EUROPEAN REPORT ON DEVELOPMENT

FINANCING RENEWABLE ENERGY IN DEVELOPING COUNTRIES: MECHANISMS AND RESPONSIBILITIES

Prof Stephany Griffith-Jones, Initiative for Policy Dialogue, Columbia University,
Prof Jose Antonio Ocampo, Initiative for Policy Dialogue, Columbia University,
Dr Stephen Spratt, Institute of Development Studies

MOBILISING EUROPEAN RESEARCH
FOR DEVELOPMENT POLICIES

SYNOPSIS

This paper reviews the instruments currently in use to finance renewable energy in developing countries, and considers those that have been proposed but not yet fully employed.

This paper served as a background paper to the European Report on Development 2011/2012: *Confronting scarcity: Managing water, energy and land for inclusive and sustainable growth*. The European Report on Development was prepared by the Overseas Development Institute (ODI) in partnership with the Deutsches Institut für Entwicklungspolitik (DIE) and the European Centre for Development Policy Management (ECDPM).

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Abbreviations

AfDB	African Development Bank
CAF	Corporación Andina de Fomento
CAPEX	Capital expenditure
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CO_2	Carbon Dioxide
COP	Conference of the Parties
CSP	Concentrated Solar Power
DFI	Development Finance Institutions
EIB	European Investment Bank
ETS	European Trading System
ETS	European Trading System
EU	European Union
FIT	Feed-in tariff
FTT	Financial Transaction Taxes
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GhG	Greenhouse gas
IEA	International Energy Agency
IFC	International Finance Corporation
IIED	International Institute for Environment and Development
IPPC	Intergovernmental Panel on Climate Change
JREC	Johannesburg Renewable Energy Coalition
KwH	Kilowatt hour
LDCs	Least Developed Countries
LICs	Low-income countries
MICs	Middle-income countries
NO_x	Nitrogen oxide
PACE	Property Assessed Clean Energy
PFM	Public Finance Mechanisms
R&D	Research and development
REDD	Reducing Emissions from Deforestation and Forest Degradation
REED	Rural Energy Enterprise Development
RPS	Renewable Portfolio Standards
SCAF	Seed Capital Assistance Facility
SRIs	Socially Responsible Investors
SWF	Sovereign wealth fund
UK	United Kingdom
UNEP	United Nations Environment Programme
US$	US dollars
USA	United States of America
WEF	World Economic Forum
WTA	Willingness to accept
WTP	Willingness to pay

Introduction

In order to halve current carbon emissions, the International Energy Agency (IEA) estimates that, globally, US$45 trillion needs to be invested in renewable energy by 2050. This equates to a little over US$1 trillion per year on average; in 2010 global investment in renewable energy reached a record high of US$243 billion (UNEP and Bloomberg New Energy Finance, 2011), roughly a quarter of what is needed.

While halving global emissions seems a daunting task, it is at the bottom of the range of what is required. In order to have a reasonable chance of keeping temperature increases below 2°C–2.4°C – the level beyond which scientists fear that feedback mechanisms could be triggered – the Intergovernmental Panel on Climate Change (IPPC) estimates that global emissions need to fall by between 50% and 85% by 2050. We are nowhere near on track to achieve this; global emissions would need to peak by 2015 and decline rapidly thereafter, but are still increasing at an accelerating rate. If current trends continue, the United Nations estimates that global temperatures could increase by more than 6°C over the course of the century, which is far beyond levels that human civilisation has ever experienced (Hansen et al., 2008).

The situation is thus challenging to say the least. Of the estimated US$1 trillion of annual investment required, around half is needed for energy efficiency or to replace existing technologies (e.g. fossil fuel-based with renewable energy systems). Much of this is in the developed world, but US$530 billion per year is needed for newly installed capacity, mainly in developing economies. It is estimated that 85% of this total investment will need to come from private sources (IEA, 2009).

While this is daunting, particularly the target for private investment, it is not impossible. Annual fossil-fuel subsidies, for example, are around US$300 billion per year, which means that US$530 billion of investment in 2030 would represent only 3% of global investment.

Although many felt that the 15th Conference of the Parties (COP15) in Copenhagen in 2009 was a disaster, COP16 held in Cancún in 2010 gave grounds for more optimism about the possibility of reaching a global deal. Also, despite the difficulties in the intergovernmental negotiations, neither the financial crisis and recession, nor the failure at Copenhagen, was able to derail investment growth – global investments in renewable energy reached record levels in 2010. We remain well short of where we need to be, but investment is growing rapidly, and a range of incentivising instruments have been employed to support this investment. We now have a clearer understanding of the potential and limits of such instruments, and a range of proposals has emerged to fill gaps or address weaknesses in the current portfolio of tools available to policy-makers.

The purpose of this paper is to review the instruments we currently have, and to consider those that have been proposed but not yet fully employed. To do this, however, we need to understand why such instruments are needed in the first place, or, to put it another way, why investment is not already flowing to the extent required. Section 2 then reviews mechanisms in the light of this, while Section 3 considers international transfer mechanisms and concludes.

1 Why is private renewable energy investment insufficient?

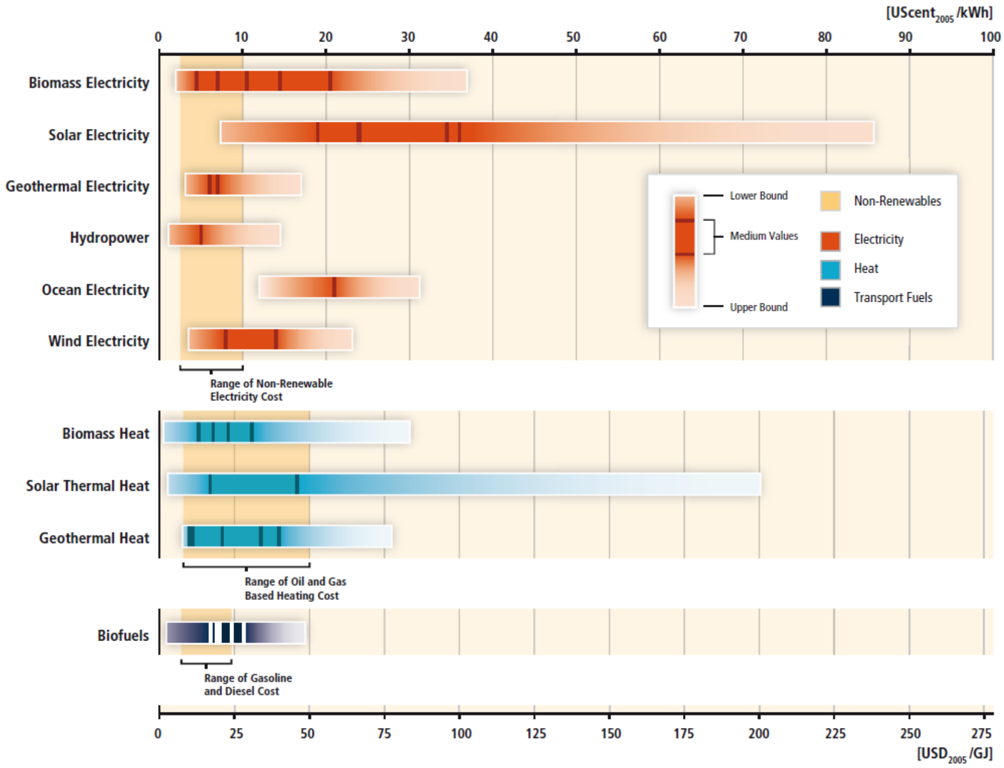
Before considering how private investment could be increased to the extent needed we need to understand the current obstacles. These can be organised into three categories:

1. The economics of renewable energy
2. The supply of finance
3. Uncertainty and risk

1.1 The economics of renewable energy

First and most fundamentally, the economics of renewable energy are generally not competitive, as production costs per unit of energy are usually higher than for fossil fuels.

Figure1.1 Relative costs for renewable energy technologies compared with each other, and with non-renewable energy



Source: IPCC, 2011

Figure 1.1 shows relative costs for renewable energy technologies compared with each other, and with non-renewable energy. As we can see, non-renewable costs are in the range of US$0.3–US$0.10/KwH, while most renewable forms are more expensive and have a far greater cost range. In part, this reflects the relative maturity of technologies, but the significant cost difference of renewable energy production (depending on factors such as wind speed and degrees of solar intensity) is also a major factor. Finally there is a matter of scale: fossil-fuel technologies have been developed, improved and manufactured on an increasing scale for a century, which is not the case for the renewable sector.

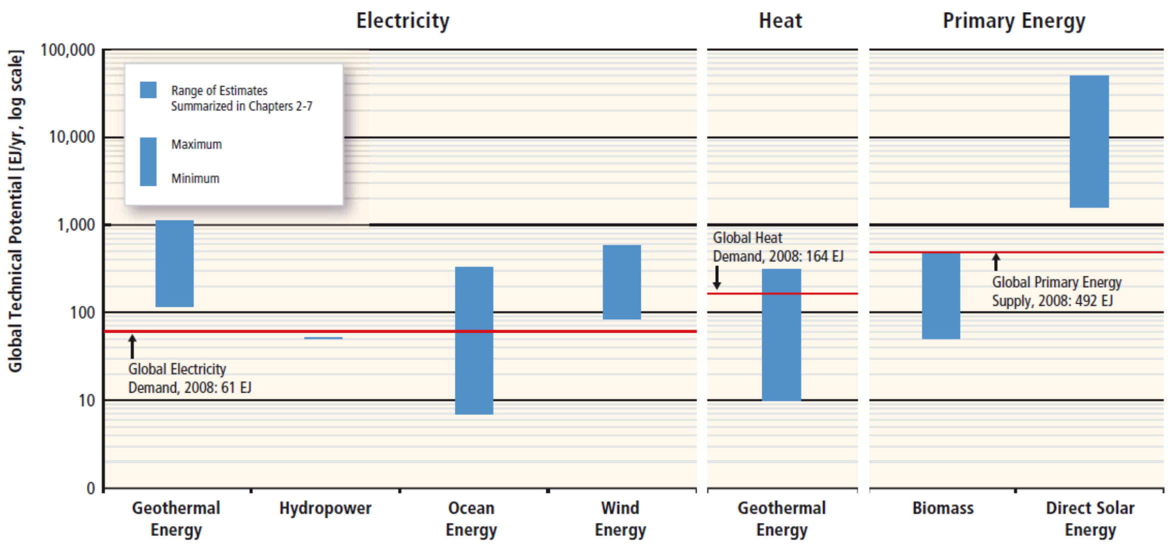
All of these factors suggest scope to reduce renewable production costs. As Figure 1 illustrates, however, this varies considerably by sector. The most expensive is 'ocean' (or tidal) electricity, which, even at the bottom of the potential cost range, remains uncompetitive with fossil fuels. The next is solar power. At its cheapest, it is potentially competitive with fossil fuels, but mid-range costs are well above fossil fuels. For solar power, the wide range reflects the cost implications of different technologies. For example, large-scale Concentrated Solar Power (CSP) techniques employed in a desert environment could produce electricity at a far lower cost than small solar panels fitted to residential properties. Wind power is potentially cheaper still, but remains more expensive than fossil fuels in most instances. Again, the range reflects differing scales of energy generation, but also the different cost structures of onshore and offshore wind. Finally, biomass, geothermal and hydropower in particular are already competitive with fossil fuels in some circumstances (IPCC, 2011).

In addition to the absolute costs of renewable energy production, costs relative to fossil fuels are also important. Three points should be stressed. First, fossil-fuel energy does not reflect its full social costs. In 2006, the Stern Review described climate change as the 'biggest market failure in history' as the environmental costs associated with carbon emissions are not included in market prices (Stern, 2006). Not only are these externalities not reflected in prices, but fossil fuels are actually subsidised to the tune of US$300 billion per year. Removing these subsidies and incorporating external costs into non-renewable energy costs would dramatically change relative costs. For the latter, carbon taxes would be ideal, but if that is not feasible politically, it may be desirable to add a shadow price of carbon to evaluations of energy projects by public agencies (see below, and also Griffith-Jones and Tyson, 2011 for European Investment Bank (EIB) experience on this).

Second, it is more expensive to deliver non-renewable energy in some places than others. For example, rural communities in developing countries are often not connected to grids, so that localised, 'off-grid' energy production – particularly solar power – is more competitive than in a fully networked context.

Third, as shown in the Figure 1.2, there is no shortage of renewable energy potential at the global level. In terms of primary energy, it is already technically possible to generate many multiples of global energy supply using solar energy. Similarly, there is ample wind or geothermal power to meet all of today's global electricity demand.

Figure 1.2 Ranges of global technical potentials of RE sources



Range of Estimates of Global Technical Potentials

	Geothermal Energy (Electricity)	Hydropower	Ocean Energy	Wind Energy	Geothermal Energy (Heat)	Biomass	Direct Solar Energy
Max (in EJ/yr)	1109	52	331	580	312	500	49837
Min (in EJ/yr)	118	50	7	85	10	50	1575

Source: IPCC, 2011

Perhaps more importantly, much of this global solar power potential is concentrated in developing countries, but there is also high potential in other areas.

Table 1.1 Top ten countries globally in terms of renewable energy potential relative to energy use

Years of Energy Use	Potential
Mongolia	66.19
Mauritania	30.11
Namibia	28.14
Chad	23.00
Bolivia	20.15
Niger	19.08
Mali	16.88
Congo	16.80
C. African Rep.	13.92
Guyana	11.10
Source: Buys et al. (2007)	

Table 1.1 lists the top ten countries globally in terms of renewable energy potential relative to energy use. That they are all developing countries is partly a reflection of their relatively low energy use at present, but also the relative abundance of solar, wind, hydro and geothermal energy.

