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Chapter 16: Cross-Cutting Investment and Finance Issues

Contents

Executive Summary

Climate stabilization requires significant global emission reductions. Investments must be directed from activities that are responsible for GHG emissions to technologies with low- or zero-emissions. This chapter provides information on ***investments*** and ***financial flows*** required for supporting low-emission development pathways.

Macroeconomic costs are not to be confused with investments. Investments are meant to build productive assets that generate output over their lifetime. A mere re-allocation of investments across sectors has distributional consequences but does not necessarily generate a macroeconomic cost. A macroeconomic cost arises when investments are directed from more productive to less productive uses. Macroeconomic costs of transformation pathways are assessed by Chapter 6.

Incremental investments refer to the change of investments induced by climate mitigation policy with respect to a well-defined business-as-usual scenario (BAU). In order to estimate the incremental investments, it is necessary to have a model that assesses the optimal mix of mitigation actions and compares mitigation investments to BAU investments. Unfortunately this area of research has not been developed in the past and large gaps remain. This chapter attempts to quantify investment needs for mitigation based on literature estimates and using model results for the transformation pathways developed in Chapter 6. Incremental annual investment needs for renewable energy and energy efficiency in different sectors including buildings, transport, industry and waste for 2030 are in the range of at least USD 200-500 billion in industrialised and USD 200-700 billion for developing countries (see 16.2.1.2). Incremental investment levels can be partly compensated by reduced investment in other parts of the economy *(limited evidence, high agreement).*

From a microeconomic point of view, the ***incremental cost*** measures the additional cost that investors must face to install low-emission technologies compared to analogous high-emission technology. In many but not all cases renewable energy and efficiency investments lead to reduced fuel costs which can partly or fully compensate or over-compensate the cost of capital for incremental investments. The incremental cost for low-emission technologies is examined by the technology chapters. Literature results suggest that renewable energy deployment is likely to require substantial annual subsidies of above USD 100 billion each in industrialised and developing countries in 2030. Forest protection in developing countries is expected to require at least USD 20 billion annually in the coming decade *(limited evidence, medium agreement)* (see 16.2.1.2).

Climate finance is a broad category that encompasses both incremental investments and pure financial flows. There is no agreement on what qualifies as climate finance and no comprehensive system for tracking climate finance yet. Available estimates of the current financial flows, therefore, reflect different definitions and the limitations of the diverse data sources. While it has emerged recently that domestic finance – largely provided by national development banks - dominates current climate finance, international flows of climate finance are of particular interest due to developed countries commitments under UNFCCC (see 16.2.2).

International climate finance is primarily meant to support mitigation or adaptation activities in developing countries. It can come from foreign, mainly developed, countries or from international sources, including international carbon markets such as the Clean Development Mechanism (CDM). The only comprehensive overview available in the literature estimates that in 2009/2010 international climate finance amounted to USD 97 billion. USD 93 billion was used for mitigation, mainly originating from the private sector (USD 55 billion) *(limited evidence, medium agreement)* (see 16.2.2.2).

The current level of investments and financial flows in low-emission technologies is low compared to the stated climate stabilization goals. This is in large part explained by the lack of or an insufficient political commitment, in most countries of the world. Without a strong political commitment that

covers incremental costs and reduces political uncertainty, private funds will not be mobilized at the necessary scale. The majority of non-land-use reduction potentials is located in industrialised and developing countries with investment grade sovereign rating. In many other countries risk-mitigation instruments could to be put in place or other sources of finance like international grant finance be tapped to pursue emissions reduction objectives *(high confidence)* (see 16.2.1.3).

The private sector – e.g. pension funds, insurance companies, banks, mutual funds, and private foundations – has developed tools to finance large and risky projects when there is a clear return on the investment. Private climate finance is therefore expected to become a key source of funding for low-emission investments once the right incentives will be established *(high confidence)* (see 16.2.3.1).

The public sector has major role in reducing political uncertainty, in promoting a sound (i.e. enabled) investment environment for mitigation technologies and by financing sectors and investments in which there are large externalities, in particular Research and Development and large demonstration projects *(high confidence)* (see 16.2.3.1).

The public sector has the potential to raise revenues by collecting carbon taxes, by auctioning carbon allowances or selling assigned amount units (AAUs) (see 16.2.3.3). These innovative, carbon-related sources of funding are already sizable in some countries and have the potential to generate very large financial flows under ambitious stabilization targets *(medium evidence, high agreement)* (see16.2.3.3; 16.3).

A contraction of fossil fuel subsidies, not compatible with low-emission trajectories, could be an additional source of funding. Conversely, revenues collected through royalties, severance taxes, leasing bonuses, auctions of lease rights, and other fees, including taxes on final consumption of fossil fuels, will vanish in a low-emission world (see 16.2.3.2).

Both the private and the public sectors have developed financial instruments to fund investments and to manage risk. Risk mitigation tools include business interruption insurance, credit enhancements, production and savings guarantees. Feed-in-tariffs are frequently used to support renewable energy in Europe, USA and in Japan and in some developing countries (see 16.3.1.2). Innovative tools include shared savings, tax-exempt lease purchase, power purchase agreements, efficiency service agreements, rebates, on-bill financing or repayment, energy assessment financing district (see 16.3.1.3).

An ***effective governance of climate change on the national, regional and international level*** is an essential pre-requisite for an efficient and effective system of finance for mitigation. Appropriate institutional arrangements are essential for ensuring that financing to address and in response to climate change responds to national needs and priorities in an efficient and effective way *(high confidence)* (see 16.6).

International transfer of mitigation technologies will require substantial funding from developed to developing countries (see 16.5.2). Financing should facilitate deployment and diffusion of mitigation technologies, and local production of mitigation technologies. Funding should also develop capacity to be able to absorb increasing flows of funding in order to enhance the ability of the public and private sectors to identify, adopt, adapt, improve, and employ the most appropriate technologies.

Available estimates show that adaptation projects presently get only a minor fraction of international climate finance. Economic analysis currently does not provide conclusive results on the most efficient temporal distribution of funding on adaptation vis-a-vis mitigation (see 16.7.1.2). It is however important to take into consideration that ***complementarities and trade-offs between financing mitigation and adaptation*** exist (see 16.7.2.3).

16.1 Financing low-carbon investments, opportunities and key-drivers

16.1.1 Rationale of this Chapter

Climate stabilisation requires significant emission reductions in developed countries and steering developing countries on to a considerable lower carbon intensity trajectory. Transformational change towards a low-carbon and climate resilient society can only be initiated and catalyzed if substantial flows of finance and investmentcan be raised, provided, channeled and implemented effectively and efficiently. This chapter will focus on finance and investment for climate change mitigation, in the following referred to as climate finance. Adaptation finance will only be explicitly dealt with in section 16.7. Climate finance includes both private and public funds, and can be either domestic or international financial flows.

A transition towards a low-carbon and climate resilient society is constrained by many factors which include lack of legally binding targets and appropriate regulations, existing stock of old and inefficient technologies, institutional weakness, inadequate R&D investments and lack of adequate finance. Increased availability of climate finance can help both developed and developing countries address some of the constraints like R&D investments, retiring the existing capital stock, as well as increasing the penetration of low-carbon technologies.

Significant investments are required for the business as usual growth trajectory, i.e. in the baseline scenario. Incremental finance and investment is required to cover the transition to a low-carbon growth trajectory. The financial needs at different levels must be identified, recognising significant differences between developed and developing countries in terms of financial sources, financial instruments and specific sectors. Given the ambiguity of long-term policy guidance and regulations current financial flows and mechanisms are inadequate to facilitate the transformation towards a low-carbon future. An enabling environment is required that consists of a coherent set of policies and frameworks, as well as respective institutional arrangements. It is also crucial to develop innovative financial mechanisms to mobilize new funding from public and private sources for mitigation activities.

Climate finance, anchored in Article 4.3 of UNFCCC, has been a central issue in global climate negotiations since its beginning (UNFCCC, 1992). At the Conference of the Parties in Copenhagen 2009 (COP 15) and Cancún 2010 (COP 16), developed countries made a concrete commitment, in the context of meaningful mitigation actions and transparency on implementation, to a goal of jointly mobilizing USD 100 billion per year by 2020 to address the needs of developing countries. These funds will come from a wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance (UNFCCC, 2010, 2011a)

16.1.2 Opportunities and key drivers for low carbon investments

Even though there are daunting low-carbon investment gaps for climate change mitigation (see 16.2.1) considerable opportunities exist for investments for a global transition to a low-carbon economy. More specifically, the increasingly sustainable orientation of national economies due to other environmental considerations, result in development programmes such as sustainable agriculture, sustainable transportation, green buildings, green tourism and improved waste management which induce low-carbon investment flows to specific sectors. In recent years, various green fiscal stimuli have been established by governments in response to economic recession while embarking on a low-carbon development path. These newly developed market instruments (see 16.3.1) provide opportunities for private investors. The market for new renewable energy has seen a six-fold increase in new investment from USD 46 billion in 2004 to USD 257 billion in 2011 (UNEP, 2012).Despite the opportunities, risk and uncertainty (regarding prices and access to services) are prevalent features in both developed and developing countries. A clear, credible and long-term structuring of incentives would lower risk and uncertainty associated with low-carbon investments.

Additional benefits would accrue, for example, if the transition will provide opportunities for new business that would in turn support the creation of new employment opportunities (Barbier, 2010).

There is a range of economic and financial drivers for low-carbon investments. Developed countries have the chance to both provide and facilitate climate finance to their own economies, as well as to offer financial assistance to and undertake low-carbon investments in developing countries since climate change mitigation will be neither effective nor efficient without the abatement efforts of developing countries, which have legitimate development needs. Businesses have incentives to invest in low-carbon projects or adopt low-carbon or renewable technologies and measures, in order to help cut their energy and resources costs, optimise logistics and avoid reputational risks (Kauffmann and Tébar Less, 2010).

16.1.3 Public and private sector perspectives

There are a number of specific roles that private sector and public sector can play to capitalize on the growth opportunity from a transition to a low-carbon economy, and both sectors are indispensable to the solution.

The **public sector** has a crucial role in setting the policy framework, including targets, enforcement, financing arrangements and institutions. It can play a key role in mobilizing, leveraging and redirecting private funds. It can stimulate investments in new low-carbon products and services for private sector by removing the informational or financial barriers, providing financial support and advice, and boosting demand for innovative low-carbon goods and services. They can also be an important complement to build capacity, correct market imperfections (e.g. supporting projects with large externalities, such as R&D in green technologies), and target areas overlooked by private sector.

While certain amount of public funding is needed to mobilise and leverage private capital, the bulk of the financial needs will come from the **private sector** (UNFCCC, 2007; Maclean et al., 2008). UNFCCC (2007) indicates that only 14% of gross fixed capital formation is by the government. The private sector can play a major role in promoting innovation and deployment of climate-friendly technologies and measures, and fostering entrepreneurship in climate-relevant sectors.

16.1.4 Roadmap to the Chapter

Chapter 16 proceeds as follows: An assessment of overall financial needs for mitigation, adaption and technology at different levels and the scale of financial gaps given the existing financial means is provided in Section 16.2. Hereafter, sections 16.3 assesses financing for mitigation activities regarding specific instruments and sectoral particularities, both in developed and developing countries. Section 16.4 explains the enabling environments for finance and investments in low-carbon development, including means and barriers. This is followed by section 16.5 which examines the financial particularities for greening conventional technologies and developing and diffusing low-carbon technologies. In the subsequent section 16.6 key preconditions in terms of institutional arrangements for these financial flows to happen are discussed. Finally, benefits and trade-offs between financing mitigation and adaptation will be demonstrated as well as integrated approaches in section 16.7.

16.2 Scale of financing at national, regional and international level in short-, mid- and long-term

16.2.1 Future demand

Developing credible and transparent estimates of the financing requirements needed to meet specific global GHG emission reduction goals is important for at least four reasons. First, the scale of required developing country financing is important to the design of the funding mechanism. The quantum of financing required would influence the design of viable mechanisms and approaches.

Second, knowledge of the global scale of all required investment including developed and developing countries is important to gauge the impact global financing demands will place on capital markets and how much head room exists in those markets to meet the needs of developing countries.

Third, it is important to disaggregate the global demand by region and if possible by country. Wealthy countries like the U.S. and those of the EU will likely have high finance requirements to meet global GHG emission reduction objectives, but these needs will be largely self-financed; however, countries at the opposite end of the wealth spectrum will be unable to self-finance and will require assistance from the funds committed at COP16. Assessing the magnitude of the funds required means assessing the needs of individual countries or groups of countries.

Fourth, investment risk varies from country to country. Many developing countries have high investment risk. Thus, for any given physical investment in mitigation, more investment funds must flow to those countries to buy down the risk or to compensate for expected financial losses. Properly assessing the magnitude of the global financial needs means quantifying the risk premiums that must be included in the investment accounting. In other words, investment requirements adjusted for risk, including country and sector risk, determines the actual financial flows required.

16.2.1.1 Incremental costs

Incremental costs can be calculated on different scales and against different references. They can be calculated for an individual project, for a programme, for a sector, a country an entire region. As for UNFCCC, article 4.3 of the Convention states that developed country Parties shall provide the financial resource needed by the developing country Parties to meet the agreed full incremental costs to comply with their commitments under Convention outlined in Art. 4.1 (UNFCCC, 1992). However, a formal definition of the crucial phrase “incremental cost” has not been agreed. Since one of the purposes of this chapter is to assess the magnitude and regional distribution of the financing needed to achieve a set of mitigation targets, a suitable definition or set of definitions with respect to full incremental cost is required.

From and economic perspective a country-level compensation based measure of incremental cost could be defined as a monetary measure of lost social welfare, but more easily as a measure of lost gross domestic product (GDP) or consumption. The full incremental cost for a given developing country could be calculated as the difference between GDP in the absence of UNFCCC commitments and GDP when the country in undertaking actions to meet those commitments. Since a developing country is either meeting UNFCCC commitments or not, one of these two states of the world is a counterfactual and therefore operationalizing the calculation of full incremental cost requires modelling.[1]

[1] The compensation based measure of full incremental cost can be positive or negative, that is, while it’s reasonable to assume that meeting UNFCCC mitigation commitments, for example, will be more costly in terms of lost GDP than business as usual, given the heterogeneity of country circumstances and the nature of any particular country’s commitment, some might argue that GDP would be enhanced through efforts to mitigate emissions.

The compensation based measure of full incremental cost is instructive in the sense that it provides a country-level perspective on the macro aggregate cost of mitigation actions, but it does not provide information on the micro economic investments that must be made and costs incurred to meet the mitigation commitments. This distinction is important if the operationalization of the international climate finance commitments will be through institutions designed to provide micro-level investment and cost support rather than macro-level compensation payments.

