ENDANGERED HABITATS LEAGUE

DEDICATED TO ECOSYSTEM PROTECTION AND SUSTAINABLE LAND USE

EHL

May 7, 2018

VIA ELECTRONIC MAIL

San Diego County Planning Commission
ATTN: Lisa Fitzpatrick
5510 Overland Ave Suite 310
San Diego CA 92123

RE: Valiano Specific Plan and General Plan Amendment; Hearing Date, May 11, 2018, Item 2

Dear Chairman Pallinger and Member of the Commission:

Endangered Habitats League (EHL) *opposes* this proposed General Plan Amendment. For your reference, EHL is a long-term stakeholder in County planning endeavors and a Southern California regional conservation group.

There is no demonstrable need to amend the General Plan for this automobile-dependent proposal outside of Village boundaries on the basis of housing capacity. The County is in compliance with all RHNA and housing element requirements. Instead, we urge diligent build-out of existing Villages, and not undermining such build-out with competing units. The project itself is standard suburban density, presumably with no housing affordable to households with mean income levels.

In regard to land use, the project includes an outrageous proposal to remove Neighborhood 5 from the Elfin Forest-Harmony Grove subarea of the San Dieguito CPA so that the entire Project site would be located within the San Dieguito Community Plan. Any changes to community plan boundaries should considered comprehensively in the context of the community plan as a whole. Such changes should not be driven by the convenience of individual projects and decided in that narrow forum. This proposed boundary change is reason enough for project denial.

The GHG analysis is flawed. The project proposes to use "Option 2" within the County's recently adopted Climate Action Plan (CAP). The CPA, including its provisions for GPAs, is currently the subject of litigation. Option 2 for 'net zero' GHG emissions has no criteria for feasible on-site GHG reduction but rather depends upon the applicant's own and hardly objective assessments. Additionally, the project proposes to use "carbon offsets," which are inexpensive but also often ineffective if not illusory (see enclosures). The County even allows out-of-state and foreign offsets, which are outside of its monitoring and enforcement ability. *There are no local carbon credits available.* We urge you to reject this unaccountable and unsound scheme.

8424 SANTA MONICA BLVD SUITE A 592 LOS ANGELES CA 90069-4267 ♦ WWW.EHLEAGUE.ORG ♦ PHONE 213.804.2750

The integrity of the 2011 General Plan is at stake here and no compelling planning rationale has been advanced to change it.

Yours truly,

Dan Silver
Executive Director

Enclosures

Carbon Credits Likely Worthless in Reducing Emissions, December 2017
How additional is the Clean Development Mechanism? March 2016

ATTACHMENT Q

Carbon Credits Likely Worthless in Reducing Emissions, Study Says

Schemes allowed by the Paris climate agreement won't help countries reach their reduction targets, European report says, and should be phased out.

BY NICHOLAS KUSNETZ Follow @nkus

APR 19, 2017

Trading emissions credits from clean energy projects don't help reduce emissions, a new study says. Credit: Getty Images

As nations grapple with how they can slash their emissions as part of the **Paris climate agreement**, some may use international credit schemes that were approved in the treaty process. A new **report from the European Commission** casts serious doubts about such credits, however, concluding that the vast majority of them likely fail to actually reduce emissions.

The report, which was written last year but not published until this April, concludes that buying and selling emissions credits for overseas projects should be limited to a select list that meet rigorous standards, and used only as part of a transition to more effective policies for mitigating greenhouse gas emissions.

"Given the inherent shortcomings of crediting mechanisms, we recommend focusing climate mitigation efforts on forms of carbon pricing that do not rely extensively on credits," the report said, adding that credits should play only a limited role after 2020.

"It's a confirmation that offsetting is fundamentally problematic," said Aki Kachi, international policy director for **Carbon Market Watch**, an advocacy group in Brussels.

The study examined the **Clean Development Mechanism**, created under the Kyoto Protocol to allow countries to offset emissions by purchasing credits linked to green-energy projects on an international market. The system allows a power plant in Germany, for example, to buy credits for the emissions savings from a wind farm in India.

The problem, the report says, is that the Indian wind farm likely would have been built anyway, even without the credits purchased by the Germans. In emissions-trading lingo, the reduction would be considered not "additional."

"Overall, our results suggest that 85 percent of the projects covered in this analysis and 73 percent of the potential 2013-2020 Certified Emissions Reduction (CER) supply have a low likelihood that emission reductions are additional and are not over-estimated," said the report, which was prepared by the Öko-Institut e.V., a German research group. "Only 2 percent of the projects and 7 percent of potential CER supply have a high likelihood of ensuring that emission reductions are additional and are not over-estimated."

In short, the vast majority of credits are unlikely to actually reduce emissions. And while the report examined the Clean Development Mechanism specifically, it said that many of the problems are inherent to emissions crediting schemes, and that the lessons learned would likely apply elsewhere.

Carbon offset credits were included as part of the Kyoto Protocol, but have fallen out of favor after scandals in Europe and poor performance, Kachi said. Some countries now decline to use them and the **European Union plans to prohibit international trading** after 2020.

The Paris Agreement left the door open on emissions trading, but it left the details undefined, Kachi said.

"Two years later we're supposed to have more detailed rules for how these things will work under the Paris Agreement, but there's been no progress," he said. "It's a controversial issue that the world definitely has found no consensus over."

PUBLISHED UNDER:
GLOBAL CLIMATE TREATY
PARIS CLIMATE AGREEMENT

ATTACHMENT P

www.oeko.de

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

How additional is the Clean Development Mechanism?

Analysis of the application of current tools and proposed alternatives

Berlin,
March 2016

Study prepared for DG CLIMA
Reference: CLIMA.B.3/SERI2013/0026r

Authors

Dr. Martin Cames (Öko-Institut)
Dr. Ralph O. Harthan (Öko-Institut)
Dr. Jürg Füssler (INFRAS)
Michael Lazarus (SEI)
Carrie M. Lee (SEI)
Pete Erickson (SEI)
Randall Spalding-Fecher (Carbon Limits)

Head Office Freiburg
P.O. Box 17 71
79017 Freiburg
Street address
Merzhauser Straße 173
79100 Freiburg
Tel. +49 761 45295-0

Office Berlin
Schicklerstraße 5-7
10179 Berlin
Tel. +49 30 405085-0

Office Darmstadt
Rheinstraße 95
64295 Darmstadt
Tel. +49 6151 8191-0

info@oeko.de
www.oeko.de

Partner

INFRAS

SEI

INFRAS
Binzstrasse 23
8045 Zürich, Switzerland
Tel.: +41 44 205 95 95

Stockholm Environment Institute (SEI)
1402 Third Avenue, Suite 900
Seattle, WA 98101, USA
Tel.: +1 206 547-4000

We thank Lambert Schneider for reviewing the study and for his valuable comments and suggestions.

Contents

List of boxes

List of figures

List of tables

Abbreviations

CAR	Climate Action Reserve
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFL	Compact Fluorescent Lamp
CO_2	Carbon Dioxide
CORSIA	Carbon Offset and Reduction Scheme for International Aviation
CP	Crediting Period
CPA	Component Project Activity of a PoA
DOE	Designated Operational Entity
EB	Executive Board of the CDM
ETS	Emissions Trading Scheme/System
f_{NRB}	Fraction of non-renewable biomass
GHG	Greenhouse Gas
GS	Gold Standard
JCM	Joint Crediting Mechanism
LED	Light Emitting Diode
MP	Methodologies Panel under the CDM EB
MRV	Monitoring, Reporting & Verification
NDC	Nationally Determined Contribution
NRB	Non-renewable Biomass
OECD	Organisation for Economic Co-operation and Development
PDD	Project Design Document
PMR	Partnership for Market Readiness (Initiative of the World Bank)
PoA	Programme of Activities
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VCS	Verified Carbon Standard

Executive summary

With the adoption of the Paris Agreement, which establishes a mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development (Article 6.4), it is clear that the Clean Development Mechanism (CDM) as a mechanism of the Kyoto Protocol will end. However, in terms of its standards, procedures and institutional arrangements, the CDM certainly forms an important basis for the elaboration and design of future international crediting mechanisms.

While this study provides important insights to **improve the CDM up to 2020**, the approach taken in this study could **also be applied more generally both to assess the environmental integrity of other compliance offset mechanisms**, as well as to avoid flaws in the design of new mechanisms being used or established for compliance. Many of the shortcomings identified in this study are inherent to crediting mechanisms in general, not least the considerable uncertainty involved in the assessment of additionality and the information asymmetry between project developers and regulators.

A fundamental feature of both the CDM and the mechanism under Article 6.4 is that they aim to achieve environmental integrity by ensuring that only real, measurable and additional emission reductions are generated. This study analyzes the opportunities and limits of the current CDM framework for ensuring environmental integrity, i.e. that projects are additional and that emission reductions are not overestimated. It looks at the way in which the CDM framework has evolved over time, assesses the likelihood that emission reductions credited under the CDM ensure environmental integrity and provides findings on the overall and project-type-specific environmental integrity of the CDM. In addition, it provides lessons learned and recommendations for improving additionality assessment that can be applied to crediting mechanisms generally, including to mechanisms to be used for compliance under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), and to mechanisms to be implemented under Article 6 of the Paris Agreement.

To ensure robust judgements, we have systematically analyzed the determination of additionality, the determination of baseline emissions and other issues that are key for environmental integrity. Towards this goal, we have evaluated those general CDM rules that are particularly relevant for environmental integrity and assessed in the case of specific project types the likelihood that they deliver real, measurable and additional emission reductions. Based on our analysis **key findings** include the following:

- Most **energy-related project types** (wind, hydro, waste heat recovery, fossil fuel switch and efficient lighting) are **unlikely to be additional**, irrespective of whether they involve the increase of renewable energy, energy efficiency improvements or fossil fuel switch.
- **Industrial gas projects** (HFC-23, adipic acid, nitric acid) are **likely to be additional** as long as the mitigation is not otherwise promoted or mandated through policies.
- **Methane projects** (landfill gas, coal mine methane) have a **high likelihood of being additional**.
- **Biomass power projects** have a **medium likelihood of being additional** overall because the assessment of additionality very much depends on the local conditions of individual projects.
- The additionality of the current pipeline of **efficient lighting projects** using small-scale methodologies is **highly unlikely** because in many host countries the move away from incandescent bulbs is well underway.

- In the case of **cook stove projects**, CDM revenues are often insufficient to cover the project costs and to make the project economically viable. Cook stove projects are also likely to considerably **over-estimate the emission reductions** due to a number of unrealistic assumptions and default values.

Overall, our results suggest that 85% of the projects covered in this analysis and 73% of the potential 2013-2020 Certified Emissions Reduction (CER) supply have a low likelihood that emission reductions are additional and are not over-estimated. Only 2% of the projects and 7% of potential CER supply have a high likelihood of ensuring that emission reductions are additional and are not over-estimated.

Our analysis suggests that the **CDM still has fundamental flaws in terms of overall environmental integrity**. It is likely that the large majority of the projects registered and CERs issued under the CDM are not providing real, measurable and additional emission reductions.

When considering the Paris Framework, the most important change from the Kyoto architecture is that all countries have made mitigation pledges in the form of Nationally Determined Contributions (NDC). An important implication is that host countries with ambitious and economy-wide mitigation pledges have **incentives to limit international transfers of credits** to activities with a **high likelihood of delivering additional emission reductions**, so that transferred credits do not compromise the host country's ability to reach their own mitigation targets. A second important implication is that countries should **only transfer emission reductions where this is consistent with their NDC**, implying that baselines may have to be determined in relation to the host country's mitigation pledges rather than using a 'counterfactual' business as usual scenario as a default.

Taking into account this context and the findings of our analysis, we recommend that the role of crediting in future climate policy should be revisited:

- We recommend potential buyers of CERs to limit any **purchase of CERs** to either **existing projects which risk discontinuing GHG abatement** when the incentive from the CDM ceases, such as landfill gas flaring or to new **projects among** the few project types identified t**hat have a high likelihood of ensuring environmental integrity**.
- Buyers should **accompany purchase of CERs with support for a transition of host countries to broader and more effective climate policies**. In the short–term, where offsetting is used, it should only be on the basis that purchase of CERs does not undermine the ability of host countries to achieve their mitigation pledges.
- Given the inherent shortcomings of crediting mechanisms, we recommend focusing **climate mitigation efforts** on forms of carbon pricing **that do not rely extensively on credits** and on measures such as results-based climate finance that does not result in the transfer of credits or offsetting the purchasing country's emissions. International crediting mechanisms should play a limited role after 2020, to address specific emission sources in countries that do not have the capacity to implement alternative climate policies.
- To enhance the environmental integrity of international crediting mechanisms such as the CDM and to make them more attractive to both buyers and host countries with ambitious NDCs, we recommend limiting such mechanisms to **project types** that have a **high likelihood of delivering additional emission reductions**. We also recommend reviewing methodologies systematically to address risks of over-crediting, as identified in this report.
- We also recommend provisions that provide strong incentives to the Parties involved to ensure the integrity of international unit transfers. This includes robust accounting provisions to **avoid double counting** of emission reductions, but could also extend to other elements, such as im-

plementation of **ambitious mitigation pledges** as a prerequisite to participating in international mechanisms.

With the adoption of the Paris Agreement, implementing more effective climate policies becomes key to bringing down emissions quickly on a pathway consistent with well below 2°C. Our findings suggest that **crediting approaches** should play a **time-limited and niche role** focusing on those project types for which additionality can be relatively assured. Crediting should serve as a stepping-stone to other, more effective policies to achieve cost-effective mitigation. Continued support to developing countries will be key. We recommend using new innovative sources of climate finance, such as revenues from auctioning of emission trading scheme allowances, rather than crediting for compliance, to support developing countries in implementing their NDCs.

Summary

Aim of the study

With the adoption of the Paris Agreement, which establishes a mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development (Article 6.4), it is clear that the role of the CDM as a mechanism of the Kyoto Protocol will end. However, in terms of its standards, procedures and institutional arrangements, the **CDM** certainly forms an **important basis** for the elaboration and design of future mechanisms for international carbon markets. One key feature of both the CDM and the mechanism under Article 6.4 is that they should generate **real and additional** emission reductions. In other words, emission reductions that are credited and transferred should not have occurred in the absence of the mechanism and should not be overestimated. This study analyzes the opportunities and limits of the current CDM framework and the way in which it has evolved over time and been applied to concrete projects. It provides findings on the **overall and project-type-specific environmental performance of the CDM** in the form of estimates of the **likelihood that the CDM results in real and additional emission reductions**. In addition, it provides lessons and recommendations for improving additionality assessment that can be applied to future crediting mechanisms.

Methodological approach

The main focus of this study is to assess the extent to which the CDM meets its objective to deliver "real, measurable and additional" emission reductions. In order make well-founded judgements about the overall and project-type-specific likelihood of additionality of CDM projects, we systematically analyze CDM rules and how they have been applied to real projects in practice. We examined the rules for 1) **additionality assessment**, for 2) the **determination of baseline emissions** and 3) a number of **other issues** including the length of crediting period, leakage effects, perverse incentives, double counting, non-permanence, monitoring provisions and third party validation and verification. We approach these aspects from two different perspectives: we evaluate 1) **general CDM rules** that are particularly relevant for the delivery of real, measurable and additional emission reductions and we evaluate 2) **specific project types** with a view to assessing how likely these project types deliver additional emission reductions. To assess the impacts of our analysis, we further estimate the **potential 2013-2020 CER supply** from different project types.

Project-types-specific results

Table 1-1 (p. 13) below provides an overview of the findings on environmental integrity based on the detailed analysis of individual project types. **Most energy-related project types** (wind, hydro, waste heat recovery, fossil fuel switch and efficient lighting) are **unlikely to be additional**, irrespectively of whether they involve the increase of renewable energy, efficiency improvements or fossil fuel switch. An important reason why these projects types are unlikely to be additional is that the revenue from the CDM for these project types is small compared to the investment costs and other cost or revenue streams, even if the CER prices would be much higher than today. Moreover, many projects are economically attractive, partially due to cost savings from project implementation (e.g. fossil fuel switch, waste heat recovery) or domestic support schemes (renewable power generation).

Table 1-1: How additional is the CDM?

	CDM projects			Potential CER supply 2013 to 2020		
	Low	Medium	High	Low	Medium	High
	... likelihood of emission reductions being real, measurable, additional					
	No. of projects			Mt CO_2e		
HFC-23 abatement from HCFC-22 production						
Version <6		5			191	
Verson >5			14			184
Adipic acid		4			257	
Nitric acid			97			175
Wind power	2.362			1.397		
Hydro power	2.010			1.669		
Biomass power		342			162	
Landfill gas		284			163	
Coal mine methane		83			170	
Waste heat recovery	277			222		
Fossil fuel switch	96			232		
Cook stoves	38			2		
Efficient lighting						
AMS II.C, AMS II.J	43			4		
AM0046, AM0113			0			0
Total	4.826	718	111	3.527	943	359

Sources: Authors own calculations

Industrial gas projects (HFC-23, adipic acid, nitric acid) can generally be considered **likely to be additional** as long as they are not promoted or mandated through policies. They use end-of-pipe-technology to abate emissions and do not generate significant revenues other than CERs. HFC-23 and adipic acid projects triggered strong criticism because of their relatively low abatement costs, which provided perverse incentives and generated huge profits for plant operators. In the case of HFC-23 and nitric acid projects, perverse incentives have been adequately addressed. With regard to **adipic acid** projects, the risks for **carbon leakage have not yet been addressed**.

Methane projects (landfill gas, coal mine methane) also have a **high likelihood of being additional**. This is mainly because carbon revenues have, due to the GWP of methane, a relatively large impact on the profitability of these project types. However, both project types face **issues with regard to baseline emissions and perverse incentives** and may thus lead to over-crediting.

Biomass power projects have a **medium likelihood of being additional** since their additionality very much depends on the local conditions of individual projects. In some cases, biomass power can already be competitive with fossil generation while in other cases domestic support schemes provide incentives for increased use of biomass in electricity generation. However, where these conditions are not prevalent, projects **can be additional**, particularly if CER revenues for **methane avoidance can be claimed**. Biomass projects also face other issues, in particular with regard to demonstrating that the **biomass used is renewable**.

The additionality of **efficient lighting** projects using small-scale methodologies is **highly problematic** because there were large PoAs in countries in which the move away from incandescent bulbs was well underway. The **new methodologies** address these problems but they are **not mandatory** and the small-scale methodologies are, while the remaining small-scale methodology could still allow for automatic additionality for CFL programmes.

For **cook stove** projects, CDM revenues are often insufficient to cover the project costs and to make the project economically viable. Particularly in urban areas, the additionality of these project types is questionable. Cook stove projects are also likely to considerably over-estimate the emission reductions due to a number of unrealistic assumptions and default values.

Overall environmental assessment

Based on these considerations, we estimate that **85% of the covered projects and 73% of the potential 2013-2020 CER supply have a low likelihood** of ensuring environmental integrity (i.e. ensuring that emission reductions are additional and not over-estimated). Only **2% of the projects and 7% of potential CER supply have a high likelihood** of ensuring environmental integrity. The remainder, 13% of the projects and 20% of the potential CER supply, involve a medium likelihood of ensuring environmental integrity (Table 1-1, p. 13).

Compared to earlier assessments of the environmental integrity of the CDM, our analysis suggests that the CDM's **performance as a whole has anything but improved**, despite improvements of a number of CDM standards. The main reason for this is a **shift in the project portfolio towards projects with more questionable additionality**. In 2007, CERs from projects that do not have revenues other than CERs made up about two third of the project portfolio, whereas the 2013-2020 CER supply potential of these project types is only less than a quarter. A second reason is that the **CDM Executive Board (EB)** has not only improved rules but also **made simplifications** that undermined the integrity. For example, positive lists have been introduced for many technologies, for some of which the additionality is questionable and some of which are promoted or required by policies and regulations in some regions (e.g. efficient lighting). A third reason is that the **CDM EB** did not take effective means to **exclude project types** with a low likelihood of additionality. While positive lists have been introduced, project types with more questionable additionality have not been excluded from the CDM. Standardized baselines provide a further avenue to demonstrating additionality but do not reduce the number of projects wrongly claiming additionality. The improvements to the CDM mainly aimed at **simplifying requirements and reducing the number of false negatives** but did not address the false positives.

The result of our analysis therefore suggests that the **CDM has still fundamental flaws in terms of environmental integrity**. It is likely that the large majority of the projects registered and CER issued under the CDM are not providing real, measureable and additional emission reductions. Therefore, the experiences gathered so far with the CDM should be used to improve both the CDM rules for the remaining years and to avoid flaws in the design of new market mechanisms being established under the UNFCCC.

Recommendations for improving general additionality rules

For an additionality test to function effectively, it must be able to assess, with high confidence, whether the CDM was the deciding factor for the project investment. However, additionality tests can never fully avoid wrong conclusions. **Information asymmetry** between project developers and regulators, combined with the economic incentives for project developers to have their project recognised as additional, are a major challenge. We carefully scrutinised the **four main approaches** used to determine additionality. Our analysis shows that **prior consideration** is a necessary and important but not sufficient step for ensuring additionality of CDM projects and that this step largely works as intended. The subjective nature of the **investment analysis** limits its ability to assess with high confidence whether a project is additional. Especially for project types in which the financial impact of CERs is relatively small compared to variations in other parameters, such as large power projects, doubts remain as to whether investment analysis can provide a strong 'signal to noise' ratio. The **barrier analysis** has lost importance as a stand-alone approach of demonstrating additionality. Non-monetized barriers remain subjective and are often difficult to verify by the DOEs. In general, the **common practice analysis** can be considered a more objective approach than the barriers or investment analysis due to the fact that information on the sector as a whole is considered rather than specific information of a project only. However, the way in which common practice is currently assessed needs to be substantially reformed to provide a reasonable means of demonstrating additionality; it is important to reflect that market penetration is not for all project types a good proxy for the likelihood of additionality.

Against this background, we recommend that the **common practice analysis** is given a **more prominent role in additionality determination** though only after a significant reform:

- The 'one-size-fits-all' approach of determining common practice should be replaced by **sector- or project-type-specific guidance**, particularly with regard to distinguishing between different and similar technologies and with regard to the threshold for market penetration.
- The **technological potential** of a certain technology should also be taken into account in order to avoid that a project is deemed additional although the technological potential is already largely exploited in the respective country.
- The common practice analysis should at least cover the **entire country**. However, if the absolute number of activities in the host country does not ensure statistical confidence, the scope needs to be extended to other countries.
- As a default, all CDM projects should be included in the common practice analysis, unless a methodology includes different requirements.

We further recommend that the **investment analysis** is excluded as an approach for demonstrating additionality for projects types in which the 'signal to noise' ratio is insufficient to determine additionality with the required confidence. For those project types in which the investment analysis would still be eligible, the project participant must confirm the all information is true and accurate and that the investment analysis is consistent with the one presented to debt or equity funders. The **barrier analysis** should be abolished entirely as a separate approach in the determination of additionality at project level (though it may be used for determining additionality of project types). Barriers that can be monetized should be addressed in the investment analysis while all other barriers should be addressed in the context of the reformed common practice analysis.

