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Submission to the CDM Executive Board on HFC-23 CDM projects

1 Introduction

Öko-Institut e.V. / Institute for Applied Ecology welcomes the decision by the CDM EB to revise the methodology AM0001 and to ask for public comments on this issue, as we are highly concerned about the consequences of this methodology for both the climate and the ozone layer. In the following, we would like to provide important background information that should help to thoroughly understand the consequences of HFC-23 destruction under the CDM, also with respect to the protection of the ozone layer under the Montreal Protocol. Based on this analysis, we would also like to make concrete recommendations for dealing with this issue under the Kyoto Protocol and the Montreal Protocol.

HFC-23 is a by-product of HCFC-22 production with a very high GWP. Equipping HCFC-22 plants with HFC-23 destruction technology would greatly aid efforts in mitigating climate change as the annual emissions of such plants are typically in the order of several million tons CO_2 eq. Whereas we agree with the overall objective of methodology AM0001, in its current version its application is likely to lead to considerably higher global GHG emissions due to leakage effects which are not addressed. In addition, application of the methodology adversely affects the protection of the ozone layer.

In the following analysis, firstly we show that CER revenues have large effects on HCFC-22 production costs (section 2). Secondly, we analyse the implications of reduced HCFC-22 production costs and other effects of such CDM projects for the mitigation of climate change and the protection of the ozone layer (section 3). Finally, we present two different solutions for this issue (section 4) and make a recommendation (section 5).

2 Economic consequences of HFC-23 destruction under the CDM

The ratio of HFC-23 to HCFC-22 depends on the plant and the process parameters applied. Based on the 1996 Revised IPCC Guidelines, a default factor of 4% is considered in AM0001 if no plant specific factor is available. HFC-23 is a greenhouse gas and has a GWP of 11,700.

HFC-23 abatement costs are relatively low:

- According to information from a workshop held in Sanya Citiy (China)[1] on this issue, the destruction of HFC-23 costs about 4 to 6 US$ per kg HFC-23, including amortization of the required investments. This would result in abatement costs of about 0.34 to 0.51 US$ per t CO_2 equivalent.
- The US EPA (2001) estimates typical investment costs for thermal oxidation system with approximately 7 million US$ per plant and operational costs of 200,000 US$ per year. This results in somewhat higher abatement costs of 0.73 US$ per t CO_2 equivalent, assuming a discount rate of 8%.

In summary, HFC-23 abatement costs may vary between about 0.30 and 0.80 US$ per t CO_2 equivalent.

According to information from different companies, the market price of HCFC-22 amounts to about 1.5 to 2 US$ per kg, depending on retail quantities and place of sale. It can be assumed that production costs are lower or similar. For our analysis, we assume production costs of 1.7 US$ per kg.

The revenue from the destruction of HFC-23 under the CDM depends on the market price of CERs, HFC-23 mitigation costs and the ratio HFC-23/ HCFC-22. We calculate the effect of the CDM HFC-23 destruction projects on HCFC-22 production costs in three different scenarios, which reflect a range of possible impacts. For all scenarios, we use the default HFC-23/ HCFC-22 ratio of 4%.[2] The results for these scenarios are presented in Table 1 below.

Scenario		1	2	3
Market price of CERs	US$/ton CO2 eq	3,00	5,00	10,00
HFC-23 mitigation costs	US$/ton CO2 eq	0,80	0,50	0,30
Ratio HFC-23/HCFC-22	-	4%	4%	4%
	US$/ton CO2 eq	2,20	4,50	9,70
Net revenue from CERs	US$/kg HFC-23	25,74	52,65	113,49
	US$/kg HCFC-22	1,03	2,11	4,54
Cost of HCFC-22 production				
without CERs	US$/kg HCFC-22	1,70	1,70	1,70
with CERs	**US$/kg HCFC-22**	**0,67**	**-0,41**	**-2,84**
Relative cost reduction due to the CDM	**US$/kg HCFC-22**	**61%**	**124%**	**267%**

Table 1: Effect of AM0001 on the costs of HCFC-22 production in different scenarios

- In **scenario 1** we calculate the lower range of the potential impact of the CDM on HCFC-22 production costs. In this scenario we assume a relatively low price of 3 US$ per CER and relatively high mitigation costs of 0.80 US$ per ton of CO_2 equivalent. As a result, the production costs are lowered by about 1 US$/kg HCFC-22 or about 60%.

