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# GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2011

*Analysis of Trends and  
Issues in the Financing  
of Renewable Energy*



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## **Concept and Editorial Oversight**

Angus McCrone (Lead Author, Chief Editor)

Eric Usher (Lead Editor)

Virginia Sonntag-O'Brien

Ulf Moslener (Lead Editor)

Jan G. Andreas

Christine Grüning

## **Contributors**

Nicole Aspinall

David Strahan

Vandana Gombar

Victoria Cuming

Rohan Boyle

Kieron Stopforth

Ashwini Bindinganavale

## **Coordination**

Angus McCrone

## **Design and Layout**

Jeanne Marais

## **Media Outreach**

Terry Collins

Angelika Werner

## **Thanks to the following experts who reviewed and provided feedback on the draft report:**

Frédéric Crampé

Gunter Fischer

Mark Fulton

Nick Robins

Michaela Pulkert

Samuel Tumiwa

# FOREWORD FROM ACHIM STEINER

Investments in renewable energies, from wind and solar power to geothermal and waste-into-energy, continued their remarkable growth in 2010.

A combination of stimulus package funds making their way into the market, the introduction of smart policies like feed-in tariffs and target-setting sparked a record \$211 billion of investment in renewable energy.

The more-than-\$48 billion new investment in China merits attention in terms of scale and growth. Other highlights of this year's report are rising investments across other parts of the developing world, and the sharp increase in investment in small-scale renewables in countries such as Germany and Italy, where predominantly rooftop solar projects surged to \$60 billion-worth of investment, up over 90% from 2009.

Excluding Brazil, Mexico took the lead in Latin America where investments, mainly in wind but also in geothermal, grew close to 350%, triggered in large part by a government decision to raise renewable energy capacity from 3.3% to over 7.5% by 2012.

Argentina, with a target of 8% of its energy to be sourced from renewables by 2016, saw investment grow nearly seven-fold to \$740 million. 2010 also saw important investment in Chile, Peru and Venezuela.

In Asia, Pakistan and Thailand saw investments tripling and quadrupling respectively. In Pakistan \$1.5 billion-worth of wind was financed and in Thailand \$700 million-worth of investment flowed, mainly into large-scale photovoltaic projects.

Significant investment is also starting to be seen in Africa, which posted the highest percentage increase of all developing regions, if the emerging economies of Brazil, China and India are excluded.

In Egypt, renewable energy investment rose by \$800 million to \$1.3 billion as a result of the solar thermal project in Kom Ombo and a 220MW onshore wind farm in the Gulf of Zeit. In Kenya, investment climbed from virtually zero in 2009 to \$1.3 billion in 2010 across technologies such as wind, geothermal, small-scale hydro and biofuels. Small but significant advances were also made in Cape Verde, Morocco and Zambia.

Renewable energies are expanding both in terms of investment, projects and geographical spread. In doing so, they are making an increasing contribution to combating climate change, countering energy poverty and energy insecurity, stimulating green jobs and meeting the Millennium Development Goals.

The UN climate convention in Durban later in the year, followed by the Rio+20 Conference in Brazil in 2012, offer important opportunities to accelerate and scale up this positive transition to a low-carbon, resource efficient Green Economy in the context of sustainable development and poverty eradication.

**Achim Steiner**

**UN Under-Secretary General and UNEP Executive Director**





# FOREWORD FROM UDO STEFFENS

With investments of \$72 billion in 2010, for the first time developing countries have committed more than developed countries to utility-scale renewable energy projects and companies. This is the central and exciting investment story of the Global Trends Report 2011.

China has led this surge, with nearly \$50 billion invested in 2010, making it by far the largest source of, and destination for, clean energy investment globally. However, other parts of the developing world have also shown strong growth, such as the Middle East and Africa region, which more than doubled investment in renewables in the past year.

This investment activity in the developing world is leading to innovation in renewable energy technologies and markets. First-mover investors are financing a range of new business models and entrepreneurs in the developing world, several of which are profiled in the report's Special Focus Chapter.

To enhance the attractiveness of investments in developing and emerging economies, the UNEP Collaborating Centre for Climate & Sustainable Energy Finance at the Frankfurt School of Finance & Management works to build and strengthen institutional capacities in the financial sector in these markets all over the world.

The Centre is an integral part of the Frankfurt School. Our academics, experts and consultants look back on profound experience with international advisory services in energy efficiency and renewable energy projects, covering research, training, and education.

Our work with the financial sector has shown that more and more financial institutions are beginning to lend for sustainable energy investments and are building new business segments to serve this market.

Still, there are barriers to overcome, and it is the Centre's aim to contribute to making investments in renewables in developing countries more attractive for investors. We hope the Global Trends report also serves our objectives.

**Udo Steffens**  
**President and CEO, Frankfurt School of Finance & Management**

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# METHODOLOGY & DEFINITIONS

All figures in this report, unless otherwise credited, are based on the output of the Desktop database of Bloomberg New Energy Finance – an online portal to the world's most comprehensive database of investors, projects and transactions in clean energy.

The Bloomberg New Energy Finance Desktop collates all organisations, projects and investments according to transaction type, sector, geography and timing. It covers 40,000 organisations (including start-ups, corporates, venture capital and private equity providers, banks and other investors), 26,300 projects and 22,800 transactions.

## METHODOLOGY

The following renewable energy projects are included: all biomass, geothermal and wind generation projects of more than 1MW, all hydro projects of between 0.5 and 50MW, all solar projects of more than 0.3MW, all marine energy projects, and all biofuel projects with a capacity of 1m litres or more per year.

Unlike previous years' Global Trends reports, this edition concentrates on renewable energy and does not cover energy-smart technologies such as smart grid, electric vehicles and power storage – except in the box at the end of Chapter 2.

Where deal values are not disclosed, Bloomberg New Energy Finance assigns an estimated value based on comparable transactions. Deal values are rigorously back-checked and updated when further information is released about particular companies and projects. The statistics used are historic figures, based on confirmed and disclosed investment.

Annual investment in small-scale and residential projects such as rooftop solar is estimated. These figures are based on annual installation data, provided by industry associations and REN21. In Chapter 7, we have also stated estimates for solar water heaters, which do not generate power and are therefore excluded from the main small-scale projects figure and from the overall total for investment in renewable energy. The figures on investment in small-scale projects in previous years in this report have been revised up to reflect an improved estimating methodology.

Bloomberg New Energy Finance continuously monitors investment in renewable energy. This is a dynamic process: as the sector's visibility grows, information flow improves. New deals come to light and existing data are refined, meaning that historic figures are constantly updated.

This 2011 report contains revisions to a number of investment figures published in the 2010 UNEP Global Trends In Sustainable Energy Investment report. Revisions reflect improvements made by Bloomberg New Energy Finance to its calculations during the course of 2010 – including deep analysis of corporate and government research and development, and the inclusion for the first time of bridging loans and construction debt for renewable energy projects.

## DEFINITIONS

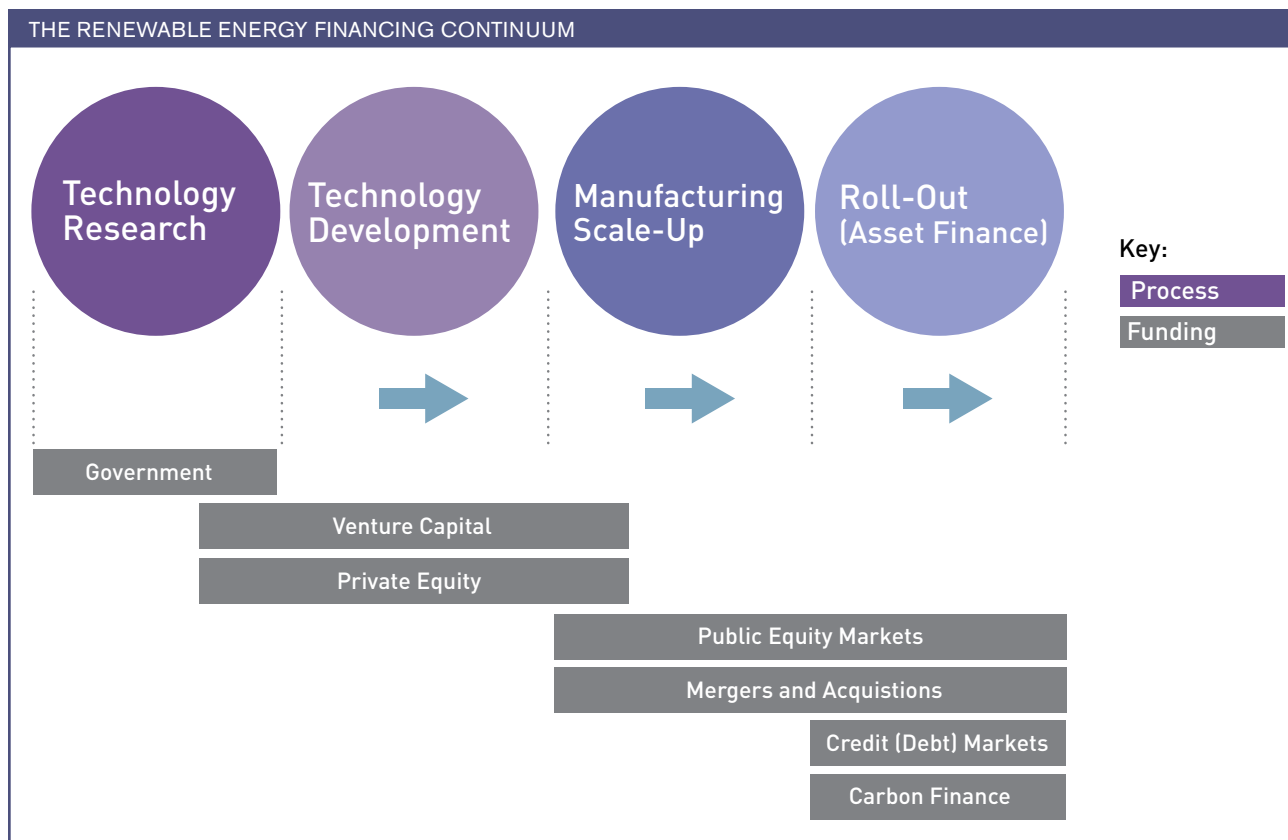
Bloomberg New Energy Finance tracks deals across the financing continuum, from R&D funding and venture capital for technology and early-stage companies, through to public market financing for projects and mature companies. Investment categories are defined as follows:

**VENTURE CAPITAL AND PRIVATE EQUITY (VC/PE):** all money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure.

**PUBLIC MARKETS:** all money invested in the equity of publicly quoted companies developing renewable energy technology and clean power generation. Investment in companies setting up generating capacity is included in the asset financing figure.

**ASSET FINANCING:** all money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance. This excludes re-financings.

**MERGERS AND ACQUISITIONS (M&A):** the value of existing equity purchased by new corporate buyers in companies developing renewable technology or operating renewable energy projects.



REN21's annual **Renewables Global Status Report (GSR)** was first released in 2005. It grew out of an effort to comprehensively capture, for the first time, the full status of renewable energy worldwide. Over the years, the GSR has expanded in scope and depth, in parallel with tremendous advances in renewable energy markets and industries. The report has become a major production that involves the amalgamation of thousands of data points, hundreds of reports and other documents, and personal communications with experts from around the world. The Global Status Report is the sister publication to UNEP Global Trends in Renewable Energy Investment report, and the latest edition will be released in July 2011.

# KEY FINDINGS

- Global investment in renewable energy jumped 32% in 2010, to a record \$211 billion. It was boosted in particular by wind farm development in China and small-scale solar PV installation on rooftops in Europe.
  - Of the major types of investment, there were sharp increases in asset finance of utility-scale projects such as wind farms, in venture capital provision for young firms, and in equity-raising on the public markets by quoted renewable energy companies. Asset finance rose 19% to \$128 billion in 2010, venture capital investment increased 59% to \$2.4 billion, and public market investment gained 23% to \$15.4 billion.
  - However the sharpest percentage gains were in investment in small-scale projects, up 91% year-on-year at \$60 billion, and in government-funded research and development, up 121% at \$5.3 billion, as more of the “green stimulus” funds promised after the financial crisis arrived in the sector.
  - Only two areas of investment showed a fall in 2010 compared to 2009. One was corporate research, development and deployment, down 12% at \$3.3 billion, as companies retrenched in the face of economic hard times. The other was provision of expansion capital for renewable energy companies by private equity funds, down 1% at \$3.1 billion.
  - One of the striking features of 2010 was that, in terms of financial new investment (asset finance and investment by venture capital, private equity and public markets), developing countries overtook developed economies for the first time. Financial new investment in the former totalled \$72 billion, against \$70 billion in the latter.
  - This performance by developing economies owed much to China, which with \$48.9 billion (up 28%) was the world’s leading country in terms of financial new investment in renewable energy in 2010. However other parts of the emerging world also showed strong growth.
  - Financial new investment in South & Central America jumped 39% to \$13.1 billion, and in Middle East & Africa by 104% to \$5 billion. India gained 25% to \$3.8 billion, and Latin America excluding Brazil a near-tripling to \$6.2 billion. Asian developing countries excluding China and India saw increases averaging 31%, to \$4 billion in total.
  - Europe saw a decline of 22% to \$35.2 billion in financial new investment in renewable energy in 2010. However this was more than made up by a surge in small-scale project installation, predominantly rooftop solar. Germany alone saw small distributed capacity investment of \$34 billion, up 132%, while Italy saw \$5.5 billion (up 59%), France \$2.7 billion (up 150%), and the Czech Republic \$2.3 billion (up 163%).
  - That boom in European small-scale solar owed much to feed-in tariff subsidies in the countries concerned, combined with a sharp fall in the cost of PV modules. By the end of 2010, many countries were rushing to make their PV tariffs less generous. But the small-scale solar market is likely to stay strong in 2011.
  - Clean energy share prices had a difficult 2010. The WilderHill New Energy Global Innovation Index, or NEX, fell 14.6% during the year, under-performing wider stock market indices by more than 20%. This showing reflected investor concerns about industry over-capacity, cutbacks in subsidy programmes and competition from power stations burning cheap natural gas.
  - Acquisition activity in renewable energy, representing money changing hands rather than new investment, fell from \$66 billion in 2009 to \$58 billion in 2010. The two largest categories of M&A – corporate takeovers and acquisitions of wind farms and other assets – both fell by around 10%.
- An overview of investment trends in renewable energy in the early months of 2011 is shown in the box on page 15.

# EXECUTIVE SUMMARY

Global investment in renewable power and fuels set a new record in 2010, and the margin over totals for previous years was wide, not narrow. Investment hit \$211 billion last year, up 32% from a revised \$160 billion in 2009, and nearly five and a half times the figure achieved as recently as 2004.

The record itself was not the only eye-catching aspect of 2010. Another was the strongest evidence yet of the shift in activity in renewable energy towards developing economies. Financial new investment, a measure that covers transactions by third-party investors, was \$143 billion in 2010, but while just over \$70 billion of that took place in developed countries, more than \$72 billion occurred in developing countries.

This is the first time the developing world has overtaken the richer countries in terms of financial new investment - the comparison was nearly four-to-one in favour of the developed countries back in 2004. It is important to note that in two other areas not included in the financial new investment measure, namely small-scale projects and research and development, developed economies remain well ahead.

However the balance of power in renewables has been shifting towards developing countries for several years. The biggest reason for this has been China's drive to invest: last year, China was responsible for \$48.9 billion of financial new investment, up 28% on 2009, with the asset finance of large wind farms the dominant part of that. But the developing world's advance in renewables is no longer a story of China and little else. In 2010, financial new investment in renewable energy grew by 104% to \$5 billion in the Middle East and Africa region, and by 39% to \$13.1 billion in South and Central America.

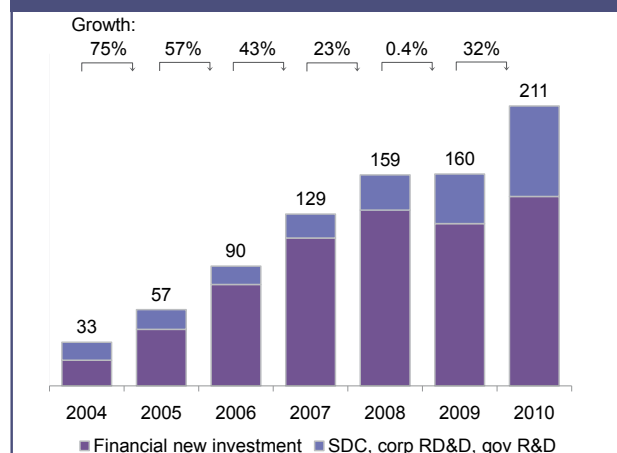
The developing world - at least outside its most powerful economies - may not be able to afford the same level of subsidy support for clean energy technologies as Europe or North America. However it has a pressing need for new power capacity and, in many places, superior natural resources, in the shape of high capacity factors for wind power and strong solar insolation. It also is starting to host the development of a range of new renewable energy technologies for specific, local applications. As Chapter 10 recounts, these range from rice-husk power generation to solar telecommunications towers and are becoming the technology of choice, not a poor substitute for diesel or other fossil-fuel power options.

A second remarkable detail about 2010 is that it was the first year that overall investment in solar came close to catching up that in wind. For the whole of the last

decade, as renewable energy investment gathered pace, wind was the most mature technology and enjoyed an apparently unassailable lead over its rival power sources. In 2010, wind continued to dominate in terms of financial new investment, with \$94.7 billion compared to \$26.1 billion for solar and \$11 billion for the third-placed biomass & waste-to-energy. However these numbers do not include small-scale projects and in that realm, solar, particularly via rooftop photovoltaics in Europe, was completely dominant. Small-scale distributed capacity investment ballooned to \$60 billion in 2010, up from \$31 billion, fuelled by feed-in tariff subsidies in Germany and other European countries. This figure, combined with solar's lead in government and corporate research and development, was almost enough to offset wind's big lead in financial new investment last year.

No energy technology has gained more from falling costs than solar over the last three years. The price of PV modules per MW has fallen by 60% since the summer of 2008, according to Bloomberg New Energy Finance estimates, putting solar power for the first time on a competitive footing with the retail price of electricity in a number of sunny countries. Wind turbine prices have fallen 18% per MW in the last two years, reflecting, as with solar, fierce competition in the supply chain. Further improvements in the levelised cost of energy for solar, wind and other technologies lie ahead, posing a bigger and bigger threat to the dominance of fossil-fuel generation sources in the next few years.

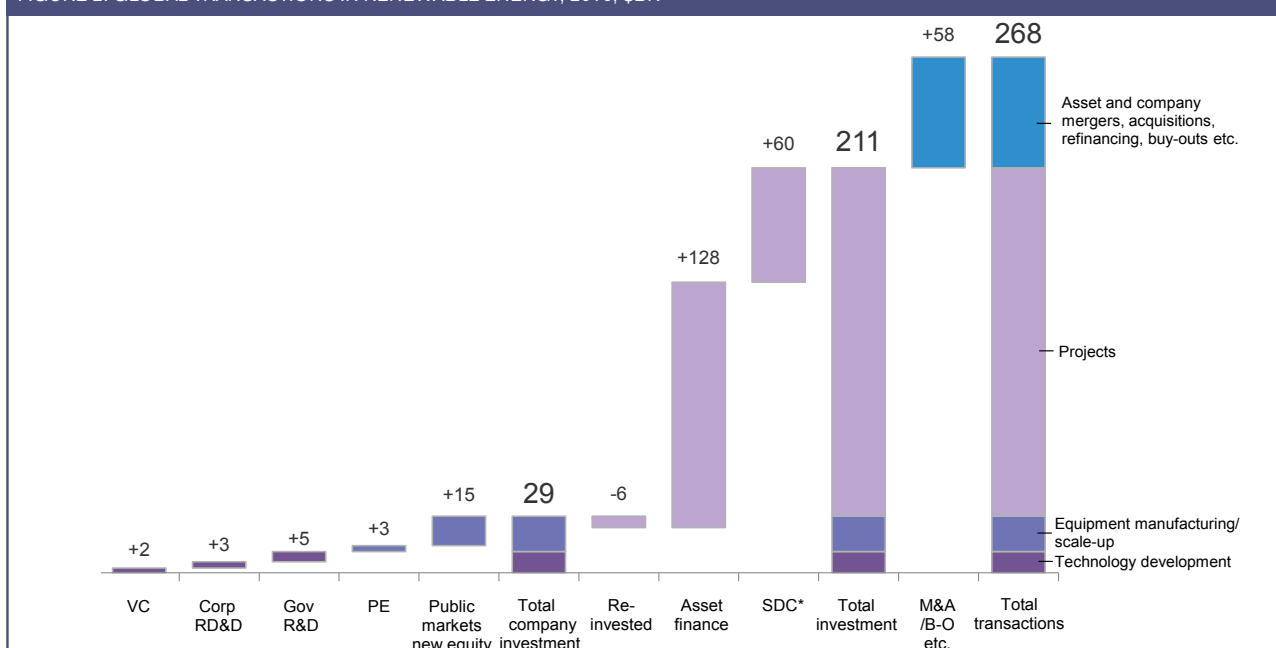
FIGURE 1: GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY, 2004-2010, \$BN



SDC = small distributed capacity. New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance

FIGURE 2: GLOBAL TRANSACTIONS IN RENEWABLE ENERGY, 2010, \$BN



SDC = small distributed capacity. Total values include estimates for undisclosed deals. \* data based on estimates from various industry sources

Source: Bloomberg New Energy Finance, UNEP

FIGURE 3: GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2011 DATA TABLE, \$BN

Category	Year	2004 \$bn	2005 \$bn	2006 \$bn	2007 \$bn	2008 \$bn	2009 \$bn	2010 \$bn	2009-10 Growth %	2004-10 CAGR %
<b>1 Total Investment</b>										
1.1 New Investment		33	57	90	129	159	160	211	32%	36%
1.2 Total Transactions		41	83	125	187	224	225	268	19%	37%
<b>2 New Investment by Value Chain</b>										
<b>2.1 Technology Development</b>										
2.1.1 Venture capital		0.4	0.6	1.3	1.9	2.9	1.5	2.4	59%	36%
2.1.2 Government R&D*		1.1	1.2	1.3	1.5	1.6	2.4	5.3	121%	29%
2.1.3 Corporate RD&D*		3.8	2.9	3.1	3.3	3.7	3.7	3.3	-12%	-2%
<b>2.2 Equipment Manufacturing</b>										
2.2.1 Private equity expansion capital		0.3	0.8	3.1	3.2	6.6	3.1	3.1	-1%	45%
2.2.2 Public markets		0.4	4.0	11.0	22.0	12.8	12.5	15.4	23%	87%
<b>2.3 Projects</b>										
2.3.1 Asset finance		18.3	37.2	62.1	90.1	114.7	107.5	127.8	19%	38%
Of which re-invested equity		0.0	0.0	1.1	5.7	4.5	2.4	6.0		
2.3.3 Small distributed capacity*		8.6	10.7	9.4	13.2	21.1	31.2	59.6	91%	38%
Total Financial Investment		19	43	76	111	132	122	143	17%	40%
Gov'n R&D, Corporate RD&D, Small projects		14	15	14	18	26	37	68	82%	31%
<b>Total New Investment</b>		33	57	90	129	159	160	211	32%	36%
<b>3 M&amp;A Transactions</b>										
3.1 Private equity buy-outs		0.8	3.3	1.6	3.3	5.5	2.8	0.8	-71%	0%
3.2 Public markets investor exits		0.0	1.3	2.1	3.9	1.0	2.0	1.3	-34%	243%
3.3 Corporate M&A		2.4	8.6	13.2	18.7	18.0	21.6	20.0	-7%	42%
3.4 Project acquisition & refinancing		5.3	12.7	18.1	31.5	40.7	39.3	35.6	-9%	37%
<b>4 Financial New Investment by Technology</b>										
4.1 Wind		11.3	21.9	29.7	51.1	62.7	72.7	94.7	30%	43%
4.2 Solar		0.5	3.2	10.4	21.8	33.3	25.3	26.1	3%	91%
4.3 Biofuels		1.6	6.0	20.4	20.0	18.7	6.9	5.5	-20%	23%
4.4 Biomass & w-t-e		3.7	6.7	10.0	11.4	10.1	11.5	11.0	-5%	20%
4.5 Small hydro		1.1	4.4	4.2	5.0	5.8	4.1	3.2	-22%	19%
4.6 Geothermal		1.0	0.4	1.3	1.9	1.6	1.4	2.0	44%	12%
4.7 Marine		0.0	0.0	0.5	0.4	0.1	0.2	0.1	-44%	33%
<b>Total</b>		19	43	76	111	132	122	143	17%	40%
<b>5 Financial New Investment by Geography</b>										
<b>5.1 Global</b>										
5.1.1 Europe		9.0	18.4	27.3	46.6	47.6	45.0	35.2	-22%	25%
5.1.2 North America		3.8	10.3	24.6	29.4	32.3	19.7	30.1	53%	41%
5.1.3 South America		0.5	2.8	4.7	7.7	15.7	9.4	13.1	39%	70%
5.1.4 Asia & Oceania		5.6	11.0	18.3	26.2	34.4	45.7	59.3	30%	48%
5.1.5 Middle East & Africa		0.3	0.1	1.5	1.5	2.4	2.4	5.0	104%	57%
<b>Total</b>		19	43	76	111	132	122	143	17%	40%
<b>5.2 Selected Developing Countries/Regions</b>										
5.2.1 Brazil		0.4	1.8	4.2	6.4	13.2	7.3	6.9	-5%	62%
5.2.2 China		1.5	4.7	9.2	14.2	23.9	38.3	48.9	28%	80%
5.2.3 India		1.3	2.7	3.8	5.1	4.1	3.0	3.8	25%	19%
5.2.5 Africa		0.3	0.1	0.6	0.7	1.1	0.7	3.6	384%	51%

New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

## \$211 BILLION INVESTMENT

Figure 1 shows the trend in renewable energy investment from 2004 to 2010. In this year's Global Trends report, we are concentrating on renewable power and fuels rather than the wider definition of clean energy, which includes energy-smart technologies such as smart grid and electric vehicles, covered in previous years' reports. However we do also take a brief look at energy-smart technology investment in a box at the end of Chapter 2.