In addition, we recommend improvements to key general CDM rules:

- **Renewal and length of crediting periods:** At the renewal of the crediting period the validity of the baseline scenario should be assessed for CDM project types for which the baseline is the 'continuation of the current practice' or if changes such as retrofits could also be implemented in the baseline scenario at a later stage. Crediting periods of project types or sectors that are highly dynamic or complex should be limited to one single crediting period. Moreover, generally abolishing the renewal of crediting periods while allowing a somewhat longer single crediting period for project types that require a continuous stream of CER revenues to continue operation may be considered.
- **Positive Lists:** The review of validity should also be extended to project types covered by the microscale additionality tool. In addition, positive lists must address the impact of na-

tional policies and measures to support low emission technologies (so-called E- policies). To maintain environmental integrity of the CDM overall, positive lists should be accompanied by negative lists.

- **Standardized baselines:** Once established in a country, their use should be made mandatory and all CDM facilities should be included in the peer group used for the establishment of standardized baselines.
- **Consideration of domestic policies (E+/E-):** The risk of undermining environmental integrity by over-crediting emission reductions is likely to be larger than the creation of perverse incentives for not establishing E- policies. Therefore, adopted policies and regulations reducing GHG emissions (E-) should be included when setting or reviewing crediting baselines while policies that increase GHG emissions (E+) should be discouraged by being excluded from the crediting baseline where possible.
- **Suppressed demand:** An expert process should be established to balance the risks of over-crediting with the potential increased development benefits. In addition, the application of suppressed demand could be restricted to countries where development needs are highest and the potential for over-crediting is the smallest.

Recommendations to improve project type specific rules

Industrial gas projects: Adipic acid production is a highly globalised industry and all plants are very similar in structure and technology. Therefore, a global benchmark of 30 kg/t applied to all plants would prevent carbon leakage, considerably reduce rents for plant operators, and allow the methodology to be simplified by eliminating the calculation of the N_2O formation rate. After issues related to perverse incentives have been successfully addressed through ambitious benchmarks, **HFC-23** and **nitric acid** projects would provide for a high degree of environmental integrity. However, industrial gas projects provide for low-cost mitigation options. These emission sources could therefore also be addressed through domestic policies, such as regulations, or by including the emission sources in domestic or regional ETS, and help countries achieve their Nationally Determined Contributions (NDCs) under the Paris Agreement. Parties to the Montreal Protocol are also considering regulating HFC emissions. We therefore recommend that HFC-23 projects are not eligible under the CDM.

Energy-related project types: We recommend **that these project types should, in principle, no longer be eligible** under the CDM. However, in least developed countries, some project types, particularly wind and small-scale hydropower plants, may still face considerable technological and/or cost barriers. These project types may thus remain **eligible in least developed countries**. In cases in which **biomass power generation** is not competitive with fossil generation technologies, CER revenues can have a significant impact on the profitability of a project, particularly if credits for methane avoidance are claimed as well. We therefore recommend that only biomass power projects avoiding methane emissions remain eligible under the CDM, provided that the corresponding provisions in the applicable methodologies are revised appropriately.

With regard to **demand-side energy efficiency** project types with distributed sources – **cook stoves** and **efficient lighting** – we have identified concerns which question their overall environmental integrity. However, if cook stove methodologies were revised considerably, including more appropriate values for the fraction of non-renewable biomass and if approaches for determining the penetration rate of efficient lighting technologies were made mandatory for all new projects and CPAs while the older methodologies are withdrawn, we recommend that these project types should remain eligible.

Methane projects: Landfill gas and **coal mine methane** projects are likely to be additional. However, there are concerns in terms of over-crediting, which should be addressed through improvements of the respective methodologies, particularly by introducing region-specific soil oxidations factors and requesting DOEs to verify that landfilling practices are not changed. With regard to landfill gas, we recommend that this project type only be eligible in countries that have policies in place to transition to more sustainable waste management practices.

Implication for the future use of international carbon markets

The **CDM has provided many benefits**. It has brought innovative technologies and financial transfers to developing countries, helped identify untapped mitigation opportunities, contributed to technology transfer, may have facilitated leapfrogging the establishment of extensive fossil energy infrastructures and created knowledge, institutions, and infrastructure that can facilitate further action on climate change. Some projects provided significant sustainable development co-benefits. Despite these benefits, after well over a decade of gathering considerable experience, the **enduring limitations** of GHG crediting mechanisms are apparent.

Firstly and most notably, the **elusiveness of additionality** for all but a limited set of project types is very difficult, if not impossible, to address. Information asymmetry between project participants and regulators remains a considerable challenge. This challenge is **difficult to address through improvements of rules**. Secondly, international crediting mechanisms involve an **inherent and unsolvable dilemma**: either they might create **perverse incentives for policy makers** in host countries not to implement policies or regulations to address GHG emissions – since this would reduce the potential for international crediting – or they **credit activities that are not additional** because they are implemented due to policies or regulations. Thirdly, for many project types, the **uncertainty of emission reductions** is considerable. Our analysis shows that risks for over-crediting or perverse incentives for project owners to inflate emission reductions have only partially been addressed. It is also highly uncertain for how long projects will reduce emissions, as they might anyhow be implemented at a later stage without incentives from a crediting mechanism – an issue that is not addressed at all under current CDM rules. A further overarching shortcoming of crediting mechanisms is that they do **not make all polluters pay but rather they make them subsidize the reduction of emissions**. Most of these shortcomings are inherent to using crediting mechanisms, which **questions the effectiveness of international crediting mechanisms as a key policy tool** for climate mitigation.

The future role of crediting mechanisms should therefore be revisited in the light of the Paris Agreement. Several **elements of the CDM could be used** when implementing the mechanism established under Article 6.4 of the Paris Agreement or when implementing (bilateral) crediting mechanisms under Article 6.2. However, the context for using crediting mechanisms has fundamentally changed. The most important change to the Kyoto architecture is that all countries have to submit NDCs that include mitigation pledges or actions. The Paris Agreement therefore requires countries to **adjust their reported GHG emissions** for international transfers of mitigation outcomes, in order to **avoid double counting** of emission reductions. This implies that the baseline, and therefore additionality, may be determined in relation to the mitigation pledges rather than using a 'counterfactual' scenario as under the CDM, and that countries could only transfer emission reductions that were beyond what they had pledged under their NDC. A second important implication relates to the incentives for host countries to ensure integrity. Host countries with ambitious and economy-wide mitigation pledges would have incentives to ensure that international transfers of credits are limited to activities with a high likelihood of delivering additional emission reductions. However, our analysis showed that only a few project types in the current CDM project portfolio have a high likelihood of providing additional emission reductions, whereas the environmental integrity is questionable and uncertain for most project types. In combination, this suggests that the future supply of credits may mainly come either from emission sources not covered by mitigation pledges or from countries with weak mitigation pledges. In both cases, host countries would not have incentives to ensure integrity and credits lacking environmental integrity could increase global GHG emissions.

At the same time, demand for international credits is also uncertain. Only a few countries have indicated that they intend to use international credits to achieve their mitigation pledges. An important source of demand could come from the market-based approach pursued under the International Civil Aviation Organization (ICAO), and possibly from an approach pursued under the International Maritime Organization (IMO). For these demand sources, avoiding double counting with emission reductions under NDCs will be a challenge that is similar to that of avoiding double counting between countries. A number of institutions are exploring the use of crediting mechanisms as a vehicle to disburse results-based climate finance without actually transferring any emission reduction units. This way of using crediting mechanisms could be more attractive to developing countries; they would not need to add exported credits to their reported GHG emissions, as long as the credits are not used by donors towards achieving mitigation pledges. The implications of non-additional credits are also different: they would not directly affect global GHG emissions, but could lead to a less effective use of climate finance. However, donors of climate finance aim to ensure that their funds be used for actions that would not go ahead without their support. Given the considerable shortcomings with the approaches for assessing additionality, we recommend that donors should not rely on current CDM rules in assessing the additionality of projects considered for funding.

Taking into account this context and the findings of our analysis, we recommend that the role of crediting in future climate policy should be revisited:

- We recommend potential buyers of CERs to limit any **purchase of CERs** to either existing **projects that are at risk of stopping GHG abatement** or the few project types that have a **high likelihood of ensuring environmental integrity**. Continued purchase of CERs should be accompanied with a plan and support to host countries to **transition to broader and more effective climate policies**. We further recommend to pursue the purchase and cancellation of CERs as a form of **results-based climate finance** rather than using CERs for compliance towards meeting mitigation targets.

- Given the inherent shortcomings of crediting mechanisms, we recommend **focusing climate mitigation efforts on** forms of carbon pricing that do **not rely extensively on credits**, and on measures such as results-based climate finance that do not necessarily serve to offset other emissions. International crediting mechanisms should play a limited role after 2020, to address specific emission sources in countries that do not have the capacity to implement broader climate policies.

- To enhance the integrity of international crediting mechanisms such as the CDM and to make them more attractive to both buyers and host countries with ambitious NDCs, we recommend **limiting** such mechanisms to **project types** that have a **high likelihood of delivering additional emission reductions**. We recommend reviewing methodologies systematically to address risks of over-crediting, as identified in this report. We further recommend revisiting the current approaches for additionality, with a view to abandoning subjective approaches and adopting more standardized approaches. We also recommend curtailing the length of the crediting periods with no renewal.

- Given the high integrity risks of crediting mechanisms, we recommend provisions that provide strong incentives to the Parties involved to ensure integrity of international unit transfers. This includes robust accounting provisions to **avoid double counting** of emission reductions, but could also extend to other elements, such as **ambitious mitigation pledges** as a prerequisite to participating in international mechanisms.

In conclusion, we believe that the CDM has had a very important role to play, in particular in countries that were not yet in a position to implement domestic climate policies. However, our assessment confirms, alongside other evaluations, the strong shortcomings inherent to crediting mechanisms. With the adoption of the Paris Agreement, implementing more effective climate policies becomes key to bringing down emissions quickly on a pathway consistent with well below 2°C. Our findings suggest that **crediting approaches** should play a **time-limited and niche-specific role** in which additionality can be relatively assured, and the mechanism can serve as stepping-stone to other, more effective policies to achieve cost-effective mitigation. In doing so, continued support to developing countries will be key. We recommend using new innovative sources of finance, such as revenues from auctioning of ETS allowances, rather than international crediting mechanisms, to support developing countries in implementing their NDCs.

1. Introduction

With almost 7,700 Clean Development Mechanism (CDM) projects and almost 300 programmes of activities (PoAs) registered and more than 1.6 billion Certified Emissions Reductions (CER) issued, the CDM has developed into an important component of the global carbon market. However, its role in the future remains uncertain. With the adoption of the Paris Agreement, which establishes a mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development (Article 6.4), it is clear that the role of the CDM as a mechanism of the Kyoto Protocol will end, most likely soon after 2020.

However, in terms of its standards, procedures and institutional arrangements, the CDM forms certainly an important base for the elaboration and design of future mechanisms for international carbon markets. The mechanism established under Article 6.4 of the Paris Agreement includes several provisions that are similar to the CDM. Parties also decided that the rules, modalities and procedures of the new mechanism should be adopted on the basis of the "experience gained with and lessons learned from existing mechanisms". Moreover, experiences gained from the CDM can also be used for the development of domestic baseline and credit policies both in developed and developing countries.

One key feature of both the mechanism under the Paris Agreement (Article 6.4) and domestic baseline and credit policies is that they should generate real and additional emission reductions, in other words: the credited and transferred emission reductions should not have occurred in the absence of the mechanism and or policy. The ability to deliver such a result depends heavily on having a reasonably effective way to assess additionality both for specific project types and on an aggregate basis, and to set a baseline such that the number of credits issued does, in total, not exceed actual reductions.

Demonstrating additionality and setting baselines are the areas in which the most concerns have been raised with the CDM, in particular regarding the investment, barrier and common practice analysis and the assessment of prior consideration. Given its counterfactual nature, asymmetries of information regarding costs, financing, barriers and local project conditions, and signal-to-noise issue, it has been difficult to implement a reliable method for assessing additionality and setting baselines. Other factors that also affect the overall mitigation outcome are the length of the crediting period used, how leakage concerns are dealt with and whether any perverse incentives are addressed, among others.

The difficulties with these traditional approaches have resulted in further refinement and revision of these approaches as well as the introduction of several alternative approaches to setting of baselines and testing additionality. Examples include the use of default values, performance benchmarks or penetration rates and discounting approaches. More fundamental changes include the use of highly standardized baselines and additionality tests at the sectoral level. It remains to be seen whether the methodological difficulties with highly standardized approaches can be solved to make them operational, and whether they will result in a lower likelihood of non-additional credits being issued.

The additionality of CDM projects has been assessed in the past in several general and project-specific studies. Much of the research was conducted before the improvement of rules and the introduction of new approaches, such as standardized baselines. This study aims to assess whether and how these changes have affected the quality of CDM projects, focusing on the project portfolio available in the second commitment period of the Kyoto Protocol and taking due account of the improvements implemented over time.

In order to make well-founded judgements about the overall and project-type-specific likelihood of additionality of CDM projects, a systematic assessment is required of the CDM rules and how they have been applied to real projects in practice. A similar exercise should be carried out for the different reforms suggested to the existing rules. This study therefore analyzes the opportunities and limits of the current CDM framework and the way in which it has evolved over time and been applied to concrete projects. It provides robust and quantified conclusions on the overall and project-type-specific environmental performance of the CDM in the form of estimates of the likelihood that the CDM results in real and additional emission reductions.

2. Methodological approach

2.1. General research approach

The main focus of this study is to assess the extent to which the CDM meets its objective stipulated in Article 12.5(c) of the Kyoto Protocol to deliver "real, measurable and additional" emission reductions. Based on the findings, concrete recommendations are made for further reform of the CDM and implications for the future role of the CDM are discussed.

There are two principal challenges to evaluating of the ability of the CDM to deliver additional emission reductions: the inherent uncertainty of a counter-factual baseline and the uncertainty and bias associated with project and baseline data. Therefore, any assessment of the extent of non-additional or otherwise under- or over-credited CDM activity can therefore only provide rough and directional estimates. Project design documents (PDDs) and monitoring reports provide substantial data and assumptions. However, these data and assumptions are often limited (they may not cover all relevant activity, especially non-CDM activity) and can involve considerable judgment by parties that have an interest in the outcome (e.g. selecting among alternative projections of future fuel prices) made for the purpose of meeting CDM requirements.

We examine the three main aspects as regards whether the CDM delivers additional emission reductions:

1. **Additionality assessment:** The assessment of additionality refers to the question of whether a project was implemented due to the CDM. Additionality is the most important prerequisite to providing an emissions benefit. If a project would have been implemented in the absence of the CDM incentives, the emission reductions would have occurred anyway. If a Party uses non-additional CERs rather than reducing its own emissions to meet its emission reduction commitments, global GHG emissions would be higher than they would have otherwise been. Because errors in additionally determination affect the validity of an entire project's CERs, additionality assessment forms the main focus of this study.

2. **Determination of baseline emissions:** A second important aspect is how the baseline emissions are determined. Determining baseline emissions is associated with considerable uncertainty. A crediting baseline that is above the emissions that would most likely occur in the absence of the project can lead to significant over-crediting. Vice versa, ambitious baselines that are below the emissions that would most likely occur in the absence of the project, can result in under-crediting.

3. **Other issues:** A number of other issues are important to deliver additional emission reductions, including:

    - the length of crediting period,
    - criteria for the renewal of the crediting period,

- approaches for determining indirect emission effects, such as leakage effects,
- the way in which perverse incentives for both project developers and policy makers are addressed,
- the extent to which double counting of emission reductions within the mechanism and with other mechanisms and pledges is avoided,
- whether potential non-permanence of emission reductions is sufficiently addressed,
- whether monitoring provisions are appropriate, and
- the effectiveness of the regulatory framework for third party validation and verification.

We also touch upon these issues, in particular when they raise concerns with regard to the integrity of the CDM. They do not, however, form the focus of this study.

In our examination, we approach these aspects from two different perspectives:

- **General CDM rules:** In Chapter 3, we evaluate approaches for determining general CDM additionality rules that are particularly relevant for the delivery of real, measurable and additional emission reductions. This includes an assessment of innovative and potentially more objective approaches for setting baselines and determining additionality and an analysis of whether and how these approaches could improve the determination of additionality under the CDM.

- **Specific project types:** In Chapter 4, we evaluate specific project types with a view to assessing how likely these project types deliver additional emission reductions. A separate evaluation by project type is important as the likelihood of additional emission reductions can differ significantly among project types. This evaluation covers the major project types contributing to a large share of the emission reductions in the CDM portfolio.

Drawing on findings from Chapters 3 and 4, we provide an overall assessment of the additionality of the CDM project portfolio in Chapter 5. In Chapter 6, we provide a summary of key recommendations for further reform of the CDM. Finally, we discuss the implications for the future use of the CDM in Chapter 7.

The study employs several analytical methodologies and approaches:

- **Literature analysis** forms the basis for our evaluation of general CDM rules, specific project types, and innovative approaches towards baseline setting and additionality assessment.

- **Qualitative assessment of relevant CDM rules** with a view to their ability for ensuring additional emission reductions. We identify potential shortcomings in the current rules and propose options for addressing them.

- **Empirical, quantitative evaluation of how the CDM rules are applied** through analysis of a representative random sample of projects. The analysis will be based on information in PDDs and validation reports and, where necessary, also monitoring and verification reports. The projects will be identified through stratified random sampling, aiming to ensure representativeness of host countries and project types. This empirical analysis aims to identify possible shortcomings in the application of general CDM rules. The information and data to be evaluated is specific for each of the identified general CDM rules and the questions identified. The methodological approach of the empirical evaluation is further specified in Section 2.2 below.

- **Economic assessment** of the feasibility of different project types is another important building block of the study. The economic assessment is conducted for the evaluation of specific project types in Chapter 4. The methodological approach of the empirical evaluation is further specified in Section 2.3 below.

- **Sectoral analysis** of the market situation for specific project types to assess whether the technology has often already been implemented without the CDM and whether an observed market uptake occurs due to the CDM. The sectoral analysis is conducted for the evaluation of specific project types in Chapter 4. The methodological approaches are further specified in the corresponding sections.

We use the CDM rules and the CDM project portfolio as of 1 January 2014 as the basis for the assessment.

To assess the impacts of our analysis, we further estimate the potential 2013-2020 CER supply for different project types. The method used to estimate the potential CER volume is described in Section 2.3.

2.2. Empirical evaluation of CDM projects

The assessment of key CDM rules for additionality demonstration in Chapter 3 is based on an in-depth evaluation of PDDs, validation reports, etc. of randomly selected CDM projects. The project samples were randomly drawn from the so-called CDM project pipeline as of 1 January 2014 (UNEP DTU 2014). This pipeline is a compilation of certain information and data provided in the project design document (PDD) of each CDM project. For this assessment, only registered CDM projects were taken into account as the PDDs usually undergo significant changes during the validation period. To ensure representativeness, the samples were stratified by the following characteristics and strata:

- Location (host country/region)
  - China
  - India
  - Asia & Pacific
  - Brazil
  - Latin America
  - Rest of the World
- Technology
  - Industry (HFC-23, N_2O, cement, energy efficiency, energy distribution, etc.)
  - Electricity generation from hydro
  - Electricity generation from wind
  - Electricity generation from renewable energy (solar, tidal, etc.)
  - Other renewable energy (biomass, geothermal, mixed renewable energy, etc.)
  - Waste sector (landfill gas, methane avoidance, etc.)
  - Other (afforestation, reforestation, agriculture, transport, etc.)
- Scale
  - Large-scale projects
  - Small-scale projects
- Time (registration year)
  - Pre 2010
  - In 2010 or 2011
  - Post 2011.

The in-depth assessment of project samples was conducted for the key additionality determination rules: investment analysis (Section 3.2), barrier analysis (Section 3.3) and common practice analysis (Section 3.3). For each of these rules a separate sample of 30 randomly selected CDM projects was drawn.

Since the CDM project pipeline did not include information about which option of additionality determination was applied in the PDD, we had to conduct a two-step sampling: In the first step, we drew a representative sample of 300 projects. For each of the projects of this sample we identified which additionality determination rules were applied so that we could use this sample as population for the second sampling step in which we drew the samples for each of the additionality determination rules.[1]

2.3. Estimation of the potential CER supply

We estimate the potential CER supply[2] for the purpose of assessing the overall integrity of the CDM based on our findings for specific project types or specific additionality tests. The potential CER supply is estimated mainly on the basis of the CDM pipeline as of 1 January 2014 (UNEP DTU 2014). Moreover, we included additional information from a similar pipeline which is provided by IGES (2014). All CDM projects which were registered by 1 January 2014 are taken into account (7,418). In the case of industrial gas projects (HFC-23, adipic acid, nitric acid), some baseline and monitoring methodologies were significantly revised, which has a major impact on the potential CER supply in the second and third crediting periods. For these projects, we use specific bottom-up estimates derived from project-specific information (Schneider & Cames 2014).

We distinguish the CER supply potential considering the duration of the commitment periods under the Kyoto Protocol:

- from credit start to the end of 2012,
- from the beginning of 2013 to the end of 2020 and
- from the beginning of 2021 to the end of the crediting periods (CP).

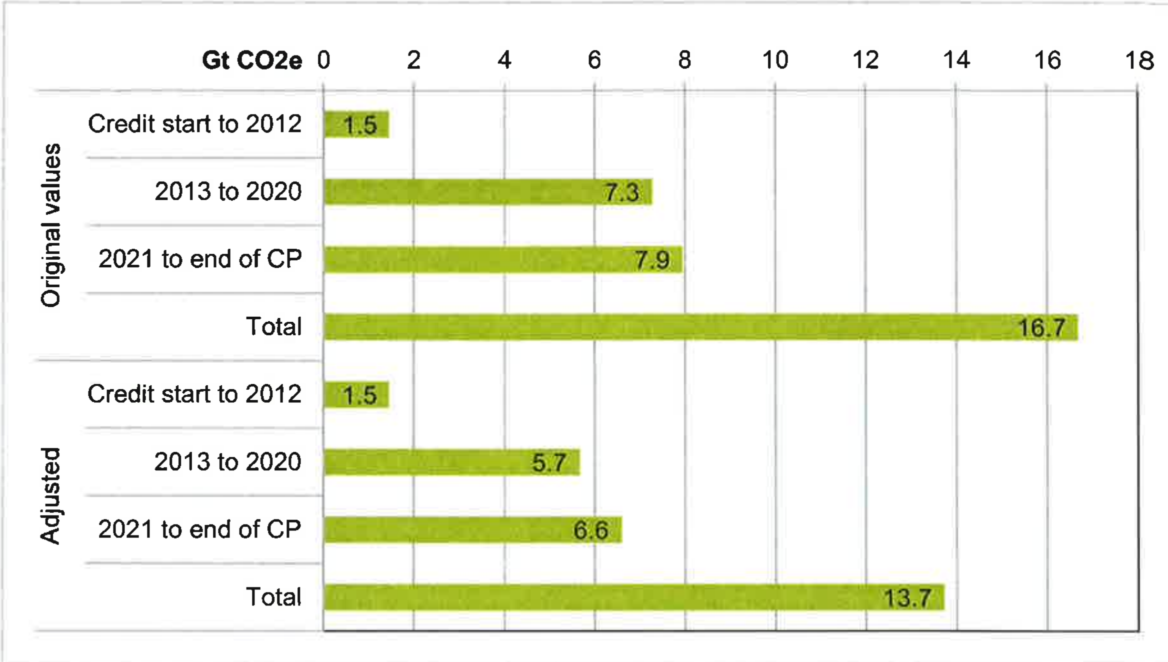
Our study is focused on the period of 2013 to 2020.