[1] International Workshop on HFC-23 Clean Development Mechanisms (CDM) Project Cooperation in China. 4-6 February 2004. Sanya City, Hainan Province, China

[2] Scenarios with a lower HFC-23/HCFC-22 ratio are illustrated below in Table 2.

- In **scenario 2** we assume a market price of 5 US$ per CER and mitigation costs of 0.50 US$ per ton of CO_2 equivalent. In this scenario the revenue from CERs is higher as the HCFC-22 production costs.
- In **scenario 3**, we assume the higher end of current market prices for CERs of about 10 US$ per CER (which corresponds to current future prices in the European Emissions Trading Scheme) and relatively low mitigation costs of 0.30 US$ per ton of CO_2 equivalent. In this case, the revenue from the CER amounts to about 4.50 US$/kg HCFC-22, outweighing the production costs of HCFC-22 by a factor of more than two.

This means that as a consequence of the CDM project activities applying methodology AM0001, **HFCF-22 production costs are lowered considerably and likely to get even negative**. This has considerable effects and perverse incentives regarding both the protection of the climate and the ozone layer, as we illustrate in the following.

3 Consequences of HFC-23 destruction under the CDM

3.1 Mitigation of climate change

Low or negative HFCF-22 production costs may have the following consequences:

1. **Increased consumption of HCFC-22 due to lower market prices.** Due to the high economic revenue from CERs, the global market prices for HCFC-22 would decrease considerably and as a result the global production and consumption of HCFC-22 is likely to increase due to the CDM. This may occur due to different effects, e.g. the delay of substitution of HCFC-22 by other substances or the potential use of HCFC-22 in applications where currently also other substances are used. For example, a large fraction of new cooling appliances, in developing countries, e.g. in cars, could use HCFC-22.

   Under the Montreal Protocol, production and consumption of HCFC-22 in developing countries are only restricted from 2016 onwards to levels determined by the production and consumption in the year 2015. Developing countries are then allowed to remain at 2015 levels for the subsequent 25 years (i.e. until 2040). Increased production and consumption of HCFC-22 in developing countries induced by the CDM would thus lead to an increased allowed level of HCFC-22 production and consumption for that period and beyond[3]. Thus, the impacts would last well beyond the crediting period of any CDM project activity.

   A policy paper by Germany comes to the conclusion that 'the HCFC-22 market is only driven by economic conditions and existing legal constraints in the export markets'[4]. Accordingly, a significant drop of HCFC-22 market prices would have strong impacts on the demand for the substance.

3 HCFC-22 used as feedstock for the manufacturing of PTFE is not limited under the Montreal Protocol and will therefore continue to be manufactured beyond 2040. Consequently, this (and other leakage) effects may even apply beyond 2040.

4‘ Policy paper on the responsibility of the Multilateral Fund and potential eligibility requirements for Studies on the Management of HCFCs', submitted to the ExCom by the Government of Germany, 2004

An increased level of HCFC-22 production would in the long-term lead

(a) to an increased level of HFC-23 emissions, where plants do not abate HFC-23 emissions[5], or

(b) to an increased quantity of CERs from mitigation of HFC-23 emissions in new HCFC-22 production plants which are only constructed due to the CDM.

In the first case, the CDM would indirectly cause additional emissions in the future, in the latter case, additional emissions will be generated elsewhere due to the CDM.

In addition to these leakage effects, any increased level of HCFC-22 production will have long term damaging effects on efforts to protect the ozone layer (see below).

