you're going to see growth in all stages—in the seed stage, early-stage growth capital, and in buyouts—whereas traditionally, outside of very few discrete investments, it's been mostly an early-stage game."[61]

(8) Renewable energy company valuations have skyrocketed.

London's Alternative Investment Market (AIM) is a lead

listing candidate for clean energy technology because it is less regulated than the U.S. market.[62] Since late 2004, 26 clean energy companies have issued initial public offerings (IPOs) on AIM or carried out secondary offerings.[63] During 2005, the value of AIM's clean energy stocks rose by 29 percent—a performance bested only by Frankfurt's market.[64] In general, smaller clean energy technology companies list on the AIM market, while larger companies often court NASDAQ.[65] As noted in Section 3 of this report, the market capitalization of leading renewable energy companies and divisions valued at over $40 million each jumped from $25 billion in mid-2005 to $50 billion by mid-2006. In the United States, more and more solar-related companies are becoming public, a trend that began markedly in 2005.[66]

Against the background of this market activity, it is important to note that significant market correction has been necessary. New Energy Finance's NEX index (87 clean energy stocks that include technology, equipment, and asset owners on 18 markets internationally) grew by 29 percent compound from December 2002 to December 2005. During the first 19 weeks of 2006, the index climbed 41 percent and then crashed. By mid-2006 it was up only 9.5 percent on the year. The reasons for the correction, according to New Energy Finance's Michael Liebreich, include over-exuberance in valuations, particularly in solar PV; the crash in EU Emissions Trading Scheme prices; general market conditions; and supply bottlenecks in wind, solar, and biofuels.

(9) Mergers and acquisitions by major renewable energy companies remain buoyant.

Acquisition prices suggest a willingness to pay substantial sums. Two of Australia's biggest renewable energy generators, Pacific Hydro and Southern Hydro, were acquired in 2005 for a total price of Aus$2.3 billion ($1.7 billion), and the Swedish market power producer Vattenfall bought Swedish Offshore Wind for $12.7 million to construct the $1 billion Kriegers Flak wind farm in the Baltic Sea.[67] New Energy Finance suggests that merger and acquisition activity in the global renewable energy sector has been growing at just under 50 percent per annum for five years, reaching $14 billion in 2005 and, furthermore, activity in the already acquisitive solar PV sector is forecast to increase.[68] According to Walter Nasdeo of Ardour Capital Partners, the worldwide shortage of silicon has been a key reason for the trend in this sector.[69]

(10) Market growth looks set to remain sturdy.

Renewable energy market growth is happening in almost all sectors, countries, and investment stages. In a few sectors the industry is facing bottlenecks, but when these open up, renewed growth will be seen. The growth of private finance and investment flows suggests that the renewable energy sector has become more than a transient spot on the edge of financiers' radar screens. One investment firm commented that clients really weren't interested in renewables back in 2002 and 2003, but in the last two years "the market has exploded." New Energy Finance estimates global financing flows for the clean energy sector at $59 billion in 2005, including mergers and acquisitions ($15 billion), asset finance for large-scale projects ($18 billion), "distributed projects" or small-scale renewable investments ($7 billion), government R&D ($6 billion), corporate R&D ($4 billion), corporate plant and equipment ($3 billion), public equities investment ($4.3 billion), and venture capital for plant and equipment ($1.6 billion).[70] (These numbers don't correspond directly with investment numbers cited elsewhere in this report, as they include some non-renewables technologies and don't count all capacity additions or technologies.)

Overall, the clean energy sector has gone well beyond idealists to include serious entrepreneurs. In the words of one renewables entrepreneur, "The face of the market has gone from long hair to business suits—it might be the same folks with the same values, but the appeal is different now." Indeed, investors are feeling more and more comfortable committing capital for the long periods required by most projects in this sector, particularly as technologies mature, expertise increases, and risk management is better understood.[71]

SOURCES OF DATA

Sources of information for this report and the original *Renewables 2005: Global Status Report* are highly diverse. The 2005 report drew from over 250 published references, plus a variety of electronic newsletters, unpublished submissions from contributors, personal communications, and Web sites. There is generally no single source of information for any fact globally, as most existing sources report only on developed (OECD) countries or on regional or national levels, such as Europe or the United States. (Wind power and solar hot water are exceptions; single sources for global data do exist.) Thus, global aggregates are built from the bottom up, adding or aggregating individual country information. Developing countries in particular require country-by-country sources, as very little material exists that covers developing countries as a group. All of the information, graphs, and tables in the report are built from multiple sources, often involving triangulation of conflicting or partial information using assumptions and growth trends. Key sources of data for the original report and this update include the following (see references in this report and the original 2005 report for details and web links):

- International Energy Agency publishes statistical annuals for OECD countries, including the Renewables Information annual reports, and maintains a global renewable energy policy database.
- U.S. Energy Information Administration publishes statistical and descriptive annuals.
- Interstate Renewable Energy Council maintains the DSIRE database of U.S. state-level renewable energy policies.
- Systèmes Solaires publishes the comprehensive "EurObserv'ER" statistical and descriptive series for renewable energy in Europe, with several bulletins each year, each covering different technologies.
- World Energy Council publishes a periodic survey of world energy resources that includes renewables.
- F. O. Licht publishes comprehensive annual and monthly reports on global biofuels.
- Industry associations often have up-to-date statistics and information on their web sites, such as Global Wind Energy Council, World Wind Energy Association, American Wind Energy Association, European Solar Thermal Industry Federation, European Biodiesel Board, European Bioethanol Fuel Association (eBIO), U.S. Renewable Fuels Association, Canada Renewable Fuels Association.
- REN21 is beginning to post online individual country submissions describing progress with the Bonn "Renewables 2004" International Action Programme.
- Magazines and newsletters report on industry and policy developments, such as RenewableEnergyAccess.com, PV News, Photon International, and Renewable Energy World.
- Conference proceedings and online conference presentations may provide up-to-date information.

Global investment numbers reflect a database by Eric Martinot of installed capacity by technology and by year. These installed capacity figures are multiplied by assumed average capacity costs (i.e., in $/kW or $/m2). Capacity costs are taken globally, with the exception of small hydropower and solar hot water in China, to which lower cost estimates are applied. Some costs, such as biomass power generation, vary widely, and a global average becomes problematic. Thus, the investment numbers are approximate, although the time progression, using a consistent set of assumptions, should reasonably portray the growth of investment.