Figures for the period from credit start to the end of 2012 reflect the actual CER issuance rather than the potential supply (UNFCCC 2015a). For the latter two periods, we take into account the issuance success rate provided in the CDM pipeline and adjust the expected CER supply accordingly. For some projects, more CERs were issued than projected while for most of the CDM projects less CERs were issued. Several projects had not issued any CERs (4,913). For those projects we assume either the average issuance rate for the respective project type or – if no CERs have been issued for that project type so far – the overall average of the issuance success rate. Figure 2-1 provides an overview of the potential CER supply.

[1] A more detailed description of the sampling approach, the code used for drawing the samples and the reference numbers of the projects drawn into each of the samples can be found in Section 8.1 of the Annex.

[2] The actual CER supply depends on various conditions of the global carbon market and particularly on price expectations. However, also under normal market conditions, price forecasts are very uncertain. Under post-2012 market conditions, prices are even more uncertain. We therefore only estimate the potential CER supply which is derived from information in PDDs and other project specific or general documents but ignore any interaction with the global carbon market. At price levels of less than $1/CER, the estimated volumes will not be achieved in practice.

Figure 2-1: Potential CER supply, original and adjusted values

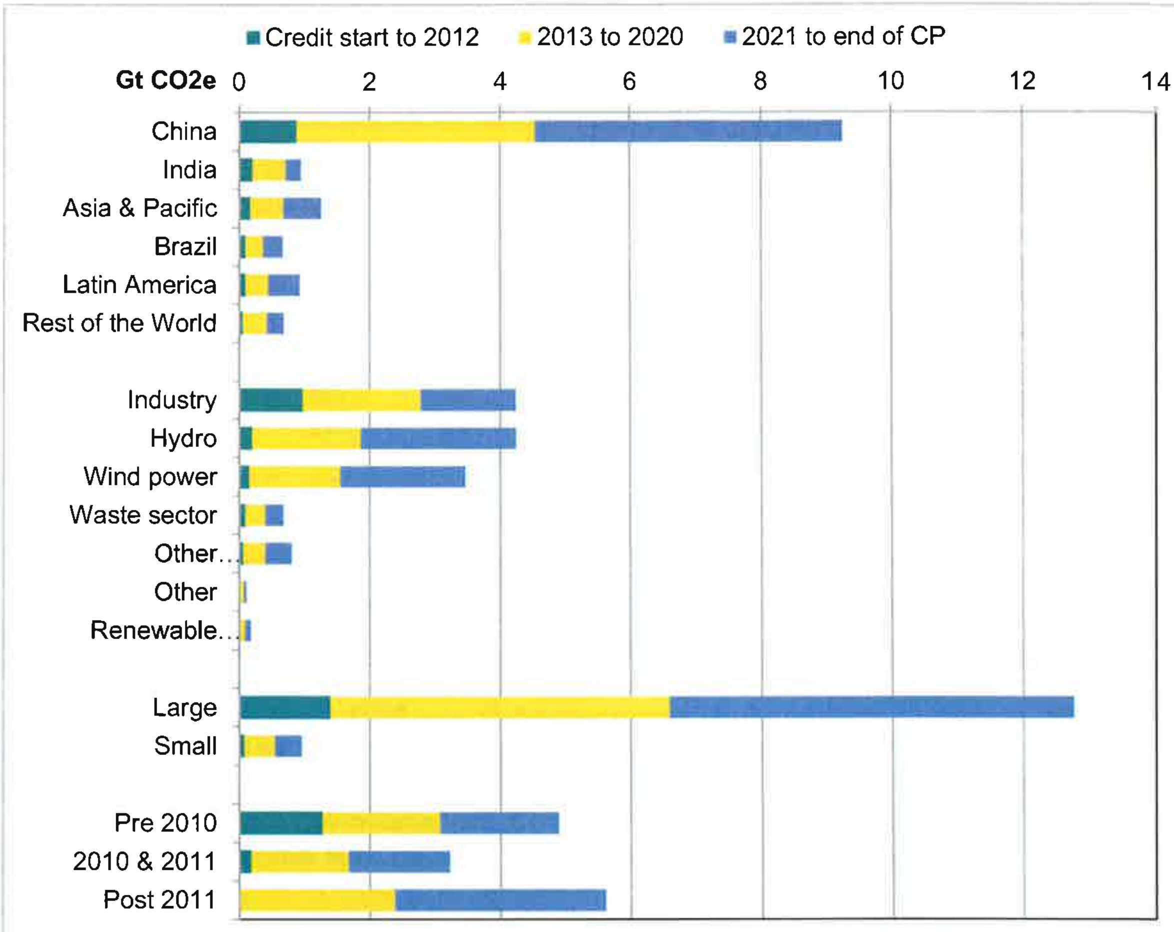


Sources: UNEP DTU 2014, IGES 2014, UNFCCC 2015a, Schneider & Cames 2014, authors own calculations

The average adjustment factor is -22% though it ranges from -4% for N_2O projects to some -67% for transport projects. The adjusted CER supply for the period of 2013 to 2020 amounts to almost 5.7 billion CERs, almost 4 times the volume issued for the first crediting period.

Figure 2-2 illustrates where the potential CER supply stems from. Obviously China was and will remain the largest potential supplier of CERs. Almost two thirds (64.5%) of the potential CER supply in 2013 to 2020 are expected to be provided by Chinese CDM projects. In terms of project types, the large majority of supply stems from industry (32.0%), hydro (29.4%) and wind (24.6%) projects. Not surprisingly, the large majority (91.3%) of CERs stems from large scale projects while the breakdown in terms of registration period is more even: 31.8% stems from projects registered before 2010, 26.3% from projects registered in 2010 and 2011 while 41.8% of the potential CER supply in the period of 2013 to 2020 can be generated from CDM projects registered after 2011.

Figure 2-2: Potential CER supply by stratification categories



Sources: UNEP DTU 2014, IGES 2014, UNFCCC 2015a, Schneider & Cames 2014, authors own calculations

In Chapter 4 we analyze the extent to which the likelihood of projects and CERs being additional depends on the project type. We look at 12 different project types, which together cover a broad range of activities and technologies. In terms of CER supply, these 12 project types amount to 85% of the potential supply in the period of 2013 to 2020 (Table 2-1). The largest supply potential is provided by hydro and wind power projects (29.4% and 24.6%, respectively). Industrial gas projects amount to almost 15% of the supply potential while biomass power, landfill gas, waste heat recovery and fossil fuel switch projects could each generate some 3-4% of the supply potential. Compared to these projects types the supply potential of cook stoves (0.04%) and efficient lighting (0.07%) are almost negligible. However, since these project types are often included in government purchase programs or voluntary offset schemes and since their share among projects registered after 2012 is significant, we consider it worthwhile to examine these two project types in greater depth and to assess their likelihood of being additional and of generating additional CERs.

Table 2-1: Potential CER supply by project type

	No. of projects	Credit start to 2012	2013 to 2020	2021 to end of CP	Total
			Adjusted		
			Mt CO_2e		
HFC-23 abatement from HCFC-22 production	19	507	375	547	1,429
Adipic acid	4	201	257	269	727
Nitric acid	97	57	175	172	404
Hydro power	2,010	191	1,669	2,388	4,249
Wind power	2,362	148	1,397	1,929	3,475
Biomass power	342	25	162	169	355
Landfill gas	284	57	163	159	380
Coal mine methane	83	34	170	123	327
Waste heat recovery	277	63	222	62	346
Fossil fuel switch	96	51	232	175	458
Cook stoves	38	0.1	2.3	0.4	2.7
Efficient lighting	43	0.4	3.8	0.2	4.5
Not covered	1,763	124	842	603	1,569
Total	7,418	1,459	5,671	6,596	13,726

Sources: UNEP DTU 2014, IGES 2014, UNFCCC 2015a, Schneider & Cames 2014, authors own calculations

The first Programme of Activities (PoA) was registered in July 2009. From then until the end of 2013, 243 PoAs were registered in total, the large majority of them in 2012 (193). While cook stoves and efficient lighting account for only a small share in the CDM project pipeline, they are quite relevant in the context of PoAs. By the end of 2013, they account together for a quarter of the registered PoAs. Table 2-2 provides a breakdown of the potential CER supply from PoAs by project types.

Table 2-2: Potential CER supply from PoAs

	No. of programs	Credit start to 2012	2013 to 2020	2021 to end of CP	Total
			Mt CO_2e		
Hydro power	26		5	13	17
Wind power	24		18	45	63
Landfill gas	4	0	12	27	40
Coal mine methane	2		5	10	15
Fossil fuel switch	2		0	0	0
Cook stoves	31	0	33	82	115
Efficient lighting	30	2	17	63	82
Not covered	124	0	70	144	214
Total	243	2	161	385	547

Sources: UNEP DTU 2014, UNFCCC 2015b, authors own calculations

The main difference of PoAs compared to projects bundles is that PoAs can – once registered – be extended over time by an unlimited number of so-called component project activities (CPA). An estimate of the CER supply potential is thus less reliable than the estimate for the project pipeline.

However, taking into account all CPAs included in PoAs by the end of 2013, the potential CER supply can roughly be estimated, though it is obvious that the actual supply could be much higher. PoA volumes are much more difficult to estimate, because a PoA might be registered with only one CPA that has 1,000 tCO_2 per year emissions reductions but which may ultimately include CPAs that reduce hundreds of thousands of tCO_2 per year.

Noting these limitations, all PoAs could supply some 0.16 billion CERs in total in the period of 2013 to 2020. The final volume of these PoAs could be many times this amount. Almost a third (31.4%) of this supply would be provided by cook stove or efficient lighting PoAs. CERs from renewable power generation programmes amount to 14% of the supply potential of PoAs. Interestingly, almost half of the PoAs do not fall into the project type categories which together account for 85% of the potential CER supply from CDM projects. This supports the hypothesis that PoAs address project categories or technologies that cannot be adequately addressed by individual CDM projects.

2.4. Economic assessment of CER impact

The demonstration of additionality has been a key issue in the CDM since the beginning of the Kyoto mechanisms (Chapter 3). While most researchers agree that there is no simple and objective approach to determining additionality, several authors argue that the impact of CER revenues on the economic feasibility of projects is an important indicator for the likelihood for projects to be additional (for example Sutter 2003, Schneider 2007, Spalding-Fecher et al. 2012). This builds on the assumption that project proponents are more likely to implement a project due to the CDM if CER revenues have a significant impact on the economic performance of the project. While other benefits from the CDM (e.g. the public relation aspect of registering a project under the UNFCCC) may in some cases help projects to go ahead that would not be implemented in the absence of the CDM, the economic benefit of CER revenues may be considered the main driver to implement CDM projects on a larger scale.

A high economic benefit resulting from CER revenues does not guarantee additionality, because some projects may already be economically viable without CER revenues and may only become more profitable with the CDM. However, low CER revenues are an indicator of a lower likelihood that the project is additional, because with low CER revenues it also becomes more likely that the project would be implemented in the absence of the CER revenues.

In 2005, the CDM Executive Board (EB) decided that, in order to be additional, projects have to demonstrate that they are economically unattractive; however, they are not required to demonstrate that with CER revenues they would become economically viable. Schneider (2007) highlighted that this leads to the situation in which projects with very low CER revenues can prove additionality even though the CER revenues contribute only marginally to closing the profitability gap.

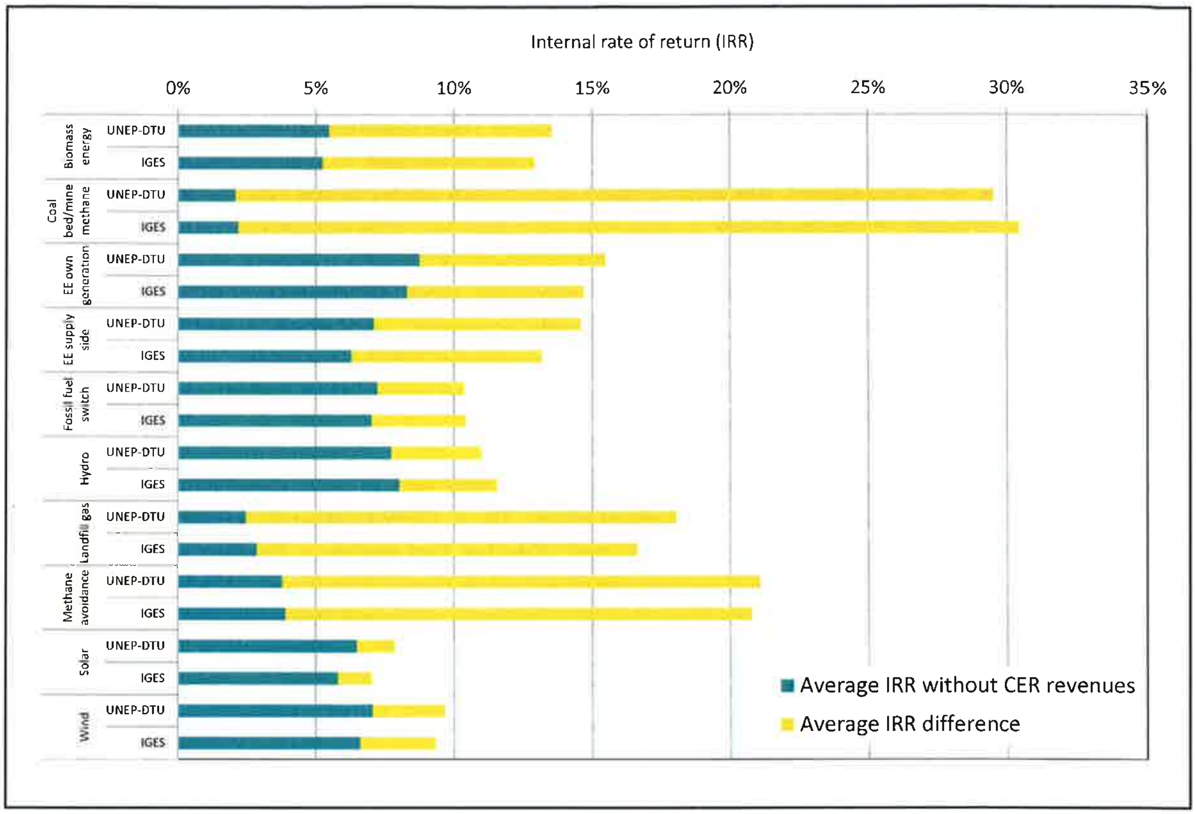
It is difficult to define a minimum required level of contribution from CER revenues that is needed to trigger an investment decision. An important concept in this context is the *signal-to-noise ratio* issue for investment analysis, as mentioned by, for example, Spalding-Fecher et al. (2012): The generally high variability and uncertainty of key parameters that determine the profitability of a mitigation project is often considerably higher than the expected economic benefit of CERs. If the economic impact of the CERs is lower than key uncertainties in the investment analysis, it is rather unlikely that the registration under the CER was the conclusive trigger for the investment and, hence, it is likely that the project is non-additional.

Table 2-3: Impact of CER revenues on the profitability of different project types

Type	Source	Projects with available IRR information	Average IRR without CER revenues	Average IRR with CER revenues	Average IRR difference
Biomass energy	UNEP-DTU	271	5.5%	13.6%	8.1%
	IGES	216	5.2%	12.9%	7.7%
Coal bed/mine methane	UNEP-DTU	70	2.1%	29.5%	27.5%
	IGES	75	2.2%	30.5%	28.3%
EE own generation	UNEP-DTU	205	8.8%	15.5%	6.7%
	IGES	202	8.3%	14.7%	6.4%
EE supply side	UNEP-DTU	36	7.1%	14.6%	7.5%
	IGES	23	6.3%	13.2%	6.9%
Fossil fuel switch	UNEP-DTU	47	7.2%	10.4%	3.1%
	IGES	39	7.0%	10.4%	3.4%
Hydro	UNEP-DTU	1,753	7.7%	11.0%	3.3%
	IGES	1,635	8.0%	11.6%	3.6%
Landfill gas	UNEP-DTU	183	2.5%	18.0%	15.6%
	IGES	165	2.8%	16.6%	13.8%
Methane avoidance	UNEP-DTU	203	3.8%	21.1%	17.3%
	IGES	204	3.9%	20.8%	16.9%
Solar	UNEP-DTU	154	6.5%	7.9%	1.4%
	IGES	122	5.8%	7.0%	1.2%
Wind	UNEP-DTU	2,162	7.1%	9.7%	2.6%
	IGES	1,804	6.6%	9.4%	2.8%

Sources: UNEP DTU 2014, IGES 2014, authors' own calculations

Figure 2-3: Impact of CER revenues on the profitability of different project types



Sources: UNEP DTU 2014, IGES 2014, authors' own calculations

Information on the impact of CER revenues on economic profitability is available from different sources. Table 2-3 and Figure 2-3 show the impact based on data included in project design documents and as documented in the databases by UNEP DTU (2014) and IGES (2014). In addition, Lütken (2012) has analyzed the annual CER revenues in relation to the capital investment and observed for some project types a (very) limited impact stemming from CER revenues. Spalding-Fecher et al. (2012) analyze the impact of CER revenues on the project IRR for different project types in the IGES database. They conclude that the CER impact on the project IRR is the lowest for renewables including hydro and wind (increase of IRR by 2-3%), fuel switch (4%), and supply-side efficiency (5%). They also provide an overview of more studies analysing the impact of CER revenues for different project types. The relatively low impact of CER revenues compared to other cash flows that are relevant for investment decisions is shown for energy efficiency projects below (Box 2-1).

Overall, the available information shows that the impact of CER revenues on the economic performance of projects varies considerably between project types:

- **Non-CO_2 projects**, such as industrial gas abatement, manure management, waste water treatment, landfill gas utilisation and coal mine methane capture, are characterised by a medium to high impact of CER revenues. For several of these project types, CER revenues increase the IRR by more than 10 percentage points, and for coal mine methane projects even by more than 25 percentage points. For these project types, the CER revenues clearly make a difference, which indicates a higher likelihood of additionality.

- **CO_2 projects in renewable energy** such as wind and hydro projects are characterised by a relatively low impact of CER revenues: for wind power, the IRR increases by about 2.5% to 3%, for hydropower by about 3% to 4%, and for solar by about 1% to 1.5%. According to Lütken (2012), the annual CER revenues in relation to investment costs (median) amounted to 1.84% for wind and 3.5% for hydro. Given the typical uncertainties surrounding costs and load factor in renewable projects, this level of CER contributions seems relatively low to justify that the project would not have been implemented in the absence of the CDM. Therefore, in many cases, the additionality of projects within these types may seem rather unlikely (though in some cases it may not be ruled out that additional CER revenues of +3.5% may be the decisive factor rendering a project attractive – though it may not be possible to prove this in an objective way). In addition, many renewable energy projects – in particular hydropower – show a relatively high economic performance without CER revenues (e.g. an IRR of nearly 8% for hydropower without CER revenues), compared to non-CO_2 projects (e.g. landfill gas, coal mine methane and methane avoidance with an IRR of about 2% to 4% without CER revenues).

- **CO_2 projects in fuel switch, energy efficiency, and waste heat utilisation** are typically characterised by relatively low investment costs. Thus, CER revenues are higher compared to investment costs (5% for waste heat and 20% for fuel switch – median value). The impact of CER revenues on the internal rate of return is about 3 to 8 percentage points. However, in this project type, fuel prices are the decisive element determining its profitability. Box 2-1 compares the impact of typical fuel costs and CER revenues for energy efficiency projects. Our analysis indicates that CER revenues tend to have a low impact on project profitability. In addition, these project types show a relatively good economic performance without CER revenues, compared to non-CO_2 projects.

Lütken's analysis was based on a CER price of €12. Our analysis in Table 2-3 and Spalding-Fetcher's build on PDD data with similar CER price assumptions. With today's much lower CER prices, the low impact of CER revenues on CO_2 projects and therefore their high risk of non-additionality is further aggravated.

In conclusion, non-CO_2 projects are characterised by a medium-to-high impact of CER revenues and a relatively low economic performance without CER revenues, while for most CO_2 project types the impact of CER revenues is much smaller and the performance without CER revenues higher. Overall, this indicates that on average non-CO_2 projects have a higher likelihood of additionality.

Box 2-1: An analysis of the impact of CER revenues for energy efficiency projects

Another way of assessing the relevance of CER revenues in investment decisions is to compare them to other important revenues or savings in the investment analysis. For instance, for energy efficiency projects to become profitable, they have to (i) save sufficient costs for fossil fuels and (ii) earn sufficient CERs to pay back the investment costs for new equipment improving the energy efficiency. Figure 2-1, Figure 2-2 and Figure 2-4 illustrate the order of magnitude of fuel cost savings in relation to one tonne of CO_2 reduced or CERs generated in the case of projects saving natural gas, light fuel oil and steam coal. For instance, if an installation implements new equipment that reduces the specific consumption of natural gas and the related GHG emissions by one tonne of CO_2, then the related reduction in fuel costs in 2010 would amount to approx. 150 USD/tCO_2 (at OECD average prices in 2010). For light fuel oil, the fuel cost reduction amounts to over 250 USD/tCO_2 and for steam coal, the savings still amount to 37 USD/tCO_2 (in 2010). With this, it becomes obvious that the impact of fuel cost savings on the project cash flow is much higher than contribution from CER revenues.