16.2.1.2 Available estimates

While agreement to fund the full incremental cost of developing country has been in place since 1992, seemingly research interest in the implied financing requirements has been low until the Copenhagen Accord. However, the USD100 billion commitment arose from a political process and therefore ambiguity exists with respect to the adequacy of the US$100 billion commitment to meet the developing country mitigation and adaptation needs. Thus, there are few published studies that have undertaken a comprehensive analysis of the financing needs, and the mechanisms and institutions required to fulfil the pledges.

[Editorial comment for FOD: Below results of the WITCH model (www.witchmodel.org) are presented as a case study; as the dataset becomes available this chapter will show results of the same methodology applied to other models and scenarios. The data used in this illustrative example is from a publication that is "revise and resubmit" in Energy Economics, based on data prepared for the Asia Modelling Exercise. Results obtained from Chapter 6 will be used instead to arrive at estimates of investments required by country/region and sector.]

Olbrisch et al. (2011) provide the most comprehensive survey of estimates of incremental investment for mitigation actions for the energy sector at the global level and with greater detail for developing countries. The studies focus on (1) investments to increase energy efficiency, and on (2) investments in low-carbon energy supply, while they have limited coverage of investments in non-CO_2 gases abatement and investments to increase carbon sinks (agriculture and forestry). Estimates range from USD 380 to 1,215 billion per year in 2030, at a global level; in developing countries incremental investments range between USD 177 and 695 billion per year (UNFCCC, 2007; McKinsey, 2009). In addition, over the coming decade forest protection in developing countries is expected to require at least USD 21 billion per year (UNFCCC, 2007).

Unfortunately comparisons of these estimates do not reach far because they do not correspond to the same emission reduction target in 2030. The IEA assumes pathways in its "New Policies Scenario" of emissions that are consistent with a 450 ppm CO_2-eq target in 2100 (37.1 $GtCO_2$-eq, only fossil fuels) (IEA, 2011); the UNFCCC assumes emissions to be 20% below the 1990 level (29.1 $GtCO_2$-eq)(UNFCCC, 2007); McKinsey uses GHG abatement cost curves and the assumptions that all measures are implemented to their full potential (32 $GtCO_2$-eq) (McKinsey, 2009). The UNFCCC estimates thus appear the most optimistic because it obtains the lowest level of emissions in 2030, with the least amount of investments. Even accounting for the higher level of emissions, the IEA has lower investments than McKinsey. The IEA estimates additional investment in all sectors for both developed and developing countries of around USD 1.2 billion annually by 2030 (figure 16.1). In addition, IEA reports incremental costs for the deployment and operation of renewable energies (figure 16.2), which need to be provided as subsidy of some kind, summing up to more than USD 200 billion per year in 2030 globally.

Both UNFCCC and IEA show a very interesting result: Climate change mitigation policies will induce higher investments in energy efficiency and in the power sector, but lower investments in fossil fuels extraction. The contraction of GDP which represents the incremental cost of the policy would also generate a contraction of overall investments in an economy, unfortunately not shown by the models.

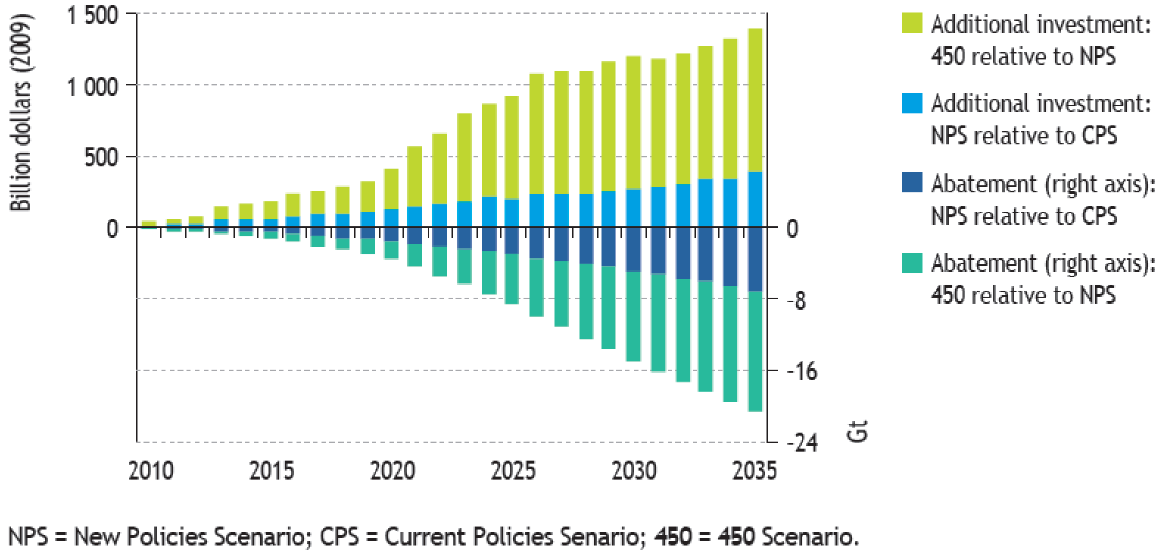

Figure 16.1. Additional investment and respective greenhouse gas emission abatement for two policy scenarios relative to the current policy scenario (IEA, 2011, figure 13.9)

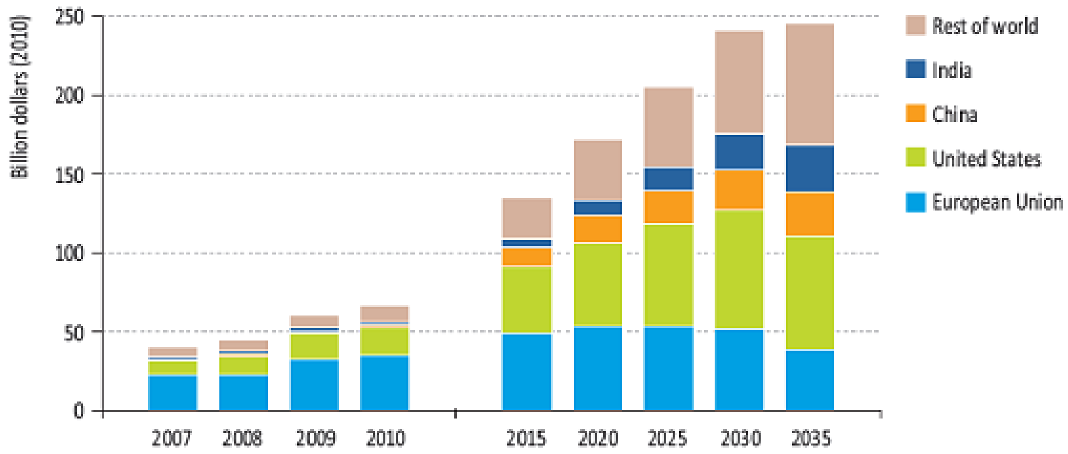

Figure 16.2. Need for subsidies for a renewable based energy sector in the IEA New Policy Scenario (IEA, 2011, figure 14.13)

A major problem with these estimates is the challenge to have a meaningful comparison across different models because of very different assumptions, climate mitigation targets and methods. McKinsey estimates are also difficult to compare to those of UNFCCC and IEA because they are not based on a model in which alternative mitigation options are simultaneously evaluated and the cost-minimizing mix is an output of the model.

World Bank's World Development Report 2010 (2009) collects estimates of incremental investments required in 2030 to achieve a 2°C trajectory in 2100 generated by three integrated assessment models: MESSAGE and REMIND. Results indicate incremental investment needs much lower than those expected by McKinsey and IEA, between USD 264 and 384 billion (2005 USD). This might in part be due to lower emission reductions in 2030 with respect to the above cited studies, or to a greater role of cost-less efficiency measures in the short term. Unfortunately, also in this case we cannot find a thorough assessment of investments.

The Global Energy Assessment (Riahi et al., 2012) estimates investment needs in 2050 to achieve a 2°C target in 2100 with at least 50% of probability while also improving energy security and access and reducing pollution. Energy-sector investments are projected to increase almost two-fold with respect to the present level. Depending on the importance of demand-side versus supply-side changes, average annual global investment in 2050 ranges between USD 1.7 trillion and USD 2.2 trillion, or about 1.8-2.3% of GDP. These figures do not include demand-side investments for all energy components and appliances, which would likely be an order of magnitude bigger. The study reveals the need to shiftinvestments from upstream fossil to downstream electricity generation and transmission. The focus is on the energy sector and the implications on macroeconomic investments are not presented.

In the RECIPE study on low-carbon mitigation scenarios, three European research institutes, estimate that incremental investments in mitigation technologies to achieve a 450 ppm CO_2 concentration target in 2100 would total USD 1.2 trillion in 2050. Investments in conventional fossil fuels based sources of energy generation would be reduced by USD 300 to 550 billion with respect to the reference scenario (Edenhofer et al., 2009) The largest fraction of incremental investments is directed towards renewable energy sources and to power plants with CCS.

An important characteristic of the RECIPE project is that the estimates of additional investments are generated by three integrated assessment models (IAMs) that use the same policy scenarios. Results are therefore easily comparable. The three IAM used have a sophisticated structure in which energy demand and supply composition are both endogenous and derived using a long-term policy scenario. This allows meaningful insights.

Integrated assessment models would be the ideal tool to estimate the incremental investments needed to achieve a given mitigation target. They provide detailed information on the least cost mitigation measures over a wide range of sectors and technologies, regions and over time.

For example, when estimating incremental investment needs it is important to recognize that there are two forces at play: more technologically advanced power plants will increase the investment cost per unit of installed capacity, but at the same time installed capacity will decline as electricity demand declines (with respect to the reference scenario). The optimal balance of these two forces varies depending on the model, on country-specific characteristics and on the severity of mitigation policy.

It is common practice in the IAM community to perform large modeling comparison exercise in which 10-25 models use a harmonized set of policy scenarios. Chapter 6 reviews several of those exercises. Unfortunately, the large volume of literature developed by the IAM community to study optimal transformation pathways is still untapped to study these forces. Data on investments is – in most cases implicitly, in some cases explicitly – part of the output of the IAM modelling comparison exercises. Unfortunately, the analysis of investment dynamics has not been a priority in the IAM community so far and there is only a handful of study directly addressing this topic. Using data from the scenario database developed by Chapter 6 provides useful insights on incremental investments and financial flows associated to the transformation pathways examined in Chapter 6.

Carraro, Favero and Massetti (2012) used the IAM WITCH to study investment patterns in the power sector, in energy efficiency R&D and in oil up-stream. They use four global carbon tax scenarios for which concentrations of GHGs are between 460 ppm-eq. and 633 ppm-eq. in 2100. This allows a more general analysis of how mitigation policy might affect incremental investment needs. Climate policy induces higher investments in the power sector (1) in non-OECD economies, in (2) later years and/or (3) when the carbon price is high. Figure 16.3 illustrates these findings. Non-OECD economies attract the largest share of investments and have more space for energy efficiency improvements. The low tax scenarios do not require additional investments with respect to the reference scenario. The t450 scenario requires instead a massive transformation and investments double in 2050.

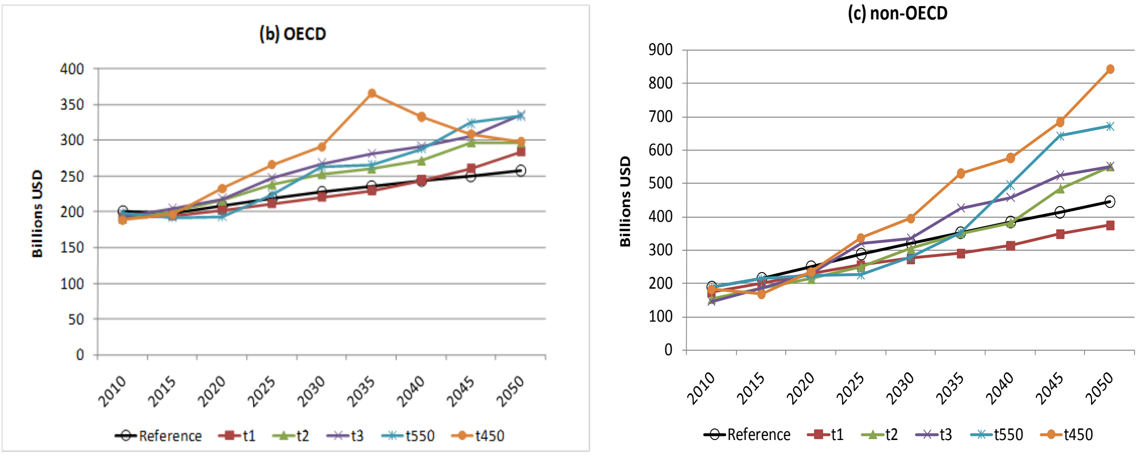

Figure 16.3. Total investment in the power sector: OECD and Non-OECD countries, 2005-2050 (Carraro et al., 2012)

An important side-benefit of investing in low- or zero-emission power technologies is the savings that they bring in terms of reduced use of fossil fuels. There are substantial savings in respect to fuel costs, partly or fully compensating the incremental investment cost. However, often model based results do not distinguish between savings to lower power generation from savings due to the penetration of non-fossil fuels power generation.

Mitigation policy will affect heavily investment in fossil fuels supply. Most importantly, oil consumption is expected to go to zero in a 2°C scenario. Coal and natural gas can be used with CCS, but not oil. Climate policy also indirectly affects investments in all sectors. If energy, capital and labour are complement, as the empirical evidence suggests, climate mitigation policy reduces the incentive to invest in generic fixed capital as well. The overall macroeconomic cost that IAM consistently find associated to mitigation policies is a consequence of the reduction of investments in other sectors of the economy. If summed to the contraction in oil upstream we see that climate policy induces a net contraction of investments. This is an important result that calls for a more appropriate definition of incremental financial needs, of both developed and developing countries.

Chapter 6 [or sectoral chapter] has shown that innovation is a key ingredient for a low-carbon transformation pathway. The financial flows to boost R&D activities may be modest if compared to the aggregate investments, but the extremely fast expansion suggested by the model represents a challenge for both firms and governments. Firms are under pressure to start new risky research projects, with possibly supply constraints in the short-term (Goolsbee, 1998; Nordhaus, 2002; D Popp, 2004). Governments must play a role to ensure that private and social returns are aligned.

16.2.1.3 Outlook

The estimates derived in the previous sections are obtained from models that usually assume: (1) flexible markets and institutions which deliver a cost-minimizing mix of mitigation options at regional and global level, (2) a full set of technology options, (3) global and immediate enforcement of climate policy, (4) absence of risk and uncertainty.

