

Public and private risk sharing in the financing of low- emitting urban infrastructure projects: The case of CDM projects in the waste sector

Dorothee Teichmann¹

Low CO₂ emitting urban infrastructure projects are expected to play an important role in mitigating climate change. By enabling projects to sell their CO₂ emission reductions on the international carbon market, the Clean Development Mechanism (CDM) turns the positive environmental benefits of such projects into financial cash flows. However, investors and lenders to these projects frequently face significant financial risks relating to the realisation of these cash flows, reducing the attractiveness of such projects for investors.

This paper both identifies and proposes ways of mitigating project and partnership risks of CDM projects in the waste sector based on a literature review and several examples of CDM projects.

The paper concludes that public-private partnerships and the integration of external financial institutions can be used to mitigate certain exogenous and endogenous project risks by allocating them to that partner (public project sponsor, private operator or external investors and lenders) who has private information on these risks or is most capable of assuming the risks.

However, the relationship structures of the projects will become more complex. Partnership risks arise, which concern the distribution of carbon revenues between the partners. These risks differ from one contract type to the other. A concession contract (which allocates the carbon revenues directly to the contracted private operator) can be preferred against a management contract (under which the operator is remunerated by a management fee) as this aligns the incentives between builder and operator of the infrastructure and mitigates partnership risks. Public and private financial institutions can assume project risks. Bank debt may be preferred over external equity as it increases the efforts of the operator in terms of CO₂ emission reductions.

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1. The author is PhD candidate in economics at the Paris-Dauphine University (under the academic supervision of Jean- Hervé Lorenzi and Christian de Perthuis) as well as research fellow at CDC Climat Recherche, Paris.
dorothee.teichmann@cdcclimat.com



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1 Introduction

According to the World Development Report 2010, global development goals are threatened by climate change, with the heaviest impacts to fall on the poorest countries. Climate change mitigation, by developing low CO₂-emitting technology, is part of global climate risk prevention policy. Low-emitting infrastructure development is one important aspect of this policy and has been promoted by regulatory instruments.

One of them is the UNFCCC's Clean Development Mechanism (CDM), under which projects in developing countries that reduce CO₂ emissions can monetise those reductions by selling them on the international carbon market. The CDM puts a price on CO₂, which in theory allows investor and lender to integrate the price of CO₂ into their decision making like any other commodity price. However, in practice, reluctance of banks to lend to and of investors to invest in CDM projects can be observed.

The objectives of this paper are threefold. The first is to explain why investors and lenders often keep away from these projects by means of a detailed risk analysis. Secondly, contractual arrangements, under which private sector willing to take on risks, are identified. Thirdly, it will be analysed whether contractual arrangements can enhance the efficiency in the internalisation of climate change externalities.

The paper is structured as follows. In a first step, the CDM is described as well as the project risks it creates. Project risks are defined as those independent of the contract itself and related to the amount of real carbon revenues generated. In a second step, it is shown how the contracting out of parts of the infrastructure services to the private sector in form of Public-Private Partnerships as well as the integration of external financial institutions can help to diversify and better manage the risks. The carbon rent is often used to compensate project partners for risk assumptions.

In the final section an important trade-off is presented. The integration of new partners does, in fact, create partnership risks that exist due to contractual structures and the distribution of carbon revenues between the partners. It is analysed which contractual arrangements allow to best mitigate these risks by comparing a management contract with a concession contract.

The analysis is based on the incentive and contract theory (Laffont & Tirole, 1993) as well as the theory of financial contracting as applied to public-private partnerships (Dewatripont & Legros, 2005). Examples from urban infrastructure projects in the solid waste and wastewater sector financed under the CDM are given throughout the article to picture the problems raised.

2 Clean Development Mechanism: internalisation of climate change externalities under the creation of risks

2.1 The internalisation of climate change externalities into urban infrastructure projects

In this article a rather large definition of urban infrastructure is used. According to Kessides (1997, p. i) infrastructure services include “safe water, sanitation, solid waste collection and disposal, storm drainage, public transport, access roads and footpaths, street lighting, public telephones, and often other neighbourhood amenities (safe play areas, community facilities), electricity connection, and social services”. Urban infrastructure is important for the economic development of a particular urban area as well as to meet the basic needs of the local inhabitants (Kessides, 1993) and includes therefore economic infrastructure (transport, water distribution etc.) as well as social infrastructure (solid waste collection and disposal)².

By contributing to greenhouse gas emissions (GHG) infrastructure use produces a global externality³. According to the IPCC’s 4th Assessment Report (2007), urban infrastructures are either directly or indirectly (e.g. transport encouraged by the construction of roads) responsible for over 50% of greenhouse gas emissions worldwide. Moreover, IPCC (2007) estimates that 1.6 to 2.5 Gt CO₂eq/year (of which 0.15 in developing countries) can be reduced in the transport sector by using public transport and hybrid vehicles. In the waste sector the reduction potential is estimated to amount to 0.4 to 1 Gt CO₂eq/year (of which between 0.2 and 0.7 Gt CO₂eq/year) by CH₄ capture.

Infrastructure projects are also likely to be among the largest victims of the negative externalities they contribute to. Higher evaporation rates, rising sea levels, floods and droughts are some of the phenomena that will have an impact on the value of infrastructure assets. Assets of long-term investors are therefore at greater risk and the vulnerability of economies to climate change increases⁴.

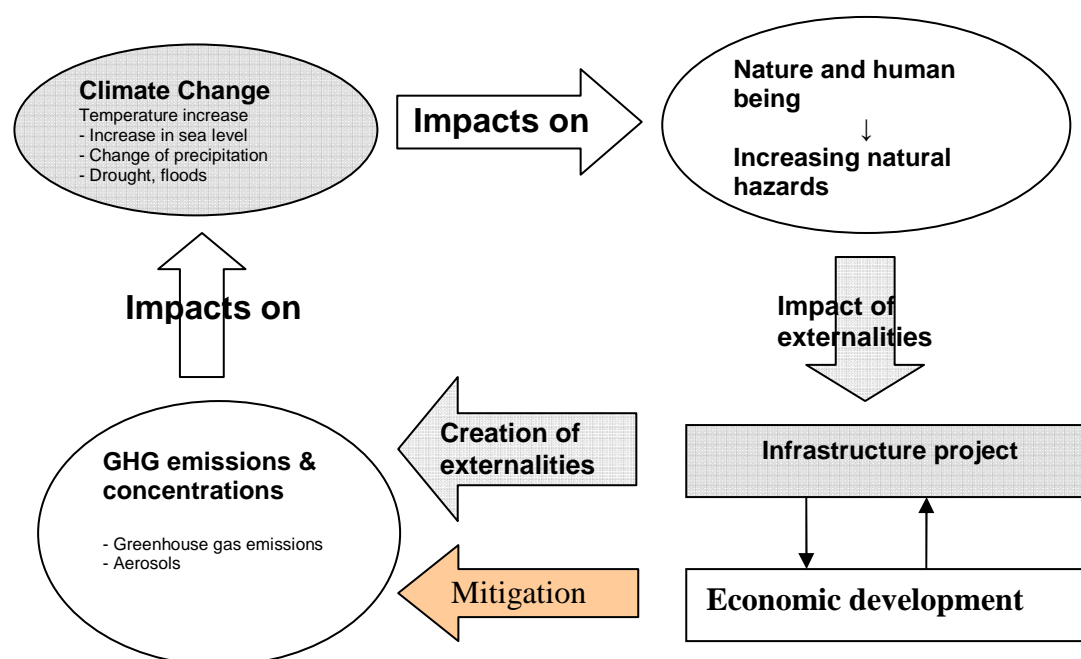
Figure 1 illustrates the project externalities related to climate change.

² For a more detailed classification of economic and social infrastructure see for example Holm (2010).

³ GHG externalities are usually referred to as “diffuse externalities” as it is impossible or very difficult to identify the pollution source or point of receipt. That is, the full costs of GHG emissions, in terms of climate change, are not immediately and hardly ever directly borne by the emitter, so they face little or no economic incentive to reduce emissions (Stern, 2007).

⁴ According to the IPCC (2007), developing countries will feel most of these negative impacts of climate change, at least initially. This is partly because climate change augments the frequency and intensity of extreme events, which result in increased economic and human losses. There is statistical evidence that since the late 1980s damage caused by major weather disasters have increased (IPCC, 2007): 95% of the people affected by extreme events live in developing countries.

Figure 1: Infrastructure and climate change externalities



Source: Based on IPCC Climate Change 2001: Synthesis Report – Summary for Policymakers, modified by the author

The aim of climate change mitigation policy in this context is to make project promoters and investors sensitive to the climate cost associated with their activity. Mitigation policy is based on the economic theory of internalisation of externalities and aims at defining regulatory and/or financial incentives (including Pigouvian economic instruments⁵) in order to make project operators and investors use low-emitting technologies. In the Pigouvian model world, a tax will price the externality by making the polluter pay the difference between the social and private costs of production. A subsidy will compensate the polluter for the additional costs associated with the abatement of the pollution. In both cases, the externality will be internalised within the theoretical model.