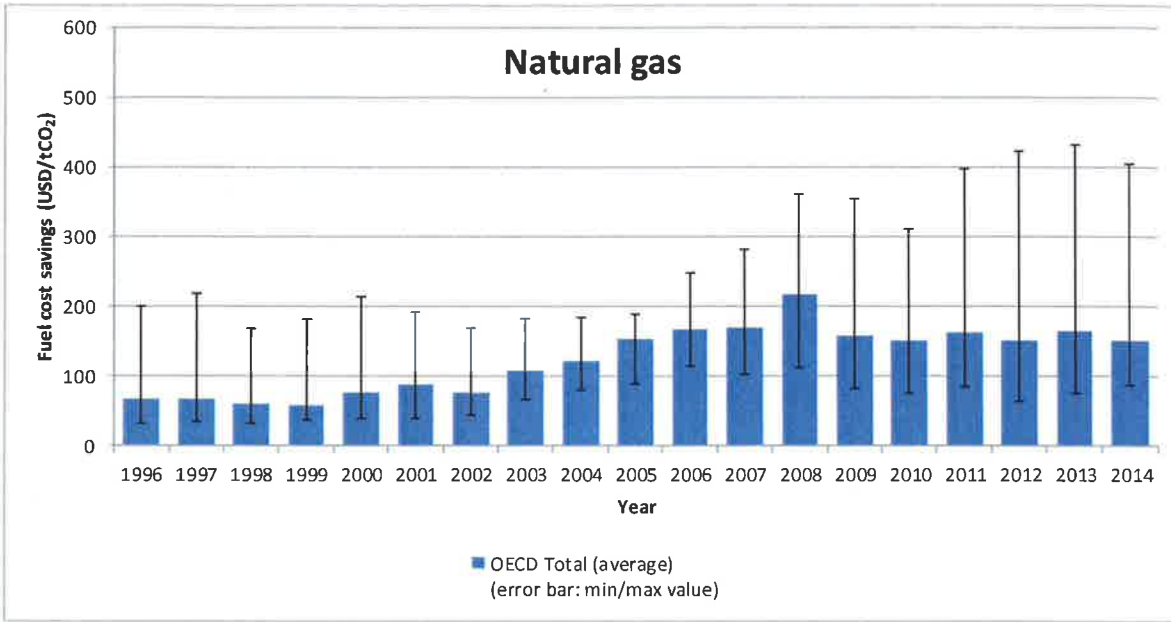
Figure 2-1, Figure 2-2 and Figure 2-4 also show the development of average (and min. and max.) OECD prices over time, which illustrates the high variability of energy prices since 1996. Average specific energy prices have fluctuated in the order of 20 USD/tCO_2 (steam coal) to 200 USD/tCO_2 (light fuel oil). Also compared to the historic fuel price variability, typical CER revenues are low to negligible compared to fuel cost savings.

Please note that because of limitations in data availability, the figures are based on fuel prices in OECD countries, which in many cases also include taxes and may not be representative for all developing countries. In particular, in some developed and developing countries fossil fuel subsidies are very high. In these cases, because of the low prices, the fuel cost savings are low and may be on a similarly low level as the contribution from CER revenues to the positive project cash flow. However, in such a low price situation, the total positive cash flow may in any case be far too small to justify investments in energy efficiency equipment and the scope for CDM may become rather limited.

Overall, it may be argued that for projects to have a high likelihood of additionality the impact of CER revenues should at least be comparable to the main contributor to a positive cash flow, the related fuel savings. This would indicate that in such project types CER prices for energy efficiency projects would need to reach a level of at least 10-20 USD/tCO_2 for steam coal, 30-50 USD/tCO_2 for natural gas and 100-200 USD/tCO_2 for light fuel oil based systems (if prices on the level of OECD countries are assumed). With such CER prices, the economic contribution from CER revenues to positive cash flow reaches a level that may be considered significant (i.e. in the order of ¼ to ½ of fuel cost savings).

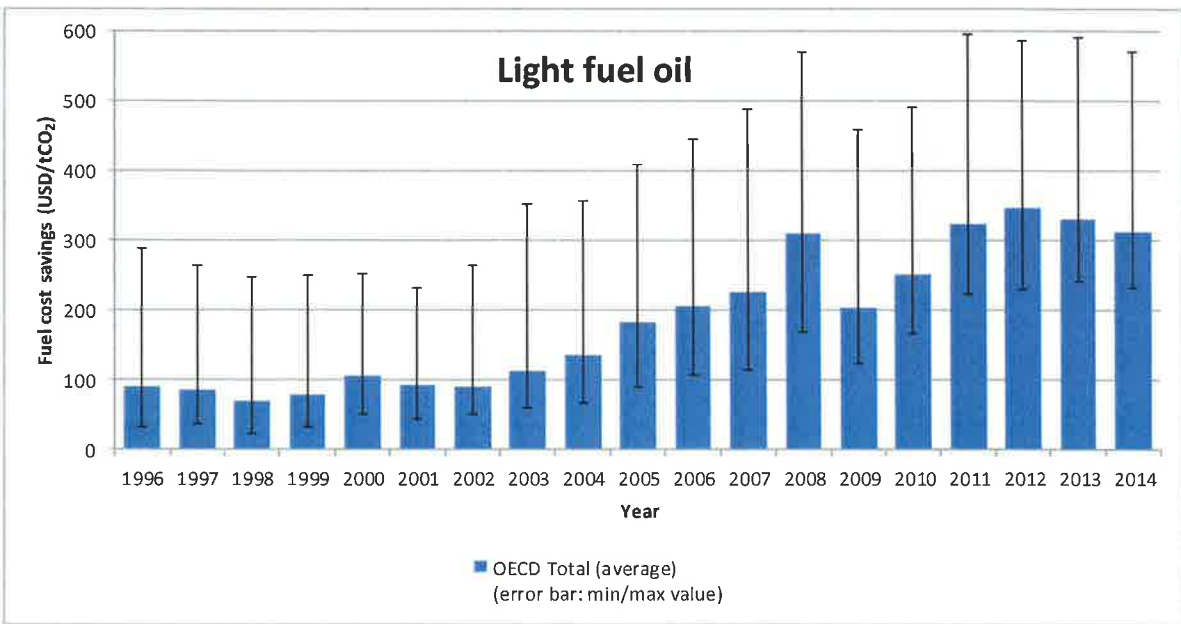
At prices significantly below this level, the economic impact of CERs is insignificant and the risk of non-additionality is very high.

Figure 2-4: Natural gas cost savings per tonne of CO_2 reduced in energy efficiency projects



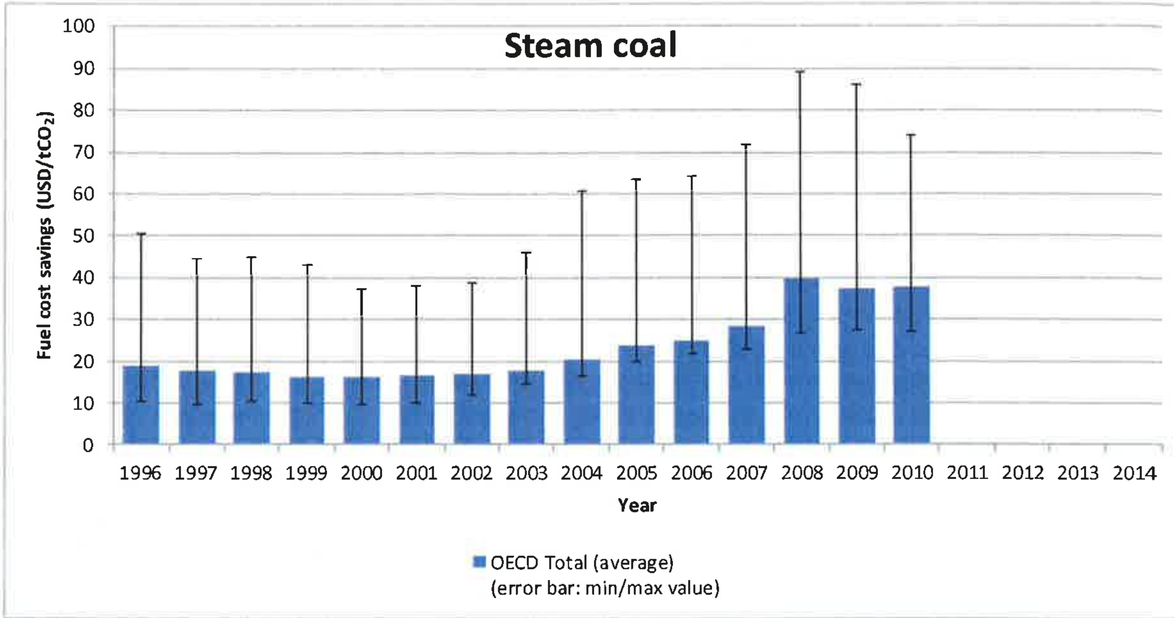
Notes: Average fuel prices of OECD countries (in USD/TJ).
Sources: IEA 2015, IPCC 2006, authors' own calculations

Figure 2-5: Light fuel oil cost savings per tonne of CO_2 reduced in energy efficiency projects



Notes: Average fuel prices of OECD countries (in USD/TJ).
Sources: IEA 2015, IPCC 2006, authors' own calculations

Figure 2-6: Steam coal cost savings per tonne of CO_2 reduced in energy efficiency projects



Notes: Average fuel prices of OECD countries (in USD/TJ).

Sources: IEA 2015, IPCC 2006, authors own calculations

3. Assessment of approaches for determining additionality and rules relevant towards additionality

3.1. Prior consideration

3.1.1. Overview

Prior consideration is a key requirement in the CDM. It aims to ensure that only projects are registered in which the CDM was seriously considered when the decision to proceed with the investment was made.

In the first version of the additionality tool prepared in 2004[3], a provision was introduced for projects with a crediting period starting prior to registration, which stipulated that evidence has to be provided "that the incentive from the CDM was seriously considered in the decision to proceed with the project activity" and that the "evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity." The provision remained almost unchanged in the second version of the additionality tool in 2005.

In the third version of the additionality tool in 2007, the provision was removed and then included in the Guidelines for completing the PDD, which are applicable to all projects and not only those applying the additionality tool. These guidelines stipulated that "project proponents shall provide an implementation timeline of the proposed CDM project activity" and that "the timeline should include, where applicable, the date when the investment decision was made, the date when construction

[3] EB 16, Annex 1: Tool for the demonstration and assessment of additionality.

works started, the date when commissioning started and the date of start-up (e.g. the date when commercial production started)". Also, according to the guidelines, "project participants shall provide a timeline of events and actions, which have been taken to achieve CDM registration, with description of the evidence used to support these actions"[4].

In 2008, the CDM EB introduced general guidance on the demonstration and assessment of prior consideration[5]. The guidance was subsequently revised twice[6], including further guidance for DOEs on how to validate real and continuing actions; in 2011 it was incorporated in the project standard (PS)[7]. According to the latest version of the project standard[8], "if the start date of a proposed CDM project activity ... is prior to the date of publication of the PDD for the global stakeholder consultation, project participants shall demonstrate that the CDM benefits were considered necessary in the decision to undertake the project as a proposed CDM project activity". More specifically, project participants of project activities with a starting date on or after 2 August 2008 *"shall inform the host Party's designated national authority (DNA) and the secretariat of their intention to seek CDM status in accordance with the Project cycle procedure"*, while "for a proposed CDM project activity with a start date before 2 August 2008 and prior to the date of publication of the PDD for global stakeholder consultation, project participants shall demonstrate that the CDM was seriously considered in the decision to implement the proposed project activity". For this purpose, "project participants shall provide evidence of their awareness of the CDM prior to the start date of the proposed project activity, and that the benefits of the CDM were a decisive factor in the decision to proceed with the project"[9], *"provide evidence that continuing and real actions were taken to secure CDM status for the proposed project activity in parallel with its implementation"*[10] and "provide an implementation timeline of the proposed CDM project activity. The timeline should include, where applicable, the date when the investment decision was made, the date when construction works started, the date when commissioning started and the date of start-up (e.g. the date when commercial production started). Project participants shall provide a timeline of events and actions, which have been taken to achieve CDM registration, with description of the evidence used to support these actions".

The CDM project cycle procedure[11] includes details about the notification process related to prior consideration (i.e. forms to be used, etc.). According to this procedure, for project activities with a start date on or after 2 August 2008, notification to the DNA of the host country and to the Secretariat must be made "within 180 days of the start date of the project activity". A list of notifications received by the Secretariat is available on the UNFCCC website.[12]

The requirements for demonstrating prior consideration set out in the project standard are generally applicable with the exception of programmes of activities (PoAs).

---

4 EB 41, Annex 12: Guidelines for Completing the Project Design Document (CDM-PDD) and the Proposed New Baseline and Monitoring Methodologies (CDM-NM) (Version 07).

5 EB 41, Annex 46: Guidance on the Demonstration and Assessment of Prior Consideration of the CDM.

6 EB 48, Annex 61 and EB 49, Annex 22.

7 EB 65, Annex 5.

8 CDM project standard, Version 07.0, EB 79, Annex 3.

9 Relevant evidence could, for instance, relate to "minutes and/or notes related to the consideration of the decision by the EB of Directors, or equivalent, of the project participants, to undertake the project as a CDM project activity".

10 Relevant evidences "should include one or more of the following: contracts with consultants for CDM / PDD / methodology / standardized baseline services; draft versions of PDDs and underlying documents such as letters of authorization, and if available, letters of intent; emission reduction purchase agreement (ERPA) term sheets, ERPAs, or other documentation related to the sale of the potential CERs (including correspondence with multilateral financial institutions or carbon funds); evidence of agreements or negotiations with a DOE for validation services; submission of a new methodology or standardized baseline, or requests for clarification or revision of existing methodologies or standardized baselines to the EB; publication in a newspaper; interviews with DNA; earlier correspondence on the project with the DNA or the secretariat".

11 Current version 07.0, EB 65, Annex 32.

12 https://cdm.unfccc.int/Projects/PriorCDM/notifications/index_html.

With regard to PoAs, the project cycle procedure includes the non-binding provision that "*the coordinating/managing entity may notify to the DNA(s) of the host Party(ies) of the PoA and the secretariat in writing of the intention to seek the CDM status for the PoA, using the [corresponding form] for the purpose of determining the start date of the PoA*". According to the CDM project standard, the start date of a PoA is either "*the date of notification of the intention to seek the CDM status by the coordinating/managing entity to the secretariat and the DNA*" or "*the date of publication of the PoA-DD for global stakeholder consultation*". With regard to CPAs, "*the start date of a CPA is the earliest date at which either the implementation or construction or real action of the CPA begins*" and it shall be confirmed that "*the start date of any proposed CPA is on or after the start date of the PoA*". The only exception to this rule relates to afforestation and reforestation (A/R) PoAs, which allows *"the inclusion of any A/R project activity that started after 1 January 2000 but has not been registered as a CDM project activity as a CPA in an A/R PoA"*.[13]

3.1.2. Assessment

The issue of projects obtaining registration as CDM projects without serious consideration of the CDM benefits at the time of the investment decision was especially a concern during the first years of the CDM. The requirement to demonstrate prior consideration was only gradually introduced over time and became generally applicable only in 2007. Also, as pointed out by Schneider (2007), the requirement was also not always followed: only 36% of the projects seeking retroactive crediting provided evidence that the CDM was considered in the decision to proceed with the project and it is reported that relevant documentation has been backdated. It can, therefore, be concluded that for early CDM projects, the demonstration of prior consideration was questionable.

The approach applied as of August 2008 (i.e. for the bulk of projects and generated CERs) requires notification of the prior consideration of the CDM as well as, in situations of delay, evidence of continued interest in the CDM using a form designed for this purpose. This requirement addresses the issue of prior consideration in a more objective and appropriate manner, avoiding the risk of back-dating of company-internal information or subjective claims of prior consideration. In this regard, the rules have improved over time and there is no evident flaw in the current rules and therefore no need for the current practice to be changed.

However, it should be noted that the notification of prior consideration ensures that projects cannot claim CDM registration retroactively, but does not demonstrate whether or not a project is additional. In this regard, this rule does not provide any information on the additionality of projects since both truly additional projects and free riders may apply for the CDM status. This rule is therefore important to exclude projects which did not consider the CDM at all and are therefore clearly not additional, but it is not sufficient for assessing whether a project can be considered additional or not.

With regard to the practical implementation, a period of 180 days for notification of prior consideration can be considered quite generous. While a certain grace period is certainly reasonable due to the administrative process of making the PDDs available for global stakeholder consultation, a period of six months could mean that the project is already quite advanced, which would then call into question whether CDM benefits were actually necessary for the project to proceed. A long grace period could therefore be regarded as allowing retroactive crediting.

The requirements regarding the start date of PoAs and CPAs are sufficiently strict to avoid any project activity that has already started being registered as CPAs under a PoA. The only rule that cannot be considered adequate relates to the inclusion of old A/R activities in a newly registered

[13] Clarification "Start date and crediting period of component project activities under an afforestation and reforestation programme of activities", EB 73, Annex 16.

A/R PoA (see above). For these A/R activities, CDM rules do not require demonstrating prior consideration of the CDM.

3.1.3. Summary of findings

There is no evident flaw in the general design of this rule with the exception of the inclusion of old A/R activities in a newly registered A/R PoA. Also, as outlined above, the time frame for notification of prior consideration appears to be quite generous.

3.1.4. Recommendations for reform of CDM rules

The only rule that needs to be changed relates to the inclusion of old A/R activities in a newly registered A/R PoA (see above). It is therefore recommended that the corresponding rule be withdrawn.

Furthermore, it is recommended that the time frame for notification of prior consideration be shortened in order to reduce the risk that projects apply for the CDM having only learned of the possibility after the project has started. The grace period for notification to the secretariat should therefore be reduced in general, e.g. to a maximum of 30 days after the project start.

3.2. Investment analysis

3.2.1. Overview

The CDM's *additionality tool* requires demonstration that a prospective project is either not financially viable without the CDM (using investment analysis) or that there is at least one barrier preventing the proposed project without the CDM (using barrier analysis). Though both methods are common (and some projects use both), investment analysis is the most widely used, by over three-quarters of all projects and over 90% of the renewable energy (especially hydro and wind) projects that are expected to dominate future CER supplies (Spalding-Fecher & Michaelowa 2013). Investment analysis (or a variation of it) is also used in the *combined tool* and in some CDM baseline and monitoring methodologies that refer neither to the *additionality tool* nor to the *combined tool* for demonstrating additionality.

The additionality tool provides three alternative options for conducting investment analysis:

- For projects with costs but no revenues (other than CERs), a **simple cost analysis** can be used to demonstrate that at least one scenario (other than the project) is less costly. This approach is quite common for a few project types (e.g. projects that capture N_2O from adipic acid plants, or methane from landfills), but it is not common overall.
- The **investment comparison analysis** compares the economic attractiveness of the project without revenues from CERs to other investment alternatives that provide similar outputs or services; this approach is common for just a few project types (e.g. higher-efficiency fossil power), and is not common overall.
- The **benchmark analysis** is used to demonstrate that a proposed project is, without revenues from CERs, economically not attractive (i.e. it does not meet a stated financial benchmark); this approach is, by far, the most common form of investment analysis.

In all cases, investment analysis relies on the premise that, if a project is not a better investment (or less costly) than an alternative or a financial benchmark, then it would not have proceeded but for the existence of the CDM. Exactly how the CDM causes it to proceed, whether through CER revenue or otherwise, does not need to be specified.

The approach to investment analysis has also been refined over time. In particular, in 2008 the CDM EB adopted "Guidelines on the assessment of investment analysis", which aimed to provide further clarity and reduce ambiguity by, for example, clarifying how to calculate the common financial benchmarks net present value (NPV) and internal rate of return (IRR) and suggested ranges for conducting sensitivity analysis in these parameters. In 2011, this guidance was further revised to introduce default values for the expected return on equity for different project types and host countries, which can (but are not required to) be used by project developers as benchmarks for the benchmark analysis.

3.2.2. Assessment

The expected financial performance of a project is clearly one important factor in determining whether or not it will proceed (see further discussion of this in Section 2.3). For example, unless mandated by an (enforced) government policy, there is little reason for projects with no revenue (other than CER values) to proceed, simplifying the assessment of additionality.

For projects that do collect revenue other than CER values, such as by selling electricity, the CDM rules seek to determine whether the project would not have been financially attractive (and therefore not have proceeded) without the CDM. Researchers have raised several critiques of this approach, which we address in this report under two broad themes.

The first is perhaps the most fundamental, and is whether investment analysis is appropriate for investments that may be driven largely by other (non-economic) factors. This critique asserts that many investments in common CDM activities – e.g. power generation – are undertaken for a host of political, social, and strategic reasons that extend beyond simple project-level economics and may not be designed to maximise economic return. Such critics argue that a market-based test such as investment analysis is not applicable in what is largely a non-market environment, perhaps especially so in centrally planned countries such as China (He & Morse 2010). For example, Bogner & Schneider (2011) and Haya & Parekh (2011) have argued that governments have already subsidized and developed large hydroelectricity projects in developing countries well before the CDM, making them financially viable and therefore raising questions about the extent to which investment analysis can credibly determine that they would not proceed but for the incentive provided by the CDM. For investment analysis to function properly – indeed, for any additionality test to function properly – it must be able to demonstrate, with high confidence, that the CDM was the deciding factor for the project investment. For project types that are routinely constructed outside the CDM, including (but not exclusively) for broader economic, energy security, or political reasons, it remains highly difficult to determine with confidence that, in any particular case, a project's financial returns are the reason it is not proceeding and that the financial incentive provided by the CDM is the reason for it proceeding (Dechezleprêtre et al. 2014).

Table 4-5 provides an example of how the decision of selecting a certain fuel (coal, fuel oil or natural gas) may depend on many factors that are not are only insufficiently covered in an investment analysis, such as level of initial investment or flexibility in operation that may lead, for example, in investment in a natural–gas-fired boiler rather than a coal–based one, even though natural gas may be more costly than coal in terms of direct costs.

The second critique is concerned with transparency, subjectivity, and information asymmetry, such as whether project developers provide sufficient and credible information to allow replication of their calculations and justification of their conclusions, as well as the inherent information asymmetry between project developers and those, especially the CDM EB, tasked with reviewing the information. For example, early research found that project developers regularly provided investment analyzes that were opaque, relied on proprietary company information, or were incomplete (Schneider 2009).

This analysis takes a new look at several aspects of this second critique, including:

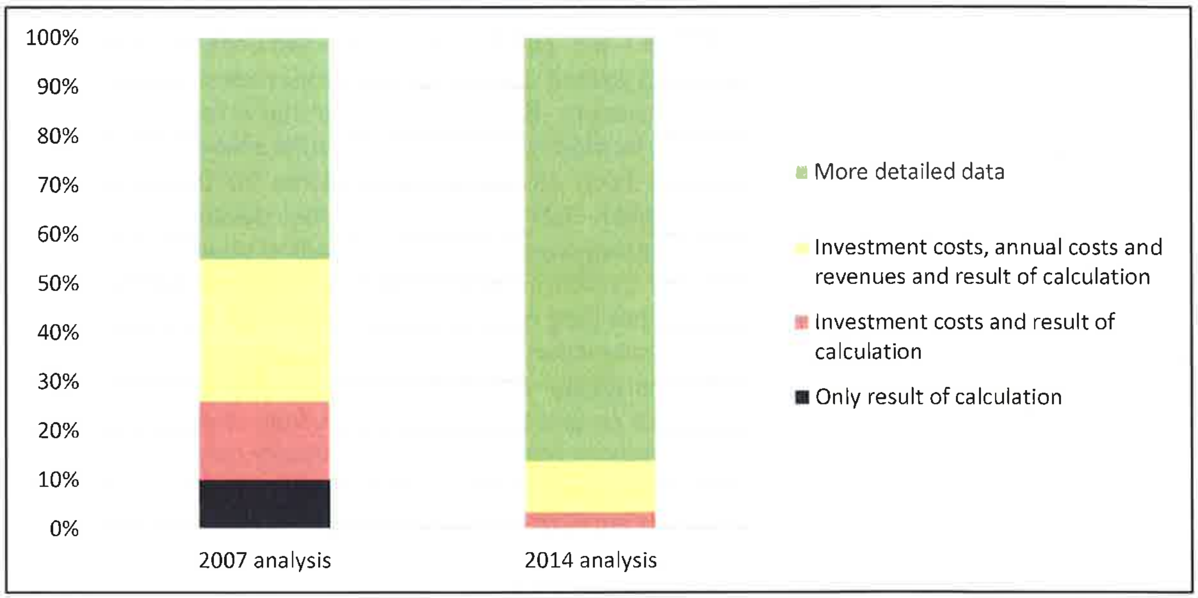
- Transparency, by re-visiting the prior work of Schneider (2009) to gauge how transparently developers conduct the investment analysis.
- Subjectivity and asymmetry, with a new exploration of benchmark rates and CER prices.

