UNFCCC report on Investment in Renewable Energy and Energy Efficiency

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Methodology

All figures in this report, unless otherwise credited, are derived from the New Energy Finance Desktop - an on-line portal to the world's most comprehensive database of investors and transactions in clean energy.

The NEF Desktop collates all organisations, projects and investments according to transaction type, sector, geography and timing. It covers 15,000 organisations (including start-ups, corporate, venture capital and private equity providers, banks and other investors), 5,500 projects and 6,000 transactions.

Each transaction is assigned a deal value based on information provided by the participants. Where the deal value is not disclosed, NEF assigns an estimated value based on the average value of similar transactions. Deal values are rigorously back-checked when further information is released about the particular organisation and/or project.

Investment totals include all known transactions (both disclosed and estimated deal values), plus an allowance for unidentified transactions (for example, where the total investment into a specific sector within a country is known, but all the individual deals have not been identified). The investment totals are referred to as grossed-up values in the notes to each chart.

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

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About New Energy Finance

New Energy Finance is a specialist provider of analysis to the world's leading investors in renewable energy, biofuels, low-carbon technologies and the carbon markets. The company's research staff of 45 (based in London, Washington, New York, Beijing, Shanghai, New Delhi, Tel Aviv and Perth) tracks deal flow in venture capital, private equity, M&A, public markets and asset finance around the world.

New Energy Finance covers all sectors of clean energy: renewables (wind, solar, marine, geothermal, mini-hydro); biomass & biofuels; energy architecture (supply- and demand-side efficiency, smart distribution, power storage, carbon capture & sequestration); hydrogen & fuel cells; carbon markets and services.

Services include the New Energy Finance Briefing, New Energy Finance Desktop, Newswatch daily news service and Focus Reports on sectors and countries. New Energy Finance co-publishes the world's first global clean energy market index, the WilderHill New Energy Global Innovation Index (ticker symbol NEX). New Energy Finance's subscription-based Insight Services providing deep market analysis to investors in Wind, Solar, Biofuels, Biomass, China, VC/PE, Public Markets and the US. The company also undertakes bespoke research and consultancy, and runs senior-level networking events.

New Carbon Finance, a division of the company, provides analysis and price forecasting for the European, global and US carbon markets.

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Options / Tools / Mechanisms

This section analyses investment in renewable energy and energy efficiency. While these have very different investment patterns and require different policies to promote their adoption, they are inextricably linked. Using less energy has the potential to balance the supply-demand imbalance far more quickly and more cheaply than increasing renewable energy capacity.

The IEA has argued that energy efficiency needs to be viewed like other energy sources; it estimates that without the energy savings achieved between 1973 and 1998, energy consumption in OECD countries would have been almost 50% higher, making energy efficiency's contribution greater than that of oil and coal. The IEA also estimates that over 65% of the reduction in GHG emissions in developing countries over the next twenty years could be driven by continued improvements in energy efficiency (source: World Bank: Clean Energy Investment – Towards an Investment Framework, April 2006).

Under the IEA's emissions-cutting strategy, each dollar invested in energy efficiency yields generates more than $4 in savings, with a payback period of around four years (Source: IEA in Business Week, 29 January 2007).

5.1 Analysis of Funding Sources and Trends in 2005

5.1.1 Overview across funding spectrum

Overview of Funding Sources 2005 (US$ millions)

		Renewable Energy		**Energy Efficiency**		**Total**	*% of total*
	Source	OECD	Dev'ing	OECD	Dev'ing		
Total investment							
1 Debt							
Private sector	*NEF*	9,088.7	655.6	40.8	6.0	9,791.1	*33.4%*
Multilateral	*CRS*	-	385.9			**385.9**	*1.3%*
Total Debt		9,088.7	1,041.5	40.8	6.0	10,177.0	
2 Equity							
Total equity (private sector)	*NEF*	14,106.7	2,906.0	1,341.8	96.0	18,450.6	*63.0%*
3 Grants							
Multilateral (GEF)	*GEF*	-	41.5	-	29.5	**71.0**	*0.2%*
Bilateral	*CRS*	-	600.9			**600.9**	*2.1%*
Total Grants		-	642.3	-	29.5	671.8	
Total investment		**23,195.5**	**4,589.9**	**1,382.7**	**131.5**	**29,299.5**	
Private investment		23,195.5	3,561.6	1,382.7	102.0	28,241.7	*96.4%*
Multilateral / bilateral		-	1,028.3	-	29.5	1,057.8	*3.6%*

Notes: New Energy Finance assumptions on leverage (debt as % of whole): VC/PE - VC all equity, PE for companies 30% debt, OTC/PIPE 10% debt; Public Markets - 100% equity; Asset Finance - balance sheet finance and lease/vendor finance 100% equity // bond finance 100% debt // project finance based on New Energy Finance standard levels of leverage (wind 74%, solar 77%, mini-hydro 70%, geothermal 70%)

Private investment (as measured by New Energy Finance) is defined as investment made by financial institutions and corporates. It excludes public sector investment and R&D (whether funded by companies or governments)

Sources: As listed within table

Private investment is by far the largest source of investment for renewable energy and energy efficiency. In 2005, New Energy Finance recorded $28.2 billion of debt and equity funding flowing into these sectors, of which $26.8 billion was for renewable energy.

Multilateral and bilateral funding for renewable energy in 2005 amounted to $1.1 billion, less than 4% of overall investment flowing into the sector (NB energy efficiency is not split out by CRS, the source for these flows). It should be noted that the investment figures above do not include public sector funding (such as government funding for R&D or grants) or corporate R&D.

In 2005, private investment flowed into all of the major asset classes, namely Venture Capital & Private Equity (VC/PE), Public Markets and Asset Financing. Of the $26.8 billion invested in renewable energy, $2.9 billion was provided by VC/PE investors, $3.8 billion was raised via the public markets, and $20.1 billion was supplied through asset financings. Note, as companies become more mature (and therefore create sustainable revenues and earnings) investors can leverage their equity investment with debt. Asset financings typically involve 20-30% equity and 70-80% debt.

The range of investment activity reflects the different stages of development of each clean energy sector. For example wind is the most mature technology and therefore received the highest proportion of asset finance ($18.0 billion) as new wind projects were built and commissioned in both OECD and developing countries. Solar received a high proportion of public market investment ($2.2 billion) as solar companies raised capital to expand their manufacturing capacity. This was in response to an increased demand for silicon PV cells and modules, especially driven by the solar incentives in Germany.

A number of sectors received venture capital investment in 2005, including energy efficiency and solar. This investment was used to test and prove new commercial applications, and develop the next generation of renewable energy and energy efficiency technologies.

Private investment is – and is likely to remain - the main source of financing for renewable energy and energy efficiency. Consequently, RE has flourished in countries with developed financial markets and active private investors.

Supportive government policy is also a key driver of investment. Renewable energy deals continue to be policy-driven rather than purely commercial, although certain technologies (onshore wind, notably) are starting to compete with conventional generation in their own right. There is therefore a strong correlation between favourable policy and levels of investment in RE and EE. This is particularly true in developed countries, where deep financial markets. Germany, for example, has actively promoted PV installation with generous (and simple) feed-in tariffs and as a result attracted 49% of global solar investment in 2005 (source: New Energy Finance).

In less developed countries, however, financing for renewables and energy efficiency tends to come from domestic sources (public and private), and from joint ventures between local and foreign companies, reflecting these countries' higher investment risk. Multilateral and bilateral funding is also a significant source of investment in developing countries, although historically much of this has been directed at environmental and social aid rather than specifically at renewable energy or energy efficiency. ODA's primary objective is poverty reduction.

This situation is changing, particularly in the fast-growing emerging markets of China, India and Brazil which are seeing increasing flows from foreign investors. Their rapidly expanding electricity sectors are also attracting outside investment. Less developed countries, such as Sub-Saharan Africa, and smaller developing countries, however, still attract very limited private sector investment, and continue to rely on ODA and soft loans from supranational organisations such as the World Bank.

Gearing levels for renewable energy projects are comparable to gearing for coal/oil/gas-fired generation, which range from 80-90% (debt as a % of total debt plus equity). Average gearing for wind projects in 2005 was 87%, and 90% for solar. (Source: Dealogic data from UNFCCC secretariat).

Overview of Destinations / Recipients of Private Investment, 2005

	RE invt	***% global invt***	**EE invt**	***% global invt***	**wind**	**other major RE investment**
	$ m		$m		% of RE invt in country / region	% country / region
Developed (OECD)	**23,258.0**	***87%***	**1,382.7**	***93%***	**83%**	**solar (13%)**

Developing	**3,499.0**	***13%***	**102.0**	***7%***	**71%**	**solar (16%)**
EU	15,588.5	*58%*	439.0	*30%*	87%	solar (12%)
Germany	2,950.8	*11%*	27.4	*2%*	41%	solar (58%)
Spain	4,761.0	*18%*	-	*0%*	96%	solar (2%), mini-hydro (2%)
France	986.9	*4%*	329.8	*22%*	100%	none
US	4,903.1	*18%*	817.4	*55%*	73%	solar (20%)
China	1,735.1	*6%*	70.4	*5%*	67%	solar (32%)
India	558.5	*2%*	-	*0%*	100%	solar (13%)
Brazil	366.0	*1%*	-	*0%*	82%	mini-hydro (18%)

Source: New Energy Finance

Developed countries continue to receive most of the private investment (93%) into renewable energy and energy efficiency, although investment has been increasing significantly in fast-growing emerging economies such as China and India. In 2005, the US attracted the largest investment flows in both renewable energy (mainly for wind) and energy efficiency (Source: New Energy Finance).

In 2005, New Energy Finance recorded $26.7 billion of investment into renewable energy (excluding bioenergy), 87% of which was in OECD countries, where renewable energy is most mature and financial markets deepest. This investment was heavily weighted toward asset financing, which accounted for $20.1 billion (75%) of RE investment in 2005, showing continued strong roll-out of RE projects. Almost all (90%) of this asset finance flowed into the wind sector.

Biomass & waste, a subcategory of bioenergy (which is not included in the RE investment totals in this section), attracted an additional $2.7 billion of investment. 89% of this was asset finance. Again, most investment was in developed countries, with the UK, US, Italy, Germany and Austria as the main beneficiaries. Among developing countries, China stood out, attracting 8% of 2005 investment into biomass & waste. However, investment in biomass & waste in developing countries is likely to be higher than these figures suggest. Government programmes, for example to subsidise heating stoves in poor rural areas, would not be captured by these numbers.

In wind, investment was much more dispersed than in solar (where just three markets, Germany, the US and China accounted for 92% of 2005 solar investment). But still there is a noticeable investment bias towards countries with solid policy support (see table below). Germany's relatively low share of wind investment (6%) reflects the market's maturity: its positive policies have created the highest installed wind capacity of any country in the world (20.6GW at the end of 2006 / 18.4GW at the end of 2005. Source: European Wind Energy Association).

Top Five Countries for Investment in 2005, by type of Renewable Energy					
	1	**2**	**3**	**4**	**5**
Wind	Spain	US	Portugal	UK	Italy
Solar	Germany	US	China	Spain	Australia
Geo-thermal	US	Iceland	El Salvador	Philippines	Germany
Mini-hydro	Spain	Canada	Brazil	Vietnam	Sri Lanka
Marine	Portugal	UK	Finland	Spain	Denmark
Renewable Energy	**US**	**Spain**	**Germany**	**Portugal**	**UK**
Energy Efficiency	**US**	**France**	**Canada**	**UK**	**China**

Source: New Energy Finance (UNFCCC analysis)

As the European and US markets mature, financing is becoming increasing cross-border. Financiers have become comfortable with the risks associated with RE projects (particularly for onshore wind, which is now valued as a commodity) and competition is forcing investors to look beyond their home shores for deals.