Investment risk in many countries can be higher than what assumed in the models, meaning that a marginal dollar invested in a high risk country delivers (on average) lower mitigation than a dollar invested in a low risk country. We use two sources of information to assess the investment risk of specific country/regions: the World Bank and the World Economic Forum. From the World Bank we draw in the World Bank Governance Index (Kaufmann et al., 2009) and the World Bank Ease of Doing Business Index (World Bank and IFC, 2011) and from the World Economic Forum the Competiveness Index (World Economic Forum, 2011). In each case we have utilized the aggregate indexes as well as sub-components. An additional approach would be to use sovereign risk ratings to adjust the investment figures to arrive at finance requirements. According to Harnisch (2012) about 80% of non land-use related greenhouse emissions in 2008 were located in countries whose government bonds in early 2012 were considered investment-grade. This suggests that country risk for most of the required mitigation investment could be small and errors introduced into model results by neglecting investment risks moderate on a global scale. At the same time, the country risk for a large number of countries with frequently low income and low cumulative GDP is considered high by international investors. For these countries, in which “energy access” and “energy poverty” are often major challenges, de-risking private sector investments could be very costly or impossible. The IEA World Energy Outlook (IEA, 2011) estimates the additional investment need of USD 50 billion per year, which would have to be sourced largely from international grant finance or local public or private sources, unless investment risks in respective countries were greatly reduced.

16.2.2 Current financial flows

There is no agreement on what qualifies as climate finance and no comprehensive system for tracking climate finance (Haites, 2011; Stadelmann, J. T Roberts, et al., 2011; Buchner et al., 2011; Forstater and Rank, 2012). Available estimates of the current financial flows (e.g. see Figure 16.4), therefore, reflect different definitions and the limitations of the diverse data sources. International flows of climate finance are of particular interest due to developed country commitments under UNFCCC (see 16.1.1). Information on the sources of finance – public and private, domestic and international – is largely missing.

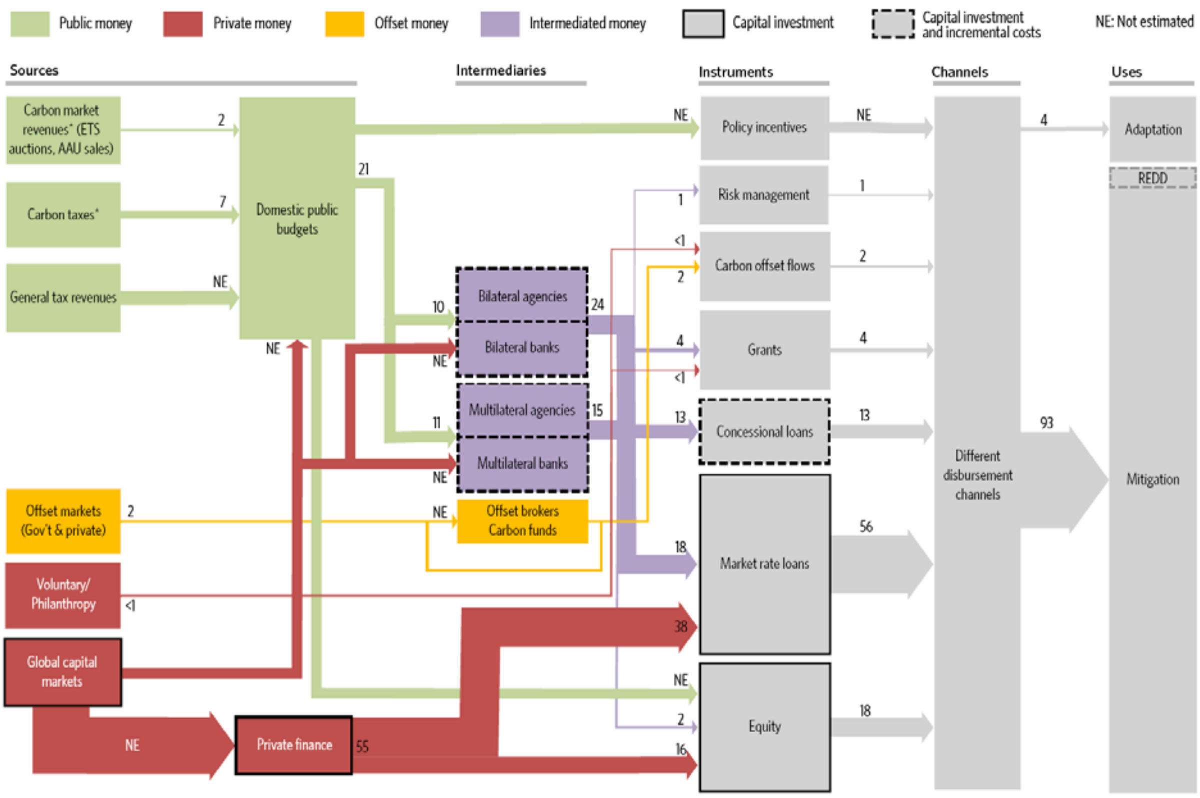

Figure 16.4. Schematic visualisation of north-south flows for mitigation and adaptation in 2009/2010 (Buchner et al., 2011)

This section presents available estimates of current financial support for mitigation and adaptation activities, while focusing on mitigation only whenever estimates allow for. Estimates of domestic climate finance are scarce but more information exists on international climate finance, for which herein we use a broad interpretation. Some experts apply narrower interpretations, for example, that climate finance commitments under the UNFCCC should be measured on a “net benefit” basis and that international carbon market flows should not count as climate finance (Stadelmann, J. T Roberts, et al., 2011).

16.2.2.1 Domestic climate finance

Within a country the sources of climate finance are government budgets, private finance and philanthropy. Most countries have multiple levels of government – national, state, municipal – that can provide financial support for domestic mitigation and adaptation activities. Reasonably robust estimates of domestic climate finance are available for only a few countries and cover largely the renewable energy sector (BNEF, 2012).These investments amounted to USD 264 billion in 2011. Only 10 countries accounted for 75% of the global total, namely USA, China, Germany, Italy, India, UK, Japan, Spain, Brazil and Canada (in the order of decreasing relevance).

Data from the 19 development banks of the International Development Finance Club (IDFC) for 2011 indicate that the 14 developing country banks devoted all USD 44 billion of climate finance to domestic projects (Höhne et al., 2012). The 5 developed country banks allocated USD 28 billion of their USD 45 billion of climate finance to domestic projects. Concessional funding provided by public development banks plays an important role in financing domestic climate projects in particular in countries like Brazil, China and Germany.

16.2.2.2 International climate finance

International climate finance supports mitigation or adaptation activities in a developing country. It can come from foreign, mainly developed, countries or from international sources including international carbon markets such as the Clean Development Mechanism (CDM).[2]

The only overview of current international climate finance is Buchner et al. (2011). The data relate mainly to 2009 and 2010. Of the estimated USD 97 billion in international climate finance, USD 55 billion is provided by the private sector. Bilateral and multilateral organizations provide USD 39 billion by combining government contributions of at least USD 21 billion with funds borrowed on international capital markets. The remaining USD 3 billion comes from international offset markets and philanthropy. USD 93 billion is for mitigation.

Private finance is generated from a firm's cash flow or from domestic or foreign capital markets in the form of debt or equity.[3] Buchner at al. (2011) estimates a range of USD 37.0 billion, reflecting "green" Foreign Direct Investment (FDI) in developing countries, to USD 72.2 billion, reflecting reports on finance for renewable energy projects in developing countries, with a mid-point of USD 55 billion. Stadelmann et al. (2011) estimate private finance at USD 25 to 125 billion per year. Private firms usually deal directly with related firms in recipient countries.

Most climate finance from government budgets flows through bilateral institutions or multilateral institutions which supplement these flows with funds borrowed on international capital markets. **Bilateral institutions** (those sponsored by one nation, e.g. JICA, AFD, KfW) received around USD 11 billion from government budgets and provide USD 24 billion of finance for mitigation and adaptation in 2010/11 (Buchner et al., 2011). Information on bilateral climate finance is available from several sources, including the OECD's Creditor Reporting System (CRS), which collects data from member countries on assistance committed[4] and national communications of Annex II parties on financial support. Both show a clear increase of climate finance in the last 4 year.

Multilateral institutions (funded by several countries, e.g. World Bank and regional development bands) received around USD 12 billion and distributed USD 15 billion in 2010/11 (Buchner et al.

[2] Voluntary purchases of emission reductions are classified as philanthropy.

[3] Government-owned enterprises, such as utilities and national oil companies, which have a structure similar to that of a private business, generally are considered to be part of the private sector.

[4] See Michaelowa and Michaelowa (2011) for reviews of the CRS markers.

2011). Annex II parties reported USD 44 billion of financial support to multilateral institutions during 2005–2010 (UNFCCC, 2011b). Several multilateral development banks provide project data on their websites, but the climate finance provided can be difficult to extract (D. Tirpak et al., 2010). These figures include USD 1 to 3 billion p.a. that flows through climate funds, mostly administered by multilateral institutions (Buchner et al., 2011).

The **CDM and JI** issue credits that can be used for compliance by installations regulated by domestic emissions trading systems, such as the EU ETS and NZ ETS. The credits can also be used by Annex I governments for compliance with their emissions limitation commitments under the Kyoto Protocol. This international market for compliance credits provides funds for mitigation actions.[5] The market generates both investment flows and revenue from the sale of credits. Van Melle et al. (2011) puts the investment in CDM projects in 2010 at approximately USD 23 billion and the value of CDM credits issued at about USD 5 billion.[6] Buchner et al. (2011) estimates the revenue from the sale of CDM and JI credits at USD 2.2 to 2.3 billion per year.[7]

Voluntary flows include both philanthropic donations and purchases of voluntary emission reduction (VERs) credits. Estimates of global philanthropic donations to tackle climate change in developing countries are not available. American donations are estimated at USD 0.2 billion (Buchner et al., 2011). Purchases of VERs are estimated at between USD 0.15 and 0.24 billion per year (Stadelmann, J. Timmons Roberts, et al., 2011; Buchner et al., 2011). Charities usually provide funds directly to volunteer organizations in recipient countries

16.2.3 Potential climate finance sources

There are several source of finance that could be used to finance and invest into mitigation activities. Some of these sources are already been explored and used for climate finance (conventional sources), while others have only recently been applied in limited volume or have not yet been used for climate related finance yet (innovative sources).

16.2.3.1 Conventional sources

Capital is generated and invested by either the public or private sector (Jain, 1989). Public sector funding originates from the government while private sector funding originates from financial institutions, businesses/corporations and the investing public.

Public sector funding of mitigation activities take the form of government programs, some of which drive or catalyse investment in the space. The budgets for those programs come from government agencies or departments, which are in turn ultimately funded by taxpayers in the jurisdiction. For example, the U.S. Department of Energy’s (DOE) 1705 program provides loan guarantees to RE projects as a means of leveraging capital. The credit subsidy cost requires the DOE to use taxpayer funds, which are provided through a Congressional appropriation to the loan guarantee program (Anadon et al., 2009). A number of developing countries have also increased their internal spending the past year to serve both to advance economic development and limit growth of emissions, e.g. several countries have introduced budget allocations for energy efficiency and renewable energy programs.

[5] Voluntary emission reductions (VERs) generate credits that cannot be used for compliance. Finance generated by VERs is included with philanthropy.

[6] This is about half of the UNEP Risø (2012) figure for 2010. The value of credits issued is higher than the value of credits sold.

[7] JI credits account for USD 0.3 billion. Work is underway for the CDM Policy Dialogue to generate updates estimates of both the investment, including the host country share, and revenue estimates. The information will be available in time for the SOD, but not the FOD.

International public finance sources mostly take the form of Official Development Assistance (ODA). Although ODA funds are currently less than 1% of investment globally, it represents a larger share of total investments in developing countries (6%) (UNFCCC, 2007). Even though currently most of the investment in mitigation measures is domestic, ODA plays an important role in many developing countries to mobilize resources for climate action. Multilateral and bilateral development banks can stimulate shifts of private investments in clean energy and more climate resilient development. Additionally, they shift their own investments by integrating climate change risks and costs of adaptation and mitigation into their lending practices. See section 16.2.2 for estimates for development banks' mitigation lending.

Private climate finance originates mostly from financial institutions, businesses, the investing public and philanthropy. Financial institutions i.e. endowments, pension funds, insurance companies, banks, mutual funds, and private foundations are examples that oversee the investment of large pools of capital. Institutions obtain their capital through aggregation of various sources depending on their business model. For example, pension funds obtain their capital through the contributions of their future pensioners; insurance companies from the premiums collected through policies; mutual funds from their investors; and foundation endowments from corporations and high net worth individuals. Institutions have a broad universe of investment options that span publicly traded market securities, such as stocks and bonds, to private investment vehicles, such as venture capital (VC), private equity (PE), project finance (PF), and hedge funds (HF). These investment vehicles in turn provide profits to their institutional investors by making low-carbon investments, such as purchasing fractional ownership in or lending to mitigation projects and companies. Banks are a fundamental source of debt funding, providing loans, project finance (also known as non-recourse finance), mezzanine finance, and offering refinancing services to replace existing debt arrangements with new ones (Justice and Hamilton, 2009). Banks aggregate capital through deposits, returns from lending, and loans from other banks (including federal central banks).

Businesses / Corporations provide financing to mitigation activities when the returns are worthwhile or for strategic reasons or philanthropic interest to the firm (Baron, 2000). Private sector investments in carbon mitigation activities in developed countries are evaluated in the same manner as any other investment, essentially distilled to identifying risks and potential for financial return (Justice and Hamilton, 2009). As such, the same sources of capital that participate in the financing of other industries or sectors also participate in financing mitigation activities in a similar manner. Through on-balance sheet financing, business entities can finance their own mitigation projects arranged through the corporate treasury (Justice and Hamilton, 2009). Business entities can also structure equity and debt investments in an unaffiliated business entity or project, typically financed through retained earnings or by raising capital from outside sources.

The last years showed a lowering of the **foreign direct investment** (FDI) but at the same time "in 2009 low-carbon FDI flows into three key low-carbon business areas (renewable, recycling and low-carbon technology manufacturing) alone amounted to USD 90 billion"(UNCTAD, 2010, pp. 111–116). In the database on Greenfield Investments, identifiable low-carbon FDI projects are primarily found in alternative/renewable energy (which accounts for the bulk of cases), recycling activities and environmental technology manufacturing. During 2003–2009, the value of these combined deals amounts to USD 344 billion (UNCTAD, 2010).

Retail investors provide financing through public market securities, in the form of tradable stocks, bonds, and numerous derivative products directly bought and sold by the investing public or indirectly through mutual funds, exchange traded funds (ETFs), or other similar investment vehicles.