These two broad topics are addressed in turn below.

Transparency

To explore transparency in investment analyzes, Figure 3-1 updates the analysis of Schneider (2009) who reviewed a randomly selected group of PDDs for the level of information provided. In our updated analysis, 29 registered projects using the investment analysis were selected at random.[14] Over 90% of the projects selected were registered after 2007, the year of Schneider's prior analysis, so this sample can indicate how practices have changed. In particular, over 80% of the 29 projects in this new analysis provided detailed input data to support their calculations of capital and operating costs and revenues, compared to 2007, when fewer than half did. Furthermore, no projects provided only the result of their calculation in this analysis, with no input data to support their findings. These findings suggest that investment analysis has become more transparent.

Figure 3-1: Level of information provided in PDDs on the investment analysis



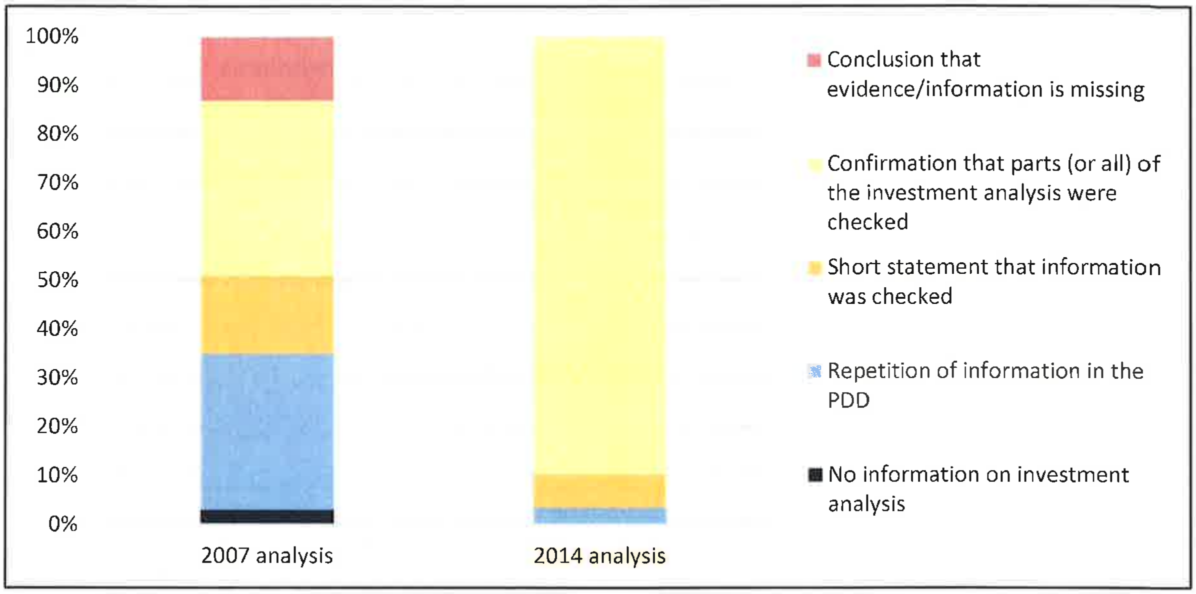
Notes: 2007: n=31, 2014: n=29.
Sources: Schneider (2009), authors' own calculations

Validation reports that review the investment analyzes also appear to have become more thorough. Figure 3-2 also returns to Schneider's prior analysis to update it based on the same randomly selected group of projects as in Figure 3-1. As seen in Figure 3-2, more than 80% of the validation reports confirm that validators checked some or all of the key assumptions of the investment analyzes. The validation reports often review each of several of the most critical investment analy-

[14] According to the sampling design, 30 projects using investment analysis were to be selected. Upon further examination, one of the thirty projects selected, a small-scale, run-of-river hydropower plant, had demonstrated additionality using other methods, as outlined in the "Guidelines for Demonstration Additionality of microscale project activities" and so was not considered in this analysis.

sis inputs and describe that the inputs are reasonable, in many cases citing contract or other documents reviewed to support the choice of inputs.

Figure 3-2: Information in validation reports on the investment analysis



Notes: 2007: n=31, 2014: n=29.
Sources: Schneider (2009), authors' own calculations

Subjectivity and information asymmetry

Despite the findings above, transparency and validator review of the input parameters do not remove subjectivity or choice of alternate input parameters in different contexts. For example, in some cases, project proponents have used different values for key input parameters when submitting applications to financial institutions (Haya 2009), suggesting that the metrics used (and choice of inputs therein) and reliability of such may vary. Indeed, project developers will always have much more information on the project's local conditions – including costs and technical parameters – than will outside parties, whether validators or CDM administrators, and therefore have an incentive to provide biased or inaccurate information to increase the chance of a successful additionality determination and, therefore, the eventual awarding of credits to their project (Gillenwater 2011). This phenomenon is widely referred to as *'information asymmetry'*. As shown above, validators do have more information at their disposal now than in the past, but still lack an objective basis for determining that the investment would not have been undertaken and that inputs provided are the same as they would have been had CDM credits not been sought. Small changes in a number of input parameters – even if individually well within the range of other similar projects (CDM or not), could lead to significant changes in the overall stated financial return of the project. Interestingly, under the CDM, project participants do not need to provide any confirmation that they are submitting truthful information. Some project developers reported that different versions of investment analysis were used for CDM purposes and for the purpose of securing other funding for a project (e.g. loans). Other crediting mechanisms, such as the VCS and CAR, require declaration or attestations from project developers that all information is accurate and presents the truth. To explore further the issue of subjectivity and information asymmetry in input parameters, we take a deeper look at two particular inputs: benchmark rates and CER prices.

Closer examination of benchmark rates

This critique concerns appropriate levels for financial benchmarks (e.g., IRR) (Michaelowa 2009). To explore this question, we reviewed data on IRR benchmarks used by wind, hydro, biomass, and waste gas or heat projects in China, wind and hydro projects in India, and hydropower projects in Vietnam.[15]

Nearly all projects in China use standard, government-issued IRR benchmarks. By far the most common benchmark used is 8%, which is applied for most power projects, and derives from a 2002/2003 Chinese government source, *Interim Rules on Economic Assessment of Electric Engineering Retrofit Projects*. Other common benchmarks based on government rules include 10% for small hydro projects, and 12-13% for waste gas/heat projects.

Table 3-1: Summary of most common benchmark rates used in IRR analysis in Chinese CDM projects

Project type	Common IRR benchmark	Fraction of projects using this benchmark	Source of this benchmark
Wind	8.0%	99%	Government's *Interim Rules on Economic Assessment of Electric Engineering Retrofit Projects* (2002/2003)
Hydro	10.0%	71%	Government's *Economic Evaluation Code for Small Hydropower Projects* (1995)
	8.0%	29%	Government's *Interim Rules on Economic Assessment of Electric Engineering Retrofit Projects* (2002/2003)
Biomass	8.0%	98%	Government's *Interim Rules on Economic Assessment of Electric Engineering Retrofit Projects* (2002/2003)
Waste gas / heat	12.0%	30%	Government's *Economical Assessment and Parameters for Construction Project, 3rd edition* (2006)
	13.0%	17%	Government's *Economical Assessment and Parameters for Construction Project, 3rd edition* (2006)
	18.0%	16%	Conch Cement Company internal WACC

Notes: In this table, and throughout this section, we report IRR benchmarks and values based on analysis of IGES's investment analysis database. We believe that most of the benchmarks, and values reported in the database, are in real terms, based on a review of a small number of PDDs and the assumption in the CDM's Guidelines on the Assessment of Investment Analysis that is conducted in real terms. We make no attempt to identify or convert values in the database that may be in nominal terms.

Sources: IGES 2014, authors' own calculations

Despite the ubiquity of the 8% government-set threshold in China, it is not clear how or why it matches the internal thresholds used by actual project inventors, who may themselves demand returns either higher or lower. (For example, benchmarks for wind power projects in India, where they are determined to a greater extent by investor hurdle rates, are more variable and, on average, higher). For this reason, it is not clear why 8% is the 'correct' benchmark for a test intended to gauge the attractiveness of an investment. Furthermore, it is not clear why common benchmarks used for hydro or waste gas are higher (10% or at least 12%, respectively), and whether these

[15] These project type / country combinations were selected because each of them represents at least 1% of the registered projects in the CDM that use investment analysis (IGES 2012). Though this 1% threshold is arbitrary, it provided us with a basis for focusing the analysis.

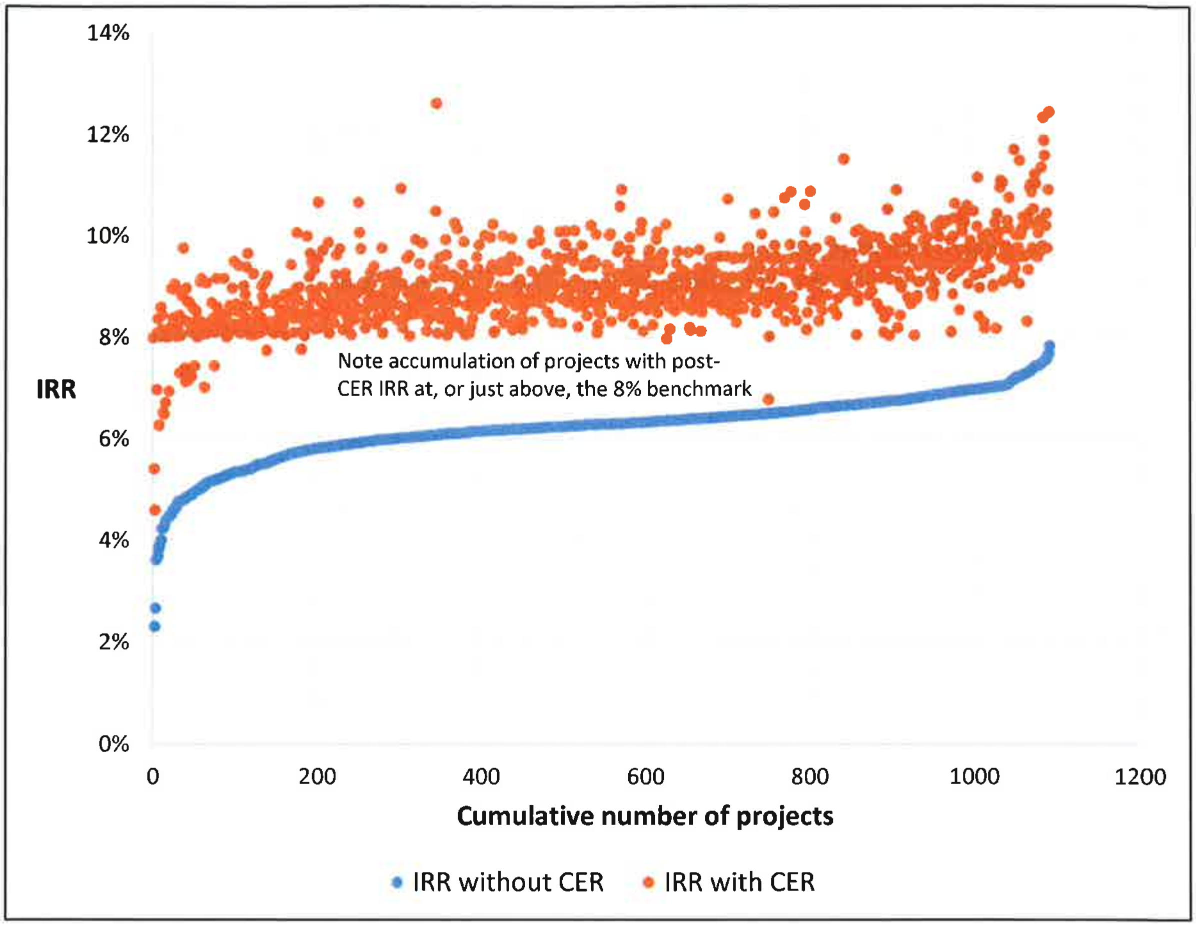
rates accurately capture the risk and expected financial returns in these types of projects. Further analysis of this issue may be warranted, e.g. by comparing it with other sources of equity rates for different investments in China or for similar projects in other countries. A source of such data for projects within China was not immediately known, however.

In principal, the logic of investment analysis is that the project would not have proceeded but for the financial incentive provided by the CDM. That financial incentive is the value of CERs. Many project developers conduct an analysis to show that, at assumed CER prices, the financial return of the project is expected to clear the financial benchmark used. However, this is not actually required by the additionality tool. (In the first versions of additionality, a step 5 'impact of the CDM' was included, which was interpreted by many project developers as an obligation to show that the project is made economically attractive through the CDM. This was later removed).

The above discussion investigated benchmarks used in China, with special attention paid to the widely used 8% benchmark. Because of its ubiquity, this 8% benchmark provides an opportunity to investigate the extent to which CER values indeed bring about expected project returns above this value and therefore, in the logic of the investment analysis, enable the project to proceed. As stated above, though projects are not required to actually show that CER values would push the project above its stated threshold, most do report results of expected return.

The following chart (Figure 3-3) shows the stated IRRs before and after CERs for all wind projects in China that use a benchmark of 8%. As seen in the figure, most of these projects state an IRR without CERs of between 6% and 7%, and an IRR after CER value of 8% to 10%. Note in particular the sharp line at 8%, at which very few projects claim an after-CER IRR of just under 8%, but a large number of projects find a post-CER IRR of just barely more than 8%.

Figure 3-3: Stated IRRs of Chinese wind projects using a benchmark of 8% before and after assumed CER value



Sources: IGES 2014, authors' own calculations

In principle, one explanation for this distribution is that projects in which the 8% threshold is not reached with CER revenues are not implemented, do not apply for CDM registration, and are therefore not represented in this graph. The fact that so many projects just barely meet the 8% threshold (even though they are not required to do so), and so few do not meet it, may instead indicate, however, that project developers are eager to claim that the CER value has allowed the project to clear the benchmark rate.

In contrast to the situation in China where standard government benchmarks are provided, most projects in India use internal, company-specific required rates of return as their IRR benchmarks. However, as in China, the CER value tends to provide a similar increase in expected return (e.g., an increase in IRR of two to three percentage points), just clearing the stated benchmark.

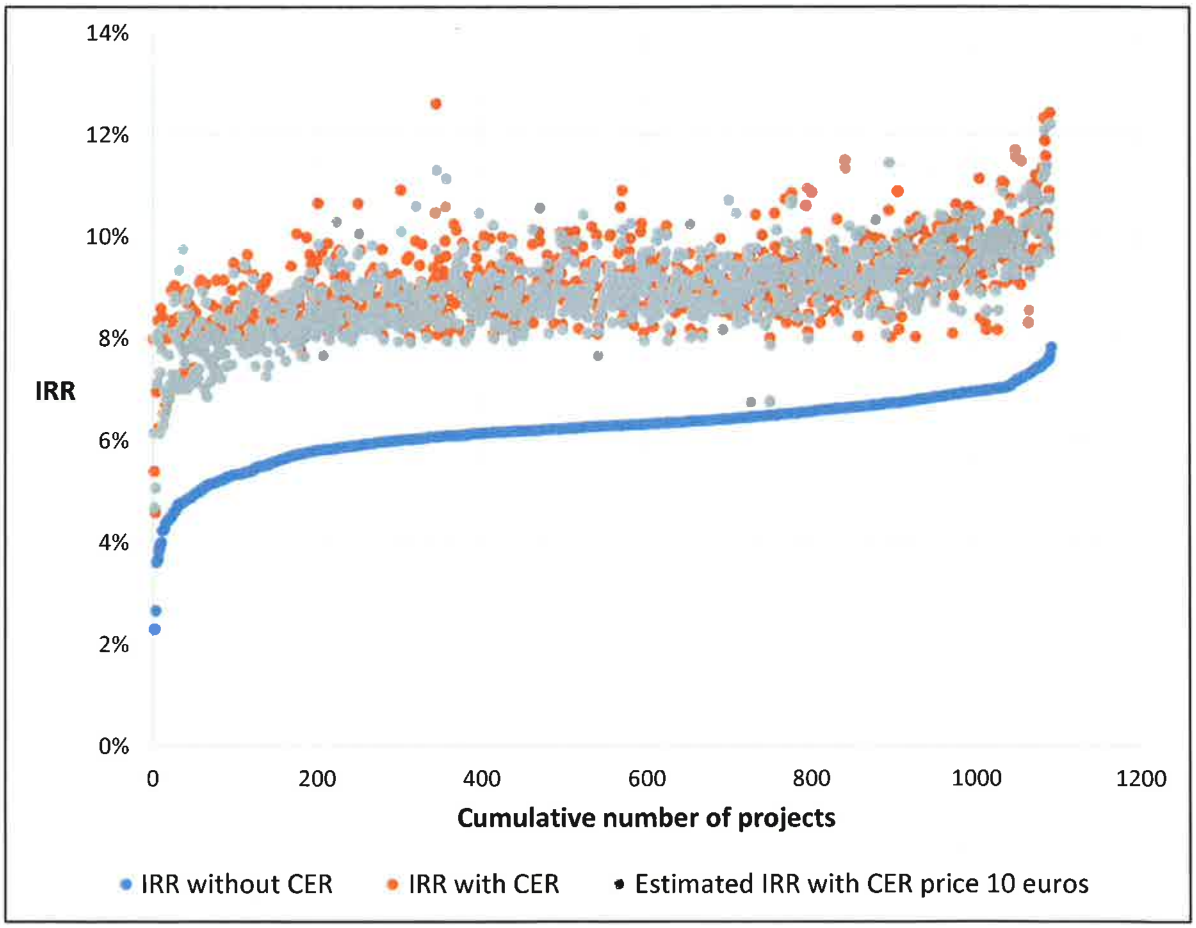
To demonstrate that projects just clear the benchmarks, project developers could select project input parameters so that the benchmark is achieved. These parameters could include CER price, load factor, electricity tariff, or a number of other inputs required in calculating an IRR.

One such parameter that could be adjusted is the expected CER price, which rose consistently through mid-2008, then fell precipitously, and for which forecasts have varied widely since, providing a potentially broad scope for selecting possible future CER prices.

Closer examination of selection of the CER price

To explore the potential effect of the CER price in more detail, Figure 3-4 adjusts the post-CER values stated in the PDDs (as displayed in Figure 3-3) to use a common CER value of €10 for all projects. (€10 is the median value used across all registered projects.) In this example, a large number of projects no longer meet the 8% benchmark. In particular, about 70 projects with pre-CER IRRs of 4% to 6% used CER prices as high as €17 in order to claim they would meet the 8% benchmark. Though this represents just a small share (about 1%) of wind power projects in China, it strongly suggests that input parameters (CER values) have been chosen to achieve the desired result of the 8% government-set IRR benchmark.

Figure 3-4: Estimated IRRs of Chinese wind projects using a benchmark of 8% before and after CER value of €10



Sources: IGES 2014, authors own calculations

Similar to the situation for Chinese wind power projects discussed above, a number of Indian wind projects that claimed that CER values (median price assumed: €14) would lead them to exceed their benchmark would not have been able to claim that their benchmarks are met if they had used a lower, and more common, CER price of €10. This suggests that, as found in the case of wind power projects in China, project developers in some instances may select CER values that depart from values used by their peers in order to claim that CDM revenues will make the projects financially attractive.

A similar pattern emerges for hydropower projects in Vietnam, where benchmarks (averaging 13.1%) were derived either as the weighted average cost of capital (WACC) or a stated commercial lending rate.[16] Of the projects analyzed[17], over half of the hydro projects would not have met their benchmarks if they had used a CER price of €10 instead of higher prices (median price assumed: €15.5, and as high as €30, in contrast to the remainder of Vietnamese hydro projects with median price assumed of €10). As above, while this is not definitive evidence of gaming, it suggests that project developers tend to invoke higher CER prices than their peers when needed to claim that their projects become economically viable under the CDM.

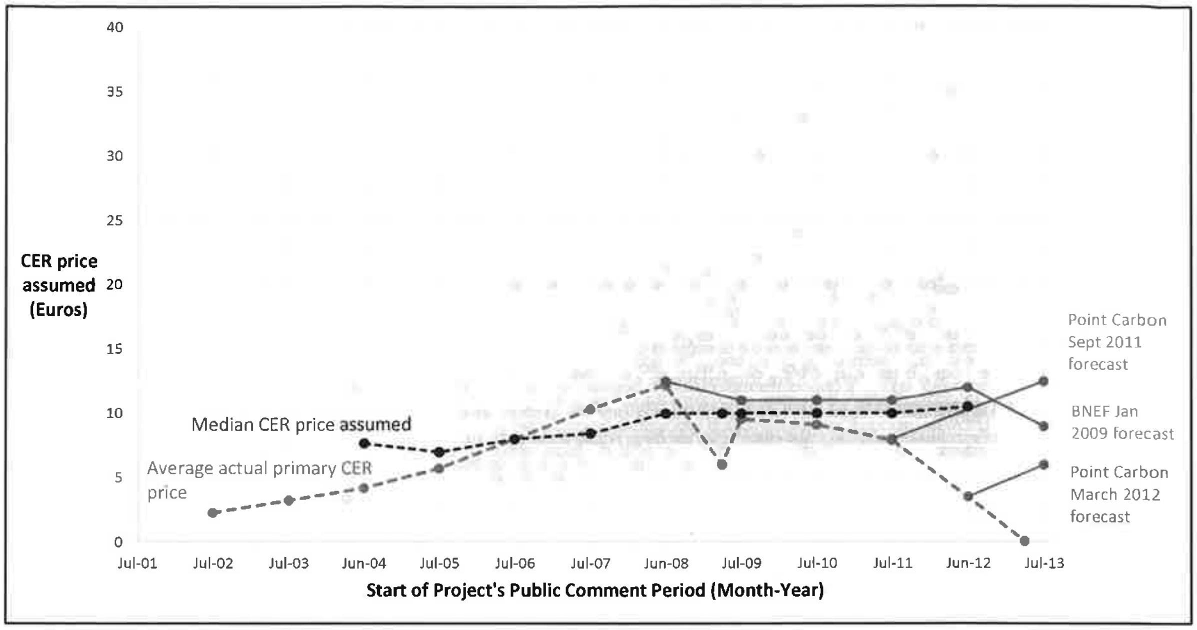
This raises the question of the plausibility of CER prices used by project developers. Looking at all registered projects (Figure 3-5), it appears that the CER prices used by project developers, though highly variable, tended to track then-current primary CER prices, through 2010, when CER prices began a steady decline. Project developers did not then use lower prices, but neither did industry analysts, who forecasted that higher prices would return.