Investment in energy efficiency was far lower than in renewable energy, attracting just under $1.5 billion in 2005 (Source: New Energy Finance). This was heavily weighted towards Europe and the US. Unlike renewable energy, however, energy efficiency received very little asset financing, with investment focused on early stage financing (48%) and public market activity (49%). This reflects the fact that energy efficiency is a technology-driven sector, and that efficiency projects tend to be funded invisibly within corporates. It also lacks visible infrastructure and remains a largely hidden resource. These figures therefore understate the scale of investment into energy efficiency, as this is mainly financed by the beneficiaries of increased efficiency and reduced energy use, such as utilities, energy service providers, manufacturers and developers, rather than financial institutions. Much investment therefore does not show up in deal flow.

Energy efficiency is also hard to define. At its broadest level, it includes consumer purchases of energy efficient white goods or cars. A recent report by the American Council for Energy Efficiency estimated that Americans spent $200 billion a year on energy efficiency technologies, broadly defined (and that this could double to $400 billion with the right encouragement). However, more narrowly defined, energy efficiency is most visible as new energy-saving technologies, ventures such as ESCOs (Energy Service Companies) and energy efficiency projects - while New Energy Finance data captures investment in electricity efficiency, an even narrower category.

5.1.2 Bilateral / Multilateral public sector instruments

Sources of Bilateral and Multilateral Funding, 2005 ($ millions)

Donor	Donor	Power generation/ renewable sources	Geothermal energy	Solar energy	Wind power	total RE	
Bilateral	Germany	193.5	0.1	13.0	94.1	300.6	*50.0%*
	Japan	4.0	184.3	16.0		204.2	*34.0%*
	Denmark	51.2			13.1	64.3	*10.7%*
	Finland			24.8		24.8	*4.1%*
	Netherlands			1.2	0.0	1.2	*0.2%*
	Others	2.2	0.1	3.2	0.2	5.7	*1.0%*
	Total bilateral	**250.8**	**184.5**	**58.1**	**107.4**	**600.9**	***100.0%***
Multilateral	AfDB			166.3		166.3	*43.1%*

IBRD	132.0				132.0	*34.2%*
EC	15.3	40.4			55.7	*14.4%*
IDA	32.0				32.0	*8.3%*
Total multilateral	**179.3**	**40.4**	**166.3**	**0.0**	**385.9**	***100.0%***

Source: Credit Reporting System (CRS), OECD Statistics, 2007

Investment into renewable energy (excluding biomass and hydro) from bilateral sources was $600.9 million, and from multilateral sources $385.9 million in 2005, totalling just under $1 billion for the year (Source: CRS / UNFCCC secretariat). (These figures do not include investment in energy efficiency, as these flows are not split out by CRS). GEF grants of $71 million bring the total to just over $1 billion. These flows are small relative to private investment, but they are an important source of funding for developing countries, which otherwise rely heavily on domestic investment. Multilateral funding also plays an important role in mobilising investment from other sources, particularly the private sector, via guarantees and co-financing.

While total ODA reached a record high of $106.8 billion in 2005 (source: OECD DAC http://www.oecd.org/dataoecd/52/18/37790990.pdf), a declining portion of this went into "economic infrastructure", which includes transport and all energy (renewable and fossil fuel). ODA specifically earmarked for climate change and renewable energy is limited.

The key multilateral sources of funding for renewable energy and energy efficiency are the World Bank (via two development institutions, the International Bank for Reconstruction & Development (IBRD) and the International Development Association (IDA)) and the UNFCCC (via the Global Environment Fund (GEF)). The four regional development banks (African Development Bank, Asian Development Bank, EBRD and Inter-American Development Bank Group) are also active.

In 2005, the World Bank Group committed $662 million to renewable energy (Source: WBG Clean Energy Investment paper, 2006). (This is higher than the $386.5 million multilateral flows in 2005 recorded by CRS, because commitments made in a particular year may be for several years ahead.) This includes $91 million of renewable energy commitments from the Multilateral Investment Guarantee Agency (MIGA), $488 million from IBRD, IDA, GEF and the WBG's Carbon Finance business and $83 million from the IFC. The World Bank has committed to increasing its support for renewables and energy efficiency by 20% a year for the next five years.

The WBG also committed $87 million to energy efficiency in 2005, mostly ($80 million) via the IBRD, IDA, GEF and Carbon Funds, with the balance ($7 million) from MIGA (source: WBG Clean Energy Investment paper).

GEF committed $71m to renewable energy and energy efficiency in 2005 (source: GEF data from UNFCCC secretariat). Renewable energy and energy efficiency account for about a third of GEF's total budget to date, with around $1 billion invested in each area. GEF is the most important source of grants for renewable energy in developing countries, especially solar thermal power plants (STEGS) and biomass.

MIGA and GEF, in particular, mobilise significant additional investment. By providing guarantees of $428 million between 1995 and 2004, MIGA leveraged $2.4 billion of FDI for renewable energy and energy efficiency projects. GEF, which allocated $838 million to 130 renewable energy projects in developing countries between 1991 and 2003, leveraged an additional $4 billion in co-financing, mainly from the public sector (including the World Bank, UNEP and UNDP) (Source: BIREC report - Increasing Global Renewable Energy Market Share: Recent Trends and Perspectives, December 2005). Each dollar of multilateral funding therefore has the potential to leverage $4-$6 in co-financing.

The EBRD invested more than $200 million in energy efficiency in 2005: $66.9 million in dedicated energy efficiency projects, $102.4 million in the energy efficiency components of industrial projects and $35 million in reducing energy losses in distribution. It is the only IFI with a specialised energy efficiency team. The EBRD launched its Sustainable Energy Initiative (SEI) in 2006, through which it proposes to more than double its energy efficiency and clean energy investments, investing around €1.5 billion in 2006-2008, with donor support of €100 million. (source: www.ebrd.com - Sustainable Energy Initiative – Furthering Transition, Securing the Future (Summary document). July 2006)

The African Development Bank, which has a renewable energy portfolio worth more than $250 million, invested $166 million in solar in 2005 (source: CRS). Renewable energy, energy efficiency and green transport projects in Latin America are also supported by trust funds set up by the IDB, the Hemispheric Sustainable Energy and Transportation Funds.

Of the bilateral agencies, Germany's KfW is among the most active, committing $170 million to renewable energy projects in developing countries in 2005. The German government and KfW have also set up a Special Facility for Renewable Energies and Energy Efficiency with funding of $625 million, to provide concessional loans to public agencies until 2009 for investment in countries that form part of Germany's programme of development cooperation. In 2005, the German government made financing commitments of $210 million under this facility (Source: REN21 Renewables Global Status Report, 2006 Update).

The US Agency for International Development (USAID) has supported renewable energy initiatives, but is now moving towards more general support for economic and social development (which may still include renewable energy even though this is not their main focus). The UK (DFID), Netherlands (DGIS) and Denmark (IDA) are also all active in renewable energy, as are other bilateral agencies in France, Sweden, Switzerland, Austria, Norway, Canada and Australia.

But where do multilateral and bilateral funding flows end up? Renewable energy accounts for just over 18% of multilateral and bilateral investment. Hydro generation (large and small) attracted similar levels of investment. Multilateral funding in 2005 focused on solar energy and the general category of renewable power generation. Bilateral funding was more dispersed, flowing into renewable power generation, geothermal and wind (followed by solar).

In terms of geography, bilateral funding was also more fragmented than multilateral. While multilateral flows went to just ten countries, bilateral flows went to 62 different countries. However, in both cases, the top five recipients accounted for most of the total investment (see table below).

Top Recipients of Multilateral and Bilateral Funding for Renewable Energy, 2005

Top 5 recipients of multilateral funding for RE (2005 $m)	
Morocco	166.3
China	132.0
Kenya	40.4
Rwanda	25.0
Djibouti	7.0
together accounting for 96% of total multilateral funding for renewable energy	
Top 5 recipients of bilateral funding for RE (2005 $m)	
Guyana	185.0
Djibouti	144.4
Guinea-Bissau	141.6
Sao Tome and Principe	21.8
Azerbaijan	20.5
together accounting for 85% of total bilateral funding for renewable energy	

Source: Credit Reporting System (CRS), OECD Statistics, 2007

Overall, Africa received most multi/bilateral funding for renewable energy (see table below). The distribution of multilateral and bilateral funding confirms that this is focused on those regions which have least access to investment from other sources. However, because these flows are relatively small, compared to private investment, countries in these regions remain underfunded.

Distribution of Multilateral and Bilateral Funding for RE by Region, 2005		
	% of total	**Principal recipients**
Africa	41%	Djibouti, Guinea-Bissau
Latin America	21%	Guyana
North Africa	17%	Morocco
Developing Asia	15%	China
Transition Economies	2%	Bosnia-Herzegovina
Other	4%	
Source: Credit Reporting System (CRS), OECD Statistics, 2007		

5.1.3 International and domestic private sector tools / instruments

In 2005, private sector investment (foreign and domestic) into renewable energy (excluding bioenergy) and energy efficiency was $28.2bn (New Energy Finance). Two-thirds of this took the form of asset finance - money flowing into projects, portfolios and manufacturing capacity, with the balance raised as early stage finance (venture capital and private equity for technology and expansion) or on the public markets.

The surge of private investment into renewable energy and energy efficiency has been mirrored by the growth of specialist funds. There are now 176 funds seeking clean energy opportunities, of which 150 have disclosed a total of $17.7 billion under management. This figure understates the true sum available for investment in renewable energy, as general infrastructure and technology funds as well as hedge funds are also active in the sector.

Privately owned funds (139 funds, with disclosed capital of $9.8 billion) generally invest in projects and early stage financing. Private funds are defined as those that cannot be bought or traded on a public market. Their focus varies from the broad (such as cleantech, which includes water treatment, pollution, waste recycling and other technologies related to sustainability, as well as clean energy) to the narrower category of clean energy (funds focused on investing in companies developing low-carbon technology). A third category of private funds invest specifically in renewable energy projects. (Funds with a broader focus, such as utilities, energy generation and general technology funds, have been excluded, even though they may invest in the renewable energy and energy efficiency sectors)

The remaining 37 funds (with disclosed capital of $8.0 billion) are publicly-quoted and invest predominantly in the shares of quoted companies.

5.1.3.1 Renewable energy

Private investment into renewable energy focused strongly on asset financing for the wind sector. More than 80% of investment in renewable energy was in the wind sector, which accounted for 75% of financing assets (the roll-out of wind projects).

Most investment flowed into the US and Europe combined (76%). The US and Spain were the highest single recipients, each attracting 18% of total investment each. This reflected high wind investment in both countries. Spain attracted a fifth of global wind investment in 2005, continuing a trend of fairly stable growth since 1997 when the Electric Power Act 1997 promoted the use of renewable energy. In 2003, installed capacity reached a critical mass of 1GW, and since then 1.1-2GW of new capacity has been added annually (source: European Wind Energy Association). However, Spain's status as a very stable environment for wind power, with a two-tier support system of feed-in tariffs and options to sell on the spot market, was shaken in 2006, with a continuing debate over whether this generous support should be continued now that Spain was meeting its renewable targets.

Investment in developing countries was dominated by China and India, which represented 6.5% (wind and solar) and 2.1% (all wind) of total investment, respectively. Brazil received 1.4%, mostly into wind (82%) with some into mini-hydro (18%).

The range of financing options available to renewable energy projects and companies has expanded significantly as technologies have matured and moved into the mainstream. Correspondingly, financiers have developed increasingly innovative financing packages. Wind projects, in particular, have been able to access mainstream financial instruments, with longer maturities and keener margins becoming more widely available. Investors and utilities are also acquiring wind project development pipelines as well as commissioned projects. Equity is being used for the former, debt for the latter, now that wind generation has established itself as an asset class.