2.2 The functioning of the Clean Development Mechanism

The Clean Development Mechanism is defined in the Kyoto Protocol that was adopted at the Conference of the Parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Kyoto, Japan, in December 1997.

⁵ These economic instruments are based on the theory of Pigou (1932) that proposes to tax agents who do not adhere to the government's environmental objective or to subsidise the agent that abate environmental pollution. Because of the taxation or the subsidy, economic agents will have an incentive to reduce production externalities. Subsidies to compensate the agent for putting in place emission reduction measures and taxation of emissions have the same effect according to Pigou's theory.

As of March 2010, 2062 projects had been registered under the CDM. Until 2012 these projects are expected to reduce 1.8 Million tons of CO₂ equivalents and attract investments of ca. 18 billion Euros in CDM credits⁶. The main project types are hydraulic, HFC, wind farms, energy efficiency; N₂O, with the majority of projects implemented in China, India, Brazil, South Korea, and Mexico⁷.

Urban infrastructure projects, which are those projects that include a municipal authority either as project participant or as owner of land or infrastructure, make up for 13% of all CDM projects registered so far. The CDM has been especially successful in the wastewater treatment and landfill gas sectors as it is illustrated by the following table.

Table 1: Urban CDM projects initiated by cities or involving city authorities, by sector

Project type	Urban transport	HVAC and lighting	Energy efficiency (buildings, households)	Local distribution networks	Waste water treatment	Landfill gas	% urban infrastructure/all CDM projects
Number of registered projects	2	12	1	2	103	154	13%

Source: CDC Climat Research - based on registered projects in the UN CDM Pipelines & project design documents (PDDs) as of 1/3/2010

The UNFCCC’s Clean Development Mechanism (CDM) is an economic instrument that can facilitate the internalisation of CO₂ emissions externalities into the project development and financing of major infrastructures in developing countries. The polluter is compensated for emission reductions as the environmental value of CO₂ emission reduction within the project are monetized compared to a baseline (the project that would have been implemented without CDM). Additionality is an important criterion in this context. Only emission reductions that are additional to emission reductions that would have occurred without CDM are eligible. The emission reductions and the sale of CERs must, hence, be a deciding factor in the decision to go ahead with the project or not (UNFCCC Marrakech Accord, 2007).

The CDM puts a price on carbon in developing countries by providing for the possibility to capture the environmental value of CO₂ emissions through Certified Emission Reductions (CER) generated, measured in metric tons of carbon dioxide equivalent, that correspond to the reduced emissions compared to a baseline scenario. These CER can be sold on the

⁶ An average price per tCo₂ eq is assumed to stand at 10 Euro.

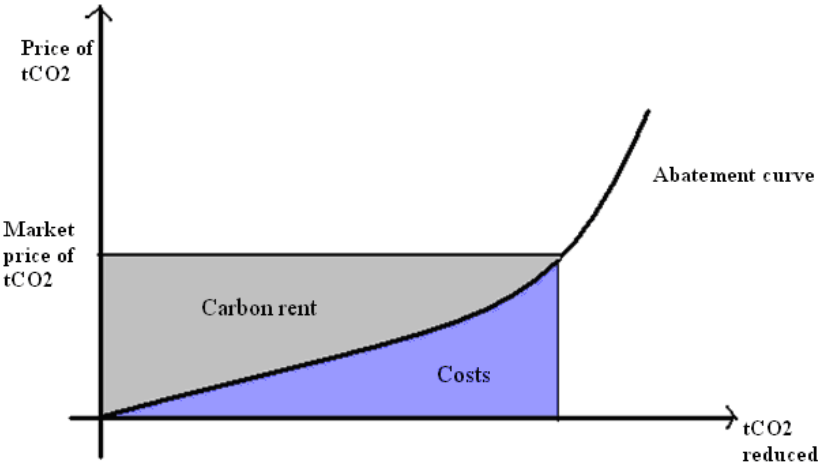
⁷ Source: CDM/JI pipelines UNEP RISO, own calculations

international carbon markets and can be an additional revenue stream (for example, after electricity sales) obtained by a CDM project.

Carbon revenues are thus used not to frame new projects, but to finance new technology options that would not have been used without the provision of these additional revenues due to market barriers⁸ and financial risks (as discussed further down).

The CDM, being a market based regulatory instrument, allows the project partners to generate a carbon rent if they are able to reduce CO₂ emissions at lower unit costs than what they earn for every CER sold on the international carbon market (see figure 2 below).

Figure 2: The Carbon rent



For existing CDM projects, the carbon rent can be determined approximately by dividing the carbon revenues (quantity of CER *price of CER) by the additional investment costs compared to the baseline⁹.

As will be shown in the next section, the CDM does not always allow project partners to benefit from the carbon rent as expected, but rather confronts them with financial risks associated with the generation of carbon credits.

⁸ See for example World Development Report by the World Bank (2010) and World Investment Report by UNCTAD (2010) for an analysis of technological and market barriers of new climate friendly technology.

⁹ This approach is approximate as it supposes a flat abatement cost curve, which means that the costs of CO₂ emission abatement are the same for every quantity of CO₂ reduced.

Box 1: The carbon rent of landfill and wastewater projects

According to UNCTAD (2010) the waste and wastewater sector – mainly landfills and wastewater treatment – is forecast to account for relatively few emissions in 2030, and almost all of these can be reduced at a relatively low cost (compared to transport and buildings). The abatement potential lies to a very large extent in landfill methane recovery. Under the CDM the following projects have been financed.

CDM Opportunities in the Urban Sector- Some examples

Solid Waste Management	Waste Water Treatment
Composting of biodegradable portion of municipal solid waste	Methane capture and flare in wastewater treatment projects
Methane capture for flaring / heat / electricity in landfill	Sludge treatment
Waste to Energy through incineration/RDF	Energy Production

Source: based on http://www.unctad.org/en/docs/iteiit20051a1_en.pdf

For flaring and landfill gas projects the baseline scenario is a “do nothing” situation, which means that the investment costs in the baseline scenario are zero. The overall investment costs of the projects as provided in the CDM pipeline can hence be interpreted as “additional investment costs” related to the implementation of the new technology. The carbon rent can therefore be calculated as the carbon revenues over the total investment costs.

The carbon rents of these projects can be seen in the following table.

Carbon rent of urban CDM projects

Project type	Average amount of carbon rent/project	Highest carbon rent	Lowest carbon rent	Number of projects, for which data available
Landfill gas recovery & utilization	5 Million USD	12,4 Million USD	- 2 Million USD	21
Wastewater treatment	2,8 Million USD	6,6 Million US	0,35 Millions USD	19

Source: calculations by author based on IGES database and CDM pipeline

2.3 Project risks associated with the generation of CER

The amount of carbon credits generated by the CDM project is subject to project risks. Following the approach of De Palma (2009), project risks are here defined as those risks that are intrinsic to the project. Project risks include demand risk, construction risks, risks of extreme events etc. CDM specific exogenous risks are related to uncertain revenues¹⁰ associated with CER due to variable prices and quantities. For example, the emissions baseline may need to be adjusted during the crediting period due to technological changes or changes in the demand and the activity level. There are also uncertainties about costs, such as transaction costs and project cycle costs and uncertainties about the renewal of the crediting period (Janssen, 2000). Trotignon/ Leguet (2009) find that the risk of delay of validation, registration and verification can be significant as well. Furthermore, there is the risk that all projects at validation will not be registered, as well as the risk of under/over performance and thus variable credit revenue¹¹.

¹⁰ Another important type of risks is associated with the transaction costs created by the CDM. These risks are not treated here as only the revenue side is considered.

¹¹ The project risks dealt with in this article are only those that are directly associated with the generation of CER. Other more general project risks are widely studied in the literature (UNEP RISOE, 2005; UNEP and Partners, 2009, Deodhar, 2003, etc.). Also, the same way as traditional projects, CO₂-mitigation projects in the CDM face country risks, macroeconomic risks (currency risk, risk of economic crises, etc.) and political risks (risk of expropriation, etc.), especially when implemented in developing countries. However, additional risks can arise due to the fact that projects are typically relatively small in terms of the market value of carbon emissions abated, and that climate-friendly technologies such as renewables are usually more capital intensive than fossil fuel alternatives. Zhang & Maruyama (2001) provide a good overview of the traditional project risks and the new risks of mitigation projects (see annex 1).

Box 2: Project risks of landfill projects financed under the CDM

The following table provides examples for the most important risks that solid waste projects financed under the CDM may face.

Type of risks	Examples
Technology risks	Risks related to failures and possible underperformance of innovative technologies that allow methane capture of landfills.
Market risks	Risks related to the amount of waste coming in and being treated.
Regulatory risks	Uncertainties regarding Post-Kyoto CDM; quality/quantity control on offset credits, volatility of CO ₂ price.
Political risks	Departure of one key participant; electoral cycles of mayor of the municipality and changing priorities as regards waste treatment; permit/licence approval.
Operational risks/ performance risks	Timing and the volume of the CER flow from a project: e.g. a digester will not produce as much methane as originally planned as the waste stream coming into an anaerobic digester does not have the characteristics required for the waste to be digested anaerobically.