These trends therefore display little evidence that project developers have systematically over- or under-estimated expected CER prices, at least as judged by the median (black line) values. However, the distribution of prices around that median displays a skew wherein a small fraction of projects use very high prices, perhaps because, as shown above, such high prices may be needed to demonstrate that these projects have met benchmarks.

[16] In Vietnam, the median IRR benchmark used by projects in Vietnam was 13.1%, and most benchmarks were derived either as the weighted average cost of capital (WACC) or a stated commercial lending rate. The default expected return on equity for power projects in Vietnam, per the CDM's *Guidelines on the Assessment of Investment Analysis*, is 12.75%; 60% of power projects in Vietnam use an IRR benchmark higher than this rate; 5% have an IRR without a CER value exceeding this.

[17] From the IGES investment analysis database, all hydro projects in Vietnam were selected that reported CER price assumptions in € as well as pre- and post-CER IRR values.

Figure 3-5: CER prices – assumed and estimated



Notes: CER prices assumed by project developers (grey dots) have been relatively consistent with industry forecasts made at the time (blue lines), even though they have been higher than market prices (orange line) since 2008.

Sources: IGES 2014, Point Carbon 2011, Point Carbon 2012

Sensitivity analysis: can it help address subjectivity?

The CDM addresses the subjectivity of input parameters, in part, through the use of sensitivity analysis required in investment analysis. As specified in the *Guidelines on the assessment of investment analysis,* "variables…that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation … and the results of this variation should be presented." However, the guidelines do not require that parameters be varied simultaneously, and few project developers do so. For example, in calculating project IRRs (in the PDDs), no project developer of the 30 randomly selected projects assessed the possibility that more than one of the key input variables could vary simultaneously. Furthermore, nearly all claim that even the standard variations of as much as 10% in the individual parameters are implausible, despite evidence (as presented here) that variation in the input values used is quite common. Accordingly, because the possibility that individual parameters could vary widely is discounted, and the possibility that multiple inputs could vary is not considered, the sensitivity analysis as currently applied is not sufficient to address the subjectivity in these parameters.

3.2.3. Summary of findings

Investment analysis is designed to determine whether a project would be uneconomical or less attractive than an alternative in the absence of the CDM. The premise is that if the project is not economical (most often as compared to a particular investment threshold), it would not have proceeded. From a strictly financial perspective, this may well be the case. However, researchers have pointed out that several types of projects in the CDM – especially large power projects that dominate the CDM pipeline – are pursued for reasons that extend beyond simple financial return, particularly in the largely non-market regulatory environments that are found in some of the largest CDM countries. This may be the most fundamental critique of investment analysis, and yet it is also the most analytically challenging to prove or disprove. Projects may proceed for a variety of factors – economic, strategic, and social – that defy attempts to attribute the viability, or failure, to any one factor. Complicated statistical tests have been proposed – and some statistical research has been attempted – but few compelling approaches have yet emerged.

This research has further explored the issues of information asymmetry, transparency, and subjectivity of input assumptions. Regarding information asymmetry, project developers have considerably more information about their own project than do those – likely including validators – that are charged with reviewing and assessing their additionality. Regarding transparency, this research finds that, since 2007, the transparency of both project design documents and validator assessments has increased markedly, such that the strong majority of projects now include detailed information on input assumptions that their investment analysis could be replicated.

In some cases, there is little reason to question the validity of these input assumptions, as they are based on contract documents (e.g. with equipment providers that would seem to reflect actual prices paid). In other cases, the input assumptions are highly subjective, as in estimates of future fuel prices (e.g. for biomass), electricity tariffs that may be adjusted, or CER prices. In particular, this research has identified dozens of cases in China, India, and Vietnam in which it appears that project developers have used CER prices higher (in some cases, much higher) than their peers in order to claim that the CDM would make their project exceed the chosen financial benchmark. This demonstrates how eager some project developers may be to select input values to give results that would give the appearance of additionality.

3.2.4. Recommendations for reform of CDM rules

As stated above, for an additionality test to function properly, it must be able to demonstrate with high confidence that the CDM was the deciding factor in project implementation. This analysis has demonstrated that the subjective nature of the investment analysis limits its ability to provide that confidence. It is possible that improvements could decrease this subjectivity, such as by applying more complicated tests to assess the true motivations and financial performance of the project. Still, doubts may remain, especially for project types for which the financial impact of CERs is insufficiently large relative to variations in other potential inputs to provide a strong 'signal-to-noise' ratio, such as for large power projects. CDM administrators may therefore want to consider whether certain project types, if they cannot be confidently deemed additional by other tests (e.g. barrier analysis, common practice analysis, as in the next sections of this report), might be phased out of the CDM. If the investment analysis continues to be applied, we recommend further improving the guidance to reduce subjectivity. CDM rules could also require formal declarations by the project participants that information is true and accurate. Such declarations may discourage project participants from providing false information, as a violation of such a declaration may have consequences under national legislation. An even stronger form could be a declaration in lieu of an oath.

3.3. First of its kind and common practice analysis

3.3.1. Overview

The CDM uses two approaches to assess additionality based on the market penetration of technologies: the first-of-its-kind approach and the common practice analysis. Under the first-of-its-kind approach, a project is deemed automatically additional if certain conditions apply. The common practice analysis often complements the investment or barrier analysis. It requires an assessment of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. It is a credibility check to demonstrate that a project is not common practice in the region or country in which it is implemented. The common practice analysis can also be used to demonstrate that the baseline technology or practice is frequently implemented and is hence a realistic scenario. The common practice analysis is only relevant for large-scale projects. Small-scale projects are entitled to use simplified modalities and procedures for small-scale CDM project activities, which do not require common practice analysis.

The first-of-its-kind approach was initially applied as part of the barrier analysis; it was sometimes also referred to as the barrier of lack of 'prevailing practice'. In 2011, the EB adopted guidelines specifying how first-of-its-kind should be demonstrated. The guidelines were further revised in 2012 and reclassified as a tool in 2015.[18] Showing that a project is the first-of-its-kind is the first step in the additionality tool and combined tool, which stipulate that if a project is the first-of-its-kind, it is considered additional. The steps to be followed for demonstrating first-of-its-kind are further specified in the corresponding guidelines and, since 2015, the methodological tool. According to version 03.0 of the tool, a project activity is "first of its kind in the applicable geographical area" if

- "the project is the first in the applicable geographical area that applies a technology that is different from technologies that are implemented by any other project" with the same output and that "have started commercial operation in the applicable geographical area before" the PDD "is published for global stakeholder consultation or before the start date of the proposed project activity, whichever is earlier", if
- "the project implements one or more of the measures" and
- "the project participants selected a crediting period for the project activity that is "a maximum of 10 years with no option of renewal".

The common practice test was first introduced in the additionality tool in 2004 to complement the investment and barrier analyzes, as a safeguard to ensure the environmental integrity of the CDM. In a first step, other previous or current projects which are similar to the project activity were analyzed. Projects were considered similar "if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc." Other CDM projects were excluded from this analysis. In case similar activities were identified, it was necessary to justify why these exist, while the project activity is considered to be financially unattractive or as facing barriers. 'Essential distinctions' had to be identified which may for instance be due to the fact that new barriers have arisen or promotional policies have ended.

For both the first-of-its-kind approach and the common practice analysis, the key issues are defining what is regarded as a comparable technology, what the appropriate geographical scale is and what threshold should be used for a technology to be regarded as first-of-its-kind or common practice. Critics pointed out that no clear definitions of when a project activity should be regarded as common practice were given in the early versions of the additionality tool (Schneider 2009). Another criticism was that the common practice test allows project developers to claim that a frequently implemented project type is not deemed common practice if they can justify 'essential distinctions' from other projects. Yet the key terms 'similar' and 'essentially distinct' were defined so vaguely that any project could be argued to be not common practice, simply by defining 'similar' very narrowly or 'distinct' very broadly (Schneider 2009; Spalding-Fecher et al. 2012).

The requirements for the common practice analysis in the additionality tool remained largely unchanged until September 2011 when the "Guidelines on Common Practice" were introduced, incorporating elements from the additionality tool and providing additional guidance[19]. In parallel to the revision of the "Guidelines on first-of-its-kind", the "Guidelines on Common Practice" were further revised in 2012 and reclassified as a tool in 2015.

[18] Methodological tool. Additionality of first-of-its-kind project activities (version 03.0).

[19] The new requirements of the Guidelines on Common Practice were then also incorporated in the additionality tool in the same year.

Both guidelines or tools are applicable to four GHG reduction activities, namely, "fuel and feedstock switch, switch of technology with or without change of energy source (including energy efficiency improvement), methane destruction" and "methane formation avoidance"[20]. Both also use similar approaches for defining similar or different technologies and the appropriate geographical area.

In the 2011 version of the common practice guidelines, the first step was to calculate the applicable output range as +/-50% of the capacity of the project activity. In the next step, all existing plants in the geographical area within this capacity range needed to be identified (with the exception of registered CDM projects). The default applicable geographical area was the entire host country. If the technology was not country-specific, the geographical area should be extended to other countries. If projects differ significantly between locations, the geographical area could also be smaller than the host country. In the next step, among the identified projects, those with different technologies from the project activity were identified. A technology was considered different if it has a different energy source/fuel, feedstock, installation size (micro, small, large), investment climate at the time of the investment decision[21] or other features.[22] Eventually, if the share of plants using similar technology as in the project activity in all plants with the same capacity as the project activity is greater than 20% and if the absolute number of projects using a similar technology is larger than three, then the project activity is considered common practice.

In revising the Guidelines on Common Practice in September 2012, the rules and definitions were further clarified. It is now mandatory to provide a justification for using a geographical area smaller than the entire host country (e.g. province, region). The reference to extending the geographical area was removed from the guidelines. The exclusion of CDM activities was broadened to include registered projects, those requesting registration and those at validation. Furthermore, several definitions and the step-wise approach were better explained (without change in substance). Minor changes to the common practice analysis were made in subsequent versions of the additionality tool.

The definition of different technologies in the first-of-its-kind approach corresponds to the common practice analysis, with the exception that investment climate at the time of the investment decision and other features are not included.

3.3.2. Assessment

The general strength of using market penetration approaches for assessing additionality is that they do not assess the motivation or intent of project developers, but provide a more objective approach to evaluating additionality, based on the extent to which the project activity is already being implemented in the host country or region (Schneider 2009).

The initial criticism of the lack of clear definitions of similar projects and essential distinctions for common practice was addressed by the introduction and further refinement of the common practice guidelines, which clearly outline steps to follow and provide a definition of terms for a common understanding between project developers. Especially, the introduction of a threshold for common practice (20% and at least three similar projects) constitutes a significant improvement since it requires a quantitative assessment against a clear threshold. Clarity about the rules related to common practice analysis has therefore improved considerably over time. Also, from the sampled projects, it can be concluded that the introduction of the common practice guidelines has generally led to more detailed and better structured PDDs.

[20] For other types of GHG reduction activities, the more general rules of the additionality tool continue to apply.
[21] "Inter alia, access to technology, subsidies or other financial flows, promotional policies, legal regulations."
[22] Such as a difference in unit cost of output by at least 20%.

However, several unresolved issues still exist. In the following, different aspects of the common practice analysis and the first-of-its-kind approach are discussed and assessed. The assessment is based on an analysis of the common practice provisions and on the findings of an empirical evaluation of 30 representatively selected projects (i.e. the review of PDDs and validation reports) (Section 2.2).[23]

When defining similar projects in the common practice tool, the applicable output range is defined as "+/-50% of the design output or capacity of the proposed project activity". This definition does not always reflect the scales of a technology, between which meaningful technological differences occur. For instance, in the case of a power plant with a size of 400 MW, power plants between 200 MW and 600 MW would need to be considered in the analysis. However, there may be smaller (e.g. 100 MW) or larger (e.g. 800 MW) power plants which still feature similar technical, economic characteristics (e.g. efficiency), a similar regulatory environment, or which are used in a similar manner (e.g. provision of electricity to the public grid). At the same time, a small power plant (e.g. 5 MW), may be significantly different in terms of technology or use. Also, when several plants are grouped to form a project (e.g. wind farm consisting of several wind generators), an output of +/-50% may be misleading. For instance, for a wind farm with 20 wind generators of 1 MW capacity, the output range would be 10 to 30 MW. However, a smaller wind farm with only 10 wind generators of 1 MW capacity has similar characteristics since the wind generator is identical. For wind power, the test may provide more meaningful results if there was no scale at all since wind parks are usually composed of different wind generators of the same size. However, small internal combustion engines may well differ, from a technological perspective, from a large combined cycle power plant. In conclusion, the definition in the common practice guidelines (+/- 50%) does not allow for a meaningful classification of scale for different technology types. This definition can therefore be considered arbitrary and may lead to the erroneous exclusion of similar plants from the analysis. In contrast to the common practice tool, the first-of-its-kind tool does not use an output range to define similar technologies. This approach seems more appropriate.

When identifying similar projects, the common practice tool excludes CDM projects (registered, submitted for registration or undergoing validation) from the analysis. In the empirical analysis, of the 30 sampled projects, only three identified similar non-CDM projects. All other projects only identified projects under the CDM. A commonly used rationale (i.e. used by 9 of the 30 projects) is that, because all other comparable facilities are either CDM projects or are awaiting registration as CDM projects, the proposed project would also be non-viable without the CDM (i.e. not common practice). However, it could be argued that the general viability of projects is assessed as part of the barriers and/or investment analyzes and should therefore not be used as a pre-emptive argument for excluding CDM projects from the common practice analysis. The exclusion of CDM projects from the common practice analysis is particularly problematic if most or all new facilities in a sector use the CDM. For example, if all new wind power plants in a country register under the CDM, wind power could never become common practice, even if it reached a market share of more than 50% and was highly economically attractive. In contrast to the common practice tool, the first-of-its-kind tool does not have provisions to exclude CDM projects, which suggests that all existing projects, including CDM projects, are considered.

[23] Of the 30 projects sampled for the evaluation of the common practice analysis, the majority stem from China (20 projects), followed by India (3), Egypt (2), Pakistan (2), Brazil (1), Nicaragua (1) and Israel (1). Ten projects were registered before 2010, eight in the 2010-2011 period and twelve after 2011. Technology types in the sample are wind power (17 projects), hydropower (5), industrial projects such as coal mine methane utilisation or waste heat recovery (3), waste projects such as landfill gas capture (4) and other renewable energies such as biomass (1). Most projects (28 of 30) are classified as large-scale. Although the sampled two small-scale projects are not required to conduct a common practice analysis, some information on common practice was given in the corresponding PDDs.

The common practice tool and the first-of-its-kind tool use the same definition of the geographical area, which should be the entire host country, unless justification can be provided for a smaller geographical area. In the common practice analysis sample, 24 of 30 projects limited the applicable geographical area to a specific area smaller than the host country (such as province, region, state, municipality, etc.). All sampled wind projects from China (11)[24] and from India (3) selected an area smaller than the host country as the applicable geographical area. The most commonly used justification in the corresponding PDDs for limiting the geographical area is that investment conditions, especially in terms of electricity tariffs, available resources and labour costs, differ from province to province, making provincial/state level comparison necessary.

At first sight, this appears to be plausible since China and India are large countries with regions/states being important players in infrastructure development. Notwithstanding this, the size of the country and the political structure may not be sufficient to justify the choice of the regional/state level. In China, a nationwide feed-in tariff for wind power generation was introduced in 2009, establishing four different tariff categories, ranging from 0.51 CNY/kWh (0.08 USD/kWh) to 0.61 CNY/kWh (0.10 USD/kWh), depending on the region's wind resources (International Renewable Energy Agency 2012). For projects in India, the Electricity Act of 2003 and the resulting new tariff regulations were cited as the cause of different investment climates in various states. In fact, for wind power, the tariff varies based on local wind resources. Four bands of wind power density in W/m^2 determine the level of the feed-in tariff (International Energy Agency 2012). This means that the feed-in tariff may differ even between project locations in the same province if these feature different wind conditions. Therefore, the fact that there are different feed-in tariffs between provinces alone does not explain fundamentally different investment conditions in the different regions, as claimed in many PDDs, but rather only accounts for locally different wind resources, while the general support scheme is national[25]. Based on these considerations, the rationale used by many projects for limiting the geographical area to a level below the entire country seems questionable. It can also be problematic to consider only the host country as the geographical area. If no or only a very few plants providing the same service exist in the host country, market penetration approaches do not give reasonable results. For example, the first aluminium plant in a country would always automatically be deemed additional, even if it used a technology that is clearly business-as-usual.

While the introduction of the common practice guidelines aimed to address the criticism of a vague definition of what constitutes 'different' technologies, several concerns remain. The possibility of defining a technology "as being different if there is a difference with regard to energy source/fuel, feed stock, installation size (micro, small, large), investment climate at the time of the investment decision (including, "inter alia, access to technology, subsidies or other financial flows, promotional policies, legal regulations") or other features (such as difference in unit cost of output by at least 20%)" still allows for significant possibilities to claim that rather similar projects are very different. This allows for the project to be defined rather narrowly and other plants very broadly, so that the threshold of 20% is not reached. With regard to the installation size, the same issue as for the output range (above) applies. Also, the criterion 'energy source/fuel' may be misleading. For instance, if a country has been using light fuel oil as a basis for its power plants, a switch to natural gas constitutes a different fuel, but does not explain a significant difference since the same generation technology can be used for both fuels. The same holds true for different solid fuels. Finally, 'other features' is a very broad term allowing for arbitrary interpretations. For example, a difference in unit cost of output does not constitute a plausible difference per se[26]. For instance, higher unit costs

[24] Also all other Chinese (non-wind) projects included in the sample use a sub-national geographical area with a similar rationale as that for wind projects.

[25] A differentiation of the feed-in tariff depending on local wind resources is common practice in other countries as well.

[26] Two sampled hydro projects used this rationale.

may be required for technical or other reasons and may be compensated for by higher yields[27]. Also, according to this interpretation, a proposed CDM project with *lower* unit costs would be considered different from projects already implemented without CDM, even though it is more profitable than other projects. Although in some cases, 'differences' may be well justified (e.g. by explaining that the investment climate was significantly different due to a change from a state-controlled to a more private investment-oriented power market), overall, the review of arguments presented in the sampled PDDs indicate that the term 'different' allows for significant room for interpretation.

The threshold of 20% market diffusion in the common practice tool cannot be considered robust if applied to all technologies and sectors. The stringency of the 20% is highly dependent on the number of technologies in a sector. In a sector with only two technologies, both available technologies could easily exceed the threshold, whereas none of the technologies may ever reach the 20% threshold in sectors with many different technologies. For instance, in a country with several fuels and technologies available for power generation (e.g. natural gas, coal, wind, hydro, biomass, PV), a low market diffusion may still constitute common practice due to the abundance of options and due to the (potentially) limited potential of some technologies. For instance, hydro electricity generation may constitute only 5% of overall electricity generation. Nevertheless, hydropower could still be considered common practice due to the fact that hydro resources are limited and most of the resources have already been exploited. In contrast, in a sector in which there are only a few technologies (e.g. for a certain industrial process) a market diffusion of 20% may constitute a reasonable value for determining common practice. Also, even though a technology may not be considered common practice considering all existing plants in a sector (i.e. considering the market saturation), it may be common practice considering the recent trend (i.e. considering the market share in a certain year)[28]. For instance, electricity generation from wind may constitute only a small share of the overall electricity generation in a country (e.g. 1%). However, capacity additions in recent years may constitute a significant share of overall new capacity built. In the former case, wind power would not be considered common practice, whereas in the latter, trend-oriented, perspective wind power would constitute common practice. This issue is especially relevant in the case of long-lived capital stock such as in the power sector (Kartha et al. 2005). Similarly, the provision that at least three plants with a similar technology must have been constructed to consider a project common practice may not be appropriate in all situations. For example, if only four plants exist in a country and three use the same technology, thus constituting a market share of 75%, the construction of a fifth plant with the same technology would still not be regarded as common practice. In conclusion, a one-fits-all value as threshold for market diffusion cannot be considered appropriate.

With regard to the quality of evidence used for the demonstration that a project is not common practice, almost all PDDs provided anecdotal evidence to support their claims. Commonly made statements are that there is no evidence to suggest that a similar project has been, is being or will be implemented in this area and that all other projects use CDM financing as well. To support these claims, publicly available external documents such as energy statistics were used in the majority of projects (20 of 30 projects). Yet, these public documents do not provide information about different investment climates in terms of labour costs, available resources and feed-in tariffs.

As regards the validation of common practice, in 21 of 30 sampled projects, the DOE reviewed documents such as the World Bank website or energy statistics. Other means of validation were conducting interviews with stakeholders such as personnel with knowledge of the project design and implementation, local residents and officials.[29] However, the DOEs did not evaluate claims

[27] E.g. higher units costs may be required for certain equipment for small hydro in a mountainous area, which may be compensated for by higher yields due to a higher head of water.
[28] See Kartha/Lazarus/LeFranc (2005) for a definition of market saturation vs. market share.
[29] There is no further information available in the PDDs on the content of the interviews with the stakeholders.

made in the PDDs about different investment climates. In nine cases, the DOE in its validation report just repeated the claims made by the PDD.

3.3.3. Summary of findings

Overall, clarity about the rules related to first-of-its-kind and common practice analysis have improved considerably over time. In addition, from the sampled projects it can be concluded that the introduction of the common practice guidelines has generally led to more detailed and better structured PDDs. However, several flaws remain:

- The definition of the output range in the common practice tool is arbitrary and not linked to actual differences in scale of technologies or use.
- The exclusion of CDM projects from the analysis is questionable in a market situation in which most projects are implemented as CDM projects and significant technological changes and cost reductions occur.
- The rationale for limiting the geographical area to a level below the entire country is questionable. In some instances, limiting the geographical area to the host country can be problematic.
- The definition of a project as 'different' in the current common practice guidelines is still too vague and corresponding rules still leave significant room for interpretation.
- The share of 20% market diffusion and absolute number of three similar projects, across all sectors, cannot be considered robust since the appropriateness of these values depends on the number of available technologies in the sector. Additionally, the result of the common practice analysis is highly sensitive to whether all plants of a sector are considered or whether the recent trend (new plants built) is considered. This is especially relevant for sectors with long-lived capital stock.
- Generally, evidence used for the common practice analysis was not adequate in the sampled projects since relevant information for the determination of common practice (e.g. on different investment climates, available resources or feed-in tariffs) was not provided in the PDDs. Also, the validation by DOEs was not adequate in the sampled projects since claims on investment climates were not evaluated and since in several cases the DOE only repeated the claims made by the project participants.

3.3.4. Recommendations for reform of CDM rules

In general, the first-of-its-kind approach and the common practice analysis can be considered more objective approaches than the barrier or investment analysis due to the fact that information on the sector as a whole is taken into account rather than specific information of a project only. It reduces the information asymmetry inherent in the investment and barrier analysis. In this regard, expanding the use of market penetration approaches could be a reasonable approach to assessing additionality more objectively. However, the presented analysis shows that the way in which first-of-its-kind and common practice are currently assessed needs to be reformed in order to provide a reasonable means of demonstrating additionality. In the following, several recommendations are made for the reform of the current rules.