It is therefore clear that there is significant scope to increase the use of renewable energy in developing countries. This is not limitless, however. Although we can expect the costs of renewable energy to continue to fall relative to fossil fuels, particularly in countries with high renewable energy potential, fossil fuels are likely to retain a cost advantage in most cases.

Two important conclusions can be drawn from this. First, the basic economics of renewable energy need to be artificially altered, either by increasing the cost of fossil fuel-based energy (e.g. through taxes or equivalent mechanisms), or by reducing the costs of renewable energy (e.g. subsidies), or by boosting the returns to renewable energies (e.g. through paying a premium for this form of energy).

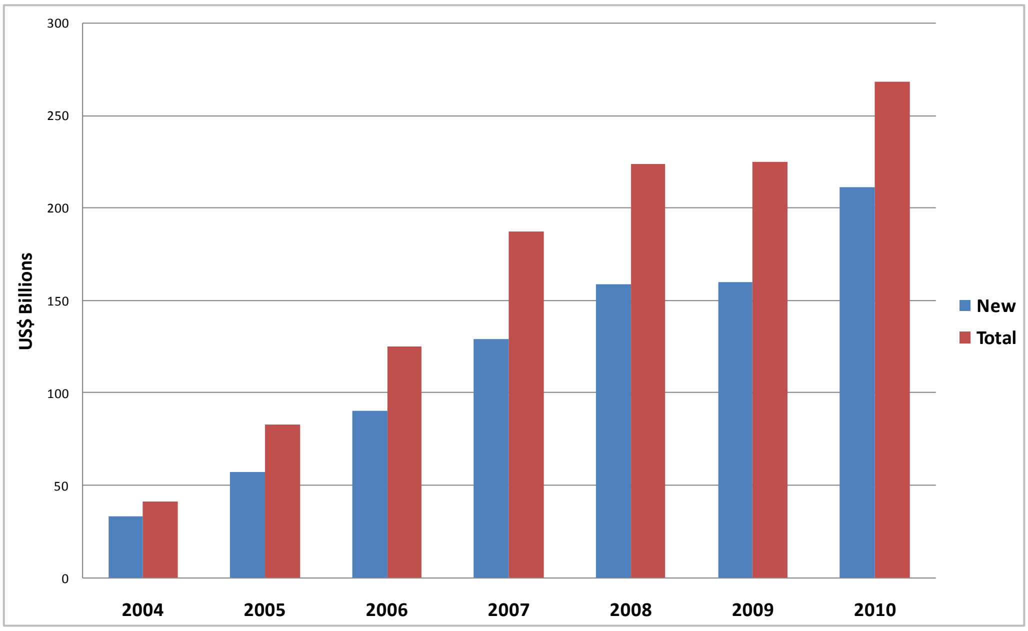
Second, it does not follow that developing countries should be required to meet these costs. Where it is the case that employing renewable technologies makes economic sense, this is not an issue – only limited incentives are needed and it is reasonable to expect them to be met domestically because of the benefits that will accrue to the country. However, where the development of renewable energy capacity could place countries at a competitive disadvantage and/or *these countries bear no responsibility for climate change*, the costs should be met by countries that do bear such a responsibility. This case is even stronger while developed countries are subsidising fossil-fuel energy.

This suggests that, in most cases, low-income countries (LICs) should generally not be expected to subsidise the development of a renewable energy sector. Significant implications result from this, which we shall return to throughout this paper.

1.2 The supply of finance

Despite the issues described in the previous section, renewable energy investment (i.e. total private and public investment) has increased six-fold in as many years, from US$41 billion in 2004 to US$268 billion in 2010.

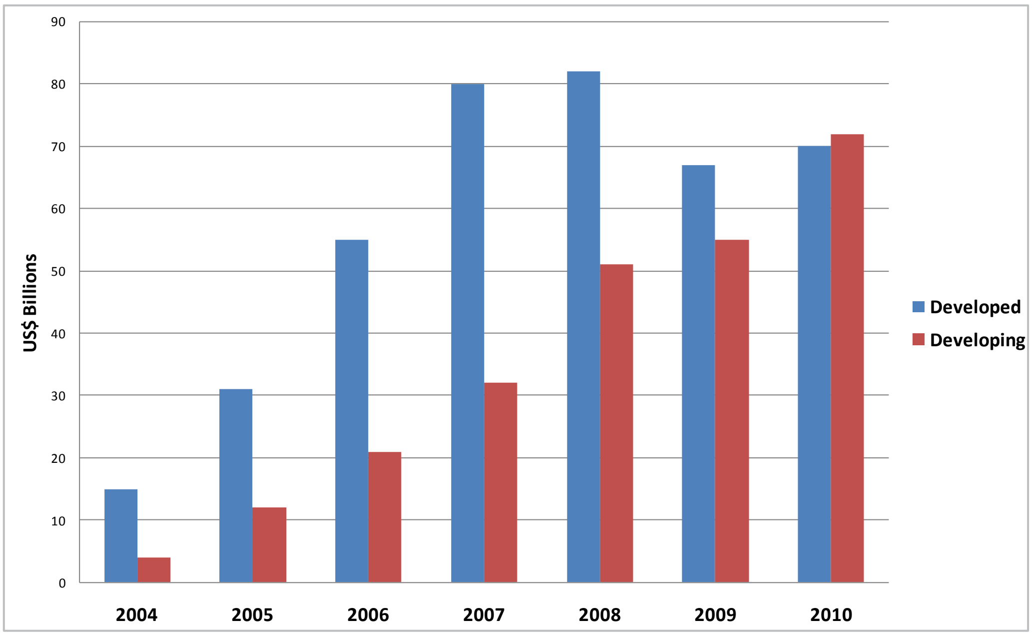
Figure 1.3 Global Renewable Energy Investment, 2004-10



Source: UNEP and Bloomberg New Energy Finance, 2011

Furthermore, after dominating global investment for years, developed economies have now been surpassed by investment in renewable energy in the developing world.

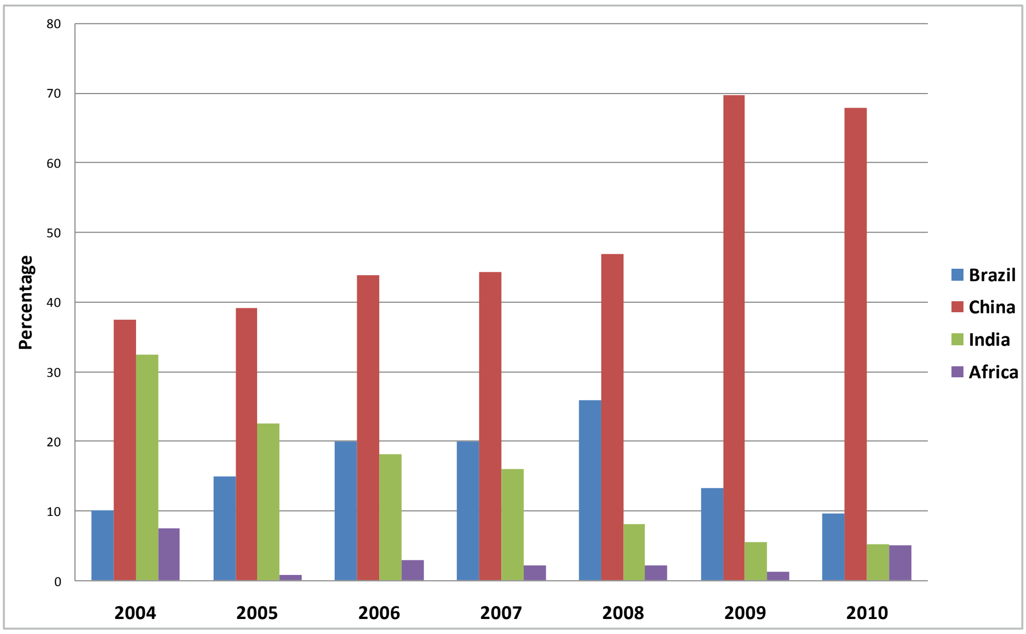
Figure 1.4 Developed vs. Developing Country Renewable Energy Investment



Source: UNEP and Bloomberg New Energy Finance, 2011

While all developing regions have seen rapid growth, total volume figures are dominated by Brazil, India, and particularly China, as shown in Figure 1.5.

Figure 1.5 Share of Developing Countries' Renewable Energy Investments



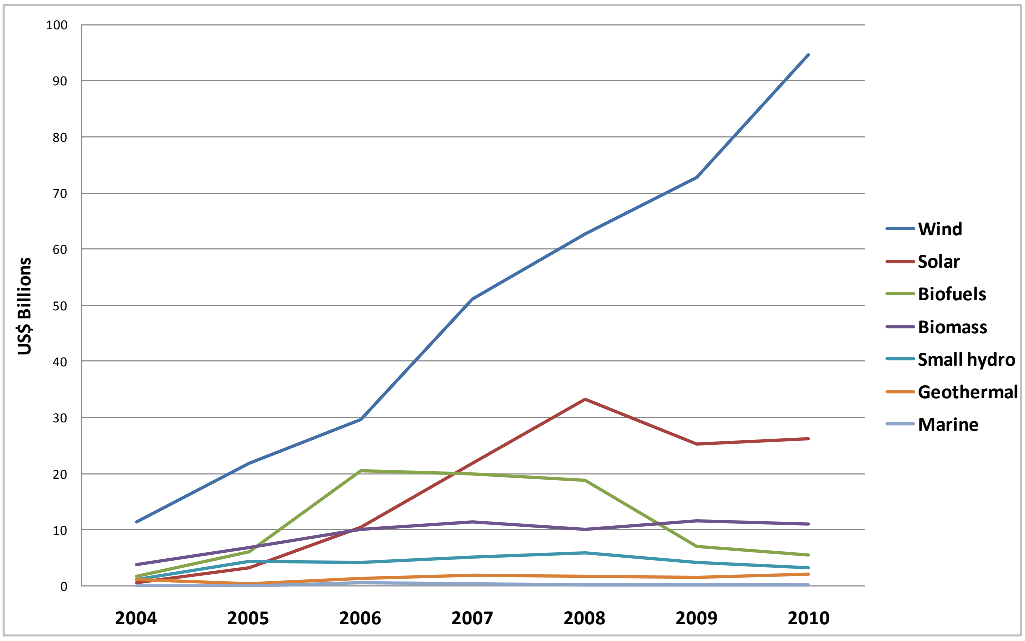
Source: UNEP and Bloomberg New Energy Finance, 2011

Figure 1.5 shows that China accounted for almost 70% of total developing country investment in 2009 and 2010. Brazil had the next largest share at around 10%, while India only accounted for around 5%, as did Africa in 2010.

Although Figure 1.5 shows a steady decline in India's share, in absolute terms Indian investment tripled over the period. At the same time Brazil's renewable investment grew 17 times, while China experienced a 33-fold increase in investment. By 2010, Chinese investment in renewable energy was by far the largest in the world, almost as much as Europe and the USA combined.

In Africa, investment in renewable energy has displayed a rather different pattern. Between 2004 and 2009 it grew from US$300 million to US$700 million, which was only 1% of developing country investment at that point. In 2010, however, investment leapt to $3.6 billion, the same level as India and 5% of total developing country investment.

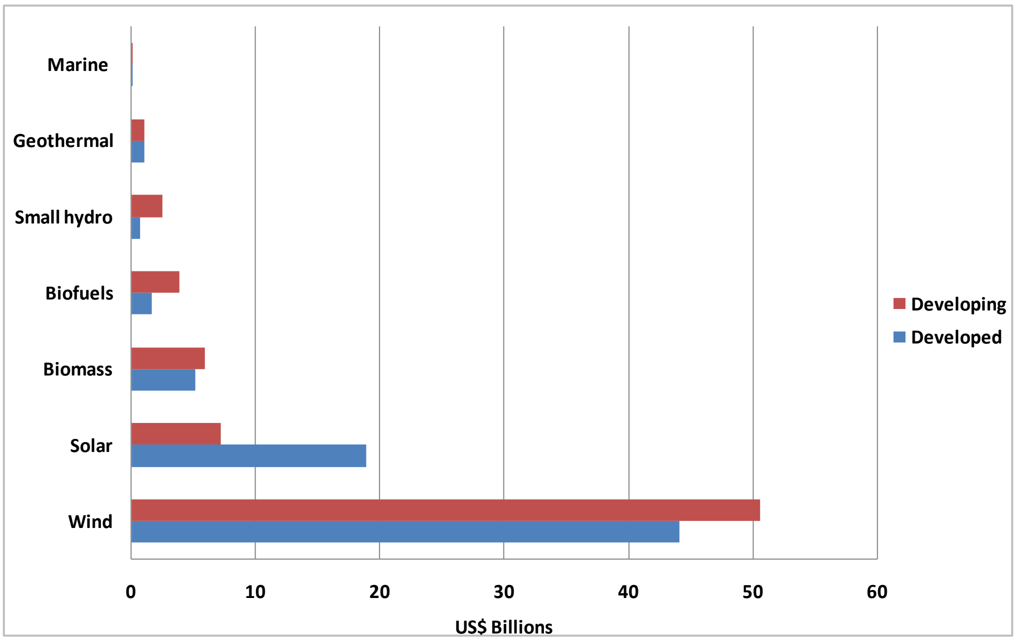
Figure 1.6 Global Renewable Investment by Sector, 2004-09



Source: UNEP and Bloomberg New Energy Finance, 2011

Globally, wind power captures the largest share of global investments, reaching 66% in 2010. The next largest sector is solar, with a little over 18%. When we compare developed and developing countries' sectorial investment in Figure 1.7 below, we see the dominance of wind power was even more pronounced for developing countries in 2010. This is almost entirely accounted for by the huge increase in Chinese investment in large-scale wind-farms.

