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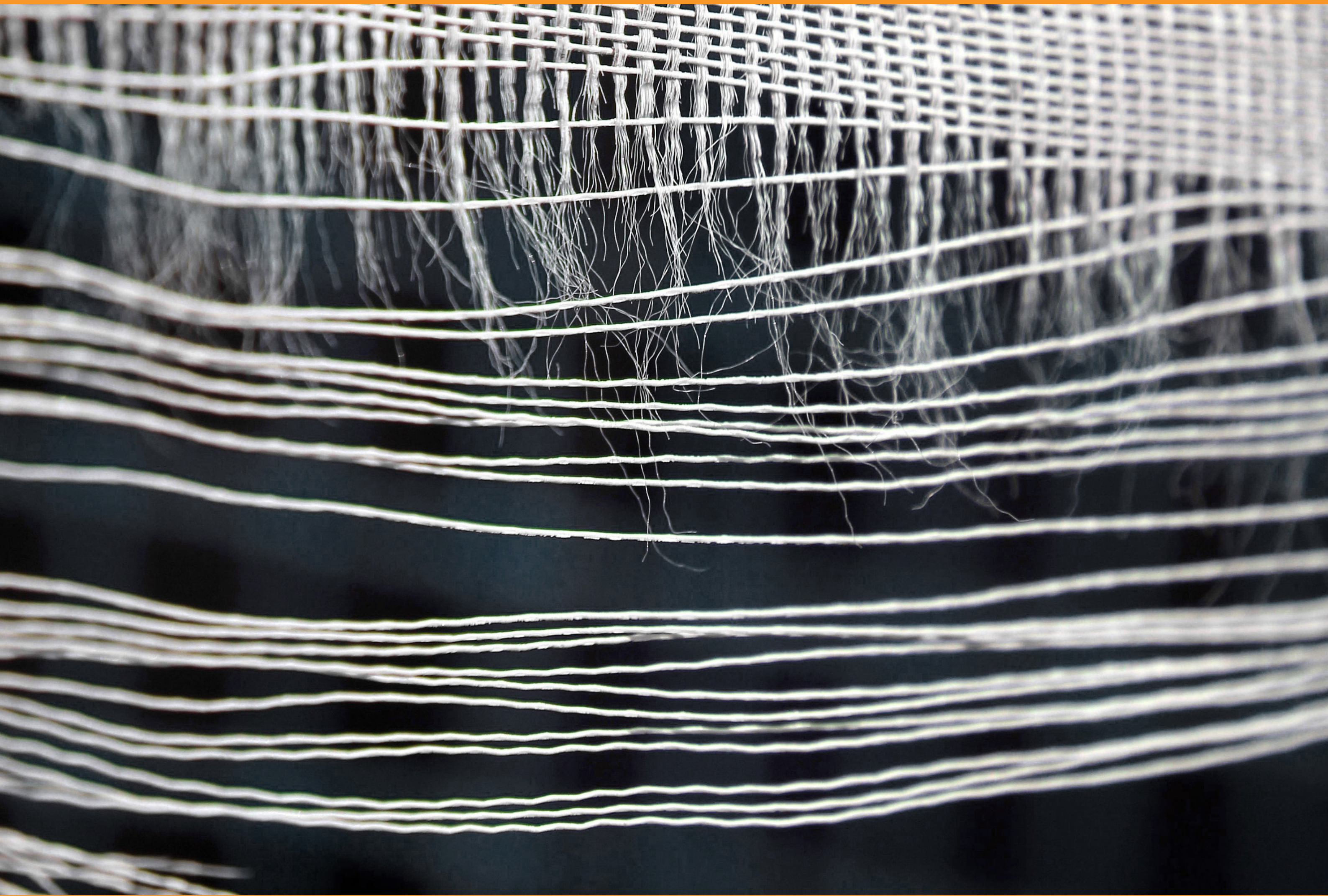

Potential for International Offsets to Provide a Net Decrease of GHG Emissions

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ABSTRACT

At COP 17 in Durban, the Parties called for new market mechanisms, and more broadly, "various approaches, including markets" to "achieve a net decrease and/or avoidance of greenhouse gas emissions". This paper explores what a net decrease might mean in practice, how it might be achieved, and the potential scale of the net atmospheric benefit that could be attained in 2020. It finds that achieving a net decrease in global GHG emissions hinges on: a) the ability to generate offset units for which additionality is relatively certain; b) measures (such as shortened crediting periods or pre-issuance discounts) that lead to more GHG abatement than credited, i.e. surplus reductions; and c) a means to account for any surplus reduction in a way that it does not simply contribute to meeting an existing GHG reduction pledge. The paper also draws lessons from the Clean Development Mechanism about challenges in attaining a net decrease, and examines the potential for existing CDM project types to produce surplus credits. Within the CDM, we find industrial gas projects to be most promising for yielding a net decrease in global GHG emissions, potentially yielding a net decrease on the order of 100 million tonnes CO_2e in 2020. However, there is declining interest among major offset buyers, the EU in particular, in using the CDM or other offset mechanisms for low-cost, industrial gas abatement. Lastly, this paper finds that for offsets to attain a net decrease in GHG emissions, Parties must also reach agreement on how to avoid double counting of emission reductions associated with offsets.

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1. INTRODUCTION AND CONTEXT

International greenhouse gas emission offsets have been a central piece of most enacted or proposed international climate policy architectures. For example, the Kyoto Protocol created the Clean Development Mechanism (CDM), which has issued over one billion credits to date. Offsets bring flexibility in location of emission reductions and thus offer the potential to decrease the overall costs of GHG abatement.

While the potential to reduce costs may lead to more ambitious climate targets, in principle, offsets are a zero-sum game for the atmosphere. For every unit of emission reduction credit purchased and used, an entity can increase its emissions by an equivalent amount above its target level, resulting in the same total emissions as would occur in the absence of offsets (assuming that targets are met equivalently in both cases).[1]

However, analysts have proposed ways in which offsets could go beyond this zero-sum calculus and offer a net benefit to the atmosphere, by reducing emissions more than the number of offsets issued and used (Chung 2007; Schneider 2009a). If such a net benefit were attainable, offsets could become a more attractive option to policy-makers and others arguing for greater mitigation ambition. In a sense, a goal of net benefit could breathe new life into a concept that has come under significant criticism in recent years due to doubts about its environmental benefit.

Indeed, international climate negotiators have recognized the importance of a net benefit. At COP 17 in Durban, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) called for new market mechanisms, and more broadly, "various approaches, including markets" to "achieve a net decrease and/or avoidance of greenhouse gas emissions" (UNFCCC 2012c, para.79). With this language, which echoed earlier decisions, the Parties thus departed from the zero-sum premise of the CDM.

This paper explores the concept of achieving a net benefit, or decrease, of emissions through offsets: what it means, how it might be achieved, and what it might deliver.[2] In the section that follows, we examine definitions of "net decrease and/or avoidance" of GHG emissions, and the importance of host country approaches to emissions accounting in enabling a net decrease. Section 3 develops criteria for assessing what types of offset projects are suitable for attaining a net decrease, by exploring lessons from the CDM. Section 4 reviews and assesses mechanisms that could help offsets achieve a net decrease. Section 5 estimates the potential scale of net decrease, including regions, activities, and mechanisms that might provide the best opportunity for a decrease. Finally, Section 6 discusses conclusions and implications.

2. DEFINING 'NET DECREASE AND/OR AVOIDANCE OF GHGS'

In the COP 17 decision cited above, the Parties called for mechanisms to "achieve a net decrease and/or avoidance of greenhouse gas emissions", but they did not specify the meaning of "net". Most simply, *net* could mean that each offset credit issued is associated with more abatement than credited, i.e. that the ratio of actual abatement to credits issued is greater than 1. However, the reference point – net of *what*? – is not clear. In particular, *net decrease* could be assessed against two different reference points:

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[1] Due to a variety of indirect effects, the presence of offsets may actually make it more or less likely that emissions targets will be met. For example, if offsets lower the costs of reducing emissions, they could increase the probability of meeting the target. Alternatively, if due to over-crediting or other factors, on average, a tonne CO_2 of offsets represented less than a tonne CO_2 of emission reductions, then the likelihood of meeting the target would be reduced.

[2] Throughout, we will use the terms *reduction*, *decrease*, and *avoidance* of GHG emissions interchangeably.

