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DISCUSSION PAPER

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HWWA DISCUSSION PAPER

175

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
2002
ISSN 1616-4814

The HWWA is a member of:

- Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (WGL)
- Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute (ARGE)
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This paper has been prepared within the Research Programme „International Climate Policy“ of HWWA.

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Abstract

Transaction costs will reduce the attractiveness of the Kyoto Mechanisms compared to domestic abatement options. Especially the project-based mechanisms CDM and JI are likely to entail considerable costs of baseline development, verification and certification. The AIJ pilot phase and the PCF programme give indications about the level of these costs. Under current estimates of world market prices for greenhouse gas emission permits, projects with annual emission reductions of less than 50,000 t CO_2 equivalent are unlikely to be viable; for micro projects transaction costs can reach several hundred € per t CO_2 equivalent. Thus the Marrakesh Accord rule to have special rules for small scale CDM projects makes sense, even if the thresholds chosen advantage certain project types; projects below 1000 t CO_2 equivalent per year should get further exemptions. An alternative solution with no risk for the environmental credibility of the projects would be to subsidise baseline setting and charge lower, subsidised fees for small projects for the different steps of the CDM/second track JI project cycle.

Zusammenfassung

Transaktionskosten verringern die Attraktivität der Kyoto-Mechanismen im Vergleich zu heimischen Verringerungsmaßnahmen. Besonders die projektbasierten Mechanismen CDM und JI bringen voraussichtlich erhebliche Kosten für Referenzfallentwicklung, Verifizierung und Zertifizierung mit sich. Die AIJ-Erprobungsphase und das Programm des PCF geben Anhaltspunkte für die Höhe dieser Kosten. Bei den derzeitigen Schätzungen der Weltmarktpreise für Treibhausgasemissionsrechte sind Projekte mit weniger als 50,000 t CO_2-Äquivalent pro Jahr ökonomisch nicht attraktiv; für Kleinstprojekte können die Transaktionskosten mehrere Hundert € pro t CO_2-Äquivalent betragen. Daher sind die Marrakesch-Beschlüsse, Sonderregeln für CDM-Kleinprojekte auszuarbeiten, sinnvoll, wenn auch die dort gewählten Schwellenwerte bestimmte Projekttypen begünstigen. Projekte unter 1000 t CO_2-Äquivalent pro Jahr sollten weitere Vergünstigungen erhalten. Eine Alternative ohne Gefährdung der umweltpolitischen Glaubwürdigkeit der Projekte wäre die Subventionierung der Referenzfallerstellung und die Erhebung geringerer, subventionierter Gebühren für die verschiedenen Schritte des CDM/2.-Weg-JI-Projektzyklus.

1 Introduction

The Kyoto Protocol allows industrialised countries and countries in transition (Annex B countries) to reach part of their greenhouse gas emission targets abroad through the so-called Kyoto Mechanisms. There are four mechanisms:

- Bubbles where a group of countries sums up their targets and redistributes them internally (Art. 4),
- Joint Implementation (JI) projects in other Annex B countries (Art. 6) that lead to Emission Reduction Units (ERUs),
- Projects in countries without emission targets (Clean Development Mechanism, Art. 12) that lead to Certified Emission reductions (CERs), and
- International emissions trading (IET) of Assigned Amount Units (AAUs) among Annex B countries (Art. 17).

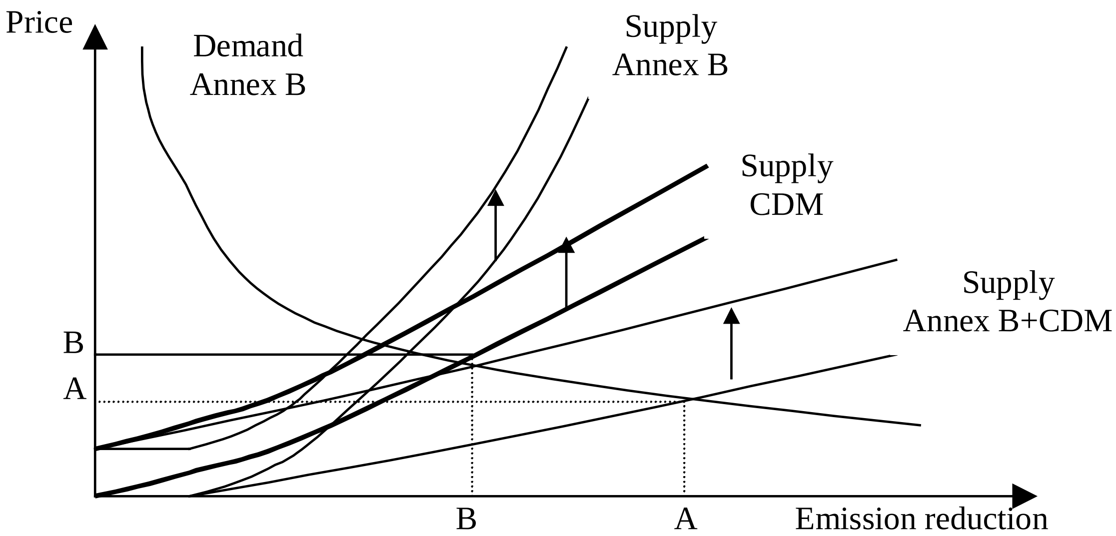
In the last years, there have been intense negotiations on the detailed rules for the mechanisms that were finalised by the Marrakesh Accords in November 2001. The different units are freely interchangeable.

2 Transaction costs

Theoretically, the mechanisms can lead to a minimum cost solution of reaching a quantitative emissions target by eliminating differences in marginal abatement costs. In practice, however, due to transaction costs cost differentials will persist and the degree of utilisation of the mechanisms will be reduced. As early as 1937 Coase defined transaction costs to be the costs that arise from initiating and completing transactions, like finding partners, holding negotiations, consulting with lawyers or other experts, monitoring agreements, etc., or opportunity costs, like lost time or resources. Thus, simply being the costs that arise from the transfer of any property right, they occur to some degree in all market economies. The most obvious impact of transaction costs is that they raise the costs for the participants of the transaction and thereby lower the trading volume or even discourage some transactions from occurring.