Source: based on CD4CDM (2007), Clapp et al. (2010 forthcoming)

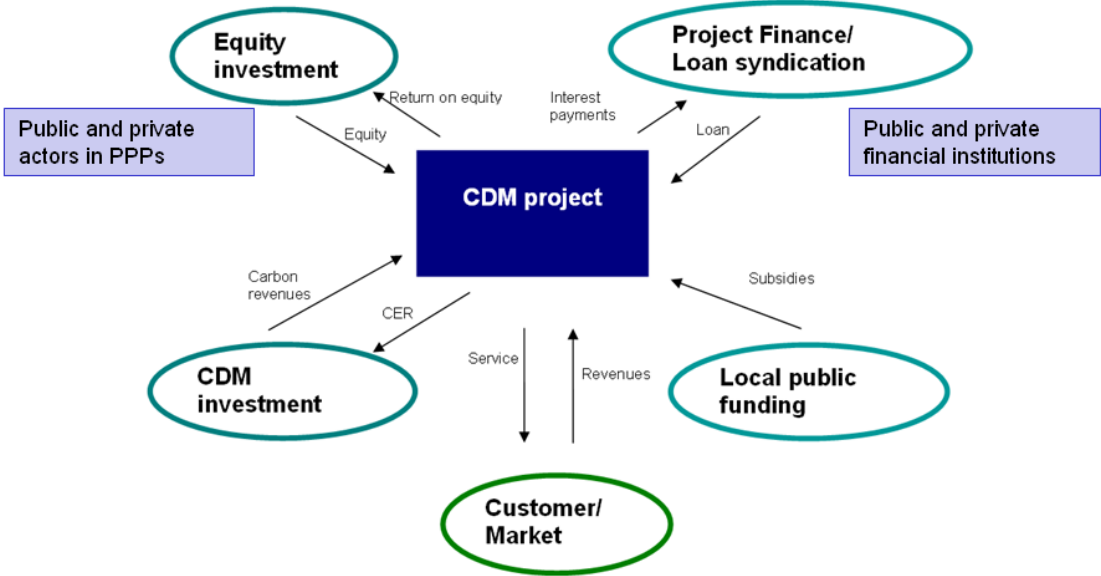
In CDM project it can be useful to attract different public and private partners, such as private or public project sponsors and private or public external financial institutions in order to share the project risks associated with the amount of CER generated. The risks can be shared among the project partners, be transferred to external financial institutions or compensated for by the sharing of the carbon rent. In the following chapter, the different project partners are presented before discussing risk sharing and transfer as well as carbon rent sharing mechanisms.

3 Management of project risks: additional partners needed!

3.1 Financial actors involved in the financing of traditional and CDM infrastructure projects

In order to manage CDM project risks usually certain financial actors are integrated into the project structure (as presented in figure 3). The most important of these actors can be classified under the following categories: equity provider (public and private project sponsors and operators), lenders (public and private banks), local or international public funding institutions (like energy agencies, waste management agencies, environmental agencies etc.), CDM investors (carbon credit buyers, such as carbon funds etc.¹²). The costumers of the project (the final beneficiary of the infrastructure) have to be mentioned as well as they provide revenues to the project by paying their infrastructure service bills.

Figure 3: Financial structure of infrastructure projects with CDM financing



Source: author

In this section the risk sharing between public and private equity providers in public- private partnerships as well as the risk transfer to external public and financial institutions will be analysed in more detail.

¹² Carbon credits can, in fact, be acquired by different actors at different stages in the primary market. Stephan & Alberola (2010) group buyers of carbon credits on the primary market in distinguishing between companies engaged in trading schemes for emission allowances, financial investors covering carbon funds, banks and financial intermediaries, and finally the professional developers of CDM projects.

CDM investors, customers and local public funding institutions are also important, but are analysed in less detail here. CDM investors are mentioned here as they may not only buy carbon credits generated by the project, but also provide additional capital in form of equity or debt and hence bear project risks as other external capital providers do. In fact, the CDM investor can offer equity investment in the CDM project. In return for equity he receives a share of the CERs generated by the project. Alternatively, the investor can be involved as lender to the underlying project. He then receives CERs as a part payment of a fixed proportion of the interest for that loan (UNEP RISOE, 2005).

It is the different capacity and willingness to take on risks of the different public and private partners that make Public- Private Partnerships and the integration of external financial institutions worthwhile.

The same way, local or international funding institutions may finance a project in partnership with public banks, which would allow the public banks to bear additional project risks. Examples are local energy agencies that finance CDM projects mutually with a local, regional, national or international development bank.

The following table (next page) classifies the different project partners according to their ownership structure, their financing mandate and financial risk/return expectations as this all has an impact on their capacity and willingness to assume risks. In general, it can be observed that private investment decisions are primarily based on financial cost-benefit analysis, while public infrastructure investment is often carried out to achieve the direct and indirect economic benefits (with the requirement that the project is financially sound). Private firms do not usually consider environmental externalities in their investment decisions, particularly when the benefits are very long- term (as with climate change mitigation) and outside the planning horizons of private investors (Stern, 2007).

In the next section, it will be shown how risks associated with the amount of generated CER can be partly managed by Public-Private Partnerships (PPP) or by integrating external financial institutions in the project structure.

Table 3: The different partners in urban infrastructure finance and CDM project finance

		Ownership structure	Investment horizon	Criteria of decision making	Financing through	Example
Involved in PPP	Project sponsors	Public	Long term	Low financial risk/return expectations, high expectations in terms of economic risk/return	Taxes, grants	State, energy agencies, municipalities, municipal companies etc.
		Private	Short term, medium term and long term (depending on contract)	At least market capitalisation	Capital markets through shares and bonds	Commercial firms etc.
	Project operators	Public	Long term	Low financial risk/return expectations, high expectations in terms of economic risk/return	Local taxes, central government grants, in rare cases municipal bonds	Municipal firms etc.
		Private	Short term, medium term and long term (depending on contract)	Financial cost/benefit assessment, risk liquidity, exposure to market variations	Capital markets through shares and bonds	Private project operators (such as Véolia, Suez etc.)
External financial institutions	Project lenders	Public	Long term	Low financial risk/return expectations, high expectations in terms of economic risk/return	Equity provided by donor countries and leverage of funds mainly through bond issuance on capital markets	Multilateral, bilateral, national infrastructure banks etc.
		Private	Short and medium term	Financial cost/benefit assessment, risk liquidity, exposure to market variations	Capital markets through shares and bonds; deposits by account holders (in case of banks)	Commercial banks, bond buyers
	Insurers	Private	Long term	Low liquidity risks	Insurance premiums etc.	Insurance companies
CDM investment	CDM investor	Public	Until 2012	Comparison of abatement costs at home and in developing countries	Taxes	CER buyers: governments under the Kyoto protocol
	CDM investor	Private	Until 2012	Comparison of abatement costs at home and in developing countries	Capital markets through shares and bonds and in case of banks through deposits	CER buyers: companies engaged in trading schemes for emission allowances, carbon funds, financial intermediaries, CDM projects developers

Source: based on Glachant et al. (2010), CD4CDM (2007)

3.2 How to share project risks between the different partners?

By definition, economic efficiency requires that risks be evaluated and shared optimally between the partners. The risks are assigned to the central government or municipality, to the private sector operator, to an outside insurer or to an international development bank. The risk sharing arrangements between the different partners from the private and public sector include in practice contractual agreements, financial design of the project, and insurance and guarantees provided both by the private and public financial institutions.

3.2.1 Sharing of risks associated with the generation of CER within PPP

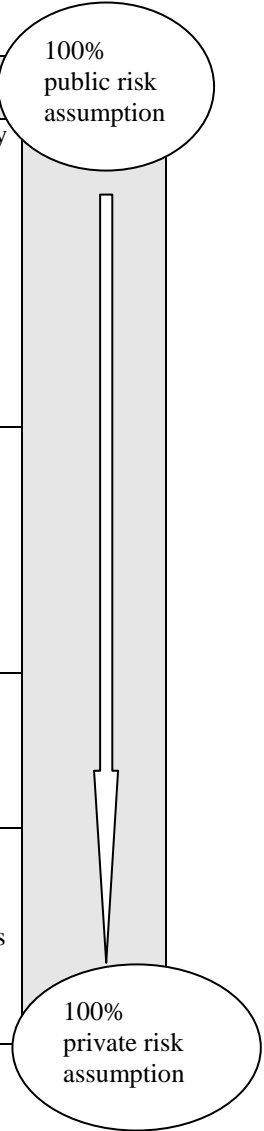
Public- private partnerships are contractual structures that allow risk sharing mechanisms between public and private equity providers. Due to the fact that infrastructure is either a public good (as it is the case for some social infrastructure, such as waste management or wastewater treatment) or creates at least significant economic and environmental externalities as described above, the public sector usually plays a pivotal role in urban infrastructure financing. Municipalities may design, finance, build and operate the projects through municipal companies or act only as sponsors and delegate the construction and operation to the private sector. For the last 20 years there have been significant new developments in private financing of infrastructure due to the lack of public funds and the inefficiencies of public service provision have given rise to initiatives to stimulate private parties to invest their resources in urban infrastructures (Estache, 2006). Private actors may finance the realization, maintenance, and operation of public infrastructures.