- **From the perspective of an offset instrument or individual offset activity:** Under this view, an offset instrument, or credit purchaser, would only need to demonstrate that actual emission reductions exceed the offset credits issued or used. (We address the question of "actual" – i.e. measurable, additional – emission reductions in Section 3.) For example, offset instruments could deliberately set emissions baselines below business-as-usual levels, so not all of the emission reductions yield offset credits.[3] The uncredited emission reductions could still be counted towards the host country's own emission reduction pledge, if it has one. (Roughly 95% of CERs issued to date originated in countries that have made emissions pledges under the Cancun Agreements.) In such a case, the net emission benefit would accrue to the host countries, in the form of assistance in meeting pledges. To the extent that a host country used the emission reductions achieved through offset instruments to help meet a pledge, rather than engage in other emission reduction activities, there would be no net decrease in global GHG emissions (see Cases 1 and 2 in Figure 1).
- **From the perspective of global GHG emissions:** Under this view of a net benefit, an offset instrument should lead to a net decrease in global emissions *beyond* what countries have already pledged, or net *atmospheric* benefit. As explained further below (see Figure 1), a net atmospheric benefit can occur only if an offset mechanism leads to emission reductions that are uncredited (or credited but not used) and that do not count towards meeting a host country target or pledge. These uncredited (or credited but not used) emission reductions would thus need to either: a) enable a host country to exceed pledged emission reductions; or b) occur in a host country that has no pledge.

It is not immediately clear which reference point the Parties in Durban intended to be used. If the goal is to increase mitigation ambition, then *net decrease* would need to be based on *global* GHG emissions. Or one could say more broadly that offsets would need to reduce global emissions below levels that would be reached in the absence of offsets. However, if the intent is to help developing countries meet their pledges, then a *net decrease* could be assessed from the perspective of the market mechanism itself.

The lack of a clear definition in the current negotiation text suggests the need to clarify two separate, but related concepts based on the two reference points above:

- *surplus reductions,* which occur when actual emission reductions associated with an offset instrument are greater than the number of credits issued; as an equation:

  (Surplus reductions) = (actual emission reductions) - (credits issued) (1)

- *net atmospheric benefit,* which occurs when an offset instrument leads to more global emission reductions than countries have pledged to achieve, and which depends on how offset units are accounted with respect to country pledges.

For example, consider the case of Least Developed Countries (LDCs), which do not have emissions pledges. Any surplus reductions from offset activities hosted by LDCs would not contribute to meeting an emissions pledge and therefore would lead directly to a net atmospheric benefit, reducing global emissions below pledged levels. Similarly, surplus reductions of GHGs or within sectors not covered by a host country pledge could also lead to a net atmospheric benefit.[4] By contrast, surplus reductions that contribute to meeting emission

[3] The CDM already calls for business-as-usual baselines to be conservative in order to account for uncertainties in baselines and monitoring, such that there is an adequate level of confidence in the GHG reductions.

[4] For example, China's pledge is for CO_2 only.

pledges could simply displace the need for other mitigation actions by the host country, with no net global GHG benefit.

Net atmospheric benefit could also occur without surplus reductions, if countries buying the credits were to cancel them instead of applying them towards a pledge. (Measures for achieving surplus reductions and net atmospheric benefit will be discussed in detail in Section 4.)

Therefore, as an equation:

(Net atmospheric benefit) = (2)

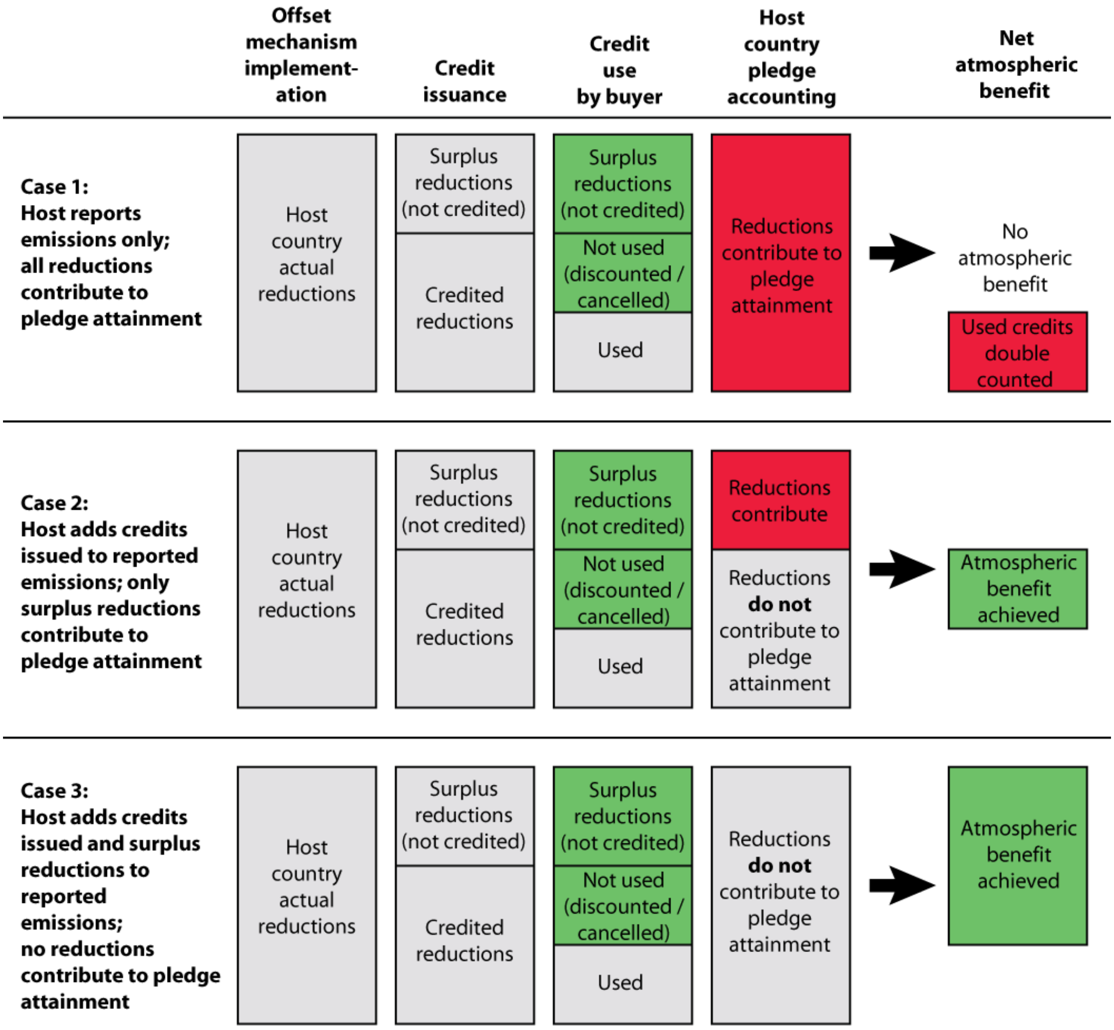
(surplus reductions)

\+ (credits cancelled or otherwise not used by buyers)

– (surplus or credited reductions that contribute to attainment of host country pledges)

Figure 1 illustrates the key terms in this equation and highlights the importance of the GHG emissions accounting rules applied to the host country.

Figure 1: Illustration of sources of net atmospheric benefit[5]



[5] Size of each source and quantity is not to scale.

Case 1 depicts a scenario in which emission reductions associated with the offset mechanism contribute to pledge attainment by the host country. This would occur if countries were to report their GHG emissions without adjusting for either offset credits issued or surplus reductions created.[6] In this case, the credited reductions would be double-counted, since they would contribute toward attainment of the pledges of both the host and buyer country. Not only would no net atmospheric benefit exist, but global GHG emissions might actually *increase* compared to the situation where these credited reductions did not exist.

Case 2 assumes that the host country adds the amount of offset credits issued to its reported emissions, avoiding double-counting. As with Case 1, any uncredited, surplus reductions that contribute to meeting the host country pledge would not generate a net atmospheric benefit. A net decrease in global GHG emissions would only result if a fraction of these issued credits were not used by the buyer – for example, as the result of cancellation or discounting (e.g. requiring the surrender of 5 credits for every 4 units of emissions to be offset).

Case 3 assumes that the host country adds both the offset credits used and the quantity of surplus reductions to its reported emissions, leading to the greatest net atmospheric benefit.[7]

Both Case 2 and Case 3 assume that countries would use accounting procedures that add back the amount of offsets issued to their reported emissions (i.e. if total emissions were 1,000 tonnes CO_2, and offsets worth 100 tonnes CO_2 were issued, the total reported emissions would be 1,100 tonnes CO_2). Case 3 would also require procedures to quantify and track the amount and vintage of surplus reductions, so that the appropriate amounts can be added back as well.[8] In both cases, further work would be needed to develop workable accounting procedures.[9]

The proper accounting of offset credits is an issue facing all pledge accounting and is not specific to the question of net atmospheric benefit. Unless addressed through accounting rules, the potential to double-count emissions reductions associated with offsets could present a significant risk to both the integrity and comparability of emissions pledges (Erickson and Lazarus 2013). As a result, addressing the issue of potential double-counting is likely to be a prerequisite to the achievement of any net atmospheric benefit.[10]

Pledge accounting aside, and as specified in equation 2, net atmospheric benefit can only exist if either: a) surplus reductions (as defined above) exist, or b) issued credits are cancelled or otherwise not used towards any pledges. The next chapter further explores how offsets could yield surplus reductions, drawing on lessons from the CDM to develop a set of considerations for evaluating the project types that would be good candidates for yielding surplus reductions.