Data for developing countries is often some years older than data for developed countries, and thus extrapolations to the present must be made from older data, based on assumed and historical growth rates. This is one of the reasons that capacity data (kW) instead of energy data (kWh) are reported, as capacity expansion is easier to extrapolate than energy production and is less prone to seasonal and annual variations that are common to many forms of renewables. (Other reasons are that capacity data better mimic investment trends over time, as capacity is usually directly proportion to investment, while energy production is not; and capacity data is generally more available for developing countries than energy production.)

Most capacity figures are taken from reports of existing capacity, extrapolating to the present if current-year data are not available. Recent retirements or rehabilitations may appear only in future data. Annual increments to capacity are generally available only for wind, solar PV, and solar hot water. Solar hot water retirements are significant in some countries, and data reporting attempts to account for these retirements.

Future editions of this report can improve data sources and presentation in several key areas, including shares of electricity generation and total primary energy consumption, costs and economics, different ways of reporting biomass electricity and heat production, and rural energy.[72]

REFERENCE TABLES

Table 1. Renewable Energy Added and Existing Capacities, 2005
(Updated from *Renewables 2005 Global Status Report*, Table N3)

		Added during 2005	Existing at end of 2005	Growth rate of existing in 2005
Power generation				
Large hydro power		12–14 GW	750 GW	1.5–2%
Small hydro power		5 GW	66 GW	8%
Wind turbines		11.5 GW	59 GW	24%
Biomass power		2–3GW	44 GW	---
Geothermal power		0.3 GW	9.3 GW	3%
Solar PV, grid-connected	(GW)	1.1GW	3.1 GW	55%
	(homes)	200,000	650,000	---
Solar PV, off-grid		0.3 GW	2.3 GW	15%
Solar thermal power		~ 0	0.4 GW	---
Ocean (tidal) power		~ 0	0.3 GW	---
Hot water/heating				
Biomass heating		n/a	220 GWth	---
Solar collectors for hot water and space heating, glazed	(GWth)	13 GWth	88 GWth	---
	(m^2)	19 mil m^2	125 mil m^2	14%
	(homes)	7 million	46 million	---
Geothermal heating		2.6 GW	28 GWth	9%
Transport fuels				
Ethanol production		2.5 billion liters/year	33 billion liters/yr	8%
Biodiesel production		1.8 billion liters/year	3.9 billion liters/yr	85%
Rural (Off-grid) Energy				
Biomass cooking stoves in use	(total, all types)	n/a	570 million	---
	("improved" types)	n/a	220 million	---
Household-scale biogas digesters in use		n/a	21 million	---
Household-scale solar PV systems in use		> 270,000	2.4 million	---

Sources and notes: updated from other tables and notes in this report. Solar thermal power, ocean (tidal) power, biomass heating, and rural energy were not changed from 2004 figures due to lack of data and relative lower investment activity. Small amounts, on the order of a few megawatts, are designated by "~0." Solar hot water existing includes added capacity minus retirements, so growth of existing stock is significantly less than implied by added capacity.

Table 2. Added and Existing Wind Power, Top 10 Countries, 2005
(Updated from *Renewables 2005 Global Status Report*, Table N6)

Country	Added in 2005 (MW)	Existing in 2005 (MW)
Germany	1,810	18,430
Spain	1,760	10,030
United States	2,430	9,150
India	1,430	4,430
Denmark	20	3,120
Italy	450	1,720
United Kingdom	450	1,350
China	500	1,260
Japan	240	1,230
Netherlands	120	1,220

Source: Global Wind Energy Council 2006

Table 3. Grid-Connected Solar Rooftop Programs, 2005 (MW except for existing number of homes)
(Updated from *Renewables 2005 Global Status Report*, Table N7)

Program and years	Added 2002	Added 2003	Added 2004	Added 2005	Existing 2005	Existing homes 2005	Supporting policies
Japan: residential program (1994–2004)	140	170	230	—	830 (by 2004)	250,000	"Sunshine" program capital subsidy started at 50% in 1994, and declining to 10% by 2003.
Japan: other programs and private	40 (*)	50 (*)	40 (*)	310 (*)	610 (*) (**)	70,000	NEDO R&D programs, commercial installations, local government installations, and unsubsidized residential
Germany (1999–2003 and 2004 to present)	80 (*)	150 (*)	490 (*)	600 (or more) (*)	1500 (*)	250,000 (***)	100,000 roofs program provided low-interest loans and feed-in tariff of €0.50/kWh to 2003. In 2004, tariffs set €0.45–0.62/kWh.
California programs (1998–2011)	n/a	n/a	40	55	140	30,000	Initial state program subsidy of $4.50/W(AC) declined to $2.80/W(AC) by 2005. Utility (SMUD, LADWP) programs.
Other U.S. programs	n/a	n/a	10	10	100	20,000	
Other EU programs	n/a	n/a	n/a	40	200	40,000	
Other	n/a	n/a	n/a	30	40		
Total Added	270	400	800	1050			
Cumulative					3100	650,000	

Table 3. Grid-Connected Solar Rooftop Programs, 2005 (continued)

Sources and notes: Maycock 2003, 2004, and 2005; *PV News* May 2006; German Ministry of Environment 2006; EurObserv'ER 2006; Solarbuzz 2006; unpublished data from Prometheus Institute; unpublished data from Japan METI; Japan PV Energy Association (JPEA); German Solar Industry Association (BSW); California Energy Commission.

(*) = An unknown share of this data is off-grid. Amounts for Germany are likely quite small. The amount for Japan is assumed to be about 150 MW cumulative as of 2005.

(**) Data is reported by METI and JPEA on a fiscal year basis, ending in March. So the 2005 figures include installations from January–March 2006. Assuming about 15 MW per month as an average installation rate, then about 50 MW should be subtracted to reflect data as of December 2005. Thus the actual number for Japan's grid-connected PV as of December 2005 is estimated at 1250 MW, also subtracting assumed off-grid amounts, and this figure is used for the global total. The number of grid-connected solar customers who had registered their systems as part of Japan's certification and accounting for its new renewables portfolio standard was 1020 MW as of March 2006 (up from 740 MW in March 2005). This figure is too low, as some customers have not registered their systems. The higher METI numbers should account for customers who have not registered, as well as off-grid installations, and grid-connected installations entirely for self-consumption. Industry surveys and R&D program totals are used for these figures.