In the context of the Kyoto Mechanisms, transaction costs are caused by the administrative process and thus depend on the institutional framework. The differing characteristics of the mechanisms will have different impacts on the components of transaction costs. Taking uncertainty into account might change the optimal choice between domestic and foreign actions. Since reduction measures abroad might bear higher risks this might shift the relative advantage to domestic actions. Figure 1 shows this. Most Annex B countries have a net demand for emission reduction that is aggregated in the demand curve while some Annex B countries have a net supply of AAUs and ERUs. This supply curve does not start at zero quantity due to availability of "hot air". The CER supply curve starts at zero as we assume that additionality tests exclude projects with negative costs. Addition of the curves leads to the world supply curve. Transaction costs now shift the curves upward and lead to a reduction of equilibrium quantity and rise of price from A to B.

Figure 1: How transaction costs influence the equilibrium use of the Kyoto Mechanisms



An important issue now is how transaction costs differ among the mechanisms because this influences their share. If CDM transaction costs are higher than JI transaction costs, the CDM share will fall. We discuss transaction cost components and try to estimate the magnitude of each component using case studies.

2.1 Who bears transaction costs?

Transaction costs can accrue to different participants in the mechanisms: to governments (including international institutions) and private actors. Generally, the private transaction costs of the non-project mechanisms are likely to be low, whereas they will be high in the case of the project-based mechanisms. Bubbles have high ex-ante negotiation costs before countries fix the allocation of targets within the bubble. The same applies to government-to-government trades under IET (Woerdman 2001). Private companies have low costs to lobby ex ante for an advantageous allocation. In the case of IET, governmental transaction costs are quite low as they only have to develop general rules for the functioning of the market and to set up a registry. However, if governments fear that companies could oversell permits and thus jeopardise compliance, they could introduce a cumbersome approval structure for international trades which could increase transaction costs of both governments and private participants. The JI- and CDM-related governmental costs will be higher than for IET due to the repeated process of approval and the need of institutions that define criteria for CDM projects (see Table 1). National registries which are necessary to use any of the mechanisms can be financed either through fees or by the governments.

Table 1: Who bears a higher share of transaction costs?

	Bubbles	**IET**	**JI**	**CDM**
Government	✔	✔		
Private			✔	✔

Of course, governments can shoulder private transaction costs of CDM and JI if they pay for search costs and development of baselines, verification and certification. We already see this phenomenon in the Dutch tender programmes where project proponents who are invited to elaborate a full proposal after an initial screening of the idea receive a reimbursement for baseline development (SENTER 2002). Several Annex B countries have opened CDM/JI offices that help companies to find suitable partners; the Canadian office has recently been allocated 17 million € and its staff travels to potential host countries to screen project proposals.

The costs of the operation of the CDM Executive Board (EB) are to be borne by project proponents in form of a fee. It is still unclear on which base this fee will be levied (for each registration or issuance of CERs?) and whether it will be proportional or a lump sum. As the first year budget draft (UNFCCC 2002b) of the EB amounts to 6 million € and it estimates that 200 project proposals are to be dealt with, a simple averaging would give a cost of 30,000 € per project. Obviously, a high share of the costs is due to the initial rule-setting, such as the 60% for panel activities. Still, EB meetings and UNFCCC staff cost as well as website administration amount to 2.3 million €, leaving 11,500 € per project.

2.2 When do transaction costs accrue?

Transaction costs accrue at different stages in the process of a transaction or project cycle (see Table 2)

Table 2: Definition of transaction cost components

Transaction Cost Components	Description
Project based (JI,CDM): Pre-implementation	
Search costs	Costs incurred by investors and hosts as they seek out partners for mutually advantageous projects
Negotiation costs	Includes those costs incurred in the preparation of the project design document that also documents assignment and scheduling of benefits over the project time period. It also includes public consultation with key stakeholders
Baseline determination costs	Development of a baseline (consultancy)
Approval costs	Costs of authorisation from host country; and
Validation costs	Review and revision of project design document by operational entity
Review costs	Costs of reviewing a validation document
Registration costs	Registration by UNFCCC Executive Board / JI Supervisory Committee
Project based (JI,CDM): Implementation	
Monitoring costs	Costs to collect data
Verification costs	Cost to hire an operational entity and to report to the UNFCCC Executive Board /Supervisory Committee
Review costs	Costs of reviewing a verification

Certification costs	Issuance of Certified Emission Reductions (CERs for CDM) and Emission Reduction Units (ERUs for JI) by UNFCCC Executive Board /Supervisory Committee
Enforcement costs	Includes costs of administrative and legal measures incurred in the event of departure from the agreed transaction
Trading	
Transfer costs	Brokerage costs
Registration costs	Costs to hold an account in national registry

Sources: PriceWaterhouseCoopers (2000), Dudek et. al. (1996), own additions

2.3 What factors can reduce transaction costs?

Especially in the first stage of the use of the Kyoto Mechanisms transaction costs may be an essential element in determining the degree of use of the mechanisms and their shares. Their level depends on the rules of the mechanism, the degree of utilisation of the respective mechanism and on the degree of standardisation of procedures. The more transactions are being done, the more specialised intermediaries will develop who will compete against each other. Thus, transaction costs decline with the accumulated amount of permit trades. This could raise first mover advantages for those countries that have gained some experience in unilaterally implemented permit trade before an international scheme is introduced.

2.4 Links between risks and transaction costs

Often, transaction costs are closely linked to the degree of risk an emission reduction entails. Risks also occur on different stages of the transaction: political, technical, environmental and economic risks. A part of these risks, but not all can be insured. Portfolio diversification reduces risks, but enhances “ordinary” transaction costs. For a thorough analysis of these issues see Janssen (2001). We will not elaborate them further.

2.5 Sensitivity of transaction costs to institutional settings

Heller (1999) argues that transaction costs strongly depend on the institutional framework. This applies to the situation in host countries which may differ considerably and influences the negotiation of all mechanisms and the approval costs of the project-based ones. It is obvious that transaction costs will be higher in countries with an inefficient regulatory framework and lead to a competitive disadvantage vis-à-vis other countries.

An elaborate project cycle may enhance up-front transaction costs but lower them ex post. Moreover, rules that enhance transparency will be critical to reduce search costs even if they entail ex-ante costs. Dudek and Wiener (1996) argue for a voluntary bulletin board; the UNFCCC CDM Executive Board will develop a website where project ideas can be posted. Funds such as the Prototype Carbon Fund (PCF) can reduce transaction costs by developing generic procedures such as standardised contracts. They can also specialise on specific project types.