2. **Production shifts from Annex I to non-Annex I countries**. As a result of the CDM, the HCFC-22 production is likely to move from Annex I Parties to non-Annex I Parties, as the production is economically more attractive under the CDM in non-Annex I Parties. Such production shifts are unlikely to occur directly – dismantling a plant in an Annex I country and reconstruction of the same plant in a non-Annex I country –, but are rather likely to occur indirectly in the long term, with plants in Annex I countries closing down, as they are not competitive against production with the CDM in non-Annex I countries, and new plants in non-Annex I countries being constructed as they are very competitive due to the CDM.[6]

   These production shifts do not result in any real emission reductions, but (a) Annex I countries would account the reduction of emissions in their GHG inventories, and in addition, (b) CERs would be generated by the new plants in non-Annex I countries. Consequently, due to such double counting global GHG emissions would increase by the amount of CERs generated.

3. **Market distortions.** Due to the high economic revenue from CERs, plants already applying advanced technologies to reduce or destroy HFC-23 have a severe economic disadvantage compared to plants with out of date technology that implement these standards through a CDM project. As a consequence, environmentally advanced production plants may be shut down due to their higher production costs. If they are replaced by new HFCF-22 production plants built under the CDM, the generated CERs would not correspond to real emission reductions either.

4. **Construction of new HCFC-22 plants without any production purpose.** Starting with CER market prices of about 4 US$ per ton, it would be economically feasible to build a HCFC-22 production plant with the only purpose of destroying the HFC-23 waste streams and without selling the actual product (HCFC-22) to the market. As a consequence the production of HCFC-22 (and together with it the HFC-23 waste stream) may only be initiated because of the CDM. CERs generated from such plants would not correspond to

5 E.g. after the end of the crediting period, HCFC-22 production plants may shut down the thermal HFC-23 destruction in order to save operation costs.

6 Although the approach from AM0001 builds on the approach of „historical / existing“ emissions, the methodology does not clearly exclude the application to new HCFC-22 production plants. In contrast, the last sentence on page 3 contains a reference to the baseline in case of new plants.

any real emission reductions, on the contrary additional green house gases related to the construction and operation of the plant would be emitted to the atmosphere.

5. **Additional radiative forcing due to increased emission of HCFC-22 and substitutes**. Although HCFC-22 is controlled under the Montreal Protocol and not one of the Kyoto gases, it has a GWP of 1,700[7]. Therefore, the increased production and consumption of HCFC-22 due to CDM projects would also directly lead to increased concentrations of GHG in the atmosphere. In addition, the increased use of HCFC-22 leads indirectly to additional HFC emissions with high GWPs because HCFC-22 will mostly be substituted by HFC in the future.
6. **Effects on policies and measures in non-Annex I countries.** AM0001 provides strong incentives for governments in non-Annex I countries not to implement policies and measures to reduce HFC-23 emissions. As a consequence, the CDM is likely to delay the implementation of emission reductions in non-Annex I countries leading to additional GHG emissions.

The CDM methodology AM0001 does not take into account any of these effects, which result in significant leakage. These leakage effects are likely to be very large, in particular regarding the first three aspects described above, as the CERs will influence the global market price for HCFC-22 considerably. One further should take into account that – due to the large influence of CERs on HCFC-22 production costs – for plant operators there is practically no choice, but to use the CDM for the reductions of HFC-23 emissions in order to be competitive in the market. Taking this and all the different effects described above into account, we estimate that **leakage effects are probably larger than direct emission reductions** through abatement of HFC-23.

3.2 Protection of the ozone layer

Under the Montreal Protocol, developing countries shall limit their HCFC-22 production from 2016 until 2040 to their production and consumption levels in 2015. The low prices for HCFC-22 due to the CDM will be a strong incentive for developing countries against limiting or even phasing out the substance sooner than required under the Montreal Protocol. On the contrary, increases in HCFC-22 production due to the CDM would lead to higher production rights until 2040. As a consequence, efforts to protect the ozone layer would be undermined by the CDM.