(***) There were more than 200,000 total PV installations in Germany, according to the German solar energy association. By 2005, about 40 percent of installed capacity was residential (average size 3 kW), another 50 percent was small and medium commercial (between 50–1000 kW, average size 50 kW), and 10 percent was large commercial (1–10 MW, average size 3 MW). The small and medium commercial includes farmers, smaller equity funds (such as for schools, churches, and community buildings) and small enterprises (Gbr and Gmbh). Many of the small enterprises are community energy-service companies serving (and owned by) groups of households (neighbors), so-called single-purpose enterprises. The residential 40 percent of 1500 MW, assuming 3 kW per household, yields 200,000 homes, plus some 50,000 households served by single-purpose enterprises, gives an estimated 250,000 households.

(a) Cumulative number of homes are rough estimates based on 3 kW per home and assuming 70 percent of the installations are residential in California (there is some data to support this), 80 percent in Germany/EU, and 90 percent in Japan. German Solar Industry Association reported 175,000 new solar plants installed in 2005 (incl. solar hot water).

(b) The estimate for 2004 added grid-connected PV in the *Renewables 2005 Global Status Report* was 700 MW. The number here of 800 MW is a revision to that 2004 number, primarily due to higher revised numbers for Germany.

(c) JPEA reported 305 MW domestic shipments from April 2005 to March 2006, including a small amount of imports.

(d) Consistent solar PV data, especially estimates of the grid-connected share, gets more difficult each year. The inconsistencies arise for several reasons, including counting methods (e.g., looking at inverter sales vs. module sales), whether installations actually occur in a given calendar year, and the problem of DC (solar PV side) vs. AC (power grid side) capacity. All data for solar PV is approximate, within +/- 10 percent. Germany's solar industry association and environment ministry BMU reported 600 MW added in 2005, while other estimates ranged up to 700 MW. Solarbuzz reported 837 MW in their 2006 "Marketbuzz" report. Eurobserv´ER (2006) wrote: "As was the case for the year before, there's a dispute between provisional figures published by industrialists and figures resulting from the annual survey made by *Photon International* magazine. The German solar industry association (BSW) announced a 2005 market equal to at least 600 MW. *Photon International* announced a 2005 market of 870 MW in its March 2006 issue! This figure is based on the production of inverters intended for the German photovoltaic market. It should be remembered that a situation like this already occurred the year before. At the beginning of 2005, the two German organizations had announced markedly different figures for the 2004 market (363 MW for BSI and 593–673 MW for *Photon International*) before they each revised their first estimates upwards a few months later (at respectively 500 MW and 770 MW). While awaiting re-evaluations and in the absence of a consensus with respect to German market figures, we used the first BSW estimates, which were also those used by the German Ministry of the Environment."

Table 4. Renewable Electric Power Capacity, GW existing as of 2005
(Updated from *Renewables 2005 Global Status Report*, Table N4)

Technology	World Total	Developing Countries	EU-25	China	Germany	U.S.	Spain	India	Japan
Small hydropower	66	44	12	38.5	1.6	3.0	1.7	1.7	3.5
Wind power	59	6.3	40.5	1.3	18.4	9.2	10.0	4.4	1.2
Biomass power	44	24	8	2.0	1.7	7.2	0.5	0.9	> 0.1
Geothermal power	9.3	4.7	0.8	~ 0	0	2.8	0	0	0.5
Solar photovoltaic-grid	3.1	~ 0	1.7	~ 0	1.5	0.2	< 0.1	~ 0	1.2
Solar thermal electric	0.4	0	~ 0	0	0	0.4	~ 0	0	0
Ocean (tidal) power	0.3	0	0.3	0	0	0	0	0	0
Total renewable power capacity (excluding large hydro)	182	79	63	42	23	23	12	7	6
For comparison:									
Large hydropower	750	340	115	80	7	95	17	n/a	45
Total electric power capacity	4,100	1,500	710	510	130	1,060	78	n/a	280

Sources and notes: Figures from historical database of capacity by country and technology by Martinot, supplemented by EurObserv'ER 2005a and 2006; Global Wind Energy Council 2006; IEA *Renewables Information 2005*; IEA *Electricity Information 2005*; UNDESA Energy Statistical Yearbook 2002; U.S. EIA biomass Web page www.eia.doe.gov/cneaf/solar.renewables/page/biomass/biomass.html); and several unpublished submissions from report contributors. Countries with geothermal plants under construction in 2005 were El Salvador, Guatemala, Iceland, Italy, New Zealand, Nicaragua, Papua New Guinea, Philippines, Portugal, and Russia varying from 20 to 40 MW each. Geothermal totals could be as high as 9.5 GW, although some sources give only 9.0 GW. Over 500 MW of new plants in the United States secured power contracts in 2005 (REAccess January 2006, Geothermal Energy 2005 in Review"). Small amounts, on the order of a few megawatts, are designated by "~0."

Table 5. Solar Hot Water Installed Capacity, Top 10 Countries/EU and World Total, 2005
(Updated from *Renewables 2005 Global Status Report*, Table N8b)

Country/EU	Additions 2004 (million m^2)	Existing 2004 (million m^2)	Additions 2005 (million m^2)	Existing 2005 (million m^2)	Existing 2005 (GWth)
China	13.5	64.3	15.0	79.3	55.5
EU	1.6	14.4	2.0	16.0	11.2
Turkey	1.2	7.3	1.2	8.1	5.7
Japan	0.3	7.6	0.2	7.2	5.0
Israel	0.1	4.8	0.1	4.7	3.3
Brazil	0.05	2.3	0.05	2.3	1.6
United States	0.05	2.4	0.05	2.3	1.6
Australia	0.2	1.6	0.2	1.7	1.2
India	0.2	1.1	0.4	1.5	1.1
South Africa	--	0.5	--	0.5	0.4
(other countries)	< 0.1	< 2	< 0.1	< 2	< 1.5
World Total	17	110	19	125	88

Sources: Existing 2004 and additions 2004 from Weiss et al. 2006 and ESTIF 2005, adjusted with other unpublished data for China. Additions for 2005 from China Association of Solar Thermal Energy Application 2006, European Solar Thermal Industry Federation 2006, Japan Solar System Development Association (SSDA), and Ministry of Economy, Trade and Industry (METI). Japan METI gives 0.23 million m^2 added and 0.67 million m^2 retired in 2005. German solar hot water increased to 0.95 million m^2 added in 2005, up from 0.78 million m^2 added in 2004. Other countries besides China, EU, and Japan are assumed same as 2004, with 5 percent subtracted from cumulative total to model retirements. Note: Weiss et al. 2006 give China as "44% of the world market" in 2004. This percentage includes accounting for unglazed swimming pool heating (23 GWth worldwide in 2004). Using the glazed and evacuated tube statistics from Weiss et al. 2006, China 43.4 GWth and 75 GWth total, China would be 58 percent of global installed capacity.