A number of financial institutions support renewable energy investment in developing countries, including Fortis, Rabobank, ANZ Banking Group and American International Group. However, domestic financial institutions have been more ready to finance renewable energy projects in their own countries, and the commercial lending market in the fastest-growing developing countries has become competitive. In India, for example, foreign banks without a local network are reluctant to compete with aggressive domestic banks. IREDA, the independent financial arm of India's MNRE, has been particularly active in domestic investment, and has recently expanded its share capital to increase its lending capability.

There are also a few specialist financial institutions that focus specifically on renewable energy in developing countries. Triodos Bank, a small Netherlands ethical bank, provides seed capital, loans and business development support for renewable energy entrepreneurs in Asia and Africa.

E+Co has been investing in renewable energy in Africa, Asia and Latin America since the mid-1990s. It aims to stimulate long-term, institutionalized channels of investment in environmentally superior forms of energy production and use in developing countries. E+Co's approach is to empower local small and medium enterprises (SMEs) that supply clean and affordable energy to households, businesses and communities in developing countries, by providing business development services and investment capital to enterprises. E+Co's financing to SMEs mostly consists of "seed capital": modest amounts of financing for the early stage of an enterprise. At that stage, entrepreneurs have little or no track record in the business; generally, only the idea, the opportunity and a champion exist. Often the business plan still needs to be developed (source: www.eandco.net).

5.1.3.2 Energy Efficiency

$1.5bn flowed into energy efficiency worldwide in 2005, most of which was venture capital or private equity. This investment represents investment in electricity efficiency (supply, distribution and demand side), including technologies that reduce overall production / consumption, either via passive components (such as building materials), active components (such as controls/systems) and information (such as metering). As discussed above, the true level of investment in energy efficiency is likely to have been much higher than this, as the nature of the technology (and the dynamic of who gains the benefit) means that most developments and refinements are funded internally at a corporate level.

Geographically, private investment into energy efficiency was far more concentrated than in renewable energy, with Europe and the US taking more than 90% of EE investment worldwide. This probably reflects the technology bias of much disclosed investment, favoured by the US and Europe with their developed venture capital industries.

China, which has energy efficiency targets, accounted for 4.7% ($70 million) of 2005 investment. This reflects not only the invisible nature of a large part of energy efficiency investment, but also the fact that developing countries tend to receive energy efficiency investment from multilateral and bilateral sources as part of a broader energy programme. ODA may also include some energy efficiency measures.

5.1.4 International public / private tools and instruments

CDM is a key source of international financing and an important mechanism for mobilising investment from developed to developing countries. Depending on the carbon price (and assuming a range of $15-$20 per tonne of CO_2 emitted), CDM and JI flows are estimated to be between $770 million and $1 billion a year, based on renewable energy and energy efficiency projects that have been registered or are in the pipeline (1783 CDM projects, including some 550 registered, and 156 JI projects). 2005 CDM flows alone are not representative of the mechanism's potential as the first projects were registered in 2004, and first CERs (Certified Emissions Reductions – each equivalent to a tonne of CO_2) issued in October 2005 – and also because of the imbalance between registered projects and those in the pipeline. At May 2007, 661 CDM projects had been registered.

These estimated CDM/JI flows are similar in value to annual multilateral and bilateral funding (just over $1 billion in 2005), and are very likely to increase as more projects enter the pipeline and if the carbon price increases. Hydro has been excluded from renewable energy totals, as there is no distinction between small and large hydro, although there is a large number of hydro projects, which combined would add a further $400-$500 million a year. Biomass projects account for an additional $350-$475 million. If both these flows are included, annual CDM/JI revenue approaches $2 billion.

This is in line with the $11 billion governments and companies have earmarked for CDM funding to 2012 (Source: OECD/IEA report: Overcoming Barriers to Clean Development Mechanism Projects). However, it is estimated that around $25bn of carbon credits (at current prices) will be needed in order to meet compliance targets under Kyoto and the EU ETS by 2012. This leaves a shortfall of around $14 billion – but because there are projects in the pipeline that have not pre-sold their expected credits, New Carbon Finance estimates that the net shortfall in CDM and JI project development activity is around $11bn. This investment will be needed between now and 2012 to generate sufficient credits to achieve compliance with Kyoto and EU ETS targets. Some of this will be covered by money already raised in existing funds but not yet deployed, but a substantial proportion will need to come from new capital and project activity.

India, China and Brazil dominate the CDM pipeline; India in terms of number of projects (33.9%), and China in terms of value. Between them, these three countries account for 75% of CERs to be issued by 2012. African CDM activity is conspicuously low, accounting for just 1.3% of projects.

JI activity is led by Eastern Europe, with 99 of the 155 projects in the pipeline, followed by Russia and Ukraine.

Renewable energy is by far the largest CDM sector, with 59% of projects. Within this, wind, biomass and hydro are the most significant technologies.

Energy efficiency represents 13% of the CDM pipeline. Large-scale projects are mostly natural gas cogeneration (supply side) and using waste gas or heat for power generation (industry / demand side). Small-scale projects are predominantly demand-side, with most projects involving energy efficiency and fuel switching for industrial facilities, with some supply-side efficiency and buildings efficiency projects. As before, India dominates energy efficiency CDM, with 66% of the projects in the pipeline, compared with China's 25%.

However, the most valuable projects are those with the highest carbon offset value – investments in reducing methane and other greenhouse gases with high warming effects relative to CO_2 - rather than relatively smaller renewable energy and energy efficiency projects, which have higher transaction and abatement costs. The former are currently stealing the limelight. Balancing the long-term objectives of CDM (such as local development, encouraging renewable energy / energy efficiency projects) with shorter-term market forces (which instinctively seek out the lowest cost carbon abatement) is a challenge for the carbon market.

The growth of the carbon sector has driven growth in specialist carbon funds. Recent analysis by New Carbon Finance shows that money flowing into the carbon fund sector is currently $11.8 billion, an increase of around 50% since mid-2006. There are now 58 carbon funds. Flows in 2005 were negligible, reflecting the carbon sector's youth. In 2005, the total cumulative investment in carbon funds was approximately $4.6 billion, with $1.9 billion raised in 2005.

The UK has emerged as the clear leader in carbon fund management, with 72% of private carbon funds and 50% of all carbon funds being managed out of London. The private sector has driven most of this new money coming into the market, accounting for nearly 90% of the increase.

Carbon funds cover the full carbon value chain from compliance purchasing through to intermediary trading and project development. Some 85% of the new money raised has been targeted at project development and intermediary trading, with a significant proportion targeting direct investment in projects. This means that less than half (42%) of the total money committed to the carbon markets is now for direct compliance purchasing, with the remaining amount (58%) being invested in developing the projects required to generate carbon credits.

Increased interest in investing directly in projects has been driven by falling carbon prices in the ETS - from a high of $30/t to a low of around $13/t (now at around $19/t) – which squeezed intermediate buyers' margins. This meant that better returns could be found by investing directly in projects and selling carbon credits for $10/t. However, investing in projects is a longer-term investment as investors must wait for a project to be built before it starts to generate credits. Many projects are unilateral (i.e. located and financed within a developing country, with no developed country counterpart), and many are financed on-balance sheet and do not need external equity financing. The challenge for investors looking to provide equity to projects is to find opportunities where external financing is required.

5.1.5 Domestic public funding

Government support for renewable energy generally takes the form of favourable policy (such as renewable portfolio standards), financial mechanisms (such as feed-in tariffs that help level the playing field with conventional generation) and fiscal support (such as tax breaks and depreciation holidays). There is also some direct funding, such as capital grants. But on the whole, OECD governments have paved the way for market-led development, while developing countries focus their limited resources on funding infrastructure and rural electrification rather than directly financing renewable energy projects and technology.

Governments are often more directly involved in funding new technology, via incubators and R&D programmes (as discussed in sub-section e. below). They also play an important role in education and raising awareness, which is particularly relevant for energy efficiency.

Most OECD countries have renewable energy programmes in place, including targets and support mechanisms such as feed-in tariffs and renewable portfolio standards, but very little direct government support. A number of developing countries, including China, India and Brazil, also have large renewable energy programmes. These generally include non-mandatory targets for renewable energy and are not always underpinned by support mechanisms such as feed-in tariffs and RPS – often in countries whose electricity markets are at earlier stages of liberalisation, and would not support this kind of intervention. In April 2007, India announced that it would introduce a feed-in tariff system.

Domestic policies for developed countries, and how these have stimulated investment are discussed in section 2. below. The table below summarises renewable energy policies and government support in developing countries, with headline renewable energy targets.

Country	Policy Name	Policy Type	Technology	Renewable EnergyTarget
Brazil	The PROINFA Programme	o Guaranteed Prices / Feed-In o Obligations o Tradeable Certificates o 3rd Party Finance	o Onshore Wind o Bioenergy o Hydropower	Additional 3300 MW from wind, small hydro, biomass by 2016; 15% of primary energy supply by 2020
	National Programme for Energy Development of States and Municipalities (PRODEEM)	o Rural electrification	o All technologies simultaneously	
	National Rural Electrification Programme	o Rural electrification	o All technologies simultaneously	
China	Brightness Programme	o Capital Grants	o On-shore wind o Solar Photovoltaics	
	The People's Republic of China Renewable Energy Law	o General Energy Policy o Guaranteed Prices / Feed-In o Obligations o RD&D o Regulatory and	o All technologies simultaneously	3.3GW by 2006 from wind, biomass and mini-hydro. To reach 120GW of RE by 2020. 10% of energy from RE

Country	Policy Name	Policy Type	Technology	Renewable EnergyTarget
		Administrative Rules		by 2010, 16% by 2020. - Wind: 30GW by 2030 - Solar PV: 300MW by 2010, 1.8GW by 2030
	Reduced VAT and Income Tax	o Excise Tax Exemptions o Sales Tax Rebates o Tax Credits	o Onshore Wind	
	Wind Power Concessions Programme	o Bidding Systems o Guaranteed Prices/Feed-In	o Onshore Wind	
	Energy Efficiency	o Non-mandatory targets: energy intensity to fall by 20% and major pollutants discharge by 10% during the 11th Five Year Plan (2006 – 2010)	o All / Energy Efficiency	
India	Policy and Economic Incentives for Investment in Renewable Energy Sources (Model Renewable Energy Law in planning)	o FDI & Joint Ventures o Depreciation Allowance o Income Tax Holiday o Excise & Customs Incentives o Planning Exemptions o Loans o Feed-in tariffs due to be introduced for wind and solar (announced May 2007)	o All technologies simultaneously	10% of additional electricity capacity by 2012 (excluding large hydro): increasing to 20% by 2020 10GW RE by 2012
	Incentives for Investment in Wind Power Generation	o Concessional Import Duties o Accelerated Depreciation o Sales Tax & Excise Duty Relief o Soft Loans o Income Tax Holiday o Wheeling Charges o Buy-Back Facility o 5% Annual Tariff Escalation o Financial Incentives for Demonstration Projects	o Wind	
	Incentives for Investment in Small Hydro Power Generation	o Survey & Investigation Subsidies o Project Development	o Small Hydro Power	