4 Conclusions and recommendations

The analysis above shows that:

1. There is a large HFC-23 potential at rather low abatement costs (below 1 US$ per ton of CO_2 equivalent). From an economic and environmental viewpoint, these emissions should be abated as a priority – with or without the CDM.
2. In terms of mitigation of climate change, the abatement of HFC-23 under the current approved methodology AM0001 results in a number of perverse incentives that result in considerable leakage effects that are likely to outweigh all direct emission reductions

[7] IPCC TAR 2001 *The Scientific Basis*, p. 388

generated from such projects. As a result global GHG emissions would increase considerably due to the CDM, also in a longer term beyond the crediting period of any HFC-23 destruction project.

3. In terms of protection of the ozone layer, the abatement of HFC-23 under the CDM is likely to result in strong economic incentives to prolong the use of this ozone depleting substance, and potentially in significantly increased emissions of ozone depleting substances in the atmosphere until 2040.

To prevent such effects, there seem to be **two general approaches**:

Option A. The destruction of HFC-23 emissions from HCFC-22 production in non-Annex I countries is not conducted under the CDM, but financed from other (multilateral) sources.

Option B. Revision of the methodology AM0001 (with different options).

In the following, these options are analysed in more detail.

4.1 Option A: Destruction of HFC-23 outside the CDM

In this case, the abatement of HFC-23 emissions from HCFC-22 production would not take place under the CDM, but would be financed through other financial resources and institutions, such as the Global Environment Facility (GEF) or the Multilateral Fond (MLF).

The main advantage of this approach is that there would not be any perverse incentives neither under the Kyoto Protocol nor under the Montreal Protocol. The costs for the global abatement of HFC-23 from HCFC-22 production would be rather low and the abatement of HFC-23 would be additional to commitments under the Kyoto Protocol. Multilateral financial resources to deal with the abatement of HFC-23 would also allow for a significant amount of additional CDM investment in other sectors, in which the contribution to national sustainable development objectives of developing countries may be higher.

Both the GEF and the MLF support programmes with high potential synergy effects for the destruction of HFC-23:

- The GEF is supporting projects addressing global environmental problems which can include HFC-23 destruction projects. The GEF is designated as the interim financial mechanism of the Stockholm Convention which targets persistent organic pollutants (POPs) like DDT. The destruction of POPs and HFCs can be achieved by similar processes and it is possible to build combined HFC-23/POPs destruction facilities. This would be an economically attractive way of addressing two different environmental issues at the same time.
- The main task of MLF is to finance the phasing out of consumption and production of ozone depleting substances (ODS). Developing countries are starting to build up used and not recyclable stocks of ODS which have to be eliminated in the future. Again, those ODS can be destroyed by the same processes as HFC-23 and therefore there are synergies for facilities which destroy both.

A combined destruction of HFC-23 with other pollutants could be an attractive course of action for plant operators as well as they might charge fees for the destruction of those substances for third parties.

A disadvantage of this option is that the provision of multilateral financial resources may delay the implementation of HFC-23 abatement. Usually market mechanisms (such as the CDM) are more efficient in practical terms of implementation: Operators of HCFC-22 production facilities have strong economic incentives to participate in the CDM – if they do not participate they probably have to shut down their plant as they cannot compete with producers that use the CDM. This ensures a broad participation. With the provision of multilateral financial resources the incentives to make use of these financial resources are weaker, which may result in slower implementation.

4.2 Option B: Revision of AM0001

In the following, we would like to discuss different options for modification of AM0001. These options are not alternatives, but should be combined.

4.2.1 Limitation of HFC-23 projects to existing facilities

The use of AM0001 could be limited to HCFC-22 production plants that have started production prior to a certain date (e.g. April 2003, when AM0001 was originally submitted). Such a provision would mostly prevent that new plants are being built as a result of the CDM, which may occur – as described above – through

(a) a globally increased HCFC-22 production due to the CDM,

(b) production shifts from Annex I to non-Annex I countries,

(c) market distortion effects, and the

(d) construction of new production plants with the sole purpose of generating CERs.