Table 6. Biofuels Production, Top 15 Countries plus EU, 2005
(Updated from *Renewables 2005 Global Status Report*, Table N9)

Country	Fuel ethanol (billion liters)	Biodiesel (billion liters)
Brazil	15	—
United States	15	0.25
Germany	0.2	1.9
China	1.0	—
France	0.15	0.6
Italy	—	0.5
Spain	0.3	0.1
Canada	0.2	0.1
India	0.3	—
Columbia	0.2	—
Sweden	0.2	—
Czech Republic	—	0.15
Poland	0.05	0.1
Denmark	—	0.1
Austria	—	0.1
Slovakia	—	0.1
EU Total	0.9	3.6
World Total	33	3.9

Sources and notes: F.O. Licht, *World Biofuels Report* 2006; EurObserv'ER 2005b; European Biodiesel Board, www.ebb-eu-org; European Bioethanol Fuel Association (eBIO) 2006, www.ebio.org; U.S. Renewable Fuels Association; Canada Renewable Fuels Association, www.greenfuels.org; Natural Resources Canada 2006; and submissions from report contributors. Major increases in ethanol production during 2005 were the EU (0.5 million liters/year increase) and the United States (more than two billion liters/year). Brazil remained fairly stable. Major increases in biodiesel production were the EU (1.6 billion liters/year increase) and the United States (0.17 billion liters/year increase). In total, estimated increase in biofuels production in 2005 was 4.3 billion liters/year. Alternative figures are reported for Brazil by others. Moreira reports 16.3 billion liters ethanol production, of which 1.5 billion liters was used in non-fuel purposes (not counted here) and 2.5 billion liters were exported.

Table 7. Cumulative Number of Countries/States/Provinces Enacting Feed-in Policies
(Updated from *Renewables 2005 Global Status Report*, Table 5)

Year	Cumulative Number	Countries/States/Provinces Added That Year
1978	1	United States
1990	2	Germany
1991	3	Switzerland
1992	4	Italy
1993	6	Denmark, India
1994	8	Spain, Greece
1997	9	Sri Lanka
1998	10	Sweden
1999	13	Portugal, Norway, Slovenia
2000	14	Thailand
2001	16	France, Latvia
2002	20	Austria, Brazil, Czech Republic, Indonesia, Lithuania
2003	27	Cyprus, Estonia, Hungary, Korea, Slovak Republic, Maharashtra (India)
2004	33	Italy, Israel, Nicaragua, Prince Edward Island (Canada), Andhra Pradesh and Madhya Pradesh (India)
2005	40	Turkey, Washington (USA), Ireland, China, India (Karnataka, Uttaranchal, Uttar Pradesh)
2006	41	Ontario (Canada)

Note: Figure for 2006 is for early part of the year only.

Table 8. Cumulative Number of Countries/States/Provinces Enacting RPS Policies
(Unchanged from *Renewables 2005 Global Status Report*, Table 6)

Year	Cumulative Number	Countries/States/Provinces Added That Year
1997	1	Massachusetts (USA)
1998	3	Connecticut, Wisconsin (USA)
1999	7	Maine, New Jersey, Texas (USA); Italy
2001	12	Arizona, Hawaii, Nevada (USA); Flanders (Belgium); Australia
2002	16	California, New Mexico (USA); Wallonia (Belgium); United Kingdom
2003	20	Minnesota (USA); Japan; Sweden; Maharashtra (India)
2004	34	Colorado, Maryland, New York, Pennsylvania, Rhode Island (USA); Nova Scotia, Ontario, Prince Edward Island (Canada); Madhya Pradesh, Karnataka, Andhra Pradesh, Orissa (India); Poland; Thailand
2005	38	District of Columbia, Montana, Delaware (USA); Gujarat (India)

NOTES

Notes are provided here for information that supplements the "Notes and References Companion Document" of the *Renewables 2005 Global Status Report*, which contains many further analytical details and citations.

[1] Total hydro in China in 2005 was 116 GW, including 38.5 GW of small hydro, up from 105 GW in 2004, including 34.5 GW of small hydro. Thus about 7 GW of large hydro was added in 2005. Brazil's "Boletim Energia" no. 206 published by ANEEL (official regulatory body) in February 2006 gives total added hydro capacity in 2005 as 2425 MW. Brazil added only 20 MW of small hydro in 2005. India commissioned at least two plants in 2005: 280 MW Dhauliganga in Uttranchal and the 1000 MW Indira Sagar Project. Annual information on large hydropower installations is difficult to collect. There are also problems with the allocation of new capacity to a particular year. Some double counting can happen, as schemes often begin their operating phase during construction (units commissioned in series). The International Hydropower Association (IHA) is working on a census of hydropower plants. One of the trade journals looks at equipment-supplier contracts, and this gives an indication of hydro investment for the period, but not commissioned hydro capacity. Another journal prepares country reports, but these are not comprehensive, nor are they updated every year. For comprehensive global coverage of hydropower installations, see the *World Atlas and Industry Guide* published annually by the International Journal on Hydropower and Dams (www.hydropower-dams.com), which provides an overview of world water resources development in 2004–05, a list of major dams under construction, and other information.

[2] Comprehensive global statistics for biomass use are not available, but are generally available for the United States and EU, although not necessary for the most recent year. IEA 2006a provides estimates of biomass power production for 2004 for all OECD countries, which are used here. Wood energy use in the EU increased by 6 percent on a primary energy basis in 2004, with significant growth rates (10–30 percent) in Austria, Belgium, the Czech Republic, Germany, the Netherlands, and the United Kingdom, according to EurObserv'ER 2005c, which provides wood energy statistics for the EU in 2004. Note: Biomass power capacity reported for 2004 in the *Renewables 2005 Global Status Report* was 39 GW; new data available suggests the 2004 number was closer to 40–41 GW. All biomass figures in this report exclude municipal solid waste.

[3] See notes after Table 3 for extensive details and sources on solar PV additions in 2005.