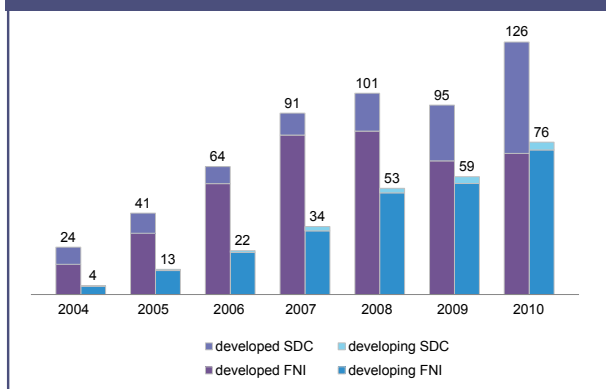
Total investment in renewable energy in 2010 was \$211 billion, up from \$160 billion in 2009 and \$159 billion in 2008. Within the overall figure, financial new investment - which consists of money invested in renewable energy companies and utility-scale generation and biofuel projects - rose to \$143 billion, from \$122 billion in 2009 and the previous record of \$132 billion in 2008.

A sharper increase however has been evident in the other components of the total investment figure - namely small-scale distributed capacity, and government and corporate R&D. These jumped to \$68 billion in 2010, from \$37 billion in 2009 and \$26 billion in 2008, reflecting mainly the boom in rooftop PV, but also a rise in government-funded R&D, as spending increased from "green stimulus" announced after the financial crisis.

Figure 2 shows in detail how the \$211 billion total investment figure is reached. The left side of the chart shows investment in technology, via venture capital financing of small companies, and R&D spending by governments and larger corporations. Slightly further on is financing of the expansion of manufacturing capacity by private equity and public market investors. Then there is the largest single element of total investment - the asset finance of utility-scale projects such as wind farms, solar parks, biofuel refineries and biomass or waste-to-power generators - and finally, small-scale distributed capacity (overwhelmingly photovoltaics on rooftops). On the right hand side of Figure 2 is \$58 billion of acquisition transactions - this is not included in total new investment, because it is money changing hands, not net funding coming into the renewable energy sector.

The momentum of clean energy investment over recent years has been strong, but there have been many jolts and bumps on the way, as the detail of Figure 3 shows. These have included the biofuel boom of 2006-07 and subsequent bust, resulting in a fall in financial new investment in that sector from a peak of \$20.4 billion in 2006 to just \$5.5 billion last year; and the impact of the financial crisis and recession on Europe and North America. Financial new investment in renewable energy was significantly lower in 2010 in both Europe and North America, although this setback was more than out-weighted by growing investment in China and other

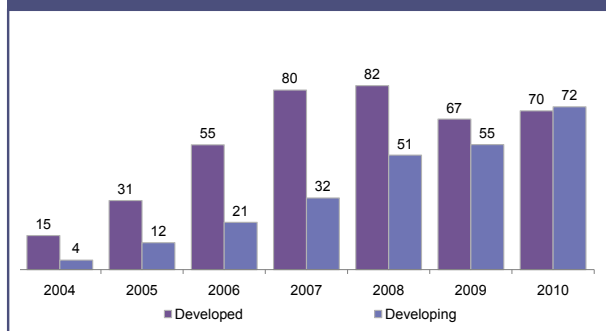
FIGURE 4: FINANCIAL NEW INVESTMENT AND SMALL DISTRIBUTED CAPACITY IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2004-2010 \$BN



FNI = Financial new investment; SDC = small distributed capacity. New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance

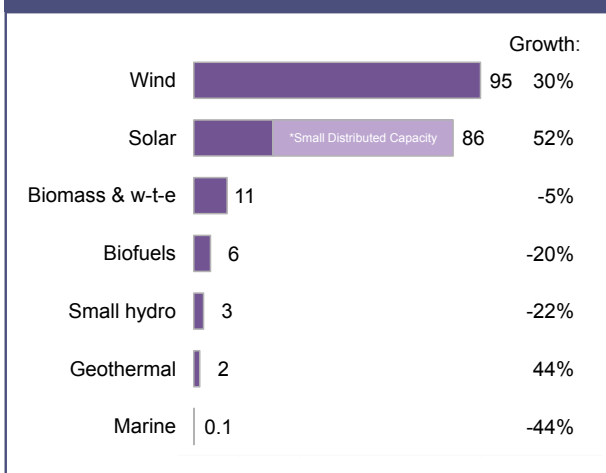
FIGURE 5: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2004-2010



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

FIGURE 6: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY BY TECHNOLOGY, 2010, AND GROWTH ON 2009, \$BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP



emerging economies, and in small-scale PV projects in the developed world.

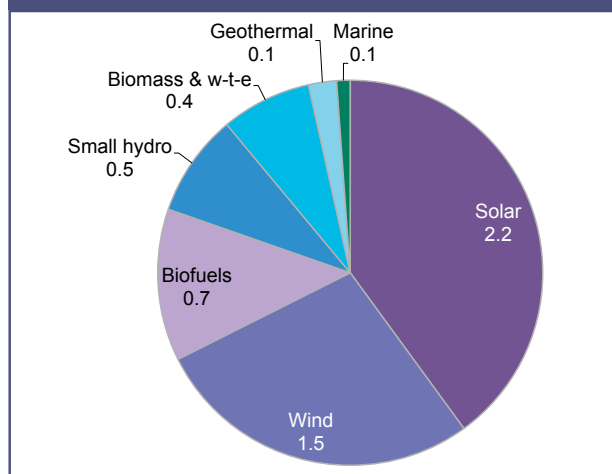
The shift in investment between developed and developing countries over recent years is shown in Figures 4 and 5. Figure 4 shows that developed countries in 2010 retained a huge advantage in small-scale projects, but not what we define as financial new investment. Figure 5 shows that in 2010, developing countries edged narrowly ahead of developed countries in terms of financial new investment for the first time. In 2007, developed economies still had an advantage of more than two-to-one in dollar terms, but the recession in the G-7 countries and the dynamism of China, India, Brazil and other important emerging economies has transformed the balance of power in renewable energy worldwide. As later chapters show, that has led to big changes in the location of initial public offerings and manufacturing plant investments by renewable energy companies.

Wind was the dominant sector in terms of financial new investment (though not of small-scale projects, as noted above) in 2010, with a rise of 30% to \$95 billion. Figure 6 shows that on this measure of investment, other sectors lagged far behind. Although the number of GW of wind capacity put into operation last year was lower than in 2009, the amount of money committed was higher. This reflected decisions to invest in large projects from China to the US and South America, a rise in offshore wind infrastructure investment in the North Sea, and the IPO in November of Italy's Enel Green Power, the largest specialist renewable energy company to debut on the stock market since 2007.

In venture capital and private equity investment, wind came a creditable second, with a figure of \$1.5 billion last year, up 17% on 2009. However, as Figure 7 illustrates, solar stayed ahead as the most attractive destination for early-stage investors, its \$2.2 billion figure coming after a 30% gain year-on-year. The positions of the two technologies were reversed again in terms of public markets investment (Figure 8), with wind boosted by the Enel Green Power flotation, and also some healthier figures for investment in 2010 in quoted companies specialising in biofuels, biomass and small hydro.

Asset finance of utility-scale projects (Figure 9) is the dominant figure within financial new investment. Wind "mega-bases" in China continued to receive billions of dollars of funding, while large projects in Europe attracted important support from multilateral development banks, notably European Investment Bank debt for the Thornton Bank project off the coast of Belgium. US wind farm investment owed much to the Treasury grant programme, introduced in 2009 but due to expire at the end of 2011.

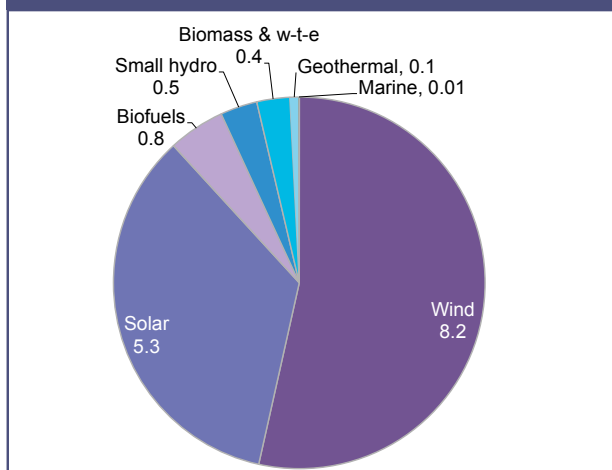
FIGURE 7: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY TECHNOLOGY, 2010, \$BN



VC/PE new investment excludes PE buy-outs. Total values include estimates for undisclosed deals.

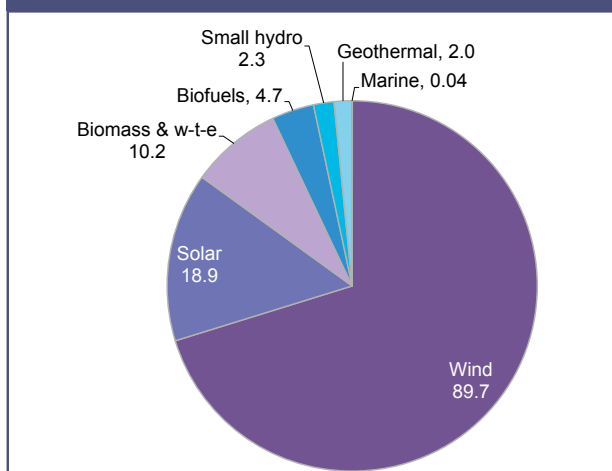
Source: Bloomberg New Energy Finance, UNEP

FIGURE 8: PUBLIC MARKETS NEW INVESTMENT IN RENEWABLE ENERGY BY TECHNOLOGY, 2010, \$BN



Source: Bloomberg New Energy Finance, UNEP

FIGURE 9: ASSET FINANCE OF NEW-BUILD RENEWABLE ENERGY ASSETS BY TECHNOLOGY, 2010, \$BN



Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

## PROBLEMS AS WELL AS PROGRESS

2010 was not a year of uninterrupted joy for renewable energy. New challenges emerged, and some existing challenges became tougher. First, moves by Spain and the Czech Republic to make retroactive cuts in feed-in tariff levels for already-operating PV projects damaged investor confidence. Other governments, such as those of Germany or Italy, announced reductions in tariffs for new projects - logical steps to reflect sharp falls in technology costs. What caused concern was the idea that governments, facing economic hardship, might go back on previously promised deals for existing projects, damaging returns for equity investors and banks.

A second challenge came from the natural gas price. The Henry Hub US benchmark stayed in a range of \$3 to \$5 per MMBtu for almost all of 2010, far below the \$13 peak of 2008 and also below the levels prevailing in most of the middle years of the decade. This gave generators in the US, but also in Europe and elsewhere, an incentive to build more gas-fired power stations and depressed the terms of power purchasing agreements available to renewable energy projects.

A third challenge for renewables came from outside scepticism. This manifested itself both in the stock market - where clean energy shares under-performed wider indices by more than 20% on pessimism about future profit growth - and in international politics, where the mood post-Copenhagen and post-Climategate was cooler than in some previous years. In fact, more progress towards emission reduction was achieved than expected at the December 2010 meeting in Cancun; and the consensus among climate scientists about man-made global warming actually strengthened during last year. However neither has - yet - catapulted clean energy back to the top of government agendas.

There was a sense, in both the second half of 2010 and early 2011, that progress in renewable energy was taking place at a pace that public opinion and policy-makers in many countries were simply failing to spot. This progress was both in investment levels and, even more, in cost-competitiveness with conventional power sources.

### INVESTMENT IN 2011

Given the rush to complete a number of big investment transactions in the closing weeks of 2010, in some cases to "catch" attractive subsidy deals before they expired, it was little surprise that activity in the first quarter of 2011 was relatively subdued. As Figure 10 shows, financial new investment totalled \$31 billion, down from \$44 billion in the fourth quarter of last year and lower than the \$32 billion figure for Q1 2010.

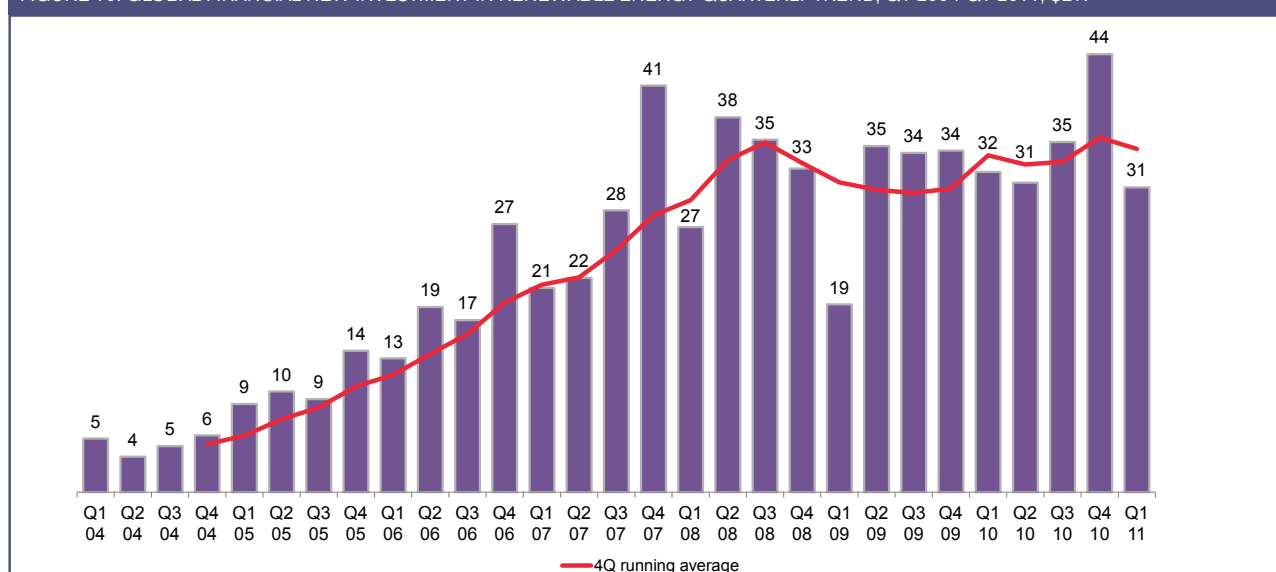
In asset finance, the biggest reductions in terms of absolute dollars came in US wind and European solar. The brightest spots of January-March 2011 were Chinese wind, up 25% on the same quarter of 2010, and Brazilian wind, which saw investment double from a year earlier.

Key projects going ahead included the 211MW IMPSA Ceara wind auction portfolio and 195MW Renova Bahia portfolio, both in Brazil, and the 200MW Hebei Weichang Yudaokou village wind farm in China. In Europe, there were several large offshore wind infrastructure commitments, including the Dan Tysk project off Germany, the Skagerrak 4 project off Denmark, and the Randstad project off the Netherlands.

In public market investment, transactions included a \$1.4 billion share sale by Sinovel Wind in China, and a \$220 million offering by solar manufacturer Shandong Jinjing Science & Technology, also in China. In venture capital and private equity investment, the largest transaction of the quarter was a \$143 million expansion capital round for US biomass and waste-to-energy specialist Plasma Energy.

March 2011 brought a tragic event with potentially far-reaching consequences for energy, including renewables. The Japanese earthquake, and the ensuing crisis at the reactors at Fukushima Daiichi, cast into doubt the future of nuclear power in Japan and also in other countries such as Germany. Initially, this led to a sharp rise in the share prices of renewable energy companies. But it could be that gas-fired generation will be the prime, short-term beneficiary of nuclear's problems, not renewables.

FIGURE 10: GLOBAL FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY QUARTERLY TREND, Q1 2004-Q1 2011, \$BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

## TOTAL INVESTMENT V FINANCIAL NEW INVESTMENT

In Chapters 1 to 9 below, we explore the trends in global investment in renewable energy. The narrative makes use of two aggregate figures. The first of these is total investment (which covers all the sub-categories in Figure 2 other than acquisition activity). The second is financial new investment, which covers just three categories - venture capital and private equity investment, public markets investment, and asset finance of utility-scale projects.

The reason for the use of the narrower aggregate in some places in this report is that the data for VC/PE, public markets and asset finance investment are available in much greater, granular detail in Bloomberg New Energy Finance's database, quarter-by-quarter. Data on the remaining asset classes of government and corporate R&D, and small distributed projects, are not available in comparable detail or easily allocated to one quarter of the year rather than another.



# 01 INVESTMENT BY TYPE OF ECONOMY

- Financial investment in renewable energy in developing countries outstripped that in developed economies for the first time. New financial investment – total investment excluding small-scale projects and government and corporate R&D - in developing countries rose \$17 billion to more than \$72 billion, while in developed economies it gained less than \$4 billion to \$70.5 billion.
- China attracted the most investment in renewables for the second year running in 2010, with new financial investment up 28% at almost \$49 billion, representing more than a third of the global figure. Expenditure in the US, ranked second, jumped 58% to just over \$25 billion.
- Besides the three big developing economies, China, India and Brazil, the regions of the developing world all achieved substantial growth in renewables investment: Latin America almost tripled to \$6.2 billion; Asia rose 31% to \$4 billion; and Africa jumped almost five-fold to \$3.6 billion.
- Government policies had a major impact, both positive and negative. Italy took the number three spot, with investment up three-and-a-half-fold (248%), partly as a result of generous solar feed-in-tariffs, while in Spain investment slumped 55% in response to cuts in renewable power subsidies for both new and operating projects.
- In the UK, offshore wind financings were not as large as in 2009 and there was some policy uncertainty after the change of government in May 2010. These influences helped push investment down 73% to \$2.9 billion.
- In small-scale power projects (not included in the figures above), developed countries still lead the way, with Germany, Italy and the US the three biggest locations in 2010.

During 2010 the centre of gravity for global renewables investment continued to shift to the developing world. New financial investment (asset finance, plus capital raising by companies from venture capital, private equity and public market investors) in developing countries outstripped that in the developed world for the first time, with developing countries receiving \$72.2 billion versus \$70.5 billion for the developed world.

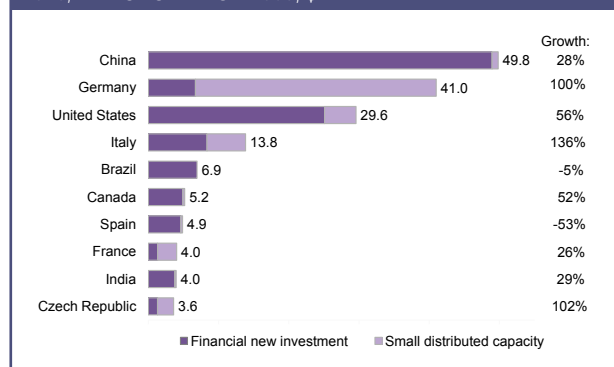
Figure 11 shows that China enjoyed a huge lead in financial new investment over the US in second place, and Italy a distant third (see dark part of the bars in the chart). But if small-scale projects are included, Germany's rooftop PV boom took it up to second place. Focusing on financial new investment, China's total of \$48.9 billion dwarfed all other countries, accounting for more than two-thirds of the developing countries total and more than a third of the global total. China's lead over the US in financial new investment edged up from \$22.3 billion to \$23.8 billion.

However, growth rates in a number of developed countries exceeded those in other major developing economies. In the US, financial new investment leapt 58% to just over \$25 billion; Canada, up 47% to \$4.9 billion, and Belgium, up 40% to \$2.4 billion. Investment in Italy rose an astonishing three-and-a-half-fold (248%) to \$8.4 billion, as a result of generous solar feed-in-tariffs and one major IPO, to claim the number

three spot globally. By contrast, in India new financial investment climbed 25% to \$3.8 billion, while in Brazil it fell 5% to \$6.9 billion.

The shifts are largely explained by swings in utility-scale project funding. The developing countries' \$17 billion overall gain was closely matched by a \$16 billion rise in asset finance; while the US advance of \$9.2 billion was fuelled by a rise in North American asset finance of \$10.7 billion. In both cases, the growth was dominated by wind, for which global asset finance rose \$23 billion to \$90 billion (see Chapter 6 on Asset Finance).

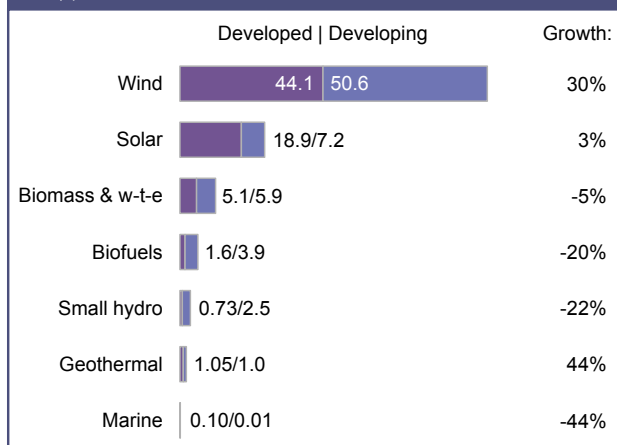
FIGURE 11: FINANCIAL NEW INVESTMENT AND SMALL DISTRIBUTED CAPACITY IN RENEWABLE ENERGY BY COUNTRY, 2010, AND GROWTH ON 2009, \$BN



Top 10 countries. Adjusted for re-invested equity

Source: Bloomberg New Energy Finance, UNEP

FIGURE 12: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2010, AND TOTAL GROWTH ON 2009, \$BN



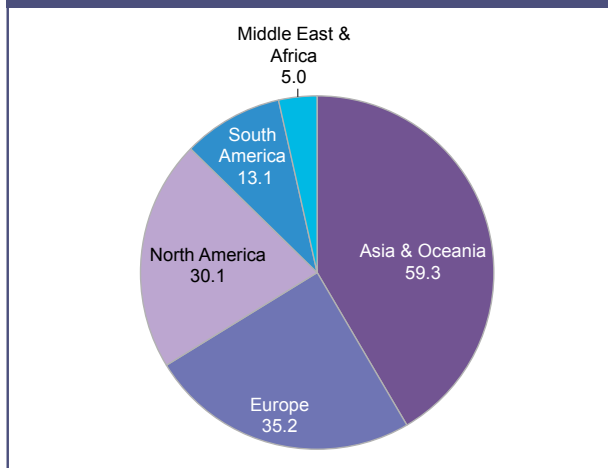
Total values include estimates for undisclosed deals. Adjusts for re-invested equity. This comparison does not include small-scale projects.

Source: Bloomberg New Energy Finance, UNEP

Figure 12 shows that financial new investment in wind in 2010 was \$6.5 billion greater in developing countries than in developed economies. The comparison for solar was very different – financial new investment in developed countries was \$18.9 billion, compared to \$7.2 billion for developing. In other technologies, Figure 12 shows that developing economies had the advantage in terms of financial new investment, to differing degrees, in biomass and waste-to-energy, biofuels and small hydro.

Looking at the regional picture for financial new investment (Figures 13 and 14), Asia & Oceania led the field in 2010 with \$59.3 billion, up 30% on 2009, followed by Europe with \$35.2 billion, down 22%. North America came third with \$30.1 billion, up 53%, and South America fourth with \$13.1 billion, up 39%.

FIGURE 13: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2010, \$BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. This comparison does not include small-scale projects.

Source: Bloomberg New Energy Finance, UNEP

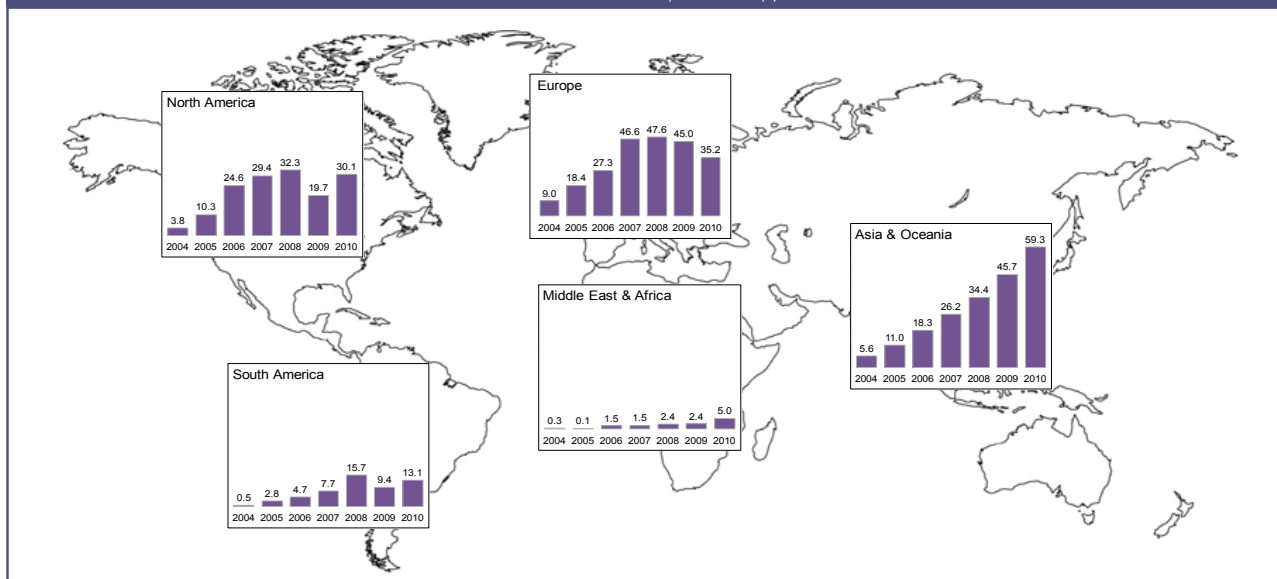
Middle East & Africa lagged in fifth with \$5 billion, but this was up 104% on 2009 levels. The country background to some of these changes is explored below.