Private philanthropy, i.e. private donors, foundations and companies are becoming increasingly important entities in development finance. Along with growing resources, their participation can encourage innovative partnerships to raise funds. Private financial contributions for international purposes climbed to USD 18.5 billion in 2007, with the US the largest source (66%). Private charitable flows to support climate action in developing countries compare to certain official multilateral flows in the same area, such as GEF or UNFCCC funds.

16.2.3.2 Innovative sources

A **carbon tax** can be explicit (applied to GHG emissions) or implicit (energy or fuel tax on fossil fuel). Annual carbon tax revenues for Finland, Norway, Sweden, Denmark, Switzerland and Ireland amount to approximately EUR 6 billion (Elbeze and De Peethuis, 2011).[8] In Canada, the provinces of Quebec and British Columbia raised USD 1 billion respectively during 2011. Implicit carbon taxes, e.g. on electricity sector or taxes on petrol (gasoline and diesel fuel), in many countries make a much larger contribution to public budgets Jurisdictions with a cap-and-trade system may raise revenue by **auctioning allowances**. In2009 about USD 1.1 billion haven been raised through the EU-ETS (see 14.xx). Revenue streams from auctioning EU allowances in and after 2013 will be a multiple of these initial levels. The revenue raised through auctions for the nine US American states that participate in the Regional Greenhouse Gas Initiative (RGGI) declined from USD 349 million to USD 283 million to USD 175 million between 2009 and 2011 as allowance prices fell. The emissions trading systems in New Zealand and Switzerland do not auction any allowances.

Several eastern European countries expect their 2008–2012 emissions to be lower than their commitment under the Kyoto Protocol and are **selling surplus assigned amount units** (AAUs) directly (Estonia, Czech Republic, Poland and Russia) or through Green Investment Schemes (Bulgaria, Latvia, Lithuania, Slovakia and Ukraine) (Linacre et al., 2011). Revenue rose from USD 276 million in 2008 to USD 2 billion in 2009 to less than USD 1.1 billion in 2010 (Kossoy and Ambrosi, 2010; Linacre et al., 2011).

Governments generate **revenue from fossil fuel production** through royalties, severance taxes, leasing bonuses, auctions of lease rights, and other fees. Countries vary with respect to whether such revenue is committed to specific purposes. In Australia, for example, federal revenues from fossil fuel production are treated as part of consolidated revenue, while Norway directs all federal income from petroleum to the Government Pension Fund-Global. India was among the first nations to impose a carbon tax on coal, both domestic and imported, at a rate of INR50 per ton (equivalent to USD1/ton) in March 2010. These tax proceeds are earmarked to build the corpus of the National Clean Energy Fund. The government collected INR31 billion (or USD 600 million) in the first year (fiscal year 2010-2011) from the coal tax. Need data on royalties collected.

Redirecting funds for fossil fuel subsidies represents another potential source. However, the volume of these subsidies is difficult to measure and fluctuates with the world price of oil (Koplow, 2009; Jones and Steenblik, 2010; IEA et al., 2011). Estimates of global subsidies for the consumption of fossil fuels range from USD 550 billion in 2008 to USD 410 billion in 2010 (IEA et al., 2011). Systematic estimates of subsidies to fossil fuel producers are not available, but they may be on the order of USD 100 billion per year worldwide. In 24 industrialized countries, measures to support fossil-fuel production or use had a value of USD 45–75 billion a year between 2005 and 2010 (OECD, 2011a).

South-South cooperation is beginning to provide larger amounts of resources for development, particularly in the productive sectors and infrastructure, two areas with potentially large impacts on both future greenhouse gas (GHG) emission trajectories and vulnerability to climate change. Among other major emerging non-OECD donors, Saudi Arabia's development cooperation expenditure was about USD 2.5 billion, China's USD 1.4 billion, India's USD 1 billion, and Brazil's USD 437 million.

[8] Approximately half of the total revenue is raised in Sweden.

16.3 Financing mitigation activities

For any investment, the risks must be shared among the sources of finance. Those arrangements are reflected in financial instruments, such as loan agreements, insurance policies, etc. An investment that yields a revenue flow, e.g. renewable energy, is usually financed with a mix of equity and debt. Debt bears relatively little risk, earns a negotiated return (the agreed interest), and is repaid from the revenue and possibly other sources. Equity bears most of the risk and earns the residual return. Some risks can be transferred, at a cost, to insurance companies. Risks to lenders (debt) and owners (equity) can be reduced by grants from governments or international financial institutions. Public institutions, domestic and international, also reduce risks by providing debt on concessional terms.

16.3.1 Financial instruments

A financial instrument is a tradable asset of any kind, either cash; evidence of an ownership interest in an entity; or a contractual right to receive, or deliver, cash or another financial instrument. According to the International Accounting Standards 32 and 39, setup by the International Accounting Standards Board (IASB), a financial instrument is “any contract that gives rise to a financial asset of one entity and a financial liability or equity instrument of another entity.”

16.3.1.1 Risk mitigation

Insurance can play an essential part in helping to ensure that a successful project financing structure is achieved by transferring risk away from borrowers, lenders and equity investors. As investors and lenders are averse to risks that can give rise to exposures in a firm’s or project’s ultimate ability to generate revenues, the application of appropriate risk management instruments is essential. Various insurance products provide financial protection from delays or damage during fabrication, transport, installation, construction, operation, and distribution of a product, project and/or company (Marsh, 2006).

Business interruption insurance is designed to protect against the consequential financial losses arising from physical loss or damage insured under the construction all risks or operating all risks policies (Marsh, 2004).

Credit enhancements are intended to reduce real and perceived lending risks, and thereby to facilitate loan making, reduce interest rates, and improve loan terms while leaving to lenders the ultimate evaluation of borrower credit. However, there is no assurance that even solid financeable projects can secure credit at favourable terms, even with these enhancements. Credit enhancement tools include guarantees, interest rate buy-downs, loan loss reserve funds and other arrangements.

Production and savings guarantees are typically provided by energy service companies (ESCO) and large EPC contractors to their clients. The sum of savings or output must be higher than the incremental cost of implementing the EE or RE project. Only proven methodologies and technologies are eligible to receive credit guarantees, covering both technical risk (from customer payment default due to non-performance attributable to the ESCO or EPC contractor), and comprehensive risk (defaults due to technical and financial creditworthiness of the customer)(IDB, 2011).

16.3.1.2 Advanced market commitments

Power purchase agreements and feed-in tariffs (FITs) require utilities to purchase electricity from renewable electricity system owners at long-term, fixed rates—based on technology, system size, and project location—approved by regulatory commissions. A FIT’s long duration, guaranteed off-take for electricity output, and built-in grid access help to secure both debt and equity financing for a project. The result is that a FIT can lower the risk for project developers, lenders, and investors and, consequently, lower the cost of capital and required rate of return on these projects (Cory et al., 2009). FITs are the dominant policy mechanism for supporting RE in Europe, used in 18 of 25 European Union countries (Cory et al., 2009) and could substitute for either rebates or PBIs in supporting technology-specific renewable generation. The cost of a FIT program is often recovered by utilities through rates or supported through public benefit funds. FITs for renewable energy have been initiated in some developing countries also, e.g. in India.

16.3.1.3 Innovative Instruments

Loan fund programs are programs that generally are not linked to or incorporated within state or utility direct incentive programs but rather exist as standalone loan fund. These programs are generally offered through state energy offices or economic development agencies (Interstate Renewable Energy Council, 2009). They can help overcome capital cost barriers without directly subsidizing projects. To the extent that borrowers do not default, initial capital can be recycled and reinvested to achieve mitigation goals. However, if they do not provide a clear market advantage over commercially available credit or if they assume an unacceptable level of risk, then these programs do not fill a market gap but rather compete against private lenders (Oregon Department of Energy, 2011). Sometimes these funds are leveraged with matching capital from private lenders or other sources (Sanders, 2009).

Rebates are the simplest form of financial incentive to provide because the incentive is established in advance on a measure or technology-specific basis, clearly states eligibility criteria, and provides for simple fulfilment, which could be handled in many cases by third-party processors, manufacturers, or retailers directly. Rebates can be structured to decline over time as installed capacity levels are reached, encouraging early adopters and reflecting anticipated technology cost reductions. They are easily comprehendible by consumers and provide immediate price reductions. However, uniform rebate levels may create an economically inefficient level of support, when individuals and businesses capture rebates for actions they likely would have taken without the support of a rebate and, therefore, program dollars are not utilized most effectively (the free rider or the additionality problem).

Shared savings are a variation of a conventional loan. It is applied as part of Energy Performance Contract (EPC) projects, in which the energy services company takes on the risk associated with the loan and receives a pre-agreed fraction of the dollar value of the measured savings over the duration of the contract. If no savings manifest over a savings period, then the building owner makes no payment for that period. Ownership of equipment transfers from the ESCO or finance partner to the building owner at the end of the contract (Hopper et al., 2005).

Tax-exempt lease-*purchase* are used in order to not encumber the balance sheet as with conventional loans. Payments are considered an operating expense rather than a capital expense, and thus the municipal lease is not considered a long-term debt obligation. Once the lease term expires, the lease organization owns the equipment (ICF International and National Association of Energy Service Companies, 2007).

Efficiency service agreements are like power purchase agreements for EE. Third-party financiers own efficiency assets and cover all engineering, design, construction, equipment, installation, maintenance, and ongoing monitoring costs associated with an EE project. This enables customers to avoid all upfront capital outlay and make service payments using their operating budget. Customer payments are made to the project owner on a quarterly or semi-annual basis and reflect the energy and operating savings realized by a project. Payments are denominated on negotiated cost per avoided energy unit and are set below a customer's baseline utility costs. The project owner also enters into an Energy Services Performance Contract (ESPC) agreement with an ESCO or Energy Service Provider, which covers the engineering, procurement, and construction scope of work on a project as well as ongoing maintenance and measurement and verification services.

On-bill financing or repayment (Hinkle and Kenny, 2010) is essentially an instalment payment plan administered by utilities for EE/RE improvements that are financed by third-party lenders. Often, monthly payments are structured to be below the value of the monthly energy savings, thereby making the investment cash flow positive to the customer. Second, the debt obligation is tariff-based and, therefore, linked to the building's gas or electric meter, not to a specific building owner. As a result, the obligation is transferred with a change in building ownership. This removes the disincentive to invest in improvements with financial paybacks that exceed any one customer's expected building ownership horizon and that may not be fully captured in a building's selling price. Monthly payments are incorporated into utility bills so that the building owner does not need to make a separate loan payment.

Green bonds for the residential sector The loans to property owners typically have 20-year terms, allowing repayment to be matched with energy savings; thus, costs are not front-loaded but paid for during the period of use, and purchase decisions do not depend on the need for a quick payback. In other existing and newly proposed programs, the structure has allowed for locally appropriate and cost-effective technology choices (Fuller, Kunkel, et al., 2009). The bond issuer bears the credit risk of the loans but collects loan payments on each property's tax bill. The tax assessment belongs to the property, rather than the individual end user, even when the property is sold, protecting the purchaser of the RE system from loss if they sell their property before their investment has been paid back in the form of energy savings (Fuller, Portis, et al., 2009; Daniel M. Kammen, 2009).

Pooling of Financial Instruments. Debt and equity financial instruments used in traditional financing arrangements give only a glimpse on how countries can both create and generate a credible financial resource base for their national mitigation programmes and activities, if it is proactive and determined enough. These instruments by themselves may not be sufficient, but when they are pooled together, a powerful financial depth is created that is capable of supporting project implementation at different scales, enabling a country to implement both economic and social projects. There is a growing view that future climate change budgets should be vertically and horizontally integrated both in terms of funding sources and across sectors if developing countries are to make much headway in combating the negative effects of climate change. For instance, the Climate Mitigation Sinking Fund (CMSF), proposed by the Global Mechanism Report (2012) is a vehicle based on various sources, namely: government, local authorities, private sectors, donors, etc., and the financial market.

16.3.2 Sector specificities in developed countries

16.3.2.1 Energy and power sector

Even if technological barriers are to be overcome, financial and investment barriers exist for the deployment of such technologies. These are (i) high initial costs and limits of market capacity, (ii) grid integration challenges, (iii) uncertainty or inadequacy of policies, (iv) technology and other risks, and (v) difficulty to have consensus among stakeholders which in turn, also increases risk.

Given the scale of the investment challenge, that traditional modes of financing in the electricity sector, i.e. balance sheet borrowing and project finance, will not suffice (Hopper et al., 2005; European Climate Foundation, 2011; Whitehouse et al., 2011). There is the need to attract new investors, including institutional investors to the low-carbon energy sector, in order to broaden the pool of available capital and accelerate capital recycling in the sector.

For the development of renewable energy technologies, there are barriers in obtaining competitive forms of finance. Therefore, additional financial support and/or policies and regulations are often required. Some of the measures being used by many countries to address the challenges of financing the deployment of renewable energy include: feed-in tariffs, competitive public auctions, obligation for electricity providers to buy and supply a specific percentage of renewable energy and various financial and tax incentives. In order to facilitate a least cost integration of fluctuating renewable energies, further issues need to be addressed. These comprise (1) the rather low price elasticity of demand (IEA, 2003), (2) the often existing lack of local price elements that reveal network constrains (K. Neuhoff et al., 2011), and (3) the rising difficulties of back-up power plants to capture their investment costs for increasing shares of renewable energies under the conditions of “energy-only markets ”(Bode and Groscurth, 2009). Demand response measures, nodal pricing schemes and capacity markets have been proposed to address these failures. While increasing demand response is generally seen as beneficial, the necessity of model pricing schemes and capacity markets (Joskow, 2008) is still under debate.The power sector is characterized by very strong inertias. Long lead-in times for investment and very long infrastructure lifetimes mean that, firstly, any significant shift of investment will take time; and secondly, investment decisions will have a legacy effect of 20 to at least 40 years under “normal” conditions. Furthermore, there are the inherent uncertainties related to the deployment of new technologies such as those related to: technical and social feasibility, climate policy and policy in general which make the predictability and reliability of policies so crucial.

16.3.2.2 Industry

Greening the economy requires growing new industries, along with developing and disseminating new technologies. This process can be eased with specific policies that target (1) the development and dissemination of technologies and innovations by correcting the effect of a knowledge spillover, and (2) the development of new industries and sectors, by correcting the effect of non-environmental market failures (such as coordination failures and capital market imperfections (World Bank, 2012).

Policy instruments include: market based instruments (e.g. emissions or energy efficiency credit trading schemes), fiscal policies (e.g. carbon and energy taxes, subsidies), regulatory measures (e.g. energy performance standards), voluntary agreements, R&D policies, and information delivery schemes (e .g. benchmarking). Additionally, local air quality standards and waste management policies have an indirect effect on GHG mitigation. Given the priorities of many governments these indirect policies have played a relatively more effective role than climate policies, e.g., in India (Roy, 2010).