3 Level of transaction costs of project-based mechanisms in real-world transactions

There is not much experience with project-based environmental policy mechanisms. Many economists (e.g. Bohm 1999) argue that they will not be attractive due to high transaction costs without quoting empirical evidence. Palmisano (1996) and Woerdman (2001) argue the other way round. Harrison and Schatzki (2000) have looked at transaction costs of different U.S. environment policy mechanisms. For the project-based mechanisms “Offsets” and “Netting” they were 10-15,000 $ per transaction.

3.1 Transaction costs in the AIJ pilot phase

The UNFCCC launched a pilot phase of Activities Implemented Jointly (AIJ) in 1995 – prior to the proposed implementation of the Kyoto Protocol - in order to learn more about the possible operation of JI and CDM projects under the Protocol’s flexibility mechanisms. It was also hoped that this exercise will build confidence in the approach and allow a framework for international implementation of JI and CDM to be developed. Of the AIJ projects started, approximately 70 have reported transaction costs. However, definitions of transaction costs vary considerably so that these numbers have to be used with caution and we thus do not list them here. The Swedish AIJ programme in the Baltic states is the only AIJ programme with a consistent reporting of transaction costs in four categories (technical assistance, follow up, reporting and administration) and over time (see Appendix). It includes 51 projects that have been strongly standardised.

The category of follow-up costs has been allocated to the projects by dividing total follow up cost of the whole programme by the number of projects active in each year. Reporting costs have also been dealt with in this way. This obviously advantages the projects that started early as reporting costs are likely proportional to the duration of the project. In the following analyses, follow-up and reporting costs will not be discussed.

The categories technical assistance and administration have not been averaged. They accrue in one-off sums in the start year of the project. Due to the effect that project costs accrue annually until the end of the loan[1], the share of transaction costs has to be normalised for the full lifetime. The Swedish data can then be analysed for the whole lifetime of the loans concerning

- impacts of project categories. One would expect that transaction costs of renewable energy projects are lower than those of energy efficiency projects due to the more situation-specific need of planning and the higher number of participants in the latter case
- impacts of start date within the same project categories. Learning effects should reduce transaction costs of projects that started later
- economies of scale within the same project categories
- host country specifics within the same project categories

However, one should be cautious about applying these cost estimates to full-scale CDM and JI projects as in the Swedish programme no costs for external validation and certification have accrued.

Concerning project categories[2], we find an average technical assistance and administration cost of 20.5% of total project cost for energy efficiency projects, while it is only 14.4% for renewable energy projects. Concerning the start dates, we get a declining tendency over time, as expected (see Table 3):

1 This is due to the interest subsidy provided by Sweden. Loan duration is 10 years.

2 The mixed projects are excluded in these calculations as well as projects with no entry in one of the two cost categories “technical assistance” and “administration”

Table 3: Start dates and transaction costs (technical assistance and administration only) in % of total costs

Start	Energy efficiency (number of projects)	Renewable energy (number of projects)
1993	-	18.3 (3)
1994	16.8 (1)	12.9 (4)
1995	28.8 (3)	14.7 (6)
1996	20.1 (6)	14.3 (9)
1997	20.0 (9)	12.3 (1)
1998	12.7 (3)	14.0 (2)
Average	**20.5 (20)**	**14.4 (25)**

If we however look at the size of projects, we see that the apparent difference is just due to the higher average size of the renewable energy projects. Economies of scale are very important and the differences between project types of the same size are negligible (Table 4).

Table 4: Project size and transaction costs ($/t CO_2)

Size (t CO_2/year)	Energy efficiency (number of projects)	Renewable energy (number of projects)	Mixed (number of projects)
> 10,000	-	1.3 – 1.8 (5)	1.4 (1)
5000 –10,000	-	1.7 –3.1 (8)	-
2500 - 5000	2.7 (1)	2.7 – 5.6 (5)	4.6 (1)
1000 - 2500	3.0 – 9.7 (6)	5.1 – 11.1 (8)	11.7 (1)
500 -1000	17.8 – 40.4 (3)	-	16.2 (1)
100 - 500	29.1 – 61.2 (9)	-	
<100	80.8 – 123.9 (2)	-	

3.2 Prototype Carbon Fund

The PCF, operated by the World Bank, provides funding to host partners who wish to develop projects consistent with the JI/CDM mechanisms under the Kyoto Protocol. It presently has about 50 projects operating or in development. Some estimates of the transaction costs of these projects have been made and these are presented in Table 5 – Table 7 below. Data has been supplied by staff at the PCF and is not published as yet. Moreover, the data in Table 6 and Table 7 is based on country and project-specific data that is not yet in public circulation. We have been requested to make this data more generic and so have not specified the project host country, but instead specified the world region in which the country is located.

Table 5 presents the ranges, together with a "typical" or average, for the transaction costs associated with the pre-implementation phase of the project cycle for the PCF projects.

Table 5: PCF Range of pre-implementation transaction cost components

Pre-Implementation phase	Typical Cost (1000 €)	Low Cost (1000 €)	High Cost (1000 €)
Negotiation	250	125	366
Approval	40	35	207
Baseline and MVP development	35	30	40
Validation	30	30	35
Sub-total	355	220	648
10% contingency	36	22	65
Total: Pre-Implementation	**391**	**242**	**713**

Source: PCF (2002), personal communication

Table 6 shows, for individual projects hosted by Annex B countries, the transaction costs incurred to date. Table 7 gives the same information for non-Annex B countries where CDM projects would be located. The information on CO_2 reductions resulting from these projects is not currently available in all cases. As a consequence, only five projects have their transaction costs expressed per ton of carbon abated. In these five cases, we have assumed, unless there is evidence otherwise, that annual implementation costs (e.g. monitoring) are 80% of year 1 costs in subsequent years of the project lifetime. This assumption – based on the fact that there is a learning curve that makes the latter years' implementation less resource-intensive – is taken from PriceWaterhouseCoopers (2000). The validity of the assumption is discussed below but we believe that for the purposes of making a first approximation of possible transaction costs this is a reasonable conservative estimate. Furthermore, we assume that certification costs are mainly fixed as reported by certifiers. SGS (2002) clearly states that verification and certification costs are relatively independent of project size; they quote an estimate of 17,000 € for the first verification and 8500 € for each additional round. This is supported by KPMG (2002) who stresses "whereas there will be some correlation between the cost of validation and verification and the size of the project the relationship will not be linear". DNV (2002) stresses that the credibility of certifiers would be jeopardised if their fee is proportional to the amount of emissions rights verified.