3. ACHIEVING SURPLUS REDUCTIONS: LESSONS FROM THE CDM

The Clean Development Mechanism is the largest GHG offset mechanism to date, having issued its billionth credit in 2012, with the potential to issue 4 to 8 billion credits by 2020 (Kossoy and Guignon 2012). Parties to the UNFCCC designed the CDM to allow for flexibility in the location of emission reductions, thereby decreasing the cost of meeting

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[6] As at least one country (Brazil) has stated it intends to do this (Federative Republic of Brazil 2010).

[7] Note that surplus reductions can also lead to net atmospheric benefit to the extent that they enable a host country to lower its emissions below its pledge.

[8] For example, the amount of surplus reductions could be explicitly calculated and reported as part of development and use of crediting methodologies.

[9] Offset credits are often issued for monitoring periods that span multiple calendar years, and do not necessarily have a clear single-year vintage that can be used for host country accounting. Rules could be developed, for example, to assign additional vintages to offsets that represent the year in which emission reductions occur, rather than merely the year in which the offsets were issued.

[10] For further discussion of accounting for offset credits, and potential double-counting, see Prag et al. (2011).

emission targets under the Kyoto Protocol. Because the purchase of offset credits allows the buyer country to increase its own emissions by a corresponding amount above its target level, the CDM, in principle, should function as a "zero sum" instrument, with no effect on global GHG emissions levels. Emission reductions in developing (seller) countries are offset, one for one, with emission increases in industrialized (buyer) countries.

Per equation 2 in Section 2, a net atmospheric benefit could be achieved if, for example, two tonnes of actual emission reductions result in the issuance of only one CER (yielding one tonne of *surplus reduction* for each CER) and the host country does not count these surplus reductions towards a target. In this case, global emissions could decrease by one tonne per CER: a net atmospheric benefit. This section investigates evidence for surplus reductions achieved through the CDM. If the CDM is already yielding surplus emission reductions for certain project types, then it may provide lessons for how to achieve net atmospheric benefit in the *various approaches* and *new market mechanisms* called for at COP 17 (UNFCCC 2012c). Note that surplus reductions can only exist if CDM credits are truly additional, and if other issues (such as leakage and permanence) are adequately addressed, as will be discussed in the next section.

3.1 Potential for surplus reductions in the CDM

In the CDM and most other offset mechanisms, project credits are assessed relative to the (baseline) level of emissions that would have been expected had the CDM project activity not taken place. Because this "without CDM" baseline can never be known with certainty, actual emission reductions could be more or less than the number of credits awarded. For example, research has indicated that baselines have been set artificially high for some power sector projects (Michaelowa 2011) and for projects that reduce HFC-23 emissions (Schneider 2011), potentially leading to over-crediting of these projects. Emission reductions can also be overestimated if indirect emission effects, referred to as "leakage", are not properly taken into account. For example, evidence suggests that the incentives from crediting N_2O abatement in adipic acid plants led to production shifts and that, as a result, emission reductions were overestimated (Schneider et al. 2010).

On the other hand, other factors may lead to emission reductions being greater than the number of credits issued: *surplus reductions*, per the equation in Section 2. For example, some types of CDM projects may outlast the limit of the CDM's crediting periods (usually either 7 years, renewable twice, or 10 years without renewal), continuing to reduce emissions even as credits are no longer generated. This may be particularly likely for projects that generate revenues via long-lived capital stock, such as renewable energy projects.

CDM projects could also lead to surplus reductions when their baselines are set lower than expected "actual" emissions, or where discount or conservative parameters are introduced (Spalding-Fecher et al. 2012). For example, in the most recent version of the methodology AM0001 for calculating HFC emissions, CDM regulators purposefully set the baseline lower than expected to avoid perverse incentives for plant operators to artificially increase the rate of GHG generation (CDM Methodologies Panel 2011). Some monitoring methodologies require the use of "conservativeness factors" that effectively discount emission reductions in order to reflect the uncertainty inherent in specific measurement devices or methods, with the intent of limiting the risk of over-crediting. Similarly, where default values are used in lieu of actual measurement, these are generally conservative.[11] On an aggregate basis, these conservative factors and values may result in surplus reductions. Spill-over benefits, such as technology transfer and learning, can also lead to surplus reductions by catalyzing activities beyond the boundaries of CDM projects (Wang 2010).

Quantifying these potential sources of surplus reductions is difficult, in part because the "true" baseline emissions can never be known with certainty. One recent analysis conducted by the authors (Spalding-Fecher et al. 2012) estimated that, if all CDM projects are truly additional, consistent with the views of some project developers, and all wind and hydropower projects outlasted their crediting periods, then the CDM could yield (on average) up to 1.55 tonnes of emission reductions for each offset credit issued (See Box 1).

However, these surplus reductions (in fact, any emission reductions at all) only exist if the projects are additional: if they would not have occurred except for the incentive provided by the CDM (Gillenwater 2011). (Additionality, as well as baselines, can be further complicated by the fact that in some cases, the CDM may have the effect of accelerating investment; in other words, the same project activity – e.g. a hydropower project – would have occurred anyway, but several years later in the absence of the CDM incentive.)[12]

Unfortunately, additionality is most doubtful for the very same project types where under-crediting seems likeliest: power sector projects. Research suggests that these renewable energy (and higher-efficiency fossil fuel) technologies are already common practice and that the financial incentive provided by the CDM is in most cases too small to plausibly be responsible for their implementation (Lütken 2012; Lazarus and Chandler 2011; Bogner and Schneider 2011; He and Morse 2010; Schneider 2009b; Au Yong 2009; Wara and Victor 2008). It is therefore unlikely that these projects could contribute to surplus reductions. Supposing that only hydropower and wind projects where carbon revenues contribute at least a 20% return on investment were additional (Lütken 2012), the CDM could yield (on average) as few as 0.38 tonnes of emission reductions for each offset credit issued through 2020 (Spalding-Fecher et al. 2012; see Box 1).

[11] For example, project developers have asserted that use of default flare efficiencies for methane destruction projects underestimates actual flare performance, and that defaults for the fraction of non-renewable biomass are too low, thus leading to systematic under-crediting (Spalding-Fecher et al. 2012; Lee et al. 2013).

[12] In such cases, a project could result in fewer emission reductions than the number of credits issued, if the crediting period extends beyond the time at which the activity would have commenced.

Box 1: Surplus or deficit GHG reductions due to the CDM: Two scenarios

(Adapted from Spalding-Fecher et al. 2012)

The extent to which the CDM leads to either a surplus or deficit in reductions depends highly on one's perspective of the additionality of several project types. Under a "pessimistic" scenario reflecting critical perspectives found in the literature, the CDM could lead to a net increase of emissions. Alternatively, under an "optimistic" scenario of project additionality and under-crediting (a perspective often expressed by the project developer community), the CDM could lead to net surplus reductions.

In this example, a "pessimistic" scenario presented in a recent research report for the CDM Policy Dialogue (Spalding-Fecher et al. 2012) assumes that a) only projects where carbon revenues contribute at least a 20% return on investment are additional (per Lütken 2012); b) no surplus reductions should be claimed for operation beyond the crediting periods; and c) leakage has led to over-crediting of N_2O reductions at adipic acid plants. A contrasting "optimistic" scenario presented in the report assumes that a) all projects are additional; b) all power supply projects continue to reduce emissions beyond the end of their crediting periods, up until the end of their stated operational lifetimes (yielding 1.5 to 2 times as many reductions as CERs issued); c) for HFC projects the recent methodology change leads to under-crediting by a factor of 3 for future renewal of crediting periods; and d) conservativeness parameters lead to under-crediting by 5% for power supply projects and 10% for landfill gas projects.