The private sector can get involved in urban infrastructure projects through the different contract types presented in table 2 on the next page: service contracts, management contracts, build-operate- transfer contracts or concession contracts. The risk assumption by the private sector in terms of building, operational risks etc. varies from one contract type to the other. Depending on the degree of risks assumption in general of the private sector, the risk assumptions in terms of risks associated with the amount of CERs generated will also vary between the different contract types. A private concessionaire will assume more CDM risks than a private operator that has been delegated the management of a publicly financed infrastructure. It can be observed by looking at the project design documents of CDM projects financed in the waste sector that the more risks a private actor takes the more likely he will be

responsible for the selling of the CER as stipulated in a separate contract, the emission reduction purchase agreement (ERPA).

Table 2: Different contract types of PPP in urban waste and wastewater projects

Type of contract	Description	Contract period	Risk sharing
Service contract	Contract between a municipality and a municipal company. The primary responsibility of the municipal company is to manage existing assets. The municipal company may be charged with undertaking substantial investment.	Around 3 years	The municipal company is paid through cash flows from the service that it provides, with the possibility of rewarding the company for good performance.
Management contract	Private company is responsible for the management and delivery of a service.	Around 3 years	Public authority retains financial responsibility for the service, thus limiting the risk for the contractor, remuneration of contractor in form of a flat fee.
Build, operate, transfer (BOT)	New facility is built and operated by a private operator. The municipality owns the facility and leases it to the operator.	20- 30 years	Income for the contractor derives from the revenue stream of the facility.
Concession	Private company is responsible for operations and capital of municipal service provider. Assets are typically leased from the municipality by the concessionaire.	20-30 years	Private sector assumes more risks related to operating costs and revenues as investments are paid back from profits.



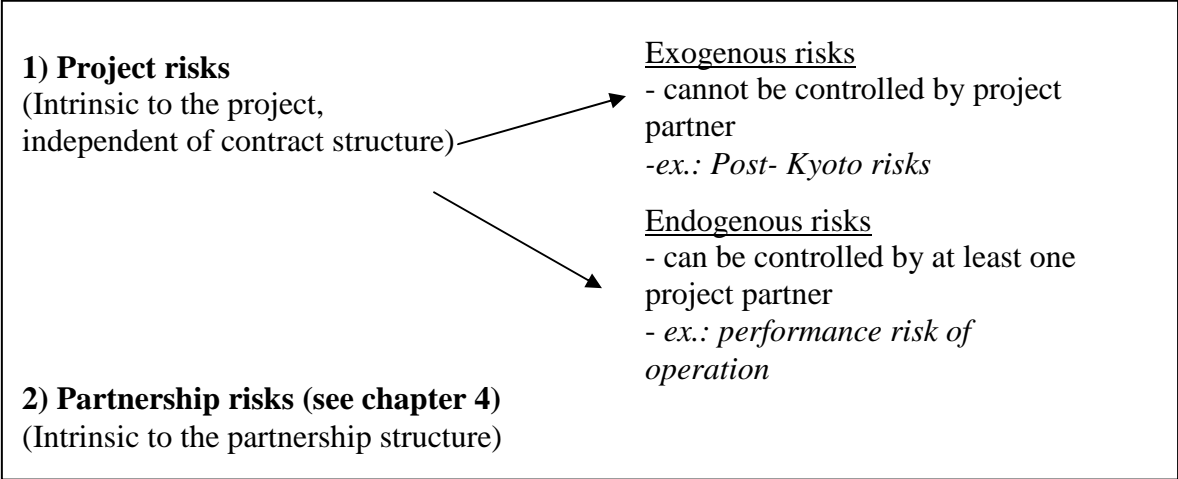
Source: based on Kennedy (2002) and OECD (2008)

These contracts do not only deal with the question of how much risks the different parties should assume, but they also stipulate the exact repartition of risks between the public and private partners.

A rather large economic literature deals with risk allocation measures within PPP. De Palma et al. (2009) point out that there is no clear cut method for the sharing of risks. However, there is a consensus in the literature that most risks can be transferred to the private sector, whereas the state should essentially remain in charge of managing acts of nature (e.g. volcanic eruptions) and fiscal risks.

Generally in literature, *exogenous* and *endogenous* project risks are distinguished. Exogenous risks are those that cannot be controlled by project partners, whereas endogenous risks can be controlled by the project partners (OECD, 2008, Dewatripont & Legros, 2005).

Figure 4: Distinction between project and partnership and endogenous and exogenous risks as used in this article



Source: based on De Palma, et al. (2009), OECD (2008)

De Palma et al. (2009) put also forward that the party who has private information on certain risk factors should bear the particular risks. These are typically risks that were labelled above as endogenous risks. The approach used by de Palma et al. (2009) is based on a principal-agent framework where the public sponsor (the municipality) is the principal that contracts out infrastructure services to the agent (the private operator). This implies a hierarchical relationship structure between municipality and private contractor and help to understand the risk sharing arrangements between these actors¹³.

In case the project is operated by a private operator the risks associated with the operation of the infrastructure should be borne by the private operator as he will be in the best position to manage and mitigate the risks. In fact, project risks associated with business interruption (other than force majeure), with the quantities of CER produced, the adjustment of the baseline scenario and with uncertain abatement and transaction costs should be borne by the private operator as it can directly influence the operational process and the generation of emission reductions and is hence incentivised to perform these tasks in the best possible way. The public sponsor of the project (the principal) is expected to bear risks associated with project specifications, such as the location, the technology etc. Following the approach of de

¹³ Here only risk sharing arrangements are analysed. The principal- agent concept is also important for the analysis of relationship risks as presented in chapter 4 of this article.

Palma's et al. (2009) it is, in fact, useful to not only include cases in the analysis where the agent (the private contractor) is better informed than the principal (the public sponsor) as is usually done in standard theory. In fact, there may be rather cases where the principal may have more information on the technology installed and the expected abatement costs than the agent. He will, hence, bear the risks associated with the selection of the type of infrastructure, the location of infrastructure and the choice of material etc.

Also, the public sector is generally called in the event of non-insurable acts of nature.

Those risks that sponsor and operator have the same (so-called symmetric) information about, such as risks related to the fluctuations of CER price, to the continuity of CDM, to delays in project registration etc., have to be shared between public and private sector and no general rule can be formulated. In case the public sector does have some political power and is in close contact with the CDM authorities, it can make sense to make the public sector bear the risks related to the continuity of the CDM etc.

The following table sums up the propositions in the literature on how to share project risks between private and public partners and provides concrete examples of risks associated with the provision of CER.

Table 4: CDM project risk sharing in PPP

Public sector	Risks associated with CER generation	Private sector (PPP operator or external insurance)	Risks associated with CER generation
Project specification	<ul style="list-style-type: none"> • Methodology development and approval • DOE validation • Links with foreign partner 		
		Concept, construction	<ul style="list-style-type: none"> • Contract performance renegotiation risk
		Operation, maintenance	<ul style="list-style-type: none"> • Crediting risk: quantity of issued credits, timing of credit issuance • Sales of carbon credits and carbon price volatility
“Act of nature” non-insurable	“Act of nature” that are not yet covered in insurance contracts	“Act of nature” insurable	<ul style="list-style-type: none"> • Extension of already existing insurance contracts (ex. breakdown of electricity production of project)
Regulatory risks	<ul style="list-style-type: none"> • Post- Kyoto CDM continuation • Quality/Quantity control on offset credits 		
Political risks	<ul style="list-style-type: none"> • Changes in priorities at the city or other important level • Government budget and carbon positions • Departure of one key participant 		
Residual risk			

Source: based on de Palma et al. (2009), OECD (2008), Clapp et al. (2010, forthcoming), Jansen (2000)

3.2.2 Risk transfer to external financial institutions

External financial institutions are typically integrated into the project structure when a private or public development banks provide debt or equity financing to the project.

The carbon credit buyers can equally act as debt or equity providers to the project.

As a general rule, insurable risks should always be transferred to private insurances. Jansen (2000) analyses as to which types of risk can be transferred to the private insurance companies. In a first step, he checks for insurability of risks related to the Kyoto Mechanisms, which are generally regarded to be the following in literature:

- there is a low possibility of moral hazard

- losses occur with a high degree of randomness
- the maximum possible loss is very limited
- the average loss amount upon loss occurrence is small
- the average time interval between loss occurrence is short, losses occur frequently
- the insurance premium willing to be paid for the coverage is high enough
- coverage of the risk is consistent with public policy
- the law permits the coverage

Janssen (2000) gives the following example to explain in what case CDM specific risks could be insured by an extension of already existing insurance contracts. In the case of a breakdown of the electricity production of a company due to an accident, production will reduce, which will lead not only to fewer sales, but also to fewer emission reductions¹⁴. The first kind of loss is most likely already covered and the risks related to the reduced generation of carbon credits could be included in the insurance.

Multilateral development banks, such as the World Bank, can act as risk bearer and hence facilitate the project negotiations between the project partners of a CDM project.

Traditional risk mitigation instruments, such as guarantees to mitigate performance and repayment risk, linked for instance to currency, interest- rate or commodity- price risk, technology risk or non-commercial risk are generally used and adapted for CDM (Huhtala & Ambrosi, 2009). The table in annexe 2 summarises possible risk coverage measures for mitigation/CDM projects.