With the limitation of AM0001 to existing plants, these potential leakage effects would mostly be avoided. However, to a smaller extent an increase of the global HCFC-22 production level may occur also due to reduced costs in existing facilities, which then also leads to additional radiative forcing due to HCFC-22 and its substitutes.

A consequence of the limitation of the applicability of AM0001 to existing plants, new HCFC-22 production plants in developing countries may not install a HFC-23 abatement technology and continue to emit HFC-23 emissions. The HCFC Task Force Report of the Technology and Economic Assessment Panel under the Montreal Protocol estimates that the demand for HCFC-22 in developing countries will triple between 2002 and 2015[8]. In addition, HCFC-22 manufacturing will continue beyond 2040, as HCFC-22 used as feedstock is not limited by the Montreal Protocol. An option would be to address these emissions by multilaterals sources as discussed above.

4.2.2 HFC-23/HCFC-22 ratio

Currently, AM0001 suggests, based on the *1996 Revised IPCC Guidelines*, an upper limit for the HFC-23/HCFC-22 ratio *w* of 4%. However, taking into account more recent information, this default value is not conservative, but reflects the upper value of the possible range:

8 HCFC Task Force Report of the Technology and Economic Assessment Panel under the Montreal Protocol, UNEP Ozone Secretariat, 2003

- The IPCC states in its Third Assessment Report under the heading "Optimization of the HCFC-22 production process to minimize HFC-23 emissions": "*This technology is readily transferable to developing countries. Process optimization is relatively inexpensive and is demonstrated to reduce emissions of fully optimized plants to below 2% of HCFC-22 production. Nearly all plants in developed countries have optimized systems.*"[9]
- Harnisch and Höhne (2002) analyzed atmospheric measurements and reported emissions of HFC-23 as well as HCFC-22 production data. Based on the comparison they came to the conclusion that "*a 4% by-production factor around 1990 does not seem to be supported by atmospheric measurements, while* ***2% in 1990 and less thereafter*** *seems possible*". This indicates that on a global scale, most plants have likely already a significantly lower ratio than 4%. In contrast, the default value of 4% seems to reflect the upper end of the possible range, which Harnisch and Höhne (2002) estimate to be between 0% and 4%.
- At their Louisville plant DuPont achieves a ratio between HFC-23/HCFC-22 of 1.37%. The company states that this ratio is economically attractive due to higher production efficiencies.[10] While such a low ratio might not be applicable to all plants especially in developing countries, it proves that the default factor of 4% can be considered as 'worst practice', and that a better process optimization is in most cases economically attractive.

In summary, the default value of 4% seems not appropriate. We believe that the CDM methodology should take into account that optimization of the HFC-23/HCFC-22 ratio to a lower level than 4% through process optimization is an economically attractive course of action. The baseline ratio should not be higher than such economically attractive best practices. We believe that best practices should even be used as reference for the baseline scenario if a single plant has had a higher ratio in the past and not yet implemented such economically attractive practices, as it can be assumed as likely that such plants would implement common practice in the nearer future even without the CDM due to economic benefits from such measures.

Furthermore, the introduction of an upper ratio w of 2%, based on estimates by Harnisch and Höhne (2002), would reflect recent technological developments and research results which indicated that 4% is far too high as a default value. Such a **maximum** value should also be supported to limit market distortions and avoid perverse incentives for plant operators: With a high maximum value of 4%, companies applying already plant optimization in order to reduce HFC-23 emissions would be punished as they may get less CERs than companies not applying any HFC-23 abatement measure. In addition, with a default value of 4% it would be a sensible approach for companies to build or plan HCFC-22 production plants with a very high HFC-23/HCFC-22 ratio in order to increase their revenues from CERs.