Table 1: Net surplus (+) or deficit (-) reductions, cumulative to 2020 ($MtCO_2e$)

(parentheses indicate negative numbers)

		Pessimistic	Optimistic
Industrial gases			
HFC reduction / avoidance	Non-additional CERs	(91)	-
	Over-/under-crediting	-	382
	Subtotal	(91)	382
N_2O decomposition	Non-additional CERs	(46)	-
	Over-/under-crediting	(61)	18
	Subtotal	(107)	18
Methane recovery	Non-additional CERs	(291)	0
	Over-/under-crediting	-	40
	Subtotal	(291)	40
Renewable energy			
Hydropower	Non-additional CERs	(1,313)	-
	Over-/under-crediting	-	1,316
	Subtotal	(1,313)	1,316
	Non-additional CERs	(1,271)	-
Wind power	Over-/under-crediting	-	969
	Subtotal	(1,271)	969
	Non-additional CERs	(558)	-
	Over-/under-crediting	(1)	507
Other power supply	Subtotal	(559)	507
	Non-additional CERs	(3,571)	-
	Over-/under-crediting	(62)	3,232
Total of above	Total	(3,633)	3,232
	Total forecast CERs (IGES 2012b)	5,885	5,885
	"Actual" abatement as ratio of CERs	0.38	1.55

In summary, given the high uncertainty in the additionality of key project types, there is no evidence that the CDM as a whole is already leading (or likely to lead) to surplus reductions on its own. Rather, there are conditions that, if present, could lead to certain CDM project types yielding surplus reductions. They include:

- **High confidence in additionality**, meaning there is a high confidence that the CDM is causing the implementation of the projects.[13] If projects are not additional, then no emissions reductions can be ascribed to the offset mechanism, and no surplus reductions are generated. Surplus reductions can only exist if offsets are truly additional.
- **High confidence that the baseline scenario is realistic for all crediting periods**, meaning there is a high confidence that the baseline is realistic or conservative for the entire length of crediting (up to 21 years for normal CDM projects).[14]
- **High confidence that indirect emission effects (leakage) are appropriately addressed,** meaning that increases in upstream or downstream emissions (outside the boundary of the credited activity), are quantified or avoided.
- **High likelihood that the projects are leading to more actual abatement than credited with CERs.** In the CDM, this condition could hold true in either of two ways:[15]
    - **Use of discounts or conservativeness parameters,** such that the actual number of CERs credited is to be less than the actual abatement attained. Currently in the CDM, such discounts and parameters (as well as conservative baselines) are used to address uncertainty. The practice could also lead to surplus reductions. However, the precise quantity of surplus reductions would be difficult to determine, given uncertainties in the underlying parameters. Discounts could also be applied not to address uncertainty, but specifically to attain a net reduction in emissions (Schneider 2009a), as will be discussed in the next section.
    - **High likelihood that the emission-reducing activity will continue operation (and remain additional) beyond the project's crediting period.** If long-lived capital projects or other practices are likely to outlast the crediting period, they could yield surplus reductions. This situation may arise for projects that continue to generate revenues (e.g. power generation technologies) and which would still be considered additional at the end of the crediting period.

3.2 CDM project types most amenable to achieving surplus reductions

As indicated in the discussion above, achieving surplus reductions would only be possible via projects where additionality could be determined with high confidence. Analysts have suggested that additionality is relatively certain for projects that reduce emissions from the industrial gases

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[13] See Chapter 3 of the CDM Policy Dialogue's report on governance (Classen et al. 2012) for an analysis of the concept of additionality.

[14] Under current CDM rules, the baseline scenario is not re-assessed at the renewal of a crediting period. However, for some project types and sectors, future developments over a period of 21 years may be rather uncertain, and it may be difficult to establish a realistic baseline scenario for this entire period.

[15] It is also possible that the very use of offsets could, by lowering abatement costs, help deepen the ambition of future pledges. However, research for the CDM Policy Dialogue found no evidence that availability of offsets affected the ambition of targets under the Kyoto Protocol (Spalding-Fecher et al. 2012).

HFC-23 and N_2O, for manure management, and (perhaps to a lesser extent) for projects that capture methane at landfills and coal mines (Spalding-Fecher et al. 2012). In most cases, these projects would not be expected to occur except for the incentive provided by the CDM.

While some factors may lead to over-crediting for these project types, such as leakage at adipic acid projects as noted above, other factors may contribute to surplus reductions. For example, uncertainty discounts used for N_2O reduction projects at adipic acid and nitric acid plants and for emissions at solid waste landfills could (if all other factors were addressed) lead to emission reductions in these projects being under-credited by 5% to 10% (Spalding-Fecher et al. 2012). Similarly, the recent change in the baseline HFC-23 emissions methodology in AM0001 could lead to surplus reductions (CDM Methodologies Panel 2011).

However, these discounts are intended to reduce the risk of over-crediting; under-crediting is not assured, and would be difficult to quantify given the very uncertainties in the underlying parameters that the discounts are intended to address.

Discounts or other conservativeness parameters could also be applied with the specific intent of yielded surplus reductions (Schneider 2009a; Kollmuss and Lazarus 2011; Chung 2007), as will be discussed in more detail in the next section. However, for projects to be financially viable and proceed, the discount must not be so great as to reduce revenues below the marginal cost of abatement (including any transaction costs), or else CER revenues will not provide adequate financial incentive to pursue, implement, and operate projects.[16] Accordingly, discounts are most applicable for activities with marginal costs far below the expected price of offsets. Table 3 displays estimated marginal costs of activities for which additionality is relatively certain. With marginal costs of $1 per tonne or less, industrial gas projects could be particularly well suited to discounts. Even in these cases, however, uncertainty over the "true" baseline emissions level for activities make it difficult to know the exact amount of under-crediting.

Costs vary more widely for projects that capture methane at landfills, coal mines, wastewater treatment facilities, and livestock management systems. Because the costs can be much higher for these project types, discounting is less viable, because there may be less spread between a potential offset price and the actual marginal cost of the projects. Discounting credits from these activities may lead to a greater number of missed opportunities. Furthermore, a discount would have a greater impact on the viability of projects that depend on the CER revenues than it would on projects that are likely to proceed anyway (in part, perhaps, because they generate economic returns through the use or sale of the methane). In short, a discount is most applicable to activities with consistently low marginal costs, so that a discount would neither lead to significant incidence of missed opportunities nor disadvantage truly additional projects that rely on CDM revenues.

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[16] Discounting might also have the effect of increasing the price of CERs, however, which could help to compensate for some of the revenue lost by reducing the number of credits.

Table 2: Marginal costs of GHG abatement of selected activities included in the CDM

	Approximate marginal cost (USD per tonne CO_2e), not including transaction costs	Sources and notes for cost estimates
Industrial gases		
HFC reduction / avoidance	$0.28	US EPA (2006); TEAP (2007) says less than $0.20 per tonne
N_2O decomposition – adipic acid	$0.18	Schneider et al (2010); slightly higher than US EPA (2006, pp.IV–11)
N_2O decomposition – nitric acid	$0.50 - $1.00	US EPA (2006, pp.IV–11)
Methane recovery		
Landfill gas	$0 to $5 and higher[17]	US EPA (2006, pp.III–11)
Coal mine	$0 to $5	US EPA (2006, pp.II–11)
Manure	$0 to$35 and higher[18]	US EPA (2006)
Wastewater	$0 to $100 and higher[19]	US EPA (2012)

In summary, research on project types with significant activity under the CDM has helped to identify activities with high confidence in additionality and the capacity to yield more actual abatement than credits, the two key criteria for achieving a net reduction in emissions. Currently in the CDM, most industrial N_2O and HFC projects meet the first criterion. Furthermore, because these activities have consistently low marginal costs, they could be subject to a significant discount, in which case the second criterion could be met.[20]

Although this analysis has focused on project-based activities of the CDM, other types of mitigation activities may be able to meet these criteria. For example, discussions of new market mechanisms, sectoral crediting, and REDD+ have in some cases focused on ambitious baselines that would be set below business-as-usual and include an "own country" commitment. If such baselines could be confidently set below business-as-usual, then such mechanisms could meet these criteria.

4. MEASURES FOR ACHIEVING NET ATMOSPHERIC BENEFIT

So far, this paper has explored possible definitions of "net decrease" in emissions, developed definitions for *surplus reductions* and *net atmospheric benefit*, and developed a set of conditions for assessing what types of offset activities could be suitable for attaining surplus reductions. This chapter assesses the specific measures that could be employed to achieve surplus reductions and net atmospheric benefit: stringent baselines, discounting, shortened crediting periods, and unit cancellation.

We compare and examine each of these measures below in Table 3, considering how well suited each is to attaining surplus reductions and, if so, to a net atmospheric benefit, based on the following factors:

- Entity that implements the measure, since some measures (e.g. stringent baselines) will implicate the crediting program administrator (e.g. UNFCCC/CDM Executive Board) while others can be enacted by the host or buyer countries (e.g. unit cancellation);

[17] $5/tonne would capture about 75% of the abatement potential. MAC curve rises steeply beyond $5/tonne.
[18] $35/tonne would capture about 75% of the abatement potential. MAC curve continues to rise beyond $35/tonne.
[19] $100/tonne would capture about 25% of the abatement potential. MAC curve continues to rise beyond $100/tonne.
[20] To date, the second criterion has not been met, because these projects have been subject to concern over perverse incentives and/or emissions leakage. If these issues were addressed (discounting would help), then the second criterion could be met.

- Confidence that the measure will lead to surplus reductions, as some options are likely to be more (e.g. stringent baselines) or less (shortened crediting periods) certain to yield more actual emission reductions than credits issued;
- Extent of net atmospheric benefit, since it may be useful to understand the extent of net atmospheric benefit that individual crediting activities or entire mechanisms can achieve, and which can depend on how the surplus reductions are accounted;
- Whether the mechanism may lead to missed opportunities by affecting project economics to the extent that truly additional projects may be disadvantaged; and
- Extent of applicability to various activities and sectors.