For the particular case of risks related to the delivery of CER, the following are examples for risk mitigation measures that have been used by the World Bank for CDM projects.

In a first instance, the emission reduction purchase agreements (ERPA) can be structured in a way that the most stable and longest revenue stream is provided for by the project. This is meant to render the project financially stable and attract private investors (Bishop, 2004). For example, the carbon delivery and currency risk has been mitigated by the World Bank Prototype Carbon Fund through offering emission reduction purchase agreements for 10 or more years, denominated in US\$, with the World Bank as trustee of the PCF.

Another risk sharing measure is the use of an escrow account for CER revenues, which enables the project promoter to borrow against these revenue streams and to use the carbon revenues to service debt. Moreover, placing the escrow account outside the host country

¹⁴ This is because the quantity of emission credits generated by the project is usually calculated as the difference between the baseline emissions and the actual emission rate multiplied by the actual output of electricity.

mitigates currency convertibility and transfer risk (Bishop, 2004). Furthermore, this can overcome barriers due to information asymmetries between bank and sponsor as the carbon revenues are paid directly to the bank. The default risk is, hence, minimised for the borrowing bank. This method was used for the Brazil Plantar project that sold its carbon credits to the Prototype Carbon Fund and received private financing from Rabobank (Bishop, 2004 and CD4CDM, 2007).

What has been demonstrated by the World Bank is slowly getting practice for private banks as well. As Clapp et al. (2010, forthcoming) remind the private sector can also become an early CER purchaser and thereby provide upfront financing to the project by taking on the risks related to the generation of carbon credits.

3.3 Sharing of the carbon revenues between the project partners to compensate for project risks

The carbon rent can compensate project sponsor or operator as well as external financial institutions for the assumption of general project risks and those risks specifically related to the generation of CER.

Mollen et al. (2005) examine the alternative use of the carbon rent by using a case study from the electricity sector. They show that the carbon rent in a CDM project can be used to lower prices, which makes the local state and the users benefit from lower prices. The alternative is to recycle the carbon rent as an additional income every year in order to attain sufficient remuneration for a classical financial structure. The non profit making financing is replaced by a classical capital contribution by private investors to be remunerated at an attractive level. A choice will have to be made between maximising the direct carbon income by retaining a high share of the carbon rent and maximising the capacity to attract additional foreign investment by leaving the rent to private project developers.

Figure 5 on shows in a stylised way the most common ways of distributing the carbon revenues between the project partners.

On the supply side, carbon revenues can provide the project sponsor/operator (depending on which contractual structure is chosen¹⁵) with additional revenues and, hence, decrease his commercial risks associated with the new technology used as well as the operation process. This is especially important as CDM projects can face significant market risks that are due to

¹⁵ Under a management contract the risks of the private partner may be limited, whereas a private actor investing in the project will assume higher risks.

the new technology used. Especially in developing countries, users tend to be reluctant to pay for the additional costs of infrastructure services that use more expensive low-emitting technology. The willingness-to-pay for an improved environment is typically low in these countries given that economic problems seem more pressing in poor countries (WDR, 2010). It can therefore make sense for the project developers and the municipality to share the carbon revenues with the customers and to decrease tariffs as this decreases the market risks.

If the decision is taken to integrate external private commercial lenders into the project financing, the carbon rent can be used to increase the commercial revenues and hence the risk-return profile of the project. The following table (table 5) presents the increases in projects' rates of return as a result of additional revenues from sales of emission reductions compared to the baseline scenario. To calculate these increases in the financial rate of return, the authors used a price of 4 USD, which is the risk-free price paid by the World Bank for early CDM projects¹⁶.

Table 5: Increase in financial rate of return due to carbon finance (in % points)

Technology	Increase in financial rate of return (IRR)
Hydro, Wind, Geothermal	0.5 – 3.5 %
Crop/Forest residues	3 - 7%
Municipal solid waste	5-60%

Source: CD4CDM (2007)

The reason why the IRR increases significantly due to carbon finance in the case of municipal waste projects is that waste projects generally generate little commercial revenues and the overall revenues in the baseline scenario are therefore small compared to the overall revenues of a project that receives carbon finance. Furthermore, these projects reduce the emission of a gas (methane) that has a high global warming potential (21 in the case of municipal waste, compared to CO₂ whose GWP is by convention equal to 1) (CD4CDM, 2007). Even though a high global warming potential is not a necessary condition for strong increases in IRR, it can be observed that a high global warming potential is often correlated with a high increase in IRR due to carbon finance (CD4CDM, 2007).

¹⁶ A risk free price is a price paid in advance. This means that the price is paid at contract conclusion and before the CERs are actually generated. The risk free rate amounts currently to 10 USD. It can hence be assumed that for more recent projects the increase in the financial rate of return due to carbon finance is higher than what is presented here. The CER spot price can vary significantly. In 2009 the price varied from 11 to 22 USD (based on Kossoy & Ambrosi, 2010, by assuming an exchange rate of 1Euro=1.4USD).

Box 3: Rent sharing in the Rio Frio Wastewater Project- a case study

The Rio Frio wastewater treatment project's objective is to reduce greenhouse gas emissions from the wastewater treatment sector in the metropolitan area of Bucaramanga, Colombia, through its modernization. The project will be developed, managed and operated by Cooperacion Autonoma Regional para la Defensa de la Meseta de Bucaramanga (CDMB), which is a regional public sector entity. This modernization of the waste water treatment will result in abatements of methane (CH₄) and nitrous oxide (N₂O) emissions of about 39 kilo tons of carbon dioxide equivalents per year (kton CO₂eq/year) and in an improved effluent quality from the plant. The project costs stand at US\$ 10.7 million in the first stage of the project, excluding the transaction cost associated with the emission reductions as well as the social program. The project will expand its capacity in 2012 implying an additional investment of US\$5.3 million. The carbon revenues represent roughly 10% of total project costs.

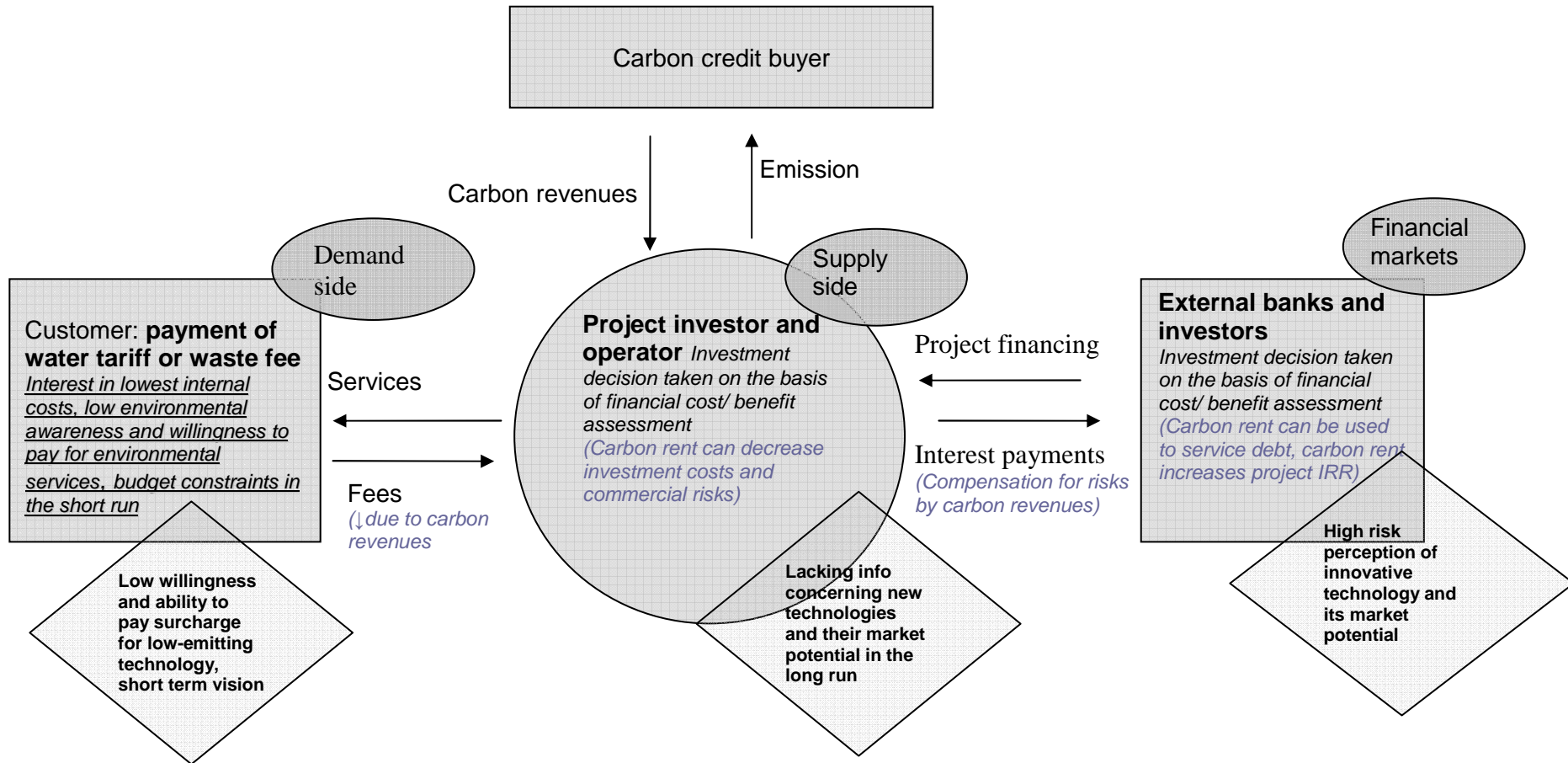
The certified emissions reductions are estimated to amount to US\$ 2.6 million up to 2020; and to US\$1.6 million up to 2016 by using a carbon price of US\$ 4.75 per ton of CO₂e. The sharing of the carbon rent between the sponsors and the costumers helped to overcome asymmetries related to the low willingness and ability to pay of the final costumers. In Colombia where the national income is rather low (in 2008 the gross national income/capita stood at 4660 \$ according to the World Development Indicators, 2008) and little environmental regulation is in place concerning CO₂ emissions, there is little willingness to pay for the low-emission waste water services.