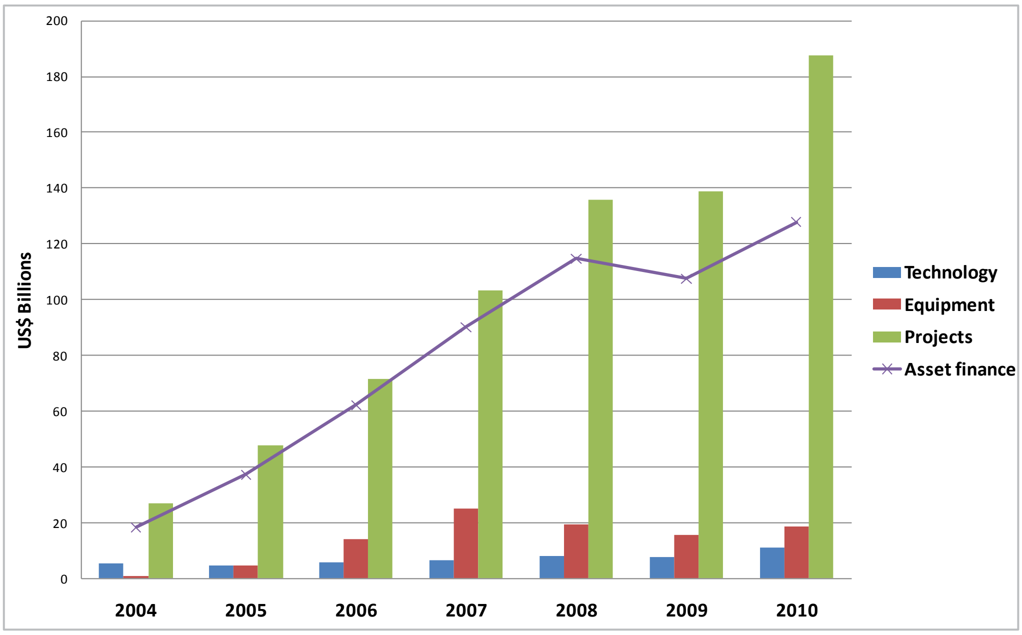
Figure 1.7 Developing vs. Developed Sectoral Investment 2010



Source: UNEP and Bloomberg New Energy Finance, 2011

It is interesting to note that developed countries' investment in solar energy was more than double that of developing countries, particularly given the much higher concentration of solar potential in the latter.

Figure 1.8 Renewable Investment forms



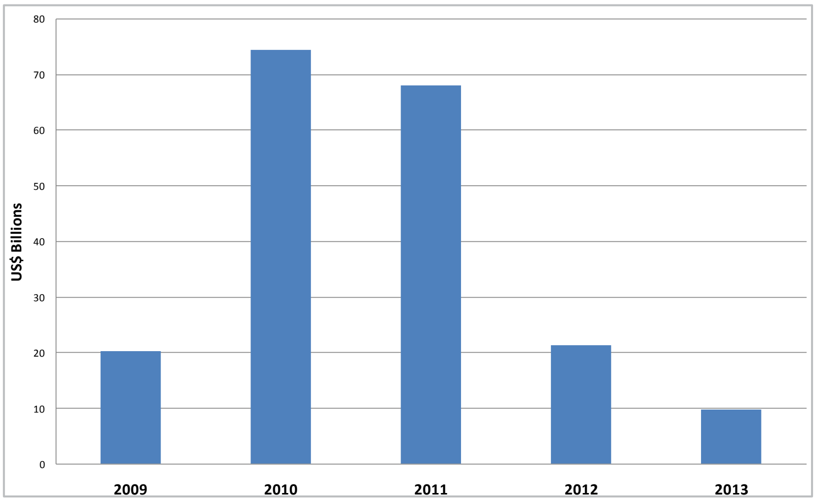
Source: UNEP and Bloomberg New Energy Finance, 2011

Figure 1.8 above illustrates the three main forms of investment: technology (including research and development (R&D) and venture capital); equipment (e.g. expansion capital from private equity funds or public markets); and projects (i.e. new renewable energy facilities). As can be seen, it is the latter which accounts for the majority of investment. The line on the chart shows that this in turn is dominated by the asset financing of large facilities, compared to small distributed capacity (e.g. residential solar capacity).

The numbers for total investment and investment growth are impressive. Despite the setback at Copenhagen, and the global financial crisis, investment in renewable energy has continued to grow globally.

However, there are important caveats. First, China is crucial to this story, representing a third of all new investment in 2010. Second, renewable energy investments have been supported globally by significant public support as part of the post-crisis stimulus packages in many countries.

Figure 1.9 Support for Renewable Investments in Post-Crisis Stimulus Packages



Source: UNEP and Bloomberg New Energy Finance, 2011

Due to lags in disbursing these public funds, 2010 saw a very large influx of almost US$75 billion, representing a significant proportion of total investment. Despite this support, however, investment in Europe fell from a peak of US$47.2 billion in 2008 to US$35.2 billion in 2010. The corresponding figures for North America were US$32.3 billion and £30.1 billion. It is the increase in Chinese investment, from US$23.9 billion in 2008 to US$48.9 billion in 2010, which has driven the global growth figures.

Part of China's investment growth relates to its stimulus package but it is also a continuation of high levels of ongoing investment, which cannot be described as 'private':

> *The source of funds for Chinese projects varied, but rarely came from Western financial institutions. Quite often, state-owned or partially state-owned companies put up the capital. A typical example was a 201mW wind project financed with US$ 295.3 million in November by China Guangdong Nuclear Wind Power Co., a subsidiary of state-owned China Guangdong Nuclear Power.* (WEF, 2011: 13)

In the USA and EU, private investment remains dependent on state support, reflecting the basic economics described in the previous section. For a variety of reasons, not least the economic turmoil in the eurozone,[1] a number of European countries are reducing their support for renewable investment. In the USA, investment was supported by stimulus support that allowed investors to claim back up to 30% of the CAPEX of projects in the form of grants. Investment in the USA could thus be constrained by government spending cuts over the next decade. This trend may have negative implications for investment in renewables (public but also private), not just in developed but also in developing countries.

In terms of costs relative to fossil fuels, onshore[2] wind remains the most competitive form of renewable energy. In the most favourable locations, it is now on a par with or cheaper than coal, but can still not compete with gas-fired power stations due to the low cost of natural gas. This in large part explains the surge in wind investment in recent years, but this has still not been enough to attract investment on purely commercial terms in many instances:

> *One of the largest wind projects to secure funding last year was the 845mW Shepherds Flat wind farm being built by closely-held Caithness Energy of the US, in Oregon. It closed a $1.3 billion loan from a group of 26 institutional investors and commercial banks led by Citigroup, Bank of Tokyo-Mitsubishi UFJ, RBS Securities and West LB Securities.* ***The loan carries an 80% guarantee from the US Department of Energy, supported by stimulus funding****.* [Emphasis added] (UNEP and Bloomberg New Energy Finance, 2011: 41)

As well as the time-limited nature of these programmes, underlying demand in the USA is falling as many states get close to fulfilling their Renewable Portfolio Standards (RPS), which require them to supply a certain amount of energy from renewable standards. Perhaps most fundamentally, the failure to pass supportive legislation – notably the cap and trade bill – in the USA has further undermined appetite for risk of long-term investors. These factors were reflected in market pessimism, where clean energy stocks underperformed the market by 20% in 2010 (UNEP and Bloomberg New Energy Finance, 2011).

The dependence on public support of US firms has been starkly demonstrated by the filing for bankruptcy of two major solar power companies. Following Evergreen Solar's bankruptcy announcement in July 2011, August saw Solyndra announce that a Chapter 11 bankruptcy process was underway. The company had received US$527 million of taxpayer support as part of the stimulus, as well as US$1 billion of private investment. In the context of concerns that US companies are losing out to China in the renewable energy sector, Congressman Henry Waxman of the House Committee on Energy and Commerce said the bankruptcies:

[1] Information available at: http://www.nytimes.com/cwire/2010/07/29/29climatewire-europe-slashes-low-carbon-energy-subsidies-a-61653.html?pagewanted=1

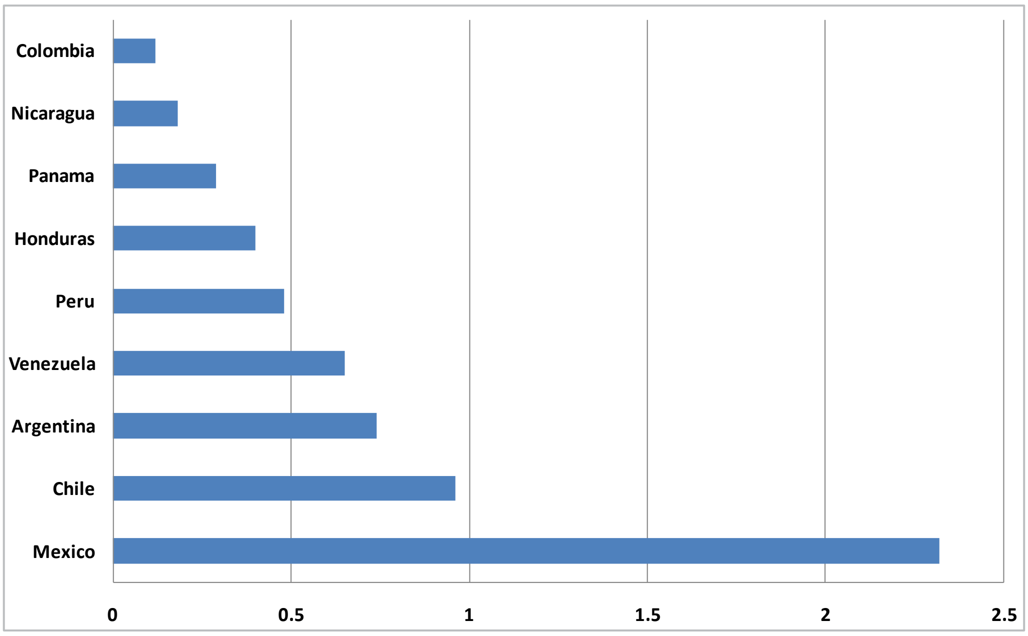
[2] Offshore wind is a much less mature technology, with considerable technical challenges, and remains considerably more expensive than onshore.

> *...are unfortunate warnings that the United States is in danger of losing its leadership position in the clean energy economy of the future. We should be doing everything possible to ensure the US does not cede the renewable energy market to China and other countries.*[3]

China is by far the biggest of the 'big three' developing country investors, and has focused increasingly on wind power in recent years. At a much smaller scale, India has also focused on wind power, while Brazil has seen investment in wind at the same level as that of biofuels.

Excluding Brazil, Latin America saw a sharp increase in investment, with much of this focused in the Mexican wind sector, and driven by the government decision in 2009 to raise its target for total renewable capacity from 3.3% to 7.6% of total energy supplies. The other countries that saw rapid growth shown in Figure 1.10 below also benefited from government targets for renewable energy, and in many instances significant non-commercial funding and support, both domestic and from external sources.

Figure 1.10 Renewable Investment in Latin America ex Brazil, 2010 (US$ billions)

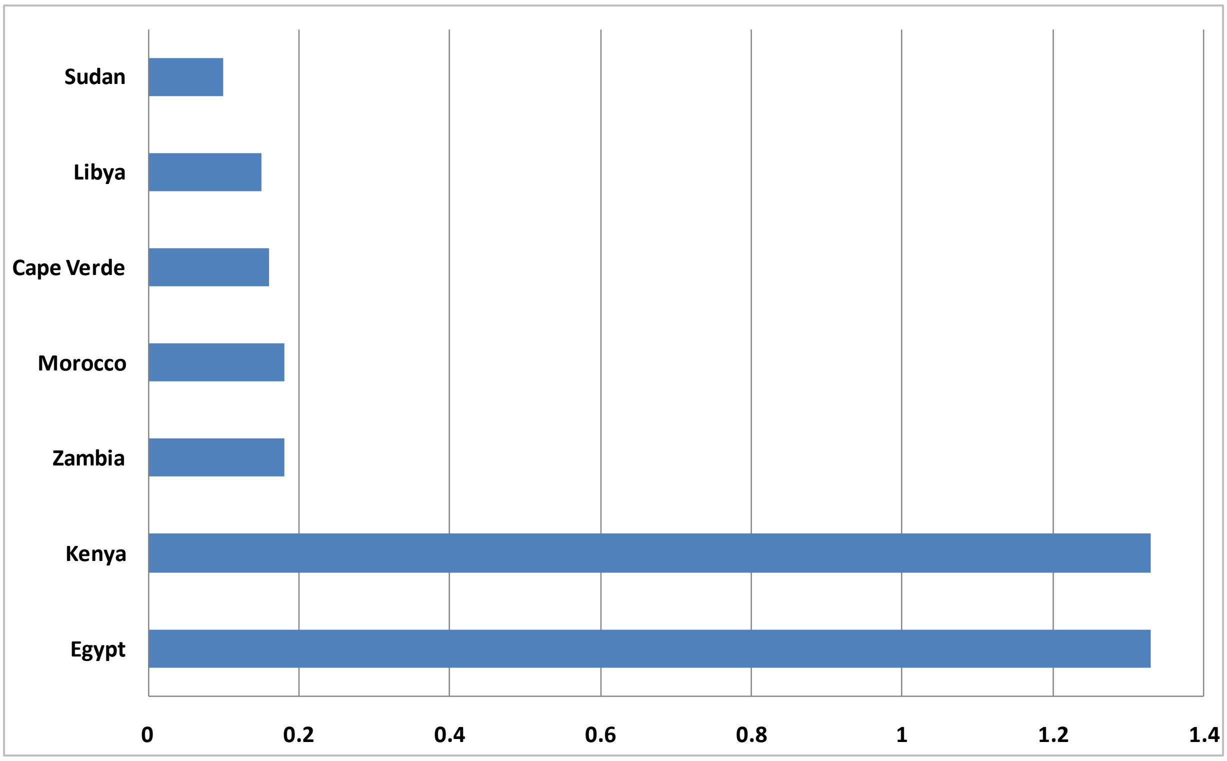


Source: UNEP and Bloomberg New Energy Finance, 2011

In Asia (excluding China and India) renewable investment grew by a little over 30%, largely due to rapid growth in Pakistan (mainly wind power) and Thailand (mainly solar). As in Latin America, significant non-commercial funding was required.