For the purpose of clarity of the comparison, we assume that absent such measures, the underlying crediting mechanisms would otherwise accurately quantify the emission reductions that they create. In other words, we assume that additionality is correctly assessed, that crediting baselines reasonably represent business-as-usual emissions (i.e. baselines are not systematically over- or under-crediting), that indirect emission effects (leakage) are appropriately taken into account, and that non-permanence of emission reductions is addressed.[21] In reality, as noted above, in particular additionality and baselines are inherently challenging to determine with accuracy for most types of activities, and systematic bias could have an impact on net benefit larger than the effect of the measures explored here.

The first three options listed in Table 3 are measures that would generally need to be implemented by the crediting program administrator that would be responsible for approving (stringent baseline) methodologies, issuing credits (pre-issuance discounts), and establishing the (shortened) length of crediting periods.

Stringent baselines, wherein crediting baselines are set below business as usual levels, are perhaps the most often discussed method for achieving surplus reductions, particularly in the case of new, aggregated crediting mechanisms that would generate offsets for emission reduction across groups of sources (Prag and Briner 2012). To the extent that a BAU baseline can be determined with confidence, it would be relatively straightforward to establish a stringent baseline or crediting threshold lower than this level. Indeed, this lower-than-BAU crediting threshold is fundamental to the new market mechanism design advocated by the European Union, with the explicit purpose of generating surplus reductions (UNFCCC 2012b).

In contrast, **pre-issuance discounts** would be applied after a baseline and a monitoring methodology have been used to estimate emission reductions (or through provisions within a baseline and monitoring methodology), but before offset issuance (i.e. on the supply side). In some senses, discounts are already used to address uncertainty or avoid perverse incentives in the CDM and other offset programs (Kollmuss and Lazarus 2011; Schneider 2009a). If additionality and other offset quality criteria (per above) are relatively assured, then discounts can provide a high certainty of surplus reductions, and one that is easy to quantify: for example, a discount of 20% would lead to a surplus reduction of 1 / (1-0.20) -1 = 25%.[22]

Both pre-issuance discounts and stringent baselines reduce offset revenue and can therefore, in some cases, unintentionally disfavor investments that are truly additional and depend on the offset revenue to proceed and/or operate. This can lead to missed opportunities and

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[21] All of the mechanisms for achieving a net decrease depend on the underlying offset credits being additional and already yielding (before application of the mechanisms discussed here) surplus reductions: at least one tonne of actual abatement for each offset credit.

[22] For further details on discounts, see Kollmuss and Lazarus (2011) and Schneider (2009a).

discourage additional activities more than non-additional ones. For this reason, stringent baselines and pre-issuance discounts are most applicable for activities with relatively certain additionality but marginal costs well below the offset price. In such cases, these measures have the added feature of reducing windfall profits to project developers.

Stringent baselines and pre-issuance discounts differ in some key respects. Stringent baselines will tend to eliminate crediting for activities that provide only a small improvement in emissions performance (i.e. those that fall between a BAU and stringent baseline), whereas pre-issuance discounts could credit all activities that exceed BAU emission performance. Therefore, stringent baselines may be preferred if the intent is to only credit more significant improvements. Pre-issuance discounts may be simpler to apply than stringent baselines, as they do not require changes to individual methodologies, which might be particularly cumbersome for existing mechanisms (e.g. CDM). However, stringent baselines provide greater incentives than pre-issuance discounts to further reduce project emissions. If overall emission reductions are discounted, a further reduction in project emissions will provide the operator less than one credit. In contrast, under a stringent baseline a further reduction of project emissions is fully rewarded by one additional credit. Stringent baselines may therefore be more effective to achieve high mitigation levels in sectors where project emissions can be managed by the plant operators and depend on the incentives from the carbon market.

Shortened crediting periods would yield surplus reductions by offering fewer years in which offsets can be generated (Spalding-Fecher et al. 2012). They would yield surplus reductions to the extent that continued operation of a given facility or activity is not dependent on continued offset revenues (e.g. operating costs are lower than other revenues or benefits, as will likely be the case for renewable energy with no fuel costs). Relative to the two other options available to crediting mechanism administrators, shortened crediting periods offer the potentially valuable advantage of taking the “haircut” (reduction in credits) in the later years of a project or activity, and providing more “front-loaded” revenue, which can be appealing to investors, who often have limited confidence in the longevity of CDM revenues. Shortened crediting periods, however, are not an effective means to yield surplus reductions for activities which require continued revenue from carbon market units to operate the activity. For example, N_2O abatement in nitric acid plants may stop once the crediting period ends, as the N_2O abatement involves costs but no revenues for plant operators.

Offset purchasing countries have at least two options for achieving surplus reductions and net atmospheric benefit on their own (without measures being taken by the mechanism administrator or host country): **post-issuance discounts** (i.e. on the demand side) or **unit purchase and cancellation**. Buyer countries (or entities within them) can apply post-issuance discounts at the point where offsets are acquired or where they are used for compliance with an emission reduction obligation.[23] In such cases, offsets are not counted as full units when used for compliance with a country’s emissions target. This outcome is very similar to what would be achieved were the buyer country (or entity) to purchase and cancel a portion of the offsets purchased instead of using them for compliance with an emissions target (UNFCCC 2012a). They would be most alike if, in both cases, the units were acquired at market prices prior to unit discounting or cancellation.

[23] For example, the American Clean Energy and Security Act of 2009 (Waxman and Markey 2009) passed by the U.S. House of Representatives in 2009 would have valued international offsets at 1.25 offsets per emissions allowance, in effect a 20% discount or the forced cancelation of 20% of the number of international offsets purchased by capped entities.

Finally, host countries could conceivably elect to purchase and cancel a fraction of units issued in order to provide a direct net atmospheric benefit, and make their offset units more attractive to buyer countries seeking this benefit.

Table 3: Assessment of measures for offsets to achieve surplus reductions and net atmospheric benefit (where offsets originate from a sector/country with existing pledge)

<table>
<tr><th></th><th>Who implements measure</th><th>Confidence that surplus reductions will result[24]</th><th>Extent of net atmospheric benefit (with surplus reductions)</th><th>Risk of missed opportunities</th><th>Extent of applicability to various activities and sectors</th></tr>
<tr><td>Stringent baselines</td><td rowspan="3">Crediting mechanism administrator</td><td rowspan="2">Medium to high. Verifiable ERs are explicitly not credited, however may provide greater disincentive to additional vs. non-additional projects.</td><td rowspan="3">Depends on whether associated reductions are counted towards a host country / sector target or commitment</td><td rowspan="2">Some activities (those with marginal costs close to the offset price) may be rendered uneconomic[25]</td><td>Requires changes to each methodology Most effective for activities with relatively certain additionality, where BAU can be confidently known, and with low marginal abatement costs</td></tr>
<tr><td>Pre-issuance discounts</td><td>As above, but could be applied across activities without changes to individual methodologies</td></tr>
<tr><td>Shortened crediting periods</td><td>Medium to low, since surplus depends on emission-reducing activity continuing and continuing being additional beyond the crediting period, which adds uncertainty</td><td>Similar to above, but front-loads more revenue, likely leading to fewer missed opportunities Activities with only carbon market revenues may stop operation and lead to missed opportunities (e.g. industrial gas projects)</td><td>Types of activity likely to continue operation (sufficient non-offset benefit) after end of crediting periods (e.g., renewable energy)</td></tr>
<tr><td>Post-issuance discounts</td><td>Buyer country</td><td rowspan="2">These measures do not create surplus reductions (as defined above) since they do not affect the underlying offset crediting methodologies</td><td rowspan="2">Each unit cancelled and not used leads to corresponding net atmospheric benefit</td><td rowspan="2">If credits are first purchased at market prices, then cancelled or discounted, may have little impact,[26] otherwise impact similar to discount (above) in that discount may render some projects uneconomic</td><td rowspan="2">To any offset credit</td></tr>
<tr><td>Unit purchase and cancellation</td><td>Host or buyer country</td></tr>
</table>

[24] Key conditions outlined above include that additionality is correctly assessed, that crediting baselines reasonably represent business-as-usual emissions (i.e. they do not systematically over- or under-credit), that indirect emission effects (leakage) are appropriately taken into account, and that non-permanence of emission reductions is addressed.

[25] For example, imagine a project that requires USD 1,000 to yield 100 offset credits. This project would be economic at a cost of USD 10/tonne. Under a 20% discount, the project would yield 80 offset credits and therefor only be economic at USD 1,000 / 80 = USD 12.50/tonne (Kollmuss and Lazarus 2011).

[26] Discounting or retirement would have virtually no impact on offset flows and prices where an offset use limit is in place (e.g. as in the EU and California emission trading systems) and sufficient offsets are available up to this limit at market prices (Erickson, Lazarus and Larsen 2011; Erickson, Lazarus and Kelly 2011).

Note that, consistent with equation 2, net atmospheric benefit would not be created if the host country were to count credited or surplus reductions towards its own target. In order to create a net atmospheric benefit, the host country would need to add the reductions (as emissions) to its emissions account, for the purpose of assessing progress towards its pledge (Prag et al. 2011).