[4] Total ethanol consumption by cars in Brazil was 12.3 billion liters in 2005, 6.42 as hydrated, used in neat ethanol and flex-fuel cars, and 5.87 as anhydrous, blended to gasoline. Total gasoline for road use (essentially cars, since almost no truck uses gasoline) in 2004 was 17.62 billion liters. Thus, on a volume basis, gasoline represents 17.62 billion liters in a total volume of 29.91 billions liters of liquid fuels for cars. Ethanol share is 41.09 percent. Production of ethanol in 2005 was 16.3 billion liters , which is slightly less than gasoline production of 17.6 billion liters. From the 16.3 billion, 2.5 billion was exported and 1.5 billion used for other purpose than fuel. For the year 2006 it is expected there will be an increase in ethanol consumption and a decline in gasoline, but even so gasoline will be responsible for more than 50 percent. Source: Luis Carlos Correa, "Energia e Crescimento: Economia Mundial e Oportunidades para o Brasil," presented at the workshop held at Instituto Fernando Henrique Cardoso, São Paulo, Brazil, 27 April 2006.

[5] It should be noted that the "net energy" from ethanol production differs greatly depending on feedstock and other conditions, so that equivalent volume production in the United States and Brazil does not mean equivalent net energy supply if energy used to produce feedstock is included. See Farrell et al. 2006 for a discussion.

[6] Production figures for ethanol and biodiesel in this report are on a volume basis. For true comparisons with gasoline and diesel fuels, an equivalent energy basis should be used, particularly for cost comparisons and for calculating shares of transport energy. For example, the energy content of ethanol is only about 70 percent of gasoline on a volume basis, so (1/0.7) 1.4 litersof ethanol is required to provide the same energy as one liter of gasoline. Biofuels production in

billion liters per year means 10^6 liters per year (English use of the word "billion").

[7] Biofuels Investment and Capacity Costs. The United States added ethanol production capacity of 2.6 billion liters/year in 2005, representing perhaps $1 billion of investment in 2004–05. And U.S. capacity under construction in early 2006, 6.5 billion liters/year, represented another $2.5 billion of investment. In the EU, biodiesel production capacity almost tripled from 2004 to mid-2006, representing over four billion liters/year of added capacity and perhaps $1.2 billion of investment during 2003–05. In 2006, France planned €1 billion of investment through 2008 for 10 new biofuels plants to fulfill its share of the EU biofuels target (5.75 percent). A February 2006 report by the U.S. Ethanol Fuels Association estimated construction costs of $1.40/gallon ($0.40/liter) for a new dry mill ethanol plant and $1.00/gallon ($0.27/liter) for a plant expansion. According to the association, the capacity currently under construction or expansion represents an additional $2.4 billion by the ethanol industry. See www.ethanolrfa.org/objects/documents/576/economic_contribution_2006.pdf.

Biodiesel converted from tons to liters using conversion factor of 1130 liters/ton (average density 0.88), and ethanol converted using factor of 1260 liters/ton (average density 0.79). Taken from "Bioenergy Conversion Factors" at http://bioenergy.ornl.gov/papers/misc/energy_conv.html.

In Brazil, a new series of investments in sugar mills and ethanol distilleries began in 2005 that is expected to add 5 billion liters/year ethanol production by 2009. Actual sugar cane harvesting did not increase appreciably in Brazil in 2005. Harvested area went from 5.63 million hectares (ha) to 5.77 million ha in 2005, for a 2.3 percent increase, per U.N. Food and Agriculture Organization statistics. In 2005, 60 percent of sugar cane was for sugar, so new land area used for ethanol was probably just 53,000 ha. Production increased from 416 million tons to 420 million tons, although yield dropped from 739 Hg/ha in 2004 to 728 Hg/ha in 2005. The planned 40 new sugar mills will have an average installed capacity of three million tons of sugar cane per year. Another 40 new sugar mills are under development but investment figures aren't available. When fully operational, these 80 plants would require an additional 240 million tons/year of sugar cane. These sugar mills should be operational by 2009 but some perhaps as early as 2007. Due to shortages of sugar cane, full operational capacity may not be achieved until 2011. Many sugar mills are being retrofitted and expanded, which should require more sugar cane supply. Assuming a central value, an average investment cost is perhaps $150 million per plant, or $6 billion total for 40 plants. A typical plant might produce 127 million liters/year and take two years to construct. Considering a yield of 85 liters per ton of sugar cane, 80 new plants would add a total capacity of 10.2 billion liters of ethanol since it is expected that 50 percent of sugar cane will be used for sugar and 50 percent for ethanol. Thus, these sugar mills will also produce 16 million tons of sugar. Assuming the investment cost is equally shared by sugar and ethanol, this yields a value of $0.59/liter/year ($75 million/127 million liters/year) produced. This cost is twice the average cost of distilleries and may be explained by the significant increase in land prices. A sugar mill requires around 5,000 ha for producing 30 percent of its sugar cane demand for alcohol, which means a cost of $25 million for land. Subtracting this cost, investment attributable to ethanol is reduced to $50 million, yielding a per-unit investment cost of $0.39/liter/year.

[8] The World Bank Group also provided carbon finance of $40 million for renewables, including large hydro. This report does not cover carbon finance, however, so the figures are excluded from the totals in the text. Future editions of the *Renewables Global Status Report* could begin to cover carbon finance.

[9] Industry employment estimates have not been updated, but some additional data has become available. By 2006, the global wind industry employed 235,000 people according to WWEA 2006, a substantial difference from the previous estimate of 40,000–70,000 in the *Renewables 2005: Global Status Report*. Germany reports 12,500 people employed in the solar hot water industry and 30,000 people employed in the solar PV industry.