For the five projects in which there is complete data, these results show a close, though not perfect, correlation between size of project and transaction cost per ton of CO_2 reduced. Due to the large size of the projects, transaction costs per t are much lower than in the Sedish AIJ cases.

Table 6: JI – country projects under the PCF: transaction costs

World Region	Sector[1]	t CO_2 red.	Project lifetime	Pre-Imple-mentation	Implementation Year 1	Implementation Year 2	Certification[2]	Total Project TACs	TAC/t CO_2
		1000	yrs	€ (1000)		€ (1000)	€ (1000)	€ (1000)	€
CEA				220	110	n/a	n/a		
CEA				220	110	n/a	n/a		
CEA				176	88	n/a	n/a		
CEA	SER	2053	25	287	20	20	119	815	0.40

Table 7: CDM – country projects under the PCF: transaction costs

World Region	Sector[1]	t CO_2 red.	Project lifetime	Pre-Imple-mentation	Implementation Year 1	Implementation Year 2	Certification[2]	Total Project TACs	TAC/t CO_2
		1000	yrs	€ (1000)	€ (1000)	€ (1000)	€ (1000)	€ (000)	€
N.Afr	ELE	5830	20	397	277	120	102	3056	0.52
CAM	AGR	2508	8	482	161	321	51	1788	0.71
S. Asia 1				150	150	n/a			
S. Am 1				150	150	n/a			
S. Am 2				220	110	n/a			
S. Am 3	AGR	11266	21	220	110	n/a	102	2192	0.19
RSM				176	88	n/a			
S. Am 4	ELE	5867	20	176	88	n/a	102	1703	0.29
Asia 1				220	110	n/a			

Note: where possible the GTAP nomenclature of countries/regions is used. For countries where country data is confidential, we classify the country according to the world region. Thus, S.Asia = South Asia; S.America = South America. There are four South American projects, and they are numbered to distinguish them.

[1] AGR: Agriculture, ELE: Electricity, SER: Sink
[2] SGS figures, biannually

3.3 Data from consultants and certifiers

There are several estimates of the different types of transaction costs by consultants and certifiers active in the emerging business of developing the Kyoto Mechanisms.

PWC carried out research with the objective to "present an independent private sector view of the implications of some of the key options for the design of the Clean Development Mechanism (CDM)." (PriceWaterhouseCoopers, 2000) The transaction costs given by them are ordered along three categories:

1. Types of transaction costs:
   Costs are divided into a pre-implementation and implementation phase.

2. Number of operational entities (OE's) involved in the project:
   In order to avoid conflicts of interest validation, verification and certification may be undertaken by separate institutions. Therefore different levels were distinguished according to the number of OE's used over the project cycle. We look only at those that are possible under the Marrakesh Accords:
   (i) One OE is responsible for the whole project cycle (validation, verification and certification[1]). The same OE can do both validation and verification if it gets a special permit by the CDM Executive Board.
   (ii) One OE is responsible for the validation in the pre-implementation phase, one other OE provides verification and certification services in the implementation phase[2]

3. Project type, project size and host country

PWC has estimated the additional costs incurred by project developers in gaining CDM credits. The costs are short run forecasts and are expected to decrease in the long run, due to experience. The transaction costs for five generic project types, a Combined Cycle Gas Turbine (CCGT) plant, Retrofit CCGT project, Wind project and two Photovoltaic projects with 1 MW and 100 kW capacity, are presented in Table 8 – 12;

1 Then it was assumed that certification would be done by OEs, not the Executive Board.
2 The third level is not relevant any more under the Marrakesh Accords; it assumed three different OEs.

they are derived from the number of person-days necessary for each step. Assumptions about rates per person-day are:

- project developers : range 750 – 1200 €; central value 1000 €;
- project consultants -local engineers/NGOs in host country: 200 €;
- international management consultancy in host country: 300 €;
- international management consultancy in OECD states: 1500 €.

These assumptions result in a range of estimates for each project. The figures given are mid-range estimates.

Table 8: Transaction Costs (TAC) for new Combined Cycle Gas Turbine (CCGT) Plant

CDM type	**Total TAC (1000 €)**	**€/t CO_2**	**Phase 1 TAC (1000 €)**	**€/t CO_2**	**Phase 2 TAC (1000 €)**	**€/t CO_2**
One OE	558	0.09	103	0.02	455	0.07
Two OEs	675	0.11	103	0.02	582	0.09

Table 9: Transaction Costs (TAC) for Retrofit project

CDM type	**Total TAC (1000 €)**	**€/t CO_2**	**Phase 1 TAC (1000 €)**	**€/ t CO_2**	**Phase 2 TAC (1000 €)**	**€/t CO_2**
One OE	489	0.08	73	0.01	416	0.07
Two OEs	584	0.10	73	0.01	511	0.09

Table 10: Transaction Costs (TAC) for Wind project

CDM type	**Total TAC (1000 €)**	**€/ t CO_2**	**Phase 1 TAC (1000 €)**	**€/ t CO_2**	**Phase 2 TAC (1000 €)**	**€/t CO_2**
One OE	392	0.8	61	0.1	331	0.7
Two OEs	446	0.9	61	0.1	385	0.8

Table 11: Transaction Costs (TAC) for 1MW PV project

CDM type	Total TAC (1000 €)	€/ t CO_2	Phase 1 TAC (1000 €)	€/ t CO_2	Phase 2 TAC (1000 €)	€/t CO_2
One OE	387	70	57	10	330	60
Two OEs	441	80	57	10	386	70

Table 12: Transaction Costs (TAC) for 100 kW PV project

CDM type	Total TAC (1000 €)	€/ t CO_2	Phase 1 TAC (1000 €)	€/ t CO_2	Phase 2 TAC (1000 €)	€/t CO_2
One OE	387	702	57	103	330	599
Two OEs	441	800	57	103	386	697

PWC gives total costs over the project cycle and total days for phase 1 (pre-implementation) and phase 2 (implementation). The lifetime of each project is 15 years. As the division into the separate day rate categories is not given by PWC we calculate the costs for Phases 1 and 2 simply by using the percentages of the split of days.

The emissions reduction figure is obtained by multiplication of energy (per lifetime) for the new plant (capacity x load factor x 131,400 h) with the difference between old and new emissions. Table 13 provides the data for these calculations.