Increasingly, industry leaders and policy makers are looking at innovation as a key to making radical improvements in corporate environmental practices and performance. There are indeed signs that investment in clean technologies and innovation is taking pace. For example, Deloitte’s 2009 survey on Global Trends in Venture Capital reports that 63% of surveyed venture capitalists anticipate an increase in their investment in clean technologies over the next three years, the highest percentage among all sectors considered. Similar venture capital surveys confirm this trend (e.g. NVCA, Deutsche Bank/Bloomberg New Energy Finance). Venture capital flows to clean technologies dropped by around one third in 2009 as a result of the financial crisis, with strong declines in solar, wind, agriculture, biofuels (Cleantech Group, 2010). At the same time, other clean technology areas attracted more investments than before, such as electric and hybrid cars, battery technologies, energy efficiency and smart grids. Moreover, the global volume of mergers and acquisitions (M&As, an indicator of commercial activity) in clean technology sectors declined only marginally between 2008 and 2009, while the overall volume of M&As was cut by half (OECD, 2011b).

16.3.2.3 Transportation sector

Transportation sector faces a host of practical challenges, including complex, costly and lengthy transactions (Sterk and Wittneben, 2005; Ellis et al., 2007). The fragmentation of the transport GHG reduction project results in transaction costs that are generally superior to the climate benefits. Therefore, policies for the transportation sector that are integrated to other sectors are crucial. However, the high cost of this “policy packaging” often receives little attention.

There is a need to differentiate between investment cost (for retrofitting or new construction) and maintenance and operation costs. There are differences between both the nature of potential financial resources and of required incentives. In the transportation sector, public sources are key both for investment, maintenance and operation costs. Three main sources of funding are open to governments: i) transfer through another level of public bodies; ii) local taxation; and finally, iii) the pricing of services provided ("user charge"). In the absence of a strong evolution of the tax base, the increase in rates will be limited, both for political reasons and often because of the application of ceilings or legal limitations, which are set at the central level, to avoid potential local drifting.

16.3.2.4 Building sector

Rising energy-related GHG emissions from the building sector requires urgent action, taking also into account that property is a low-replacement industry, thus with high risks of lock-in. When dealing with financing issues and solutions for GHG mitigation actions in building sectors, there is a need to differentiate office, residential (Private building / house and social housing), and equipment (school, gymnasium, library, etc).

The existing global green building market is valued at approximately USD 550 billion and is expected to grow through to 2015, with Asia anticipated to be the fastest growing region (R Lewis, 2010). Economic instruments and incentives are recognized as very important means to encourage stakeholders and investors in building sector to adopt more energy efficient approaches at the stages of design, construction and operation of buildings (UNEP, 2007). Economic instruments are often considered more efficient than regulations and standards as the benefits of the incentives can be calculated to the value of the building investment itself (UNEP, 2007). The examples of these instruments include: reduced tax rates, improved loan conditions, increased rates of return on investment (ROI).

Major stumbling blocks to scaling up energy efficiency investment in buildings include:

- Fragmentation and complexity of construction or retrofitting projects. Hence it is easier to finance GHG emission reductions in office, social housing and equipment than in private housing.
- Combination of demand-side management measures and supply-side energy efficient technology. Thus funding for integrated technical and managerial measures is required (Heating & cooling system optimisation, efficient lighting, double or triple-glazing, enhanced ventilation, efficient appliances etc).
- Baseline definition and the subsequent additionality demonstration are relatively challenging.

Loans with interest rates subsidized by governments are increasingly used to enhance private individual owners to engage energy efficiency works in their residences.

ESCOs help develop energy efficiency solutions in buildings. In a performance contract, the ESCO provide a guarantee that the package of technologies will perform as specified and thus guarantees energy and/or money savings for the project. They are increasingly bundling renewable technologies with energy efficiency improvements. ESCO compensation is linked in some fashion to the performance of the project (Hopper et al., 2005). Generally ESCOs are leveraging publicly-funded incentives and government tax credits. For instance, it is estimated that public and institutional markets – federal, state and local governments, schools, universities and colleges, hospital – account for about 84% of U.S. ESCO industry revenues in 2008 (USD 3.4 billion) (Satchwell et al., 2010).

16.3.2.5 Agriculture, land use and forestry

The mitigation potential of these sectors remains largely untapped. This is largely due to practical challenges posed by the specific nature of these sectors in terms of regulating multiple and diffuse emissions sources, monitoring, reporting and verification challenges, and other uncertainties in measuring and ensuring emissions reductions. Furthermore, the diversity in the conditions of production within and across countries leads to large heterogeneities in abatement costs. It should also be noted that there are still significant differences between the sectors affecting the land surface. Agriculture and forestry, for example, are often governed by different policies, and are often governed by different departments or ministries within government. The land managers are also very different. Similarly, the tenure varies between the sectors; agriculture tends to be managed by small private landholders; forestry by Government and corporate entities.

16.3.3 Sector specificities in developing countries

Energy and power, industry, transport, building, and agriculture, land use and forestry are sectors that offer both the greatest potential for mitigation in developing countries as well as the lowest investment per tCO_2e reduction. Each has unique features and specificities.

In all sectors, the mitigation potentials come via the introduction of technology either for greater efficiency or for replacement with cleaner energy and via efficiency improvements that come simply from restructuring, better management and change in lifestyles.

National policy and regulatory frameworks are essential in helping tap most effectively from the gamut of financial sources. These sources are amply listed and described in other sections.

16.3.3.1 Energy and power sector

The number of mitigation options and their financing in developing countries are numerous and include: energy efficiency improvements on the demand and supply side, switching to clean energy such as hydro, wind, geothermal, solar, and application of new technologies such as Carbon Capture and Storage (CCS).

But opportunities for mitigation action also exist in energy system improvements such as for transitions from outdated analogue to modern digital technologies with optimized interconnected networks using up-to-date information and communications technology (Shock et al., 2012).

Cumulative investments needed to meet a growing energy demand are immense and mentioned in another section of this chapter. For developing countries alone, these cumulative investments needs constitute some 65 percent of the overall projected total. This large investment needs create both a challenge as well as an opportunity for adding the marginal additional investments required for the improvement of existing technologies and the introduction of new ones designed to increase mitigation potential.

16.3.3.2 Industry

There are immense opportunities for financing mitigation action in industry in developing countries. The greatest mitigation potential in industry resides in the most energy intensive industries that include: pulp and paper, cement, non-metallic minerals, non-ferrous metal smelting and iron and steel smelting, metal and non-metal mining, chemical products, and other manufacturing products such as automotive industry, leather and allied products, furniture, plastics and rubber products (Nyboer et al., 2007).

For many of these industries, future energy use will be based on the expected trends on the consumption and production of materials. Some industries for example, such as those linked to the production of materials for the development of infrastructure – e.g. cement and steel - and where developing countries are the major producers, offer great mitigation potential (Banerjee et al., 2012). Some small and medium enterprises such as ferrous and non-ferrous foundries, ceramics, bricks, glass, lime concrete, food and beverage, cement kilns, steel production, and steel rolling mills are highly energy intensive and offer great opportunities for mitigation in developing countries where SMEs play a key role in the economy.

16.3.3.3 Building sector

Opportunities for financing mitigation actions in building include: reducing energy use and embodied energy in buildings, switching to low carbon fuels, and controlling the emissions of non CO2 GHGs. Because of the significant opportunities offered, most of the attention has focused on the energy efficiency opportunities through technologies readily available also in developing countries. Financing is required to access many of these technologies: passive solar design, high efficiency lighting and appliances, highly efficient ventilation and cooling systems, solar water heaters, insulation materials and techniques, high reflectivity building materials and multiple glazing (Levine et al., 2007).

Much of the debate on buildings focuses on electricity. Opportunities for mitigation financing, however, also include the appliances that they use and the increase in the numbers of appliances and cooling systems in the last few years in both developed as well as developing countries (Nyboer et al., 2007). The large increases in energy demand is mostly driven by floor space growth – mostly driven by population and GDP growth, a growing service sector, and the rise on the information economy in both developed as well as many developing countries (WBCSD, 2008).

As in other sectors, policy and regulatory frameworks are essential drivers of investment in the building sector. Energy labelling and efficiency standards have been quite effective in many countries, particularly for new buildings. Fiscal and financial incentives for retrofitting existing buildings have also proved effective in driving investments (Nyboer et al., 2007).

16.3.3.4 Transportation sector

But there are many areas important for mitigation in transport and where mitigation financing is needed and where both public and private sector financing is required. The key areas where investment finance is needed in the transport sector are: vehicle efficiency (via technology and operation), low-carbon fuels, transport regulatory framework implementation, infrastructure and land use investment and regulations, and transport system operation (Figure 16.5). Given the immense expected rise in transportation demand in developing countries and given that much of the infrastructure is yet to be built, this is a sector with great potential for mitigation finance opportunities.

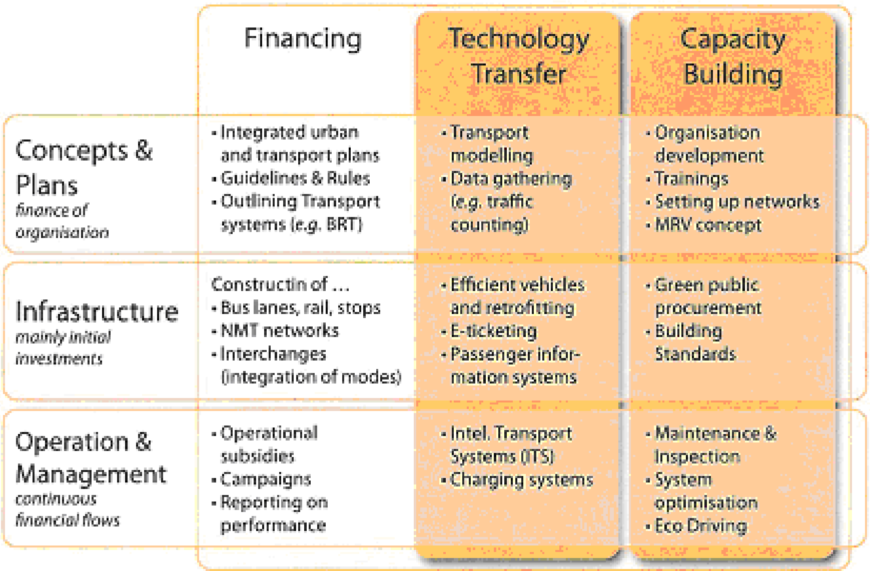

Figure 16.5. Types of climate change mitigation activities that can be supported by climate finance (Binstead et al., 2010)

16.3.3.5 Agriculture, land use and forestry

There are at least three types of emissions: those that are energy related, those related to land-use change, and those related to changes in land management practices such as tillage practices that increase the potential for carbon sequestration and with greatest technical potential for climate mitigation is in soil carbon (Verchot, 2007).

In developing countries, the largest contributor to emissions in these sectors is deforestation. It is also a sector in which investments in mitigation action are more difficult because of several factors including that there is limited quantitative information on the cost-benefit ratios of mitigation interventions in forestry and that the success rate of investment /funding is often not determined in terms of amount of forest established or protected or carbon sequestered. Public sector financing, therefore, (domestic and ODA) has an important catalytic role rather than private investment as is the case in other sector covered here.

There are at least three major barriers for encouraging investments in the forestry sector aimed at reducing deforestation: 1) the incentives for profit usually work against conservation and sustainable forest management, 2) many direct and indirect drivers for deforestation reside outside of the forest sector rather that the forest sector per se, and 3) lack of institutional and regulatory capacity limit the effectiveness in implementation and thus, do not help in driving investments in the sector (Trines, 2007).

Risks are also considered high and present barriers to private investment in the sector. Public sector needs to play a key role to mitigate risk and encourage investments not only in the forestry sector but also in the land use practices with high benefits for mitigation and carbon sequestration (Gains and Grayson, 2009).

16.4 Enabling environments

An environment that is enabling of specific policies to encourage mitigations activities is made up of cross-cutting domains. It encompasses different factors such as institutions, infrastructures and political outcomes, and economic actors, each of which influences the attractiveness of financing and investing in mitigation activities while interacting in different configurations (Mitchell et al., 2011). These various configurations present different challenges to deployment, depending on the countries and their states of development, and local needs and conditions.[9] This section highlights the potential contribution of these individual factors and actors toward promoting mitigation finance that goes beyond government action alone.

To enable mitigation finance, government needs to: a) evolve policy, fiscal, legal and educational frameworks; b) build institutional capacity across sectors and at various levels; c) proactively respond to the needs and preferences of actors; d) establish and maintain a range of oversight, accountability, and feedback mechanisms; and e) mobilize and allocate public resources and investments(Brinkerhoff, 2004).

Actions that government can take to fostering an enabling environment may be generically characterized as mandating, facilitating, and resourcing. **Mandating** refers to the legal and regulatory framework that affects mitigation; from basic constitutional rights to corporative laws. Laws affecting how government entities operate also play an enabling or constraining role, which relates to the broader features of democratic political structures and economic liberalism that support the socio-economic development (Brinkerhoff, 2004).

Facilitating refers to the political, fiscal and educational frameworks. Government provides incentives and capacity-building for actors, public and private, to pursue mitigation activities by, for example, making available information to the market understandable and accessible or creating market demand through quotas (Brinkerhoff and Goldsmith, 2003).

Government **resourcing** can involve direct public funding, as in the case of contracts and grants, and establishment of financial incentives, such as tax policy, that encourage other suppliers and consumers to invest resources for mitigation (Brinkerhoff, 2004).

16.4.1 Means

Governments' approaches to encouraging mitigation activities are generally comprised of five broad categories of means: stimulating demand, stimulating supply, affecting price of consumption, and affecting performance.

Stimulating Demand (Cunningham, 2009)**.** Demand-side innovation policy instruments may be defined as a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations, and/or to improve the articulation of demand in order to spur innovations and the diffusion of innovations (Edler, 2009). Market framework conditions are necessary to reduce the time-to-market of new goods and services, and to enable emerging sectors required for increased mitigation activity to grow faster. Companies should experience quicker return on their R&D and innovation investments, and should attain greater outputs as measured, for example, by jobs, new-to-market products and patents (Cunningham, 2009). Some such policy examples include procurement, quotas and performance incentives.[10]

Stimulating Supply. Demand-side innovation policy complements supply-side policy, which mainly uses public mechanisms to stimulate basic science, R&D, innovation, manufacturing, and scale-up of

[9] See IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2011) Chapter 11, table 11.4 for a summary of dimensions of and participants in enabling environments.