Small-scale power projects are not included in the financial new investment totals above, but are covered in detail in Chapter 7. Germany's dominance in small-scale in 2010, reflecting its attractive feed-in tariff for PV, is shown in Figure 15.

## CHINA, INDIA AND BRAZIL

China attracted the most new financial investment in renewables for the second consecutive year, securing \$49 billion, or just over a third of the total globally.

FIGURE 14: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2010, \$BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. This comparison does not include small-scale projects.

Source: Bloomberg New Energy Finance, UNEP



The increase was driven largely by a sharp rise in asset finance, and this in turn was mainly thanks to the continuing spectacular growth of Chinese wind capacity. Wind asset finance made up 78% of total investment in China (Figure 16), and it was also another record year for capacity additions, up 17GW in 2010, taking the total installed wind capacity to 42.5GW<sup>1</sup>. China now has the largest installed wind capacity in the world, with 10 times that of Denmark, but since only 73% of that is grid-connected, the US still leads in grid-connected capacity. The project pipeline nearly doubled to 105GW during 2010, and the latest five-year plan, agreed in March 2011, targets another 70GW of wind capacity by 2015. The next few years will be critical to determine whether Chinese growth rates are sustainable, but with strong government support and the offshore resource just beginning to be developed, Bloomberg New Energy Finance expects strong wind installations for the rest of the decade.

Renewables investment in China continued to benefit from the \$46 billion 'green stimulus' package announced at the height of the financial crisis. By the end of 2010, some 70% of the funds had been spent, although data about the details are sketchy. China's solar manufacturers benefitted from a series of huge government debt financing deals. Loan guarantees worth \$32.5 billion were extended to 10 manufacturers including LDK Solar, Yingli Green Energy and Suntech Power Holdings, creating an intimidating backdrop for foreign competitors. China now produces over half of the photovoltaic modules used globally and is home to several of the biggest brands in the sector. China also dominated in public markets, with \$5.9 billion in new investment in renewables, mostly wind and solar, and much of it through major IPOs such as that of Goldwind. Chinese companies increasingly list on domestic rather than US stock markets.

Renewables investment in India grew almost as strongly but from a far lower base, up 25% to \$3.8 billion, and the country ranked eighth in the world. Again, wind projects were the biggest single item, at \$2.3 billion (Figure 17), followed by \$400 million each for solar, and biomass and waste-to-energy. The growth in renewables investment was supported by a number of factors, including a race to exploit the accelerated depreciation tax break for wind projects before it is reformed in 2012; the government's new Solar Mission to develop 1GW of grid-connected capacity by 2013; and the launch of Renewable Energy Certificate and Renewable Purchase Obligation schemes.

In Brazil, by contrast, financial investment in renewables slipped 5% to \$6.9 billion (Figure 18), after tumbling 44% in the previous year. The subdued performance was largely due to consolidation of the highly fractured Brazilian biofuels sector. There was no shortage of

**FIGURE 15. SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2010, AND GROWTH ON 2009, \$BN**

UNITS	2010	% GROWTH ON 2009
Israel	0.4	90%
Belgium	0.6	16%
China	0.9	43%
Australia	0.9	74%
Czech Republic	2.3	163%
France	2.7	150%
Japan	3.3	48%
United States	4.5	49%
Italy	5.5	59%
Germany	34.3	132%

Top 10 countries. Represents investments in solar PV projects with capacities below 1MW

Source: Bloomberg New Energy Finance

**FIGURE 16: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN CHINA BY SECTOR AND ASSET CLASS, 2010, \$BN**

UNITS	ASSET FINANCE	PUBLIC MARKETS	VC/PE	TOTAL
Wind	38.1	3.2	0.1	41.4
Solar	2.0	1.8	0.01	3.8
Biomass & w-t-e	3.7	-	-	3.7

Asset finance adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

**FIGURE 17: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN INDIA BY SECTOR AND ASSET CLASS, 2010 \$BN**

UNITS	ASSET FINANCE	PUBLIC MARKETS	VC/PE	GRAND TOTAL
Wind	2.3	0.3	-	2.6
Biomass & w-t-e	0.4	0.2	0.02	0.6
Solar	0.4	0.1	0.03	0.5

Asset finance adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

**FIGURE 18: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN BRAZIL BY SECTOR AND ASSET CLASS, 2010, \$BN**

UNITS	ASSET FINANCE	PUBLIC MARKETS	VC/PE	GRAND TOTAL
Biofuels	2.1	0.3	-	2.4
Wind	2.3	0.1	-	2.4
Small hydro	1.0	-	0.2	1.2
Biomass & w-t-e	0.8	-	0.1	0.9

Asset finance adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

<sup>1</sup> These wind installation figures come from Bloomberg New Energy Finance's database and are close, but not identical, to data from the Global Wind Energy Council. The gaps may reflect different treatment of the timings of installation, connection and the start of generation.





investment activity, it was just concentrated in mergers and acquisitions, which do not count as new funds coming into the sector (see Chapter 8 on acquisition activity). Instead of investing in new capacity, capital was directed to rationalising the sector both horizontally and vertically. Two deals topped \$1 billion each, while Shell and Cosan announced a joint venture with assets of at least \$12 billion. The consolidation seems likely to continue, since there are still 220 players in the Brazilian ethanol market, but so far only 10 with capacity greater than 10 million tonnes.

On a more positive note, renewable reverse auctions have boosted interest in the wind sector, where investment grew strongly during 2009, and more modestly in 2010, up 10% to \$2.4 billion.

## DEVELOPED ECONOMIES

Among the developed economies, the US was a big winner, with financial new investment in renewables jumping from just under \$16 billion to just over \$25 billion<sup>2</sup>. As in China, the big feature was asset financing of wind, which totalled \$14.9 billion (Figure 19), as debt market conditions stabilised after the financial crisis. The increase was helped by falling turbine prices due to excess manufacturing capacity, along with an improved market for power purchase agreements in the second half of the year, which came in spite of persistently low natural gas prices caused by the boom in shale gas production. Wind capacity additions in 2010 halved to 4.9GW, reflecting the fact that asset finance figures for the US in 2008-09 were poor. The improvement in asset finance in 2010 opens up the prospect of higher capacity addition totals for 2011. Beyond that, much will depend

FIGURE 19: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN THE UNITED STATES BY SECTOR AND ASSET CLASS, 2010, \$BN

UNITS	ASSET FINANCE	PUBLIC MARKETS	VC/PE	GRAND TOTAL
Wind	14.9	0.4	0.8	16.1
Solar	2.6	1.0	1.9	5.5
Biofuels	0.2	0.3	0.7	1.2
Biomass & w-t-e	1.3	0.1	0.05	1.4
Geothermal	0.6	0.01	0.1	0.7

Asset finance adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 20: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN ITALY BY SECTOR AND ASSET CLASS, 2010, \$BN

UNITS	ASSET FINANCE	PUBLIC MARKETS	VC/PE	GRAND TOTAL
Wind	1.0	3.6	-	4.5
Solar	3.1	-	-	3.1
Biomass & w-t-e	0.7	-	0.04	0.8

Asset finance adjusts for re-invested equity.

Source: Bloomberg New Energy Finance, UNEP

<sup>2</sup> As stated above, financial new investment does not include small-scale projects. If that were included, Germany would be ahead of the US in terms of overall investment. See Chapter 7 and Figure 15.

on whether the US Treasury grant scheme expires at the end of this year, and what if anything replaces it.

The US also saw significant new investment in solar, amounting to \$5.5 billion across all classes of investment, as capacity installation jumped by 87% to 878MW. Investment in the sector benefited from a range of subsidies, and from low module prices caused by overcapacity.

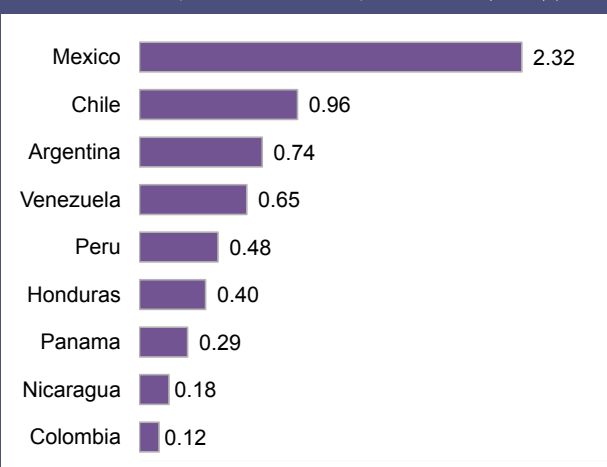
Solar was also a significant factor in Italy's extraordinary leap from ninth to third in the global renewables investment league (see Figure 20). Financial new investment jumped from \$2.4 billion to \$8.4 billion as PV asset finance surged to just over \$3 billion, on the back of generous feed-in-tariffs. The rest of the increase was due to the IPO of Enel Green Power, the biggest renewable energy flotation in 2010. It raised \$3.5 billion.

Germany enjoyed financial new investment of \$6.7 billion in 2010, up 18%, but this was dwarfed by its \$34.3 billion boom in small-scale projects such as rooftop PV (see Figure 15). As far as financial new investment was concerned, the highlight was Trianel's agreement in December with the European Investment Bank, NRW Bank of North Rhine-Westphalia and 11 commercial banks for a \$724 million debt package towards its 200MW Borkum West II wind farm in the German section of the North Sea.

In Spain, renewable energy investment slumped by more than half to \$4.6 billion – having already halved in 2009 – as the government imposed retroactive cuts on its solar feed-in-tariffs, making financing difficult even for projects with permits under the cap. Rumours that the government was considering the move first emerged in the spring and were confirmed in June, depressing the market all year until the details were finalised in December. The cuts range from 7% to 30% and will have a serious effect on project economics, particularly where there is high leverage, and the fear is that some austerity-stricken governments elsewhere in Europe might be tempted to follow suit. Project investors are mounting a legal challenge in both Spain and the Czech Republic, which also made retroactive measures, in its case via a tax on PV project revenues.

In the UK, the introduction of a feed-in-tariff for sub-5MW installations caused a surge in interest, but this was more than offset by a lull in big financings for offshore wind farms. Some 45MW of new solar capacity was installed in UK between April, when the feed-in tariff scheme was introduced, and the year end, according to the regulator Ofgem. Following strong interest from institutional investors in the feed-in tariff for PV, in early 2011 the government announced a review of the subsidy levels.

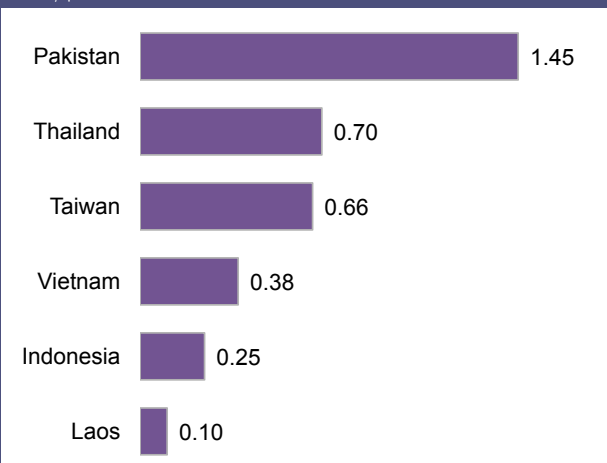
FIGURE 21: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN LATIN AMERICA (EXCLUDING BRAZIL) BY COUNTRY, 2010, \$BN



Omits countries with less than \$0.1bn investment

Source: Bloomberg New Energy Finance, UNEP

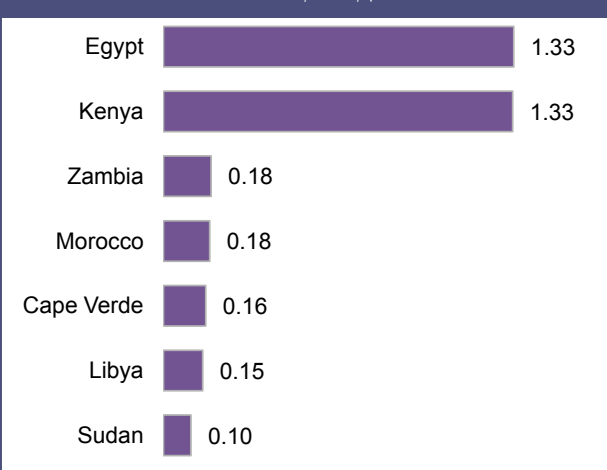
FIGURE 22: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN NON-OECD ASIA (EXCLUDING CHINA AND INDIA) BY COUNTRY, 2010, \$BN



Omits countries with less than \$0.1bn investment

Source: Bloomberg New Energy Finance, UNEP

FIGURE 23: FINANCIAL NEW INVESTMENT IN RENEWABLE ENERGY IN AFRICA BY COUNTRY, 2010, \$BN



Omits countries with less than \$0.1bn investment

Source: Bloomberg New Energy Finance, UNEP

The sharp fall in UK financial investment in renewable energy, from \$10.8 billion to \$2.9 billion, reflected in part the strength of the 2009 number – buoyed up by the financial go-ahead for the 1GW London Array and other large offshore wind projects. It was always going to be difficult for 2010 to rival that figure, and indeed investment in wind projects shrank from \$9.6 billion to \$1.3 billion. Also contributing to the slowdown was uncertainty over policy, following the replacement of the Labour government by a Conservative-Liberal Democrat coalition in May 2010. The new administration voiced its intention to replace the UK's Renewables Obligation Certificate scheme for large-scale renewables, with a feed-in-tariff arrangement.

## OTHER DEVELOPING ECONOMIES

Excluding the three big developing economies, China, India and Brazil, the regional economies of the developing world all achieved substantial growth in renewables investment during 2010. Latin America excluding Brazil saw investment almost triple to \$6.2 billion (Figure 21); Asia excluding China and India rose 31% to \$4 billion (Figure 22); and Africa jumped five-fold (384%) to \$3.6 billion (Figure 23). Together they represented 9.7% of global financial new investment (\$142.7 billion).

## OTHER LATIN AMERICA

Latin America excluding Brazil saw the biggest absolute increase in renewable energy investment among the regions of the developing world, and within Latin America, the largest gain was achieved by Mexico (Figure 21). Renewables investment in Mexico jumped more than fourfold (348%) as a rash of major wind projects secured funding, along with one geothermal project. The surge follows the government's announcement in 2009 of a plan to raise renewable energy capacity from 3.3% of the total to 7.6% by 2012, with non-binding targets for wind, geothermal, biomass and biogas capacity. Wind alone is intended to make up 4.3% of total capacity, and 988MW of wind capacity was financed in 2010.

A number of other Latin American countries with recently-announced renewable energy targets also made progress. Argentina, which has set a legally-binding target of 8% energy sourced from renewables by 2016, saw investment leap almost seven-fold (568%) to \$740 million. The investments included not only wind farms, but also ethanol, biodiesel, and biomass plants. In Peru, where the government has announced a target of 5% renewable generating capacity by 2013,

investment more than doubled to \$480 million, and covered small hydro, ethanol and biomass plants. In Chile, where the target is for 10% renewable energy production by 2025, investments in small hydro, wind and biomass raised the total renewables spending by 21% to \$960 million.

Venezuela also saw strong growth from a low base, the result of a single investment by the state oil company PdVSA in four biofuel plants.

## OTHER ASIA

Asia, excluding China and India, saw renewables investment increase 31%, from \$3 billion to \$4 billion in 2010, largely due to strong performances from Pakistan and Thailand.

Estimated investment in Pakistan tripled to \$1.5 billion as the country financed 850MW of new wind capacity across 16 projects. This may help ease the country's long-running power crisis, in which chronic rolling blackouts have sparked widespread rioting. Estimates of the shortfall in the country's generating capacity range up to 6GW, caused by planners' failure to anticipate demand growth, and further weakened by last year's floods, which damaged hydro capacity and thousands of power lines. In April 2010 the government introduced emergency energy-saving measures to cut demand by 1.5GW, including halving the power supplied to government offices, and banning neon signs and all-night wedding parties.

In Thailand, renewables investment rose more than fourfold (320%) to \$700 million, as the country funded 195MW of new capacity through nine deals. All but one were large-scale solar PV projects. Thailand's Strategic Plan for Renewable Energy Development calls for 20% of total final energy consumption to be supplied by 2020 from renewable sources, which are supported by feed-in-tariffs.

## AFRICA

Africa achieved the largest percentage increase in renewable energy investment among developing regions excluding the big three economies. Total investment on the continent rose from \$750 million to \$3.6 billion, largely as a result of strong performances from Egypt and Kenya.

In Egypt, renewable energy investment rose by \$800 million to just over \$1.3 billion, but this was the result of just two deals, a 100MW solar thermal project in Kom Ombo, and a 220MW onshore wind farm in the Gulf of El Zeit region. The country's next move in

renewable energy is scheduled to be the tender for several hundred MW more of wind projects in the Gulf of Suez region.

In Kenya, the advance was more broadly based. Investment rose from virtually zero to more than \$1.3 billion, including funding for wind, geothermal and small hydro capacity of 724MW, and for 22 million litres per year of ethanol production. Geothermal was the highlight, with local electricity company KenGen securing debt finance for additional units at its Olkaria project.

Smaller advances in renewable energy were made by several other African countries, including Zambia, Morocco and Cape Verde. In Morocco, there could be a step-jump in renewable power investment with a 150MW wind farm near the northern city of Taza

and a 500MW solar thermal project at Quarzazate in the country's south. Both of these have reached the tendering or pre-selection stage. South Africa is likely to be one of the most important locations in the continent for renewable energy over coming years, with December 2010 seeing the government in Pretoria receiving 384 applications from companies seeking to build up to 20GW of renewable power capacity. Local utility Eskom was in line by the spring of 2011 for a \$365 million loan from the African Development Bank to help pay for a 100MW solar thermal plant in the Northern Cape and a 100MW wind farm in the Western Cape.





# 02 PUTTING RENEWABLE ENERGY INVESTMENT IN PERSPECTIVE

- Renewable power, excluding large hydro-electric, made up 8% of total world electricity generation capacity in 2010 and 5% of actual generation. It accounted for 34% of additional capacity brought online and 30% of additional generation.
- \$187 billion was invested in large and small scale renewables generating capacity (excluding large hydro), compared to \$219 billion and \$157 billion of gross and net fossil-fuel investment respectively. If the estimated \$46 billion of large hydro investment is included in the renewable energy total, then renewables investment is clearly ahead of both gross and net investment in fossil fuel capacity.
- By early 2011, some 119 countries had policies or targets in place to support renewables, more than half of them in the developing world.
- The arrival of renewables into the energy mainstream is leading to an increasingly globalised value chain that some countries are trying to counter with local content rules.
- As governments work to put in place a new agreement to replace or extend the Kyoto Protocol, the low-carbon options favoured by industry are renewables and energy efficiency.

Renewable energy is still regarded as a modest-sized niche by some investors, media commentators and politicians. That view has it that the “serious” investment activity still goes on in conventional energy sectors such as oil and gas, coal and - prior to the Fukushima crisis in March 2011 - nuclear, and that renewables are an entertaining, albeit expensive, sideshow.

This perception has been out-of-date for many years, and never more so than in 2010. Overall new investment in renewable energy of \$211 billion was up 32% on 2009 levels, and nearly seven times the figure for 2004, just six years earlier. There is also burgeoning investment in the parallel area of energy-smart technologies - including smart grid, electric vehicles and energy efficiency devices and systems (see the second Box in this chapter).

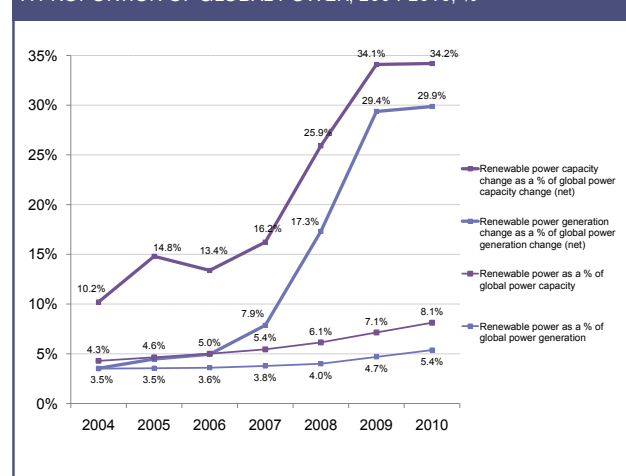
## RENEWABLES VERSUS FOSSIL FUELS

How important is renewable energy in 2011 in comparison to fossil-fuel energy? Two comparisons are to look at the trend in installed power capacity, and in electricity generated. Figure 24 shows that non-hydro renewable power capacity reached 8% of total world electricity capacity in 2010, up from 7% in 2009, 6% in 2008 and 5% in 2007. In terms of capacity added, non-hydro renewables accounted for 60GW worldwide in 2010, or 34% of the total, compared to 92GW for conventional thermal (coal, gas and oil), 5GW for nuclear, and 24GW for hydro-electric including pumped storage<sup>3</sup>. If combined with

hydro large and small, renewable power accounted for 84GW out of the 180GW of net power additions in all technologies worldwide, equivalent to 47%.

Several renewable energy sources produce intermittent rather than baseload power, so the comparison is less impressive in terms of electricity generated. Wind farms typically have capacity factors in the 20% to 35% range, and solar PV parks in the 15% to 25% range, although some other renewable power options such as biomass-to-energy and geothermal do have capacity factors comparable with coal- or gas-fired generation.

FIGURE 24: RENEWABLE POWER GENERATION AND CAPACITY AS A PROPORTION OF GLOBAL POWER, 2004-2010, %



Renewable power excludes large hydro. Renewable capacity figures based on Bloomberg New Energy Finance global totals.

Source: EIA, IEA, Bloomberg New Energy Finance

<sup>3</sup> Figures for renewable energy capacity addition are from Bloomberg New Energy Finance. Figures for fossil-fuel capacity addition are from US Energy Information Administration and from International Energy Agency.

Figure 24 shows that the percentage of worldwide power generated from renewables (excluding large hydro) rose to 5.4% in 2010, from 4.7% in 2009 and 4% in 2008<sup>4</sup>. Figure 24 shows that non-hydro renewables made up 34.2% of overall power capacity added worldwide in 2010, and a somewhat smaller proportion of the total additional generation.”

Even at 5.4% of total world power generation, renewables accounted for 954TWh in 2010, up from 702TWh in 2009. The 2010 figure is enough electricity to satisfy the entire demand of almost two Brazils or one India, according to IEA data.

In investment terms, renewable energy’s total of \$187 billion for asset finance and small-scale distributed projects in 2010 can be compared to the amount of capital spending worldwide on new fossil fuel plant (see Figure 25). This shows that renewable energy, excluding large hydro, is showing fast growth in investment but that it is still some way short of matching the still-rising line for fossil-fuel capacity investment. In numbers, total investment in fossil-fuel power plant was \$219 billion, some \$31 billion more than that in renewables excluding large hydro. The gap in 2009 was \$74 billion.

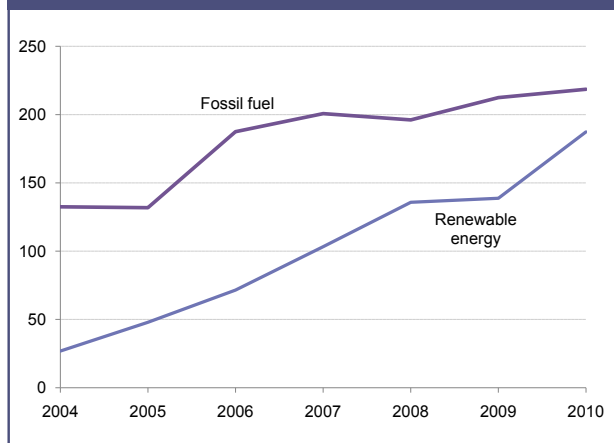
However that is only one way of looking at the comparison. An alternative is to compare renewable energy capacity investment with the net investment in fossil-fuel plant - since a significant part of the annual spending on new coal- and gas-fired power stations is to replace plant that is being decommissioned. The gross addition of fossil-fuel capacity in 2010 is estimated to have been some 128GW, but the net addition, as mentioned above, was only 92GW. That 92GW would equate in capital cost per GW terms to a net investment of \$157 billion, comfortably below the investment in renewables excluding large hydro. This is the first year this has been the case<sup>5</sup>.

Even if we use a comparison on gross, rather than net, investment, renewables move ahead of fossil-fuel if their total includes hydro-electric. As the box on large hydro in Chapter 6 shows, a gross 27GW of capacity entered service in 2010, and if the investment cost per MW is estimated at \$1.7 million, this adds a total of \$46 billion to the renewables investment total, taking it to \$233 billion in 2010. That is ahead of the fossil-fuel power gross investment total of \$219 billion.

Of course, fossil-fuel energy consists of much more than electricity. Investment in renewable energy falls far short of that in “upstream oil and gas” - estimated at

\$470 billion in 2010 by the IEA<sup>6</sup>. In addition, there are billions invested each year in the development of coal mines, conventional gas reserves and shale gas, some of that for eventual use in the electricity sector and some for use in the supply of heat. Renewable energy is estimated to have made up just over one sixth of the total investment in all energy of \$1.2 trillion in 2010.