[10] Market capitalization. The following list shows companies according to two criteria: (1) publicly traded stock; and (2) more than $40 million in market capitalization attributable to renewable energy. This list is preliminary and may inadvertently exclude companies that meet these criteria or incorrectly include companies, with no liability assumed for

any missing or incorrect entries. This is not investment advice. The list is: Acciona (Spain), Alliant Energy (USA), ATS Automation (Canada), Beacon Power (USA), Bharat Heavy Electricals (India), Biofuels Corporation (UK), Boralex (Canada), BP (UK), Brascan (Canada), British Energy (UK), Calpine (USA), Canadian Hydro Developers (Canada), Carmanah Technologies (USA/Canada), Centrosolar (Germany), Clean Power Income Fund (Canada), Conergy (Germany), Corning (USA), Cypress Semiconductor (USA), Daystar (USA), Dyesol Ltd. (Australia), Dynamotive (USA), E.On Energie (Germany), Endesa (Spain), ENEL (Italy), Energiekontor (Germany), Energy Developments (Australia), Enersis (Chile), ErSol Solar Energy AG (Germany), E-Ton Solar (Taiwan), Evergreen Solar (USA), Florida Power & Light Energy (USA), Gamesa Energia (Spain), General Electric (USA), Geodynamics (Australia), Great Lakes Hydro Income Fund (Canada), Ishikawajima-Harima Heavy Industries (Japan), Japan Wind Development (Japan), Kaneka SolarTech (Japan), Kyocera (Japan), Marubeni (Japan), MEMC (USA), Mitsubishi Electric (Japan), Mitsubishi Heavy Industries (Japan), Motech Industries (Taiwan), NEPC India (India), Nordex Energy (Germany), Ocean Power Technologies (UK), Omron (Japan), Ormat Technologies (USA), Pacific Hydro (Australia), Pfleiderer (Germany), Qcells (Germany), REC (Norway), Reinecke+Pohl Sun Energy (Germany), Renewable Energy Holdings (UK), Repower Systems (Germany), RWE (Norway), SAG Solarstrom (Germany), Sanyo (Japan), Scottish Power (UK), Sekisui Chemical (Japan), Sharp (Japan), Shell (UK), Siemens (Germany), Solar Integrated Technologies (UK), Solar-Fabrik (Germany), Solarparc (Germany), Solartron (Thailand), SolarWorld (Germany), Solon (Germany), Spire (USA), Sunline (Germany), Sunpower (USA), Suntech Power (China), Sunways AG Photovoltaic Technology (Germany), Suzlon (India), Talisman Energy (Canada), Tokuyama (Japan), TransCanada (Canada), TXU (USA), Verbund (Austria), Vestas (Denmark), Wacker-Chemie (Germany), XCEL Energy (USA).

In addition to these companies with publicly traded stock, there are many other companies involved in renewable energy, such as private unlisted companies and public utilities, that are not traded on stock exchanges. There were no clear criteria or data available to include these companies in an expanded list for this version of this report. Prominent examples of such companies include Iberdrola of Spain, Nuon and Essent of the Netherlands, Electricité de France, Hydro Quebec of Canada, Hydro Tasmania of Australia, Norsk Hydro and SN Power of Norway, and Enercon of Germany. The list also excludes project developers that may not have large capital bases of their own but still are major players in terms of investment flow. Examples include Zilkha Renewables of the United States (owned by Goldman Sachs), Clipper Windpower and AES of the United States (which just bought Seawest), Eurus of Japan, and many others. There is also the issue of renewable energy value chains and what part of the value chain constitutes a renewable energy business—such as PV silicon wafer manufacturers, manufacturing equipment suppliers, and wind turbine blade manufacturers (notably LM Glasfibre of Denmark). Future versions of the status report could attempt to create a more comprehensive list based on these and other criteria.

Market capitalization attributable to renewable energy is a rough estimate. For pure play renewable energy stocks (stocks that have bulk of earnings from renewables), market capitalization is assumed to be 100-percent attributable to renewable energy. For companies engaged in renewable energy as a minority of earnings, we made rough estimates of earnings from renewable energy, divided this by total earnings, and multiplied this percentage by total market capitalization to derive a rough estimate of renewable energy market capitalization. In cases where this was not possible due to information being either confidential or not available, we made an outside-in estimate of renewable energy capacity, revenue, and operating profit. We then took the ratio of renewable energy operating profit by the comapny's total operating profit, then multiplied this ratio by the total market capitalization. This is a rough estimate and will be refined in the future. Categories of renewable energy included in this list include biofuels, biomass, geothermal, hydro, solar, wave, and wind energy. Sources include: Bloomberg, MarketWatch.com, CLSA Asia-Pacific Markets, InvestGreen.ca, Investext, *Reuters*, and company data.

[11] Acciona established a joint venture while the others are wholly owned subsidiaries.

[12] Goldwind had 90 percent of production by Chinese manufacturers in 2005, with Zhejiang Windey and Dongfang

Steam Turbine Works each about 5 percent.

[13] See EurObserv"ER 2005c.

[14] A one-megawatt trough plant in the U.S. state of Arizona was completed in 2005, and there have been other demonstrations and R&D activities in recent years, including solar dish systems.

[15] Sugar cane production was to increase from 420 million tons in 2005 to 570 million tons by 2009.

[16] Details for Spain from "Plan de Energías Renovables en España 2005–2010", Ministerio de Industria, Turismo y Comercio, and IDAE. The plan includes capacity addition targets for the period 2005–10, for small and medium hydro (900 MW added), biomass (1700 MW added), wind (12,000 MW added), solar PV (400 MW added), and solar thermal power (500 MW added). The target would mean 20,000 MW of wind power by 2010. The plan also includes an increase in solar hot water from 0.7 million m^2 in 2004 to 4.2 million m^2 in 2010, and an increase in biofuels from 0.23 million tons of oil equivalent (mtoe) in 2004 to 2.0 mtoe in 2010.

[17] Thailand expects 11,600 GWh/year from 2,200 MW by 2011, up from 860 MW in 2005.

[18] See World Bank 2006 and the REN21 Web site, www.ren21.net, for reports of progress under the Bonn 2004 International Action Program by Pakistan and others.

[19] Both policies might be considered RPS policies, except that the targets are not legally binding on utilities, so strictly speaking these are policy targets rather than RPS policies. See p. 19 and Note 25 of the *Renewables 2005: Global Status Report* for breakdown of U.S. and Canadian states/provinces with policy targets and RPS policies.

[20] Italy's feed-in tariff for solar PV is 44.5–49.0 eurocents/kWh for the first 20 years for system sizes between 1 kW and 1 MW, with an initial cap set at 100 MW total. See PV Policy Group newsletter, October 2005, www.pvpolicy.org; also see S. Castello and S. Guastella, "Italy photovoltaic technology status and prospects," www.iea-pvps.org/ar05/ita.htm.

[21] Ontario's Standard Offer program will provide Can$0.11/kWh for wind, biomass and small hydro, and Can$0.42/kWh for solar PV. The program provides power contracts lasting 20 years, with an inflation adjustment. There is no limit to the number of projects that may apply for a contract, but the size of each project is capped at 10MW.