Country	Policy Name	Policy Type	Technology	Renewable EnergyTarget
		Subsidies o Renovation, Modernisation & Capacity Upgrade financial support o Term loans		
Mexico	Accelerated Depreciation for Environmental Investment (Renewable Energy Law in Congress - not yet implemented)	o Investment Tax Credits o Tax Credits	o All technologies simultaneously	
	Grid Interconnection Contract for Renewable Energy	o Regulatory & Administrative Affairs	o Hydropower o Offshore Wind o Onshore Wind o Solar Photovoltaics o Solar Concentrating Power	
	Project of Bill to Promote Renewable Energy	o General Energy Policy	o All technologies simultaneously	
	Project of Ecological Norm for Wind Farms	o Regulatory & Administrative Affairs	o Onshore Wind	
	Project of Electricity Reform in Connection with Renewable Energy	o Regulatory & Administrative Affairs	o All technologies simultaneously	
	Public Electricity Services Law	o General Energy Policy	o All technologies simultaneously	
	Methodology to Establish Service Charges for Transmission of Renewable Energy	o Regulatory & Administrative Affairs	o All technologies simultaneously	
	Wheeling Service Agreement for Electricity from Renewable Energy Sources	o Regulatory & Administrative Affairs	o All technologies simultaneously	
		o	o	
Poland	General RES Voluntary Target	o Obligations	o All technologies simultaneously	
	Development Strategy of Renewable Energy Sector	o General Energy Policy	o Bioenergy o Geothermal heat o Hydropower o Offshore Wind o Onshore Wind	

Country	Policy Name	Policy Type	Technology	Renewable EnergyTarget
			o Solar Concentrating Power o Solar Photovoltaics o Solar Thermal	
Thailand	Strategic Plan for Renewable Energy Development	o General Energy Policy o Machinery Import Duty Exemptions o Corporate Income Tax Exemption	o Solar o Wind o Biomass o Biogas o Hydro o Biofuels o Geothermal o Fuel Cells o Energy Efficiency	8% of primary energy by 2011 (excluding rural biomass)
Turkey	Electricity Market Licensing Regulation	o Capital Grants	o All technologies simultaneously	Targeted 2% of electricity from wind by 2010
	Law on Utilisation of Renewable Energy Resources for the Purpose of Generating Electrical Energy – No. 5346	o General Energy Policy	o All technologies simultaneously	
Source: IEA, New Energy Finance, MNRE, MMDT				

It is difficult to quantify exactly what governments have invested in renewable energy and energy efficiency year by year: investments are either oblique (part of a larger project, particularly for energy efficiency), run over several years or are simply not disclosed.

Brazilian government funding is focused on biofuels and distributed renewable energy generation, aiming to invest $1.3 billion between 2002 and 2007, and to attract $2.9 billion of private investment. PROINFA (the Brazilian Alternative Energy Sources Incentive Programme, launched in 2004) has earmarked a total of $1.5 billion for electrification of one million households by 2007, and 12 million people between 2003 and 2008. Its goal is for 10% of power from renewables by 2020. Brazil recently raised its restriction on use of foreign wind turbine components.

The Chinese government is supporting a wider range of renewable technologies, including small hydro, biogas, solar hot water systems, PV and wind generation. It provides subsidies of about $125 million a year for household biogas systems, and is investing heavily in its Village Electrification Program, aiming to provide electricity to 27 million people by 2010 at an estimated cost of $2.5 billion.

India, too, has renewable energy programs coordinated by its Ministry for New and Renewable Energy (MNRE). In 2005, the MNRE had a budget of $137 million, 35% of which was destined for rural electrification.

Egypt, Malaysia, Mexico, the Philippines, South Africa and Thailand also have government funding programmes for renewable energy. In December 2006, Thailand's Ministry of Natural Resources and Environment set up a THB1.0 billion ($300 million) fund to support small renewable energy projects under the Very Small Power Producers Program (VSPPP).

Many countries also have energy efficiency programmes and targets. These are broader-ranging (covering buildings, industry, transport, households) and generally less formalised than renewable energy policy.

5.1.6 Funding of emerging technologies

New technologies are generally funded by countries where risk capital is available. This tends to be in developed countries, and particularly in the US. IFIs such as the World Bank do not have the expertise and scope to finance emerging technologies. A key challenge is making sure new technologies are developed and funded in the countries (and by the investors) that are best placed to do this, while allowing proven technology to be transferred to developing countries which are less able to develop their own.

Emerging technologies fall into two broad categories: new / immature technologies, such as marine (wave and tidal generation), and established technologies where refinements are being made to reduce cost or increase scale (for example, development of larger, lighter wind turbines for offshore use). The latter tend to be funded by companies already operating in the field, rather than third parties, and there is a limited role for external funding. In 2005, New Energy Finance estimated that R&D spending on renewable energy and energy efficiency by corporates and governments amounted to $13 billion.

Some governments also have programmes to encourage corporate R&D: the UK, for example, has a generous R&D tax credit system to encourage innovation, worth 150% of qualifying expenditure for small to medium-sized businesses.

For new technologies, though, finance is a critical factor in fostering their development and bringing them to market. There is no shortage of promising ideas for improved clean energy technology, but these can easily take 15 years from first inception to full-scale commercial roll-out, making them challenging for conventional venture capitalists, and even for many companies, who have shorter investment horizons. This intermediate stage between R&D and VC funding is sometimes called the financing “Valley of Death”. There is therefore a vital role to be played by business incubators, which can nurture technologies through this difficult stage until they are ready to move onto the next stage of funding. They can also help accelerate start-up’s passage through this stage, and often invaluable business and funding advice. Incubators often (but not always) take stakes in the businesses they help.

New Energy Finance has identified 146 business incubators around the world (excluding China) that have as their only (or significant) focus the building of businesses and commercialisation of clean energy technology from a very early stage. China, which has a far broader definition of incubator, has well over 200 incubators, 30% of which have worked on renewable energy and low-carbon technologies. However, many of these are not strictly speaking incubators, but vehicles for transferring operations from state to private ownership.

Not only has the number of incubators active in the space risen, but so has the number of companies under incubation. 332 companies are now either under incubation or have successfully graduated from the incubation process and raised independent funding – an increase of nearly 53% since 2005.

There are some very successful incubation programmes, such as the UK’s Carbon Trust, the US’s National Renewable Energy Lab’s NACEBI initiative, and that associated with Germany’s Fraunhofer Institute. The US has the most (more than 40), followed by the UK, Germany, Israel and Spain. There is a correlation between incubator activity and venture capital availability: the US has the deepest venture capital market, and also by far the highest number of incubators and incubated companies.

However, early-stage technology funding is not limited to specialist investors or incubators. In the UK, the Alternative Investment Market (AIM) is a receptive source of funding for companies with proven technology, and who are seeking to finance pilot projects or commercial production. AIM has become a magnet for fuel cell and hydrogen companies, as well as hosting the first marine IPO, of Ocean Power Technology in late 2005.

As an illustration of the growth in clean energy incubation and number of successful exits, the table below shows the number of companies incubated by the National Alliance of Clean Energy Business Incubators (NACEBI), which is funded by the US Department of Energy.

Number of NACEBI-incubated companies and outcomes

	July 2004	August 2005
No. CE Companies	99	78
No. Graduate Companies	38	57
No. Company Employees	1,158	1,595
Capital Raised	$67.1 m	$122.9 m
Revenues generated	$122.3 m	$235.1 m

State money invested	$6.3 m	$9.2 m
Other leveraged funds	$11.9 m	$35.6 m
Source: NACEBI		

The UK Carbon Trust has supported 43 companies under its incubator programme since it started in April 2004, including 13 to energy efficiency. 21 companies have raised private sector investment since joining the incubators, including four that the Carbon Trust has invested in itself, and three that have listed on AIM (CMR, Oxford Catalyst and ITM Power). More than £22 million of private funding has been raised, excluding the AIM listings. (Source: Carbon Trust)

Israel has a particularly strong culture of technology incubation. In 2002, Israel spent relatively more on R&D than any other country, including the US. Israel's national investment in R&D was 4.8% of GDP, compared to 2.2% in the US, 1.7% in the UK and an average of just below 2% across OECD countries. As a result, Israel has become an important source of new renewable technology, including the resurgent solar thermal market. Its technological incubator programme was set up in 1991 following mass immigration from former Soviet Union countries, with the aim of providing a sheltered environment where scientists could develop marketable ideas while receiving financial support.

Currently more than 24 technology incubators operate in Israel, most of which support renewable energy projects. The incubators are individually-owned and non-profit organisations, but they are brought together under the Office of the Chief Scientist (OCS). The incubators receive public and private support. In addition, Israel's universities are very active in renewable energy research, and solar energy in particular, and these work closely with the incubators. In addition, a Knowledge Centre for Fuel Cells and Energy Storage and Conversion has been established.

5.2 How Investment in Renewable Energy / Energy Efficiency Has Been Stimulated

Finance and policy have been the two main drivers of renewable energy and energy efficiency scale-up. There is a clear correlation between supportive policy and deep capital markets, and the growth of renewable energy, from technology through to installed capacity. Deals are primarily driven by policy even in established technologies like wind.

Renewable energy and energy efficiency policies come in a wide range of shapes and sizes. The policy landscape can be simplified into three broad types of policy, depending on which part of the market they influence:

- Levelling the playing field between conventional and renewable generation (via feed-in tariffs, renewable energy portfolio standards and energy efficiency standards)
- Reducing the cost of investment (tax credits, government support for R&D, capital grants)
- Putting a price on carbon (EU ETS, for example)

There is good evidence to show that creating the right policy framework and displaying a clear commitment to increasing renewable energy capacity and promoting energy efficiency attracts investment. Regulation seems to be more effective than subsidies in promoting investment in renewable energy and energy efficiency – which is positive for governments, especially where budgets are tight. Examples of countries where this has worked are discussed below.

It is the role of government to create frameworks that reward companies that invest in renewable energy, without over-rewarding them. Setting tariffs and incentives that are stable enough to spur investment, yet flexible enough to be reduced or withdrawn as the market takes off, is a fine balancing act – and one that changes over time. Any policy aimed at the clean energy industry needs to be set in place for at least ten years. It may also build in a declining level of support over time to ensure that only the best technologies and teams receive backing, while still giving investors certainty about future cash flows.

Energy policy should be as specific and straightforward as possible, and tailored to each country, taking into account factors such as renewable resource (insolation, coastline, etc), population density and wealth. It should aim to level the playing field between conventional energy and currently more expensive renewable energy, taking into account the expected time for particular technologies to become independently commercial (less time for wind than for PV, for example), when market forces should gradually be allowed to take over.

There is still a degree of policy experimentation taking place – and a policy that works in one country may well not translate successfully to another. Feed-in policies and tax breaks have clearly worked in Europe and the US (when consistently applied), although their effectiveness is largely a function of there being enough wealth to take advantage of this kind of incentive. In poorer countries, a large proportion of the population cannot afford to pay their electricity bills, let alone contribute towards the cost of a solar hot water system. Similarly, policies designed to encourage large-scale power generation will not work in countries where the primary goal is to increase distributed generation. There is therefore no 'One size fits all' solution.

Setting Renewable Portfolio Standards (quotas requiring utilities to source a specific percentage of their power from renewables) may not be the answer either. Quotas can end up being more of a political tool than a practical one. Setting an RPS is often a popular move at the outset, but as the deadline approaches and utilities start panicking and passing on the higher cost of renewable energy to their consumers, its political appeal dwindles and the RPS is at risk of being watered down. RPS tend to generate positive results in the short term, in that they make utilities sign PPAs with renewable energy developers (allowing projects to get financed), but may not be particularly effective long-term.

Different drivers apply to promoting investment in renewable energy manufacturing capacity, where factors such as business environment, logistics, labour costs and availability of raw materials become more important than policy. Government support for industrial growth, as in India's Special Economic Zones (which have preferential tax status, among other advantages), is also relevant. India and China have established themselves as world leaders in wind and solar equipment manufacturing capacity, respectively, on the back of strong export demand.