[10] For a typology of demand-oriented measures, see (Cunningham, 2009; Edler, 2009).

mitigation activities. Commercial development is arguably the critical step to turn laboratory research into economically viable technologies and practices (President's Committee of Advisors on Science and Technology and Panel on Energy Research and Development, 1997). The scale of the energy economy, and the diversity of potentially critical low-carbon technologies to address climate change argue for a set of policies to energize the public and private sectors (Branscomb, 1993), as well as strategies to catalyze productive interactions between them (Mowery, 1998). Some such policy examples include research & development, electric utilities' public benefits programs, business and technical assistance, and investment by public pension funds.

Affecting Price of Consumption. Policy can be used to influence energy consumption in many ways: directly, by expanding or confining consumers' choices, or more indirectly, through incentives or disincentives for certain choices; creation or removal of barriers or market allocation; administration or control of sales prices; regulation of price structures; and other policy instruments. Even the reduction or increase of mitigation activity supply by means of price guarantees, subsidies, etc. affects the level and structure of consumption as it changes price levels and relative prices (Suding, 1989).

Price-driven policies set price for output produced by mitigation activities and generally allow the market determine the quantity supplied. They have been called feed-in tariffs (FITs), premium payments, standard offer contracts, minimum price payments, renewable energy payments, and advanced renewable tariffs (Couture and Gagnon, 2010). Price-driven instruments generally guarantee connection and access to the network, but not always. They have different impacts on investor certainty and payment, ratepayer payments, the speed of deployment, and transparency and complexity of the system, depending on details of their design (Couture and Cory, 2009; Mitchell et al., 2011). Some such policy examples include direct monetary incentives to consumers, income tax credit to individuals purchasing qualifying mitigation goods and services, production tax credits to renewable energy and fuel companies.

Affecting Performance. Another approach commonly taken in environment and climate strategies is to develop technical requirements, in the form of mandatory technical regulations or voluntary standards, for products and production methods, so as to bring about emission reductions and gains in energy efficiency. Performance standards for products or processes may stipulate specific environmental outcomes per unit of production but do not typically pronounce how the outcomes should be achieved; as opposed to design-based requirements that specify particular features a product must have, specific actions to be undertaken during production, or determine which technologies to use for a given purpose (Tamiotti et al., 2009).

Such measures can be international, national, or sub-national; public (e.g. Minimum Energy Performance Standards (MEPS) for appliances in Australia), or private (such as the Leadership in Energy and Environmental Design (LEED), which is a set of standards in the building sector developed by the US Green Building Council); mandatory or voluntary; *de facto* or *de jure*.

Facilitating Markets. Well functioning markets are of highest importance to mitigate external effects and market failure, e.g. by assuring the complementarity of different instruments with regard to their indented objectives (Mitchell et al., 2011). To operate effectively, markets rely on timely, credible and truthful information, underlying the importance of metrics and accounting for low-carbon emissions as well as for financial flows (Mitchell et al., 2011).

Improving access to finance is necessary but not always sufficient to promote mitigation project deployment, particularly in developing countries. Successful public finance mechanisms typically combine access to finance with technical assistance programs that are designed to help prepare projects for investment and to build the capacity of the various actors involved. There are numerous examples of finance facilities that were created but that never disbursed funds because they failed to find and generate sufficient demand for the financing (Maclean et al., 2008; Mitchell et al., 2011).

For an enabling environment that promotes mitigation, often more than one of the means listed above needs to be deployed.

16.4.2 Barriers

There are numerous barriers to successful policymaking, implementation and financing, which can also hamper the development and deployment of mitigation activities (MISI, 2009; see Mitchell et al., 2011 Table 11.4) .[11]. Some of the more difficult and important impediments to mitigation finance include:

16.4.2.1 Fiscal dimension

Fiscal barriers are impediments related to taxation and public revenue and debt policies promulgated by governments that impact markets in which a mitigation technology is expected to compete. They can take many forms such as tax incentives and penalties, liability insurance, leases, land rights-of-way, waste disposal, and guarantees to mitigate project financing or fuel price risk.

They can become impediments to innovation and competition, and therefore for mitigation finance if applied in an unfavourable or inefficient manner. In addition, fluctuating and variable tax incentives as well as the possibility of future tax penalties related to GHG emissions all contribute to fiscal uncertainty, which can undermine marketplace efficiency.

Fiscal policies can be used to encourage investment in a particular technology area or to overcome market failures. Outdated fiscal instruments and fiscal policy that does not change with technologies and goals can incentivize undesired behaviours or technologies. A variety of tax subsidies, differential taxation across capital and operating expenses, unfavourable tariffs, and utility pricing policies illustrate this phenomenon (MA Brown and Chandler, 2008).

Some fiscal policies simply do not meet their intended objective or are at cross-purposes with their stated goal. Tax credits for clean energy investments that cannot be claimed and property taxes that encourage deforestation and therefore fail to achieve the anticipated market penetration of mitigation activities are cases in point.

16.4.2.2 Legal dimension

Regulations are legal restrictions supported by a threat of sanction or a fine (Brown and Chandler, 2008). They are imposed in pursuit of the public good to produce outcomes that might not otherwise occur, but they can become impediments to innovation and competition. Regulatory barriers that arise in the market include unfavourable and ineffective regulatory policies that disadvantage mitigation technologies and impede efficient market functioning. In addition, fluctuating, variable, and unpredictable regulations can undermine marketplace efficiency by introducing policy uncertainty.

Statutes typically command, prohibit, or declare policy in pursuit of the public good, but they can also become impediments to finance mitigation (Brown and Chandler, 2008). They are set down by a legislature in response to a perceived need to clarify the functioning of government, improve civil order, answer a public need, codify existing law, or provide special treatment for an individual or company. Due to the strong reliance on regulatory agencies for implementing most policies that impact mitigation technologies, there are instances where the line between statutes and regulations is unclear.

[11] For a further discussion of barriers, see the following sections of the SRREN: Chapter 1, overview of barriers to RE development and deployment; Chapters 2 through 7 cover technology-specific challenges; Chapter 8 addresses barriers to integration of; and Chapter 9 discusses barriers to RE in the context of sustainable development.

16.5 Financing technology development and transfer

Transfer and diffusion of environmentally sound technologies, in particular to developing countries, is a key element of any effective international response to global climate change challenge. It is one of the pillars of UNFCCC, where it is anchored under Art. 4, 1c) of the Convention, that reads "Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes […]."(UNFCCC, 1992)

Financial support for technology development and its transfer has gained growing attention. A variety of different theoretical and analytical perspectives has been applied to study and understand technology transfer, but no comprehensive theories yet exist. A fundamental issue concerns the various aspects that characterize a technology, a transfer process, that includes the accumulated technical, managerial and commercial knowledge; the process know-how; engineering design and construction of production facilities; organizational and operating methods; quality control; and market characteristics. In this section financing for technology transfer will be understood in a broader sense[12], following the analysis supported in the IPCC pathways as evaluated by IPCC AR4 WGI (2007) and IPCC SRREN (2011) and IPCC SRT (2000) that have significance up to today.

The importance of technology to climate change is widely understood, however there are differing viewpoints on the sufficiency and role of existing technologies to address it. There is also widespread recognition in the literature that it is highly unlikely that a single 'silver bullet' technology exists that can solve the climate problem, so the issue is not one of identifying singular technologies, but rather ensembles, or portfolios of technologies (Pacala and Socolow, 2004). The requirement of technology is also dynamic so the relevant technologies and the need for transfer change over time.

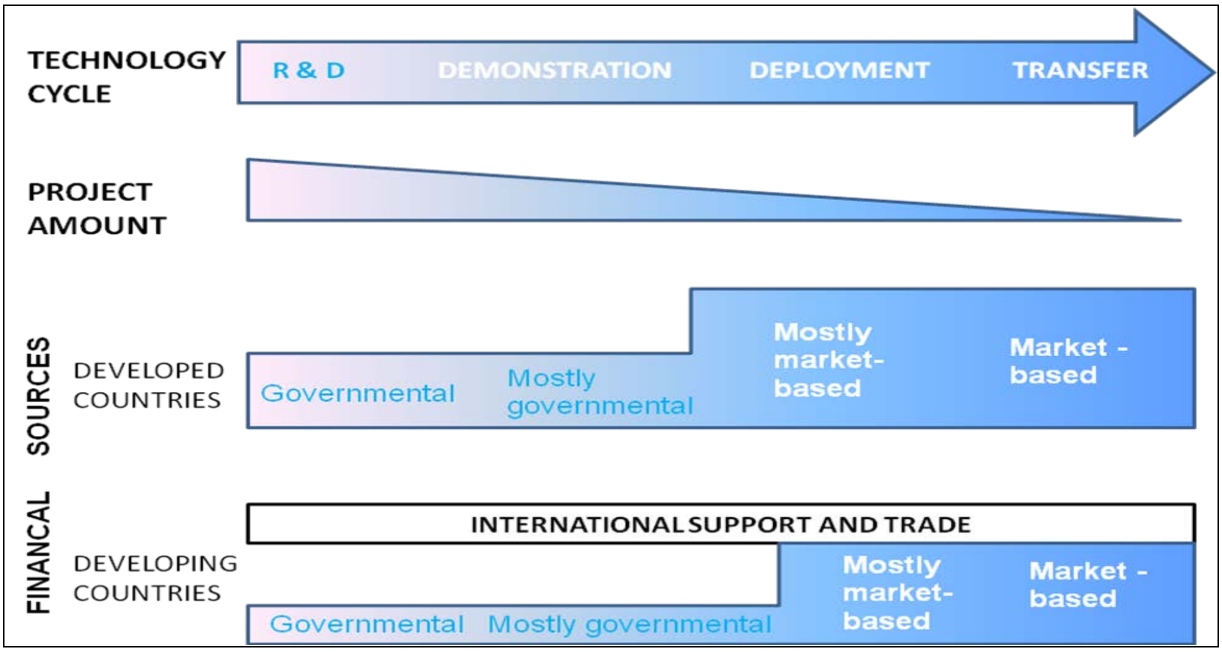

Figure 16.6. The process of financing development and transfer of technology (Ueno, 2009; UNEP, 2011)

[12] It includes end-use (demand) and production (supply) technologies. Technological change is particularly important over the long time scales characteristic of climate change. Decade or century-long time scales are typical for the lags involved between technological innovation and widespread diffusion and of the capital turnover rates characteristic for long-lived energy capital stock and infrastructures (IPCC, 1996, 2001a; b).

Financing technology development and its transfer is recognized as a whole process (Figure 16.6) that includes up mentioned phases (Ueno, 2009; World Bank, 2009; UNFCCC, 2011c), and as process shows differences among developed and developing countries. Financing technology transfer to developing countries can be differentiated into financial flows for a) deployment and diffusion of mitigation technologies, and b) local production of mitigation technologies (Ueno, 2009).

"Technology transfer to developing countries comprises several different activities, that are targets for finance and investment: 1) purchase and trade of carbon credits through the CDM and JI processes; 2) export of technologies, equipment and services on purely commercial basis; 3) transfer of intellectual property rights through licensing and related commercial means; 4) utilization of multilateral and bilateral promotional and financing schemes tailored for this purpose; 5) physical or financial investment in clean energy production and clean technology companies; 6) provision of advisory services through various technical assistance programs (Noro, 2006, p. 5)".

16.5.1 Funding approached for development

Understanding the funding process requires a systemic view of the four development steps of technology development. R&D and demonstration are often partly financed by the public sector. For the development of technological solutions to existing or new problems, the encouragement of innovation is essential. Deployment, diffusion and scaling up are more market funded (World Bank, 2009; UNEP SEFI, 2010). The diffusion of these new technologies on a worldwide basis has to address and overcome several barriers inter alia technological capacity building (Abbott, 2009).

16.5.1.1 Research and development

Technology policies based on increasing public investments in R&D are unlikely to be sufficient to fully solve the challenges. They need to be matched with "market-pull" policies that create public and private sector incentives for entrepreneurship. The diffusion of the climate-smart technology requires much more than shipping ready-to-use equipment to developing countries; it requires building absorptive capacity and enhancing the ability of the public and private sectors to identify, adopt, adapt, improve, and employ the most appropriate technologies (World Bank, 2009).

In absolute terms, global government energy RD&D budgets have declined since the early 1980s, falling by almost half from 1980 to 2007. Energy's share in government research and development budgets (not including demonstration) also plunged, from 11 % in 1985 to less than 4 percent in 2007. Neither public nor private funding of energy-related research, development, and deployment is remotely close to the amounts needed for transitioning to a climate-smart world (World Bank, 2009).

16.5.1.2 Demonstration, deployment, diffusion / scaling up

The financial crisis and it impact on the investment processes of research, development, demonstration, and deployment (RDD&D) is reducing the private spending on climate-smart technology, delaying its diffusion, and increasing the lack of needed resources. In addition the mobilization of the technology and fostering, as needed in an required scale, claim not only cooperation and pooling resources to these target, but also imply the adoption of domestic policies that promote the required environment to attract the required support, for example: a supportive knowledge infrastructure and business environment. The small market size and the lack of resources in the most developing countries specially the low-incomes, are unattractive to entrepreneurs wishing to introduce new technologies (UNCTAD, 2010).

Regarding renewable energy specifically, "2008-2009 was an inflection point in these trends. Research, development and deployment spending by governments and corporations totalled USD 24.6 billion in 2009, with government R&D up 49% at USD 9.7 billion and corporate RD&D down 16% at USD 14.9 billion (UNEP SEFI, 2010, p. 10)".

16.5.2 Transfer

There are many definitions of technology transfer. This section will use the concept applied by IPCC that defines technology transfer as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders (IPCC, 2007).

The main stakeholders involved in the transfer process are: governments, private sector entities, financial institutions, non-governmental organization (NGOs) and research/ education institutions. This inclusive understanding of transfer encompasses diffusion of technologies and technology cooperation across and within countries. It covers technology transfer processes between and amongst developed countries, developing countries and countries with economies in transition.

Technology transfer comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies (IPCC, 2000).

The compilation and synthesis of technology transfer activities reported in the fifth National Communications that are reported by Annex II Parties, to the UNFCCC, gives the possibility of draw the transfer for mitigation and its targets by sector. In this report, transfer for mitigation represents 81.5% and involves transfers for the energy sector (55.4%), in particular related to the deployment and diffusion of renewable energy and energy efficiency technologies. Their distribution by sector and technology is as follows: renewable 41.4%, fossil fuels 4.39%, energy efficiency 6.5%. The sector proportion splits up into industry 4.3%, forestry 9.8%, agricultural 3.3%, waste1.0% and others 7.6% (UNFCCC, 2011c).