[22] In the United States, four states adopted what some have called feed-in tariffs in 2005: Minnesota (for wind), New Mexico (for solar PV), Washington (for solar, wind, anaerobic digestion), and Wisconsin (for PV and biogas power). These policies are considered "limited" because some only apply to specific utilities or types of customers, or have small program limits on total payments available or capacity installed. Most are designed to supplement or provide a modest assist to existing RPS policies, and might better be called "production incentives." However, the definitional difference between production incentives and feed-in tariff premiums is not precise. New Mexico sets a cap of 1.2 MW added, and provides a premium of 12 cents/kWh to net metering customers without battery backup, through the use of purchased renewable energy certificates based on customer generation. Minnesota provides a production incentive of 1.0–1.5 cents/kWh. A Wisconsin utility has offered an experimental tariff of 22.5 cents/kWh for 1.5–100 kW solar PV systems, with a total program limit of 0.5 MW. There are several other local feed-in tariffs being offered in the U.S. by individual utilities, some continuing implementation of the PURPA feed-in law of 1978. The *Renewables 2005: Global Status Report* classified Washington state as having a feed-in tariff in 2005, and that classification remains in this report. Washington provides a production incentive of 15 cents/kWh capped at $2000/year, with higher tariffs for equipment manufactured in-state, with a limit on total incentive payments of 0.25 percent of an individual utility's power sales. New Mexico, Minnesota, Wisconsin, and others are not included as feed-in policies either because they are not state-level policies, because program limits are small, or because incentive levels are small relative to renewable power costs.

[23] The U.S. federal tax credit applies to both solar PV and solar hot water, and is capped at $2000 per home for residential installations.

[24] In California during 2006, solar PV installations less than 30 kW continued to qualify for subsidies, currently $2.80/watt, under the California Energy Commission's Emerging Renewables Program. There were also continuing subsidies under the CPUC SGIP program. California will create 3,000 MW of solar electricity in the state by the end of 2017 (RenewableEnergyAccess.com, 01 May 2006). Beginning in 2007, the California Energy Commission will manage a program of about $400 million, complementing the program approved by the California Public Utilities Commission (CPUC). The Energy Commission will work with homebuilders and the building industry to accelerate the growth of PV in new home subdivisions, whereas the CPUC will focus on solar installations on existing residential and commercial buildings. The CPUC and the Energy Commission plan to accelerate California's renewable energy goal of 20 percent procured renewable power by 2010.

[25] Australia's program provides caps at Aus$4000 per residential system and Aus$8000 per community system.

[26] Yingling Liu, "Shanghai Embarks on 100,000 Solar Roofs Initiative," *China Watch* (Worldwatch Institute), 10 November 2005.

[27] The Spanish PV requirement applies to buildings exceeding 3,000–10,000 m^2 of surface area, depending on building type (or 100+ beds for hotels and hospitals). The minimum PV required is 6.25 kW and is based on building type, surface area, and climate zone. Installations may range up to 50 kW or more. See *Photon International* (May 2006) for the PV requirements in Spain's new building code. The PV requirement applies to buildings above the following limits: superstores (5000m^2); malls and leisure centers (3000m^2); warehouses (10,000 m^2); office buildings (4000 m^2); hotels (100 rooms); hospitals (100 rooms); convention centers (10,000 m^2). Source: "Codigo Técnico de Edificación," Real Decreto 314/2006 + Documento Básico HE.

[28] These developing country policies are documented in country submissions showing progress with the Bonn "Renewables 2004" International Action Programme; see REN21 Secretariat 2006a.

[29] Agreed power prices in the third round were RMB 0.46–0.49/kWh (5.8–6.1 cents/kWh) for three of the projects. Chinese concession prices apply to the first 30,000 full-load hours. The bid evaluation criteria were modified in 2006 to assign less weight to price and more weight to other factors.

[30] See Lewis and Wiser 2006 for the Ontario case.

[31] Utility green pricing and renewables certificates remained active markets, although detailed data were not available for this report. Green Power: In the United States, as of the end of 2004, more than 2,200 MW of new renewables capacity was being used to supply green power customers, with another 455 MW either under construction or formally announced. This includes about 700 MW to supply utility green pricing programs (with another 230 MW announced by utilities), and about 1,530 MW to serve customers purchasing green power in competitive markets or as RECs (with 225 MW of additional capacity planned). Source: Bird and Sweezy 2005. In Japan, purchases of green power certificates remained popular, with 50 GWh of certificates sold in 2005.

[32] The revised Barcelona ordinance also includes improved maintenance requirements and requirements on architectural integration. The ordinance also set explicit fines for violations. By the end of 2005, 427 buildings were covered by the Barcelona solar ordinance, representing 31,000 m^2 of SHW capacity.

[33] Spain Solar Hot Water Ordinances: Source: "Codigo Técnico de Edificación," Real Decreto 314/2006 + Documento Básico HE. The solar thermal part applies to all new buildings and to those undergoing a renovation. It applies to any kind of buildings, independent of their use. Some exceptions are defined in the law; mainly in the case of buildings that either satisfy their (DHW demand by other renewables or by cogeneration or for shaded buildings. The variation of the solar fraction from 30–70 percent depends on different parameters, mainly the assumed volume of DHW demand and the geographical position of the building. If back-up energy for heating is electricity, solar contribution must meet 50–70 percent of hot water energy needs, depending on climatic zone and level of consumption. (While most of its provisions will apply only one year after publication, those concerning energy efficiency and solar energy are expected to apply within six months, i.e. probably from October 2006. Because the obligation refers to the authorisation of the

new buildings, it will then take around one further year until the impact will be felt on the solar thermal market.) The municipal solar obligations, approved in the last few years in dozens of municipalities, including Barcelona and Madrid, will remain in force as long as they are stronger than the national obligation included in the CTE. (Partial source: ESTIF, "Spain approves national solar thermal obligation," press release (21 March 2006)).

[34] Maine's subsidy is capped at $1250/system, and also has a cap on total program subsidies.

[35] Offsetting the new mandates, Germany later in 2006 was to replace its past policy of a 100-percent VAT exemption for biodiesel with reduced taxes—a €0.10/liter tax on biodiesel used in its pure form and a €0.15/liter tax on biodiesel mixed in refineries.

[36] Wisconsin requires that all state agencies reduce gasoline and diesel use in the state's vehicle fleet by 2015 (25 percent reduction of diesel and 50 percent reduction of gasoline), partly through the use of E10 and E85.