Governments should therefore distinguish between fostering investment in renewable energy projects and fostering investment in manufacturing capacity, often by foreign companies taking advantage of cheap labour in developing countries. The latter is not necessarily a bad thing: manufacturing expansion creates jobs – in Germany, the PV boom has created an estimated 35,000 jobs (source: Renewable Energy World April-May 2007, citing German politicians). However, if building up installed renewable energy capacity is the ultimate goal, it is important to bear in mind that manufacturing capacity does not necessarily translate through to installed capacity (or vice versa). India, for example, has the fourth largest installed wind capacity of any country in the world; yet Suzlon, the world-leading Indian turbine manufacturer, exports most of its turbines – and is expected to continue to do so, even as domestic demand increases.

Germany has had a different experience of the relationship between installed capacity and manufacturing. Here, a booming domestic wind market did drive manufacturing growth – probably helped by the absence of cheap equipment from India and China at the time – but its manufacturers are now struggling to build new export markets as their domestic base approaches maturity. Installed capacity and manufacturing have different life cycles, and while the two are clearly related, their relationship is by no means linear. Now that India and China are major manufacturers in wind and solar, encouraging energy capacity investment is unlikely to lead to significant domestic manufacturing capacity, as it did originally for Germany.

5.2.1 Renewable Energy

Where access to finance is not an issue – as in Germany, Spain and California – supportive government policy has resulted in a significant increase in installed renewable energy capacity. However, in developing countries, more than policy is needed to stimulate investment in new capacity: political instability, weak infrastructure and lack of legal system are barriers to investment common to many developing countries.

5.2.1.1 Germany

Germany has become a world leader in both solar and wind energy on the back of aggressive government policies to promote their installation. Germany dominates the world PV market, accounting for 58% of installed PV worldwide in 2005 (635MW out of world total of 1,092MW. Source: IEA) and driving up module prices worldwide. In 2005, Germany attracted half the investment flowing into the solar sector (source: New Energy Finance). This has been achieved through a feed-in tariff of $0.61-0.75 per kWh, and a tax credit system for individuals. While smaller systems benefit from a higher feed-in tariff than large ones, the difference is not enough to preferentially incentivise distributed generation, so the German market favours utility-scale power plants on agricultural land.

The aim of the generous tariff was to foster the domestic PV manufacturing industry, which has grown dramatically since 2004. However, the tariff reduces by 5% a year, causing the domestic market to slow. German PV manufacturers are being forced to diversify away from their domestic market, but are facing stiff competition for large contracts from new Chinese manufacturers.

Germany's wind industry has also thrived on the back of the feed-in tariff. Installed wind capacity was 20.6GW at the end of 2006, again highlighting the link between positive policy and new installation.

5.2.1.2 Spain

The Spanish government supports PV and solar thermal electricity generation (STEGs) with generous feed-in tariffs. PV receives 575% of the current electricity price for output from systems of less than 100kW. This has led to large-scale projects which are structured as portfolios of several 100kW legal entities. The government has set a target of 500MW of installed solar generation capacity by 2010. Spain was also the first country in the world to require PV on new buildings as a national policy, and requires new buildings to use solar power to meet 30-70% of their hot water energy needs.

Spain is currently reviewing its support for solar, and the law is expected to be reviewed in the next few months, but the market continues to grow rapidly. A 50MW STEG project (AndaSol) is being built near Granada, and an 11MW plant (PS10) has just opened in Seville.

5.2.1.3 United States

The US Production Tax Credit shows how policy can adversely affect investment. The recurring expiry of the PTC, which is a critical factor in financing new wind farms, has led to a stop-start pattern of investment as wind developers wonder whether the credit will still be available the following year and prevents turbine manufacturers from investing in the US at the level required to create a domestic supply chain. The uncertainty has also pushed up the industry's cost of capital as bankers build political risk premiums into financing packages. The PTC, which was recently renewed for 2007, provides a $0.019 / kWh tax credit for electricity generated with wind turbines over the first ten years of a project's operations. This was the first time that a PTC extension had been approved before the credit expired, following six years of boom-and-bust cycles caused by successive expiries.

The importance of consistency in attracting investment should not be underestimated. Investors look for a stable backdrop for their investment: even in a wealthy country with deep financial markets like the US, investors shy away from uncertainty.

California has become one of the world's leaders in solar on the back of its PV subsidy programme, which it has just extended to 2011. It has set an aggressive RPS of 20% by 2010, as well as a target of a 25% reduction in emissions relative to 1990 levels by 2020, and 80% by 2050. Its core programme is the California Solar Initiative (CSI) which was introduced in 2006 and is the second largest solar incentive programme in the world. The CSI's target is to install 3GW of distributed PV for homes, schools and businesses by 2017, at a cost of $3.2 billion, while bringing down the cost of PV so that it is competitive with conventional power sources.

The CSI is a good example of how policies can be designed to boost installed capacity while making sure market forces also play their part. The programme provides direct incentives to customers to offset the cost of installing PV. These start at $2.50 per watt of installed capacity and decline by roughly 10% a year – putting pressure on the industry to bring costs down and stopping the subsidies from artificially inflating the purchase price of the solar systems. Another key feature of the CSI is that the incentives are based on the expected performance of the system, rather than its stated capacity. So a system installed in a sunny area might receive the maximum incentive, while one installed in an area with lower solar potential would not. This feature ensures that CSI subsidies maximize the actual amount of new energy production, not simply the number of new systems installed.

5.2.1.4 China

China is the world's largest producer of renewable energy with 120GW (including 80GW of large hydro) of installed generation capacity in 2005, 25% of the country's total capacity. Official targets set by China's NDRC are for more than 350GW by 2020 (including 225GW of large hydro).

China has aggressively expanded its wind capacity, and was ranked eighth in the world at the end of 2005 with 1.26GW installed, and sixth in terms of new capacity additions (Source: World Wind Energy Association. www.wwindea.org). China has raised its official target for wind capacity from 20GW to 30GW by 2020. China's wind policy favours local manufacturers

China adopted a renewable energy law in early 2005. China's 11th Five Year Plan sets out a 10% reduction in pollution and 15% share of energy generation by renewables within the next ten years. The government is also setting targets for each province and locality, and the top thousand factories.

5.2.1.5 India

India now has the fourth largest installed wind capacity in the world - 4.43 GW at the end of 2005, with 1.43GW of new capacity added (Source: WWEA www.windea.org) and is a major manufacturer of wind equipment, most of which is exported. India has no legislation supporting renewable energy, although the country recently announced that a new renewable energy law would be introduced. It also said that it would introduce a feed-in tariff.

Energy independence is India's first and highest priority. The government has set targets for energy security by 2020, and energy independence by 2030. By concentrating on three areas - hydroelectric, nuclear power and non-conventional energy – India is aiming to increase its power generating capacity from current levels of 130GW to 400GW by 2030. Interim targets are for 10GW of renewable energy by 2012. In 2007 alone, India plans to add up to 2GW of additional renewable capacity, mostly from wind.

5.2.1.6 Brazil

PROINFA was implemented in 2004 through the MME in order to diversify the Brazilian electricity generation portfolio. Phase A of the programme established a target 3.3GW of installed capacity through wind, biomass and mini-hydro projects by the end of 2008. A further 3.3GW is due to be added by 2012, The Brazilian National Bank for Social and Economic Development (BNDES) earmarked $2.5 billion to finance up to 80% of the total cost of contracted projects through indirect and direct loans with a maximum 12-year tenor. Eletrobras (Public Electricity Utility) guarantees PPA contracts for 20 years for projects using alternative sources and established generous feed-in tariffs.

Brazil's wind market is still small: at the end of 2005, Brazil ranked just 34th in the world, with total installed capacity of 28.6MW (source: WWEA) and it increased its installed wind capacity by 208MW during 2006. However, the country is considered one of the most dynamic wind markets in the world: it increased its installed capacity by 208MW during 2006, and a further 1.2GW of PROINFA-approved projects are in the pipeline. The government's recent decision to lift its restriction on imported wind equipment (prior to which 60% had to be produced locally) will boost the market further.

5.2.2 Energy Efficiency

A growing number of governments are supplementing their renewable energy legislation with energy efficiency targets. However, as discussed earlier, energy efficiency is a very broad area and measures to improve energy efficiency range from better labelling of white goods to offering tax breaks for installing energy efficient industrial equipment. A comprehensive review of energy efficiency measures and incentives, and their impact on investment, is therefore not realistic.

There is no doubt that energy efficiency is picking up momentum. In May 2007, the Clinton Foundation announced that sixteen cities around the world had formed a partnership to renovate municipal buildings using green technology. Cities cover less than 1% of the Earth's surface, but generate 80% of greenhouse gases. The cities include New York, Chicago, London, Berlin, Tokyo, Delhi, Melbourne, Rome, Karachi, Seoul, Bangkok, Sao Paolo and Johannesburg. Global banks (Citigroup, Deutsche Bank, JP Morgan Chase, UBS and ABN Amro) have committed $1 billion to finance the upgrades, which will allow the cities to get the new technology at no cost and repay the loans from the energy savings they realise over several years. The project will be supported by energy audits by Honeywell International, Johnson Controls, Siemens and American Standard Cos. Bank paperwork and building permitting will be streamlined to get the project up and running as soon as possible.

The European Commission recently announced that it was aiming to cut energy use by 20% by 2020, which would involve using 13% less energy in 2020 than today, saving $100 billion and around 780 million tonnes of carbon dioxide every year. However, this is a non-binding target (although a binding target had initially been proposed). The EC is also focusing on R&D, and aims to have built 12 carbon dioxide capture and storage demonstration plants by 2012. Most European countries have some energy saving, energy efficiency improvement or energy intensity reduction target, but these are all currently non-binding. Almost all also have some form of financing mechanism for energy efficiency, in the form of grants and soft loans (eg from KfW), usually, but also rebates on purchase of efficiency equipment and most recently tradable white certificates.

Within Europe, Denmark is a frontrunner in promoting energy efficiency. Denmark has made a commitment to reduce CO2 emissions by 21% from 1990 levels by 2010, and by 50% by 2030. An increase in renewable energy to provide 35% of primary energy supply by 2030 will be an important part of this. The Netherlands and the UK are also actively promoting energy efficiency. There is evidence that a wide range of policies has been effective at improving efficiency in Europe (see AID-EE report: Success and Failure in Energy Efficiency Policies, March 2007 for more detail), but their impact on investment in energy efficiency is less clear.

China introduced targets in 2006 to cut energy consumption (both per capita and as a percentage of total economic output) by 20% within five years. However, China's energy efficiency targets are not mandatory, so when it failed to meet its first-year target in 2006, the Chinese government blamed the country's strong economic growth, which it said had outstripped energy efficiency gains, and there was no financial penalty to the country.

India, too, is starting to focus on energy efficiency. In April 2007, it signed a bilateral agreement with Japan's Economy, Trade and Industry Ministry to work on efficient energy-saving systems and renewable energy. The two countries will form five working groups to discuss issues relating to electricity and power generation, energy efficiency, coal, renewable energy and petroleum and natural gas. The groups will identify specific projects for cooperation. This agreement comes two weeks after Japan signed a similar agreement with China.

5.3 Barriers to Investment

Investment in renewable energy is increasing rapidly. However, there are a number of barriers that prevent investment from growing as fast as it could (and needs to if it is to meet projected demand, as discussed above).

A major barrier – as well as an opportunity – is the rapid economic growth and soaring energy demand in developing countries such as China and India. The established way of meeting this demand is through large-scale conventional power stations, especially where there are good domestic coal reserves - as there are in many fast-growing developing countries such as India, China and South Africa. The situation is politically sensitive: emerging economies are embracing renewable energy, but alongside this they are also building conventional power stations. They are determined not to see their economic growth lose momentum. There is a lack of consensus about how to balance growth and renewable energy most effectively: carrot (boosting new technologies) or stick (mandatory cap-and-trade)? The answer is probably a combination of the two: a mandatory but reasonable cap, alongside concerted investment in technology such as clean coal and carbon capture and sequestration, and in energy efficiency.