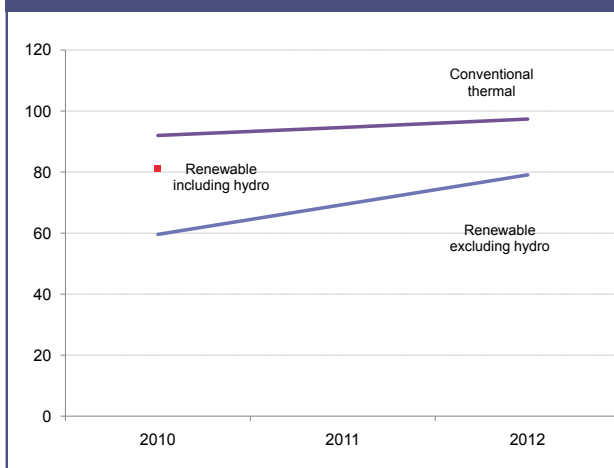
FIGURE 25: INVESTMENT IN CLEAN ENERGY V CONVENTIONAL CAPACITY, 2004-2010, \$BN



Fossil Fuel investment is calculated from EIA & IEA data. Clean energy investment includes asset finance and small scale projects, but excludes large hydro).

Source: EIA, IEA, Bloomberg New Energy Finance

FIGURE 26: FORECAST ANNUAL NET CAPACITY ADDITIONS, 2010-2012, GW



Renewable forecast based on Bloomberg New Energy Finance projections for wind, solar, bioenergy and geothermal. Conventional thermal capacity projection based on IEA compound growth rate

Source: EIA, IEA, Bloomberg New Energy Finance

<sup>4</sup> Calculation on percentage of power generated was done by Bloomberg New Energy Finance using estimates for average capacity factors of different technologies.

<sup>5</sup> The 2009 and 2010 Global Trends reports argued that renewable energy investment exceeded fossil-fuel power capacity investment in both 2008 and 2009. On the basis of the updated figures and methodology in this year’s report, this was true for 2008 and 2009 in terms of the value of net capacity added in renewables including hydro, against that for fossil fuel power. However it was not the case for the value of gross capacity added.

<sup>6</sup> International Energy Agency, World Energy Outlook 2010



## RENEWABLES VERSUS OTHER COMPARATORS

Investment in renewables, at \$211 billion for capacity and technology, remains a small sum compared to wider economic aggregates. This was equivalent to 0.3% of world GDP in 2010, or 1.5% of world investment<sup>7</sup>. World investment in renewable energy in 2010 was worth only 1.4% of US GDP, or 9% of the value of US investment on all sectors. It was equivalent to somewhere between the GDP of the Philippines and the GDP of Finland.

Looking at other sectors, investment in renewables was equivalent to close to the value of the global luxury goods market (\$234 billion), a third of the global advertising market (\$640 billion), and a quarter of the value of OECD countries' oil imports in 2010 (\$880 billion).

Another comparator is via stock market valuation, and here the specialist renewable energy sector still lags far behind long-established industries such as oil and gas, mining, pharmaceuticals, banks and IT. According to the Financial Times' Global 500 league table of the largest quoted companies worldwide by market capitalisation, the highest placed specialist renewable energy company was Iberdrola Renovables at 452nd, with a value of \$17.6 billion, although there were diversified utilities such as Eon and engineering groups such as Siemens, with partial exposures to clean energy, well above that. PetroChina, the number one company in 2010, weighed in with a market capitalisation of \$329 billion.

The reasons for this modest showing for specialist renewable energy firms in the ranks of the largest quoted companies are various. One is that the sector as a whole has been out-of-favour with stock market investors, and share prices did not keep pace with the wider indices in 2010 (see Chapter 5). A second is that it is a highly competitive sector, in which high profit margins are hard to attain - unlike oil, for instance, IT or the internet. A third is that the sector remains relatively unconcentrated - there are six major wind turbine manufacturers from the US and Europe, plus several others from China, all competing for position in the world top 10. The solar PV manufacturing chain is even more splintered.

Although renewable energy has yet to take the stock markets by storm, it is likely to become more important as investment in the sector grows. Figure 26 shows Bloomberg New Energy Finance's forecast that net capacity additions in non-hydro renewable energy will grow from 60GW in 2010 to 80GW in 2012. If hydro is included then renewables saw nearly as many net GWs installed in 2010 as fossil-fuelled plants (87GW versus 92GW).

## RENEWABLES AND CLIMATE CHANGE

Many governments have been quick to see the renewable energy sector as a key component of efforts to green their economies, but fewer have placed renewables at the centre of their stance on global efforts to address climate change. The reason for this may be that green economy efforts are seen to be built on local economic developments, whereas climate change strategies tend towards top-down 'silver bullet' solutions that rely on yet-to-be-commercialised technological innovations.

There are a wide range of low-carbon technology options and many will be needed to stabilise the climate. However only the renewable energy and energy efficiency options are receiving significant investment flows today. Nuclear, even pre-Fukushima, saw only 5GW commissioned in 2010 versus 60GW for renewables, while clean coal and carbon capture and storage technologies remain at early stages of deployment with few commercial-scale projects under way.

To restrict global carbon dioxide emissions so that the rise in world temperatures is no more than two degrees Centigrade would require much more aggressive capacity additions in renewable energy. The G-20 countries would have to invest \$350 billion a year in renewable energy assets by 2020, equivalent to a capacity addition of nearly 180GW<sup>8</sup>.

## POLICIES AND GREENING

The tipping point where renewables becomes the predominant energy option now appears closer than it did just a few years back. Much of the credit for the 'mainstreaming' of renewable energy goes to governments that have policies at the national, state and local levels driving investment in renewables forward.

According to the REN21 Renewables 2011 Global Status Report, the sister publication to the Global Trends report, the number of countries with some type of renewable energy policy target and/or support policy more than doubled from an estimated 55 in early 2005 to 119 by early 2011<sup>9</sup>. A report in mid-2011 by the Intergovernmental Panel on Climate Change also confirmed the role governments play in accelerating the growth of renewable energy deployment<sup>10</sup>.

REN21 says that at least 95 countries now have some type of policy to support renewable power generation, feed-in tariffs being the most common. More than half of those countries are developing or emerging economies. Targets now exist in at least 98 countries, over half of

<sup>7</sup> Economic aggregates are from International Monetary Fund, World Economic Outlook April 2011 database.

<sup>8</sup> Global Clean Power: A \$2.3 Trillion Opportunity, Pew Charitable Trusts, pages 7 and 24.

<sup>9</sup> REN21 Renewables 2011 Global Status Report, Paris: REN21 Secretariat. July 2011.

<sup>10</sup> The Intergovernmental Panel on Climate Change (IPCC) Special Report on Renewable Energy and Climate Change Mitigation 2011. [www.ipcc.ch](http://www.ipcc.ch)

which are developing countries. In the European Union, the supranational target for a 20% share of renewables in the overall energy mix by 2020 coexists with member country targets such as 15% by 2020 for the UK, 23% for France, 18% for Germany, 17% for Italy and 20% for Spain.

In the US, there is no federal renewable energy target, although there are targets for biofuel use in the shape of the Renewable Fuel Standard. Many individual states have Renewable Portfolio Standards, including California's, requiring electricity providers to increase procurement from eligible renewable energy resources until they reach 33% of deliveries by 2020. China has a target of 15% non-fossil fuels in energy consumption by 2020. Other countries have targets for carbon dioxide emissions, but not for renewable energy – for instance Brazil placed in law late last year a decree requiring a 1.3 billion-tonne reduction in emissions by 2020, and Japan has a pledge to cut emissions by 25% by 2020 from 1990 levels.

Targets are less common, but are growing in number, among smaller, developing economies. Momentum towards renewable energy in Africa, southern Asia and parts of Latin America is coming from the urgent need to scale up power capacity as a means of addressing energy access needs. In addition, as Chapter 10 shows, the energy access issue is resulting in the emergence of a number of innovative renewable energy technologies for particular applications that are entering use in preference to more established, fossil-fuelled options.

Where renewables are seen as an engine for green economic growth, the green collar jobs are expected to be created at home and countries are increasingly looking to local content rules to ensure this is the case (see Box). Although these efforts do have an economic rationale from the national and taxpayer perspective, the industry is moving quickly in the other direction, developing supply chains that span the globe.

## AN INTERNATIONAL SUPPLY CHAIN

Renewable energy has become, over the last few years, as internationally distributed as any other large, established industry. Important wind turbine manufacturers operate in Germany, Denmark, Spain, the US, Brazil, India, South Korea, China and several other countries. Finance for projects is provided by domestic institutions in many countries, by banks based outside the countries concerned and by international institutions.

Solar PV has seen particularly keen competition between a large number of players in different countries. In 2010, some 55% of modules worldwide were produced by companies with headquarters in China (up from 39% in 2009), with 13% from companies based in Europe, 18% from those based in the Americas, and 13% from Japanese companies. Industry concentration has in fact fallen, with 55% of modules sold by manufacturers in the world Top 10, compared with 63% a year earlier, according to Bloomberg New Energy Finance.

Large projects are often highly international in terms of the parties involved. The \$1.7 billion Thornton Bank wind project off the coast of Belgium, for instance, will use turbines from Germany-based Repower, which is owned by Suzlon of India, has French and German utilities as shareholders, German and Danish export credit agencies as risk-guarantors for some of the debt, French, Dutch and German commercial banks and the European Investment Bank as lenders, and a Danish company as blade supplier.

The 212MW Olkaria geothermal complex in Kenya has Israeli and Kenyan plant operators, and is ordering drilling equipment from Chinese companies with the help of finance from Chinese and French development banks. It also has a loan from Japan to pay for a transmission line, and from the German government towards the expansion of the project. It has pre-qualified four engineering companies, three from Japan and one from France, as bidders for the work to increase capacity by 280MW.

In Latin America, multinational involvement is also the norm. Two small hydro projects in Rio Grande do Sul province in Brazil, for instance, will use turbines made by French-owned Alstom and be developed by a Canadian-owned company. Two 40MW hydro projects in Chile, developed by a local company backed by funds from a New York investor, secured loans from Spanish, French and German banks.

Chinese renewable energy projects often have less an international dimension. There are exceptions however - US owned AES Corporation for instance began operation at two wind projects in Hebei and Inner Mongolia totalling 99MW last year, co-owned with a Chinese partner and using Chinese-made turbines. Machines made by foreign-owned companies are also figuring in some projects - for instance this spring Vestas Wind Systems of Denmark said that 25 of its 2MW turbines are going into a project in Inner Mongolia. Foreign-owned manufacturers are estimated to have won 14.5% of the orders for turbines in China in 2010, slightly up from the 2009 figure.

## LOCAL CONTENT RULES

Local content rules have become a popular device with governments in the last few years, to try to ensure that jobs associated with investment in clean energy are created in the home country, not overseas.

The first country to use local content rules to tilt the playing field in clean energy was China. Soon after the introduction of its first renewable energy law in 2005, it demanded that a certain proportion of the value-add of turbines had to be produced in China in order for them to qualify for the national wind tender programme. At one point in 2007 the local requirement reached 70%.

In Brazil the Proinfa wind feed-in tariff programme, which was replaced last year by a tendering system, also stipulated 70% local content, but the requirement was later dropped - at least for 1.5MW-plus turbines - after it became clear that there was insufficient local factory capacity to meet the programme target.

In 2009, the Canadian province of Ontario introduced a rule that its generous feed-in tariff for solar PV projects of more than 10kW would only be available for developers using modules with at least 50% of their cost based on local goods and services. With effect from 1 January 2011, that proportion has gone up to 60%.

In July last year, India announced that PV project developers participating in the first 150MW phase of its Solar Mission would only be eligible for support if they used locally assembled modules. For the main 296MW phase which will be allocated by March 2012, both cells and modules have to be produced locally.

## ENERGY-SMART TECHNOLOGIES

These do not count as renewable energy, since their aim is primarily the more efficient use of electricity and fuel rather than changing its source. However there are cross-overs – for instance plans to charge electric vehicles from renewable, rather than fossil-fuel power.

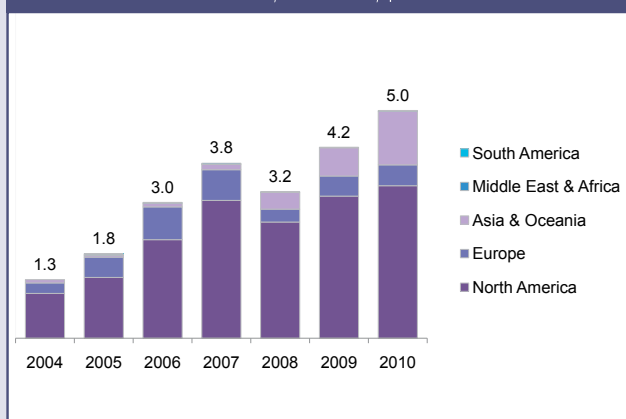
Bloomberg New Energy Finance defines energy-smart technologies as encompassing advanced transportation; the smart grid and digital energy; energy efficiency including lighting and building-integrated techniques; and energy storage including batteries and fuel cells. Many of these have been strong growth areas for investment in recent years, and indeed in 2010 energy efficiency stocks in the WilderHill New Energy Global Innovation Index, or NEX, gained 19% while the index as a whole fell nearly 15%.

Measuring investment in energy-smart technologies presents a challenge since many conventional power capital projects – such as adding more efficient cables or turbines and even installing insulation into houses – could be counted. The most useful aggregate is the amount of investment in technology, not that for projects. Energy-smart technology investment, including venture capital and private equity finance, public market equity

issuance, and research and development spending by governments and corporations, totalled \$23.9 billion in 2010. This was up 27% on 2009's total of \$18.8 billion. Figure 27 shows that within this, the financial new investment part – which excludes R&D – rose from \$4.2 billion in 2009 to \$5 billion in 2010, with North America dominant and Asia & Oceania in second place, well ahead of Europe.

One of the biggest transactions was a \$350 million second-round venture capital financing for Better Place, the US-based electric vehicle infrastructure company. On public markets, Foshan Nationstar Optoelectrics, a China-based maker of light-emitting diode products raised \$227 million via an IPO in Shenzhen, and Zhejiang Narada Power, a Chinese power storage company, raised \$300 million via an IPO on the same exchange. Tesla Motors, the California-based electric car manufacturer, raised \$202 million via an IPO on Nasdaq.

FIGURE 27: FINANCIAL NEW INVESTMENT IN ENERGY-SMART TECHNOLOGIES BY REGION, 2004-2010, \$BN



Includes fundraisings of energy smart technology companies through VC/PE or PM transactions. Does not include investment in energy smart technology projects.

Source: Bloomberg New Energy Finance

# 03 RESEARCH & DEVELOPMENT

- Research and development spending on renewable energies jumped 40% to \$9 billion in 2010.
- Government R&D soared as 'green stimulus' packages took effect, while corporate R&D fell following the recession. These changes mean that state support has overtaken company spending for the first time.
- Solar attracted most support, claiming 40% of all research dollars, reflecting the pace of technological innovation and the race for future market share. It was followed by biofuels and wind, but there was also strong growth in marine and small hydro.
- Regionally, the biggest spender was Asia & Oceania, where government support rose 27-fold to push total R&D spending to \$4.7 billion.
- These figures do not include R&D on energy-smart technologies since, although these are significant, they are outside the scope of this 2011 Global Trends report.

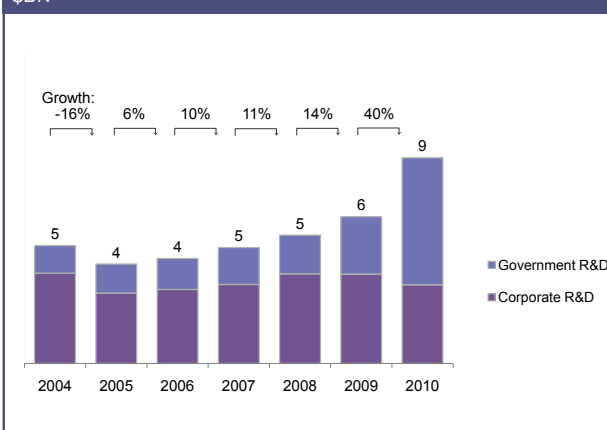
Research and development spending on renewable energies in 2010 was dominated by the 'green stimulus' packages launched during the throes of the financial crisis. Between the autumn of 2008 and the end of 2009, 12 major economies announced programmes committing some \$194 billion to support clean energy, including renewables, energy-smart technologies (EST), carbon capture and storage, and transport. By the end of 2010, just under half of this sum had actually been spent, including \$17.6 billion on R&D<sup>11</sup>.

Overall public sector support for R&D on renewables soared from just over \$2 billion in 2009 to more than \$5 billion in 2010 (see Figure 28). However, corporate spending on renewables R&D stagnated or fell in most sectors. It declined from the best part of \$4 billion to little more than \$3 billion in total, so the private sector was overtaken by the public sector for the first time, and spending rose 40% overall to close to \$9 billion.

Solar continued to command the biggest single share of worldwide R&D spending on renewable energy, and was up 8% at \$3.6 billion (Figure 29). Public sector funding of solar research and development more than doubled, but corporate spending fell by 19%. The fall in company spending may have been due, paradoxically, to an easing in the overcapacity that has plagued the industry in recent years. With overcapacity lower in 2010 than 2009, investment may have shifted from R&D to investment in new production capacity to meet spikes in demand from countries such as Germany, the Czech Republic and Italy.

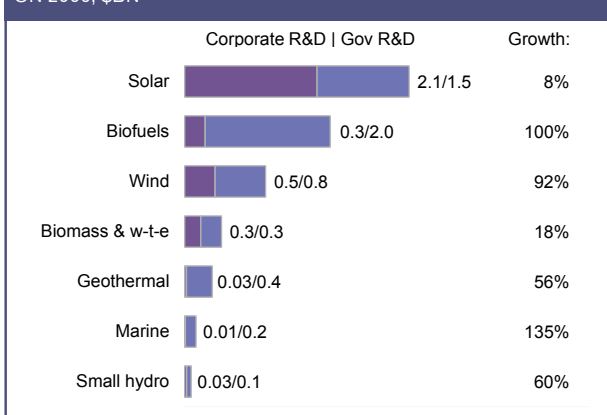
Nevertheless corporate R&D in solar was four times larger than that in the nearest competitor, wind, and companies continued to focus on improving production processes and cutting costs, for both the incumbent crystalline technology, and the newer thin-film

FIGURE 28: R&D INVESTMENT IN RENEWABLE ENERGY, 2004-2010, \$BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

FIGURE 29: CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY TECHNOLOGY, 2010, AND TOTAL GROWTH ON 2009, \$BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

<sup>11</sup> This \$17.6 billion figure includes stimulus spending on research and development in energy-smart technologies as well as renewable energy. The main figures in this chapter, however, relate to renewable energy only.



more consistent deposition of the semiconductor onto its substrate material and reducing the area occupied by the wiring that connects each cell to the electrical circuit. In polysilicon production, improving the recycling of toxic production gases is an important focus area for research. Major private sector investments in R&D were made by Sharp, Applied Materials, Sanyo, Schneider and First Solar.

Biofuels were the next largest target for R&D, as total funding doubled to \$2.3 billion. Again, this was due to a major increase in public sector spending, up 142%, while corporate investment fell marginally. Here the imperative remains to develop and improve next-generation technologies that do not compete directly with food production, such as ligno-cellulosic biofuels and biomass-to-liquid technologies using the Fischer-Tropsch process.

In ligno-cellulosic biofuels, companies such as Novozymes, Gencor and Dyadic are working to develop improved enzymes that act faster and convert a greater proportion of plant sugars into fuel. Others, such as Amyris, are developing bacteria that convert sugars not simply to ethanol, but directly into 'drop-in' fuels such as biodiesel, and into high-value chemicals.

Industry researchers are also working to reduce the two stages of ligno-cellulosic biofuel production to one. The problem is that enzymes for the first stage – separation of sugars from the biomass – and the second (fermentation of the sugars) operate at different temperatures and pH levels, and so require two separate tanks. If enzymes could be developed that worked in the same conditions, then the size of the plant could be halved and capital costs reduced significantly.

In the field of biomass-to-liquids, where the main players are Choren in Germany, Ineos in the UK and Rentech in the US, the challenges include how to remove ash from the gasification equipment without stopping the production process; cleaning the resulting syngas of impurities; and developing catalysts that are less prone to contamination as the syngas is converted into liquid fuels.

In the wind sector, R&D spending almost doubled, up 92%, to \$1.3 billion, as government funding more than tripled and corporate spending rose by 15%. In general, wind is a more mature technology than solar, so it is no surprise to see it lagging behind solar in research and development spending.

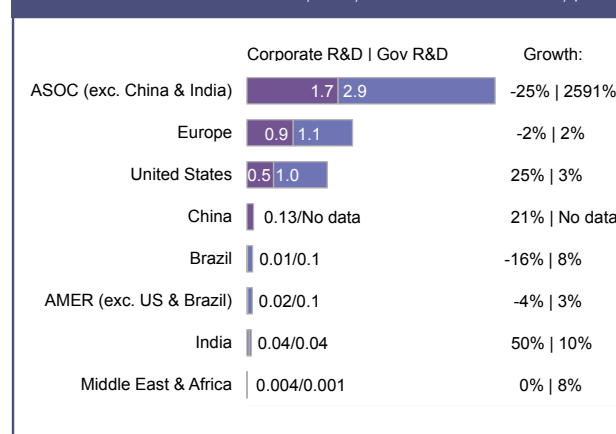
However there is a major focus for R&D in the need to move offshore, where the wind blows hardest and turbines are less likely to raise not-in-my-backyard (NIMBY) opposition than onshore, where residents often object to the sight of large turbines or the building work associated with their erection. But offshore wind farms are expensive to build and suffer extreme conditions,

so there is an urgent need to develop turbines that are more powerful, more reliable and cheaper. Key initiatives include the development of better gearboxes and alternative transmission systems; reducing the generators' reliance on expensive rare-earth metal magnets; increasing the length of turbine blades; and reducing the weight and cost of all components.

The largest turbine operating offshore is currently 5MW, but manufacturers are competing to raise the power rating of new models dramatically, through a variety of approaches. Clipper Windpower is developing the Britannia, a prototype 10MW machine with an improved gearbox that reduces loads by a factor of four; American Superconductor is developing the 10MW SeaTitan using superconducting magnets; while Wind Power of the UK has designed a vertical-axis offshore turbine called the Aerogenerator X, with support from the Energy Technology Institute. Several companies including EDP of Portugal are testing turbines on floating platforms, and Gamesa is leading a Spanish industry study to research the technologies needed to build a 15MW machine. Among other manufacturers, Nordex and Vestas have each developed 6MW offshore turbines.

Marine and small hydro saw falls in corporate R&D, as small technology developers found venture funding harder to come by, but this was far outweighed by substantial increases in government funding, particularly for wave and tidal in Europe.

FIGURE 30: CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY REGION, 2010, AND GROWTH ON 2009, \$BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

In Asia and Oceania excluding China and India, government R&D support for renewable energy rose sharply to \$4.7 billion, on the back of major stimulus packages in Japan, South Korea and Australia (see Figure 30), and probably under-reporting in earlier years. The next biggest bloc was Europe, where overall spending was unchanged at just under \$2 billion, followed by the US, up 9% at \$1.5 billion.

For China it is impossible to say exactly how much government money was spent on renewable energy R&D in 2010. Much of the \$46 billion green stimulus package announced in 2008 was originally earmarked for R&D, but most of the 70% of the funds that have been spent so far appears to have gone on other forms of support, such as project finance.

There were two bright spots in corporate R&D: in the US, companies spent 25% more than in 2009; and in India 50% more, although from a low base, raising total renewable energy R&D in that country by 27%.

With half the estimated \$194 billion of green stimulus funding still to come at the beginning of 2011, and with almost \$10 billion of that earmarked for R&D, 2011 should prove another strong year, especially if there is any recovery in corporate investment. However this prognosis comes with three important caveats.

First, substantial amounts of stimulus funding initially allocated to R&D have already been spent in other ways, as noted above, such as on grid improvements, energy efficiency schemes or renewable energy projects. Second, Bloomberg New Energy Finance research suggests measures amounting to some \$18 billion of the initial stimulus total seem to have “disappeared”; there is simply no evidence that they are on course to turn into actual spending. And third, current R&D spending falls far short of some estimates of what is required.





# 04 VENTURE CAPITAL & PRIVATE EQUITY

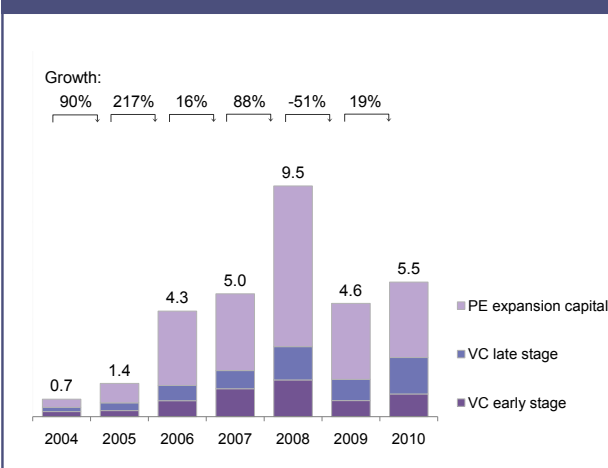
- Venture capital and private equity investment in renewable energy recovered strongly in 2010, up 19% to \$5.5 billion, but fell well short of the record levels set in 2008.
- Within the wider clean energy sector, renewables were outgrown by energy-smart technologies, which saw VC/PE investment jump 60% to \$3.1 billion, as investors continued to try to find technologies offering intellectual property protection and a fast return on investment.
- In renewables, all the growth was concentrated in venture capital, while private equity expansion capital continued to slip in 2010 from the highs established in 2008.
- North America extended its dominance of the asset class, with its share of investment rising from 56% to 67%. Solar was again the favoured technology, up 31% at \$2.2 billion.
- Biofuels fell 36% to \$700 million, but within that next-generation biofuels rose 57% to \$630 million.