[37] Thailand's biodiesel target is equivalent to 0.9 billion liters/year. Thailand also has plans for 1.8 million ha of palm oil plantations by 2013.

[38] The Philippines already uses B1 blending for government vehicles.

[39] Countries: Brazil, Colombia, Germany, France, Malaysia, Philippines, Thailand, United States (federal renewable fuel standard), Dominican Republic. States/Provinces: India (nine states plus four federal territories), China (nine provinces, cities only in four), Canada (Saskatchewan and Ontario), United States (Hawaii, Minnesota, Montana, Washington, Wisconsin).

[40] Information on New York City and the Mayor's Climate Protection Agreement comes from Rickerson and Hughes 2006. Tokyo's policy was announced in the press on 3 April 2006, and delivered orally and via handout at the Second International Solar Cities Congress, Oxford, United Kingdom, 3–6 April 2006, by Ms. Yuko Nishida of the Tokyo Metropolitan Government Bureau of Environment.

[41] Grid extension or diesel power for rural households was proving cheaper in early phases of the Brazil program, and some believed higher-cost renewables would be addressed last in the program.

[42] However, there is uncertainty about the actual number of working systems based on these installations, as program and technical monitoring has been weak and maintenance infrastructure is lacking.

[43] Sri Lanka numbers available at World Bank/GEF ESD Project Web site, www.energyservices.lk/statistics/esd_rered.htm.

[44] List of interviews: The special supplement on private investment and finance trends is based on literature cited and the following set of interviews: Katherine Richter Brass and Martin Berkenkamp, GE Energy, by Jasmine Hyman, Cologne (11 May 2006); Lucien Bronicki Ormat, by Akif Chaudhry, by phone (9 May 2006); Fabrizio Donini-Ferretti, Dexia, by Akif Chaudhry, by phone (10 May 2006); Sven Hansen, Good Energies, by Akif Chaudhry, by e-mail (9 May 2006); Hans Dieter Hermes, Lahmeyer International, by Jasmine Hyman, Cologne (11 May 2006); James Hunt, Mott McDonald, by Jasmine Hyman, Cologne (12 May 2006); Celine Lauverjat, Caisse de Depots et Consignations, by Akif Chaudhry, by phone (18 May 2006); Ursula Picewicz, European Investments and Partners, by Jasmine Hyman, Cologne (11 May 2006); Michaela Pulkert, HVB, by Akif Chaudhry, by phone (11 May 2006); Petro Sporer, G.A.S. Energietechnologie, by Jasmine Hyman, Cologne (11 May 2006); R. Thirumagen Sri, Asia Carbon Exchange International B.V, by Jasmine Hyman, Cologne (11 May 2006).

[45] Brass and Berkenkamp, op. cit. note 44.

[46] See list of interviews, op. cit. note 44.

[47] Ernst & Young L.L.P., "Renewable Energy Country Attractiveness Indices" (Spring 2006).

[48] Hermes; Brass and Berkenkamp; Sporer; Picewicz; all op. cit. note 44.

[49] Hunt, op. cit note 45. Similar views expressed by Hermes, op. cit. note 44.

[50] CleanEdgeNews (2006), "Clean Edge's Annual Trends Report Finds that Global Clean Energy Revenues Soared to $40 Billion in 2005"

[51] Donini-Ferretti, F; Pulkert, both op. cit. note 44.

[52] CleanEdgeNews, "Clean Edge's Annual Trends Report Finds that Global Clean Energy Revenues Soared to $40 Billion in 2005," press release (2006).

[53] Euromoney, "Renewables to bolster energy security in Eastern Europe," 2006, at www.euromoneyenergy.com/default.asp?Page=4&SID=611714&ISS=21352.

[54] R. Pospisil, "Finance: This is where the growth is," *Renewable Energy World*, September–October 2005, at www.reeep.org/media/downloadable_documents/b/m/REFF%20NYC%20story%20-%20REW%20Oct%20'05.pdf.

[55] CleanEdgeNews, op. cit. note 52; Knowledge@Wharton, "The End of Oil? Venture Capital Firms Raise the Profile of Alternative Energy," 26 April 2006, at http://knowledge.wharton.upenn.edu/article/1454.cfm.

[56] Citigroup, "The Environment: Sustainable Development Investment Program," 28 June 2006, at www.citigroup.com/citigroup/environment/investment.htm.

[57] UBS AG, "First ever biofuels index launched by UBS and Diapason," *UBS News Alert*, 7 March 2006, at www.ubs.com/1/e/about/newsalert?newsId=89663.

[58] DowJones VentureOne, "Venture-Backed European Companies Continue IPO Trend, Raising Most Capital Since 2000," press release (19 January 2006).

[59] "2006 Cleantech Venture Capital Report," cited in Knowledge@Wharton, op. cit. note 55.

[60] J. Glover and J. Ryan, "Investing: Wind Farms Becoming Bond-Market Collateral," *International Herald Tribune*, 16 May 2006, at www.iht.com/articles/2006/05/15/bloomberg/bxinvest.php.

[61] J. Kho, "Cleantech Private Equity Slows," *Red Herring: The Business of Technology*, 13 June 2006, at www.redherring.com/Article.aspx?a=17224&hed=Cleantech+Private+Equity+Slows&sector=Industries&subsector=Energy.

[62] Knowledge@Wharton, op. cit. note 55.

[63] M. Liebreich, CEO, New Energy Finance, "AIMing too high?" *Environmental Finance*, April 2006.

[64] Ibid.

[65] Knowledge@Wharton, op. cit. note 55.

[66] Peter Lynch, www.investor.com, 28 March 2006.

[67] "Renewable Energy Report," *Platts*, No. 94/95, 12 December 2005.

[68] C. Lacoursiere, "Silicon Shortages Drives Solar Mergers & Acquisitions," RenewableEnergyAccess.com, 23 Februrary 2006, at www.renewableenergyaccess.com/rea/news/story?id=43983.

[69] Ibid.

[70] M. Liebreich, "New Energy Finance New York Network Lunch" (New York: 2006).

[71] See List of interviews, op. cit. note 44.

[72] For the next edition, it may be possible to begin to report shares of primary energy production from renewables and shares of electricity production from renewables. The International Energy Agency does this for share of primary energy, with and without solid biomass, in its "Global Fact Sheet" report (IEA 2006d). This type of analysis was considered useful but was not done for the original 2005 report or this 2006 update.

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