[3] Available at: http://www.independent.co.uk/news/business/news/china-moves-in-on-western-solar-power-industries-2347791.html

Figure 1.11 Renewable Investment in Africa 2010 (US$ Billions)



Source: UNEP and Bloomberg New Energy Finance, 2011

As described above, in 2010 investment in renewable energy grew more rapidly in Africa than anywhere else in the world. This was partly due to the very low rates prior to this, and investment was dominated by Egypt and Kenya (see Figure 1.11 above). Investment in Egypt rose to US$1.3 billion as the result of two very large projects, one solar (thermal) and one wind power. The same level of investment was achieved in Kenya in a more diversified way, with wind, geothermal, small hydro and biofuel capacity all seeing significant investment (UNEP and Bloomberg New Energy Finance, 2011).

To an even greater extent than in other developing regions, non-commercial funding was central to investments in Africa. The role of Development Finance Institutions (DFIs)[4] has been particularly important, with the European Investment Bank (EIB) providing an interesting example. In Europe, EIB lending for renewables is part of its action to help the EU achieve its energy and climate change targets by 2020, and EIB lending for renewable energy has grown dramatically in the last few years, reaching € 6.2 billion in 2010. In addition, in 2010 the EIB provided € 2 billion to non-EU countries to support action on climate change, of which an important part was for financing renewables, as a first step in its three-year plan to increase its backing for green energy projects beyond its borders. The EIB is increasing further its resources for investment in renewables in developing countries through its Energy Sustainability Facility as well as its recently approved € 2 billion additional climate-change mandate for developing countries. An example of a major EIB project in renewables in a developing country is its investment (jointly with the African Development Bank) in a major onshore wind project in Cape Verde for € 45 million. This will provide a large amount of essential electricity-generating capacity as well as establishing wind energy as a reliable source of non-polluting renewable power in Cape Verde. The share of renewable lending in the overall EIB portfolio grew from less than 10% in 2006 to 34% in 2010 (EIB Annual Reports). The EIB is also moving into the financing of major investments into 'smart grids' in Europe that will

[4] Here we define Development Finance Institutions broadly. As well as bilateral and multilateral agencies (e.g. CDC in the UK or the IFC respectively), we include Multilateral and Regional Development Banks (e.g. the World Bank and African Development Bank) in this definition.

facilitate connections of renewable energy into the main European grid (Griffith-Jones and Tyson, 2011).

According to the EIB Annual Reports, its lending to developing countries includes a high proportion of environmental and sustainable projects, with 33% of its financing relating to this area in 2010. As well as direct financing, the EIB is engaged closely with developing countries in providing technical assistance and technology transfer, adapting technology developed in its projects in Europe. For example, solar power technology developed in Spain has been transferred to Morocco (Source: Interviews).

An interesting feature of EIB projects is that they are subject to appraisals of environmental and sustainability standards as part of the initial and ongoing project cycle. In addition, applied technology is also always required by the EIB to be the best available from the perspective of climate action. Project assessment includes a required economic rate of return which accounts for the shadow cost of carbon which, for the EIB in 2020 will reach at least € 40 a tonne, rising gradually from € 26 a tonne in 2006 (with a possible upward revision being studied). This economic rate of return evaluation is undertaken in parallel to a purely financial rate of return using market prices.

The EIB has developed a pioneering evaluation of all large projects to estimate net carbon footprints. The absolute carbon footprint of a project is compared with a baseline which reflects carbon emissions in absence of the project. Then a net carbon impact of projects is calculated, using advanced models including industry-specific ones, for example for roads or shipping.

Appraising the economic rate of return, as described above, builds on the work of Little and Mirrlees, which was widely used in the 1960s to evaluate projects with shadow prices that took account of externalities. Such exercises are rarely done in other institutions. Just as important, the EIB is mandated to fully incorporate environmental and social factors into its decision-making[5] and – crucially – is not required to make a market-level rate of return, though it is supposed to break even.[6]

According to interviews carried out at the EIB, the calculation of an economic rate of return (that takes account of a shadow price of carbon) has been particularly effective in promoting projects in renewable energy that it otherwise might not have been financed, such as solar energy projects in developing countries. However, it seems that this methodology has been less valuable for discouraging projects with high carbon emissions. Nevertheless, the fact that this economic evaluation is carried out, and that the EIB is committed to minimising the carbon footprint of its projects more broadly, has had an impact on private and public project proposals seeking EIB financing (interview material).

Another important aspect of EIB lending is that, in the context of significant externalities, it can provide concessional lending (and finance the concessional element with EU grants) or co-finance its non-concessional lending with EU grants to fund renewable energy projects. The availability of large EU grants, and close collaboration between the EIB and the European Commission, makes this difficult to replicate exactly in other institutions. Even so, the use of global environmental fund financing could be combined further with other DFI lending. Furthermore, the challenge of allocating relatively scarce public resources most effectively to different blending modalities, so as to maximise their impact on reducing climate change, is common to all institutions.

As we saw in the previous section, the circumstances of many developing countries, particularly in rural areas, alters the economics of some low-carbon technologies. In its 2011 review of investment in renewable energy UNEP makes this point in a review of examples of positive practice:

[5] See IIED (2011) for an analysis of different global investment principles and how the EIB's approach differs from other bodies in this respect.

[6] See Spratt and Ryan-Collins (forthcoming) for an analysis of how DFI mandates can affect their approach to these issues, particularly with respect to the relative weight given to commercial and non-commercial factors.

> *In an increasing number of cases, renewable energy is not just one of the easiest non-grid-connected options to establish, but also more cost-effective than the fossil fuel alternatives. This trend has led to speculation that developing economies may be able to 'leapfrog' developed countries in their use of renewable energy over the coming decade.* (UNEP and Bloomberg New Energy Finance, 2011: 54)

Examples of renewable energy options in developing countries are:

- Generating energy in off-grid, rural power plants using discarded rice husks
- Cooking at scale with solar energy ('The world's largest solar cooking system – which churns out 50,000 meals a day – is installed at the temple of Shirdi in India's Maharashtra state'. Ibid: 56)
- Powering mobile telephone masts using solar power
- Converting waste to energy
- Processing foods (e.g. dehydrating fresh fruits) with solar power

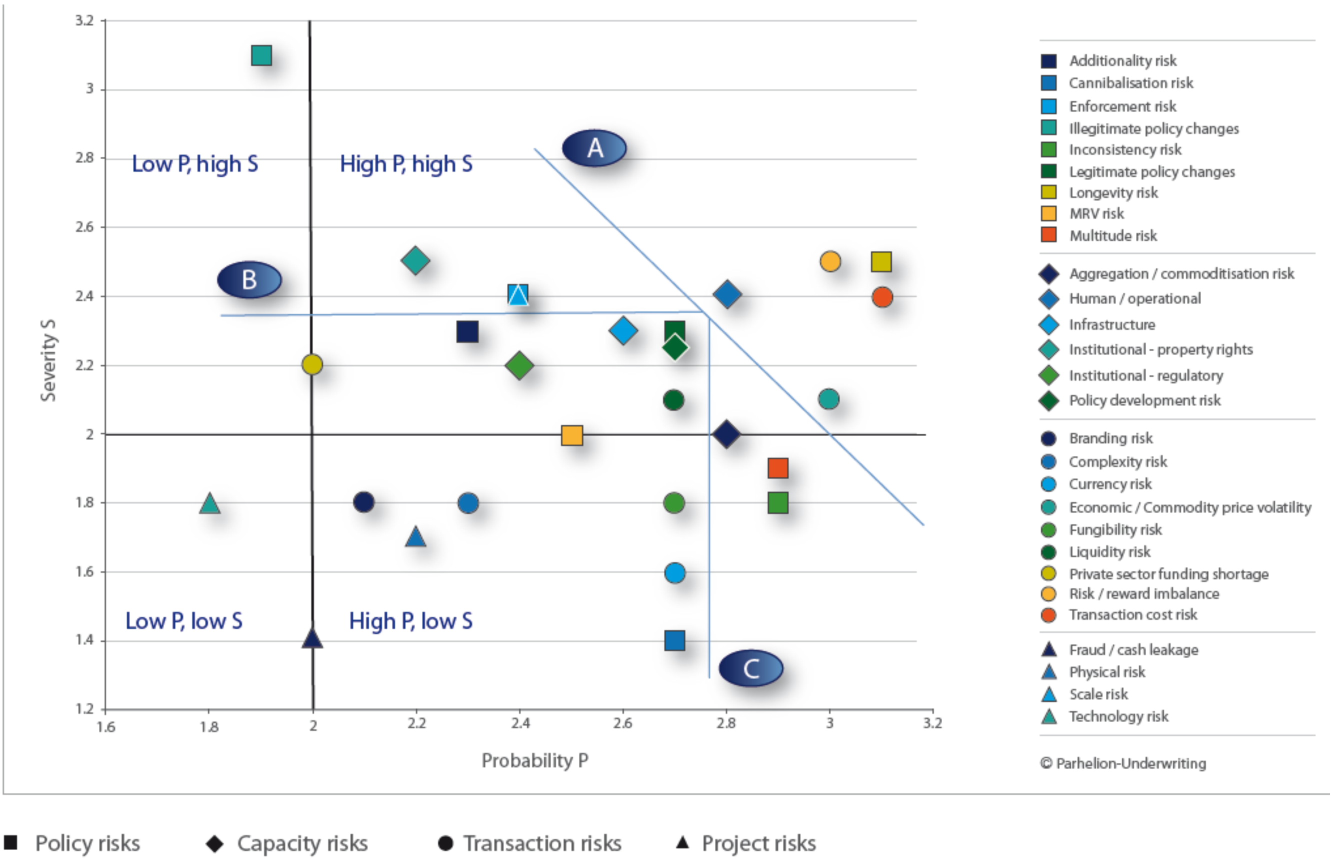
We could also add hydropower and geothermal energy to this list. As argued above, it is important to distinguish approaches such as these, which make economic and social sense for LICs, from those that may adversely affect their economic development, even though environmental effects may be positive.

1.3 Uncertainty and risk

In reality, the preceding sections have addressed the same issues from different perspectives. The economics of renewable energy have not been sufficiently favourable to attract private investment on the scale required. As we saw in Section 1.2 this has led governments – to a greater or lesser extent and in different ways – to provide financial support to the sector in a variety of forms.

In part this is a matter of relative cost and revenues. Where costs are higher than with fossil fuels, as is generally the case, the return on investment will be lower. This can be offset in one of two ways – either by subsidising costs (through fiscal incentives or grants, for example), or by boosting returns directly (paying a premium for energy generated from renewable sources, for example).

Figure 1.12 Risk List - Average Probability and Severity Scales



Source: Parhelion Underwriting Ltd.

A complementary way of looking at the problem is through the lens of risk. An in-depth survey of private investors, by underwriters Parhelion and Standard & Poor's (2010), provides an interesting insight into the range of issues this encompasses.

Figure 1.12 organises risks into four categories:

a. Policy risk (squares)
b. Capacity risk (diamonds)
c. Transactional risk (circles)
d. Project risk (triangles)

Distributed across the chart, according to perceived probability and severity, forms of risks in the top right quadrant (A) are those of most concern to investors. These are as follows:

a. Maturity mismatch

> *...investors are most concerned with the apparent mismatch between the long-term nature of capital commitments inherent in climate change financing and the relatively short time frame of climate change regulations. Investment horizons and/or capital commitment periods can range from 20 years for a reasonably sized renewable energy project to 50 years or more for a climate change adaptation-related investment.* (Parhelion Underwriting Ltd and Standard & Poor's, 2010: 5)

The primary concern with 'climate change regulations' appears to be that government interventions to alter the economics of the sector (such as through feed-in tariffs, for example) are not commensurate with the investment timeframes in the infrastructure sector.

b. Risk/Reward imbalance

The second most severe risk is the same concern in a slightly different guise. For investors, the risks involved in renewable energy may be very high. Given the timeframes involved and the level of capital required, all infrastructure investment is risky, and infrastructure investment in low-income/high-risk countries is particularly so. Given the need to maintain favourable economics (often artificially) in the renewable energy sector, the risks are considerably higher.