Finally, in selecting an appropriate HFC-23/HCFC-22 ratio, experiences from similar CDM projects should be taken into account. By limiting the maximum value to the values used in previous CDM projects, the dynamic technological development over time is taken into account and future revisions of the methodology may not be required.

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9 IPCC 2001 *Mitigation* 2001, p. 215

10 Information supplied by DuPont to the CDM Executive Board.

Text proposal

The language of the current methodology AM0001 is not very clear, whether project proponents should choose the **lower** value amongst (a) 4% and (b) the lowest measurement during the last three years.[11] Moreover, it is suggested that project proponents choose the "*lowest IPCC default value*" for new plants. However, *1996 Revised IPCC Guidelines* do not provide a range, but just a default value of 4%, and the *IPCC Good Practice Guidance* does neither provide additional values or a range. In this regard, the current methodology could be read in a way that new plants could use a default value of 4%. As it is possible that the 2006 Revised IPCC Guidelines will provide a range, the current guidance in AM0001 may be helpful for the future, but is rather unclear for project developers at the present stage. We therefore suggest to redraft the last paragraph on page 3 of AM0001 as follows:

Where Q_HCFC_y is the actual production of HCFC22 during the year y at the plant, where HFC-23 emissions originate, measured in metric tonnes. The coefficient w is the maximum waste generation rate (HFC-23)/(HCFC-22) in the baseline scenario. The value w shall be set at the lowest value among the following options:

(a) the lowest actual value, measured at the plant site, during the last three operation years prior to the start of HFC-23 destruction,

(b) the lowest value that can be achieved through process optimization in an economically rational manner,

(c) the lowest value that was used in previous HFC-23 CDM destruction projects with comparable HCFC-22 production plants,

(d) a value of 2%.

Once the 2006 Revised IPCC Guidelines are adopted, this provision may be reassessed.

4.2.3 Adjustment for leakage effects

In its current version, AM0001 does not foresee any adjustments of emission reductions for leakage effects. As illustrated above leakage effects are likely to be large and consequently emission reductions at the plant should be adjusted for leakage effects. However, the extent of leakage depends also on other modifications to AM0001:

- If AM0001 is limited to existing plants and if a maximum HFC-23/HCFC-22 ratio of 2%/best practice is introduced, leakage effects will be considerably lower.
- In addition, the introduction of an adjustment directly lowers the revenue from CERs and, consequently, the level of the adjustment influences itself the extent of the leakage effects.
- The extent of the leakage effects described above also depends strongly on future market prices for CERs, which are still rather uncertain at this point in time. As market prices may be significantly influenced by HFC-23 projects, there is a systematic difficulty in estimating the appropriate level of adjustment for leakage effects. Currently future market prices in the largest market, the European Emissions Trading Scheme, are at about 8 to 9 EUR/t CO2 ˜ 10 to 11 US$/t CO_2.)

11 Probably, the lower value is intended.

In the following, we analyse, as far as possible, the potential leakage effects for the case that a maximum HFC-23/HCFC-22 ratio of 2% is introduced. The effect of the lower HFC-23/HCFC-22 ratio is illustrated in Table 2 below.

Scenario		4	5	6
Market price of CERs	US$/ton CO2 eq	3,00	5,00	10,00
HFC-23 mitigation costs	US$/ton CO2 eq	0,80	0,50	0,30
Ratio HFC-23/HCFC-22	-	**2,0%**	**2,0%**	**2,0%**
Cost of HCFC-22 production				
without CERs	US$/kg HCFC-22	1,70	1,70	1,70
with CERs	**US$/kg HCFC-22**	**1,19**	**0,65**	**-0,57**
Relative cost reduction due to the CDM	**US$/kg HCFC-22**	**30%**	**62%**	**134%**

Table 2: Cost of HCFC-22 production with a HFC-23/HCFC-22 ratio of 2.0%

Under the three different scenarios – which were also used above – the revenues from CERs are still considerable and HCFC-22 production costs still drop below zero with current market prices in the European Emissions Trading Scheme. Even in a minimum revenue scenario (high HFC-23 abatement costs, very low market prices for CERs), the cost reductions are significant and may have considerable effects on the HCFC-22 market. As a result, global HCFC-22 production increases, production shifts from Annex I to non-Annex I Parties and market distortions are still likely to occur – next to the other leakage effects listed above. We therefore believe that emission reductions would still need to be adjusted considerably (by more than 50%).