It is shown in the financial analysis that the user charges that cover investment and operating costs for the expansion and improvements of the wastewater treatment plant, are reduced by 30% thanks to the income offered by CERs.

Furthermore, a social (community benefits) program is supported with 15% of the net revenues from carbon emission reductions.

Source: World Bank appraisal report (2005), available publicly on the World Bank project website. Note that the project has not yet been registered under the CDM mechanism.

Figure 5: Sharing of the carbon rent between the different project partners



4 Management of risks associated with the new partnership structures

4.1 Partnership risks associated with the distribution of carbon revenues

It has been shown in the previous chapter that the integration of private operators or concessionaire and external financial institutions into the project structure allows transferring the risks to those partners that are best capable of dealing with the risks and hence reduce overall project risks for all partners. However, new partnership risks emerge that have to be cautiously taken into account in the contract structures as well. The concept of “partnership” or “contract” risks presented here is based on Palma, de et al. (2009). These risks arise in infrastructure projects, where the ownership is shared between private and public actors and are associated with the specific PPP contract arrangements, in particular with the “vertical” nature of the partnership between the principal (in most cases the public sector) and the agent (in most cases the private company). As far as CDM projects are concerned, these risks are particularly associated with the distribution of the carbon revenues between the project partners and are due to information asymmetries (moral hazard) and unaligned incentives between the partners (other than moral hazard). When integrating additional partners, such as private operators or concessionaires and external financial institutions into a project structure there is a risk that the incentives created by the carbon revenues in terms of CO₂ emission reductions are diluted.

In this chapter the following partnership risks are analysed.

Table 6: Different types of partnership risk

Risks in PPP	Literature
Moral hazard on operator’s side: poor mitigation effort, reduced operation (chapter 4.2)	Laffont & Tirole (1993)
Moral hazard on municipality’s side: poor building efforts (chapter 4.2)	
Risks due to unaligned incentives between builder and operator of the infrastructure in terms of CO ₂ emission reductions (chapter 4.3)	Hart (2003), Bennet & Jossa (2004), Dewatripont & Legros (2005)
Risks between PPP and external banks/equity provider	Literature
Risk for the PPP: less incentives to exert effort as revenues have to be shared (chapter 4.4)	Jensen & Meckling (1976), Innes (1990), Dewatripont & Legros (2005)

4.2 Dealing with information asymmetries between the partners

Partnership risks in CDM projects are due to the distribution of CER between different project partners. As is the case for project risks, an important dimension of these partnership risks has its roots in the asymmetry of information between the partners (Palma, de et al., 2009). This concept is based on the theory of incentives and principal- agent (Laffont & Tirole, 1993) that has already been used to explain the sharing of endogenous risks (chapter 3)¹⁷. The assumptions used for the following analysis as applied from principal- agent theory are listed in annex 3.

The key assumptions are that the agent pursues its own interest and has more information on the state of nature and its own action (moral hazard) than the principal. For example, the private contractor of a waste project is the agent that reports to a principal, the municipality. The private contractor may have private information on the operating process and may try to enlarge his rent by exercising less effort and lowering operational costs. The municipality will not be able to measure the contractor's efforts and the real operational costs.

The same can also be true for the principal (Palma, de et al., 2009). The principal can also use his private information to increase his rent. The risks arise from the attempt of one of the partners to "exploit" the other one and are called moral hazard risks. They arise on the principal's and on the agent's side.

Moral hazard risks on the principal's (municipality's) side

In a simple case where the operation of the infrastructure is contracted out to a private operator and contractual arrangements stipulate that the operator is remunerated according to the CER generated and sold on the international carbon markets. There is a moral hazard risks at the building stage because the municipality may install a cheaper technology that allows generating less CER than expected by the operator. A way to deal with these risks is to share the CER between municipality and operator, so that the municipality does not have any incentive to deviate.

¹⁷ The concepts used in chapter 3 and 4 are closely related. However, the emphasis in this chapter 4 is not on the risk allocation but on the question as to which contract structures are the most efficient in terms of CER generation.

Moral hazard risks on the agent's (operator's) side

Moral hazard risks also exist on the operator's side. Here a situation is assumed where the operator is remunerated by fixed service fees by the municipality. He has an incentive to exert less effort as the remuneration is fixed in advance. Even if the remuneration of the operator is indexed on CER actually generated, an operator can be incentivised not to make any effort to provide the services of the landfill. If no waste is put on the landfill, no methane will be generated and emissions can be reduced compared to the baseline. A solution would be not to fix the operator's income in terms of the CER revenues but also in terms of the operational revenues.

The table 7 on page 27 juxtaposes project and partnership risks, which are associated with information asymmetries between the different partners.

It sums up the endogenous risks that arise when one partner has private information on the risks and can hence control them. Typically, the private operator has private information regarding business interruptions and the quantities of CER produced during operation. The public sponsor is better informed about the risks related to the selection of the type of infrastructure financed and the choice of material etc. As developed in chapter 3 of this article, the endogenous risks should be dealt with by exactly that partners that has an informational advantage. Symmetric risks are what we called "exogenous project risks" in chapter 3. All partners have the same information on them and the risks cannot be controlled by any of the partners. Examples are risks related to the continuity of CDM, the behaviour of external partners etc. In the column "partnership risks", partnership risks are presented that arise due to moral hazard risks that have been characterised above in this chapter 4.

In the next section, it will be described how contractual arrangements can align divergent incentives at the building and operating stage in a situation where both the municipality and the operator of the infrastructure have the best intention to reduce CO₂ emission reductions as far as possible.

Table 7: Project and partnership risks in CDM projects between private operator and public sponsor

	Project risks	Risk bearer	Partnership risks	Risk bearer
Private information by the operator	Risks associated with business interruption (other than <i>force majeure</i>)	Private	Performance risks related to poor quality of mitigation efforts	Private
	Risks related to the quantities of CER produced during operation phase	Private	Moral hazard risks associated with the true value of operating costs for CO ₂ emission reduction	Private
	Risks associated with unforeseen costs (abatement costs, transaction costs)	Private	Risks of higher costs due to unaligned incentives between builder and operator	Private
Symmetric information	Risks related to fluctuations of CER price	Public & private & multilateral banks		
	Risk related to continuity of CDM	Public		
	Risks related to delays etc.	Public (regulatory authorities, if weak enforcement also international organisations) ¹⁸		
	Risks associated with renewal of crediting period	Public & Private		
	Behaviour of external partners, such as CER buyers	Public and Private (carbon rent sharing)		
Private information by public sponsor	Risks associated with the selection of the type of infrastructure financed, of the location of infrastructure	Public	Risks of poor effort of the municipal sponsor at the building stage.	Public
	Risks associated with the choice of materials and equipment used during construction and renovation	Public		

Source: based on risk typology by de Palma et al. (2009), applied to CDM projects by author.

¹⁸ Here the assumption is made that the government as an investor can partly influence these delays by speeding up certain administrative procedures.

4.3 Bundling of infrastructure to minimise partnership risks

What does bundling of infrastructure mean?

Integrating private partners in the project implies that parts of the infrastructure services are contracted out to private partners. These different contractual arrangements imply a varying degree of unbundling of the provision of infrastructure services and the way the CERs are distributed between the project partners. Unbundling refers to the contracting out of the design, building, finance, and operation of the project to private firms. The more responsibility is contracted out the more often the private sector is directly responsible for selling the generated CER, which is contracted in a separate document, the emission reduction purchase agreement (ERPA) (see box 4 on page 29 for examples). The unbundling of the provision of infrastructure services implies different degrees of private risk assumption, whereby the risk assumption by the private sector can be anywhere on a scale between no private risk assumption (public service provision), low private risk assumption (complete unbundling) and full private risk assumption (complete bundling). Complete unbundling usually results in management contracts, whereas bundling implies that the infrastructure services are contracted out to a private concessionaire or to a private joint venture.