As a result, investors feel that they should be well compensated for taking these risks, and the concern is that over the lifetime of a project this will not be the case. When considering investments across a range of asset classes with different risk/reward ratios, renewable energy may seem a relatively unattractive form of investment.

c. Transaction cost risk

This risk is essentially a function of all the others. Investors fear that addressing the complexities of renewable energy projects will be time-consuming and expensive, creating significant transaction costs. This will also affect the risk/reward ratio negatively of course.

d. Human and operational risk

This concern partly reflects the immaturity of the sector and so its lack of established best practice. For example, projects may be dependent upon the delivery of climate finance support – through the Clean Development Mechanism (CDM), for example – but there is little accumulated expertise in managing this process. Similarly, from a technological and engineering perspective, facilities are often at the forefront of innovation, so that 'best practice' does not really apply and 'learning by doing' is more the order of the day. Such risk factors make investors very nervous, which is not surprising given the capital investments involved.

Technically, the problem is the inability to measure the risks with any degree of accuracy, which means they cannot be appropriately priced.

e. Economic/Commodity price volatility

This factor captures a number of concerns. First, the costs of fossil fuels have a large impact on the relative returns of renewable energy. As a result, movements in global oil and natural gas prices can fundamentally affect the relative economic attractiveness of a project.

Second, economic volatility (i.e. crises, recessions) are likely to influence the economics of investment, through changing government priorities and their capacity and willingness to maintain a supportive environment for the investment.

Third, the viability of renewable energy projects is fundamentally affected by current and future carbon prices. To the extent that fossil-fuel prices reflect the environmental costs of climate change, the higher the carbon price the more attractive will be renewable energy projects. Besides the average price of oil and gas (and thus carbon), there is the issue of both its short-and medium-term volatility, which impinges on the relative profitability of renewables.

f. Policy risk

A common element of many of these forms of risk is uncertainty about policy. If a project only makes sense when policy is being used to alter the underling economics, the risk is that this will not be maintained for long enough. This can be called *policy risk*, which is a major obstacle to accelerating investment in renewable energy production, particularly as it is likely to be necessary to maintain policy support for long periods given the timeframes of renewable energy facilities.

A change of government can bring a change of policy, creating uncertainty. Also, economic volatility may rise, potentially reducing a government's ability to maintain support even if it wished to do so.

As well as this national policy risk, uncertainty over global policy remains high, reflecting the difficulties in reaching agreement at the intergovernmental level. Many believe that a global deal to restrict, reduce and allocate carbon-emission rights is an essential precondition for halting the process of climate change. Such a deal would create and maintain demand for 'carbon credits', as countries sought to meet their emission-reduction targets in a variety of ways, including the purchase of credits for reductions made elsewhere. In the absence of such a framework, the supply of carbon credits outstrips the demand for them, and the 'price' of carbon is far lower than it otherwise would have been. A high carbon price would be the most effective way to alter the economics of renewable energy, and thereby create sufficient incentives for investment in the sector.

The European Trading System (ETS) remains operational and is moving to its next phase. But the anticipated US version looks dead in the water. As a result, hopes of a global carbon-trading system that would support and drive up the price of carbon – and so fundamentally improve the economics of low-carbon investment – also appear dead, at least for now. More limited schemes, for instance among European countries joined by others, could be an intermediate step.

2 Financial mechanisms

2.1 Mechanisms to alter the economics of renewable energy

In this section we will explore different mechanisms to alter the economics of renewable energy and encourage investment by the private sector. Two issues dominate. First, measures have to be strong enough to incentivise significant additional investment in renewables. Second, associated costs to governments and other public bodies must be manageable and no greater than required to provide these incentives, and must clearly be less than the level of expected benefits. As well as direct and immediate costs, these need to include any contingent liabilities in the future, as could be the case with unfunded guarantees, for example.

The key 'value for money' criterion is the effectiveness of public spending in generating additional private investment (the leverage ratio), as well as the size of positive spillover effects. There is always the option of direct public investment in renewables, either financed by governments or by international organisations, and this needs to be compared with the leveraging of private investment financed by public resources, in terms of effectiveness.

2.1.1 Raise the costs of fossil fuels

The fact that the environmental damage caused by the burning of fossil fuels is not factored into their price is a clear example of a negative externality. The concept of an externality is attributable to Pigou (1932), and occurs when private costs are lower than social costs. In such a situation, private actors will produce more of a good than is socially optimal because they capture all the returns but do not bear all the costs, a share of which are 'externalised'. By raising costs to producers or consumers,[7] Pigouvian taxes aim to align private and social costs, and so maintain production at socially (including environmentally) optimal levels. From a 'value for money' perspective, an attractive feature of fiscal incentives is that they have the potential to be self-financing.

There are three forms of Pigouvian taxes: first, second or third best. First-best taxes are designed to achieve an 'optimal' level of pollution, so that the marginal costs of measures to restrict pollution is equal to the marginal benefits that result from them. They seek to balance these costs and benefits optimally across society. All carbon emissions could be eliminated of course. The fact that this does not happen is because of the benefits – i.e. employment and incomes – created by the activities producing the emissions.

In practice, first-best taxes remain an abstract ideal rather than a reality (Sterner, 2003). In most cases the informational requirements to calculate marginal social benefits[8] and cost curves are prohibitively high as the basis for practical policy. Furthermore, there is uncertainty about future social costs and benefits.

Second-best taxes do not seek to estimate marginal social benefits, but rather determine a limit on an activity, and calibrate taxes to achieve the required reduction in the activity. Importantly, this relates directly to the pollutant. The aim will thus be to reduce airborne pollutants by taxing producers by volume of emission. With respect to fossil fuels, this would tax CO_2 emissions directly.

A number of countries use, or have used, second-best taxes of this kind for other forms of pollutants. For example, Sweden dramatically reduced nitrogen oxide (NO_x) emissions by the

[7] It may be more equitable to tax consumption rather than production. Industrialised countries have increasingly moved environmentally sensitive production to developing countries, or have purchased carbon-intensive products from producers in developing countries. Taxing production penalises these countries, whereas a tax on consumption would see the incidence of the tax fall on the source of demand and the end-users.

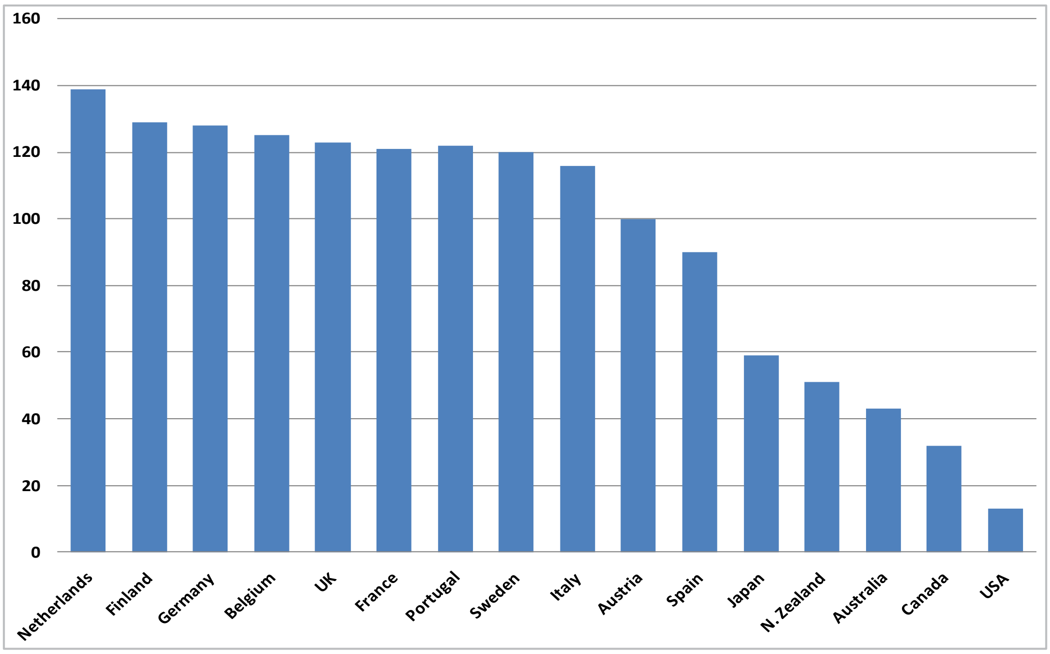
[8] This requires the calculation of people's valuation of non-traded, environmental goods. Two approaches are commonly used. Hedonic pricing estimates people's valuations through the prices of related goods, and is therefore a form of indirect revealed preference. Contingent valuations ask people directly about their valuations, often within a 'willingness to pay' (WTP) or 'willingness to accept' (WTA) framework.

use of a symmetrical tax/subsidy framework, which was also revenue-neutral. The tax rate applied depends on the level of efficiency of the producer with respect to NO_x emissions. If efficiency is average, the rate is zero; if below average it becomes sharply positive; if above average it turns negative, and the producer receives a subsidy. Penalties applied to 'bad' performers are therefore used to subsidise good performers.

Countries have yet to apply a framework of this kind directly to CO_2 emissions. The closest is to tax products in relation to their CO_2 content, which many countries have done.[9] Where this is directly related to CO_2 content (i.e. tax rates vary in proportion to products' CO_2 emissions) it is essentially a second-best Pigouvian tax. Where it is applied to a product associated with CO_2 emissions, but not directly related to the level of emissions, it is a third-best form of taxation.

The most obvious examples are taxes on fuel. Most countries use fuel taxes to some extent, and revenues from these forms of taxation account for 60%–70% of environmental tax receipts globally. Rates vary enormously, however, as shown Figure 2.1.

Figure 2.1 Petrol Taxes $US cent/litre, 2008



Source: Sterner, 2011

Revenues from fuel tax are high because fuel is price-inelastic. Over the longer term, however, elasticity increases, particularly when the availability of substitutes (e.g. public transport) is enhanced. Sterner (2011) estimates that if European economies had applied the same rates of tax as the USA in recent decades, demand for fuel would be a third higher than it is now.

The point is that fuel taxes can reduce fuel demand, but they need to be high and kept in place for long periods to achieve this. The same is true of levies on the industrial use of fuel, which will incentivise greater efficiency over time. This is not the same as reducing total usage, or the resultant greenhouse gas (GhG) emissions, however. For this, efficiency gains have to outstrip the rate of economic growth, and there has to be a progressive transfer to non-polluting forms of energy throughout the economy. As we have seen, this has cost implications, and so is likely to require carrots as well as sticks – subsidies as well as taxes.

Unlike taxes (that have the advantage of generating public revenues), subsidies come at a fiscal cost. In some cases – as in the Swedish example – these can be financed by

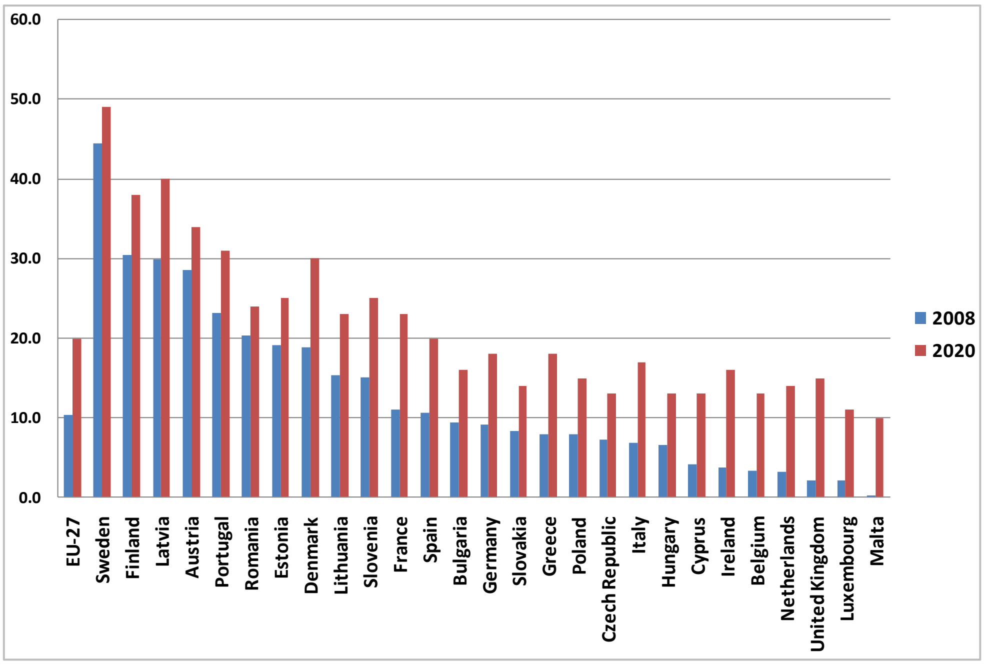
[9] For an overview see http://www.carbontax.org/progress/where-carbon-is-taxed/

complementary taxes, with no fiscal implications. Even here, however, the cost falls squarely on the economy in question. From a development perspective, this may be unfair. The reason why there is a need to make the transition to green growth is because of the accelerating problem of climate change. This, in turn, is largely the result of the historical accumulation of CO_2 in the atmosphere caused by the industrialisation of today's developed countries. During their development process, they freely exploited the energy contained in fossil fuels. The wealth that developed countries enjoy today can be seen, in no small part, as the accumulation of physical capital (wealth) at the cost of the deterioration of another form of capital (i.e. the natural capital[10] represented by a sustainable environment).

While it can be argued that some middle-income countries (MICs) have also contributed to this problem, and will increasingly do so, this is not the case with LICs. Consequently, it is unreasonable to expect them to adopt measures that will negatively affect their own development prospects because of factors for which they bear no responsibility.

As many developed countries are discovering, however, decoupling economic growth from GhG emissions is extremely hard, even in relative terms. Worryingly, there is no evidence to date of absolute decoupling – where GDP growth does not result in higher CO_2 emissions. Companies that pay carbon taxes may be put at a disadvantage when competing internationally, and on a macro scale countries that generate a large part of their energy from renewable sources would also tend to face higher costs.