Venture capital and private equity investment rose by a fifth during 2010 (see Figure 31), but the overall number disguises a rollercoaster year. Investment inflows jumped by a third in the first quarter to \$1.7 billion, rose again to \$1.9 billion in Q2, plunged by half in Q3 to \$930 million, and firmed slightly to \$970 million in the final quarter. Investor confidence began to re-emerge during 2010 but was buffeted by a combination of factors, including the difficulty venture capitalists experienced raising funds, and continuing concerns about the exit market for clean energy companies.

The wider renewable energy sector background also faced challenges, and these affected sentiment among venture capital and private equity investors. Wind felt the drag of low global gas prices, caused by the recent US shale gas boom and excess liquid natural gas (LNG) capacity at a time when demand was still depressed following the recession. Solar was hit by the threat of retroactive cuts to feed-in tariff schemes in Spain and the Czech Republic, and by uncertainty over the level of future support in other key countries. Clean energy share prices under-performed the overall stock market in 2010, and this dampened the enthusiasm of limited partners that might have invested in venture capital or private equity funds specialising in the sector.

Yet the year for VC/PE investment in renewable energy ended on a more positive note as more transactions reached sign-off. For the year as a whole, the average deal size increased, as evidenced by investment volumes rising by 20% while deal numbers were scarcely changed (Figure 31), and early-stage investment in renewable energy drew increasing interest from corporate investors. A shift in emphasis from IPOs to trade sales reflected not only the volatility of stock markets, but also increasing interest from large companies less concerned with immediate financial returns and more focused on gaining strategic

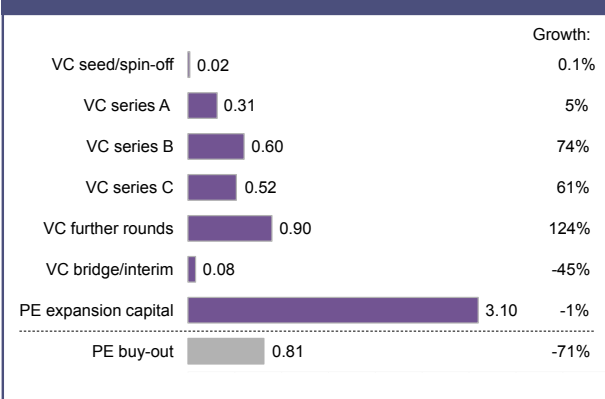
FIGURE 31: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004 - 2010, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

FIGURE 32: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2010, AND GROWTH ON 2009, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

advantage by acquiring intellectual property for the longer term.

VC/PE investment was up 19% in total, but the increase was concentrated entirely in the VC sector, and late-stage VC in particular. As shown in Figure 31, early-stage VC rose 41% to \$930 million, with solar the star sector. There were Series A rounds for polysilicon technology company Iosil Energy, thin-film PV manufacturer Applied Quantum Technology and thermal project developer Keahole Solar Power – all from the US. Late-stage surged 71% to \$1.49 billion, helped by deals for solar specialists BrightSource Energy, MiaSole and Abound Solar. Early-stage VC was still 38% shy of its 2008 peak, but late-stage VC established a new record high, almost 9% clear of its 2008 level. Meanwhile investment of PE expansion capital slipped fractionally, by \$20 million, to \$3.1 billion, following a precipitate fall in 2009, languishing at less than half the value of its 2008 peak. A more detailed breakdown of investment by funding stage is given in Figure 32.

Although exit markets showed some signs of life, private equity is still beset with challenges over fundraising, valuations and exits. Stock markets have been volatile, renewable energy stocks have underperformed – the NEX index fell almost 15% in 2010 – and private equity funds have taken far longer to close, all of which encouraged many PE investors to sit 2010 out.

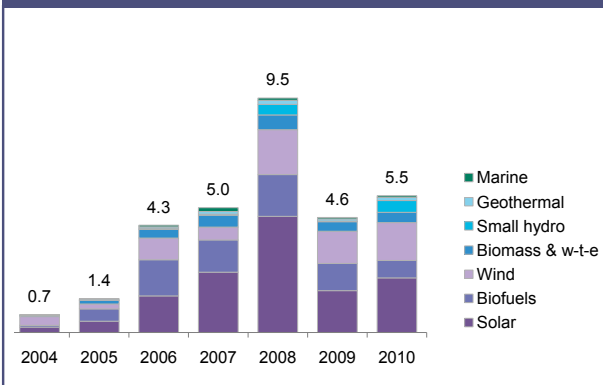
Solar remained the most popular technology, and gained 30% to \$2.2 billion in 2010. It was followed by wind, up 17% at \$1.5 billion. Biofuels continued its recent slide, dropping 36% to \$700 million (Figure 33). Small hydro increased sharply, but from a very low base, to \$480 million, through a series of private equity deals in North and South America and India (Figure 34).

North America extended its dominance of VC/PE investment, claiming \$3.7 billion, which amounts to 67% of the total, up from 56% in 2009 (see Figures 35 and 36). Investment fell in all other regions except Middle East & Africa, which doubled from a low base.

Solar's gain was driven overwhelmingly by the US, which took 86% of the investment, and came in spite of some shadows across the sector in that country, including a series of huge debt financing deals secured by competing Chinese solar companies. China extended loan guarantees worth \$32.5 billion during 2010 to 10 manufacturers, including LDK Solar, Yingli Green Energy and Suntech Power Holdings, creating an intimidating landscape for potential rivals.

It is perhaps not surprising that some of the biggest VC/PE deals in solar were by companies supported by US government loan guarantees. These included thin-film module manufacturer Solyndra, which raised \$175

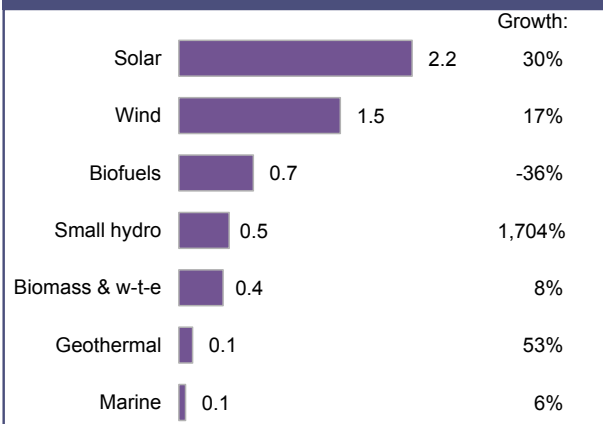
FIGURE 33: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2010, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

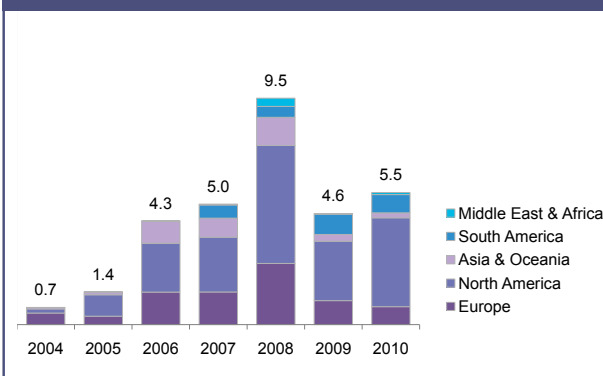
FIGURE 34: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2010, AND GROWTH ON 2009, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

FIGURE 35: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2010, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

million in private equity after withdrawing a planned IPO due to "ongoing uncertainties in the public capital markets"; Colorado-based Abound Solar, another thin-film company, which raised \$110 million from investors and closed a \$400 million loan guarantee; and solar thermal electricity developer BrightSource, which raised \$150 million from investors including Alstom, the French power equipment maker.

Activity by private equity players in solar might have been higher but for the fact that development companies found it easier in 2010 to raise non-recourse debt finance from banks for their projects. Last year's biggest solar private equity deal, raising \$300 million for Moser Baer Projects in India, was one of the few such transactions.

The fall in VC/PE investment in biofuels disguises the real story of 2010. The fall was entirely due to the collapse of investment in first-generation, food-crop based fuels, and conceals a strong recovery in next generation technologies such as cellulosic biofuels and gasification. Investment in first-generation slumped 90% to just \$71 million, while that in next-generation surged 57% to \$630 million. First-generation investment was less than a tenth of its 2008 peak, while next-generation was 29% short of its peak value. First-generation biofuels are now well established and there are fewer growth opportunities for VC/PE investors, while next-generation fuels are now separately mandated in the US under rules requiring production of more than five billion litres per year by 2011. Many of the biggest deals featured oil majors as investors. Total of France, for example, took a stake in Elevance Renewable Sciences, a company whose next-generation catalyst technology produces fuels and specialty chemicals from vegetable oils and animal fats, in the company's third-round funding, which raised \$100 million.

Other significant deals included California-based LS9, which raised \$30 million in private equity to expand its operations in Brazil, and develop its partnership with Procter & Gamble. The company, whose investors include BlackRock, Khosla Ventures and Chevron, employs genetically modified micro-organisms to convert sugar to hydrocarbon fuels and sustainable chemicals in a 'one-step' fermentation process.

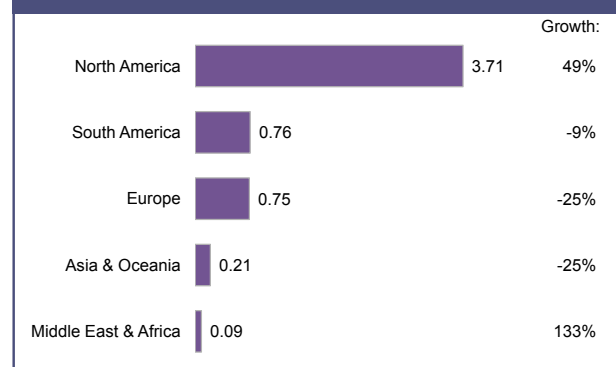
Virent Energy Systems, whose backers include Cargill and Shell, raised more than \$46 million to develop its 'BioForming' technology, which turns plant material into hydrogen and uses it to produce petrol, diesel and jetfuel. Meanwhile, Illinois-based Coskata raised over \$29 million in a fourth-round funding led by Total, to develop its 'FlexEthanol' platform, which combines licensed plasma gasification technology with a bio-fermentation process using anaerobic microorganisms. The company claims the technology can use any

material containing carbon as feedstock - even old car tyres.

VC/PE activity in the wind sector was modest overall, as befits a relatively mature renewable energy technology. However there were a number of sizeable deals, including three project developers: California-based Pattern Energy Group raised \$400 million in expansion capital; Energimp of Brazil, \$219 million; and Iberdrola Renovables Polska, \$109 million. Chinese turbine manufacturer Lianyungang Zhongfu Lianzhong Composites raised \$100 million. The US led with 15 deals, followed by 10 for the UK.

Biomass and waste-to-energy is also a well-established sector from a technology point of view, so does not generally see much early-stage VC activity. In 2010, total VC/PE investment in this sector rose 8% to just over \$400 million, the largest deal being a \$110 million private equity round for Canada-based waste-to-power developer Plasco Energy Group.

FIGURE 36: VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2010, AND GROWTH ON 2009, \$BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance



# 05 PUBLIC MARKETS

- New investment in renewable energy through the public markets recovered strongly in 2010 from two years of recession-driven lows, to finish up 23% at \$15.4 billion. Nevertheless it still fell 30% short of its pre-crisis peak.
- Despite the overall increase in investment, the value of existing clean energy shares languished in the face of difficult economic and political conditions. The WilderHill New Energy Global Innovation Index, or NEX, fell 14.6% in 2010, sharply underperforming both the S&P 500 (up 12.8%) and the Nasdaq Composite (up 16.9%).
- New investment surged in the second half of the year, when initial public offerings returned with a vengeance. China continued to dominate IPOs by renewable energy companies.
- Wind was the big winner, with public market investment up 58% at \$8.2 billion, while solar fell 17% to \$5.3 billion, and biofuels more than doubled to \$760 million. Biomass and waste-to-energy soared as did small hydro, but both from a low base.
- Regionally, the biggest increase in investment via the public markets came in Europe, with a doubling to \$5.7 billion, but that was almost entirely due to the \$3.5 billion IPO of Enel Green Power.

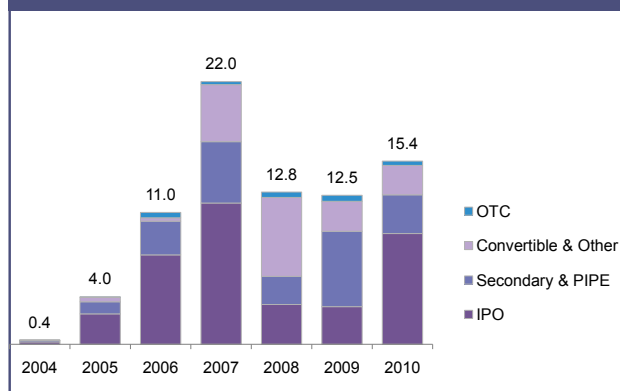
Investment in renewable energy through public markets put in a respectable performance in a turbulent year (see Figure 37), particularly given the under-performance of clean energy indices (Figure 38). New equity raisings on the public markets by renewable energy companies reached \$15.4 billion in 2010, up from \$12.5 billion in 2009 and \$12.8 billion in 2008, although still well short of 2007's record \$22 billion.

The sector, exchange and geographic breakdowns for public market investment in 2010 are shown in Figures 39 to 43, and the key trends behind those figures are discussed below. First, we look at how the year unfolded in terms of overall public market sentiment and activity in clean energy.

Activity is usually sluggish in the first quarter of each year, but in early 2010 several additional factors conspired to depress the recovery. The failure of Copenhagen to deliver a binding international agreement at the end of 2009 cast a long shadow over the prospects for renewable energy, as did the aftermath of the financial crisis and recession. This uncertainty was then further reinforced by the sovereign debt crises in Greece and Ireland.

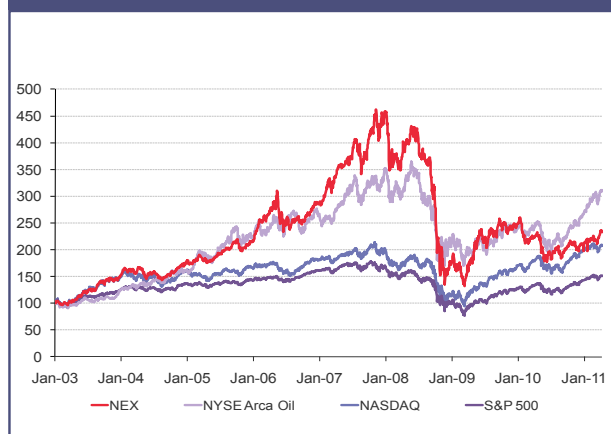
The slow strangulation of US climate legislation also depressed the sector, as President Barack Obama gave priority to healthcare reform. Already in trouble and much watered down, the legislation was finally pulled in July, killing off all hope of federal cap-and-trade or renewable energy mandates for the foreseeable future. The mid-term Congressional elections in November put the Republicans in a majority in the House of Representatives and left the Democrats with a smaller

FIGURE 37: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2010, \$BN



Source: Bloomberg New Energy Finance, UNEP

FIGURE 38: NEX VS SELECTED INDICES



Index Values as of 8 April 2011; AMEX Oil, NASDAQ and S&P 500 rebased to 100 on 30 December 2002

Source: Bloomberg New Energy Finance



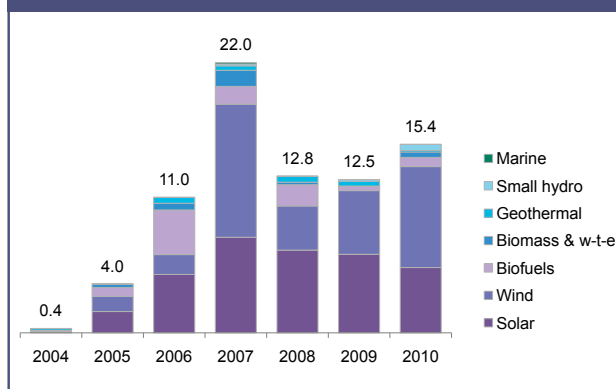
majority than before in the Senate, making the chance of fresh legislation on cap-and-trade or renewables seem even more remote. The US continued to benefit in 2010 from the 1603 Treasury Grant Program and the Manufacturing Tax Credit, but the MTC expired at the end of 2010 and the grants were extended late last year only until the end of 2011. There were also sector-specific difficulties, including first the threat, and eventually the reality, of retroactive reductions in solar feed-in-tariffs for existing PV plants in Spain. This sparked fears of a series of disorderly cutbacks in state support for renewable energy, as governments attempted to take economic pressure off their hard-pressed consumers. Rumours that Spain was considering the move first emerged in the spring, to the consternation of developers and investors, and the intention to do this was confirmed by the government in June, distressing the market all year until the details were finalised in December. The cuts range from 7% to 30% and will have a serious effect on project economics, particularly for investors looking to use a high proportion of debt to finance their investments.

Elsewhere, the Czech Republic introduced a retroactive tax on the revenues of PV projects. Although other countries did not introduce retroactive tariffs, Germany did cut support for future projects, causing a surge in investment in solar projects in 2010 (prior to the tariff depreciation), and France restricted the amount of new capacity that would be eligible for support. The UK announced a review of its feed-in tariffs for small renewable energy projects of less than 5MW, faced by signs that industrial-scale developers were moving into the sector.

Beyond the vagaries of politics, the wind and solar sectors were both afflicted by overcapacity, although for solar this was less of a problem than in 2009. Low natural gas prices also undermined project economics, impacting developers directly and suppliers indirectly.

Despite the strong headwinds, IPO volumes began to build in the second quarter, with six successful flotations, some in renewables and some in energy-smart technologies, including those of Zhejiang Narada Power Source Corporation, a Chinese rechargeable battery maker, Tesla Motors, and Codexis, a US-based company making biocatalysts for cellulosic ethanol production – again showing growing interest in advanced transportation and second-generation biofuels. But with the markets plunged into turmoil by the European sovereign debt crises, many more IPOs were shelved than went ahead. Concerns about the future of Spanish renewable energy tariffs led to IPOs being shelved or scrapped by Eolia Renovables, Renovalia Energy, Engyco, T-Solar and Solyndra. China's second largest wind turbine maker, Xinjian Goldwind Science & Technology, delayed a planned

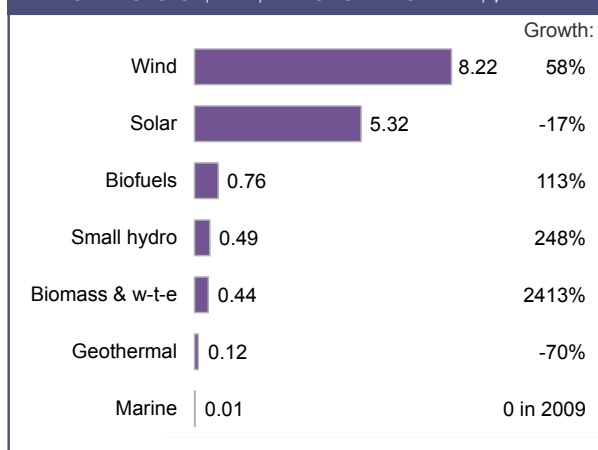
FIGURE 39: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

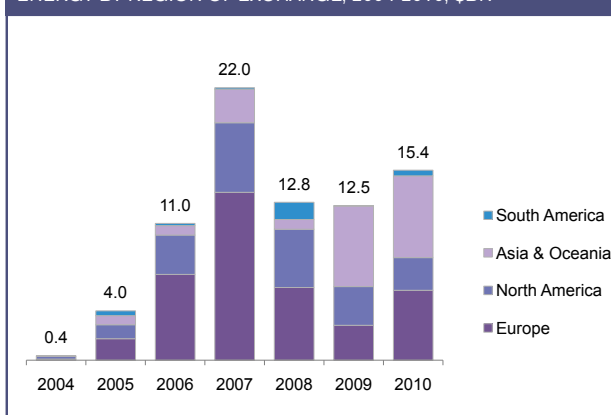
FIGURE 40: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2010, AND GROWTH ON 2009, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

FIGURE 41: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY REGION OF EXCHANGE, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP



\$1.2 billion IPO on the Hong Kong Exchange in June because of lack of investor interest.

But from the third quarter, new investment soared as investor confidence recovered, the sovereign debt crises subsided, and governments continued to pump money into the economy through quantitative easing and stimulus packages. Activity was dominated by the return of the IPO, predominantly by Chinese companies listing on Far East exchanges, and largely in wind and solar. The renewables industry in China benefitted from the country's ambitious targets and strong support from government, well-capitalised banks and enthusiastic local investors.

In Q3 there were 46 public market deals worth \$3.2 billion in total, dominated equally by wind and solar, which each attracted \$1.3 billion. The IPOs included China Ming Yang Wind Power, Risen Energy, a solar cell and module manufacturer that listed on the new ChiNext junior exchange, Trony Solar, Orient Green Power Company and Sino-American Silicon Products.

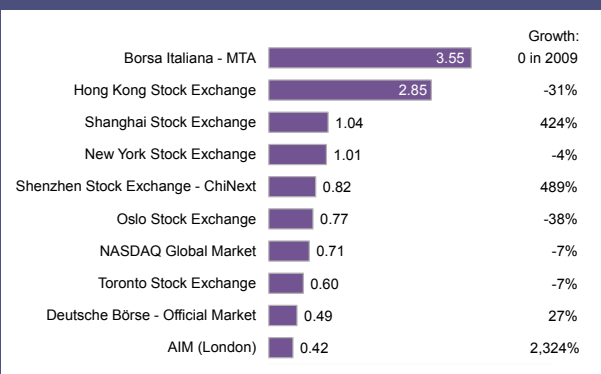
In Q4, there were 50 deals worth a whopping \$8.3 billion in total, overwhelmingly dominated by wind, at \$6.3 billion, against \$1.8 billion for solar. Most of the investment was concentrated in a few large deals, such as Goldwind, whose revived IPO in October raised over \$1 billion; China Datang Corp, \$682 million; Sanan Optoelectronics, \$456 million; and China Suntien Green Energy, \$425 million.

The biggest single public market deal was the \$3.5 billion initial public offering of 20% of Enel Green Power, the renewable energy arm of Italian utility Enel. The shares were taken up by institutions and, particularly, by private investors. However, to get the issue away, Enel had to cut the offer price from its intended range of EUR 1.80-2.10, to EUR 1.60.

The Enel Green Power IPO in November 2010 differed from those of Iberdrola Renovables of Spain in 2007 and EDP Renovaveis of Portugal in 2008 in that the proceeds of the share sale went back to the parent company, Enel, rather than directly to the newly floated green subsidiary. The proceeds of the IPO will help the Enel group reduce its debt burden, but will also underpin an ambitious growth strategy at the Green Power offshoot, with 3.4GW of new capacity planned to be built by 2014, according to the plan revealed at the IPO.

The Enel deal skewed the numbers somewhat for 2010, both in terms of the technology breakdown and the regional analysis. Regionally, Europe was the biggest gainer in 2010, with new investment more than doubling to \$5.7 billion. But the Enel float was bigger than the entire regional gain, so without this single deal public market investment in Europe would have shrunk rather than expanded.

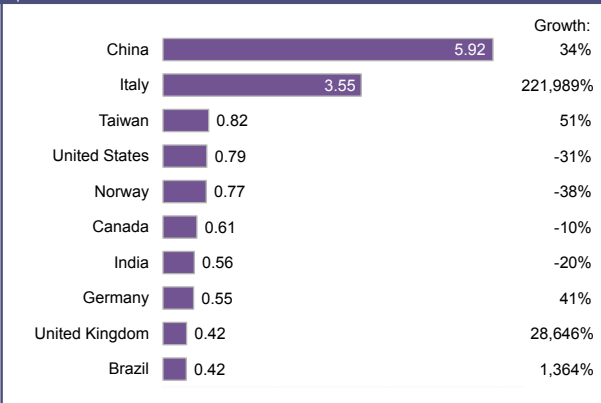
FIGURE 42: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY EXCHANGE, 2010, AND GROWTH ON 2009, \$BN



Top 10 exchanges

Source: Bloomberg New Energy Finance

FIGURE 43: PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY COMPANY NATIONALITY, 2010, AND GROWTH ON 2009, \$BN



Top 10 countries

Source: Bloomberg New Energy Finance

Figures 39 and 40 show a breakdown of public market investment by sector. The year's clear technology frontrunner was wind, up 59% to \$8.2 billion (Figure 40), but again, this was due to the inclusion of Enel Green Power in the wind sector figures. While 90% of the company's future project pipeline is indeed focused on wind, 75% of its current electricity production comes from hydro and geothermal, so it could be argued that the wind sector's gain is flattered by the data, while the opposite has happened to geothermal sector public markets investment, down 70% to \$120 million.

Despite a good number of Chinese solar IPOs, global investment in solar was down 17% at \$5.3 billion (Figure 40), with investors reeling from retroactive tariff changes in Spain. But there were impressive gains for biofuels, up 113% to \$760 million, and in biomass and waste, which soared 25-fold to \$440 million from a low base. In biofuels, some of the largest deals were by next-generation companies such as Amyris, a California-based company working with genetically modified yeast to produce petrol and diesel replacements directly from

plant feedstocks, that raised \$98 million; and Codexis, mentioned above, which raised \$78 million.