More specific barriers to renewable energy have been usefully divided into three main categories - Economic, Legal & Regulatory and Financial & Institutional – by Martinot and Beck (source: Renewable Energy Policies and Barriers), and this are discussed in more detail below.

Barriers vary regionally (between OECD and developing countries), between individual countries and between different technologies. Since renewable energy investment is still policy-driven, policy remains an important barrier / driver in both developed and developing countries. Likewise, economic barriers, whereby renewable energy is at a disadvantage to conventional generation in various ways, also apply worldwide, although to varying extents, depending on how liberalised electricity markets are. Different technologies are also affected by this to different degrees. Onshore wind, for example, is almost competitive in its own right.

Legal and regulatory barriers tend to be more of an issue in developing countries, where there is generally less certainty in areas such as contract enforceability and access to the grid. Developed countries, however, are not immune. Permitting is becoming a serious barrier in some developed countries; in the UK, for example, planning permission is increasingly a barrier for onshore wind, while the US has a much more open-minded attitude to large-scale wind ranches.

However, the starkest contrast between developed and developing countries in terms of barriers is financing. Developed countries attract the vast majority of investment in renewable energy and even though capital is flowing into fast-growing developing countries, there is still a clear imbalance. This is partly due to less developed capital markets in many developing countries, but a political desire to protect local industries plays a role too. China, for example, restricts foreign ownership - so many solar manufacturing plants, for example, are structured as joint ventures between foreign and local companies. And in China's wind sector, domestic project developers are favoured over foreign ones. Brazil too, until recently, restricted the use of foreign turbines and components in its wind projects. Where the system is skewed towards domestic players, foreign investment will obviously be held back.

Weak infrastructure is another key issue. In India, crumbling infrastructure at almost every level (roads, rail, electricity grid) is a major deterrent to foreign investment, especially in the energy sector, where grid connection and transport access are critically important. The fact that India is only just starting to introduce feed-in tariffs and renewable energy legislation has also limited foreign investment.

Smaller developing countries (including much of Africa) rely heavily on multilateral and bilateral financing, which is not available on the scale required to meet projected electricity demand. This partly reflects these countries' lower economic growth and higher perceived risk (political, social, currency, etc). However, it also reflects their current focus on providing electricity to rural areas (most developing countries have rural electrification programmes), which tends to favour distributed generation (often using renewable energy as a source) rather than major grid upgrades. Private investment, particularly from foreign sources, is more attracted to large-scale power projects, with smaller, distributed projects funded principally by ODA. This exacerbates the existing bias towards ODA in developing countries. A fundamental shift in emphasis will be needed to mobilise private investment, especially from overseas, into smaller developing countries. Bundling smaller projects into portfolios and finding innovative ways of mitigating risk, for example, might help.

Access to technology is an additional barrier, and again one that is particularly relevant for developing countries. More needs to be done to bring promising new technologies to commercialisation, and allowing developing countries to leapfrog the development stage and take advantage of proven renewable energy technologies.

Energy efficiency faces different challenges, which are addressed separately below.

5.3.1 Barriers to Renewable Energy Investment

5.3.1.1 Economic barriers (Costs & Pricing), many of which distort the market in favour of conventional generation, include:

- Higher capital costs, resulting in higher upfront investment for project developers, and also more expensive electricity cost to end-user for renewable energy. In wind projects, for example, almost all the investment is upfront – after which there is no fuel cost, and very little O&M cost. This is at odds with conventional power financing, where fuel, maintenance and interest costs (on a smaller capital amount) can be covered by revenues – hence the current dash for gas.
- Subsidies for conventional generation that distort the market and create an uneven playing field. In non-OECD countries, these amount to nearly $100 billion a year (Goldemberg and Johansson, *World Energy Assessment: Overview 2004 Update*, UNDP).
- Higher transaction costs, relatively, because renewable energy projects tend to be smaller than conventional power plants.
- Fossil fuels being priced without reflecting their cost in terms of carbon or the environment and without taking into account the future cost of fossil fuels / future supply constriction.
- Focus on size - the scale of energy demand in fast-growing developing countries such as China and India favours large-scale conventional generation solutions rather than renewable energy for baseload. In countries with good coal reserves, the field is even more weighted towards conventional generation.
- Payment collection. In many countries, electricity is provided free or heavily subsidised to rural populations, farmers, etc. Electricity theft is also a problem in many countries, and discourages investment.
- Weak infrastructure – electricity grid, transport, etc – which make project development and electricity supply more expensive (for both conventional and renewable projects)

5.3.1.2 Legal & Regulatory barriers, which make it hard for investors to gain access to markets and have confidence that their contracts and offtake agreements will be honoured, include:

- Inadequate legal framework, so that independent power producers may be unable to sell into the electricity grid. It also raises issues about the enforceability of contracts, for example in China.
- Grid connections – utilities may set onerous connection charges, with upfront payments, which may disadvantage smaller generators in particular. Rules on grid access, transmission and cost sharing are often inadequate, lacking transparency and inconsistently applied. Renewable energy generators should be guaranteed priority access to the grid. Transmission access and pricing rules may penalise smaller and/or intermittent renewable energy generators.
- Utilities may set onerous interconnection requirements that disadvantage small power producers, who may be further disadvantaged by excessive requirements for liability insurance
- Planning and siting regulations may be unduly bureaucratic or restrictive, and in some countries, opaque. Onshore wind is running into this kind of problem in developed countries such as the UK.
- Uncertain renewable energy policy (eg non-mandatory targets rather than renewable energy commitments). Consistency and stability of policy is also important. Policies that promote local development (as in China and Brazil) can be a double-edged sword – they do encourage installation of renewable generation and strong local industry, but they can also deter foreign investment.
- Political instability (as in many African countries) is a related barrier to investment

5.3.1.3 Financial & Institutional barriers, which stand in the way of transparent, commercial investment into renewable energy, include:

- Lack of credit for investors or consumers.
- Inability to repatriate profits, often in countries which are most in need of foreign investment (currency restrictions in Africa, for example).
- High risk (perceived or actual) of renewable energy projects and other investments, particularly in developing countries. Shortage of risk capital and insufficient guarantee mechanisms
- Lack of information (technical, geographical and/or commercial) allowing market participants to make sound economic decisions.
- Currency risk for foreign investors
- Fierce competition from local banks (especially in India) so that foreign banks with group offices but no network of banks on the ground stick to markets they know and understand rather than venturing into developing markets

5.3.2 Barriers to Energy Efficiency Investment

Energy efficiency has enormous potential as a fast, cheap and environmentally-sound way of addressing the energy supply-consumption imbalance. Most countries seem to be promoting it more heavily in the transport sector than in residential, commercial and services applications. This may be because it is easier to measure in a transport context (because emissions and consumption are relatively straightforward to measure), and because the rising oil price, which is so obviously linked to fuel consumption in the public's mind, has forced the issue. Furthermore, cars have a shorter lifespan and therefore a shorter investment cycle, making it easier to build better energy efficiency into the industry – unlike boilers, or existing buildings. Initiatives like the Clinton Foundation's programme to retrofit municipal buildings in cities across the world with green technology illustrate the scale of the problem.

Energy efficiency, ideally, should be market-driven. It is usually the supplier (eg electricity generator) or end-user who benefits from more efficient energy use, in the form of fewer transmission losses or lower heating bills. So logically, as the electricity prices and the cost of fuel rise, beneficiaries should instinctively invest in energy efficiency. Education and raising public awareness of energy efficiency's potential is therefore one of energy efficiency's main challenges. Raising financial institutions' awareness and experience of EE investments is also important.

In their report on Energy Efficiency Investment, BASE/SEFI divide energy efficiency into three areas, with financing the main challenge facing each:

- **Energy Efficient Technology Innovation**, which involves inventions and technologies that make energy supply and use more efficient. As with renewable energy technology, the main barrier to technology is financing, from R&D, through to demonstration and commercialisation. Innovative financing approaches are needed, such as public-backed venture capital funds (as in the UK and US) and mechanisms including contingent grants, convertible loans and guarantees.
- **Energy Efficiency Ventures**, usually small to medium sized enterprises (SMEs), including Energy Service Companies (ESCOs). ESCOs are an important market driver: in developed markets, they assume the cost of equipment, process replacement and building retrofit via an Energy Performance Contract (EPC). Their return takes the form of a percentage of energy savings. Again, financing is a key barrier at this level. ESCOs face critical funding gaps, and need seed financing and other later-stage equity instruments until they can raise debt and guarantee mechanisms for expansion.
- **Energy Efficiency Projects**, which usually pay for themselves via the energy savings they generate. However, upfront costs such as an energy audit and reduction recommendations have to be financed directly. Projects are often funded internally by the end-user or power generator, who accepts that payback will follow in the form of savings, but debt instruments, guarantees and third-party financing can all help at this stage.

5.4 The Funding Gap

There is a significant funding gap between current levels of investment and investment required by 2030. Under the mitigation scenario (BAPS), annual investment of $63.7 billion is needed to install an additional 48GW of renewable energy capacity each year. On a global basis, this is more than double current levels of investment, and nearly three times current capacity additions.

Required Renewable Energy Capacity (GW) and Investment ($) by 2030

	2005 (Report)	**2005 (BAPS)**		**2030 (Reference Scenario)**			**2030 (BAPS)**		
	$ billions	GW	$ billions	GW	$ billions	*% increase in invt*	GW	$ billions	*% increase in invt*
World	**$29.3**	**17.2**	**$28.5**	**26.9**	**$34.4**	***21%***	**47.5**	**$63.7**	***124%***
OECD	$24.6	12.8	$21.5	18.4	$22.7	*6%*	30.0	$39.8	*85%*
non-OECD	$4.7	4.3	$7.0	8.5	$11.7	*68%*	17.5	23.8	*241%*
OECD North America		3.4	$6.5	5.6	$6.6	*1%*	10.2	$12.3	*88%*
OECD Pacific		0.8	$2.5	1.4	$2.6	*4%*	3.0	$5.6	*123%*
OECD Europe		8.6	$12.5	11.4	$13.5	*8%*	16.9	$22.0	*76%*
Transition Economies		0.4	$0.7	0.7	$0.8	*21%*	1.2	$1.4	*103%*
Developing Countries		3.9	$6.3	7.8	$10.9	*73%*	16.3	$22.5	*256%*
China		1.8	$2.9	3.6	$4.4	*52%*	8.0	$9.5	*230%*
India		0.7	$1.1	1.4	$2.0	*89%*	2.7	$3.8	*257%*
Brazil		0.3	$0.6	0.5	$0.8	*39%*	0.6	$0.8	*43%*
Africa		0.3	$0.6	0.7	$1.4	*121%*	1.5	$2.9	*381%*
Middle East		0.2	$0.2	0.3	$0.6	*140%*	0.7	$1.5	*515%*

Notes: Energy Efficiency (and associated investment) is implicit in these numbers

Renewable energy includes small hydro, but excludes biomass (to maintain consistency with the rest of this section). Biomass capacity and required investment is discussed separately below.

Source: UNFCCC (WEO – RS / BAPS spreadsheets)

Investment identified under the scenario forecasting applies to generation capacity only. Investment will also be needed in the supply chain (equipment manufacturers, project developers, installers, O&M companies) to underpin this expansion of installed generation capacity.

New Energy Finance estimates that the global investment in renewables required to close the gap until 2020 is roughly $900 billion. Over 14 years, this is equivalent to $64 billion a year – which is in line with the BAPS scenario above. However, this represents investment in projects / assets only, so once supply chain investment is factored in, the requirement is probably closer to double this: $2,000 billion, or some $140 billion a year. This should be achievable: New Energy Finance expects annual investment in renewable energy to reach $100 billion a year by 2009 (it was $70 billion in 2006). Investment volumes are likely to continue to grow strongly and will exceed the required average annual investment of $140 billion well before 2020.