The implications of a leakage adjustment of emission reductions of 50% are shown in Table 3 below.

Scenario		7	8	9
Market price of CERs	US$/ton CO2 eq	3,00	5,00	10,00
HFC-23 mitigation costs	US$/ton CO2 eq	0,80	0,50	0,30
Ratio HFC-23/HCFC-22	-	**2,0%**	**2,0%**	**2,0%**
Leakage adjustment	-	**50%**	**50%**	**50%**
Cost of HCFC-22 production				
without CERs	US$/kg HCFC-22	1,70	1,70	1,70
with CERs	**US$/kg HCFC-22**	**1,54**	**1,23**	**0,60**
Relative cost reduction due to the CDM	**US$/kg HCFC-22**	**10%**	**28%**	**65%**

Table 3: Cost of HCFC-22 production with a HFC-23/HCFC-22 ratio of 2% and adjustment for leakage effects of 50%

With a maximum HFC-23/HCFC-22 ratio of 2% and an adjustment for leakage effects of 50% the abatement of HFC-23 under the CDM is still economically attractive, even with CER prices below 3 US$ per ton of CO_2 equivalent. However, with market prices of 10 EUR per CER, the reduction in HCFC-22 production costs is still considerable and may cause leakage effects that are larger than 50% of the emission reductions. For prices of 5 EUR per CER, an adjustment of 50% of emission reductions seems to be in the appropriate range.

If the methodology would be limited to existing plants, the adjustment could respectively be lower (e.g. 20-40%), as the described market effects are likely be more limited.

This analysis shows that adjustments effects are clearly required to take into account the leakage effects, but that they are arbitrary and difficult to quantify. Furthermore, the appropriate adjustment level depends considerably on the market prices of CERs, which can not be predicted for the future. Based on current market prices in the European Emissions Trading Scheme, we believe that an appropriate adjustment should be in the range of 50% to 70% if the methodology AM0001 is applicable to existing and new plants.

The current methodology includes other leakage effects which can be deemed to be rather small and which are also neglected in other approved methodologies (e.g. emissions due to transport). The current leakage effects may therefore also be neglected in order to reduce transaction costs.

Based on this analysis, we propose to redraft the section on leakage as follows:

The destruction of HFC-23 emissions from HCFC-22 production within a CDM project activity may involve several leakage effects. For the purpose of this methodology, project participants shall adjust emission reductions for the following sources of leakage:

(a) *Market effects:* an increase of global HFC-23 emissions due to an increased HCFC-22 production and consumption level, mainly as a result of decreased HCFC-22 production costs from revenues of CERs and hence a decreased market price for HCFC 22;

(b) *Relocation effects:* an increase of global GHG emissions due to the shift of HCFC-22 production plants from Annex I Parties to Non Annex I Parties;

(c) *Market distortion effects:* an increase of global GHG emissions due to the increase in competitiveness resulting from revenues from CERs for those plants that have environmentally less advanced technologies compared to fully optimised plants;

(d) *Increased radiative forcing:* an increase in radiative forcing due to an increase in consumption levels of HCFC-22 and substitutes with a Global Warming Potential.

These effects shall be considered by project participants within the timeframe for phasing out HCFC-22 production under the Montreal Protocol, taking into account the target of stabilizing HCFC-22 production in developing countries until 2040 at its 2015 levels and the continued production HCFC-22 used as feedstock after 2040. Project participants shall take these leakage effects into account by applying an adjustment factor F with a default value of XY%, as follows:

$L_y = (Q\_HFC23_y - B\_HFC23_y) * GWP\_HFC23 * F$

Project participants do not have to consider other leakage effects.