Table 13: CO_2 reduction

	g/kWh	load factor	Reduction (t/lifetime)	Reduction (t/a)
base (400MW)	900			
CCGT (400MW)	365	0.79	6,086,160	405,744
RetrofitCCGT (")	365	0.79	6,086,160	405,744
Wind (50MW)	0	0.30	486,000	32,400
PV (1MW)	0	0.17	5508	367
PV (100kW)	0	0.17	551	37

As a baseline for emissions we chose 900g/kWh for a coal burning power station. The figures for the load factor are rough estimates based on IKARUS (Federal Ministry of Research, 1995), a comprehensive techno-economic data base which has been developed for the German Ministry for Technology and Research over the last few years.

It can easily be seen that costs rise with the number of OE's involved and, more significantly, that the costs per t CO_2 reduction are negligible for big, but significant for smaller projects. For the renewable energy projects, i.e. wind and PV, less effort is required in absolute terms than for the large-scale fossil projects. This is due to the fact that the projects with zero emissions require minimal verification effort in the implementation phase.

The estimates do not take socio-economic or political conditions in different host countries into account. Moreover, the data is averaged over a number of CDM-projects in different countries and is thus not country specific.

A report by EcoSecurities (2000) examines transaction costs that arise for JI electricity generation projects. The data gives ranges of transaction costs based on several projects. Examples for a typical small and large project within these ranges are:

- a 150 MW gas plant, 20 year lifetime, resulting in reductions of 350,000 t CO_2/year;
- a 2 MW biomass plant, 20 year lifetime, resulting in reductions of 35,000 t CO_2/year.

Table 14: JI Transaction cost estimates

JI Project Cycle	**Transaction Cost (€)**
Pre-Implementation phase	
Search	12,000 – 20,000
Negotiation	25,000 – 45,000
Validation	10,000 – 15,000
Approval	10,000
Total Pre-Implementation Phase	57,000 – 90,000
Implementation phase	
Monitoring (annual)	3000 – 15,000
Certification	5-10% of ERU value
Gas plant*	87,500 – 175,000
Biomass plant*	8750 – 17,500
Enforcement (annual)	1-3% of ERU value
Gas plant*	17,500 – 51,500
Biomass plant*	1750 –5150
Total Implementation Phase (20 years, undiscounted)	
Gas plant*	2,160,000 – 4,830,000
Biomass plant*	270,000 – 753,000
Total Project Cycle	
Gas plant* (costs per t CO_2)	2.2 – 4.9 million (0.3 –0.7 €/t)
Biomass plant* (costs per t CO_2)	0.3 – 0.8 million (0.4 –1.1 €/t)

Source: Ecosecurities (2000), own calculations

* Reductions as quoted above, ERU value 5 €/t

The estimates are not country specific and there are no details given concerning the single projects underlying the transaction cost ranges.

The calculation shows that certification and enforcement costs dwarf all the other components. This is unlikely to be the case. First, the rates may be overestimated.

Second, EcoSecurities´ assumption that certification and enforcement costs are proportional to the amount of ERUs generated is debatable. As discussed above, it is likely that there will be a degressive price schedule of certifiers. Thus, absolute transaction costs will be similar for all projects, independent of the size of the project. This means that costs per t CO_2 reduced will be much higher for smaller projects and may make them less attractive to investors. The two above mentioned projects are both medium or large sized projects with small costs per t CO_2 reduced.

Maly et al. (2001) estimate the JI supply of the Czech Republic using the MARKAL model and find a set of 345 attractive projects. Assuming that each project needs 10 person-days for pre-approval assessment and 3 person-days per year for issuance of credits, a JI office of 12 permanent staff would be needed and overall host country government transaction cost is estimated at 215,000 €.

4 Transaction costs of emissions trading

Brockmann et al. (1999, p. 90) quote transaction costs of SO_2 trading in the U.S. of 1%. In the beginning, they were about 5% (Klaassen/Nentjes 1997) but when an active spot market with several specialised brokers developed, they quickly came down. Kerr and Maré (1997) found broadly defined transaction costs of about 10% in the case of the lead phasedown programme, the first large scale emissions trading programme, albeit with a relatively small number of participants. A lower boundary for transaction costs in a highly liquid market of a well defined financial commodity may be 0.2% - these are the rates quoted by direct brokerage firms in securities and bonds (see e.g. Comdirect-Bank, www.comdirect.de). Using a price of 4 €/t CO2, the transaction cost would thus start at 0.2 €/t and finally settle at around 1 cent.

It is difficult to get estimates about brokerage fees in the grey market for greenhouse gas emission rights as brokers are reluctant to disclose the fees. A fee of 7% for a transaction of several thousand t CO_2 has been mentioned.

5 Conclusions

Only recently, transaction costs became an issue in the discussion on the Kyoto mechanisms leading to the Marrakesh Accords clause that small scale CDM projects should get special treatment. Transaction costs will be substantial and will lead to a lower than expected utilisation ratio of the mechanisms. While the CDM and Second Track JI have to bear all categories of transaction costs, IET and bubbles are less impacted (see Table 16).

Table 16: Transaction cost types accruing under the different mechanisms

Transaction Cost Components	Relation to project size	Estimate (k€)	Bubbles	CDM	JI Track 1	JI Track 2	IET
Search costs	fixed	15		X	X	X	
Negotiation costs	degressive	25-400	X	X	X	X	(X)
Base-line determination costs	fixed	35		X		X	
Approval costs	fixed	40		X	X	X	
Validation costs	fixed	15-30		X		X	
Registration costs	fixed	10		X			
Monitoring costs	fixed	10		X		X	
Verification costs	degressive	8 per turn		X		X	
Certification costs	degressive	NA		X			
Enforcement costs	proportional		X				
Transfer costs	proportional	1%					X
Registry costs	proportional	0.03%		X	X	X	X
Minimum fixed cost (k€)			NA	150	80	140	NA

Sources: Cost estimates from the case studies and SGS (2002); the registry cost is derived from costs of share deposits at online brokerages

Empirical evidence suggests that economies of scale are the most important determinant for the share of transaction costs in total costs due to the important role of fixed costs components. The surveys analysed by us underline this. Table 17 tries to summarise the correlation between project size and transaction costs. It is mainly based on the PWC study, the PCF and the Swedish experiences. However, the other results fit more or less well in this picture. They were used to determine the upper and lower bounds of the five categories. But it should be stressed that this is only a rough picture and further research is necessary in order to come up with better data.