The sharp growth, from almost zero in 2009, in public markets investment in biomass and waste-to-energy was due to a handful of deals including Orient Green Power, an Indian biomass and biogas developer, which raised \$199 million; A2Z Maintenance & Engineering Services, an Indian waste-to-energy developer, \$161 million; Tianjin Teda of China, which raised \$170 million to develop three waste-to-energy plants; and small-scale renewables company Ameresco of the US, which raised \$90 million.

While the IPO market bounced back strongly during 2010, secondary share issues and private investment in public equity, or PIPE, deals halved in value (see Figure 37). One reason was that some of the larger renewable energy companies that needed to raise equity capital from the stock markets had done so in 2009, and did not need to – or were not able to – repeat these offerings in the following year.

Figures 41, 42 and 43 show 2010 activity in terms of geography - focusing respectively on the region of the exchange, the exchange itself, and the company nationality. Asia & Oceania led the way for the second year running, this time with \$6.6 billion raised on public markets. Second was Europe with \$5.7 billion (more than half of which was Enel Green Power), and third the Americas with \$2.6 billion.

Among exchanges, the most important in terms of money raised were Borsa Italiana and Hong Kong, followed by Shanghai and New York (Figure 42). The fastest growth in percentage terms was seen at London's Alternative Investment Market. It saw PIPE deals - by Clipper Windpower, which raised \$266 million; Greenko Group, an Indian small-hydro developer, \$117 million; and KSK Power Ventur, another Indian project

developer, \$99 million. As Figure 42 shows, AIM saw \$420 million invested in total, up 24-fold (2324%) on 2009, a year when the markets - particularly the junior ones - were almost closed to equity-raising. The jump in AIM financings helped London stock markets to record an almost 30-fold increase in the funds raised by UK companies (Figure 43).

The other top performing exchanges in terms of share issues reflected the themes of the year: investment in public markets in Shanghai rose more than five-fold (424%) to just over \$1 billion, driven by the surge in Chinese IPOs, while ChiNext, the junior board of the Shenzhen Stock Exchange, saw investment up almost six-fold to \$800 million in its first full year of operation.



# 06 ASSET FINANCING

- Asset finance of new utility-scale renewable energy projects saw a rebound in 2010 and touched a record \$128 billion relative to \$107 billion in the previous year.
- Asia & Oceania accounted for \$56 billion, or 44% of overall asset financing in 2010, largely due to the scale of activity in China. The region took over the lead position held by Europe for the last three years.
- Europe was the second most important region for asset financing in 2010, at \$28.9 billion, with North America on \$25.2 billion and South America on \$12.6 billion.
- The share of non-recourse debt deals in total asset financing increased in 2010 to 30%, from 24% in 2009, indicating greater availability of bank debt. However it still remains down on 2008's 40%, and balance-sheet financing continues to be the most used option for projects.
- The wind sector accounted for 70% of overall financing. Total asset-financing for wind in 2010 was \$89.7 billion, up 33% over last year. Lower turbine costs have brought the levelised cost of wind energy in the best locations closer to that of coal- and gas-fired generation, and this is helping to drive investment.

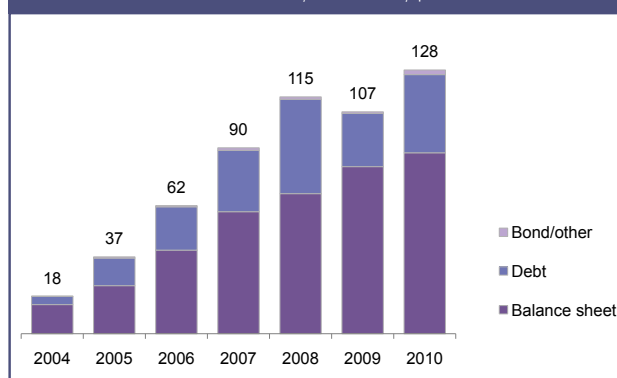
The easing of the financial crunch was evident in 2010, as asset finance of utility-scale renewable energy projects set a fresh record. Asset finance touched \$128 billion during the year, up 20% from the previous year's \$107 billion. In 2009, new-build asset finance for renewable energy had dipped by \$8 billion (see Figure 44), but a partial recovery in the availability of bank loans and the arrival of more "green stimulus" funding led to a rebound last year. Stimulus spending on clean energy (including energy-smart technologies as well as renewables) amounted to a modest \$20 billion in 2009, but this jumped to almost \$75 billion in 2010.

The asset finance numbers look especially favourable when juxtaposed with the economic challenges that various countries faced during the year, from the sovereign debt crises in Greece and Ireland on one hand to the threat of retroactive cuts in feed-in-tariffs in Spain on the other. It was also the year that saw clean energy trade disputes reach the World Trade Organization and increasing protectionist pressure making its presence felt.

Asset finance of utility-scale renewable energy projects can be divided into two types: balance-sheet financing, where developers use their own resources to fund a project, often after raising bond finance for the corporate entity; and non-recourse project financing, where funding is secured directly for the project on the strength of anticipated income flows.

Though balance-sheet financing continued to be dominant in 2010 - in line with the trend of the last few years - it went down to 68% of total asset financing,

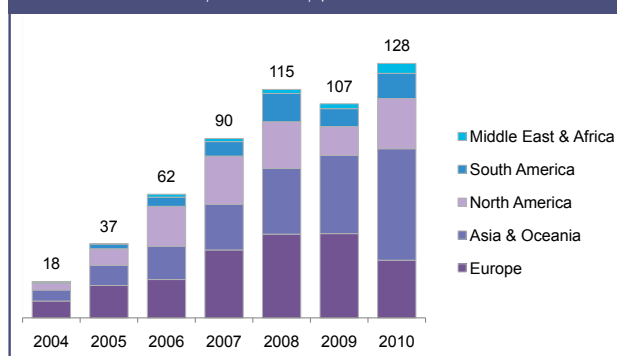
FIGURE 44: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY TYPE OF SECURITY, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

FIGURE 45: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

from 76% in 2009, reflecting the increased willingness and ability of lenders to extend funding to new clean energy projects (Figure 44). In the boom period of 2008, balance-sheet finance made up a lower proportion, 59%, of the total. In non-recourse financing, there was a gradual reduction in spreads on loans for wind and solar projects in Europe and North America during 2010, a return of 15-year tenors (at least in Europe), and many onshore wind and PV projects secured debt equivalent to around 80% of total investment - a proportion that was difficult to achieve in the months after the financial crisis.

The bounce in the 2010 asset finance numbers is largely attributable to the Asia & Oceania region, which accounted for about 44% of the total new-build asset finance during the year. The ASOC region took over the lead position held by Europe for the last three years (see Figure 45).

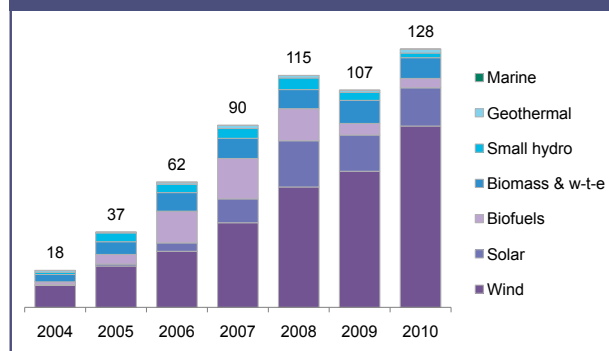
Within Asia, it was China that was pushing up the region's ranking, topping the chart for new-build clean energy with asset finance of \$43.8 billion - the largest for any single country - in 2010 (see Figure 16). The US was second on the list, though the \$19.6 billion asset finance in the country was less than half that of China (Figure 19).

China and the US made up almost half the total new-build asset finance in 2010. However European countries such as Germany, Italy, the UK, and Spain were also important, as were Brazil and India.

Wind continued to dominate asset financing, in line with the trend in previous years, though in a more pronounced manner. It accounted for 70% of all asset finance in 2010, higher than the 63% it accounted for in 2009. On an absolute basis, financing for wind was up 33% in 2010 - at \$90 billion - from the previous year (Figure 46). Solar came second, at \$19 billion in 2010, up from \$18 billion the previous year, although the majority of the action in solar was in small-scale projects not in asset finance, as Chapter 7 shows. The third most important sector for asset finance was biomass and waste-to-energy, at \$10 billion, with biofuels fourth on \$5 billion. Both were down \$1 billion on 2009 levels. Small hydro and geothermal shared fifth position.

Wind energy investments are benefitting from the fact that the levelised cost of generation of wind power plants in the best onshore locations is now close to, or even lower on some estimates and in some places than, that of coal plants. According to Bloomberg New Energy Finance analysis, the best new wind power plants in windy locations around the world have a levelised generation cost of \$65 per MWh compared to \$68 per MWh for new coal plants. To top it, coal suffers from carbon price risk. Wind's most dangerous rival in 2010 was once again gas-fired generation, with natural

FIGURE 46: ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

gas prices remaining below \$5 per MMBtu through most of 2010 and further supplies likely to come from shale gas drilling in North America and Europe.

One of the largest wind projects to secure funding last year was the 845MW Shepherds Flat wind farm being built by closely-held Caithness Energy of the US, in Oregon. It closed a \$1.3 billion loan from a group of 26 institutional investors and commercial banks led by Citigroup, Bank of Tokyo-Mitsubishi UFJ, RBS Securities and WestLB Securities. The loan carries an 80% guarantee from the US Department of Energy, supported by stimulus funding. Other onshore wind projects that tied-up funding during the year included Terra-Gen of US for the 570MW Alta Wind project, AGL and Meridien Energy for development of the 420MW Macarthur Wind Farm in Australia and Acciona for its wind farms in Mexico's Oaxaca state.

A significant share of the funding for wind energy in 2010 found its way to offshore projects. Belgian developer C-Power signed a \$1.16 billion loan agreement for its Thornton Bank wind power project off the nation's coast. A group of seven commercial banks agreed to provide non-recourse construction financing for the project along with the Danish export credit agency and its German counterpart. In December, Germany's 200MW Borkum West II offshore wind park in the North Sea secured loan finance from a group of 13 private and public sector banks.

In China too, a host of wind projects closed financing during the year, involving the country's leading development companies. The projects for which Datang secured funding include the Hanshan Hansumu wind farm, the Shangyi Bulongwan wind farm and the Xinzheng wind farm, all located in Inner Mongolia. Huaneng completed the funding for the second phase of the Changyi wind farm in Shandong province. Huadian secured finance for the first and second phase of its Xuwen wind farm in Guangdong province. Guodian completed financing for the Kangbao Zhaoyanghe wind farm in Hebei province. China Longyuan Power Group



also secured funding for the Damao Bayin wind farm located in the autonomous region of Inner Mongolia.

In solar thermal electricity generation, also known as concentrated solar power, one of the projects that secured funding in 2010 was the 392MW Ivanpah plant, being built by BrightSource Energy in southern California, helped by a \$1.6 billion loan guarantee from the US government. Equity investors in the project include VantagePoint Capital Partners, Draper Fisher Jurvetson and Morgan Stanley. The plant will use mirrors to concentrate the sun's rays on boilers mounted on top of towers. The resulting steam is then fed into a turbine to generate power.

Masdar in the United Arab Emirates secured \$600 million debt funding for its 100MW Shams 1 solar-thermal project. The 22-year loan agreement was led by BNP Paribas and included commitments from National Bank of Abu Dhabi, Union National Bank, Bank of Tokyo-Mitsubishi, and Sumitomo Mitsui Banking. Spain's Abengoa also secured funding during the year for solar thermal plants in the US and Spain.

Some PV plants that closed financing during the year included those in Italy of SunEdison at Rovigo (\$444 million) and AES Solarat Cellino San Marco (\$271 million). SunPower financed two phases totalling 44MW of its Montalto di Castro PV park with a \$260 million bond issue. In the US, Eurus Energy-NRG (\$220 million) and Beautiful Earth (\$160 million) were among those to have secured financing for big PV projects.

Besides wind and solar, one more sector - geothermal - also saw an increase in asset finance in 2010, compared to 2009. Hudson Ranch power secured \$300 million in debt financing for its 49.9MW project in California. Geothermal plants in Kenya, Nicaragua, Australia and Indonesia also secured funding during the year. The largest transaction saw more than \$1.2 billion committed for several units of the Olkaria project in Kenya. The Nicaraguan deal saw a pledge of debt finance for the \$218 million San Jacinto project.

Financing for biomass and waste-to-energy, biofuels, small-hydro and marine power was lower than in recent years. Asset financing for biomass and waste-to-energy was down 10% to \$10.2 billion in 2010. The sector continues to be plagued by feedstock supply challenges and uncertainty over future feedstock prices. Some companies are trying to overcome this uncertainty over supply, by developing projects in partnership with providers of biomass or by cultivating land themselves with the specific purpose of growing energy crops.

Projects that closed financing in 2010 included the 65MW TRM Gerbido waste-to-energy plant in Italy, costing a total of \$681 million, and the Shougang Group Lujiashan waste-to-energy plant near Beijing

(\$323 million). RWE Innogy secured finance for a 50MW biomass plant at Markinch in Scotland, costing a total of \$338 million.

It was also a challenging year for the biofuel sector, which saw a 19% dip in asset finance to \$4.7 billion. This was less than a third of the 2008 number of \$16 billion, and an even smaller proportion of the amount financed in the record year for that sector of 2007. One influence has been the shift in crude oil prices from their peak in 2008, and another has been higher costs for feedstocks such as corn and sugar than the industry had been expecting in the boom period of 2006-07. For most of last year, crude oil was at \$70-80 per barrel, and this was a dampener for the biofuel industry. The sustainability debate over biofuels, involving competition for edible feedstocks and in some cases the clearing of forests, has also deterred some investors, but the biggest problem for the biofuel sector - like biomass - is uncertainty over feedstock supplies and prices, and therefore uncertainty over producer margins. Many projects were announced in 2010, though less than 5% of these are estimated to have secured funding. Brazil - one of the key markets - had to contend with lower gasoline prices on one hand and higher sugar feedstock prices on the other. These problems were mainly felt by first-generation biofuel producers - those firms developing second-generation production using cellulosic material may also face challenges over feedstock in due course, but oil companies and venture capital investors have continued to help fund their new technologies.

Financing for small hydro was down 43% to \$2 billion, hit by a post-financial crisis lull, regulatory restrictions in Europe and concerns about the risk of rainfall variations impacting the performance of some projects. The marine power sector, meanwhile, continues to be at an immature stage of development, with most of the money flowing into wave and tidal taking the form of venture capital or government grants rather than asset finance. However ambitious plans emerged during 2010 for multi-MW projects off the coast of countries such as the UK and Portugal, so if device development continues on track, there could be more significant numbers for wave and tidal asset finance by the later years of this decade.



## DEVELOPMENT BANK FINANCING OF RENEWABLE ENERGY PROJECTS

State-owned multilateral development banks have been pillars of investment in renewable energy during recent, troubled years for the world economy.

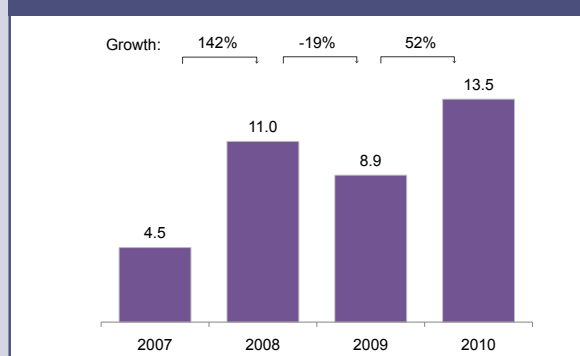
Figures compiled by Bloomberg New Energy Finance show that 13 development banks provided \$13.5 billion of finance for renewable energy projects in 2010, up from \$8.9 billion in 2009, \$11 billion in 2008 and just \$4.5 billion in 2007 (see Figure 47). Almost all of this money took the form of loans, although there were also a few equity finance deals, notably in Eastern Europe by the European Bank for Reconstruction and Development.

The three leading development banks in terms of their financing of projects in 2010 were the European Investment Bank, with \$5.4 billion, Brazil's BNDES with \$3.1 billion and Germany's KfW with \$1.5 billion. The EIB's contribution has grown almost fivefold from 2007. BNDES' activity in 2010 was twice that in 2007, but it actually peaked in 2008 at \$6.2 billion, when the ethanol investment boom in Brazil was at its height. KfW's project finance footprint has also doubled since 2007.

One uncertainty relates to China Development Bank, which last year announced some \$36 billion in credit lines to Chinese clean energy manufacturers, but only shows up as the confirmed lender to some \$600 million of renewable energy projects. The likelihood is that its contribution to projects is much larger than has so far been revealed.

The figures above for finance from the development banks in 2008 and 2009 are lower than those published in last year's Global Trends report, and reflect an improved calculation methodology. They are based on a combination of deals recorded on Bloomberg New Energy Finance Desktop, deal-specific disclosures in the annual reports and communication with the related organisations. Development banks made significant contributions to large hydro projects, which are not included in the investment figures.

FIGURE 47: DEVELOPMENT BANKS: PROVISION OF FINANCE FOR RENEWABLE ENERGY PROJECTS



Excludes debt and equity provided to renewable energy manufacturers, and debt and equity for energy efficiency

Source: Bloomberg New Energy Finance

## ASSET FINANCE OF LARGE HYDRO-ELECTRIC PROJECTS

The biggest sector of renewable power in operation worldwide is large hydro, with some 945GW generating in 2008 according to International Energy Agency estimates. However hydro-electric projects of more than 50MW are not included in the main figures in this report, due to the questionable social and environmental impact of some large hydro schemes.

In any case, producing estimates of the year-by-year investment in large hydro is difficult. This is because projects take an average of four years to build, there is often incremental capacity added along the way, and many of the developers do not provide regular updates on progress.

Bloomberg New Energy Finance estimates that some 27.1GW of large hydro capacity came online in 2010, below the figures for both wind and solar generation, but far above that for nuclear. Taking an average cost per MW of \$1.7 billion would imply that \$46 billion worth of large hydro plant started operating last year. This is just over a third as big as the asset finance figure for renewable energy excluding large hydro, of \$128 billion, but it is not strictly comparable – because it does not accurately capture the dollars actually spent in 2010.

Among the large hydro projects completed in 2010 were the 1070MW Nam Theun 2 scheme in Laos, the 2.4GW Jin'anqiao plant in China and the 460MW Tana Beles dam in Ethiopia.

# 07 SMALL-SCALE PROJECTS

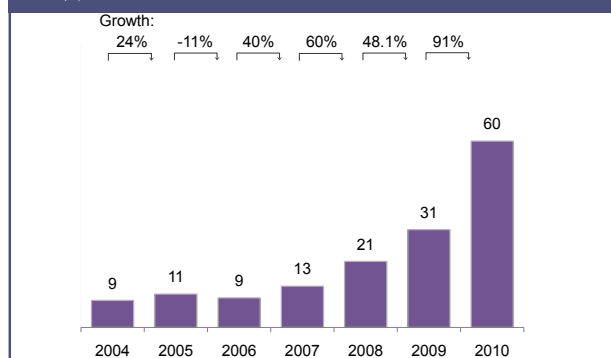
- Small-scale distributed generation power projects were the flavour of 2010, capturing \$60 billion in outlays, over a quarter of the total investment in renewable energy last year.
- Falling prices for solar modules drove the 91% growth in investment in small distributed capacity last year over 2009, encouraging consumers to make use of policy structures that were designed on the basis of higher, historical prices. Germany dominated this type of clean energy investment, taking a 57% share of the world total in 2010. Italy and the US were the next most important countries.
- As a result of the massive take-up of small-scale PV, some governments are cutting their incentives. This may reduce the popularity of small-scale solar for a while, although module prices continue to drop.
- Small-scale renewable heat is also becoming important, although it is not included in the \$60 billion figure above for investment in small-scale electricity in 2010. This sector includes biomass heating, ground- and air-source heating and solar water heating. The last of these alone is likely to have seen investment of more than \$10 billion in 2009.

Although massive wind farms and sprawling solar plants tend to dominate the headlines, renewable energy has a major role to play in decentralised and distributed generation. Recent years have seen a surge in investment in small-scale distributed generation projects with capacities of less than 1MW, notably domestic rooftop solar. Small-scale project investment rose from \$9 billion in 2004 to \$60 billion in 2010. Last year, purchases of small-scale, distributed clean energy technologies rocketed by 91% on 2009 levels, to account for over a quarter of total renewable energy investment (Figure 48). Indeed, investment in small-scale power projects made up \$29 billion, or more than half, of the \$51 billion rise in overall world investment in renewable energy in 2010.

Investment in small distributed capacity has been dominated by solar PV – not just because it is the most economic way to generate distributed power in the developed world, but also because it is supported by generous incentives in many markets. Its popularity owes much to political considerations: policy-makers like PV as it creates installation jobs and voters enjoy making a profit on their own power plant. Other voters have not so far recoiled at the impact the solar boom is having on their electricity bills. There has also been significant investment in solar water heating systems, used by households in many parts of the world – from China to Israel to Germany (see box). However Bloomberg New Energy Finance's data covers only renewable electricity and biofuels, so solar water heaters – and biomass and other heat systems – are not included in its totals for renewable energy investment.

The 91% growth in investment in small-scale power projects seen last year principally reflected the increased availability of low-priced solar PV modules,

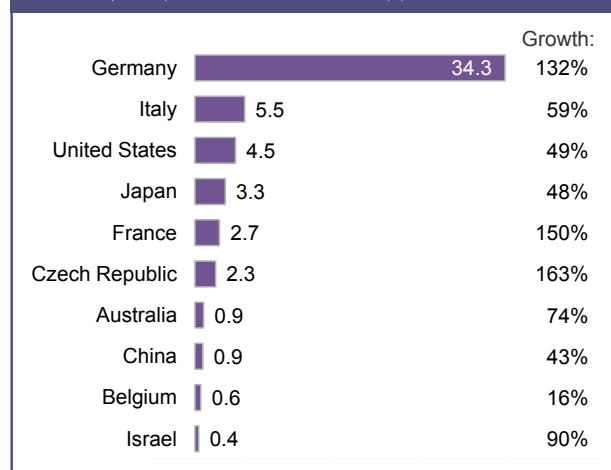
FIGURE 48: SMALL DISTRIBUTED CAPACITY INVESTMENT, 2004 - 2010, \$BN



Represents investments in solar PV projects with capacities below 1MW

Source: Bloomberg New Energy Finance

FIGURE 49: SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2010, AND GROWTH ON 2009, \$BN



Top 10 countries. Represents investments in solar PV projects with capacities below 1MW

Source: Bloomberg New Energy Finance

together with the emergence of a growing base of installers marketing to consumers. Most countries had designed their policy incentives for 2008 module prices. But these prices since plummeted from about \$4 per Watt in the middle of 2008 to just under \$2 per Watt by 2010 after the bottleneck in the supply of solar-grade processed silicon was broken. As a result consumers have been rushing to lock in the incentive structures before they go away.

As shown in Figure 49, Germany, the world's largest solar market, dwarfed the rest of the world in investment in small-scale solar projects, with a 57% share. Around 88% of all modules installed in Germany last year were on homes and small businesses and it was this that made it the second most popular destination for overall investment in renewable energy in 2010, after China and before the US. Financing of small-scale distributed capacity saw strong growth in other European countries, in particular Italy, France and the Czech Republic where the rates of increase were 59%, 150% and 163% respectively (see Figure 49). The US and Japan also saw increases in investment of nearly 50%.

German and Italian consumers are among those that have enjoyed generous feed-in tariffs incentivising investment in solar projects. Japan is a well-established residential market, where consumers buy systems because they make economic sense: it reintroduced a residential incentive in 2009 as global module prices crashed and it has very low interest rates. The US is a patchwork of state and even municipal incentives for residential PV systems, and a lively community of individuals seeking energy autonomy by trying to live 'off the grid'.

The growth in small distributed capacity comes at a price, however. Germany installed 7.4GW of PV in 2010 – well above its target installation rate of about 3.5GW per year, intended to meet an ambitious 52GW goal by 2020. Its residential systems installed by the end of the year were receiving EUR 330.3/MWh, above even Germany's somewhat high residential power prices. All consumers pay a EUR 0.035/kWh surcharge for renewable energy.

In addition, the uptake of solar power, and therefore the expense of incentive programmes, has generally exceeded policy-maker expectations, due to the falls in technology prices. The massive growth in investment has therefore prompted some countries to reconsider

their subsidy levels. Australia's \$900 million investment in small-scale solar projects in 2010 was driven by New South Wales' AUD 0.60/kWh feed-in tariff payments. These have now been cut to AUD 0.20/kWh. This will probably cool the popularity of small-scale investment for a time, although module prices continue to fall. It is also important to note that sharply falling prices mean that equal amounts of MW capacity can be installed for the same amount of money – so it could be that small-scale PV investment in the years ahead will increase at a much slower rate than the amount of capacity added.

The investment surge in small-scale PV in Western markets has been a boon for installation companies and has created many jobs. Germany, for example, had approximately 10,000 companies, mainly installers and suppliers, at the end of 2009 and probably more by the end of 2010; the German solar industry association estimates that these employ 63,000 people. These installation jobs, which cannot be outsourced to China in the same way as those in module production, constitute a major argument for governments to continue to support the small-scale PV segment. However, such rapid growth rates cannot be sustained indefinitely, suggesting that in mature markets such as Germany the government will eventually have to resist the solar lobby and hope that other sectors can take up the baton on job creation.