The literature dealing with risks and benefits related to the “bundling and unbundling” of operation and construction of infrastructure in public- private partnerships (Hart, 2003, Bennet & Jossa, 2004) analyses principal- agent structures of traditional public private partnerships (i.e. not financed by the CDM)¹⁹. The different authors try to determine the additional costs and benefits that can arise if only the operation of the infrastructure is delegated to a private operator compared to a situation where the private sector is contracted to build and operate the infrastructure. The general conclusions by these authors are used to describe and solve the particular problems arising in CDM projects and related to the distribution of CER between the different partners. The objective is to define the conditions under which the private sector assumes investment risks as regards the future CER generation.

¹⁹ The authors have developed their models against the background of the PPI in the UK that involves the contracting out of the design, building, finance, and operation of the project to a consortium of private firms for a long period of time (usually 25-30 years, Bennet & Jossa, 2004).

Box 4: Contract modalities and distribution of CER in landfill gas recovery and flaring projects

The following table provides examples of different contract modalities of landfill gas recovery and flaring projects financed under the CDM. The private risk assumption in general and with regards to the generation of CER varies significantly between the projects. In the Durban Landfill-gas- to- electricity project no private actor is involved. The Djebel Chekir project is financed by the National Waste Management Agency that receives the carbon revenues generated by the project. The operation of this project is delegated to a private operator that is remunerated by the municipality. The Salta Landfill gas capture project is similarly structured, but the private sector assumes more risks by being in charge of building, maintenance and operation of the CDM project. The contracts of the Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project, stipulate that the concessionaire assumes risks as regards the generation of CER as he is the one who will directly receive the carbon revenues. Similar arrangements were made in the Aguascalientes, Mexico, where the private joint venture receives the carbon revenues and pays a royalty fee from the sale of carbon credits to the municipality.

CDM project	Contract modalities	Private risk assumption
Durban Landfill-gas-to-electricity project – Mariannhill and La Mercy Landfills- South Africa	A municipal company is responsible for management and operation of the project. Both the municipal company and the municipality decide on the distribution of the carbon revenues as project participants.	
Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia	National Waste Management Agency finances the project; operation is delegated to a private contractor . The national agency decides on project distribution as project participant.	
Salta Landfill Gas Capture Project- Argentina	Private concessionaire in charge of building, maintenance and operation; carbon revenues administered by the municipality.	
Kunming Dongjiao Baishuitang LFG Treatment and Power Generation Project - China	Private concessionaire in charge of building, maintenance and operation; concessionaire receives directly the carbon revenues.	
Aguascalientes – EcoMethane Landfill Gas to Energy Project- Mexico	Private joint venture of investors, technology providers, engineers, and consultants in charge of financing, constructing and operating the project; the local authority is paid a royalty fee from the sale of the carbon credits.	

Source: CDM pipeline, project design documents

To bundle or not to bundle? – CO₂ emission reduction incentives in management and concession contracts

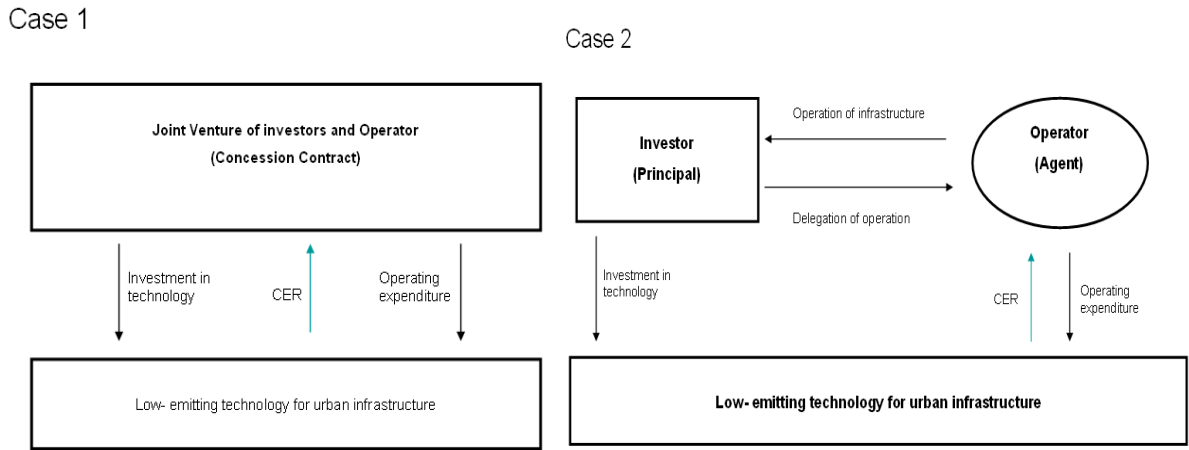
In order to analyse from a theoretical point of view the incentives as regards CO₂ emission reductions in different contract structures, two extreme examples are analysed: a management and a concession contract.

In the first case, it is assumed that the design, building, financing, operation of infrastructure are bundled and are carried out by a private concessionaire. The ERPA stipulates that the CER are sold by the concessionaire. The concessionaire is, hence, remunerated by the financial return of the project (based on carbon revenues and operational revenues).

In the second case, building and operation of a methane capture system are contracted out separately. The operation is contracted out under a management contract. The ERPA stipulates that the CER are sold by municipality and that the operator is remunerated by a fee that depends on the actual emission reductions of the project.

These contractual arrangements are pictured in figure 6.

Figure 6: Contractual arrangements in concession and management contracts



Source: author

What incentives are created in case of a concession and in case of a management contract?

It is assumed for the case of the management contract that the operator is remunerated by the municipality, but the revenues depend on carbon revenues to incentivise the operator to generate CER. The contract with the builder does not include carbon revenues, which can create risks. In fact, Dewatripont & Legros (2005) point out that the costs and the quality of the service produced (here the delivery of infrastructure services with a weak carbon footprint) depend on the financing, building and the operation of the infrastructure used for delivering the services. According to the authors there are clear links between financing, building and operating the infrastructure as building determines the quality of the infrastructure, which- in turn- influences positively or negatively the cost of operating and maintaining.

In our particular case, the municipality will contract with the most cost-efficient builder of a given technology option in order to pay the lowest price for the same possible CO₂ reduction. To be more precise, the municipality will finance the least cost intensive infrastructure for a given output in emission reductions and does not take into account the operating costs in its cost-benefit calculations²⁰. The operator therefore faces internal contract risks when entering into an operating agreement as he cannot always observe whether the best possible building option (from his point of view the one that minimises the operating costs of CO₂ reduction) in terms of material etc. is chosen by the contracted builder. The builder will not take into account the positive externalities created by the CO₂ reduction as he is not remunerated (the same way the operator is by the carbon revenue) for the creation of these externalities. Dewatripont & Legros (2005) find that if the builder is not incentivised to internalise possible externalities on the operating phase inefficiencies may arise. The builder has an incentive to internalise externalities if he also has the right to operate and maintain infrastructure. The same is true here for the CER generation and CO₂ emission reductions.

Consequently, the builder and the operator have conflicting preferences for these investments and do not choose an overall investment (with the operating costs depending on the technology chosen) that maximises the efficiency in terms of CO₂ reduction (expressed by the coefficient: tons of CO₂ reduced/ overall investment costs). There is a risk of inefficiency and unexpected costs for the public sponsor and the private operator.

In case of the concession contract, the construction and operation of the infrastructure are bundled and the externalities related to the operation and the gaining of CO₂ emission reduction credits are internalised. The positive externalities created during operation are considered during building stage, which can lead to lower overall costs. No principal-agent problem exists.

²⁰ To simplify it is assumed that the more sophisticated a technology, the lower the operational costs/ unit of reduced CO₂.

Box 5: The theoretical model by Hart (2003)

Hart (2003) develops an interesting model to show this phenomenon from a theoretical point of view. His model deals with the choice between investment that not only lowers operating costs but also leads to an increase in the social quality of the services and another one that cuts operating costs at the expense of service quality. A situation where the right to build and operate the assets is given to one party dominates here a situation where builder and operator are two separate partners, because the builder has better incentives to carry out the quality-improving investment. These results hold only true as long as private and social interests are aligned, which means cost reductions and social benefits can be achieved simultaneously. This the case for this CDM projects, where the social benefits are internalised by the carbon revenues.

Another possible solution to align incentives between operator and builder is the rent sharing or carbon revenue sharing between builder and operator or between municipality (that delegates the construction to a builder) and operator. As far as the rent sharing between the municipality and the operator is concerned, an ERPA should be put in place, where both partners benefit from the fact that the maximum of emission reductions are generated, which means that both benefit from the carbon rent. In that way both partners have an incentive to do their best in terms of investment and operation to generate carbon revenues.

However, the situation is not as stable as in a concession contract as other relationship risks (moral hazard, hold up) can also arise as soon as additional partners are accepted.

In concrete terms to increase environmental efficiency, a concession contract (which also allocates the carbon revenues directly to the contracted private operator) can be preferred against a management contract as this aligns the incentives between builder and operator of the infrastructure and, hence, mitigates certain partnership risks.

4.4 Risks management by contractual arrangements with external lenders

As it was shown above external financial institutions, such as banks or insurance companies, can play an important role in insuring exogenous risks, because they can diversify exogenous project risks over a large portfolio they finance.