5. POTENTIAL SCALE OF NET MITIGATION BENEFIT

In principle, an offset mechanism could achieve a nominal net atmospheric benefit if it reduced global emissions by just one tonne more than the number of offset credits issued. However, if the Parties' intent in achieving a net decrease is to deepen global emission reductions and help close the emissions "gap" (UNEP 2011), then scale matters. In this section, we estimate the potential scale of net atmospheric benefit achievable in the year 2020 by discounting offsets (either pre- or post-issuance) and cancelling the resulting surplus reductions.

We take two alternative approaches to estimating scale. In the first, we select three CDM project types possibly amenable to achieving surplus reductions, consider expected CER issuance from these project types, and apply discounts based on an assessment of the marginal costs and offset prices. In the second, we assume a more generic offset mechanism that grows at the historically high end of inflow rates to the CDM, assume that any and all offsets are additional, and apply a discount to all credits. In this case, few precedents exist on which to base the level of the discount, and (unlike for the project-specific case above), little empirical basis exists for the choice of discount level. Given these limitations, we explore discount rates of 10% and 40%, which are half and double the 20% discount rate considered in previous national legislation in the U.S., one of the largest prospective buyers of offsets.[27]

5.1 Scale of net atmospheric benefit via selected CDM project types

As described in Section 3, the CDM provides lessons for how new market mechanisms or other various approaches could yield surplus reductions and, if not counted towards host country targets, also a net atmospheric benefit. Here we provide an estimate of the potential scale of net atmospheric benefit achievable in the year 2020 by focusing on the CDM project types most likely to yield surplus reductions. We choose 2020 as the year of analysis so that the resulting estimates may be put in context of countries' pledged abatement for the year 2020.

To calculate potential surplus reductions, we develop and apply hypothetical discount factors to HFC-23 and N_2O projects, which are the project types identified in Section 3 as being potentially amenable to achieving surplus reductions via a discount. For N_2O projects, we apply these discounts to expected abatement in the year 2020, which we assume to be equal to CER issuance as forecast by IGES. IGES forecasts take into account expected credit demand as well as risks that any new projects entering the project pipeline do not end up being registered (Point Carbon 2012; IGES 2012a).[28] For HFC-23 projects, we develop estimates of projected abatement associated with CDM projects based on monitoring and design data for the 19 registered projects, taking into account the actual performance of the plants and the length of the crediting periods.[29] In the case of HFC-23 projects, CER issuance will be about

[27] The U.S. is one of the largest potential buyers based on its total emissions and abatement needed to meet its 2020 pledge, but it has made no statements about the extent to which it may use offsets to meet the pledge.

[28] Note that our analysis covers offsets issued in the year 2020, not cumulative offset issuance from prior years.

[29] Note that we do not consider that some HCFC-22 plants could potentially stop production due to the accelerated phase-out of HCFCs under the 2007 amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer. However, it is yet unclear whether CDM plants will be affected, since HCFC-22 production for feedstock purposes is not regulated under the Montreal Protocol, and its growth is expected to compensate for the decline in production for emissive applications.

70% lower than actual abatement, due the revised HFC-23 methodology adopted by the CDM Executive Board in 2011. The revised methodology applies conservative approaches to emission reductions to address concerns over perverse incentives to increase HCFC-22 production or HFC-23 generation.

As shown in Table 4, applying significant discounts to existing CDM project types (so that CER revenue exactly covers project costs) could yield potential surplus reductions on the order of 111 to 136 million tonnes CO_2e in 2020 relative to the number of credits issued in that year, depending on offset prices (and in turn the extent of the discount possible).[30] [31]

Whether these reductions would contribute to a net atmospheric benefit depends, as described in Section 2, on whether these surplus reductions are absorbed as part of countries' pledges. Based on the portfolio of projects registered in the CDM pipeline (IGES 2012a), we estimate that at least half the reductions in industrial gas projects are likely to occur in sectors and/or countries not currently covered by a pledge. More specifically, of the CERs forecast to be issued in 2020, we estimate that approximately 80% of HFC-23 credits, 50% of N_2O adipic acid credits, and 60% of N_2O nitric acid credits will be issued from projects that are either in countries without pledges or are in China (for which we assume a literal interpretation of China's pledge to cover CO_2 only). This suggests that the potential net atmospheric benefit of these CDM projects by a discount alone is about 80 to 100 million tonnes CO_2e. If host countries where pledges cover these gases were to cancel these CERs instead of applying them towards their own pledges, then the mitigation benefit could be the full amount estimated in Table 4.

Table 4: Potential net surplus reductions in 2020 attainable by CDM projects

Project type	HFC-23 destruction	N_2O decomposition – adipic acid	N_2O decomposition – nitric acid
Expected abatement (offset issuance) in 2020[32] (Mt CO_2e)	98 (27)	29 (29)	18 (18)
Assumed marginal abatement cost (per Mt CO_2e)	$0.28	$0.18	$1.00[33]
Including transaction costs (per Mt CO_2e)	$0.50[34]	$0.98[35]	$5.20[36]
Assumed offset price	$5 (low) to $20 (high)	$5 (low) to $20 (high)	$5 (low) to $20 (high)
Discount (abatement not credited)	90% (low) to 97% (high)[37]	80% (low) to 95% (high)	None (low) to 74% (high)
Potential surplus reductions in 2020[38] (Mt CO_2e)	88 to 95	23 to 28	0 to 13
Total potential surplus reductions all 3 project types in 2020 (Mt CO_2e)			**111 to 136**

[30] As discussed above, discounts can discourage projects that are truly additional; in such cases, the surplus reductions could be less than we calculate here.

[31] For HFC-23 and N_2O from adipic acid, crediting is currently limited to operations that started before 2005. If newer plants were also credited with high discount rates, the surplus reduction potential could exceed 200 million tonnes CO_2e in 2020, given that only about half of HCFC-22 production in developing countries occurs in CDM plants.

[32] Per Point Carbon (2012), IGES (2012a). Given a lack of further detail on methodology, we assume that IGES forecast of CER issuance for HFC projects does not already take into account the reduction in *w* factor per recent change in HFC crediting methodology.

[33] Assumed at upper end of range from Table 2 so as not to render projects with lower costs uneconomic.

[34] Schneider (2011).

[35] Schneider et al (2010, p.7). 0.75 EUR/ton, converted to USD at rate of 1.3 USD to 1 EUR.

[36] Kollmuss and Lazarus (2010, p.7). 4 EUR/ton, converted to USD at rate of 1.3 USD to 1 EUR.

[37] As noted, the recent change in the HFC-23 methodology will already yield some surplus reductions and be equivalent to about a 70% discount.

[38] Calculated as forecast offset issuance multiplied by the hypothetical discount.

Achieving net mitigation benefit through industrial gas (HFC and N_2O) projects, however, will require that there is continued interest in using the CDM or other offset mechanisms for their abatement, and buyers for such offsets. The EU and Australia have banned the use of most HFC and N_2O credits issued after 2012 due to concerns about over-crediting, limited regional distribution of projects, and possible disincentives for countries to reduce these gases through other, lower-cost actions or policies. Furthermore, some suggest that further abatement of HFCs should occur instead through the Montreal Protocol and own country efforts (e.g. domestic regulation).

5.2 Scale of net mitigation benefit via scaled-up offset mechanism

In this section, we explore the potential for a scaled-up mechanism to deliver a net atmospheric benefit. In recent years, discussions about how to scale the offset market have suggested that new mechanisms and approaches could lead to offset issuance in 2020 on the order of 1 billion tonnes CO_2e (Point Carbon 2009; Erickson, Lazarus and Larsen 2011; Parpia 2009), much greater than more recent forecasts of CER issuance in 2020, which are on the order of 300 to 400 million tons CO_2e (Point Carbon 2012; BNEF 2012; Bellassen et al. 2012). Here we explore what would happen if an offset mechanism were to yield 300 million to 1 billion credits in 2020 corresponding to actual abatement of the same amount (i.e., that additionality and baselines can be confidently assessed and other issues, such as leakage, addressed).

Simply applying a discount to a potential offset usage of 300 million to 1 billion tonnes CO_2e could, to first order, yield surplus reductions approaching the forecast offset usage multiplied by the discount. (Because the discount would also decrease supply and increase prices, the market-clearing level of offsets, and corresponding net decrease, could actually be lower, depending on the shape of the supply and demand curves.)[39] For example, a system-wide offset discount of 10% could lead to surplus reductions of up to 30 to 100 million tonnes CO_2e; a discount of 40%, a decrease of up to 120 to 400 million tonnes. As in the CDM case above, the extent to which this discount would contribute to a net atmospheric benefit depends on the extent to which these reductions occur outside the pledge and whether the credits associated with reductions within a pledged sector or country contribute to pledge attainment or are instead cancelled.