16.5.2.1 Funding approaches

Financial transfers alone will not be enough. Acquiring technology is a long, costly, and risky process ridden with market failures (World Bank, 2009).

In the absence of an official multilateral statistical source of information and figures regarding the financing transfer for mitigation, it can only be assessed indirectly through the analysis of different investments in the different mitigation sectors. In the literature there are very different approaches and estimates of public and private financial flows targeted at mitigation as demonstrated in 16.2.2 One possible proxy is Foreign Direct Investment (**FDI**). The incremental investment needed (see 16.2.1) may be an indicator for needed FDI.

The financial crisis in late 2008, first quarter 2009 did hit the sector heavily, although a bounce back was subsequently observed, and investor interest in the sector remained throughout (Justice F. 2009).Therefore levels and patterns in bilateral and multilateral official development assistance (**ODA**) programs are key determinants of the levels and composition of technology transfers (Brewer, 2008; Buchner et al., 2011).

The Kyoto Protocol’s CDM is an example of a market-based mechanism that may play a relevant role in the transfer of technology to the developing countries. The CDM does not have at technology transfer mandate, it can contribute to the emission reductions through the use of the technologies that are not available in the host countries. Only one-third of the projects shows some technology transfer aspects (Ghosh and Watkins, 2009; UNEP and WTO, 2009). But is not clear yet, how much efficient and effective, for the developing countries, they are on the diffusion of the mitigation technologies (Ueno, 2009, p. 6).

There are few foreign investment drivers that should be taken into account to complete the picture on those financial source and predictions for the future. Those are: Home market and trade conditions; home government policies and regulations; costs of production and business conditions (Tamiotti et al., 2009).

Another sector relevant for technology transfer flows is the international market. There is evidence that those links go through trade on intermediate goods and capital goods. In this regard, IPRs play an important role (Globerman et al., 2000). It may play a dual role, first it could ensure the innovators' ability to reap the benefits (through revenues from commercial exploitation of the invention) and recoup the costs of R&D investments. On the other hand they give their holders market power by allowing them to limit the availability, use, and development of technologies, and this may result in higher costs for the acquisition of technologies (Hutchison, 2006; Littleton, 2008). "While the evidence is inconclusive, TRIPS imposes minimum standards of patent protection that may impede technological development and transfer in developing countries that do not significantly benefit from increased flows of licensed technologies or foreign direct investment (Hutchison, 2006, p. 537)."

The role of **trade** on financing technology transfer for mitigation is not conclusive. "Over the last years, data show that a significant proportion of the medium and long term official export credits flows have gone to transport and industry sectors, followed by energy projects. In contrast, reflecting the export structure of OECD countries, the proportion of low-carbon export projects (e.g. renewable energies at USD 0.5 billion and less than 2% of total) remains a minor share of official export credits (OECD, 2009, p. 5)."

16.5.2.2 Framework

"Most of the technology transfer activities reported by Annex II Parties are managed by a number of government agencies and implemented by specialized agencies for development cooperation through partnerships with local stakeholders (UNFCCC, 2011c, p. 3)."

Financing and promotion of technology transfer in clean technologies has been taking and is currently taking place by these financing institutions. International finance institutions are in the key position to sustain and expand the level of funding for technology transfer (Noro, 2006).

The Kyoto Protocol proposes three flexible mechanisms to help Annex 1 countries meet their emission reduction obligations: namely emissions trading schemes (ETS), Joint Implementation (JI), and the Clean Development Mechanism (CDM) (Labatt and White, 2007). Even though the CDM bears weakness, it is one way to facilitate the technology transfer to Developing Countries. However, prices for CDM credits have to be high enough to generate demand in rich countries and a strong flow of carbon finance, but it is not necessarily cost-effective for achieving emissions cuts in poor countries due to the high transaction costs.

Moreover, there are dedicated facilities to financing technology transfer such as the GEF. Most GEF mitigation funding between 1998 to 2006 - about USD 250 million a year - was directed at removing barriers to the diffusion of energy efficient technologies. The Poznan Strategic Program on Technology Transfer established the following three windows within the GEF: 1. Conduct Technology Needs Assessments (TNAs); 2. Pilot priority technology projects linked to TNAs; 3. Disseminate GEF experience and successfully demonstrated ESTs (GEF, 2010).

16.6 Institutional arrangements for mitigation financing

An effective governance of climate change on the national, regional and international level is an essential pre-requisite for an efficient and effective system of finance for mitigation. Institutions are essential for ensuring that action on climate change responds to national needs and priorities in an efficient and effective way. This is particularly relevant in the area of mitigation financing where the diversity of needs and the complexity and diverse nature of financing instruments make the role of institutions and their existence an imperative.

It is also through institutions that knowledge is accumulated, codified and passed on in a way that is easily transferable and used to build capacities, share knowledge and transfer technologies and help develop markets. Without proper institutions, some investments may remain simply as stand-alone projects or a one-off capital equipment supply rather than a transaction with a transfer of skills, know-how, full knowledge of the technology, and a contribution to a broader system of innovation and technological change (Ockwell et al., 2008).

16.6.1 National level

16.6.1.1 National arrangements

The landscape of institutional arrangements for action on climate change across countries is diverse. In many countries, furthermore, actions on climate change are not clearly defined as such. By consequence, many of the national arrangements that exist to promote programs, activities, and action that clearly contribute to mitigation do not appear in the literature as institutions dedicated to support finance for mitigation.

In many countries, particularly in developed countries and a few in larger developing countries, finance for mitigation comes mainly from the private sector, often with public support through regulatory and policy frameworks and/or specialized finance mechanisms. The most effective institutional arrangements and mechanisms - both public and private - in this regard, therefore, are those that are successful in mobilizing and leveraging private capital for mitigation activities. The institutions and the types of public finance mechanisms that exist across countries are diverse but all have the common feature of aiming to help commercial financial institutions to do this job effectively and efficiently. Many institutions exist for the purpose of supporting specialized public finance mechanisms such as financial institutions to provide dedicated credit lines, guarantees to share the risks of investments and *debt financing* of projects, microfinance or *incentive funds and schemes* to mobilize R&D and *technical assistance funds* to build capacities across the sectors including the private and commercial sectors (Maclean et al., 2008).

In many developing countries, other than the larger ones, there is an on-going attempt to cope with the multiplicity of sources, agents and channels offering financial resources for mitigation activities (Glemarec, 2011). These efforts are at two levels. At one level, there are the government institutions that are engaged in the coordination of national efforts to address climate change. According to a survey undertaken at the end of 2010 by the United Nations Development Programme (OIES, 2011), very few developing countries have institutions that are fully dedicated to addressing climate change or the financing of mitigation activities. In many countries, it is the ministry of the environment that has the designated role of coordinating and in some cases helping in the implementation of climate change activities. In some countries, ministries of foreign affairs are also involved in finance issues through their engagement in international negotiations. Ministries of finance are also becoming more and more involved with the arrival of large multilateral funding and the promise of increased UNFCCC resources.

At another level, and for the purposes of allocating resources for specific programs and projects, there are institutions attending to the various sources and agents, namely: the UNFCCC, development cooperation agencies, bilateral financial institutions, and multilateral financial institutions. Some developing countries are beginning to establish specialized national implementing entities designed specifically to mainstream climate change activities in overall development strategies. These institutions have the responsibility of blending funding available internationally for climate change activities through national climate funds that in turn also include domestic as well as private sector resources (Flynn, 2011).

16.6.1.2 State / Provincial arrangements and other sub-national arrangements

Sub-national arrangements are increasingly becoming an effective vehicle in many countries for advancing energy and climate change goals. These arrangements and the institutions that support them are being established to advance regional collaboration in areas of common interest and to benefit from greater efficiency and effectiveness through actions with greater geographical coverage (Setzer, 2009).

Because of their population densities and economic activity, cities are major contributors to the GHG emissions worldwide and as such they are major potential contributors to the mitigation efforts worldwide (Jan Corfee-Morlot et al., 2009). In recent years, there has been an increase in the number of networks and initiatives specifically dedicated to enhance the role of cities in the fight against climate change. They include: ICLEI-Local Governments for Sustainability, the Large Cities Climate Leadership Group (C40), the Clinton Climate Initiative, the World Mayors' Council for Climate Change, United Cities Local Government, the Climate Alliance, the Asian Cities Climate Change Resilience Network, and the Covenant of Governors. Because of the impact of their efforts, these initiatives are potentially big contributors to mitigation efforts. Because of the lack of clear processes to link these initiatives to national and international climate change policy, their impact in broader policy frameworks is less certain (UN-Habitat, 2011).

16.6.2 International level

16.6.2.1 Multilateral arrangements

Multilateral arrangements for climate change mitigation are essential for several reasons. One of the most commonly cited is that because the earth's climate is a public good, investing within borders is often not seen as beneficial to a particular country unless doing so becomes a collective effort (Pfeiffer and Nowak, 2006). The UNFCCC was established, among others, to address this dilemma and to turn the global effort on climate change into a collective action that would be seen by all as beneficial to the whole (Burleson, 2007).

The UNFCCC and most particularly the Kyoto Protocol make reference to provisions for funding for mitigation by developed countries (Annex I Countries) through the binding emissions reductions to which they are committed. This has generated an emissions trading market, both regulatory and voluntary, and in funding for mitigation activities in developing countries through the CDM and the Joint Implementation for countries in transition (World Bank, 2009).

Within the Framework Convention, the funding for mitigation for developing countries has come principally through the Financial Mechanism of the Convention. Until recently, the GEF was the only operating entity of the Financial Mechanism of the Framework Convention which operates the regular Trust Fund, the SCCF and the LDCF. The Sixteenth Session of the Conference of the Parties held in Cancun, Mexico established the Green Climate Fund and this decision, it has become a new, and additional operating entity for the Financial Mechanism under the Convention. More recently, at the Conference of the Parties at Durban, Parties adopted the governing instrument and by so doing, getting closer to becoming operational. A transitional process was also established for the purposes of getting the GCF up and running as early as 2013.

The UNFCCC also encourages other multilateral organizations, regional international financial institutions and others to provide funding to developing countries for mitigation. The increasing demands for mitigation activities have led to the establishment of several funding instruments managed by multilateral banks and institutions. Some of these, such as CIFs administered by the World Bank, have their own governance and organizational structure.[13]

16.6.2.2 Regional arrangements

Regional institutions play an important role in fostering regional cooperation. These include both the regional economic commissions of the United Nations as well as the regional development banks.[14] While their mission is to promote, and in the case of the regional development banks, to finance development activities, more and more they have been engaging in creating important mitigation initiatives. In several regions, regional institutions promote the establishment and help manage regional financing arrangements for mitigation (Sharan, 2008). A good example of the initiatives taken by a regional institution is the series of regional financial arrangements established to promote funding for mitigation activities in the Asia and Pacific region by the Asian Development Bank (ADB) and which include the Climate Change Fund (CCF), the Clean Energy Financing Partnership Facility (CEFPF), the Asia Pacific Carbon Fund (APCF), and the Future Carbon Fund (FCF). Other regional development banks, particularly the Inter American Development Bank have been equally active.

Other regional groupings such as the Economic Community for West African States (ECOWAS), the Association of Southeast Asian Nations (ASEAN), the Secretariat for Central American Economic Integration, Mercosur, Corporación Andina de Fomento, and the Andean Pact to name just a few, have been actively promoting sub-regional integration of energy systems and cooperation in climate change activities for some years.

16.6.2.3 Bilateral arrangements

The role of bilateral ODA for mitigation has grown significantly over the last decade. Articles 4, 11, and 12 of the Convention provide references to the obligation of Annex I Parties to provide funding support to non-Annex Parties for implementation of the Convention (UNFCCC, 1992). This funding support is either through the UNFCCC regime and its mechanisms established for this purpose, and this will be discussed under multilateral arrangements, or through bilateral means beyond those provided through these mechanisms.

The UNFCCC requires all Annex I countries to report on this additional assistance in their national communications and there is some data on this. But this data that is collected by the UNFCCC suffers from gaps and inconsistencies which the OECD has been trying over the years to remedy. It has been trying to improve the data collection and codification (through so called "Rio Markers") in order to identify the destination of bilateral resources provided for developing countries. Therefore, it is now possible to identify with some degree of certainty and detail the types and levels of funding assistance going to mitigation activities (Jan Corfee-Morlot et al., 2009).

16.6.2.4 Plurilateral and triangular arrangements

Triangular and plurilateral arrangements have grown in number in recent years. These arrangements have attracted a number of countries particularly for technology cooperation across sectors or particularly industries. The OECD defines triangular cooperation arrangements as those involving "DAC donor and pivotal countries (providers of South-South Cooperation) to implement development cooperation programs/projects in beneficiary countries or recipients of development aid (Fordelone, 2011).

[13] http://www.climateinvestmentfunds.org

[14] Economic Commission for Latin America, Inter American Development Bank (IDB), Economic Commission for Africa (ECA), African Development Bank (AfDB), Economic Commission for Asia and the Pacific (ESCAP), Asian Development Bank (ADB), Economic Commission for Europe (ECE).

Some examples of the plurilateral type of arrangements include international technology partnerships such as the Carbon Sequestration Leadership Forum with 22 member and which focuses on CCS, Generation IV International Forum with 10 members and which is devoted to R&D on next generation nuclear systems, ITER with 7 members which is also dedicated to advanced nuclear technology, and Asia Pacific Partnership on Clean Development and Climate with 7 members and which focuses on supporting the deployment of technologies to address energy security, air pollution and climate change.

The rise of triangular arrangements has been driven by the growing role of middle-income countries and their role in providing development co-operation in addition to also receiving it and by the desire to experiment with other types of cooperation where the experience of developing countries can be brought to bear.

16.6.3 Conclusion

The most effective mitigation activities are those that are integrated into the overall national development strategies and plans. . Institutions that finance mitigation activities in countries can play a key role in ensuring that mitigation activities are properly mainstreamed, coordinated across relevant sectors, and integrated into the overall development priorities of countries. The overall state of institutions in developing countries is weak. This includes institutions responsible for financing mitigation activities. Many countries are addressing this problem through the creation of national implementing entities and funds. This weakness leads to fragmentation, duplication of efforts, and more importantly to misdirected efforts and waste of resources.

16.7 Synergies and trade-offs between financing mitigation and adaptation

Climate policy rests on the pillars of mitigation and adaptation to climate change. The interactions from the two areas are many. The objective of this section is to introduce a conceptual framework that links adaptation and mitigation in terms of financing and investment. Estimates of investments needed for mitigation and investments needed for adaptation are provided in 16.3 and WG II respectively. Firstly, this section addresses the complementariness of financing adaptation and mitigation in terms of their specific effectiveness and trade-offs, as well as their competition for funding over time. Secondly, it briefly identifies integrated financing approaches.