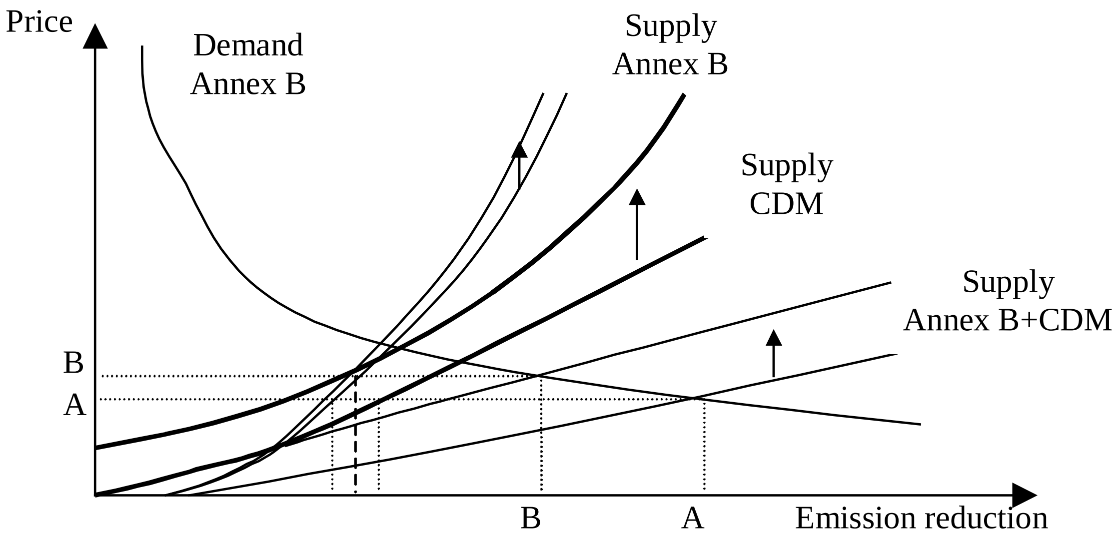
Table 17: Project size, types and total transaction costs

Size	**Type**	**Reduction (t CO_2/a)**	**€/ t CO_2**
Very large	Large hydro, gas power plants, large CHP, ***geothermal***, landfill/pipeline methane capture, cement plant efficiency, large-scale afforestation	> 200,000	0.1
Large	Wind power, ***solar thermal***, energy efficiency in large industry	20,000 – 200,000	1
Small	Boiler conversion, DSM, small hydro	2000 – 20,000	10
Mini	***Energy efficiency in housing and SME***, ***mini hydro***	200 – 2000	100
Micro	PV	< 200	1000

Project categories in italics on average have relatively high marginal abatement costs; there is thus a cumulation of high abatement and transaction cost for the smallest project categories.

Given CER market price estimates of 1 to 5 € per t CO_2 (Jotzo/Michaelowa 2001), prices for individual transactions under the Dutch Emissions Reduction Procurement Tender (ERUPT), ranging between 5 and 9 € per t CO_2 and PCF transactions priced at 3 –4 € per t CO_2 (PCF 2002) it is obvious that only projects classified as large and very large are viable. The PCF considers any project with a volume below 3 million € of greenhouse gas benefits would not to be attractive due to transaction costs. That would be a threshold of about 50,000 t CO_2/year for a 20-year project. According to Shell (2001), transaction costs should not be more than 25% of proceeds from permit sales in order to make a project viable. This would give a cost threshold of about 1 €/t CO_2 and reconfirm the size threshold calculated from the PCF estimate. Many project types currently discussed under the CDM with substantial development benefits would then not be viable. These projects often already have relatively high marginal abatement costs and thus would be less attractive than large ones. The overall effect on the transaction cost curve would be as follows (see Figure 2).

Figure 2: Shape of cost curves using the empirical results



While in Figure 2 without transaction cost (case A) the share of the CDM is higher than the one of JI and IET, with transaction costs shares become equal (Case B).

Transaction costs can be reduced as follows:

- bundle projects to jointly undertake each step of the project cycle
- do verification and certification not annually but at long intervals
- exempt projects from one or more steps of the project cycle; this however endangers environmental credibility and could lead to moral hazard.
- streamline the information needs on each step of the project cycle
- do unilateral CDM projects that reduce search and negotiation costs
- the CDM Executive Board /JI supervisory committee set a fee schedule proportional to the size of the project for the steps of registration and certification and thus cross-subsidise the smaller projects
- the CDM Executive Board /JI supervisory committee contract certifiers to offer validation and verification services at a proportional fee and pay the certifiers the difference to the market rate.

The savings potentials of these measures are summarised in Table 18. Some of them impact on the environmental credibility of the CDM.

Table 18: Cost reduction potential of different measures

Measure	Steps influenced	Cost savings potential	Influence on environmental credibility
Bundling of projects	Baseline determination, validation, registration, verification, certification	Proportional to number of projects in the bundle	None
Longer verification/ certification interval	Verification, certification	Division by number of years per interval	None
Exemptions	Respective project cycle step	Costs for the step	Negative
Unilateral CDM	Search, negotiation		None
Proportional fees	Validation, registration, verification, certification	Difference between minimum cost of each step and the fee	None

Especially for the small projects institutions or streamlining will reduce transaction costs significantly. In view of Table 17 and considering the prices paid under the decision concerning the treatment of small-scale projects under the CDM agreed upon in Bonn during COP 6bis is absolutely necessary. The Parties agreed that renewable energy projects of a capacity below 15 MW, energy efficiency projects saving up to 15 GWh and other projects emitting less than 15 kilotonnes of CO_2 annually, will benefit from simplified modalities and procedures. The annual CER volume of such projects will have the following maximum thresholds, if one assumes baseline emissions of 900 g/kWh.

Table 19: Small scale project thresholds, annual CERs and inferred transaction costs

Project type	Annual full load hours	GWh	CERs/year	TAC/ CER (€)
Hydro 15 MW	8000	120	108,000	0.5
Wind 15 MW	2700	40	36,000	2
Energy efficiency 15 GWh	NA	15	13,500	20
Fuel switch coal to gas*	NA	NA	23,350	5

* project designed to have exactly 14,999 t emission; efficiency of boiler increased from 60% to 85%

It can be seen that the threshold is relatively high for hydropower, critical for wind power but already too low for energy efficiency projects. For the other project types, the exact definition of “direct emission” is key. Under current sizes of cement plants, blending projects are unlikely to remain under the threshold. A fuel switch project with efficiency improvement could achieve a value between the efficiency and the wind project.