Figure 2.2 Renewable Energy as % of Total Energy Consumption, 2008 vs. 2020



Source: Eurostat

No country, even those with very strong support for environmental sustainability, envisages a wholesale shift towards renewable energy in the foreseeable future. As shown in Figure 2.2, just 10% of the EU-27's energy consumption is currently from renewable sources, and this is expected to rise to 20% by 2020. Renewables remain expensive in terms of fixed and variable

10 'Natural capital is the extension of the economic notion of capital (manufactured means of production) to environmental goods and services. A functional definition of capital in general is: "a stock that yields a flow of valuable goods or services into the future". Natural capital is thus the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future. For example, a stock of trees or fish provides a flow of new trees or fish, a flow which can be sustainable indefinitely. Natural capital may also provide services like recycling wastes or water catchment and erosion control. Since the flow of services from ecosystems requires that they function as whole systems, the structure and diversity of the system are important components of natural capital.' (Costanza and Cleveland, 2008, available at: http://www.eoearth.org/article/Natural_capital)

costs. If LICs are to develop renewable energy capacity, the additional costs incurred should be met from external funds. Below we provide some details on current and potential mechanisms to fulfil this role.

2.1.2 Lower the costs of renewables

If the aim of Pigouvian taxes on fossil fuels is to encourage a switch towards renewable energy, providing subsidies for renewable energy performs the same function by altering relative prices. In theory, a well-calibrated Pigouvian tax on CO_2 emissions (second best), or on fossil fuels (third best), would be sufficient to stimulate non-fossil-fuel forms of energy, such as renewables (Petrakis et al., 1997). In their absence, however, many countries have chosen to subsidise the renewable sector directly, with a particular aim of spurring R&D, innovation and the reduction of unit costs. With learning spillovers, optimal outcomes are approximated with two forms of subsidy: one on outputs, and the other at the market-entry or investment point (Bläsi and Requate, 2005).

There are a number of ways to deliver subsidies, all of which reduce the direct or indirect cost. First, grants may be made to subsidise capital expenditure. Second, loans may be provided at concessional rates, either directly or as part of a 'blended finance' model. Third, the creditworthiness of the borrower may be enhanced through providing some forms of guarantee. In relation to the optimal subsidy models suggested by Bläsi and Requate (2005), these mechanisms lower entry barriers to the sector and make financing more accessible and affordable.

For example, UNEP's Rural Energy Enterprise Development (REED)[11] seeks to lower entry barriers by providing seed capital for entrepreneurs in renewable energy in developing countries. REED focuses on small-scale, innovative projects, which would be unlikely to attract commercial funding, but have significant potential for scalability. A project with similar aims, which operates across Asia and Africa, is the Seed Capital Assistance Facility (SCAF).[12] Instead of working directly with entrepreneurs, SCAF assists energy-investment funds to provide seed financing for clean energy enterprises and projects. UNEP partners with the African and Asian Development Banks as part of the SCAF project.

2.1.3 Boost the returns from renewables

The favoured mechanism to boost the returns of renewable energy providers has been the feed-in tariff (FIT). With a FIT, producers of electricity from renewable sources are paid a guaranteed premium over fossil-fuel producers. As the idea is to spur innovation and create knowledge spillovers, FITs are generally designed to decline over time as the knowledge benefits are generated and diffused, and the unit cost of renewable energy becomes competitive with fossil fuels. Following their introduction in Germany, numerous developed countries now have FITs in place. They have also become increasingly common in developing countries, with a number of countries having implemented a FIT, or planning to do so (e.g. Argentina, Brazil, China, Ghana, Kenya, Malaysia, Nigeria, Pakistan and South Africa).

While the goals of FITs are the same in developed and developing countries, there are particular features of the latter that require consideration. For example, FITs in developed countries are generally funded by a premium placed on all energy bills. Following the logic set out above, in developing countries this could be covered by external finance from donors, particularly in LICs.

[11] Information available at: http://www.uneptie.org/energy/activities/reed/
[12] Information available at: http://www.uneptie.org/energy/activities/scaf/

2.2 Mechanisms to increase the supply of appropriate finance

There are many different forms of finance, and some are more suited than others to financing renewable energy. Even when the basic economics and returns are attractive enough, the most important characteristic is that the finance be long term. Investment in renewable energy can take years, or even decades, to yield good returns. What is needed, therefore, is 'patient capital', which is relatively hard to obtain, given typical short-term horizons of private capital markets.

An important element here is that large funds that have long-term liabilities (such as sovereign wealth funds (SWFs) and/or pension funds) should become a more significant source of long-term investment in renewables.

A relatively high-profile initiative in this area was launched by the Johannesburg Renewable Energy Coalition (JREC),[13] a group of 88 countries formed in the wake of the 2002 World Summit on Sustainable Development. The JREC established the 'Patient Capital Initiative',[14] which in turn led to the Global Energy Efficiency and Renewable Energy Fund (GEEREF).[15] GEEREF is a fund structure, which provides capital to renewable energy funds operating in developing countries, which:

> *…aims to accelerate the transfer, development, use and enforcement of environmentally sound technologies for the world's poorer regions, helping to bring secure, clean and affordable energy to local people.* (GEEREF website)[16]

With founding investment from the EU, Germany and Norway, GEEREF has attracted half of its target funding of US$200 million, and is particularly focused on attracting institutional investors.

In its investments: *'Priority is given to investment in countries with policies and regulatory frameworks on energy efficiency and renewable energy'*. Once again, this raises the question of who should be bearing these costs. We have argued that the cost of feed-in tariffs in LICs should be borne by the donor community rather than the countries themselves. It is not clear that GEEREF adopts this approach, but may instead be incentivising countries to put in place mechanisms that impose an economic cost.

2.2.1 Green bonds

A mechanism that has attracted increasing interest is Green Bonds. In terms of demand, Green Bonds are particularly appealing to Socially Responsible Investors (SRIs) that give priority to mitigating climate change. As long as the instrument can deliver a market-level return, mainstream institutional investors and SWFs are also now considering similar types of investment.

In addition to its traditional financing on the international capital markets, the EIB developed an innovative instrument to raise funds for green investment, which it finances itself. This helps develop a new Green Bond instrument (and give it liquidity), which could then be issued by other entities, either public or private. Since 2007, the EIB has issued € 1.4 billion (including € 0.5 billion in 2010 – Source: Interview material and EIB Annual Reports) of 'Climate Awareness Bonds', which are ring-fenced finance raised for the EIB's future lending to projects supporting climate action in the fields of renewable energy and energy efficiency, both within the EU and in developing countries.

The EIB has issued Climate Awareness Bonds through ten issues in six currencies, thus acting as a market maker for such instruments. The bonds are linked to a newly constructed index of

[13] Information available at: http://ec.europa.eu/environment/jrec/about_en.htm

[14] Information available at: http://ec.europa.eu/environment/jrec/pdf/pci_summary_brochure_final.pdf

[15] Information available at: http://www.geeref.com/pages/home

[16] Information available at: http://geeref.com/posts/display/1

corporate responsibility in relation to the environment, thus giving confidence to SRIs. The issuance of these bonds sets a valuable precedent for broader use of this and other similar instruments, particularly by international, regional and national public development banks, which would use the funds to finance private green investment. In the future private investors could themselves directly issue the instruments, but this is unlikely to be feasible for some time.

A key part of the attractiveness of Green Bonds is their backing by credible institutions, which are themselves backed by sovereign states. Risks are thus effectively underwritten, enabling the bonds to be packaged as safe instruments for institutional investors. Were they to be issued by private investors, the bonds' ratings would obviously be lower, reflecting the fact that risks were no longer borne by a publicly backed body. The market would need to be more liquid, and its uncertainty lower, before private Green Bonds would be attractive to institutional investors.

Following the EIB's lead, the World Bank also began issuing Green Bonds in 2008. Since then, US$2 billion has been raised through the sale of AAA-rated bonds in 15 different currencies to fixed-income investors,[17] with the proceeds used for climate-change mitigation or adaptation projects in developing countries. Specifically, the Bank looks to invest in projects in the following areas:[18]

- Solar and wind installations
- Funding for new technologies that permit significant reductions in GhG emissions
- Rehabilitation of power plants and transmission facilities to reduce GhG emissions
- Greater efficiency in transport, including fuel switching and mass transport
- Waste management (methane emissions) and construction of energy-efficient buildings
- Carbon reduction through reforestation and avoided deforestation

Coupons are compatible with their AAA status, ranging from 0.875% for 125 million Japanese Yen in 2010 to 10% for 50 million Turkish Lira denominated bond, again in 2010. By attracting institutional, fixed-income investors, Green Bonds have demonstrated significant potential to raise large quantities of relatively long-term finance. Despite their potential, however, they remain a niche product, as the rather small list of World Bank investors illustrates.

Supply is likely to elicit demand, particularly where bonds are backed by credible international institutions. This requires them to shoulder some possible risk, but their willingness (or not) to do so will send a clear signal to investors about the long-term viability of the markets in question. It is useful to remember that DFIs helped develop local currency bond markets in emerging and developing countries, a valuable precedent. Without such a credible signal, investors may not provide capital on the scale needed to develop the infrastructure for renewable energy. If confidence can be created, however, global capital markets could become a valuable source of investment in renewable energy in developing countries.

By issuing such bonds, international institutions, or donor governments, can play a very valuable market-making role, especially for LICs. In less developed countries (LICs and Least Developed Countries (LDCs)), risks may be considerably higher and returns may be more uncertain. The impact, in terms of reduced global carbon emissions, may be higher for LICs, for example, than for developed economies, since the cost of investing in renewables is often lower in poorer countries (interview material).

[17] To date, the US$ investors are: California State Treasurer's Office; CALSTERS; MMA Praxis Mutual Funds; New York Common Retirement Fund; Sarasin; SEB Ethos rantefund; SEB Trygg Liv; Second Swedish National Pension Fund (AP2); Third Swedish National Pension Fund (AP3); Trillium Asset Management; UN Joint Staff Pension Fund. Investors in other currencies are: Adlerbert Research Foundation; AP2 – Second Swedish National Pension Fund; AP3 – Third Swedish National Pension Fund; LF Liv; MISTRA; Nikko Asset Management; Skandia Liv

[18] Information available at: http://treasury.worldbank.org/cmd/pdf/WorldBank_GreenBondFactsheet.pdf

Issuing Green Bonds to fund renewables investment in developed countries is also valuable for developing countries, as deepening and making such a market more liquid would facilitate issuance for investment. An interesting question is whether such issuance could be extended also to Regional Development Banks, like the African Development Bank (AfDB).

2.2.2 Other types of bond

The most straightforward and possibly cheapest option would be to raise finance using straight government (or institutional) bonds, and earmark the revenues for renewable energy projects in developing countries as bilateral or multilateral concessional or non-concessional lending. This already happens to a certain extent, but is limited by fiscal constraints and the desire to tap alternative – climate-aware – investors.

An intermediate option would be an indexed bond where the coupon is linked to an indicator such as the price of carbon or levels of emissions. The crucial point is that yields are inversely linked to progress on mitigating climate change, which offers investors a hedge against inaction. As this paper has highlighted, a major obstacle to achieving a change in investment is uncertainty surrounding future climate regimes. Indexed bonds that pay a higher return as carbon emissions fail to fall (or carbon prices remain too low) provide a hedge for investors, making it easier for them to invest in renewable energy projects, or other investments dependent upon progress on mitigating climate change.[19] The proposal has been largely associated with climate-change mitigation in developed countries, but is potentially applicable to the developing world. In line with the framework sketched out above, it would require bonds to be issued in one jurisdiction (the UK, for example), with coupon payments linked to the mitigation of emissions in a developing country. This would provide investors in renewable energy in those countries with a hedge against future policy inaction that put their investments at risk, but the risks would be borne by the donor country where the bond was issued.

Another potential structure is energy efficiency bonds. Developed in the USA as Property Assessed Clean Energy (PACE)[20] bonds, the instrument enables residential and commercial property owners to borrow money from municipal bodies to make energy-efficiency improvements to their properties. The financing is provided by the issuance of bonds, where payments are met by the borrowers using the revenues saved through efficiency gains. Alternatively, energy suppliers may issue the bonds and finance household and commercial property owners that undertake such investments. Public utility providers (still common in many developing countries) may be asked by governments to do so, but incentives would be necessary for private providers to take on such a role, for example through strict energy-efficiency targets set by regulatory authorities.

Energy efficiency bonds are thus an example of a win-win instrument. If applied to developing countries, there would be no need for financial transfers from the donor community as the bonds are self-financing and the changes they enable (i.e. more efficient use of energy) are clearly beneficial to the countries concerned. However, international bond financing backed by multilateral development banks may be necessary for countries that lack adequately developed domestic bond markets.

Importantly, the potential of such bonds in developing countries is greater than in the developed world because of greater inefficiencies in energy use, as well as lower cost per unit of carbon saving. To leverage finance, however, energy efficiency bonds need to be credibly secured. In the US version, they are backed by the property in question – with seniority over mortgage payments. Adapting the mechanism to developing countries would require a similar level or surety, which could be difficult, though not impossible, to achieve. Institutions like the World Bank or the EIB could help to establish them in developing countries, where this is desirable. If the utility provider gives the financing to the users, however, the problem largely disappears, and the only condition necessary may be that the household or firm receiving the

[19] The proposal has been supported by *inter alia*, the Aldersgate Group (http://www.aldersgategroup.org.uk/) and the London Accord (http://www.longfinance.net/programmes/london-accord.html).
[20] Information available at: http://pacenow.org

financing must continue to use the utility company that provided it – in fact, in many cases, there may be no alternative provider anyway.