16.7.1 A macro-level perspective

16.7.1.1 Social rate of return

Several authors have recognized that optimal mitigation and adaptation strategies should be determined jointly. Adaptation and mitigation can be complementary; investing in mitigation may reducesthe need to invest in adaptation and vice versa (Schelling, 1992; Kane and Shogren, 2000; R. Dellink et al., 2009; Bosello et al., 2010). According to this view, the social discounted rate of return of resources invested in mitigation and adaptation should be equal to avoid inefficiencies. Kane and Shogren (2000) provide a formal treatment of the relationship between adaptation and mitigation measures based on the endogenous risk literature. People invest resources to reduce the risk they confront or create (Ehrlich and Becker, 1972; T Lewis and Nickerson, 1989). A conflict (and an inefficient outcome) would arise when constraints are imposed such that the social rate of returns of the investments in mitigation and adaptation are different. There are of course exceptions: all the cases in which adaptation measures also contribute to mitigate and vice versa. However, according to this literature, mitigation and adaptation generally compete to attract investments.

The view that adaptation and mitigation can be jointly optimally determined is contrasted by several authors (Tol, 2007; Ayers and Huq, 2009). From the perspective of development and climate studies, on one hand, climate change in most cases will reduce the production potential of the economy, the magnitude depending on vulnerability, efficiency and institutional capacity to adapt. On the other hand, climate change adaptation as well as mitigation can include policies like financial and technology transfer, institutional strengthening and market improvements that enhance the productive capacity of the country (Halsnæs and Verhagen, 2007).

Although many actions that integrate mitigation and adaptation offer enough co-benefits to make obvious sense immediately (see WG II, Chapter x), in many cases effective integration of mitigation and adaptation to make a significant difference in cost avoidance needs better information, better capacities for analysis and action, and further policymaking (Wilbanks and Sathaye, 2007). More detailed analysis is desirable, given that there is lack of modeling of any direct interaction between adaptation and mitigation in terms of their specific effectiveness and trade-offs (W Wang and McCarl, 2011).

16.7.1.2 Time dimension

There are emerging theoretical frameworks to assess the trade-offs between adaptation and mitigation, including from the point of view of costs. Recent studies have used integrated assessment models to solve numerically the optimal allocation of investments between mitigation and adaptation. They confirm the analytical insights of Kane and Shogren (2000) and they suggest that investments in mitigation should anticipate investments in adaptation (Lecocq and Shalizi, 2007; K de Bruin et al., 2009; Bosello et al., 2010). The reason being that climate and the economic systems have inertia and delaying action increases the cost of achieving a given temperature target. Adaptation is instead a long-term phenomenon and little investment is necessary in the first decades of this century. These studies suggest that the competition between mitigation and adaptation funds extends over time.

Other authors reinforce the idea that it is optimal to wait to invest in adaptation by arguing that uncertainty on the location of damages reduces the benefits of "targeted" proactive adaptation with regard to mitigation and reactive adaptation (Lecocq and Shalizi, 2007).

For the above reasons Carraro and Massetti (2011)suggest that the greatest share of the Green Climate Fund (see below) should finance emissions reductions in developing countries rather than adaptation.

Lecoq and Shalizi (2007) recognize that it might be difficult for developing countries to finance reactive adaptation, especially if climate shocks affect the fiscal base. Rainy-day funds are identified e.g. as a supplemental instrument that can alleviate future budget constraints while avoiding the risk of misallocating resources when the location of damages is uncertain.

De Bruin et al. (2009) , by explicitly including adaptation in an Integrated Assessment Models, show that adaptation is a powerful option to combat climate change, as it reduces most of the potential costs of climate change in earlier periods, while mitigation does so in later periods.

Patt et al. (2009) are more critical regarding the assessment using IAMS, claiming that current IAMS over-estimate the level of adaptation and under-estimate the cost and that, while adaptation could play a more significant role in reducing the impacts of climatic change, such adaptation is likely to be more difficult and costly than current models suggest.

Wang and McCarl (2011) recognizes that, in terms of an overall investment shared between mitigation and adaptation, while mitigation tackles the long-run cause of climate change, adaptation tackles the short-run reduction of damages and is more preferred when damage stocks are small. Nevertheless, they advocate that adaptation is an economically effective complement to mitigation and should occur in parallel due to the interdependent nature between mitigation and adaptation. The near term nature of the benefits given an adaptation investment makes it an important current policy option.

16.7.2 Integrated financing approaches

Despite the lack of modeling of any direct interaction between adaptation and mitigation in terms of financing, there is an increasing willingness to promote integrated financing approaches, addressing both adaptation and mitigation activities in different sectors and at different levels.

16.7.2.1 Sectoral financing approaches

Considering the details of specific adaptation and mitigation activities in different sectors shows that adaptation and mitigation can have a positive and negative influence on each other's effectiveness. Such an influence must be taken into consideration as an analytical tool for considering investment and finance.

Different sectors have different realities and demands. Therefore, financing approaches to each of these sectors are different. This sub-section presents some examples of these different approaches. The large deficiencies in infrastructure provision are as much related to inadequate institutional structures as they are to inadequate funding. Current international financial flows on infrastructure from the private sector are heavily concentrated in particular forms of infrastructure (inevitably those that are most profitable, e.g. electricity) and in better off nations or nations with economic success, which usually is responsible for a significant amount of GHG emissions and do not take into consideration adaptation needs. It is important to address how private sector investments can have a major role in the poorest nations and in nations with poor economic performance (which include many that are most vulnerable to climate change) and in those kinds of infrastructure which are public goods and are particularly important for protecting the poorest and most vulnerable groups (e.g. roads/bridges and storm and surface water drainage) (Satterthwaite, 2007).

Sustainable and organic **agriculture** offers multiple opportunities to reduce GHGs and counteract global warming. Reducing GHGs through their sequestration in soil has even greater potential to mitigate climate change. In order to reduce trade-offs among food security, climate change and ecosystem degradation, productive and ecologically sustainable agriculture is crucial (Niggli et al., 2009).

Waste management projects, especially those who have the dual benefits of producing compost and reducing methane emissions by diverting organic waste from dumping at a landfill to dumping at a composing plant (e.g. CDM project "Composting of Organic Waste in Dhaka"), which is highly suitable to LDCs, can be successful in achieving investment and delivering on sustainable development benefits (Ayers and Huq, 2008).

On the one hand, **forest sector** is projected to be adversely impacted under the projected climate change scenarios and on the other provide opportunities to mitigate climate change. Adaptation opportunities exist in mitigation projects under forest conservation, afforestation, reforestation and fossil fuel substitution activities, which are being operationalized or implemented under the UNFCCC, mechanisms such as the Global Environmental Facility (GEF), Clean Development Mechanism (CDM), activities under Article 3.3 (afforestation, reforestation and halting deforestation) and 3.4 (forest and grass management, etc.) of the Kyoto Protocol and many mechanisms such as Adaptation Fund etc. Therefore, there is need for research and field demonstration of synergy between mitigation and adaptation, including the economic aspects, so that the cost of addressing climate change impacts can be reduced and co-benefits increased (Ravindranath, 2007).

Negotiations on "Reducing Emissions from Deforestation and Forest Degradation" (**REDD**) in developing countries has attracted a lot of attention and generated expectation for funding. Two alternatives REDD financing options are usually examined: financing through a future compliance market based on emission reduction targets and the allowable cap, and financing through a non-offset fund. Isenberg and Potvin (2010) argue that the best financial approach for REDD would be a flexible REDD mechanism with two tracks: a market track serving as a mitigation option for developed countries, and a fund track serving as a mitigation option for developing countries.

16.7.2.2 Regional financing approaches

Mitigative activities have almost perfect global externalities while most adaptation activities are limited to a smaller geographical area or population, given that the first relates to a global public good while most adaptation measures relate to regional public goods. Taking into account the strong regional nature of climate change impacts, a regional financing arrangement will be more responsive and relevant than a global one. Thus, while a regional financing arrangement complements global financing arrangements for mitigation, it has a very special and even unique role in adaptation (Sharan, 2008).

Regional funding tools have made arrangements for financing adaptation activities in complement to mitigation ones: e.g. the Poverty and Environment Fund (PEF) of the Asian Development Bank promotes mainstreaming of environmental considerations including climate change considerations into development strategies, plans, programs and projects of the bank

16.7.2.3 Global financing approaches

This section examines the status of finance for adaptation in international funds. It examines complementarities and trade-offs between funding mechanisms for mitigation and for adaptation.

Most of the existing financing approaches do not have an integrative perspective, which leads to a competition between mitigation and adaptation. The question of balance allocation is a challenge, where limited funds have to be split up between mitigation and adaptation.

Although some funds have been designed to address mitigation needs (e.g., the GEF), there has been an increasing interest in the exploring the synergies and trade-offs with adaptation activities. Benefits and trade-offs between mitigation and adaptation can for instance be identified under the **Special Climate Change Fund** (SCCF) and **Least Developed Countries Fund** (LDCF) (Mace, 2005; Bouwer and Aerts, 2006). The **Green Climate Fund** (GCF) has a mandate to fund both mitigation and adaptation. For the time being, there is a gap on related literature because the fund has been recently created and is still being designed.

The World Bank, in consultation with the regional development banks, established the Climate Investment Funds (CIF) (which included in its portfolio the Strategic Climate Fund, including programs for Climate Resilience, Greening Energy Access, and Sustainable Forest Management), to mobilize new and additional financing for activities and investments that demonstrate how financial and other incentives can be scaled-up to support adaptation and mitigation in a coherent and integrated manner (World Bank, 2008). Although it has been argued that the CIFs has the potential to spark transformative changes in how climate change is integrated into economic development choices, constraint on transparency and participation in deliberations over investment plans of the fund have been raised, as well as implications for the UNFCCC negotiations have been controversial (Nakhooda, 2009).

There are also mutual enforcing approaches, where the more mitigation, the more adaptation. The Kyoto Protocol **Adaptation Fund** (AF) finances adaptation projects in non-Annex I countries, including activities to reduce LULUCF emissions (Bouwer and Aerts, 2006). Therefore potentials but also trade-offs between mitigation and adaptation activities exist. In addition there is a special link between mitigation and adaptation on the resources side of the fund. It is financed using 2% of the revenues from CDM projects (Bouwer and Aerts, 2006). Burden sharing and, more in general, the future role of CDM affect the level of funding available for adaptation.

The level of international funding for adaptation in developing countries is woefully inadequate to meet projected needs. Proposals have been made to provide funding for developing country adaptation through international levies on emissions from international maritime transport and aviation/air travel and/or through **international auctioning** of assigned amount units (i.e. an adaptation levy on the proceeds of international emissions trading) (Müller, 2009).

It is widely recognized that the primary burden-sharing problem regarding adaptation funding is to allocate funding responsibilities to richer countries to (partially) fund adaptation efforts in poorer countries. This challenge raises another point of debate on the synergies and trade-offs between financing mitigation and adaptation. Conceptual frameworks for allocating responsibilities for international financing of adaptation related to climate change have been proposed, based on the historical contribution of different countries to climate change, in terms of GHG emissions, and their capacity to pay for the costs of adaptation internationally (R. Dellink et al., 2009).

The **CDM**, although it is a financial mechanism focused on mitigation activities, activities to be eligible to the CDM must contribute to the sustainable development of the host country and, therefore, it opens a window of opportunity for multiple benefits between mitigation and adaptation. CDM projects that reduce GHG emissions and, at the same time, decrease vulnerability to climate change can increase the host country’s capacity to deal with climate risks and facilitate a more active role of developing countries in the multilateral climate change regime UNFCCC and Kyoto Protocol process (Swart and Raes, 2007.) In the debate about the CDM after 2012, there is a discussion on the relationship between the CDM and adaptation, and whether the CDM should remain the only trading mechanism which “share of proceeds” (2%) contribute to the Adaptation Fund (A. F Hof et al., 2009; Boyd et al., 2009).

16.8 Gaps in knowledge and data

[Note from TSU: Section to be completed for Second Order Draft]

16.9 Frequently Asked Questions

[Note from TSU: FAQs will be presented in boxes throughout the text in Second Order Draft]

FAQ 16.1: How much finance and investment is currently directed to mitigate climate change and how much extra flows will be needed stay below the 2°C limit?

There is no agreement on what qualifies as climate finance and no comprehensive system for tracking climate finance. However, the current level of investments and financial flows in low-emission technologies is low compared to the stated climate stabilization goals. The only comprehensive overview available in the literature estimates that in 2009/2010 international climate finance amounted to USD 97 billion. USD 93 billion was used for mitigation, mainly originating from the private sector (USD 55 billion). Incremental annual investment needs for renewable energy and energy efficiency in different sectors including buildings, transport, industry and waste for 2030 are in the range of at least USD 200-500 billion in industrialized and USD 200-700 billion for developing countries. Incremental investment levels can be partly compensated by reduced investment in other parts of the economy. Renewable energy deployment is likely to require substantial annual subsidies of above USD 100 billion each in industrialised and developing countries in 2030. Forest protection in developing countries is expected to require at least USD 20 billion annually in the coming decade.

FAQ 16.2: How can this be funded in terms of **financial sources and instruments**?

There is a need for both public and private sources, as well as domestic and international. The **public sector** has the potential to raise revenues by collecting carbon taxes, by auctioning carbon allowances or selling assigned amount units (AAUs). These innovative, carbon-related sources of funding are already sizable in some countries and have the potential to generate very large financial flows under ambitious stabilization targets. A contraction of fossil fuel subsidies could be an additional source of funding. In some developing countries, international public finance, mainly in the form of ODA, is a crucial source for climate finance.
The **private sector** – e.g. pension funds, insurance companies, banks, mutual funds– are and will continue to be a key source of funding for low-emission investments once there is a clear return on the investment and the right incentives are established.

Both the private and the public sectors have developed financial instruments to fund investments and to manage risk. **Risk mitigation tools** include business interruption insurance, credit enhancements, production and savings guarantees. Feed-in-tariffs are frequently used to support renewable energy in Europe, USA and in Japan and in some developing countries. Innovative tools include power purchase and efficiency service agreements, rebates, on-bill financing or repayment, and energy assessment financing district.

FAQ 16.3: What role do **institutional arrangements** play to support finance and investment into mitigation activities?

An **effective governance** of climate change on the national, regional and international level is an essential pre-requisite for an efficient and effective system of finance for mitigation. Appropriate institutional arrangements are essential for ensuring that financing to address and in response to climate change responds to national needs and priorities in an efficient and effective way. Financing and promotion of clean technology transfer requires more than the availability of funds but also international frameworks, where international finance institutions can play a key role.

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