To explore what fraction of the reductions might occur outside of existing country pledges, we apply a spreadsheet model previously used to estimate potential offset double-counting in 2020 (Erickson, Lazarus and Larsen 2011). The model uses relative abatement potentials and costs among countries (McKinsey & Company 2010), along with assumptions about the depth of countries' pledges[40] to calculate the market-clearing level of abatement in an idealized example where all countries' stated pledges are met exactly (e.g. Europe reduces emissions 20% below 1990 levels).[41]

By assuming that pledges are met exactly, any surplus reductions in a country with a pledge simply contributes to meeting the pledge and does not result in a net atmospheric benefit. As described in Section 2, surplus reductions only lead to a net atmospheric benefit if they are not used towards country targets. Surplus reductions in countries or sectors without pledges, however, would lead to a net atmospheric benefit.

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[39] As described in detail in Schneider (2009a).

[40] See the United Nations Environment Programme's climate pledges website, http://www.unep.org/climatepledges/.

[41] For further details on the model methodology, please see Erickson, Lazarus, and Larsen (2011). Here we discuss the "lower ambition", "current mechanism" case of that analysis, where offsets count only for the buyer, as outlined in Table 2 of Erickson, Lazarus, and Larsen (2011).

Our model estimates offset usage in 2020 of approximately 1,000 Mt CO_2e: 410 Mt CO_2e to satisfy demand in Europe, 270 Mt CO_2e for the United States, and 360 Mt CO_2e for other industrialized (Annex I) countries (Erickson, Lazarus and Larsen 2011). In the model, the majority of these offsets are sourced from developing countries with their own, quantified pledges: 880 Mt CO_2e, compared with 160 Mt CO_2e from countries without pledges.

This finding suggests that the potential for offsets to provide a net atmospheric benefit via discounts alone may be substantially limited by the fact that much of the low-cost abatement potential is in countries that have already made economy-wide (or nearly so) emission reducing pledges. Assuming that countries would still meet their GHG reduction pledges in the absence of offsets, then achieving a net atmospheric benefit would require that these countries not count the emission reductions from the offsets towards attainment of their pledges. This outcome could be achieved by adding the emission reduction amounts (whether credited or surplus reductions) to their emissions accounts for the purposes of assessing pledge attainment (Prag et al. 2011). In this case, discounts of 10% and 40% could yield (to first order) roughly up to 90 to 350 Mt CO_2e, respectively, of net atmospheric benefit.

For the reductions that occur outside pledged countries or sectors, applying a discount of 10% would yield (to first order) 16 Mt CO_2e of net atmospheric benefit; a discount of 40%, 64 Mt CO_2e. (In both cases, these estimates assuming that all offset credits are additional).

In summary, these analyses suggest:

- The existing CDM provides a limited opportunity for a net atmospheric benefit, because additionality is difficult to determine with high confidence for project types expected to provide the majority of CERs through 2020, especially power supply projects (Spalding-Fecher et al. 2012). Project types such as industrial gas projects, for which additionality is relatively certain and where discounts could be expected to lead to more abatement than credits issued, could yield a net atmospheric benefit on the order 120 million tonnes CO_2e in 2020, if host countries with Cancun pledges were not to use the surplus reductions for meeting their pledges.
- Were market mechanisms (whether reformed CDM or other mechanism) able to provide credits with relatively certain additionality and at a greater scale, they could, in theory, lead to a net atmospheric benefit in 2020 of roughly 64 million tonnes CO_2e via a (40%) discount alone, or up to 350 million tonnes if host countries with Cancun pledges were not to use the surplus reductions for meeting their pledges.

6. DISCUSSION AND IMPLICATIONS

This paper has explored the concept of a "net decrease and/or avoidance" of greenhouse gas emissions: what it might mean, how it might be achieved, and the potential scale of surplus reductions and net atmospheric benefit that could be attained in 2020. One of the most immediate questions is whether *net* is assessed from the perspective of an individual credited activity or crediting instrument (e.g. the CDM) or instead from the perspective of global greenhouse gas emissions. If the intent of the Parties at COP 17 in Durban was to achieve a net decrease in *global* GHGs, surplus emission reductions generated through stringent or ambitious baselines, discounting, or other means cannot simply contribute to a country meeting its existing pledge, but instead must lead to reductions beyond the pledges.

The largest offset mechanism to date, the CDM, presents some challenges for attaining a net decrease. Any net decrease requires a high degree of confidence in additionality, and in this respect the CDM – especially the large power sector projects expected to comprise the bulk of CERs going forward – is lacking. However, the CDM may offer some opportunities for net decrease, in particular, through industrial gas projects where additionality is relatively certain, discounts could lead to more emission reductions than credits issued, and emission reductions in many cases would occur outside countries' existing Cancun pledges. We estimate that these CDM projects could contribute to a net decrease of on the order of 100 million tonnes CO_2e in 2020. However, there is declining interest among major offset buyers, in particular the EU, in using CDM or other offset mechanisms for low-cost, industrial gas abatement.

It is likely that existing CDM projects will be able to provide more than enough CERs in 2020 to meet the demand implied by developed countries' Cancun pledges. On one hand, this low demand limits the scope for new mechanisms that could perhaps provide greater net benefits. On the other hand, it may provide a rationale for improvements to the CDM that could both address the forecast oversupply while also improving mitigation benefit. For example, our assessment has identified several mechanisms that could be employed by CDM administrators or major buyer countries, such as discounts and ambitious baselines (such as the recent change in *w* factor for HFC-23 destruction projects) that could take effect at crediting period renewals. Other changes are also possible, such as transitioning away from project types where additionality is least certain and, in the process, steering demand to project types where net benefits can be more confidently realized (Lazarus et al. 2012; Spalding-Fecher et al. 2012).

Parties at COP 17 issued a charge to develop market mechanisms that could lead to a "net decrease" in global greenhouse gas emissions. As we have described in this paper, achieving such a net decrease hinges on the ability to generate offset units for which additionality is relatively certain; measures (such as shortened crediting periods or pre-issuance discounts) that lead to more GHG abatement than credited, i.e. surplus reductions; and a means to account for any surplus reduction in a way that it does not simply contribute to meeting an existing GHG reduction pledge. One of the easiest ways for offsets to contribute to a net decrease is if they occur in countries outside existing GHG abatement pledges.[42] For offsets from countries covered by an emissions pledge, additional measures may be needed such as those discussed in Section 4, including post-issuance (buyer country) discounts or unit purchase and cancellation. As more countries could be expected to have pledges over time, measures such as these will be increasingly important for achieving a "net decrease" of global GHG emissions.

Finally, an important prerequisite to achieving a net atmospheric benefit is international agreement on how to treat offsets in pledge accounting, so that the same emissions reductions are not counted in both offset buyer and host country accounts. Without such agreement, which would facilitate the integrity and comparability of emissions pledges, serious discussion of achieving a net atmospheric benefit beyond such pledges is premature.

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[42] Though we note that the coverage (gases and sectors) of pledges could in some cases be improved.

REFERENCES

Au Yong, H. W. (2009). *Technical Paper: Investment Additionality in the CDM*. Ecometrica Press.

Bellassen, V., Stephan, N. and Leguet, B. (2012). *Will There Still Be a Market Price for CERs and ERUs in Two Years Time?* Climate Brief, #13. CDC Climat. http://www.cdcclimat.com/spip.php?action=telecharger&arg=1544.

BNEF (2012). *Carbon Markets - Global - Deep Dive: April 2012*. Bloomberg New Energy Finance, London, UK.

Bogner, M. and Schneider, L. (2011). Is the CDM Changing Investment Trends in Developing Countries or Crediting Business-as-Usual? – A Case Study on the Power Sector in China. In *Improving the Clean Development Mechanism : options and challenges post-2012*. M. Mehling, A. Steen, and K. Upston-Hooper (eds.). Lexxion, Berlin.

CDM Methodologies Panel (2011). *Information Note on AM0001*. Forty-Ninth Meeting Report, Annex 13. United Nations Framework Convention on Climate Change, Bonn, Germany. https://cdm.unfccc.int/Panels/meth/meeting/11/049/mp49_an13.pdf.

Chung, R. K. (2007). A CER discounting scheme could save climate change regime after 2012. *Climate Policy*, 7(2). 171–76. DOI:10.1080/14693062.2007.9685647.

Classen, M., Arumugam, P., Gillenwater, M., Olver, C., Lo, M., de Chazournes, L. B. and Swanepoel, E. (2012). *CDM Policy Dialogue Research Programme Research Area: Governance*. CDM Policy Dialogue. http://www.cdmpolicydialogue.org/research/1030_governance.pdf.

Erickson, P. A. and Lazarus, M. (2013). Implications of international GHG offsets on global climate change mitigation. *Climate Policy*, 13(4). 433–50. DOI:10.1080/14693062.2013.777632.

Erickson, P. A., Lazarus, M. and Kelly, A. (2011). Importance of programme design for potential US domestic GHG offset supply and quality. *Climate Policy*, 11(6). 1315–36. DOI:10.1080/14693062.2011.579314.