2.2.3 Concessional finance

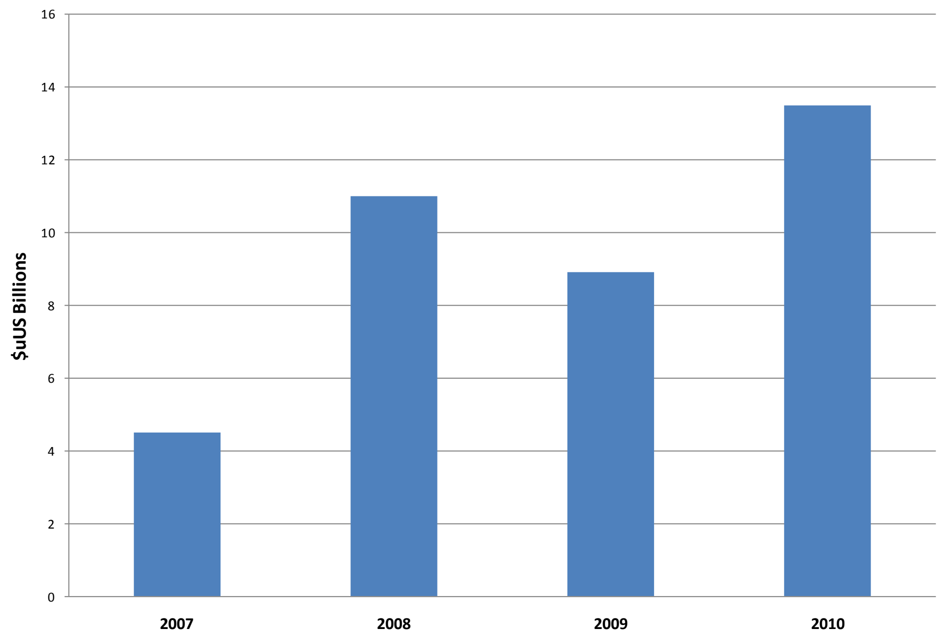
Investment in renewable energy in developing countries requires long-term, patient capital. Unfortunately, however, this is precisely the type of investment that is most difficult to attract to developing countries. Even where the economics are more straightforward than in the renewable sector, international investors often respond to perceived riskiness of investment in LICs by (a) requiring a high rate of return and (b) only making relatively short-term finance available.

This is a problem in the infrastructure sector generally. In Africa, the World Bank estimates that an additional US$48 billion per year would be needed to fill the infrastructure-spending gap (Foster and Briceño-Garmendia, 2010), but in 2008 the maximum private investment that has been attracted was a little over US$12 billion. If mature infrastructure sectors cannot raise the finance needed, it is unsurprising that infrastructure for renewable energy suffers similar problems.

A part of the solution to both general and renewable energy infrastructure is the involvement of DFIs, including Regional Development Banks.[21] In large part because of their backing by sovereign states, DFIs are able to provide finance at maturities that the private sector cannot. In a recent systematic review on DFI 'additionality', Spratt and Ryan-Collins (2012: 2) conclude that:

> *DFIs are able to: a) supply long-term finance, which is often essential for infrastructure but frequently unavailable in LICs; b) mitigate project risk, particularly in the early stages, thus leveraging additional finance by improving the attractiveness of deals (again, this is often crucial in LICs); and c) provide and leverage finance counter-cyclically, either lending when private investors will not, or retaining positions when the private sector would pull out.*

Figure 2.3 DFI Investment in Renewable Energy, 2007-10



Source: UNEP, 2011

[21] For an early review of the difficulties of purely private finance to fund infrastructure, and the desirability of public interventions to encourage private investment, see Griffith-Jones (1993).

Figure 2.3 illustrates that this is also the case in the renewable energy infrastructure, where DFI investments grew significantly between 2007 and 2010. As well as the provision of finance of longer maturities, DFIs are more able to act counter-cyclically, as evidenced by the sharp increase in their activities in renewable energy, as well as more generally, in the wake of the 2008 global financial crisis (see, for example, Ocampo, Griffith-Jones et al., 2010, for the latter).

As well as the favourable access to finance DFIs bring,[22] most of them can provide a 'political umbrella' whereby investors have confidence that they will be protected from default risk. The logic is straightforward: investors assume that borrowers are far less likely to default if a DFI from a donor country, or an international institution, is involved, as the borrower will not want to jeopardise their broader relationship. The logic is also correct: the IFC, for example, has never been part of a debt-rescheduling process and payments have never been permanently affected in a general default (Moody's, 2007).

As well as default risk, DFI participation provides assurances that governments will honour the terms of contracts. While this is important in the infrastructure sector generally, where stable and supportive regulatory structures are key, it is even more so in the renewable energy sector, where the maintenance of price mechanisms such as FITs may be essential to ensure the economic viability of a project.

In this regard, one of the most straightforward and effective ways to catalyse investment in renewable energy in developing countries would be to increase the resources available to DFIs for this purpose.[23]

2.2.4 Cornerstone and Challenge Funds

A number of innovative partnership models with DFIs and investors have been proposed. As with Green Bonds, the aim is to attract institutional investors into the renewable energy sector. Recognising that institutional investors operate at a scale far above that of individual projects, and require a minimum level of liquidity to invest, fund-of-fund structures may be appropriate (Vivid Economics, 2009).

Proposals also recognise the need to get the economics right, as discussed above. In this regard, a range of Public Finance Mechanisms (PFMs) could be made available to the fund-of-funds, where DFIs and institutional investors would co-invest.

Two options have been suggested:

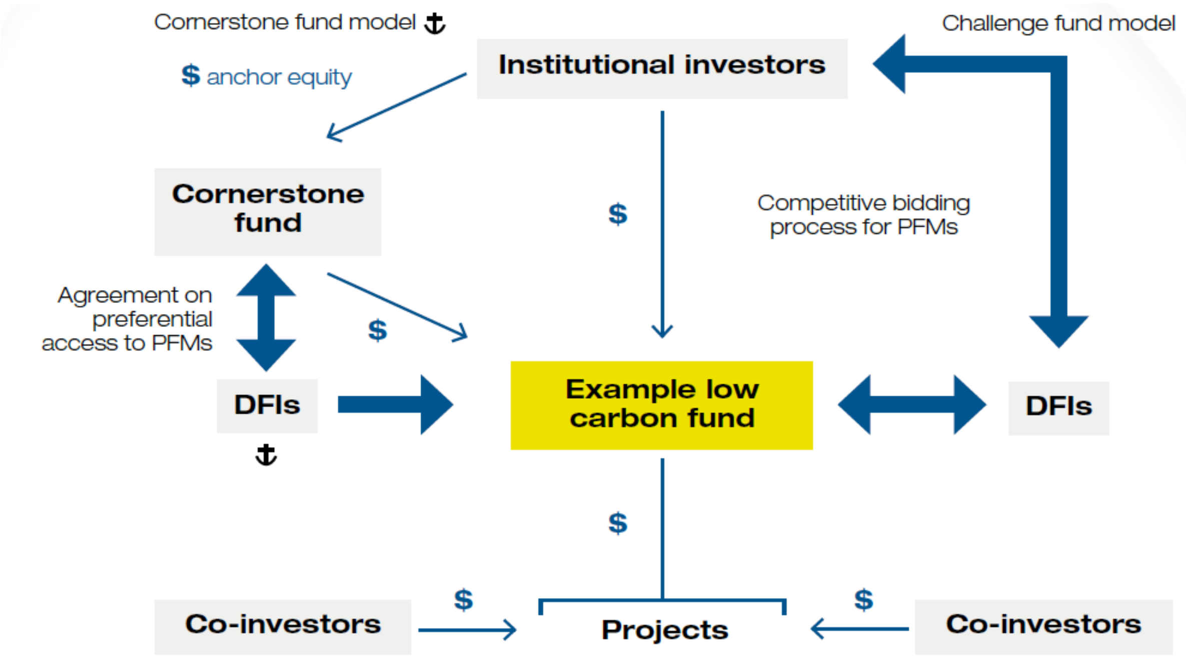
a. Cornerstone funds
b. Challenge funds

In both cases the fund-of-funds would have access to PFMs. In the case of Cornerstone Funds, these would be negotiated between the DFI and investors. For the Challenge Funds, institutional investors would compete for access to the PFMs. These two options are illustrated in Figure 2.4.

[22] For example, by acting as the 'lender of record' in its B-Loan programme, the IFC is able to provide finance to its co-investors on the same favourable terms that it itself enjoys.

[23] In order to fulfil their potential, however, alterations to the financing structure and mandates of some DFIs may be needed. See Spratt and Ryan-Collins (forthcoming) for details.

Figure 2.4 Key role of PFMs in supporting low-carbon funds



Note: Thicker arrows indicate the process of establishing and deploying PFMs.

Source: UNEP and Partners/Vivid Economics

For the PFMs, five are identified, corresponding with five risks facing institutional investors:

1. *Country risk guarantees* to protect investors from country-specific risks that may arise in the context of a developing country
2. *'Low carbon policy risk cover'* could be offered as insurance against the prospects of developing country governments discontinuing support policies (such as FITs, for example)
3. *Foreign exchange hedging products,* to insure against currency risk
4. *Low-carbon project development companies* established to ensure a flow of projects for the fund-of-funds to invest in. Funds would absorb early-stage project-development risks, bringing them to an investable stage.[24]
5. *Public-sector risk assumption.* The taking of 'first-loss' equity positions by the public sector helps institutional investors overcome issues such limited time for due diligence on multiple potential projects.

2.2.5 Mobilising Sovereign Fund and institutional investors' assets

Combined with the fund-of-fund structure, and the co-investing role of DFIs, the PFMs are designed to make it possible for institutional investors (and sovereign wealth funds) to channel funds to the renewable energy sectors of developing countries. As well as being long-term investors, the primary reason is the scale of assets under management. European institutional investors, particularly pension funds and insurance companies, are estimated to control up to US$12 trillion, and sovereign wealth funds another US$4.3 trillion (Source, Sovereign Wealth Institute, 2011, for the latter). If a relatively small proportion of this could be allocated to the renewable energy sectors of developing countries, the funding shortfall could be met.

As pointed out, sovereign wealth funds (SWFs) hold a total of US$4.3 trillion of assets; if 1% of those assets were invested in renewable energy in developing countries, this would equate to US$43 billion. If invested in a new institution, and the same conservative ratio of paid in

[24] This corresponds with the InfraCo model established by the Private Infrastructure Development Group (PIDG) as InfraCo Africa and InfraCo Asia. http://www.infraco.com/

capital to annual loans was applied as that of the Latin American Development Bank (CAF, based on its legal name, *Corporación Andina de Fomento*), US$102 billion could be lent annually.[25]

Furthermore, if the same principle and mechanism were applied to investing a further 1% of European institutional investors' assets (reaching US$12 trillion dollars) in the paid-in capital of Development Banks, whether the World Bank or Regional Development Banks, then the potential for lending for renewables could go up to around US$400 billion annually. This could significantly increase the funding available for green investment.

While this is attractive in principle, it clearly is not going to happen without complementary measures. For example, SWFs and institutional investors require commercial returns on their investments. Given the issues of commercial viability discussed above, this suggests the need for a 'blended finance' approach, perhaps in conjunction with DFIs.[26] Under such a mechanism, grants could be blended with commercial lending, generating a market-level return and allowing the impact of grants to be leveraged.

A related option could be to supplement or replace funds from grants to subsidise lending by DFIs by funding from innovative sources of finance; a potential carbon tax may be the most appropriate, but a financial transaction tax would also be a possibility (see also Noman, 2011).

2.3 Mechanisms to reduce uncertainty

This paper has discussed a number of the PFMs that are designed to reduce uncertainty.

Three main types of mechanisms are used. First, as described above, institutions can be employed to absorb initial project risk, taking projects to the stage where they may be attractive to international investors. Second, guarantees may be offered in a variety of areas. Prices, for example, may be fixed within a necessary band to guarantee profitability, or loans may be guaranteed by a public body. In the latter case, the resulting credit enhancement eliminates uncertainty over repayment, enabling the borrower to obtain finance on better terms. Third, insurance may be provided to protect investors from a range of potential events that could derail a project. This could be used to offset uncertainty over the maintenance of particular policies, or it could be related to price.

In their different ways, these mechanisms reduce the level of risk, making projects more affordable and their economics more viable. Renewable energy projects are highly dependent upon a small number of factors which are not economic variables, however, but driven by policy – the maintenance of a FIT, or the implementation of a carbon tax, for example. However, these factors are inherently uncertain, particularly given the potential economic costs involved. Importantly, in virtually all cases, such mechanisms are considered temporary. The assumption is that, in time, they will no longer be necessary as global and national conditions evolve to become increasingly supportive of renewable energy.

To return to the economics of the sector, the hope and expectation is that this will steadily improve until renewable energy is genuinely competitive with fossil fuels, at which point supporting instruments will no longer be required. There are two routes to this outcome. First, the price of fossil fuels increases, due to rising demand and dwindling supply, and/or increased Pigouvian taxes. Second, the unit costs of renewable energy fall, due to the diffusion of technological advances and the exploitation of economies of scale. Neither of the two is a certain outcome, however.

SEFI (2008) suggests that PFMs of the kind being reviewed here can leverage private finance with ratios of between 3 and 15:1. As a transitional means of developing a competitive industry, this is a very sensible investment. If the industry does not become competitive, however, it would represent a continuing drain on resources. Another way of looking at this

[25] For a more detailed rationale for these calculations, see Griffith-Jones (2011).