In light of the reported transaction costs estimates, the Marrakesh decision on simplified rules for small-scale projects and the agreed threshold seems reasonable. Looking at Table 18, it might be a good idea to introduce a third track for mini and micro projects (e.g. PV) in order to make them viable. These projects bear a very high transaction cost burden. Usually, they will not cause any indirect effects. Therefore, very simple modalities and procedures should be applied. If one wants to safeguard the environmental integrity a way to make small scale projects viable would obviously be to subsidise their transaction costs if the projects can prove that they have positive externalities.

References:

Bohm (1999):
International greenhouse gas emission trading, TEMA Nord 1999:506, Stockholm

Brockmann, Karl; Stronzik, Marcus; Bergmann, Heidi (1999):
Emissionsrechtehandel – eine neue Perspektive für die deutsche Klimapolitik nach Kioto, Physica-Verlag, Heidelberg

Coase, Ronald (1960):
The problem of social cost, in: Journal of Law and Economics, 3, p. 1-44

DNV (2002):
personal communication by Einar Telnes, Feb. 13, 2002

Dudek, Daniel; Wiener, Jonathan (1996):
Joint Implementation, transaction costs and climate change, OCDE/GD(96)173, Paris

EcoSecurities (2000):
Financing and Financing Mechanisms for Joint Implementation (JI) Projects in the Electricity Sector. Oxford

Federal Ministry of Research (1995):
IKARUS. Instrumente für Klimagas-Reduktionsstrategien, Bonn

Harrison, David; Schotzki, Todd (2000):
Setting baselines for greenhouse gas credit programs: lessons learned from experience with environmental and non-environmental programs, EPRI, Washington

Heller, Thomas (1999):
Additionality, transactional barriers and the political economy of climate change, in: Jepma, Catrinus; van der Gaast, Wytze (eds.): On the comptability of flexible instruments, Kluwer, Dordrecht, p. 78-92

Janssen, Josef (2001):
Risk management of investments in Joint Implementation and Clean Development Mechanism Projects, Bamberg

Jotzo, Frank; Michaelowa, Axel (2001):
Estimating the CDM market under the Bonn Agreement, HWWA Discussion Paper No. 145, Hamburg

Kerr, Suzi; Maré, David (1997):
Transaction Costs and Tradable Permit Markets: The United States Lead Phasedown, Motu Economic Research, Wellington

Klaassen, Ger; Nentjes, Andries (1997):
Sulfur trading under the 1990 CAAA in the US: an assessment of the first experiences, in: Journal of Institutional and Theoretical Economics, 153, 2, p. 384-410

KPMG (2002):
Personal Communication by Jed Jones, Feb. 13, 2002

Maly, Miroslav; Pretel, Jan; Splitek, Vlastimil; Nondek, Lubomir (2001):
JI in Czech Republic in context of the EU accession, Prague

OECD (2001):
Kyoto Mechanisms, Monitoring and Compliance from Kyoto to The Hague. http://www.oecd.org/env/cc/

Palmisano, John (1996):
Air permit trading paradigms for greenhouse gases: why allowances won´t work and credits will, Enron Europe, London

PriceWaterhouseCoopers (2000):
A Business View on Key Issues Relating to Kyoto Mechanisms, London

Prototype Carbon Fund (2002):
Presentation at the Canadian National Workshop on the Clean Development Mechanism (CDM) and Joint Implementation (JI), Jan. 7, 2001, Ottawa

Rentz, Otto; Wietschel, Martin; Ardone, Armin, Fichtner, Wolf; Göbelt, Matthias (1998):
Zur Effizienz einer länderübergreifenden Zusammenarbeit bei der Klimavorsorge, Karlsruhe

SENTER (2002):
Get a higher return on your investments in sustainable energy and energy efficiency, http://www.senter.nl/asp/page.asp?id=i001003&alias=erupt, accessed Feb 12, 2002

SGS (2002):
Personal Communication of Gareth Phillips, Feb. 12, 2002

Shell (2001): A walk through the CDM project cycle. Slides of the Presentation by Robert Kleiburg at the Environmental Finance Conference, 15 February 2001

UNFCCC (2002b):
Executive Board of the Clean Development Mechanism, Second Meeting, Report, CDM-EB-02, Bonn

UNFCCC (2002a):
AIJ project reports to UNFCCC, http://unfccc.int/program/aij/aijproj.html, accessed Feb. 10, 2002

Woerdman, Edwin (2001):
Emissions trading and transaction costs: analyzing the flaws in the discussion, in: Ecological Economics, 38, 2, p. 293-304

Appendix:

Transaction costs of Swedish AIJ projects (undiscounted $, EE= Energy efficiency, RE= renewable energy)

Project (average annual emission reduction over 10 years in t CO_2)	Technical assistance	Follow up	Reporting costs	Administration	Total costs until 2000 (extrapolated over loan lifetime[1])	Total gross[2] costs per t CO_2 reduction (crediting time 10 years)[3]	TAC per t CO_2 reduction (crediting time 10 years)[3]
Estonia							
Aardla, RE (start 1994, 7137)	55,000	30,306	1896	51,000	758,176 (805,500)	11.3	2.0
Adavere, EE (start 1995, 258)	54,000	26,459	1896	53,000	330,656 (257,000)	99.6	56.6
Haabneeme, RE (start 1994, 6827)	61,000	30,306	1896	51,000	843,037 (901,000)	13.2	2.3
Järvakandi, EE (start 1997, 530)	35,000	6606	1896	47,000	183,377 (208,500)	39.3	19.9
Keila, EE (start 1998, 160)	18,292	4406	1045	0	161,840 (202,000)	126.3	29.1
Kuressare, RE/EE (start 1998, 10532)	90,000	4406	3045	30,800	927,356 (1,152,000)	10.9	1.4
Mustamäe Vilde tee, EE (start 1995, 513)	114,000	30,306	1896	51,000	529,119 (549,000)	107.0	40.4
Mustamäe cooperativ, EE (start 1996, 313)	71,000	15,106	3895	40,000	666,509 (709,000)	226.5	44.9
Mustamäe ESTIB, EE (start 1997, 855)	80,000	6606	3895	47,000	478,962 (566,000)	66.2	17.8