Erickson, P. A., Lazarus, M. and Larsen, J. (2011). *The Implications of International Greenhouse Gas Offsets on Global Climate Mitigation*. SEI Working Paper WP-US-1106. Stockholm Environment Institute-U.S. Center, Seattle, WA. http://www.sei-international.org/publications?pid=1858.

Federative Republic of Brazil (2010). Communication from the Government of Brazil to the United Nations Framework Convention on Climate Change. http://unfccc.int/files/meetings/application/pdf/brazilcphaccord_app2.pdf.

Gillenwater, M. (2011). *What Is Additionality? (In 3 Parts)*. Discussion Paper. Greenhouse Gas Management Institute, Silver Spring, MD. http://ghginstitute.org/2012/01/25/how-do-you-explain-additionality/.

He, G. and Morse, R. K. (2010). *Making Carbon Offsets Work in the Developing World: Lessons from the Chinese Wind Controversy*. Working Paper #90. Stanford University Program on Energy and Sustainable Development. http://pesd.stanford.edu/publications/making_carbon_offsets_work_in_the_developing_world_lessons_from_the_chinese_wind_controversy.

IGES (2012a). IGES CDM Project Database. 1 June. http://www.iges.or.jp/en/cdm/report_cdm.html#mi.

IGES (2012b). IGES CDM Project Data Analysis & Forecasting CER Supply. 1 May. http://www.iges.or.jp/en/cdm/report_cdm.html#cdm_a.

Kollmuss, A. and Lazarus, M. (2011). Discounting offsets: issues and options. *Carbon Management*, 2(5). 539–49. DOI:10.4155/cmt.11.49.

Kollmuss, A. and Lazarus, M. (2010). *Industrial N2O Projects Under the CDM: The Case of Nitric Acid Production*. SEI Working Paper WP-US-1007. Stockholm Environment Institute - U.S. Center. http://www.sei-international.org/publications?pid=1636.

Kossoy, A. and Guignon, P. (2012). *The State and Trends of the Carbon Market 2012*. The World Bank, Washington, DC. http://go.worldbank.org/FVAX4G7AQ0.

Lazarus, M. and Chandler, C. (2011). *Coal Power in the CDM: Issues and Options*. SEI Working Paper No. 2011-02. Stockholm Environment Institute, Stockholm, Sweden. http://www.sei-international.org/publications?pid=1974.

Lazarus, M., Erickson, P. and Spalding-Fecher, R. (2012). *Transitioning Away from Large-Scale Power Projects: a Simple and Effective Fix for the CDM?* SEI Policy Brief. Stockholm Environment Institute. http://www.sei-international.org/publications?pid=2204.

Lee, C., Chandler, C., Lazarus, M. and Johnson, F. X. (2013). *Assessing the Climate Impacts of Cookstove Projects: Issues in Emissions Accounting*. SEI Working Paper 2013-01. Stockholm Environment Institute. http://www.sei-international.org/publications?pid=2252.

Lütken, S. E. (2012). *Penny Wise, Pound Foolish? Is the Original Intention of Cost Efficient Emission Reductions Through the CDM Being Fulfilled?* UNEP Risø Climate Working Paper. http://www.uncclearn.org/sites/www.uncclearn.org/files/inventory/unep210.pdf.

McKinsey & Company (2010). *Impact of the Financial Crisis on Carbon Economics: Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve*. http://www.mckinsey.com/clientservice/sustainability/pdf/Impact_Financial_Crisis_Carbon_Economics_GHGcostcurveV2.1.pdf.

Michaelowa, A. (2011). *Rule Consistency of Grid Emission Factors Published by CDM Host Country Authorities*. Perspectives Climate Change, A Report for CDM Watch. http://www.cdm-watch.org/wordpress/wp-content/uploads/2011/02/rule_consistency_of_grid_emission_factors_published_by_CDM_host_country_authorities_14_Feb_2011-.pdf.

Parpia, A. (2009). *The Impact of Forestry on the Global Carbon Market*. New Carbon Finance.

Point Carbon (2012). Carbon Project Manager. 1 May. http://www.pointcarbon.com/trading/promopages/cpmpromo/.

Point Carbon (2009). *Sectoral Mechanisms: Will It Be a Piece of Cake?* PointCarbon Research. http://www.pointcarbon.com/research/carbonmarketresearch/analyst/1.1260103.

Prag, A. and Briner, G. (2012). *Crossing the Threshold: 'Ambitious' Baselines for the UNFCCC New Market Mechanism*. OECD/IEA Climate Change Expert Group Papers, No. 2012/02. Organisation for Economic Co-operation and Development, Paris. http://dx.doi.org/10.1787/2227779x.

Prag, A., Hood, C., Aasrud, A. and Briner, G. (2011). *Tracking and Trading: Expanding on Options for International Greenhouse Gas Unit Accounting after 2012*. Organisation for Economic Co-operation and Development and International Energy Agency, Paris. http://dx.doi.org/10.1787/5k44xwtzm1zw-en.

Schneider, L. (2011). Perverse incentives under the CDM: an evaluation of HFC-23 destruction projects. *Climate Policy*, 11(2). 851–64. DOI:10.3763/cpol.2010.0096.

Schneider, L. (2009a). A Clean Development Mechanism with global atmospheric benefits for a post-2012 climate regime. *International Environmental Agreements: Politics, Law and Economics*, 9(2). 95–111. DOI:10.1007/s10784-009-9095-9.

Schneider, L. (2009b). Assessing the additionality of CDM projects: practical experiences and lessons learned. *Climate Policy*, 9(3). 242–54. DOI:10.3763/cpol.2008.0533.

Schneider, L., Lazarus, M. and Kollmuss, A. (2010). *Industrial N2O Projects Under the CDM: Adipic Acid - A Case of Carbon Leakage?* SEI-US Working Paper WP-US-1006. Stockholm Environment Institute. http://www.sei-international.org/publications?pid=1621.

Spalding-Fecher, R., Achanta, A. N., Erickson, P., Haites, E., Lazarus, M., et al. (2012). *Assessing the Impact of the Clean Development Mechanism*. CDM Policy Dialogue. http://www.cdmpolicydialogue.org/research/1030_impact.pdf.

TEAP (2007). *Report of the Task Force on HCFC Issues (with Particular Focus on the Impact of the Clean Development Mechanism) and Emission Reduction Benefits Arising from Earlier HCFC Phase-out and Other Practical Measures*. Response to Decision XVIII/12. Technology and Economic Assessment Panel (TEAP) under the Montreal Protocol on Substances that Deplete the Ozone Layer.

U.S. EPA (2012). *Preliminary Draft Global Mitigation of Non-CO_2 Greenhouse Gases*. U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/climatechange/EPAactivities/economics/nonco2mitigation.html.

U.S. EPA (2006). *Global Mitigation of Non-CO_2 Greenhouse Gases*. EPA 430-R-06-005. U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/climatechange/economics/downloads/GlobalMitigationFullReport.pdf.

UNEP (2011). *Bridging the Emissions Gap: A UNEP Synthesis Report.* United Nations Environment Programme, Nairobi. http://www.unep.org/pdf/UNEP_bridging_gap.pdf

UNFCCC (2012a). *Various Approaches, Including Opportunities for Using Markets, to Enhance the Cost-effectiveness of, and to Promote, Mitigation Actions, Bearing in Mind Different Circumstances of Developed and Developing Countries: Technical Paper*. FCCC/TP/2012/4. United Nations Framework Convention on Climate Change, Bonn.

UNFCCC (2012b). *Views on the New Market-Based Mechanism: Submissions from Parties: Cyprus and the European Commission on Behalf of the European Union and Its Member States*. FCCC/AWGLCA/2012/MISC.6/Add.3. United Nations Framework Convention on Climate Change: Ad Hoc Working Group on Long-term Cooperative Action under the Convention.

UNFCCC (2012c). *Decision 2/CP.17: Outcome of the Work of the Ad Hoc Working Group on Long-term Cooperative Action Under the Convention*. FCCC/CP/2011/9/Add.1. United Nations Framework Convention on Climate Change, Bonn.

Wang, B. (2010). Can CDM bring technology transfer to China?—An empirical study of technology transfer in China's CDM projects. *Energy Policy*, 38(5). 2572–85. DOI:10.1016/j.enpol.2009.12.052.

Wara, M. and Victor, D. G. (2008). *A Realistic Policy on International Carbon Offsets*. Program on Energy and Sustainable Development Working Paper #74. Stanford University, Stanford, CA. http://pesd.stanford.edu/publications/a_realistic_policy_on_international_carbon_offsets/.

Waxman, H. A. and Markey, E. J. (2009). *American Clean Energy and Security Act of 2009*. H.R. 2454, as passed on June 26, 2009. U.S. House of Representatives. http://thomas.loc.gov/cgi-bin/query/z?c111:H.R.2454:

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