Closing the investment gap may be within reach. More challenging, though, will be ensuring that investment flows to the countries / regions that need it most. Between now and 2030, OECD countries' share of global investment will fall, with developing countries requiring significantly higher levels of investment than they are currently receiving. From the table above, for example, investment in developing countries needs to increase from $5-6 billion a year currently to $23 billion in 2030 (under BAPS), an increase of more than four times. And this is just investment in generation capacity – total investment required is therefore likely to be even higher.

Countries with the lowest levels of investment (Africa, the Middle East) have the biggest gap to close in % terms, even though their required investment in $ terms is relatively modest compared to China and India. Africa probably faces the greatest challenge, needing to attract capacity investment of nearly $3 billion a year from a base of almost nothing.

The World Bank is stepping up its support for renewable energy in developing countries. In a recent report (Clean Energy for Development Investment Framework: The World Bank Group Action Plan, March 2007), it says that its lending for low carbon projects has grown from roughly $633 million a year in 2003-05 to about $1.7 billion in 2006 representing, in 2006, 37% of new commitments, as compared to 14% in 2003. However, much of this is focused on the "Plus 5" countries (China, India, Brazil, Mexico and South Africa), which are already seeing increased investment from other sources.

The table below illustrates the scale of investment shift required between developed and developing countries. Non-OECD countries need to triple their share of global investment into renewable energy between now and 2030.

Investment split between OECD and Developing Countries

	2005 (report)	2005 (BAPS)	2030 (RS)	2030 (BAPS)
World	**100%**	**100%**	**100%**	**100%**
OECD	87%	75%	66%	63%
non-OECD	13%	25%	34%	37%
OECD North America		23%	19%	19%
OECD Pacific		9%	8%	9%
OECD Europe		44%	39%	35%
Transition Economies		2%	2%	2%
Developing Countries		22%	32%	35%
China	6%	10%	13%	15%
India	2%	4%	6%	6%
Brazil	1%	2%	2%	1%
Africa		2%	4%	5%
Middle East		1%	2%	2%

Source: New Energy Finance, UNFCCC / WEO (RS/BAPS)

Wind will continue to dominate the renewable energy mix in both developed and developing countries. The greatest shifts will be in solar, where a massive increase in installed solar in developing countries is needed, and in marine/tidal energy, where developed countries will see a significant increase in generation capacity. This reflects the element of risk associated with these emerging and relatively unproven technologies. In contrast, developing countries will dominate mini-hydro new capacity additions, reflecting the fact that the best hydro sites have mostly already been exploited in developed countries. Overall, however, mini-hydro will play a smaller role in developing countries' renewable energy mix in 2030 than it currently does.

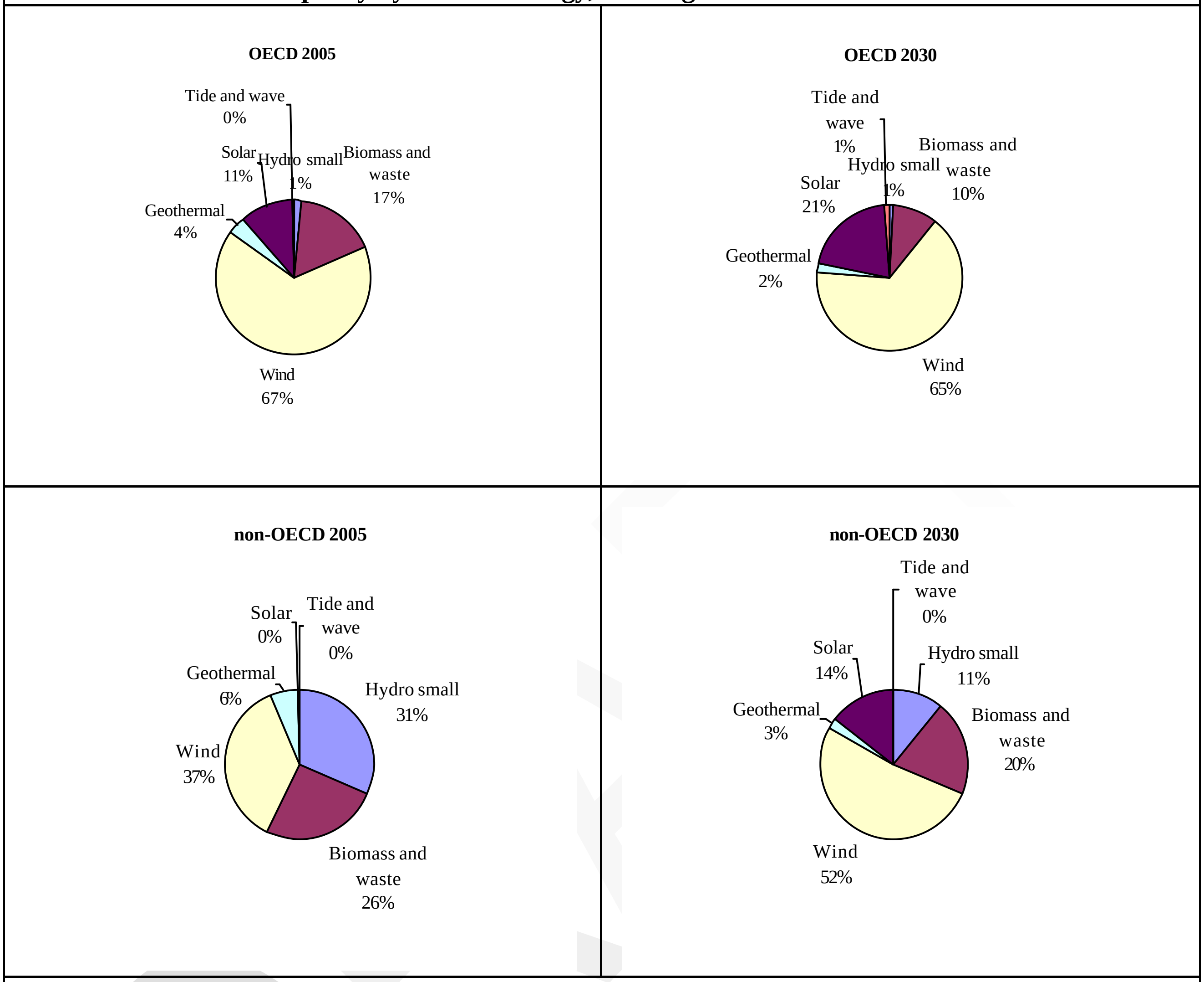
The table / charts below illustrate how the renewable energy mix is likely to change in developed and developing countries between 2005 and 2030.

The RE Technology Picture in 2030 (based on BAPS scenario)

	Hydro small	Biomass and waste	Wind	Geothermal	Solar	Tide and wave	Total RE
Required annual capacity additions (GW)							
World	2.6	7.9	33.2	1.2	10.0	0.5	**55.4**
OECD	0.2	3.4	21.8	0.6	6.9	0.5	**33.4**
non-OECD	2.4	4.5	11.3	0.6	3.1	0.0	**22.0**
Share of annual new capacity							
OECD	9%	43%	66%	52%	69%	95%	**60%**
non-OECD	91%	57%	34%	48%	31%	5%	**40%**
Required % increase in annual investment							
World	32%	81%	113%	12%	206%	608%	**114%**
OECD	1%	27%	74%	-6%	113%	575%	**73%**
non-OECD	36%	181%	313%	41%	8222%	n/a	**223%**

Notes: investment increase is based on change in investment under BAPS, between 2005 and 2030
Biomass & waste has been included in this table (although excluded in previous tables) to show its share of the overall RE mix
Source: New Energy Finance, UNFCCC / WEO (RS/BAPS)

Share of Annual New Capacity by RE Technology, showing evolution from 2005 to 2030



Source: New Energy Finance, UNFCCC / WEO (RS/BAPS)

5.5 Overcoming Barriers to Investment / Closing the Gap

The private sector will continue to be the most important source of investment in renewable energy between now and 2030. New Energy Finance estimates that global investment in clean energy will reach $100 billion per annum by 2009 – compared to the estimated $140 billion annual investment required by 2030.

There is no shortage of finance available worldwide at the moment; in fact, there is too much money chasing too few good deals – hence the need to speed up the route to market for new, ground-breaking technologies. Much of this money, however, is chasing opportunities in Europe and the US. The current imbalance therefore represents a real opportunity for developing countries. As the European and US markets become increasingly competitive, investors will continue to turn to emerging markets such as India and China, and will then look beyond them to less developed countries – many of whom have until now lacked the momentum and profile to attract this kind of attention. But if these countries are to capitalise on the weight of money favouring renewables and energy efficiency, they must address at least some of the barriers outlined above. Investors currently complain about a lack of financeable / bankable projects in developing countries, rather than a finance gap.

Firstly, governments must create an environment that is conducive to investment, including supportive policy, a sound legal system, infrastructure investment (where needed) and so on. However, it is important to note that in order to improve the return on investment in a particular company or project, it is not always necessary to offer subsidies or policy mechanisms to increase revenue. Investors will be just as attracted by policy that serves to reduce risk, cost or time-to-market. Regulation should be 'SMART' (Specific, Measurable, Ambitious, Realistic and Time-framed) as well as light-handed and market-sensitive.

It is also vital that local and national governments work together. In China, for example, the government's efforts to improve national energy efficiency are being thwarted by local government incentives for coal power plants. In the US, the problem is the other way round: states are implementing their own Renewable Portfolio Standards, while the federal government is dragging its feet on introducing a national RPS. Policies need to be supported at all levels of the government structure. Beyond this, on a global level, cooperation and consistent goals between different countries will help to coordinate investment and reduce carbon emissions.

However, there is no "one size fits all" policy solution. Different countries need different incentives depending on the issues they face, capital markets, wealth and natural resources. As Alan Miller points out in Financing Integration of Climate Change Mitigation into Development, while political uncertainty is the constraint most often cited in business surveys, the issues are country-specific. In Bangladesh the number one issue is lack of reliable power, in Hungary high tax rates, and in Guatemala crime, theft and disorder.

There are, however, certain features which are relevant to policies regardless of country: they need to be long-term, stable and as straightforward/transparent as possible, but also market-sensitive. Policy should be used to create a tipping point in favour of renewable energy – once this point has been reached, market forces should be allowed to take over, gradually.

- Increased investment in RE in **developed countries** requires effective mandatory policies – the rest will follow, with the market and emerging technologies as co-drivers of investment. In the 94th Thomas Hawksley Memorial Lecture to the Institution of Mechanical Engineers in December 2006, Sir John Houghton CBE FRS (co-chairman of the Scientific Assessment for the IPCC from 1988-2002) said: "A long-term perspective is required. I like to think of it in terms of a voyage. For the boat we are taking, technology can be thought of as the engine and market forces as the propeller driven by the engine. But where is the boat heading? Without a rudder and someone steering, the course will be arbitrary; it could even be disastrous. Every voyage needs a destination and a strategy to reach it."

- **Developing countries with fast-growing economies** are already starting to attract international funding, in spite of policy and structural weaknesses. Foreign investment remains relatively modest, but there is strong momentum behind these flows and they will increase as policy continues to evolve (eg India's forthcoming renewable energy law and new feed-in tariff) and markets open up (eg 60% wind restriction in Brazil being lifted). This momentum needs to be sustained, with market-based policies to increase these markets' attractiveness and security.