[26] Regional Development Banks would be particularly appropriate for regional schemes of renewable energy.

leverage ratio is that public funds are providing a return on the private finance invested. Using these ratios, this has been between 6% and 30%. As long as public money is available to provide this function, it will always be possible to elicit private funds, but this is clearly not sustainable in fiscal terms over the longer term. Furthermore, the global financial crisis has taught us that excessive leverage can be dangerous, if not properly monitored.

2.3.1 Guarantees linked to taxes

Given uncertainties surrounding the long-term price of oil and gas, as well as high volatility, one interesting potential policy tool could be to introduce a variable tax on the price of oil, that would increase as the price fell below a given level, and decrease as the price of oil increased beyond this level. As a result, the market price of oil would be stabilised and the profitability of investment in renewables made less uncertain. This is distinct from a Pigouvian tax on oil, which would not provide a floor for the price.

This tax/guarantee would also generate revenue for governments, which could be used to finance other investment in preventing or mitigating climate change; alternatively, it could be used to reduce government debt and deficits. Guarantees of a floor on the price of oil and gas may be a valuable mechanism for enhancing flows to low-carbon investment, particularly in developing countries that are going through or emerging from a credit-rationing (Stiglitz and Weiss, 1981) process.

Another way to protect the relative price of renewables is through the creation of a floor on the price of carbon. As with oil, however, to be feasible this would need to be achieved through the use of variable taxes. Renewable energy facilities – as well as other emission-mitigating mechanisms – may be designed with a carbon market in mind, particularly the ability to create and sell carbon credits into these markets. The project economics, however, may rest upon a minimum price being received for these credits. Implicit guarantees, achieved through the use of variable taxes, are one way of doing this.

Alternatively, a put option could be provided, which is triggered once the price falls below a certain level. The public sector provides project investors with the put contract, guaranteeing to buy the carbon credits at a specified price on a given date, thus eliminating price uncertainty. Unlike the variable tax approach, however, the open-ended commitments that providing such a put option would imply make this unrealistic as a real-world policy tool.

While not using an option mechanism, the UK became the first country to announce a floor price on carbon in the 2011 budget.[27] Starting in 2013, the price will steadily increase, with the aim being to provide certainty for investors and producers. As will be discussed in the next section, this mechanism is designed to do the job envisaged for the global carbon market. The European Trading System (ETS) is the only component of a global system that is functioning, but the UK move reflects concern that the prices generated are not high enough to produce sufficient incentives.

A different option is to design a liquidity facility (which could be part of a broader stabilisation fund) to help overcome the inability to obtain sufficient finance to support ongoing investment, if the investment in the renewable becomes unprofitable due to a fall in the price of oil or gas. Such a facility could provide the necessary financing on a temporary basis. Furthermore, where the investment in a project in renewables was already completed, but the price of oil or gas fell significantly, then a public liquidity facility could provide temporary credit, which could help keep the project functioning. Precedents already exist for this latter mechanism.

One of the main reasons why the profitability of low-carbon investment is uncertain is lack of knowledge over the future trajectory of oil or gas prices. Liquidity facilities could be used to deal with at least part of that risk. The conceptual operationalisation of a liquidity facility is relatively simple. The parties involved first agree upon a 'floor value' as the project's minimum cash-generation that allows payment of scheduled debt service. When establishing a floor

[27] Information available at: http://www.hm-treasury.gov.uk/consult_carbon_price_support.htm

value, it is important that there is sufficient margin for deviations in the operational performance from the initially projected levels. In the event of a major fall in the price of oil or gas, which results in the inability of the project to repay its debts – where the cash-generation becomes insufficient to reach the floor value – the liquidity facility is temporarily drawn upon. A loan is made to the project's senior lenders to be paid back when the project's cash flow allows. It is presumed this will happen when oil or gas prices rise. Price, availability and size of a liquidity facility would depend on estimates based on the historical fluctuations of the real price of oil.

Only one project to date has implemented this policy mechanism, which is located in Brazil and focused on infrastructure: AES Tiete. In the context of infrastructure financing, however, there are precedents for similar liquidity facilities in a somewhat different context, through currency devaluation risk. Some precedent exists in the IFC Contingent Partial Credit Guarantees, which are liquidity facilities for US dollars and local currency financing. The trigger for its use is a major devaluation in the project's host country. This guarantee is usually provided for two years, which the IFC estimates as sufficient for the project to recover from an economic downturn and be able to raise tariffs or prices sufficiently. In the case of a liquidity facility linked to oil or gas prices, the period may need to be somewhat longer, in view of the cycle of oil and gas prices.

Relatively long tenors make liquidity facilities particularly suitable for renewable financing. At the same time the long useful life of assets in such projects is a solid basis for debt repayments, allowing for such a liquidity facility to be viable. The liquidity facility has a counter-cyclical element, as the project continues without a problem in the face of external shocks, such as devaluation for the existing IFC facility, which could be applied to a drop in the price of oil or gas for renewable energy projects.

The current crisis also opens up potential opportunities for modifying private lending and investing practices, especially (but not only) where governments are playing some role as shareholders. Regarding banks, it could be mandated by their regulators that a *minimum* (e.g. 5%) of lending must be allocated towards low-carbon technology, half of which should be carried out in developing countries. As pointed out, the implementation could be facilitated for commercial banks, where governments are important shareholders (including those which were bailed out during the 2008 crisis).

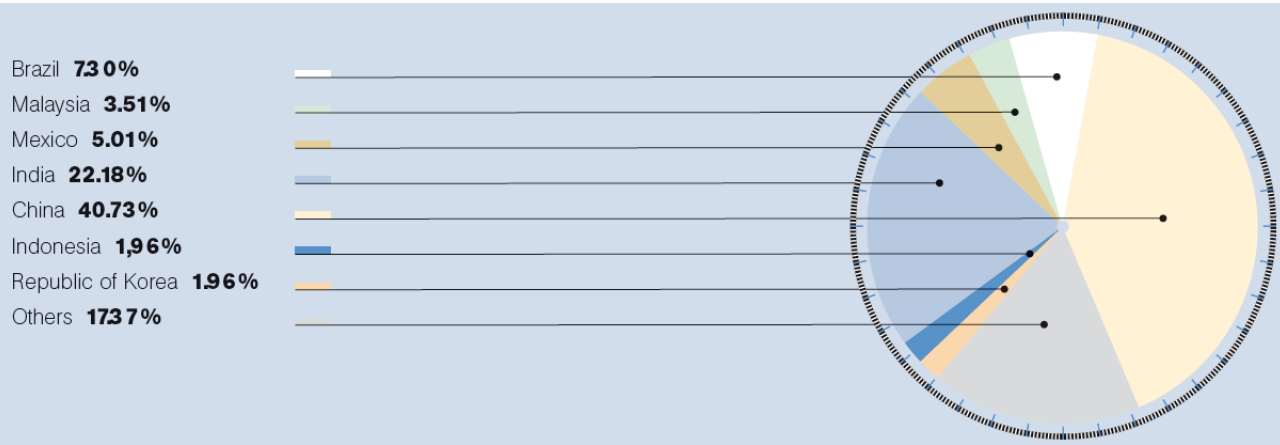
3 International transfer mechanisms and concluding comments

All the mechanisms considered in this paper, or any that could be reasonably envisaged, will entail some costs. An important issue, therefore, is that of cost effectiveness: how much private investment in renewable energy can be leveraged for a given level of public support? What are the most cost-effective mechanisms in different circumstances of doing so? We thus need to consider both the mechanisms, and who should pay for them.

For the latter, we have argued that the cost of financing renewable energy in developing countries, particularly LICs, should be met by developed economies. While this could be done bilaterally – and some countries have made considerable efforts in this regard – a number of international transfer mechanisms already exist. The most significant of these relate to the Kyoto Protocol, where (Annex 1) developed countries could count the mitigation of emissions in developing countries towards their own emission-reduction obligations.

The Clean Development Mechanism (CDM) was established under Article 12 of the Kyoto Protocol. The CDM allows Annex 1 countries to contribute to their emission-reduction targets by obtaining Certified Emission Reductions (CERs) in non-Annex 1 countries. The aim is to reduce global emissions where it is most efficient (cheapest) to do so, and to facilitate low-carbon development in poorer countries. Under CDM, if a project is approved, companies (from Annex 1) receive CERs, which they can trade/sell through mechanisms such as the ETS. From its inception in 2001 to 2012, the CDM is forecast to reduce 1.5 billion tons of CO_2 emissions.

Figure 3.1 Registered project activities by host party. Total: 2,453



Source: UNFCCC, 2010

Figure 3.1 shows the geographical distribution of CDM projects up to 2010. As can be seen, the overwhelming majority are accounted for by large emerging economies, particularly China and India. The CDM has been criticised for favouring large countries with existing, inefficient industry,[28] rather than smaller economies, particularly in Africa. Until recently, the CDM has been ill suited to smaller renewable energy projects in poorer countries. The 2010 CDM Annual Report (UNFCCC, 2010) proposes a number of approaches to address these issues, including the bundling of projects to ease the bureaucratic process.

Another criticism of the CDM has been its failure to include deforestation, which is responsible for 20% of global emissions. The mechanism developed to address this is Reducing Emissions

[28] For example, 20% of CDM projects since its inception were for destroying HFC-23 (11,700 times more potent as a GhG than CO_2) emitted while making the refrigerant HCFC-22.

from Deforestation and Forest Degradation (REDD).[29] REDD was designed to ascribe a value to the carbon content of forests and their role as carbon sinks, whereby payments would be made to developing countries to preserve their stock of forests and maintain ecosystem services. REDD+ extended the framework to include the possibility of payments for 'sustainable forest management', forest conservation and afforestation (i.e. increasing forest stocks). One of the few successes to emerge from COP15 at Copenhagen was the commitment of US$4.5 billion of 'fast start' funding to REDD+ for the period 2010–12. It is estimated that up to US$30 billion per year may ultimately be transferred to developing countries through the REDD+ system.

It remains to be seen how REDD+ will function in practice, but – as with the CDM – the growing supply of carbon credits needs demand. It was expected that the global carbon market would supply this demand. Developed – and perhaps emerging – economies would sign up for binding emission-reduction targets, and a global carbon market would be created for trading carbon credits (CERs). A binding deal to steadily reduce carbon emissions to sustainable levels would ensure a high demand for carbon credits, supporting the price of carbon. Furthermore, as the global carbon 'cap' becomes progressively tighter, the price of carbon would rise accordingly. In such as system, carbon credits from the CDM or REDD+ mechanisms would be increasingly valuable, providing strong incentives for investors to participate and ensuring a steady flow of financing to developing countries.

Unfortunately, however, no global deal has been reached and the global carbon market does not exist. It remains to be seen if this situation will change, but for the present it is hard to see how sufficient funds will be generated to fund a major shift to renewable energy in developing countries, regardless of the mechanisms. In the absence of a carbon market to provide the correct incentives, this requires someone to bear the costs. The IEA (2009) estimates that the energy switch needed will cost US$10.5 trillion, half of which is needed in developing countries. Copenhagen saw commitments to transfer US$100 million per year to developing countries for climate-change mitigation and adaptation by 2020. As yet, the source of these funds is unspecified, though recommendations were produced in the Report of the Secretary-General's High-Level Advisory Group on Climate Change Financing (2010).

The Report proposed that:

- Around US$30 billion annually could be allocated towards the $100 million target from taxes on the auctions of carbon allowances, and/or carbon taxes in developed countries.
- Up to US$10 billion annually could be generated through redirecting fossil-fuel subsidies, or innovative instruments such as Financial Transaction Taxes (FTT).
- A further US$10 billion could be raised from international shipping and aviation.
- Around $11 billion of additional funds could be leveraged via DFIs.

While members of the Advisory Group disagreed on whether private flows should count towards the US$100 billion target, it was suggested that a carbon price of US$20–US$25 per ton could generate between US$30 and US$50 billion in increased carbon market flows, though methodologies to make accurate estimates of these flows remain unproven.

Even if private finance does count towards the target figure, however, it is still dependent on a sufficiently high carbon price, which requires a minimum level of demand for carbon credits. Unless the prospects of an equitable global carbon market can be revised, it is hard to see where this demand will come from.

In this context, and given that the economics of renewable energy are not yet competitive with fossil fuels, there is little prospect that developing countries themselves will choose to hamper their own economic development with higher cost energy. In such conditions, the global switch to renewable energy, which everyone agrees is essential to avoid 'dangerous' and 'runaway' climate change, will not happen at a sufficient scale.

[29] Information available at: http://www.un-redd.org/

The alternative way of correcting the issue of economic profitability would be to greatly expand the use of grants in 'blended finance' models as suggested above. If correctly structured, such mechanisms could generate a sufficiently high rate of return for long-term investors, both private and public, seeking commercial returns, potentially unlocking the trillions of assets controlled by institutional investors and sovereign wealth funds, as discussed above.

This would need to be managed carefully to avoid creating perverse incentives. Furthermore, the scale of investment needed suggests that grant financing would have to be significantly expanded to have the required impact. The potential prize is great, however. It is perhaps only institutional investors and SWFs that have resources on the scale needed. Unlocking a proportion of these resources through the strategic use of public resources, using some of the mechanisms proposed in this paper, has the potential to make a real difference.

We cannot just expect this to happen. Exhorting private investors to sharply increase their investments in (relatively) unprofitable activities that are also very risky is clearly not going to work. Somehow the attractiveness of these investments needs to be increased. This can be done by changing the underlying economics through functioning carbon markets, or through creating 'synthetic' returns in 'blended finance' models. Where there are costs associated with creating commercial incentives, we have argued here that low-income countries in particular should not be expected to bear them.

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