We identified several issues with the approach of using the same generic approach in the context of rather different sectors or project types. We therefore recommend abandoning this 'one-size-fits-all' approach and introducing specific approaches for specific project types, which adequately reflect the circumstances of the sector, in particular with regard to the definition of what is considered a different technology and the threshold used to define common practice. A practical means of implementing this is including specific guidance in each methodology.

- Due to the inherently vague concept of 'different' technologies, it is recommended that the common practice rules are revised in such a way that methodologies or overarching guidance provide clearer guidance on how to support the claim of a 'different' technology including the evidence required (including evidence to demonstrate credible differences in the investment climate). Corresponding provisions in the VVS should also be amended in such a way to provide more specific guidance on how DOEs should assess the claim of 'essential distinctions' for different projects types. With regard to the above-mentioned arbitrary definition of the applicable output range, it is recommended that the common practice guidelines are revised in such a way to provide general guidance on how meaningful differences according to scale can be identified for different technologies. More specific guidance on how to define a range of capacity/output should then be defined in the corresponding methodology. In the absence of any definition of capacity/output range in the methodologies, the whole spectrum of plants or activities (from very small to very large) should be covered by the analysis.
- With regard to the exclusion of CDM projects from the common practice analysis, the rules should be amended in such a way that all CDM projects are to be included in the analysis as a general rule, unless specified otherwise by the methodology. Methodologies could specify that CDM projects are excluded to a certain extent and then gradually introduce them in the analysis. This is especially relevant if all projects of a certain technology use the CDM. As Schneider (2009) points out "other CDM projects could be included in the common practice analysis after a certain period or after a specific number of CDM projects have been implemented". Another criterion for inclusion of CDM could be their market penetration. (International Rivers 2011) suggest that "after 3 years of full operation, a CDM project should be included in the common practice analysis". Furthermore, a "list of project types that are not eligible for the CDM because they are common practice" (ibid.) (negative list) could also be helpful in this regard.
- Due to our finding that the selection of an area below the host country level as the applicable geographical area is a questionable assumption, it is recommended that the rules be revised to define the appropriate geographical area in the context of the specific circumstances, such as the number of projects or installations in the host country. A level below the host country level should not be used.
- The threshold for common practice should be defined depending on the type of technology and sector. Corresponding guidance should be provided in the methodologies. In sectors with long-lived capital stock (e.g. power sector), the common practice analysis could consider two different perspectives: a) common practice in the sector (e.g. power sector) as a whole (market saturation) and b) common practice in more recent investments (market share) (i.e. similar to the operating and build margin approach for projects displacing electricity). If common practice is established according to at least one of these perspectives, the project should be considered common practice. Since data availability for determining market diffusion may not be sufficient in each country and in order to ensure consistency in determining market diffusion, efforts (e.g. multilateral) for collecting this data and for providing this information to project developers could be helpful. Several global datasets already exist (e.g. UNEP DTU 2014, statistics by the World Bank, sectoral statistics, Platts database on power plants or cement statistics by Cembureau), which could be used to estimate market diffusion in different countries in a consistent manner. An extensive discussion of

the usefulness of market penetration for establishing common practice for certain projects types is included in (Kartha et al. 2005).

Due to the fact that several DOEs repeated the claims made by the project participants without documenting the way in which they actually assessed the appropriateness of the claims, we recommend strengthening efforts to ensure that all DOEs effectively comply with the reporting requirements related to the common practice analysis outlined in the VVS. For this purpose, no change in rules has to be applied, but the accreditation system may need to be strengthened to ensure compliance of all DOEs with applicable CDM requirements.

Another option for improving the analysis of common practice is to consider the overall potential available in a country. For instance, a small share of hydro in overall electricity generation may, on the one hand, be due to barriers, risks or economic unfeasibility of hydro construction (hydro electricity generation would therefore not be common practice). On the other hand, the small share of electricity generation from hydro may be due to the very limited hydro potential in the country. Most of the (small) potential may already have been exploited. Any additional hydro capacity could then be considered common practice since it has been exploited before. However, this approach would bring about the problem of defining ways to establish the potential (e.g. technical vs. economic potential, etc.), and the practicalities and transaction costs of evaluating this for many different technologies.

Furthermore, the common practice analysis could "be the first step in the additionality tool rather than the last" (International Rivers 2011). This way, instead of using often vague arguments for establishing common practice *after* the investment analysis, project developers would need to discuss common practice explicitly at the beginning of the analysis.

3.4. Barrier analysis

3.4.1. Overview

Historically, barrier analysis has been used as an important alternative or complement to the investment analysis analyzed above in Section 3.2. The barrier analysis is used to demonstrate that a project faces barriers that impede the project's implementation in the absence of the incentives from the CDM. It is applicable to both small- and large-scale CDM projects:

Small-scale projects

According to Attachment A to Appendix B to Annex II of 4/CMP.1 the following barriers may be considered for small-scale projects:

- **Investment barrier**: a financially more viable alternative to the project activity would have led to higher emissions; this includes "the application of investment comparison analysis using a relevant financial indicator, application of a benchmark analysis or a simple cost analysis".[30] In essence, this barrier allows an investment analysis to be conducted, as described in Section 3.2, but without providing any guidance on how the investment analysis should be conducted. In practice, however, it appears that guidance for investment analysis for large-scale projects (e.g. justification of benchmark IRR or sensitivity analysis) is, in most cases, also applied to small-scale projects.
- **Access-to-finance barrier**: the project activity could not access appropriate capital without consideration of the CDM revenues;

[30] See "Non-binding best practice examples to demonstrate additionality for small-scale projects" (EB 35, Annex 34).

- **Technological barrier**: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
- Barrier due to **prevailing practice**: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
- **Other barriers** such as institutional barriers or limited information, managerial resources, organisational capacity, or capacity to absorb new technologies.

Large-scale projects

In large-scale projects, the barrier analysis is part of the additionality tool and the combined tool. It is applied in two steps:

1. Identify barriers that would prevent the implementation of the proposed CDM project activity. Here, the eligible barriers are similar to the barriers relevant for small-scale projects, with the following differences:
   - The 'investment barrier' of the small-scale guidance is, in the large-scale guidance, referred to as 'investment analysis' (Section 3.2); a separate option for demonstrating additionality besides 'barrier analysis';
   - The 'access-to-finance barriers' of the small-scale guidance is called 'investment barriers' in the large-scale guidance; and
   - 'prevailing practice' of the small-scale guidance is, in the large-scale guidance, usually a mandatory additional step termed 'common practice analysis' that is required but is not sufficient in itself to prove additionality.
2. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity).

Another important requirement of the two tools is the following: "If the CDM does not alleviate the identified barriers that prevent the proposed project activity from occurring, then the project activity is not additional."

If these steps are satisfied, the project is potentially additional (pending passing of the common practice analysis).

In late 2009 (EB50), the CDM EB adopted the "Guidelines for objective demonstration and assessment of barriers" with a view to improving the objectivity of the barrier analysis. The document provides guidance on the objective demonstration of different types of barriers. For instance, it requires that "barriers that can be mitigated by additional financial means can be quantified and represented as costs and should not be identified as a barrier for implementation of project while conducting the barrier analysis, but rather should be considered in the framework of investment analysis" (Guideline 4 in EB50 A13).

In addition, methodologies may – instead of using one of the tools – provide their own combination of steps from the tools.

3.4.2. Assessment

The concept of barriers preventing investments and mitigation activities is an important element of the research and discussion on technology diffusion and low carbon pathways. From this, it seems reasonable that the additionality test could also take barriers into account and not only be based on investment analysis. However, the barrier analysis faces multiple challenges in practice that strongly limit its usefulness in the context of the CDM.

Objectivity in barrier analysis

In earlier phases of the CDM, the claim for barriers preventing the implementation of projects was often based on anecdotal evidence, and it was very difficult to provide objective proof of why a barrier is sufficient to "prevent the implementation" (Schneider 2009). In practice, the concept of barriers per se as proof for additionality is problematic, as all investment projects in all countries faces some sort of barriers to its implementation, be they financial, technical or other. In earlier CDM projects, it was sufficient for PDD consultants to state barriers without providing objective and verifiable evidence that they actually *prevent* the implementation of the project. This led to some market participants claiming that with good PDD consultants you could have any project registered based on barriers.

Guidance on objective barriers

In late 2009 (EB50), these problems with barrier analysis led to the adoption of the "Guidelines for objective demonstration and assessment of barriers" by the CDM EB (Section 3.4.1). With their requirement to monetize barriers, the guidelines aim to assess the role of barriers in preventing the implementation of projects in a more transparent way. The monetization of barriers and their inclusion in the investment analysis provide a framework that allows an objective balancing of higher barriers and associated costs with the need for higher revenues. This may be one of the reasons why investment analysis (with or without monetized barriers) has largely replaced the use of the barrier analysis without application of investment analysis in demonstrating additionality (see below).

How much alleviation is necessary to overcome a barrier?

Another weakness of the barrier analysis lies in the application of the requirement to demonstrate that the CDM "alleviates the identified barriers that prevent the proposed project activity from occurring". The fulfilment of this requirement was not often (explicitly) provided in PDDs nor checked by DOEs. Moreover, the tools do not require that the degree of 'alleviation' should be at least comparable to the strengths of the barrier under consideration. To demonstrate the viability of the project with the CDM, one would need to make the case as to why, for example, €x of CER revenues are sufficient to alleviate the risk of damage to a wind farm due to severe sand storms.

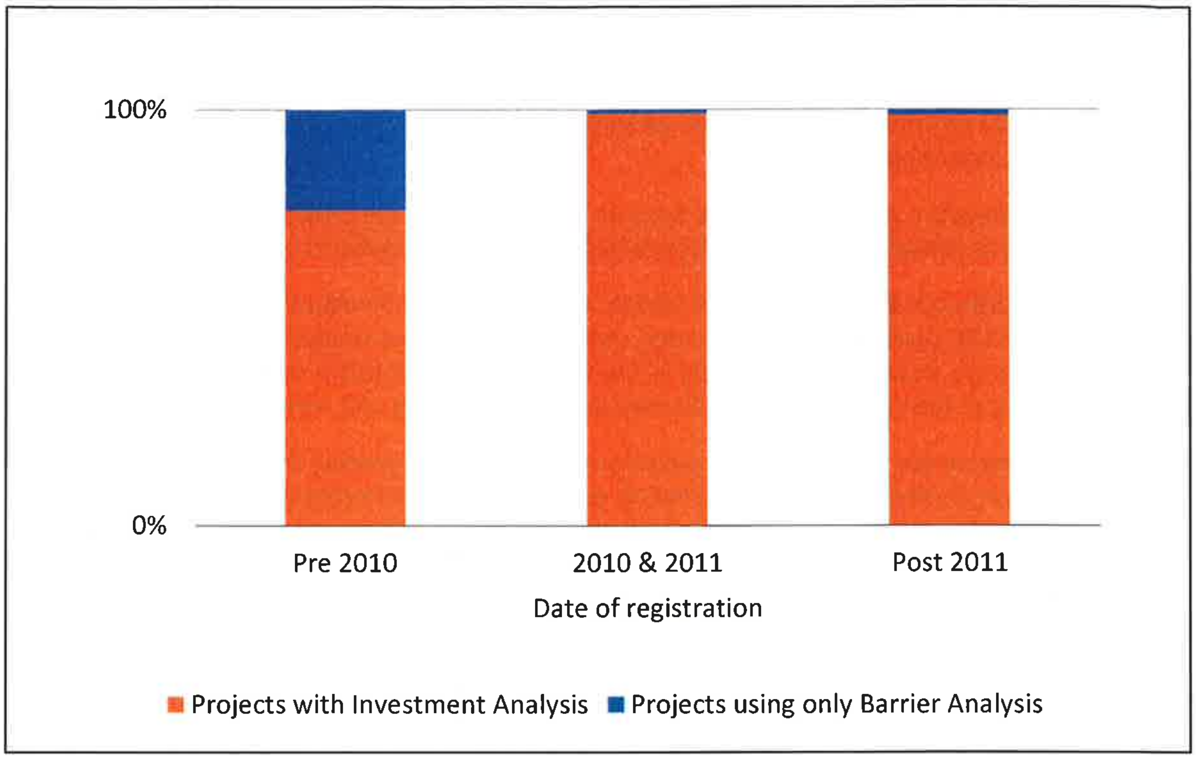
Also with regard to this requirement, the Guidelines provide greater specificity: "Demonstrate in an objective way how the CDM alleviates each of the identified barriers to a level that the project is not prevented anymore from occurring by any of the barriers" (Guideline 2 in EB50 A13).

The vanishing role of barrier analysis in the CDM

The role of barrier analysis in demonstrating additionality in the CDM has been dramatically reduced from 2010 onwards (Figure 3-6). While in the period before 2010 approx. 24% of registered projects used the barrier analysis *without applying an investment analysis in parallel*, this share was reduced to approx. 1-2% of registered projects from 2010 onwards. Since then, the barrier analysis plays a certain role in reinforcing the additionality argument made in the investment analysis, but has largely lost its role as the main approach for demonstrating additionality.

This development might be explained by the introduction of the guidelines for objective demonstration and assessment of barriers.

Figure 3-6: Share of projects using the barrier analysis without applying the investment analysis in total projects



Notes: Own research based on a representative sample of PDDs from 30 stratified and randomly sampled projects that were labelled Investment Analysis option none by the IGES (2014) database revealed that a certain percentage of these PDDs used an approach that in essence follows the Investment Analysis approach of the additionality tool, but was labelled Barrier Analysis. The confusion in terminology was most prominent in small-scale project PDDs, which have the option to demonstrate financial barriers which includes and is often an Investment Analysis. In the representative sample, the fraction of PDDs using actually an Investment Analysis while being labelled Investment Analysis option none by IGES was 36.4% pre 2010 and 90% afterwards. The share of projects using Investment Analysis from the IGES database has, therefore, been increased by these shares from the sample analysis. Without this correction, the share of projects without investment analysis in the IGES database are 38%, 10% and 14%, respectively, for the three considered time periods of registration.

Sources: IGES 2014 authors own PDD research

With the adoption of the guidelines, the barrier analysis has largely lost its role as the main argument for demonstrating additionality. After 2010, non-financial barriers are quoted in some projects, but merely as additional information to reinforce the main case for additionality, which tends to be based almost uniformly on investment analysis. Potentially, this development may have been supported by an improved performance of DOEs in validating barrier analysis in PDDs, due to an improved accreditation system.

3.4.3. Summary of findings

In early CDM projects, the routine use of anecdotal and often subjective evidence for claiming barriers has led to the registration of projects with questionable claims for additionality, which cannot be objectively assessed by DOEs. With the adoption of the Guidelines and possibly the improved performance of DOEs, the barrier analysis has largely lost its role as the main line of argument for demonstrating additionality. Rather, barriers are monetized and reflected in the investment analysis.

In the CDM, barrier analysis has lost importance as a stand-alone approach to demonstrating additionality because of the subjectivity of the approach. With the guideline, if barriers are claimed, they are monetized and integrated as costs in the investment analysis.

3.4.4. Recommendations for reform of CDM rules

Non-financial barriers can be important factors preventing the implementation of projects even though they may be profitable. Therefore, considering barriers in approaches for additionality determination is a valid approach.

However, the objective demonstration of barriers (as required in the Guidance) has turned out to be very difficult to operationalise without the reflection and monetization in an investment analysis.

Given the de facto non-application of the barrier analysis without investment analysis approaches in the current CDM practice, we recommend removing the barrier analysis from the additionality and combined tools. In return, key aspects of the Guideline related to the monetization of barriers[31] may be included in the investment analysis step in the additionality and combined tools.

In order to demonstrate additionality of projects with high (non-financial) barriers that may not be monetized, a comprehensive 'common practice' analysis or in small-scale projects 'prevailing practice' analysis shall be carried out (Section 3.3). Here, objective data on market shares of technologies/project types may be collected that may serve as objective proxy information for the extent to which barriers actually prevent the implementation of projects.

On another note, the approval of "Guideline on objective demonstration and assessment of barriers" by the CDM EB may be seen as a positive example of how the CDM regulator, under the right conditions, can react to an obvious flaw in the rules and practice, and rectify the system.

3.5. Crediting period and their renewal

3.5.1. Overview

Project participants can choose between one crediting period of 10 years without renewal or a crediting period of seven years for their project, which is due for renewal every 7 years for a maximum of two renewals (a total of 21 years for normal CDM projects). (For afforestation and reforestation projects, the choice is between one period of 30 years and three periods of 20 years). The Marrakesh Accords state that for each renewal, a designated operational entity shall determine that "the original project baseline is still valid or has been updated taking account of new data where applicable".

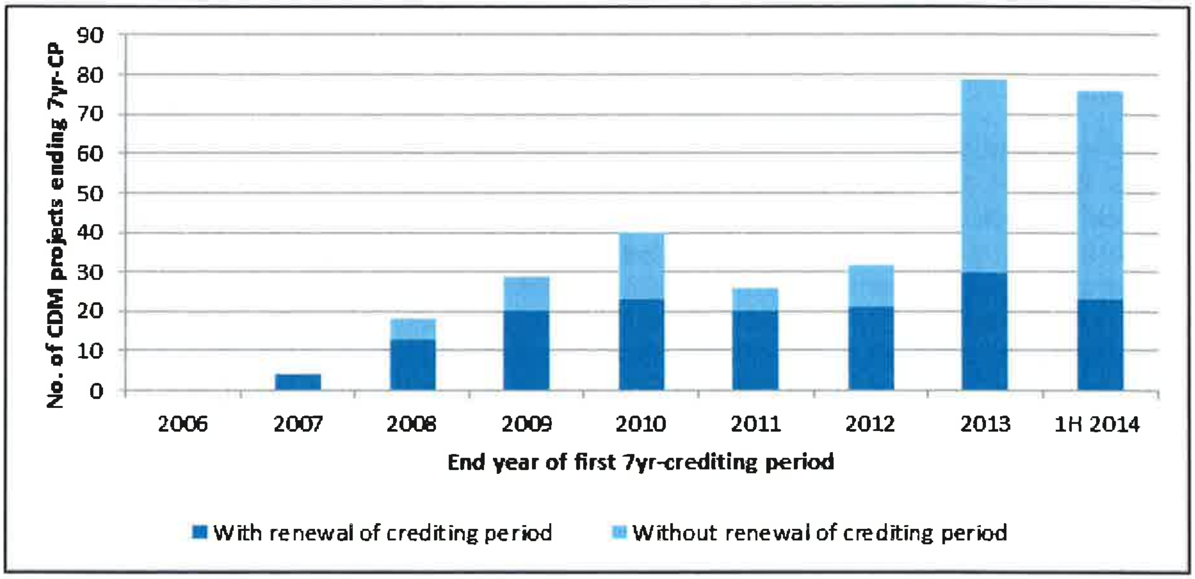
Requirements regarding the renewal of the crediting period were initially adopted in 2006 (EB28, Annex 40), subsequently revised several times (EB33, EB36, EB43, EB46, EB63, EB65, EB66), and partially incorporated in the project standard. At the renewal of crediting period, the latest valid version of a methodology must be used. If a methodology has been withdrawn or is no longer applicable, the project developers may use another methodology or request deviation from an applicable methodology. The CDM EB interpreted the 'validity test' in the Marrakech Accords in such a way that neither additionality nor the baseline scenario needs to be reassessed during the renewal of the crediting period. "The demonstration of the validity of the original baseline or its update does not require a reassessment of the baseline scenario, but rather an assessment of the emissions which would have resulted from that scenario" (Project Standard, Version 07.0, paragraph 289). The current rules mainly require an assessment of the regulatory framework, an assessment of

[31] This relates to Guidelines no. 4 and 5 of EB50 Annex 13 that may be integrated as cost items related to barriers/risks in the investment analysis of the additionality and combined tool. Guideline 2 may also be implemented in the context of the investment analysis in the tools, in that the CER revenues should be sufficient to overcome the financial gap in project finance that is due to the barrier.

circumstances, an assessment of the remaining lifetime of technical equipment to be used in the baseline, and an update of data and parameters, such as emission factors.

Figure 3-7 plots the number of projects that have chosen a 7-year crediting period and that end their first crediting period in a given year and are therefore potentially entering a process of crediting period renewal. The increase in project registrations with the maturing of the CDM market from 2005 is mirrored by a steep increase in candidate projects for renewal seven years later, after 2012. The graph also indicates that the fraction of these candidate projects that actually underwent renewal significantly declines after 2012: While before 2012 roughly two thirds of all candidate projects underwent renewal on average, the rate dropped to roughly one third after 2012. This may be explained by the collapse in pricing and the petering out of the classical CDM market in 2011-2012, whereby CER prices below marginal transaction costs make renewal of crediting economically non-viable for most projects that do not benefit from long-term futures contracts with higher prices.

Figure 3-7: Number of CDM projects ending first seven-year-crediting period – with and without renewals



Sources: UNFCCC 2014 authors own analysis

3.5.2. Assessment

The requirements to use the latest approved version of a methodology is a very important rule to assure that changes in the methodological ruling are also implemented in CDM projects within a reasonable timeframe and therefore seem appropriate. At the same time, it provides some certainty for investors that rules regarding the calculation of emission reductions are not changed within their crediting period.

The CDM EB's decision to interpret the Marrakesh requirement of assessing that "the original project baseline is still valid" in such a way that that only baseline emissions must be updated but that neither additionality nor the baseline scenario needs to be re-assessed could constitute a major risk for the environmental integrity of some project types. In 2011, the Meth Panel highlighted certain issues with this approach in an Information note to the EB (MP51 Annex 21[32]), but the rules were not changed in response. In the following, we briefly analyze two main issues:

- The case of the baseline scenario changing over the course of the crediting period in a way that is not captured by the baseline methodology;
- The case of limited 'lifetime' of a baseline scenario.

Baseline scenario changing over of the course of crediting periods

In a number of instances, a baseline scenario could change over time during crediting periods and deviate from the assumptions in the underlying methodology. One example is a CDM project consisting of the conversion of an existing open cycle power plant to a closed cycle system. Assuming that after the first crediting period, new and lower cost technologies for the conversion would become available that would make the project economically viable, the implementation of the project activity after the first crediting period might be the most probable baseline scenario in the absence of the CDM. We are not referring here to the concept of dynamic baselines, e.g. the fact that baseline emissions are calculated based on the project output (e.g. in tons of steel or MWh per year). Rather, the scenario is changing, i.e. this refers to projects (or another low carbon activity) which, in the absence of the CDM project, would have been implemented at a later date due to changing circumstances.