However, there are also risks related to the integration of debt and equity providers in the contractual arrangements of the project. The incentive structures may change if external financiers are included in a project structure.

The general lesson of the corporate finance literature (notably Jensen & Meckling, 1976) is that insisting on external finance (especially external equity financing) can undo the desirable incentive effect that bundling the construction and operation phase (in order to align the incentives for operator and builder) may achieve.

Dewatripont & Legros (2005) point out that if equity is provided by external partners, the project partners offer these external shareholders a constant share of the operating revenues (revenues related to the extraction of the consumers' willingness-to-pay). In the case of non-revenue generating projects (like some waste projects) their model can be used after having simply replaced operating revenues related to the willingness- to- pay by carbon revenues. The authors show that having to share the return on its efforts to produce services (in our case: reduce emissions), the project partners have less incentive to exert effort. This is why the share of outside shareholders should not be too high. However, it should not be too low either, because if it is too low, outside shareholders would not find it worthwhile to supply the initial financing²¹. Financial contracting has to take into account this trade- off.

For external bank debt, the case is slightly different. Dewatripont & Legros (2005) explain that the reward for exerting effort is maximised under debt finance. In case of good performance the builder, operator of the infrastructure receives a relatively high fraction of the return, whereas in case of equity financing the return has to be always shared with the equity provider.

The positive aspects of including external financiers in the project is that they may be expert in the field of CDM projects and can monitor the project sponsor and hence contribute to an improvement in the emission reduction efforts. External bank debt is to be preferred against bonds in this context. According to the theory of Diamond (1984) delegating the monitoring responsibilities to one financial intermediary is more efficient than having every single capital provider do monitoring.

²¹ This effect is much stronger in the case of external equity providers. Bank loans with fixed loan repayment and interest rates can be regarded as an effort- maximising financial mechanism in principal- agent relationship if agents are risk neutral (Innes, 1990). However, it is worth noting that in that case few risks are borne by the bank. Still, it can be worthwhile to integrate external banks or equity providers to integrate them in the risk sharing and maybe use their monitoring capacity.

There is generally a consensus in the literature that the number of external financiers should therefore be kept small, with the drawback being that project risk will not be diversified over a large number of capital providers.

5 Conclusion

It can be concluded that there is a trade-off between the necessity to integrate additional partners (private sponsors and operators and external lenders and equity providers) in CDM projects in the waste sector and the partnership risks that the integration of these new partners imply. Risk sharing opportunities implied by Public-Private-Partnership and by integrating external lenders and equity providers have to be outweighed against new moral hazard risks and unaligned incentives in complex partnership structures.

It has been shown that putting a price on carbon and linking the provision of carbon revenues to the emissions effectively reduced by the overall project still do not provide enough incentives to correctly internalise climate change externalities for every partner involved in the project. The integration of external lenders and equity providers can further dilute the emission reduction incentives. Contractual arrangements are, therefore, needed to align the incentives of the different partners to fully internalise the externalities.

It can therefore be concluded that from a theoretical point of view contractual arrangements matter and can render the CO₂ emission reduction more efficient compared to the overall investment costs and can decrease the risks of low CER generation.

By comparing management contracts with concession contracts in the waste sector, the article shows that concession contract (which allocates the carbon revenues directly to the contracted private operator) can be preferred against a management contract (under which the operator is remunerated by fixed revenues) as this aligns the incentives between builder and operator of the infrastructure and mitigates partnership risks.

Bank debt should be preferred over equity as this maximises the efforts of the operator in terms of CO₂ emission reductions.

The policy implications of the ideas developed in this article could be significant. The presented risk sharing principles are essential to understand how private and public long term investors can be attracted for CDM or climate change mitigation projects in general in the best social interest.

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Official CDM Project Design Documents (PDD) are downloadable at: <http://cdm.unfccc.int/>

Annex

Annex 1: Risks associated with mitigation/CDM project in project finance

Table 4

Risks associated with mitigation/CDM projects in project finance^a

Conventional projects	Mitigation projects	CDM projects
<i>Project performance</i> (completion, operational)	Increased risks due to	<i>Ratification of the Kyoto Protocol</i>
<i>Technology</i>	Non-conventional project	<i>Rules and design of the CDM design</i>
<i>Sponsor</i>	Non-conventional technology	Amount of CERs (baseline, leakage, eligibility)
<i>Management</i>	Insecurity of energy source	Cost-effectiveness (high transaction cost, adaptation fee)
<i>Force majeure</i> (natural disasters, etc.)		<i>Uncertainties associated with the market</i> (price, behaviour)
<i>Market</i> (quantity, price)		<i>Delivery of CERs</i>
<i>Country</i>		<i>Institutional arrangement for CDM</i>
Regulatory (underdeveloped regulatory system in assets and finance)	Unfavourable regulation on investment and import of climate friendly technologies	
Political (war, nationalisation)	Energy pricing/low conventional energy price	
Economic (foreign exchange, currency transfer, local financing, creditworthiness of local partner and clients)		
Social and institutional	<i>High initial costs</i> <i>Uncertain (usually low) rate of return</i> <i>Small project size and implicit transaction costs</i>	

^a Sources: adapted from Ohara (1996); APEC (1998); GEF (1996); Mundy (1999); Maruyama (1999).

Source: Zhang & Maruyama (2001)

Annex 2: Risks mitigation measures for mitigation/CDM projects

Table 7

Risk mitigation measures for mitigation/CDM projects

Conventional projects	Mitigation projects	CDM projects
<i>Contract</i>	GEF grant	Cost recovery through CER
Completion	ODA	Reduction of transaction costs through CDM design
Turnkey rump-sum EPC	Other bilateral/multilateral programmes	Withholding offsets as buffer and insurance to address CERs delivery risk
<i>Price</i>	CDM	
Capacity payment and energy payment	GEF non-grant financing ^a	Price hedge (forward sale, portfolio)
Long-term purchase	Contingent grants/performance grants	Reinforcement of risk coverage measures by MDBs
Take or pay/take and pay contract	Contingent or concessional loan	Mutual Fund
Performance and operational	Partial risk or credit guarantees	Reinsurance
Warranties, etc.	Reserve fund, etc.	
<i>Financial design</i>		
Cash flow control, reserve fund, deferred payment, offshore escrow account, cash deficiency support, floor price escalation, etc.		
<i>Insurance</i>		
Property, business Interruption, liability, etc.		
<i>Country risk mitigation</i>		
Co-financing, guarantees, insurance by export credit agencies, governmental institutions, MDBs(e.g., WB, MIGA, IFC, ADB)		
<i>Host government guarantees</i>	Domestic policy and measures to reduce barriers/risks in developing countries	

^a GEF non-grant financing is a new scheme currently being examined at GEF (EIC, 1999).

Sources: adapted from Ohara (1996); APEC (1998); GEF (1996); Mundy (1999); Maruyama (1999).

Source: Zhang & Maruyama (2001)

Annex 3: Assumptions of Principal- Agent- Model

The following table provides a summary of the aspects of the agency theory as applied to CDM projects. This is done for the example of a management contract that stipulates the delegation of the operation of the infrastructure to a private operator.

Dimension	Standard application of Agency Theory (Owner- manager)	Low- carbon infrastructure context (case of management contract)
<u>Unit of analysis</u>	Relationship (and contract) between owner (principal) and manager (agent)	Relationship between the operator (agent) and the sponsor/investor (principal)
<u>Problem Domain</u>	Relationship in which the principal and agent have different levels of information and partly differing goals	Relationship in which the principal and agent have different levels of information and partly differing goals
<u>Goal orientation of the actors</u>	Goal conflict between principal and agent. Owner's goal is to maximize returns. Manager's goal may be to limit work levels required.	Goal conflict: the investor's goal is to minimize capital costs of low-emitting technology and to maximize his carbon rent. The operator's goal is to minimize the operating costs and to maximize its operating rent and carbon rent.
<u>Key objective</u>	Principal- agent relationships should reflect efficient organization of information to maximize economic efficiency.	Principal- agent relationship should maximize both economic and environmental efficiency of the project.
<u>Human assumptions</u>	Self- interest Bounded rationality Individual autonomy	Self- interest Bounded rationality Individual autonomy
<u>Organizational assumptions</u>	Partial goal conflict Economic efficiency as the criterion Information asymmetry Agent is delegated tasks by owner (principal)	Partial goal conflict Economic and environmental efficiency as the criterion Information asymmetry Agent is delegated tasks by infrastructure owner (principal)
<u>Assumption about the source of problem</u>	Contract inadequate	Contract inadequate, goal difference, imperfect and asymmetric information (about technology and operating costs and the efforts to produce CER).
<u>Implications of inefficient relationship/contract</u>	Adverse selection Moral hazard	Adverse selection Moral hazard

Source: adapted from International Energy Agency (2007) and applied to low- emitting infrastructure

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Contact us :

Chaire Economie du Climat - Palais Brongniart (4^e étage)
28 Place de la Bourse, 75 002 Paris
Tel : +33 (0)1 49 27 56 34
Fax : +33 (0)1 49 27 56 28
Email : contact@prec-climat.org

Directeur de la publication : Christian de Perthuis
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