Falling module costs are also benefitting the developing world, where a PV and battery system is an increasingly viable alternative to a diesel generator for off-grid and remote homes and villages. Lighting systems charged during the daytime with a small PV panel are a relatively affordable and healthy alternative to kerosene lanterns, and their use is steadily rising. Some individuals already finance their own solar home systems, but much of the off-grid solar investment is funded through rural banks and micro-finance institutions in countries such as India, Bangladesh and Sri Lanka. See Chapter 10 for details of renewable power technologies gaining a foothold in developing economies.

In 2008, China's Wuhan Linuo, which also manufactures PV systems, announced plans to build a \$350 million solar water heater factory in Puyang, China's Henan province. In another significant deal, the private equity arm of Standard Chartered Bank closed a deal in 2009 to invest \$22.3 million in Chinese manufacturer Sangle Solar Energy.

## SOLAR WATER HEATERS

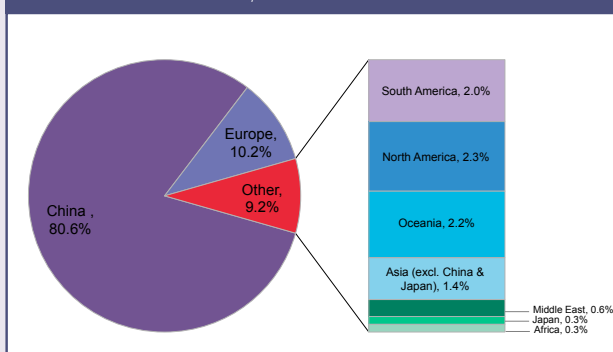
Although not included in Bloomberg New Energy Finance's overall data for investment in small-scale power projects, solar water heating makes up a significant sector in its own right. The solar water heater industry has continued to grow through the world economic downturn, particularly in China, although European markets saw a dip in 2009. This is according to latest figures provided by the International Energy Agency (IEA) and the European Solar Thermal Industry Federation (ESTIF).

By the end of 2009, the total cumulative capacity of solar thermal collectors in operation worldwide accounted for 172.4GWth, which represented 246.2 million square metres, according to the IEA. Out of this, glazed solar water collectors (flat plate and evacuated tube collectors) accounted for 151.5GWth. The remaining 20.9GWth comprised unglazed water collectors, which are designed to heat swimming pools, and air collectors which heat air using solar energy. Below we concentrate on the main, glazed solar water collector variety.

The worldwide market for glazed water collectors grew by 27.3% in 2009, compared to the previous year, according to the IEA. The year saw newly installed capacity of 36.5GWth of glazed collectors (excluding unglazed and air collectors), representing 52.1 million square metres. That was up from the previous year's figure of 29.1GWth, corresponding to 41.5 million square metres. There are no reliable estimates for the value of investment in solar water heaters worldwide, but on the basis of the IEA's square metre installation figures, it must have been well above \$5 billion, and probably above \$10 billion. The dominant markets for glazed water collectors in terms of sales were China and Europe, which together accounted for 90.8% of the world's total newly installed glazed water collectors in 2009 (see Figure 50).

China was the main driver for the "above average" market growth in 2009 with a gain of 35.5% in newly installed capacity, reaching 28 million square meters of systems, which represented 80.6% of global solar hot water/heating output. Australia also enjoyed a surge in the annual installations of glazed water collectors of 78.5% due to the introduction of a new financial incentive scheme. By contrast, the US and Japan struggled as a result of the after-effects of the economic crisis of 2008 and, in the US, the low cost of home-heating fuels in this period. The US and Japan saw declines of 8.5% and 31.8% respectively in water collector installations. The European market endured "a challenging year" in 2009, according to ESTIF. After a 60% surge in 2008, it dipped 10% in 2009, although there were some positive trends. ESTIF figures show that Europe is no longer relying so much on market leader Germany. Countries like Austria, France, Greece, Italy and Spain together accounted for 39% of the European total – compared to Germany's 38%.

FIGURE 50: GLOBAL INSTALLATIONS OF GLAZED WATER COLLECTORS BY REGION, 2009



Newly installed capacity of glazed water collectors by economic region in 2009

Source: Bloomberg New Energy Finance



Source: Cachogaray/ Wikimedia Commons

## THE TECHNOLOGY

Solar water heaters are systems that produce heat – not electricity – as an end-product. A solar water heater uses the energy from the sun to pre-heat water before it enters a conventional gas/electric heater. A typical system consists of a water storage tank and one or more solar collectors.

Solar water heating systems are usually characterised by how water is circulated – actively or passively – and how the water is heated – indirectly (closed loop) or directly (open loop). Active systems use pumps to circulate water through collectors to the storage tank. Passive systems rely on natural convection to circulate water through the collector to the storage tank. A direct/open-loop system circulates household (potable) water through the collector. An indirect/closed-loop system uses a heat-transfer fluid (water or diluted anti-freeze) to collect heat and a heat exchanger to transfer the heat to the household water.

Active solar hot water systems can be categorised into two types – direct active and indirect active. Direct active applications work by using pumps to circulate household water directly to the collector and to the homes. Indirect active systems pump a heat-transfer fluid such as a water-glycol antifreeze mixture through the collectors and a heat exchanger – the heat of which is transferred to the water and into homes.

At the heart of every solar water heating system lies the all-integral solar collector. The most commonly used solar collectors in the industry are either flat-plate or evacuated-tube – which are already used widely in many countries – and concentrating devices.

A typical flat-plate collector is made up of an insulated metal box with a glass or plastic cover referred to as “glazed” and a dark-coloured absorber plate. The heat produced in the collector is then used to heat a liquid as it flows through the copper tubes in the absorber plate. Most systems in Asian countries, the Middle East and Europe are equipped with flat plate collectors.

Evacuated-tube collectors consist of transparent glass tubes that absorb direct and indirect solar energy, converting it to heat. This type of collector is predominant in China.

Concentrating collectors are usually parabolic troughs which use mirrored surfaces to concentrate the sun’s energy on an absorber called a receiver. The mirrored surface focuses sunlight collected over a large area onto a smaller absorber area to achieve high temperatures.

The cost of a solar water heating system varies greatly. A residential application can cost as low as \$66 in China and as high as \$4,500 in Austria or \$6,600 in Hawaii, before federal and local tax credits. The cost in any location can depend on a number of factors such as installed surface area and type of system, the number of people in the household, brand, type of roof where the collector is mounted, its orientation as well as building code requirements.

## CORPORATE ACTIVITY

In 2008, Himin Solar secured nearly \$100m investment from Goldman Sachs and CDH Investments, a Chinese private equity fund, to help drive the company’s expansion in both domestic and international markets. Himin is estimated to sell two million square metres of solar water heaters annually, a figure that equals the total amount produced in the European Union or twice that of North America.



# 08 ACQUISITION ACTIVITY

- Total expenditure on acquisitions in renewable energy fell 12% to \$58 billion in 2010, while the number of deals was 459, some 34 fewer than in 2009.
- Activity was down across most regions and technologies, with the notable exceptions of Central & South America, up 79% to \$6.1 billion, and biofuels, up 17% to \$7 billion. Both increases reflected the gathering pace of consolidation in the Brazilian ethanol industry.
- Solar experienced vertical integration globally, as companies sought to protect themselves from overcapacity in cell and module manufacturing, but overall acquisition activity in solar was down 15% at \$14 billion in 2010.
- Renewable energy attracted new types of investors, as utilities sold stakes in completed wind farms to financial players such as pension funds, while industrial companies snapped up developers in PV and solar thermal electricity generation.

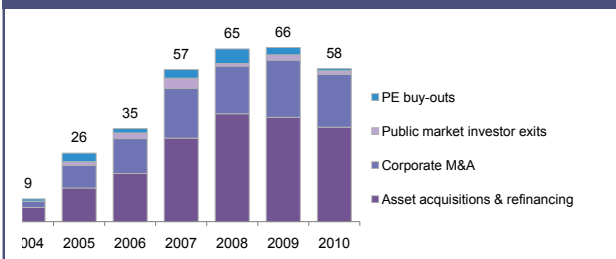
Acquisition volumes in renewable energies – including corporate mergers, refinancing and project acquisitions – shrank during 2010 by 12% to \$58 billion (see Figure 51). Renewable energy acquisition activity suffered from risk aversion among investors, greater difficulty in debt financing – especially at the height of the sovereign debt crisis – and regulatory blows such as the retroactive cuts to Spanish solar feed-in-tariffs.

Expenditure fell fairly equally among the main types of acquisition transaction: corporate M&A slipped 7% to \$20 billion, and asset acquisitions and refinancing dropped 9% to \$36 billion. Volumes fell sharply in the two biggest sectors: solar slid 15% to \$14 billion, while wind shed 16% to \$31 billion (see Figures 52 and 53). However there were increases in acquisition activity, albeit from more modest bases, for biomass and waste-to-energy, biofuels and marine. Regionally, there was also sharp variation, with Europe falling 31% to \$21 billion, and the US rising 11% to \$23 billion (see Figure 54).

In acquisition activity, the first quarter is usually the quietest of the year, but in renewables in 2010, it proved to be the highpoint (see Figure 55). Volumes slumped from \$18.8 billion in Q1 to \$12.3 billion in Q2 as the sovereign debt crisis, and rumours of impending retrospective tariff cuts in Spain, took their toll. This undermined confidence among potential corporate bidders, and, for asset acquisition, meant that debt financing continued to be a challenge to obtain. Confidence recovered somewhat as the year wore on, with volumes firming to \$12.7 billion in Q3 and \$13.8 billion in the final quarter.

The most striking feature of the year was the consolidation of the highly fractured Brazilian biofuels sector, reflecting a combination of interest from large corporate players and difficulties in securing finance on the part of small project owners and developers. Activity started to pick up in late 2009, when the French commodities dealer Louis Dreyfus bought the sugar and ethanol producer Santelisa Vale for \$722 million,

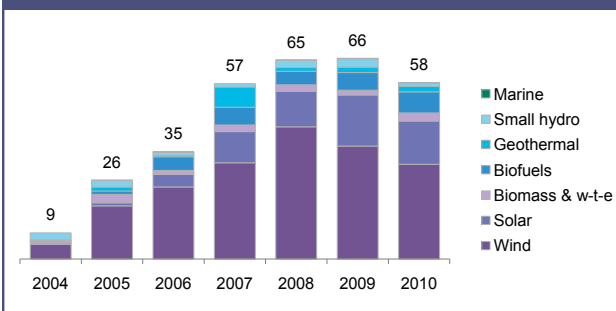
FIGURE 51: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY TYPE, 2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

FIGURE 52: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR 2010, AND GROWTH ON 2009, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

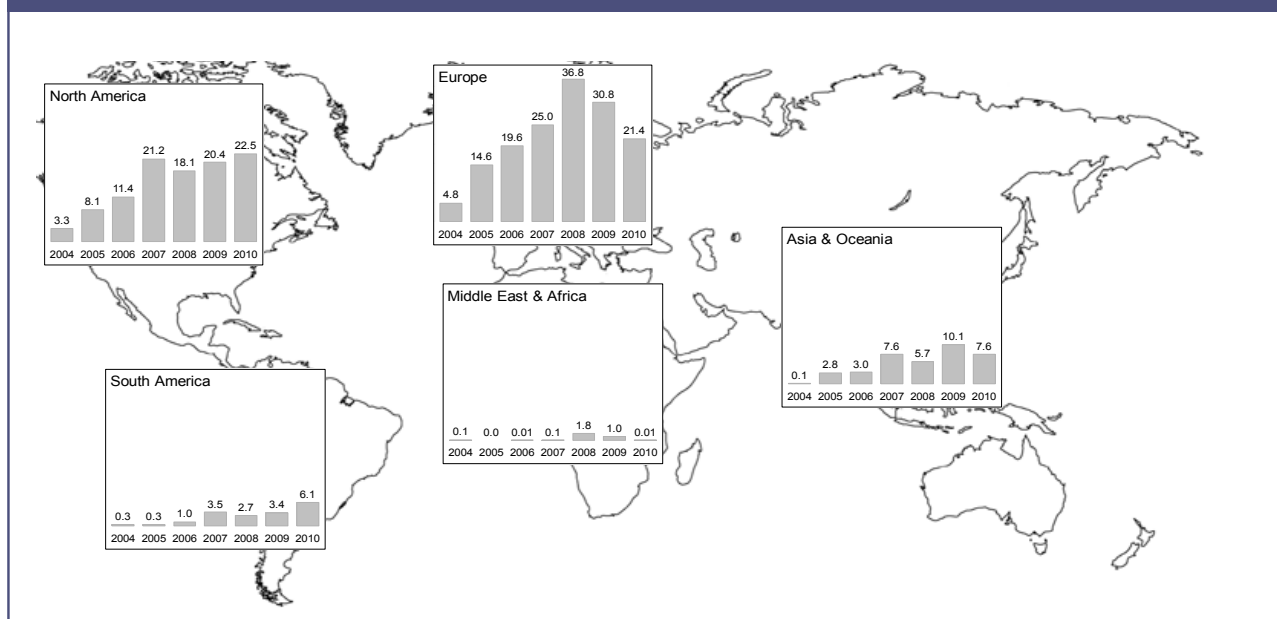
FIGURE 53: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY TECHNOLOGY, 2010, AND GROWTH ON 2009, \$BN

Technology	2010 (\$BN)	Growth (%)
Wind	31	-16%
Solar	14	-15%
Biofuels	7	20%
Biomass & w-t-e	3	69%
Geothermal	2	1%
Small hydro	1	-65%
Marine	0.2	6%

Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

FIGURE 54: ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY REGION, 2004-2010, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

but gathered pace in 2010 with a series of even larger deals. In January, Shell and Cosan signed an agreement to create a joint venture with assets of at least \$12 billion not only to produce sugar, ethanol and power, but also to make, distribute and retail transport fuels. In February, Bunge, the US agribusiness, bought Grupo Moema for \$896 million, and ETH Bioenergia bought the Brazilian Renewable Energy Company, or Brenco, for an undisclosed amount to create one of the world's biggest ethanol producers, with production capacity of three billion litres. A month later Shree Renuka Sugars of India snapped up Equipav, an ethanol and power producer, for \$1.2 billion in debt and equity. The deal-making paused during Q3, as sugar prices and the value of the Brazilian Real both rose, but there is likely to be more to come.

These deals signal that the industry is not only consolidating horizontally, but also beginning to integrate vertically, and also mean that three of the five biggest ethanol producers are now foreign owned. There are 220 players in the Brazilian ethanol market, but so far only 10 have capacity greater than 10 million tonnes.

The solar industry saw significant vertical integration in 2010, as overcapacity prompted cell and module manufacturers to move downstream, buying project developers to capture higher margins and secure a development pipeline. In the biggest such deal, Sharp, which plans to raise its current capacity of 320MW-a-year to 1GW this year, bought Recurrent Energy, a US-based project developer with 500MW of projects under way in the US and Europe, for \$305 million; America's SunPower Corporation snapped up SunRay Renewable Energy, a Malta-based project developer, for \$277 million; and LDK Solar, a Chinese maker of

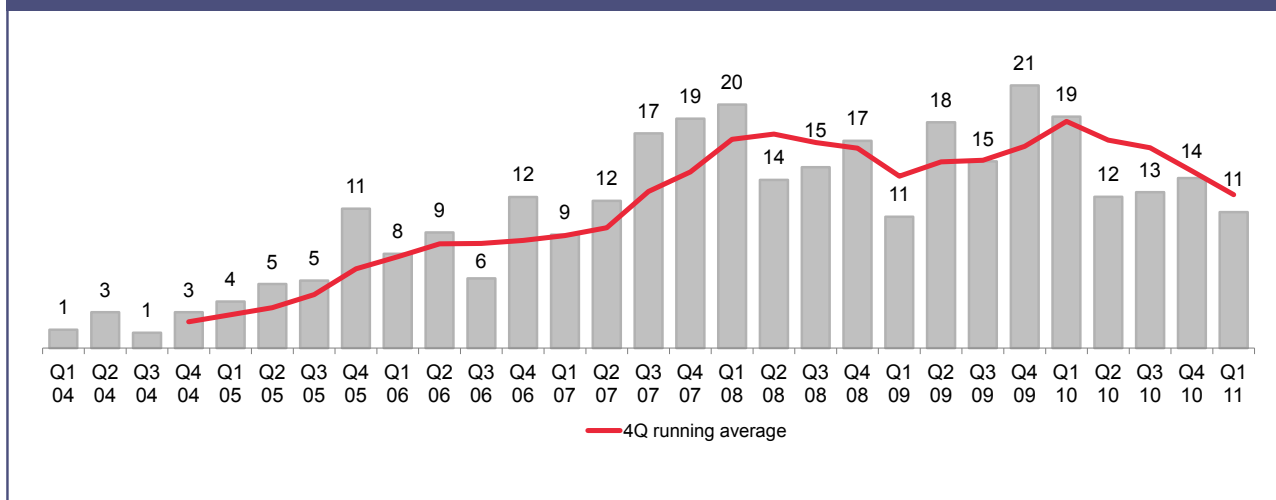
solar panels, bought 70% of California-based project developer Solar Power, for \$33 million. In a consolidation move, US solar encapsulant maker Solutia completed a \$294 million acquisition of German rival Etimex in June 2010.

Although overcapacity left manufacturers weaker, the consensus among analysts is for good growth over the next two to five years, and this combination lured some large corporations into the sector, many of them Asian. Hanwha Chem Corp of South Korea bought Solarfun Power, a Chinese holding company with PV manufacturing assets, for \$389 million; camera-to-photocopier giant Canon bought a 34% stake in Tokki Corporation, a Japanese maker of manufacturing equipment for thin-film PV modules, for \$63 million; fellow Japanese optical company Konica Minolta invested \$20 million for an undisclosed stake in US-based Konarka Technologies, to develop and distribute thin-film PV panels; and Nippon Oil Corporation bought a 14% stake in Space Energy Corporation, a PV wafer manufacturer, for an undisclosed amount. GDF Suez, EDF and Honeywell also bought further into the sector.

There were asset acquisitions in PV, with SunEdison selling the Rovigo PV project in Italy to a joint venture led by First Reserve for \$382 million in October 2010; and two funds managed by German issuing house Voigt & Collegen paying \$161 million for a 20MW PV park in Extremadura, Spain from developer Assyce.

In solar thermal electricity generation, Siemens bought Solel Solar Systems of Israel for \$418 million back in October 2009, and also a further stake in Italian receiver developer Archimede in May 2010; while Areva acquired linear Fresnel technology developer Ausra in February 2010.

FIGURE 55: GLOBAL ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY: QUARTERLY TREND, Q1 2004-Q1 2011, \$BN



Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance

Bloomberg New Energy Finance believes there is more consolidation and integration to come in solar, as competition intensifies both upstream and downstream. In Europe, as tariffs are reduced and margins shrink, project development is likely to become dominated by a few big, utility-scale players, along with many smaller companies developing projects for 'aggregators' who sell the projects on to larger investors.

Wind remained the biggest sector, with total transactions of \$31 billion, but as usual business was dominated by asset acquisitions and refinancing, which this year came to \$23 billion. Among the biggest asset acquisitions, Exelon of the US bought Deere & Co's 735MW wind portfolio for \$860 million, the El Andevalo wind portfolio in Spain went under the hammer to Iberdrola Renovables for \$445 million and Texas Gulf Wind Farm phase one sold to MetLife for an estimated \$378 million. In refinancings, the largest in a bumper crop saw some \$747 million worth of the investment cost of the 1GW London Array offshore wind project refinanced in two separate deals, as was \$377 million worth of the Green Frontier Wind Portfolio in the US. One interesting development was a slew of deals in which utilities divested stakes in completed wind farms to pension funds and other financial investors, transactions from which both sides benefit: the utility can recycle capital into new projects, while financial investors can buy an income stream while avoiding permitting and construction risk.

An example came in September 2010, when PensionDanmark bought a 50% stake in the Nysted offshore wind farm from Dong Energy for \$120 million. This followed Centrica's sale of a 50% stake in its Boreas wind portfolio, consisting of one onshore and two offshore farms, to a US-based infrastructure fund, for \$137 million in October 2009. In December 2010, Dong Energy sold a near-25% stake in Walney offshore wind project to PGGM, a Dutch pension fund, and the

Ampere Equity Fund managed by Triodos Bank, for \$21 million.

Wind saw corporate M&A deals worth \$7.5 billion, and while consolidation and integration proceeded far more slowly than in Brazilian biofuels and solar, there were some significant transactions. United Technologies, makers of the Pratt & Whitney jet engine, bought distressed turbine manufacturer Clipper Windpower for \$268 million; American Superconductor, which licenses turbine designs, acquired Blade Dynamics, a British rotor developer, for \$8 million; and Mitsubishi Heavy Industries bought Scotland-based Artemis Intelligent Power, the developers of an efficient hydraulic transmission system that could replace failure-prone gearboxes.

In the exciting but immature sector of marine power, 2010 saw an acceleration in activity by big industrial players, arguably marking a turning point in its evolution. ABB, the power-grid supplier, bought a stake in wave technology developer Aquamarine Power as part of a \$17 million financing round. Andritz, the maker of hydroelectric turbines, bought a 33.3% stake in Norwegian tidal turbine maker Hammerfest Strom. German engineering giant Siemens bought a shareholding of just under 10% in UK tidal technology specialist Marine Current Turbines.

As Figure 55 shows, 2011 started relatively quietly for acquisition activity in renewable energy, with the total of \$11 billion the lowest for any quarter for two years. The lull is unlikely to last however, given the fierce competition prevailing in most parts of the renewable energy sector, the large number of competing companies, and the interest from large industrial and utility groups. The fact that clean energy share prices remain at less than half their peak levels of late 2007 means, at least, that conditions are more in favour of the buyer than was the case back then.

# 09 INVESTMENT FUNDS

- The disclosed value of all investment funds investing in clean energy fell 3% to \$125 billion during the 12 months to the end of March 2011, largely due to a decline in the value of public equities.
- Partly as a result of this decline in value since the onset of the financial crisis, there was little appetite among investors for new public equity funds specialising in the sector. In 2010, there were just three new funds launched, compared with 45 in 2007 and 20 in 2008.
- Governments, multilateral financial groups and private sector institutions continued to support funds investing in renewable power projects.

With the world still reeling from the effects of the credit crunch, the prevailing macro-economic conditions in 2010 did not much favour the creation of new funds, nor did they make the task facing managers of existing funds any easier. Private equity fundraising remained difficult, public equity share prices underperformed relative to the wider stock market, and key countries cut feed-in-tariffs. In addition, private investor enthusiasm for clean energy ebbed somewhat after the “Climategate” controversy in early 2010.

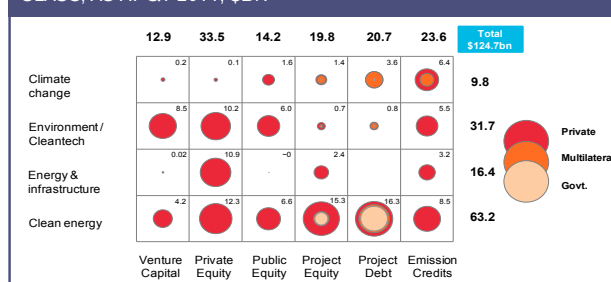
Nevertheless, the macro-economic situation was still better than the previous year and the arguments for investing in clean energy remained solidly in place, even if there was something of a push-back against the sector for the reasons above. 2010 was a difficult year for clean energy stocks. The WilderHill New Energy Global Innovation Index, or NEX, which tracks the performance of 100 clean energy stocks worldwide, sank by 14.6% over the course of 2010, under-performing wider stock market indices by well over 20%.

Some of these losses were reversed in the early part of 2011 as investors watched oil climb to more than \$120 per barrel, and as they speculated that the crisis at the Fukushima reactors in Japan would open the door for governments to increase their backing of renewable power alternatives. In the first three months of the year, the NEX rose 11%, beating the US S&P 500's 5.4% gain.

As of the end of March 2011, there was \$63.2 billion of private and public money under management in core clean energy funds (those that invest more than 50% of their money in clean energy or energy efficiency companies and projects - see Figure 56). This was a decrease of 10% from the previous year.

Environmental funds – those with a significant, but less than 50%, exposure to clean energy and energy efficiency – had \$31.7 billion under management by the end of March 2011, an increase of 4% on March 2010. Meanwhile, climate change funds, for which clean energy is a smaller but still important portion of

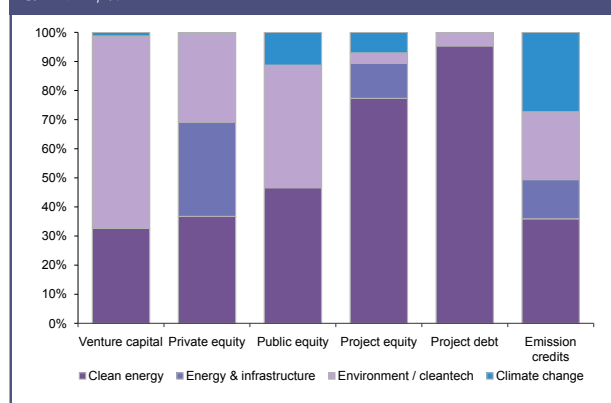
FIGURE 56: SUSTAINABLE ENERGY FUNDS BY FOCUS AND ASSET CLASS, AS AT Q1 2011, \$BN



Excludes SRI funds; Data as of 31 March; includes only funds with disclosed values

Source: Bloomberg New Energy Finance

FIGURE 57: SUSTAINABLE ENERGY FUNDS BY ASSET CLASS, AS AT Q1 2011, %



Excludes SRI funds

Source: Bloomberg New Energy Finance

the total portfolio, had \$9.8 billion in their coffers, a fall of 25% on the previous year.