Narva Jõesuu, RE (start 1995, 5371)	68,000	15,106	1896	39,300	1,054,909 (1,227,500)	22.9	2.5
Orissare, EE (start 1996, 1293)	30,000	6606	1896	47,000	216,658 (243,500)	18.8	7.8
Paldiski, RE (start 1996, 6447)	57,000	15,106	1896	40,000	986,881 (1,156,500)	17.9	1.8
Türi II, EE (start 1997, 4498)	68,000	4406	3045	31,000	697,871 (797,000)	17.7	2.7
Türi, EE (start 1997, 1770)	40,000	6606	1896	47,000	205,545 (232,500)	13.1	6.2
Valga I, RE (start 1993, 6750)	95,000	37,006	1896	32,000	683,256 (699,000)	10.4	2.5
Valga II, EE (start 1995,1610)	64,000	26,459	1896	53,000	478,186 (512,000)	31.8	9.7
Valga III, EE (start 1998,1650)	26,000	4406	1045	0	192,975 (252,500)	15.3	3.0
Viljandi, RE (start 1995, 8351)	49,000	26,459	3895	53,000	762,819 (801,000)	9.6	1.7
Võru I, RE (start 1994, 10791)	70,000	30,306	1896	51,000	742,570 (774,000)	7.2	1.5
Võru II, EE[4] (start 1996, 248)	50,000	6606	1896	47,000	219,188 (243,000)	98.0	46.6
				Latvia			
Aluksne, EE (start 1997, 2035)	49,000	6606	1896	47,000	499,139 (607,000)	29.8	5.9
Aluksne, RE (start 1994, 10620)	65,000	30,306	1896	51,000	987,128 (1,093,000)	10.3	1.8
Balvi, RE (start 1993, 5485)	101,000	37,006	1896	32,000	534,090 (576,000)	10.5	3.1
Balvi, EE (start 1996, 1013)	0	15,106	1896	40,000	656,701 (789,000)	77.9	6.9

Broceni, RE (start 1997, 4458)	72,000	6606	1896	47,000	883,084 (970,000)	20.3	3.1
Daugagriva, RE (start 1996, 10714)	70,000	15,106	3045	40,000	843,793 (914,000)	8.5	1.3
Janmuiza, RE (start 1994, 2728)	54,000	30,306	1896	51,000	676,197 (714,000)	26.2	5.4
Jekabpils, RE (start 1996, 1718)	25,000	15,106	1896	47,000	191,199 (211,000)	12.3	5.9
Jelgava I, EE (start 1994, 312)	34,000	30,306	1896	51,000	483,372 (505,000)	161.9	40.7
Jelgava II, EE (start 1996, 80)	29,000	15,106	1896	40,000	179,152 (191,500)	240.9	123.9
Jurmala, RE (start 1996, 10352)	72,000	15,106	1896	40,000	860,927 (929,000)	9.0	1.4
Liepa, RE (start 1998, 3143)	72,000	4406	3045	31,000	465,446 (514,000)	16.4	4.1
Limbazi, RE (start 1998, 6032)	75,000	4406	3045	31,000	808,433 (988,000)	16.4	2.2
Rauna, RE (start 1996, 1440)	25,000	15,106	1896	40,000	178,989 (204,000)	14.2	6.9
Saldus I, EE (start 1996,187)	40,000	15,106	1896	40,000	216,922 (232,000)	124.1	61.2
Saldus II, EE (start 1997,253)	29,000	6606	1896	47,000	181,055 (204,500)	80.8	39.3
Saldus III, EE (start 1997, 99)	26,000	6406	1045	31,000	299,927 (351,000)	354.5	80.3
Slampe, RE (start 1995, 3319)	53,000	26,459	1896	53,000	641,485 (695,500)	20.9	4.4

Talsi, EE (start 1998, 255)	30,000	0	2000	31,000	314,000 (373,500)	146.5	30.8
Ugale, RE (start 1995, 1909)	59,000	26,459	1896	53,000	394,582 (444,500)	23.3	7.9
Valka, RE (start 1996, 1916)	25,000	15,106	1896	40,000	249,203 (279,000)	14.6	5.1
Viesite, RE (start 1996, 2016)	25,000	15,106	1896	47,000	205,248 (233,000)	11.6	5.3
				Lithuania			
Baisogala, RE (start 1995, 2307)	62,000	26,459	1896	53,000	626,695 (691,500)	30.0	6.3
Birzai, RE (start 1993, 3380)	104,000	40,750	3563	40,000	909,209 (938,000)	27.8	5.6
Ignalina, EE+RE (start 1998, 3751)	110,000	4406	2500	33,250	2,583,859 (2,939,000)	78.4	4.6
Kazlu Ruda, RE (start 1995, 1297)	53,000	26,459	1896	53,000	492,476 (534,500)	41.2	11.1
Staciunai, EE (start 1997, 258)	19,000	6606	1896	47,000	253,396 (292,000)	113.2	35.7
Sventupe, EE+RE (start 1997, 651)	35,000	6606	1896	47,000	370,659 (409,500)	62.9	16.2
Varena, RE (start 1996, 10599)	90,000	15,106	1896	40,000	886,782 (953,000)	9.0	1.5
Vienybe, RE (start 1996, 1603)	64,000	15,106	1896	40,000	761,181 (888,000)	55.4	8.3
Zigzdriai, RE+EE (start 1996, 1415)	85,000	26,459	1896	40,000	511,418 (549,000)	38.8	11.7

Source: own calculations, using project reports to UNFCCC, http://unfccc.int/program/aij/aijproj.html, accessed February 10, 2002.

The reports list actual emission reduction values up to and including 2000.

[1] The extrapolation uses follow up costs of 2000 $ and reporting costs of 500 $ per year and per project

[2] No revenues from heat/electricity sales are taken into account. Costs include loans, the interest subsidy and transaction costs. Several project participants do not pay their installments on time, thereby increasing costs. We assume that the trend in installment payment witnessed in the past is continued but in the end the full loan will be repaid in one remaining installment.

[3] Extrapolation using the last reported annual emission reduction value of each project

[4] The report on the Vändra project lists exactly the same figures due to a reporting error; it is thus not listed here.