<u>Add a footnote:</u> Where project participants can demonstrate in a consistent and transparent manner that a different adjustment for leakage is more appropriate, they are invited to submit a different methodology to the CDM Executive Board.

5 Conclusions and recommendations

In summary, we believe that both options, the provision of financial resources by Annex I countries to abate HFC-23 emissions outside the CDM framework, and the modification of AM0001 may be ways forward to address the problem. In Table 4 we try to illustrate the advantages and disadvantages of the two approaches. Here we also introduce some arguments, which are not directly linked with this analysis, but more with the CDM and implementation issues.

	Option A Provision of financial resources outside the CDM	Option B Modification of AM0001
Advantages	The protection of the ozone layer is not adversely affected, as the HCFC-22 production level is not increased through the CDM Investments in the CDM occur to a larger extent in other projects with usually higher contribution to sustainable development objectives Additional benefits for the environment, as HFC-23 is abated in addition (and not instead) of other CDM projects	A market mechanisms in place (the CDM) can be used to implement HFC-23 abatement in a timely and possibly more efficient manner
Disadvantages	The provision of multilateral resources takes time and delays the abatement of HFC-23 The abatement of HFC-23 may be conducted slower, as companies have less incentives to request resources and as the provision of such resources takes time The complete exclusion of HFC-23 projects from the CDM could send a negative signal to the CDM market	The protection of the ozone layer is adversely affected due to long-term higher production / consumption levels of ozone depleting substances in developing countries Possibly lower CDM market prices with less investment in projects with high contribution to sustainable development objectives Large and arbitrary leakage adjustments are required to appropriately reflect market effects; the appropriate level for the adjustment depends on future CER prices that are uncertain The limitation of the applicability to existing plants would not allow to abate HFC-23 emissions from new plants under the CDM

Table 4: Advantages and disadvantages of different approaches to solve the problem

We believe that the best solution would be to finance the destruction of the HFC-23 emissions outside the CDM. This would avoid all the perverse incentives described above for both, the mitigation of climate change and the protection of the ozone layer. At the same time the economically and environmental attractive potential for abating HFC-23 emissions would still be used. This solution would clearly have the largest benefits from an environmental perspective, as the HFC-23 would be abated in addition (and not instead) of other CDM projects. As a result, the CDM may also be targeted to projects with higher benefits for the sustainable development in developing countries.

We recommend that the CDM EB brings this issue to the COP to assess the possibilities for the destruction of HFC-23 in non-Annex I countries with assistance from the GEF or the

MLF. The combined destruction of HFC-23 with other pollutants would support the targets of several international conventions at the same time.

As a second best option, we believe that an alternative may also be a combination of the approaches, as follows:

- The approved methodology AM0001 is limited to plants that started construction before 1 April 2003. The upper limit for the ratio *w* between HFC-23 and HCFC-22 is changed as outlined in sector 4.2.2. A leakage adjustment factor of 30% is introduced as explained in sector 4.2.3.
- For plants that started construction after 1 April 2003, the destruction of the HFC-23 waste stream is financed outside the CDM through multilateral resources.

With this approach we would combine advantages of both approaches and avoid some of the disadvantages: This approach excludes that the new HCFC-22 production plants are build due to the CDM. The large abatement potential in existing HFC-23 plants can immediately be abated through the CDM, while new plants can profit from multilateral financial resources. No time delay would occur in the abatement of emission reductions. The effect of the CDM on HCFC-22 market prices would be limited as the demand for HCFC-22 is expected to increase considerably and new plants would need to be build. As a consequence, only a lower leakage adjustment factor is required and severe effects for the ozone layer are avoided.

We are doubtful if a solution solely based on leakage adjustments without the limitation to existing plants is sufficient to ensure that all leakage effects are accounted for. For a conservative estimation of the reduced emissions the adjustment factor would need to be in the order of at least 50%-70% if such an approach would be followed.

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