Finally, a further \$16.4 billion was held in energy and infrastructure funds (those that have stipulated that they have at least 10% marked for renewable energy infrastructure investment). This was marginally higher year-on-year.

Figure 57 shows the volume of assets under management in each of these four different classes of funds. It also shows the distribution according to the type of investments made, as does Figure 58. From this

it is clear that funds making venture type investments, private equity vehicles and funds that buy and sell quoted equities are less likely than project funds to be focused narrowly on clean energy, and are likely to have a broader remit.

Overall, during the 12 months to the end of March 2011, there was a 3% decline in the disclosed value of all funds investing in clean energy, to \$125 billion. The main reason for this was the sharp slump in the value of public equities. At the end of March this year, funds investing in this asset class were valued at \$14.2 billion, compared with \$23.3 billion the previous year.

There still appears to be little appetite among investors for new public equity funds in clean energy. In 2010, there were just three new funds launched, compared with 45 back in the record year of 2007 and 20 in 2008 (see Figure 59).

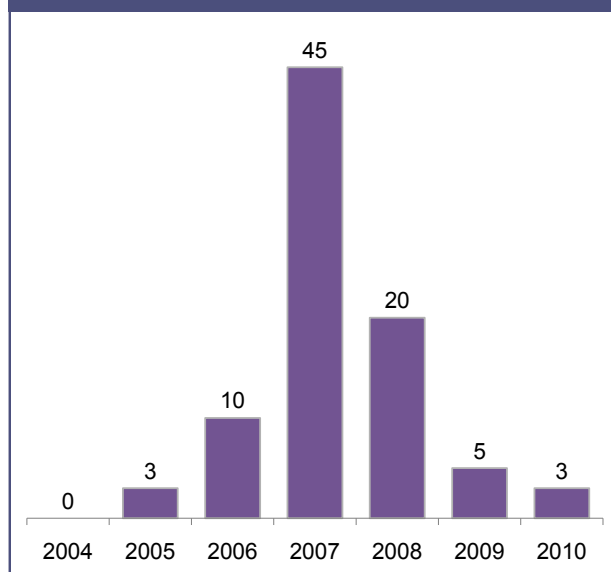
Given the recent performance of many such funds, the lack of new arrivals is not surprising. The worst performer last year was Guggenheim Solar ETF, an exchange-traded fund that tracks the MAC Global Solar Energy Index. It fell by 23.6% in 2010. However, on a volatility-adjusted basis, iShares S&P Clean Energy, the ETF that tracks the S&P Clean Energy index, was worse off.

Invesco's PowerShares Cleantech fund recorded the best performance in the same period. The exchange-traded fund, with a market value of \$152 million, posted a euro return of 15.3% in 2010. It beat Winslow Green Growth Fund's 15.2% gain and the 12.9% return by DnB Nor's Miljoinvest fund, which placed second in 2009 and first in 2007. However, DnB was the best-performing pure-play fund (one specialising narrowly in clean energy).

The number of public equity funds in the space is still relatively small. At the start of 2011, there were 35 funds investing in clean energy equities that had a minimum of EUR 100 million (\$142 million) in assets under management and at least 10% exposure to clean energy. Among these, there was considerable disparity between the performance of the pure-play clean energy funds and those with a broader investment mandate. At the end of 2010, the average trailing 12-month return of the 16 clean energy funds was minus 7.8%, while the rest managed an average positive return of 6.7%.

Despite the generally dismal performance, there were some fundraising success stories. In November, for instance, the California Public Employees' Retirement System (CalPERS), one of the world's largest pension funds, invested \$500 million in a new clean energy fund tracking a climate change investment index. This is the first time the pension fund has brought part of its green investment strategy in-house.

FIGURE 58: SUSTAINABLE ENERGY PUBLIC EQUITY FUNDS LAUNCHED, 2004-2010, UNITS



Source: Bloomberg New Energy Finance

The fund will be pegged to HSBC's Global Climate Change Benchmark Index, which includes companies that generate a portion of their revenues from solar, wind, cleantech and other renewable resources. CalPERS has so far committed more than \$1.5 billion to early-stage green investments.

In October, Impax Asian Environmental Markets, a UK trust, raised \$206 million, almost doubling in size. Most of the cash came from UK-based investors, including pension funds, insurance companies, private banks and other fund managers.

In contrast to the decline in the value of public equity funds, there was little change in the number of funds investing in clean energy compared to the previous year, or in their distribution among asset classes. The value of venture capital and private equity funds was slightly higher at \$12.9 billion and \$33.5 billion, respectively, and the pool of money in both project equity and project debt funds was also marginally greater at \$19.8 billion and \$20.7 billion. The value of emissions credit funds remained at \$23.5 billion.

Project debt and project equity funds are the two largest groups within the 'clean energy' category. Much of the money has come from substantial contributions by government and multilateral investors in the shape of initiatives such as the Marguerite Fund, set up as part of the European Economic Recovery Plan.

The Luxembourg-based fund, which seeks to bring together public and private resources, closed its first round in March 2010 after receiving more than \$900 million from government-backed financial institutions. In November 2010, it started a second round of fundraising aimed at securing \$1.1 billion, mainly from



pension funds, insurers and private investors. About a third of the money will be invested in transport projects across Europe, with the same going to energy projects that involve several European countries, and one third to renewable energy. In the latter case, the focus will be on onshore wind and solar.

The private sector has also been active in backing project and infrastructure funds. One of the few to have been launched in 2010 and early 2011 - a \$100 million fund managed by US-based New Energy Capital Partners and Piper Jaffray - will offer investors access to clean energy infrastructure.

Others also managed to raise funds. In September 2010, DIF, a Dutch investment company, closed its second infrastructure fund at \$727 million, well ahead of target. It plans to put about one third of the money into renewable energy projects. At around the same time, BNP Paribas Clean Energy Partners closed its Clean Energy Fund at \$579 million, ahead of its target of \$529 million, and Impax Asset Management raised \$168 million in a pre-final close for its second clean energy fund (Impax New Energy Investors II LP), which will invest primarily in solar and wind projects and had by May 2011 raised nearly \$400 million.

Over the next 12 months, fund managers, and those focused on European renewable power projects in particular, will have to weather more policy uncertainty and further cuts in renewable power subsidies. This will expose investors to financial risk and could deter some -

such as happened to the Matrix Group, which scrapped the launch of two UK-based tax-efficient vehicles in January 2011. The company planned to raise about \$20 million for each trust, and had already received reservations totalling about \$16 million when it called a halt to the schemes, saying the UK government review of solar tariffs had increased the risk.

Other fund managers may branch out into new markets. BNP Paribas, for instance, said that it aims to deploy some 20% of its Clean Energy Partners fund into biomass power projects following a decision by the UK government to improve support for the industry.

Venture capital investors are less sensitive - in the short term - to the subsidy adjustments and market movements that have recently unsettled project financiers, private equity funds and public equity investors. The former nurture young, often pre-commercial niche players, some of which may eventually deliver rewards; while the latter look to mainstream clean energy assets or equities to provide ongoing returns and are thus more alive to potential disruptions. Venture capitalists however still need to raise money from limited partners and still need exit routes, either via the public markets or trade sale. Both these tasks were difficult in 2010, money raising because of lingering investor caution following the 2008 financial crisis, and finding exits because of stock markets' scepticism towards initial public offerings.



# 10 FOCUS: RENEWABLES AS FIRST CHOICE FOR DEVELOPING ECONOMY APPLICATIONS

- Almost 1.5 billion people in the world do not have access to electricity. The unmet energy needs of these people - many at the bottom of the pyramid - are increasingly being met by off-grid power from renewable sources.
- In many instances, renewable power is the first choice, since it is most cost-competitive. In some instances, renewable power provides the only option for energy, especially in regions that are off the grid map.
- Such off-grid mini-plants are being used for irrigation, water desalination, or just to provide basic lighting. In some regions, they are being used to replace diesel-fired plants simply because they are more cost-competitive, and easier to maintain.
- The commercial opportunity in providing such affordable clean energy could run into hundreds of billions of dollars.

Among the many trends underlying the robust investment numbers for renewable energy investment, there is one that is still modest in dollar terms but is becoming hugely significant for the future. That is the innovative use of clean energy to meet specific local requirements in emerging economies.

This trend fits closely with the energy access agenda being pursued by the United Nations. In last year's report by the Secretary-General's Advisory Group, one of the recommendations was for low-income countries to expand access to modern energy services "to meet the needs of the several billion people who experience severe energy poverty in terms of inadequate and unreliable access to energy services and reliance on traditional biomass. They need to do so in a way that is economically viable, sustainable, affordable and efficient, and that releases the least amount of greenhouse gases."

The report suggested that middle-income countries "need to tackle energy system development in a way that enables them progressively to decouple growth from energy consumption through improved energy efficiency and reduce energy-related GHG emissions through gradually shifting toward the deployment of low-greenhouse gas emission technologies".

In an increasing number of cases, renewable energy is not just one of the easiest non-grid-connected options to establish, but also more cost-effective than the fossil fuel alternatives. This trend has led to speculation that developing economies may be able to "leapfrog" developed countries in their use of renewable energy over the coming decade.

According to the REN21 Global Status Report for 2011 (see box at end of chapter), about to be published, solar-powered lamps can give off 100 times more light than kerosene lamps or candles, and some 30,000 solar-home systems are being sold in Bangladesh every month. The report also cites figures for biogas cookers, with an estimated 40 million installed in China by 2011, four million in India and 100,000 in Vietnam. Some 8,000 solar powered pumps in India are being used for irrigation.

Although the needs are significant, in one niche market after another entrepreneurs are finding that under-served populations are willing to pay for new forms of energy supply, often since traditional energy options such as candles or kerosene are so expensive on a day-to-day basis.

But these new energy markets often require a heavy dose of innovation to be accessed, including new business models, financing approaches, value chains all the way up to the customer's door. This is a new world of opportunity for the renewable energy industry and first movers are already making progress in discovering new market niches that could experience explosive growth in coming years.

Most of the headlines in the developing world are about large-scale renewable energy projects like wind, geothermal and grid-connected solar -- but many other business opportunities exist under the radar, and that is the topic of this focus chapter.

In this chapter, we highlight five technologies that have attracted the interest of investors in the recent past and are likely to be in the mainstream in the near future. The companies cited range from small, privately-owned concerns to quoted companies.

## CASE 1. POWERING THROUGH HUSKS

Waste rice husks are emerging as a source of power for some of the poorest regions in South Asia, South East Asia and Africa. The husks would ordinarily have negative value, since their disposal would require the spending of money by the farmer.

Instead, the husks are being fed into biomass gasifiers to generate power for local communities or rural businesses. Supporters argue that use of the gasifiers leads to a reduction in energy costs - as the husk power typically replaces more expensive diesel-power - and a substantial reduction in carbon dioxide emissions. These gasifiers can also ingest other fuels like gram husk or sawdust. It is claimed to be one of the cheapest systems to set up, though concerns have been raised about the high residue ash and the water intensity of some of these plants. An Indian company has managed to convert the leftover "char" to incense sticks, substantially adding to overall margins.

One challenge for the technology in the future may be to establish a sustainable equilibrium in its feedstock use. Too much investment in power capacity could raise the costs of feedstock too high for the viability of the plants, or else result in too much biomass being taken from the rice fields for the good of the future crop. However, in general waste biomass represents a fertile opportunity for power generation in rural parts of the developing world.

### EXAMPLE 1

#### Husk Power Systems - India

**Business model:** Uses discarded rice husks and similar feedstock to fire mini-power plants of 25-60kW set up at remote locations not connected to the grid. The biomass gasification systems used are built by a local company.

**Key investors:** IFC, Draper Fisher Jurvetson, Acumen Fund, Cisco, Shell Foundation, LGT Philanthropy, Bamboo Finance

**First installation:** August 2007

**Total installations:** 75

### EXAMPLE 2

#### SME Renewable Energy - Cambodia

**Business model:** Sells multi-fuel biomass gasifiers in Cambodia and neighbouring countries. Main clients are some of the country's 300 rice mills which can use the husks to generate power in place of diesel generation. Targeted benefit is a 65% reduction in diesel consumption with a two-year payback.

**Key investors:** E+Co (\$2.2 million loan)

**First installation:** August 2006

**Total installations:** 38

### EXAMPLE 3

#### Greenko Group - India

**Business model:** Develops and acquires biomass, small-hydro and wind projects with a targeted portfolio of 1GW by 2015. It has six operational biomass plants which use rice husk, black gram husk, saw dust, groundnut shell and bagasse. It is listed on London Stock Exchange's Alternative Investment Market, with a market capitalization of GBP 263 million in June 2011.

**Key investors:** Global Environment Fund, Aloe Private Equity

**First installation:** 2006

**Total biomass installations:** 6

## CASE 2: INSTITUTIONAL COOKING WITH SOLAR

When a meal for thousands or tens of thousands has to be prepared, solar steam cooking is emerging as a solution of choice, with a fairly sharp pick up seen in the last 12-18 months. Solar cooking is increasingly finding its way into corporate staff canteens, school canteens and into star-hotels in smaller cities, where space is not a constraint.

The world's largest solar cooking system - which churns out 50,000 meals a day - is installed at the temple of Shirdi in India's Maharashtra state. The systems are also being deployed in some countries in Africa. The payback time is estimated to be about three years. Once the bulk cooking application of solar is tested, clients try the solar air conditioning and water heating solutions. The next trend is likely to be "holistic solarisation".

As with other solar thermal systems, one hurdle in the way of wide application could be energy density. A much larger area is likely to be needed for the equipment to collect sunlight to produce steam than would be needed for the plant to turn oil, coal or gas into steam. However, for well-financed companies located away from city centres, solar cooking could become an inviting option.

### EXAMPLE 1

#### **Gadhia Solar Energy Systems - India**

**Business model:** Offers solar steam cooking for large-scale requirements. Such solar thermal systems are installed and running in the corporate kitchens of companies like IBM, Reliance Industries and Tata Consultancy Services. There are no benchmark costs as these are all customised systems.

**Key investors:** High net worth individuals

**Total installations:** 100+

**First installation:** 1997

## CASE 3: POWERING TELECOM TOWERS

The ubiquitous telecom towers that have been critical in increasing the number of mobile telephone connections in the world to over five billion are essentially diesel-guzzlers. In India, which has some 350,000 towers installed, they are the second largest consumers of diesel after the Indian Railways, which uses about 2.5 billion litres every year, involving a spend of almost \$2 billion.

While plans are afoot to make diesel substitution through renewable energy mandatory for telecom towers in India, some countries in Africa are already deploying diesel-renewable hybrids to power the towers. The payback time is anywhere from three to four years, depending on the price of oil, and of diesel.

The constraints to growth for this technology could include upfront capital cost, the complexity of switching plant from renewable power to diesel, and back again, and issues over site area and security.

### EXAMPLE 1

#### **Winafrique Technologies - Kenya**

**Business model:** To recommend and deploy energy-saving products, especially for telecommunication towers. It functions as an end-to-end system integrator, installing diesel-solar and diesel-wind hybrids at telecom sites within the country. A couple of units have also been set up in Angola.

**Key investors:** Self-funded. It is now seeking partners for expansion.

**First installation:** 2002

**Total installations:** 190

### EXAMPLE 2

#### **Applied Solar Technologies - India**

**Business model:** To provide off-grid solar power to telecom towers to displace diesel generation by 50%-100%. It manages the tower site, juggling solar power, battery back-up and diesel generator to minimise the usage of diesel.

**Key investors:** IFC, Bessemer Venture Partners

**First installation:** n/a

**Total installations:** n/a

## CASE 4: WASTE-TO-ENERGY

The economic case for burning waste to generate energy becomes stronger as the size of waste mountains expands and presents an environmental and management challenge. The combustion process reduces municipal solid waste volumes by as much as 90%. With increasing urbanisation in emerging countries, the demand for such plants and the investments that flow with them, can only magnify.

The residue ash can be disposed of in a conventional landfill. The challenge is to ensure that the ash is non-hazardous, something that is addressed in many countries through appropriate legislation. The sheer size of its population ensures that China generates the highest amount of municipal solid waste every year - about 150 million tonnes - and this is increasing at the rate of 10% every year. The waste generated by India is over 50 million tonnes annually.

The issues for waste-to-energy in emerging economies are often very similar to those facing it in Europe or North America. Local populations are sensitive to the construction of incineration plants close to them, and for the developer, there is a risk exposure if a steady waste feedstock at a predictable price cannot be guaranteed. One way to spur investment is for governments to regulate landfills more rigorously, even to the point of charging for landfill use, in order to generate a negative value for waste. This kind of measure cannot be enforced easily however in countries with weak governance, and in those places, waste burning could be open to abuse.

### EXAMPLE 1

#### **China Everbright International - China**

**Business model:** Builds and operates waste-to-energy projects for concession periods of 25 years to 30 years. The company also develops renewable energy projects.

**Key investors:** Asian Development Bank

**First installation:** July 2006

**Total installations:** 4

### EXAMPLE 2

#### **Cassava Waste To Energy Company - Thailand**

**Business model:** Treating wastewater from cassava processing plants of Asia Modified Starch Company (AMSCO) through an anaerobic reactor. The recovered gas will be channeled back to AMSCO for generation of heat and electricity.

**Key investors:** Toyota Tsusho Corporation, Tokyo Electric Power Company

**Status:** Registered for CDM

**First installation:** 2009

**Total installations:** 1

## CASE 5: PROCESSING FOODS WITH SOLAR POWER

Farmlands in developing countries are increasingly turning to the sun to process the fruits grown on the land. From Guatemala to Uganda in East Africa, solar energy is replacing fossil fuels for dehydration of fresh produce which is then packaged and exported to distant markets. In the case of Alimentos Campestres, the high cost of propane represented more than 35% of operational expenses, until it started to use solar energy. The upside: there are no transmission networks or transmission leakages to contend with. Another indirect benefit is the added value of the product: in the case of Alimentos Campestres, the dehydrated fruit snacks sell as an “eco-friendly” product.

Specific applications include solar fish-drying systems, currently planned in the Indian state of Kerala and in Oman. The barriers facing Twenty-First Century solar thermal technologies include reaching a price point that would be affordable to small-scale farmers in poor countries, and space limitations.



#### **EXAMPLE 1**

##### **Alimentos Campestres - Guatemala**

**Business model:** Uses a solar thermal dehydration facility to dry fruits which are then sold to local supermarkets and exported to the US and Mexico. Solar dehydration replaces propane dryers. The company's sales were \$1.3 million in 2010.

**Key investors:** E+Co (\$125,000 loan)

**First installation:** 2007

**Total installations:** 1

#### **EXAMPLE 2**

##### **Masaka Organic Producers - Uganda**

**Business model:** Uses solar powered drying systems to dry fruits, vegetables and other products of the Masaka region with 96% of sales to export markets.

**Key investors:** E+Co

**First installation:** 2008

**Total installations:** 1

# GLOSSARY\*

<b>Asset finance</b>	All money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance. This excludes re-financings. The asset finance numbers represent investment raised in each year – i.e. equity that is committed, or debt that is provided (sometimes in tranches). The plant or project may not be commissioned in the same year.
<b>Capital expenditure – CAPEX</b>	Funds used by a company to acquire or upgrade physical assets such as property, industrial buildings or equipment. Some investment will translate into capacity in the following year.
<b>Convertible bond</b>	A bond that can be exchanged for a fixed number of shares in the issuing company
<b>Distributed generation</b>	Generation of power from small-scale technologies close to where it is used
<b>Feed-in tariff</b>	A premium rate paid for electricity fed back into the electricity grid from a designated renewable electricity generation source
<b>Green stimulus</b>	The share of government economic recovery packages allocated to “green” initiatives such as renewable energy, energy efficiency, smart power grid, transport, and other clean energy technologies.
<b>Initial public offering (IPO)</b>	A company’s first offering of stock or shares for purchase via an exchange. Also referred to as “flotation”.
<b>Investment Tax Credit</b>	Allows investment in renewable energy in the US to be deducted from income tax.
<b>Mergers &amp; acquisitions (M&amp;A)</b>	The value of existing equity purchased by new corporate buyers in companies developing renewable technology or operating renewable energy projects.
<b>Non-recourse project finance</b>	Debt and equity provided directly to projects rather than to the company developing them. The lender is only entitled to repayment from the profits of the project and has no access to the borrower’s other assets in the event of default.
<b>Over-the-counter (OTC)</b>	Trading of stocks, bonds, commodities or derivatives directly between buyers and sellers as opposed to via a formal exchange.
<b>Private investment in public equity (PIPE)</b>	The purchase of securities directly from a publicly traded company by private investors.
<b>Production Tax Credit (PTC)</b>	The support instrument for wind energy projects at federal level in the US.
<b>Public markets</b>	All money invested in the equity of publicly quoted companies developing renewable energy technology and clean power generation. Investment in companies setting up generating capacity is included in the asset financing figure.
<b>Renewable Portfolio Standard (RPS)</b>	A regulation that requires that a minimum of electricity or heat sold is from renewable energy sources. Also called Renewable Electricity Standard (RES) at the United States federal level and Renewables Obligation in the UK.
<b>Tax equity</b>	Tax equity investors invest in renewable energy projects in exchange for federal tax credits.
<b>Venture capital and private equity (VC/PE):</b>	All money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure.

\* Further definitions and explanations can be found in Private Financing of Renewable Energy – a Guide for Policymakers. S. Justice/K. Hamilton. Chatham House, UNEP Sustainable Energy Finance Initiative, and Bloomberg New Energy Finance, December 2009 and in the REN21 2011 Renewables Global Status Report

## NOTES

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## ABOUT UNEP

UNEP is working to create the policy and economic framework whereby sustainable energy can increasingly meet the global energy challenge. Changing attitudes and helping mainstream financiers to consider sustainable energy investments are key components of the energy work within UNEP and the starting point for the UNEP Sustainable Energy Finance Initiative.

SEFI provides current and targeted information to financiers and facilitates new economic tools that combine social and environmental factors – both risks and returns – as integral.

SEFI is being integrated into the mission and programme of the new Frankfurt School – the UNEP Centre for Climate & Sustainable Energy Finance at Frankfurt School of Finance & Management.

## FRANKFURT SCHOOL - THE UNEP COLLABORATING CENTRE FOR CLIMATE & SUSTAINABLE ENERGY FINANCE

Frankfurt School - the UNEP Collaborating Centre for Climate & Sustainable Energy Finance is a strategic cooperation between UNEP and Frankfurt School. The Centre is an integral part of the Frankfurt School and works to develop cost-effective ways to reduce carbon emissions from energy supply and use by mobilising finance for climate and sustainable energy investments and strengthening of their associated markets. This is achieved by working with financial institutions to develop technical know-how, innovative financing approaches and new forms of entrepreneurial and end-user finance. The Centre's approach combines project implementation on the ground with research, think tank activities as well as training and education programs.



**Frankfurt School**  
**UNEP Collaborating Centre**  
 for Climate & Sustainable Energy Finance

## ABOUT BLOOMBERG NEW ENERGY FINANCE

Bloomberg New Energy Finance is the world's leading independent provider of news, data, research and analysis to decision-makers in renewable energy, carbon markets, energy smart technologies, carbon capture and storage, and nuclear power. The group has staff of more than 160, based in London, Washington D.C., New York, Beijing, New Delhi, Hyderabad, Cape Town, São Paulo, Singapore, and Sydney.

Bloomberg New Energy Finance Insight Services provide deep market analysis to investors in wind, solar, bioenergy, geothermal, carbon capture and storage, energy efficiency, and nuclear power. The group offers Insight Services for each of the major emerging carbon markets: European, Global Kyoto, Australia, and the US, where it covers the planned regional markets as well as potential federal initiatives and the voluntary carbon market. Bloomberg New Energy Finance's Industry Intelligence Service provides access to the world's most comprehensive database of investors and investments in clean energy and carbon. The News and Briefing Service is the leading global news service focusing on clean energy investment. The group also undertakes applied research on behalf of clients and runs senior-level networking events.

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**Bloomberg**  
 NEW ENERGY FINANCE

Global investment in renewable energy jumped 32% in 2010, to a record \$211 billion. It was boosted in particular by wind farm development in China and small-scale solar PV installation on rooftops in Europe.

Of the major types of investment, there were sharp increases in asset finance of utility-scale projects such as wind farms, in venture capital provision for young firms, and in equity-raising on the public markets by quoted renewable energy companies. Asset finance rose 19% to \$128 billion in 2010, venture capital investment increased 59% to \$2.4 billion, and public market investment gained 23% to \$15.4 billion.

However the sharpest percentage gains were in investment in small-scale projects, up 91% year-on-year at \$60 billion, and in government-funded research and development, up 121% at \$5.3 billion, as more of the “green stimulus” funds promised after the financial crisis arrived in the sector.

One of the striking features of 2010 was that, in terms of financial new investment (asset finance and investment by venture capital, private equity and public markets), developing countries overtook developed economies for the first time.

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United Nations Environment Programme  
P.O. Box 30552 Nairobi, Kenya  
Tel: ++254-(0)20-762 1234  
Fax: ++254-(0)20-762 3927  
E-mail: [uneppub@unep.org](mailto:uneppub@unep.org)



**For more information, contact:**

Frankfurt School - the UNEP  
Collaborating Centre for Climate &  
Sustainable Energy Finance  
Frankfurt School of  
Finance & Management  
Sonnemannstrasse 9-11  
60314 Frankfurt/ Main  
Germany  
Tel: +49 69 154008-0  
E-mail: [unep@fs.de](mailto:unep@fs.de)  
[www.fs-unep-centre.org](http://www.fs-unep-centre.org)  
[www.unep.fr/energy/finance](http://www.unep.fr/energy/finance)

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