- In **other developing countries** increased investment in RE will require country-specific changes in domestic policies related to RE and to foreign investment, as well as an increase in international funding. Renewable energy currently accounts for less than 20% of total energy ODA to developing countries (source: CRS/analysis earlier in section) – renewable energy needs to increase its share of ODA, both of funding destined for energy investment, but also broader social/environmental ODA. In these countries, multilateral and bilateral funding also has an important role to play in co-financing and providing guarantees to increase levels of private investment.

Secondly, financing structures must evolve to meet the needs of the increasingly wide range of projects, locations, technologies and investors. The scale of finance needed means that financing must move on from small-scale venture capital funding and onto large-scale project finance and public market capital. To a certain extent, this shift will happen naturally as technologies are proven, reach commercialisation and, ultimately, compete with conventional energy sources.

- **Introduce "industrial strength" mechanisms to finance large projects in the developing world**. This level of funding can only be provided by private sector investors, but they are currently deterred by three factors: sovereign risk; legislative instability of regulations covering renewable energy investment; and governance risk. Current mechanisms are inadequate to deal with the volume of funding required. Multilateral organisations like the World Bank, EBRD, Asian Development bank and Germany's KfW are an important source of finance, but can only offer part of the solution. Traditional trade finance works for larger projects, but not distributed projects.
- **Be creative about financing and supporting smaller projects**. The IFC, for example, is in the first phase of a new project in Sri Lanka (Portfolio Approach to Distributed Generation Opportunities, PADGO) which is bringing together renewable energy projects (distributed generation / CHP) to provide risk sharing and technology diversification. Phase 1 of the project is being funded by the GEF, IFC and local financial institutions.
- **Develop retail and lease finance models for home and small business-scale clean energy projects**. Access to finance (as provided in the car industry, for example) would encourage consumers to invest in clean energy solutions, which are often disadvantaged relative to conventional energy on cost grounds. Immediate savings are valued over long-term benefits, particularly when it comes to heating, air-conditioning and building insulation. Consumers (particularly in developed countries) are price-sensitive, but want to behave in an environmentally-friendly way: making doing so cost-effective would tip the balance.
- **Roll out microfinance programs for small-scale projects in the developing world**. The key question facing many developing world countries is not how to generate power from clean sources, but how to provide power at all to much of their population. However, with the current high costs of oil and gas, clean energy can offer cheaper solutions in many situations, for example, rural electrification through solar power in grid-remote communities and biodigesters for heat and power. The initial finance for such solutions is, however, problematic. The only way to provide it efficiently on a substantial scale is through the development of microfinance initiatives.
- **Break the offshore wind funding bottleneck.** This is a policy as well as a finance issue. Offshore wind has the potential to produce clean electricity on a large scale, than most other forms of renewable energy. However, the market is currently in gridlock, with permitting problems (in both the US and UK), logistical challenges and lack of access to funding. Many developing countries have extensive west-facing coastlines and are well suited to offshore wind (Latin America, Africa, India much of Asia). As the penetration of hydroelectric and onshore wind power in more and more countries saturates, offshore wind represents the single best opportunity for large-scale development of renewable energy resources. One problem is the cost of offshore wind, around double that of onshore wind, due to the hostile environment, long distance to grid feed-in points and higher maintenance costs. The other is lengthy permitting processes, with up to 15 different agencies involved. No large-scale energy source has ever been developed without substantial legislative and fiscal support. Offshore wind will be no different.
- **Ensure the survival and extension of carbon trading**. The European Emissions Trading Scheme (EU-ETS) was a pioneering development which created new pools of finance to fund clean energy projects. Yet the combination of weak National Allocation Plans (NAPs) and abundant credits from the developing world and former Soviet block (CDM and JI credits) have swamped the system and suppressed the carbon price. The ETS needs to evolve in at least some of the following ways: extension to cover air travel and a greater proportion of Europe's industry; meaningfully tight NAPs, set by a competent and believable independent authority; a limit to the number of credits that can flood the

system from outside Europe. New Energy Finance is confident that Phase II of the ETS (2012 forward) will take into account the shortcomings of Phase I, and believes that other countries can also learn from this to establish their own cap and trade systems.

- **Encourage CDM projects**. CDM is stimulating both RE and EE investments in developing countries, however the strength of the stimulus varies by type of project. Some types of EE projects may be better suited to "programmatic CDM'. The challenge of increasing CDM activity in countries such as Africa is already being addressed.

Thirdly, new technologies must be fostered and commercialised to develop the renewable energy and energy efficiency technologies of tomorrow. Growing demand will stimulate the development of new technologies, but the process can be speeded up by promoting business incubation and boosting the availability of venture capital for new technologies, beyond the US. Increasing the number of opportunities available, for example by increasing very early stage support, will allow investors more diversification between different technologies and make them more likely to invest at the high-risk pre-commercialisation stage.

- **Accelerate the incubation of new technologies**. The success of clean energy business incubation programmes, whether public sector or private sector, can be greatly enhanced by creating a suitable legislative and cultural environment and by providing them with information and networking services.
- **Support technology companies through their early stages**. This could include improving the macroeconomic environment for early stage technology companies; identifying and breaking down regulatory barriers; reducing investment risk by improving stability and longevity of clean energy support mechanisms; and reducing technology and commodity risk, including developing mechanisms to support pilot projects which need debt but still have technology risk.
- **Increase the market size for renewable technology**. For example, by using the public sector to create markets through preferential procurement of clean solutions and rolling out pan-European (and beyond) standards for clean energy, fuels and technologies
- **Ensure the developing world has access to the most energy-efficient generation and industrial technologies**. The developing world has an opportunity to leapfrog the mistakes made by the developed world in its choices of energy sources. Just as many of the former Soviet countries passed on the development of land-line phone systems and went straight to mobile networks, so developing countries can move directly to the best clean energy solutions. Too often these newer technologies are not being made available to developing countries – either through fear of intellectual property theft or because they are marginally more expensive than existing technologies.

Energy efficiency is an important part of closing the investment gap: the more efficiently energy is used, the less generation capacity countries will have to install. Developed countries should be encouraged to lead the way in energy efficiency, setting an example in reducing per capita energy consumption and developing technologies. Achieving improvements will take political leadership to change consumer attitudes, new regulations to insure compliance, and funding for new technologies. But this is an area where government must take the lead because consumers have shown they are generally not price-sensitive to energy costs and are thus rarely willing to make long-term investments to improve the energy efficiency of their homes or automobiles. There will be an economic prize for countries that lead - rather than lag - the trend in energy efficiency.

A shift in financiers' attitude to energy efficiency is also needed. Energy efficiency technologies are already being financed at a VC/PE level. But EE ventures and projects are harder to fit into the financing spectrum: there is usually no visible infrastructure (so no collateral) and no revenue stream. The concept of financing energy savings, guaranteed through performance contracts, needs to be accepted.

In developing countries, energy efficiency presents a different opportunity. Fast-growing economies should be able to take advantage of the latest EE technology as they increase their generation capacity from the bottom up. It is easier (and cheaper) to build energy efficient generation than to retrofit existing plant, giving countries like China an advantage.

In other developing countries, multilateral organisations can incorporate energy efficiency into many of their projects and encourage EE financing mechanisms to be developed.

Making finance available for energy efficiency will clearly help its adoption: the presence of global banks in the Clinton Foundation's 16 Cities programme is fundamentally important to its success. But in spite of energy efficiency's obvious benefits (increased energy security, lower pollution and maintenance costs), it remains surprisingly hard to mobilise cost-effective investment in renewable energy. This means that mandatory policies, such as minimum standards for buildings and applicances, may also need to be introduced.

Private finance will continue to flow into both renewable energy and energy efficiency on a global basis, as investors see opportunities to increase value in both the short and long term. In 2005, there was a surge of new fund targeting the renewable energy and energy efficiency sector. However, there was a shortage of high quality venture-type investment opportunities, despite the rapid growth of the clean energy industry. According to New Energy Finance's data only $1 billion of traditional Venture Capital investment took place in 2005.

One reason for the low levels of venture capital funding lies in the nature of innovation required. Broadly speaking, clean energy technologies have already been proven to "work". Wind turbines provide nearly 30% of the power in Schleswig-Holstein in Germany; flex-fuel cars dominate in Brazil; and solar PV is already the technology of choice for a myriad of specialist applications. Even fuel cells have now found viable niche applications – in space, some uninterruptible power supplies, and high-end recreational vehicles.

The biggest challenge for many clean energy technologies now lies in reducing costs compared with fossil-fuel derived solutions. This will be achieved through a combination of three factors: economies of scale which are realised naturally as the industry grows; process improvement, which is generally undertaken by incumbent suppliers; and breakthrough technologies, which can leapfrog onto new, lower-cost experience curves. Only the last of these has relevance for venture capital funding.

Another reason for the lower-than-expected levels of venture capital investment in clean energy lies in the lack of experienced entrepreneurs. This is changing, as the clean energy industry grows its own crop of serial business-builders as well as attracting talent from other industries, but this is a slow process.

Looking forward, a number of good "classic" venture capital opportunities in clean energy will continue to show healthy growth, but no explosion. It will remain below what one might expect given the level of attention that the sector is currently attracting in the press and the venture capital community. Analogies between the clean energy and biotech industries are misleading. In biotech, development capital is required for research, for running trials, or for business development. Once a breakthrough technology is proven, scaling up manufacturing is rarely capital-intensive. Generating energy on a gigawatt scale, by contrast, requires either building industrial-scale assets, or rolling-out distributed programmes – either of which requires substantial time and money.

New and improved technologies will continue to emerge as research incubators, universities, corporates and government backed R&D organisations develop renewable energy and energy efficiency solutions, such as thin-film photovoltaics and cellulosic ethanol. Investment in these technologies and organisations will be encouraged through transparent regulations and policies that assure investors of long-term sustainable returns from the sector. Policies that reduce unnecessary risk, accelerate time to market and allow for growth over the long term are key – in both OECD and developing countries.

5.6 Conclusion

- Global investment in renewable energy and energy efficiency was $29.3 billion in 2005. Renewable energy attracted investment of $27.8 billion, energy efficiency (technology) $1.5 billion. Most investment currently comes from private sources, and flows into developed countries (87%). Multilateral and bilateral funding for renewable energy accounted for less than 4% of total investment in 2005.
- There is a clear link between supportive government policy (backed by deep financial markets) and investment in RE/EE. Countries with favourable and stable policy for renewable energy and energy efficiency have the highest installed renewable energy capacity. Policy will become less important as technologies mature, but it will remain an important driver for emerging technologies and for developing countries. There are no hard and fast rules about which policies work: this will vary according to countries' wealth, natural resources and specific challenges (eg low FDI, weak infrastructure, overcrowding, and so on), but policy should be long-term, stable, and transparent. It should also allow for market forces to take over once a tipping point in favour of renewable energy has been reached. This imperative is strongest in developing countries (where market forces are weaker, and good natural resources combined with fast-growing energy demand favours conventional generation), and for emerging technologies.
- By 2030, the required global annual investment for renewable energy and energy efficiency (efficiency savings are implicit in demand forecasts) will range between $34 billion and $64 billion (RS vs BAPS, respectively). These figures are for investment in new generation capacity; the true investment required, including financing the supply chain to support new projects, may be as much as double this, at around $140 billion a year.
- Forecast investment in 2030 involves a significant shift towards developing countries, which account for around 13% of global investment in renewable energy in 2005, but are expected to account for 34%-37% in 2030. The challenge is greatest in countries with negligible investment in renewable energy currently, such as those in Sub-Saharan Africa.
- Most of the required investment will come from the private sector, which already accounts for well over 90% of investment in renewable energy. There is enough investment to meet demand: New Energy Finance's latest estimates suggest that annual investment in renewable energy and energy efficiency will reach $100 billion by 2009. The challenge will be making sure investment flows to the countries where it is needed most. To make sure this happens, several barriers – financial, political and technological – must be overcome.

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