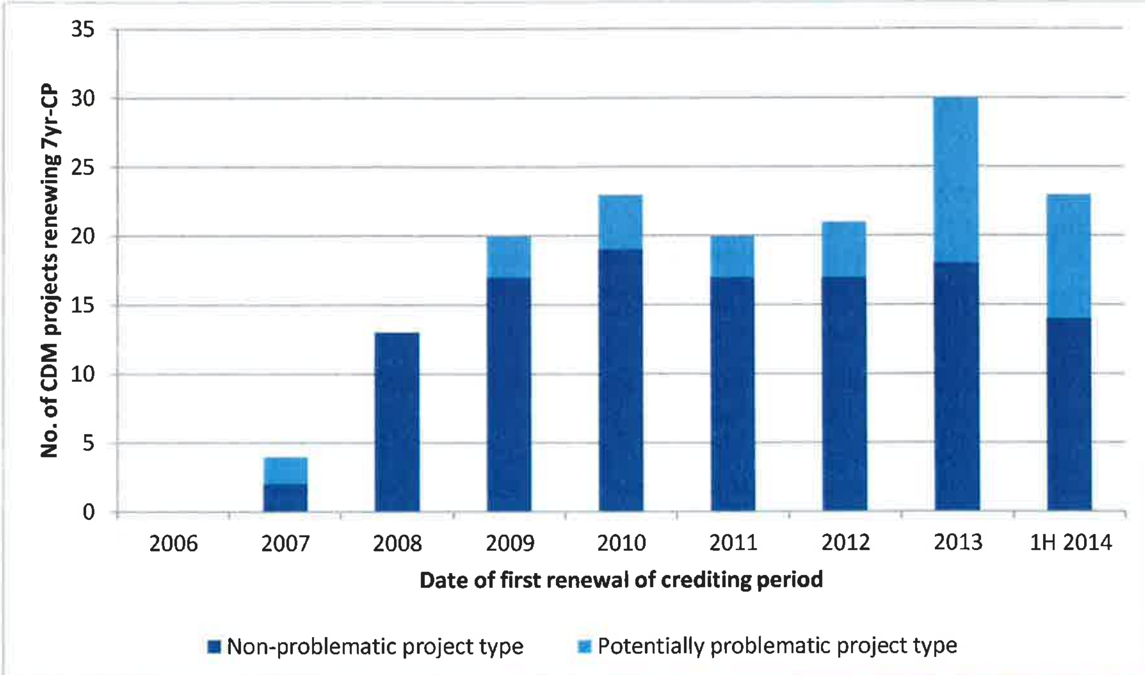
However, it is important to note that not all CDM project types are prone to changing baseline scenarios. Baseline scenarios typically change over time if they are the 'continuation of the current practice'. In such cases, changes such as retrofits could also be implemented at a later stage. In contrast, baseline scenarios do not change over time when they include a significant investment at project start in an alternative that provides similar services. This is the case if, for example, an industry can choose to fulfil their heat demand by either a new biomass boiler (project activity) or a new coal boiler (baseline). If one assumes that the project participant carries out a significant investment at the beginning of the baseline (e.g. to build the new coal boiler), it may be assumed that this investment is used until the end of its operational lifetime; replacing the coal boiler by a biomass boiler after seven years is economically not viable in general.

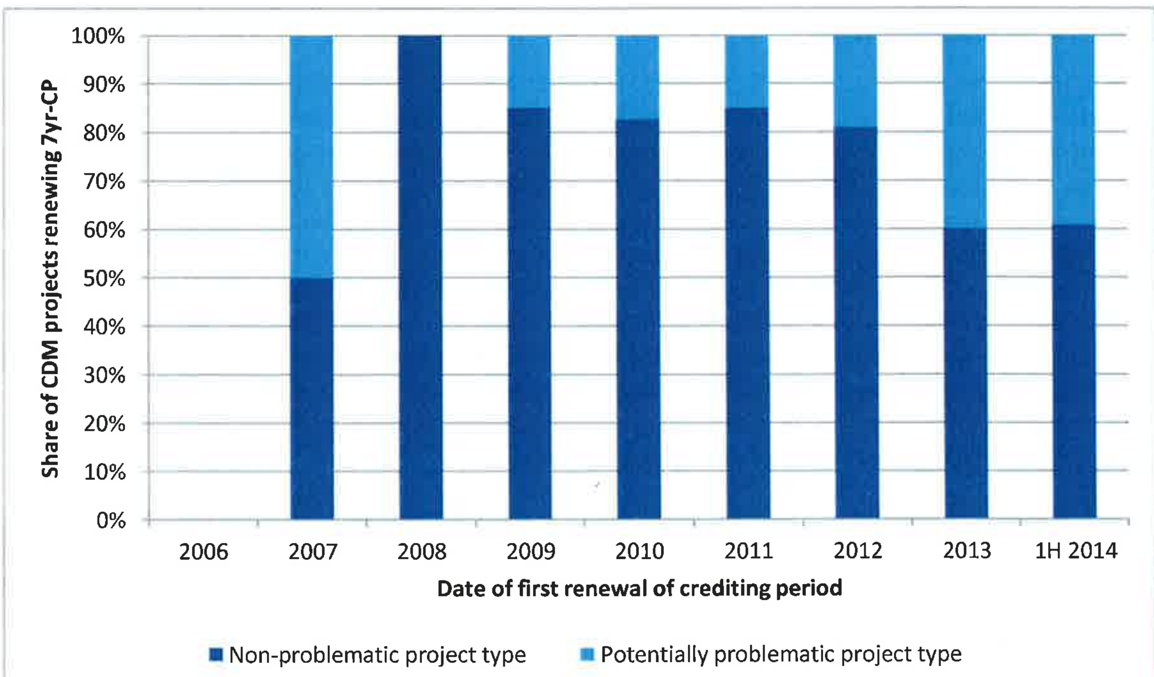
However, because CDM requirements explicitly rule out the re-assessment of the baseline scenario, cases with a change in baseline scenario cannot be taken into account, which leads to potential over-crediting in the second and third crediting periods in the case that the activity would have been implemented after the first crediting period due to changing circumstances.

Practical examples of such changing circumstances and related potential over-crediting can be found in Purdon (2014) for the co-generation sector. The paper provides an overview of how a change in external influence factors (e.g. sugar price) can influence the additionality and how a baseline scenario that is kept constant over several crediting periods can result in over-crediting.

32 https://cdm.unfccc.int/Panels/meth/meeting/11/051/mp51_an21.pdf.

Figure 3-8: Share of CDM projects renewing their seven year crediting period that is deemed non-problematic





Notes: Potentially non-problematic project types have been selected according to the criteria of having a lower risk of changes in the baseline scenario over several crediting periods.

Sources: UNFCCC 2014, authors' own analysis

Assessment of the scale of the issue

In the following, we make a very rough assessment of the scale of this issue. As mentioned above, not all project types are in danger of undergoing changes in baseline scenarios that are not foreseen in the underlying methodology. In order to arrive at a preliminary estimate of the scale of the potential issue, a list of 'potentially problematic' project types was identified that have a higher risk of changes in the baseline scenario over several crediting periods than those categorised as 'unproblematic'.[33]

Please note that 'potentially problematic' does not mean that all projects in that project type have issues with the renewal of the crediting period, it simply means that the projects are in a sub-type that may contain potentially problematic projects. Figure 3-8 depicts the number of projects of a non-problematic project type in the total number of projects that actually underwent renewal of the 7-year crediting period in a given year.

The graph indicates that the number of projects renewing their crediting periods increased in 2007-2009. Until 2012, non-problematic projects made up the large majority of renewals. However, from 2013 the share of non-problematic projects dropped to approx. 60% of renewed projects. With such a low share, the issue may become more important in the future with a further increase in renewals (although the increase may be somewhat muted by the unfavourable market conditions).

In this context, it is important to note that CDM projects do not need to renewal immediately, but may wait until market conditions are more favourable. Given the high number of projects that may undergo renewal at a later point in time combined with the lowering in the share of non-problematic project types may lead to considerable over-crediting.

Lifetime of baseline scenario

Another, also related, issue is that in more complex and very dynamic systems, such as the transport sector, the determination of a counterfactual baseline scenario is exposed to fundamental limitations in the ability to predict future developments. These limitations can lead to very high uncertainties in the baseline determination. In some instances even after a very few years, the actual baseline emissions could be significantly higher (or lower) than the calculated baseline emissions. For example, while it may be relatively certain that a project proponent choosing in the baseline situation to build a coal-fired boiler will continue to operate this boiler over its lifetime to meet its heat demand, the development of a city's transport system in the absence of a specific urban rail project could be very difficult and uncertain to predict: over some years one may assume that an increase in transport demand is catered for by increased use of private cars; however, street capacities may be limited and the municipalities may have to find solutions to their transport problems anyway, also in the absence of a specific project activity.

It therefore might be considered that for some project types in complex and dynamic environments, such as transport systems, the baseline scenario cannot be reasonably extended over a period of

[33] For a preliminary screening, the following projects sub-types (according to the classification of UNEP DTU) have been classified as "potentially problematic", i.e. it cannot be ruled out that the projects would be implemented later in time without the CDM under changing circumstances (please note that the sub-types may also contain projects which clearly do not have an issue): Adipic acid, Aerobic treatment of waste water, Agricultural residues: mustard crop, Air conditioning, Appliances , Biodiesel from waste oil, Biogas from MSW, Bus Rapid Transit, Cable cars, Caprolactam, Carbon black gas, EE industry – Cement, Cement heat, Charcoal production, EE industry - Chemicals, EE own generation - Chemicals heat, Clinker replacement, CMM & Ventilation Air Methane, CO_2 recycling, Coal Mine Methane, Coal to natural gas, Coke oven gas, Combustion of MSW, Composting, Domestic manure, EE public buildings, Existing dam, Food, Glass, Glass heat, HFC134a, HFC23, Industrial waste, Iron & steel, Landfill composting, Landfill aeration, Landfill flaring, Landfill power, Lighting, Machinery, Manure, Mode shift - road to rail, Natural gas pipelines, Nitric acid, EE industry - Non-ferrous metals, EE own generation - Non-ferrous metals heat, Non-hydrocarbon mining, Oil and gas processing flaring, Oil field flaring reduction, Oil to natural gas, EE industry – Paper, EE industry – Petrochemicals, PFCs, Power plant rehabilitation, Rail: regenerative braking, Solar water heating, Stoves, EE industry – Textiles, Ventilation Air Methane, Waste water. All other project types are deemed "non-problematic".

ten years and a renewal of crediting periods should not be allowed, given the risks of inadequate and very uncertain baseline scenarios for later time periods.

It was for this reason that the crediting period was initially limited to a single crediting period for some project types, including:

- PFC emissions from manufacturing in the semi-conductor industry (e.g. AM0092). This is an industry in which manufacturing technologies and composition of materials etc. change frequently compared to the duration of a 7-year crediting period
- Power saving from efficient management of data centers. Technologies and operating systems also typically have short lifespans compared to a 7-year crediting period.
- Complex transport systems such as the introduction of Bus Rapid Transport (BRT) systems in cities. In this context, the uncertainty in the baseline scenario and the resulting baseline emissions grows very rapidly, because development of transport systems over 5-10 years is difficult to predict with accuracy.

For these project types, the maximum crediting period has been set to 10 years in earlier versions of the methodology, because the uncertainty in the baseline scenario after 10 years did not allow for an objective determination of the emission reduction.

This limit in the crediting period to 10 years also allowed the methodology to be simplified, as the projection of baseline emissions over a limited period allows for simpler approaches and requires less monitoring provisions, thus reducing transaction costs.

Subsequently, however, the CDM EB took the decision (EB67, Para 107) that for each project type and methodology multiple crediting periods can be used (independent of any methodological limitations and uncertainty issues for the baseline setting as discussed above). This decision has been taken based on para 49 of the Modalities and Procedures for the CDM (decision 3/CMP.1, annex) that mentions alternative approaches. The paragraph was interpreted in such a way that both options shall be allowed in *each and every* methodology.

Since then, the relevant methodologies have been revised, allowing crediting for up to 21 years for all methodologies, without providing for further safeguards that would reduce the uncertainty in baseline scenario projection and potential over-crediting.

The issue of renewal of crediting period and more generally the updating of baseline scenarios is further discussed in Schneider et al. (2014).

3.5.3. Summary of findings

When the crediting period of a CDM project is to be renewed, the Marrakesh Accords require that the DOE check the validity of the original project baseline. A subsequent EB ruling (EB 43, Annex 13, paragraph 3) limited this check to an assessment of the regulatory framework, an assessment of the remaining lifetime of technical equipment that would be used in the baseline and an update of data and parameters, such as emission factors. The EB clarified that the validity of the baseline scenario should not be re-assessed.

With CDM project types for which the baseline scenario does not require a significant investment at the beginning of the crediting period (that would determine the baseline technology over the lifetime) this may lead to potential over-crediting. A preliminary analysis of projects that underwent renewal of the crediting period in recent years reveals that from 2013 onwards the share of potentially problematic project types (that might have issues of changing baseline scenarios leading to over-crediting) increases to approx. 40% of projects with renewal. It is therefore recommended that this issue is resolved.

A subsequent ruling by the EB to remove the limit in the crediting period that some project types had in their methodology in sectors especially prone to baseline uncertainty over one crediting period (e.g. semi-conductor manufacturing, information technology, transport) further exacerbated the issue.

3.5.4. Recommendations for reform of CDM rules

We recommend two reforms to the current rules:

- Reassessing the baseline scenario at the renewal of the crediting period: The issue of potential over-crediting arising from inadequate checking of the validity of the baseline at the renewal of the crediting period could be addressed by expanding the assessment to the validity of the baseline scenario for CDM projects that are potentially problematic in this regard. For this, clear criteria for problematic project types should be formulated and guidance should be provided on how to test the validity of baseline scenarios for specific CDM methodologies.
- Limitation of the overall length of crediting for specific project types: Project types in sectors or systems that are highly dynamic and complex, and in which the determination of baselines is notoriously difficult (e.g. urban transport systems) should be limited to a single 10 year CDM crediting period or should be supported by other (non-crediting) finance sources.
- A further step that may be considered is a general limitation of projects to one 7 years crediting period. This may also build on the observation that when discounting future streams of CER revenue beyond 7 (or 10) years at typical hurdle rates longer crediting periods do not really matter for the NPV calculation. Longer crediting periods would only be allowed for project types that require a continuous stream of CER revenues to continue operation such as landfill gas utilization/flaring etc.

3.6. Additionality of PoAs

The advent of CDM Programmes of Activities (PoA) in 2007, and the subsequent refinement of related additionality approaches, changed the nature of additionality testing for many project types. Additionality assessment for PoAs is simplified compared to the requirements for the registration of individual projects. Project developers can establish eligibility criteria to assess additionality, including eligibility criteria, which identify project types that may be automatically additional. More importantly, because the thresholds for identifying small-scale and microscale activities with simplified additionality procedures are set at the level of the Component Project Activity (CPA) and not the level of the PoA, the overall PoA could be far larger than these thresholds. For example, the registered PoA "Installation of Solar Home Systems in Bangladesh" (Ref. 2765) has so far installed 123 MW of solar power and has estimated emissions reductions of 569,000 tCO_2 per year, or almost ten times the small-scale CDM threshold.

In the period of 2013 to 2020, PoAs potentially could supply 0.16 billion CERs. However, as discussed in Section 2.3, the eventual volume for these PoAs could be many times this amount.

3.6.1. Assessment

There are three principle issues with the demonstration of additionality in PoAs: specific additionality concerns about the technology areas covered by PoAs, the robustness of eligibility criteria to check additionality, and the use of small and microscale thresholds for PoAs that are much larger in total than these thresholds. The first point is largely addressed in Chapter 4, because it is related to the mitigation technologies used in PoAs. As shown in Table 2-2, the majority of PoAs are in technology areas that are analyzed in this report (e.g. efficient cook stoves, efficient lighting, wind, hydropower, biomass), so these chapters should be consulted for an assessment of those technologies.

The second point concerns eligibility criteria, namely that the PoA rules require that the project participants develop a set of eligibility criteria that should guide the inclusion of CPAs. The criteria should be constructed so that, for each new CPA, simply confirming that the CPA meets the criteria is enough to ensure that the CPA is additional. These criteria should be based on approaches used in the relevant methodology or other additionality approach that is relevant for the PoA. In other words, there is not a detailed additionality assessment for each CPA in the way that project activities submitted for registration are evaluated. Instead, the eligibility criteria in the registered PoA design document (PoA-DD) should ensure that the CPA meets the relevant additionality test. For example, if part of demonstrating additionality in the relevant methodology is proving that the project is a particular scale or uses a particular technology, then the scale and technology specification would be listed as eligibility criteria against which each new CPA was checked. A possible concern could be that, if the project participants proposed eligibility criteria in the PoA-DD that did not fully capture the additionality requirements of the underlying methodology, there would be a risk that future CPAs could be included even if they were not additional. Although there was some confusion during the early days of PoAs on how to formulate eligibility criteria, this has not been the case since late 2011 when the EB published a standard for eligibility criteria. This was later replaced by the standard for "Demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities" (CDM-EB65-A03-STAN, version 3.0). This standard provides not only the full list of issues that must be covered in the eligibility criteria, but also clear rules on how additionality may assessed for PoAs.

The third point is perhaps the most important – whether allowing PoAs that are, in total, much larger than the size thresholds for small and microscale projects could increase the risks of non-additionality among PoAs. The small-scale CDM thresholds are 15 MW for renewable energy, 60 GWh savings for energy efficiency, and 60,000 tCO_2 per year emissions reductions for other project types with approved small-scale methodologies. The scale limits for the microscale additionality rules are 5 MW for renewable energy, 20 GWh savings for energy efficiency projects, and 20,000 tCO_2 for other project types, and are then combined with other criteria (described in detail in Chapter 4, e.g. country type, size of individual units, or even designation by a national authority), to qualify as automatically additional. However, the EB decided at their 86th meeting that micro-scale technologies using unit size as the basis of automatic additionality (i.e. independent units of < 1500 kW for renewables, < 600 MWh for energy efficiency and < 600 tCO_2 for other projects, all serving households and communities) would have no limit of the total scale of the project or CPA. In other words, an efficient cook stove project activity or CPA could have total emission reductions of greater than 20, or even 60, $ktCO_2$ per year.

Projects (in this case, CPAs) that qualify as small-scale CDM (SSC) then have access to the technology-based 'positive list' in the tool for "Demonstration of additionality of small-scale project activities" (Tool21, version 10.0). CPAs below the micro-scale thresholds would all be automatically additional as long as they meet both the scale and other requirements (e.g. technology, location, etc.). For small-scale CDM, the list of technologies considered automatically additional includes the following:

- Certain technologies whether grid-connected or off-grid: solar (PV and thermal), off-shore wind, marine (wave and tidal), and building-integrated wind turbines or household rooftop wind turbines up to 100 kW;

- Additional off-grid technologies below the SSC thresholds: micro/pico-hydro (with power plant size up to 100 kW), micro/pico-wind turbine (up to 100 kW), PV-wind hybrid (up to 100 kW), geothermal (up to 200 kW), biomass gasification/biogas (up to 100 kW);
- Technologies with isolated units where the users of the technology/measure are households or communities or Small and Medium Enterprises (SMEs) and where the size of each unit is no larger than 5% of the small-scale CDM thresholds;
- Rural electrification projects using renewable energy in countries with rural electrification rates less than 20%.

Both microscale additionality and the small-scale CDM positive list approaches have been used extensively by PoAs. As shown in Table 3-2, 33% of the CPAs in registered PoAs, representing 27% of expected CERs, have applied the microscale or small-scale positive list approaches ('first of its kind' is discussed in Chapter 4). An analysis by the UNFCCC Secretariat[34] also shows that 142 of the 282 registered PoAs use microscale or small-scale rules for automatic additionality, with 65% of PoAs targeting households utilising one of these tools (Table 3-3). Many of these PoAs have already exceeded the microscale and small-scale thresholds at an aggregate level, as allowed in the CDM PoA rules. In contrast, the 120 CDM project activities that have used small-scale positive lists or microscale guidelines comprise only 0.8% of projects and 0.1% of expected emissions reductions (UNEP DTU 2015a).

Table 3-2: Use of automatic additionality approaches in CPAs within registered PoAs

Approach for automatic additionality	Annual CERs ($ktCO_2/yr$)	CPAs	CERs	CPAs
Microscale tool: country, unit size or DNA selection	3,520	188	11%	23%
Microscale tool: SUZ	60	9	0%	0%
SSC positive list	5,078	91	16%	10%
None	21,279	551	70%	65%
Total	29,936	839	100%	100%

Notes: A more recent version of the PoA pipeline was used here because of a revision of how the use of automatic additionality is classified.

Sources: UNEP DTU 2015b

34 "Concept note: Thresholds for microscale activities under programmes of activities" (CDM-EB85-AA-A09)

Table 3-3: Technology and end-user types in registered PoAs that applied microscale and/or small-scale positive list criteria

Technology type	PoAs	Share of this type of PoA
End use type: Households	**92**	**65%**
Household biogas digesters	13	
Energy efficiency - household	2	
Energy-efficient lighting (LED and CFL)	28	
Improved cookstoves	36	
Solar water heaters	7	
Water purifiers	5	
Renewable-based rural electrification	1	
End use type: Others	**50**	**35%**
Energy efficiency – industrial	2	
Fuel switch	3	
Grid/off-grid connected renewable energy technologies (e.g. wind, solar PV, geothermal)	35	
Waste treatment (e.g. Wastewater, animal waste)	10	
Total	**142**	**100%**

Sources: Concept note: Thresholds for microscale activities under programmes of activities (CDM-EB85-AA-A09)

Whether granting automatic additionality to PoAs that are over the small and microscale thresholds poses a risk for additionality testing depends on the *reason* for the positive list designations. One of the main issues raised by the positive list is the *unit size* of the technology, with the argument being that the unit size on its own may be sufficient to identify a project type with a high likelihood of additionality (in combination with the other microscale criteria, where relevant). On this basis, the EB recently agreed that the size criterion for the microscale additionality tool should be *only* unit size, and not total project size.[35] This means that even a PoA using a large-scale methodology and have a total size beyond the SSC thresholds can still apply microscale additionality guidelines, as long as the unit size and other criteria are met.

The SCC positive list sets unit size limits for most categories of eligibility, although not for rural electrification or the grid-connected technologies (other than the 15 MW limit). The microscale guidelines also include the option of using a unit size less than 1% of the SSC threshold as a justification for applying these guidelines even if the projects are not located in Least Developed Countries (LDCs) or Special Underdeveloped Zone (SUZs).

The most important categories of PoAs (in terms of their contribution to expected CERs) utilising these tools are improved cook stoves, energy efficient lighting, biogas and small unit size solar power[36]. For the first three technologies, the unit size is inherently small, so the size of the total project or PoA should not, by itself, determine the viability of the technology (bearing in mind, however, that overhead programme costs are obviously lower per unit for larger programmes). The additionality issues with improved cook stoves and energy efficient lighting are reviewed in Sections 4.12 and 4.13, respectively. These sections raise important questions about the additionality

[35] The changes to the Tools for "Demonstration of additionality of small-scale activities" (version 22) and "Demonstration of additionality of microscale project activities" (version 07) were approved at EB86 (October 2015), as were changes in the Project Standard, Project Cycle Procedure, and standard on standard on "Demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programmes of activities."

[36] Although the table from the UNFCCC Secretariat refers to "Grid/off-grid connected renewable energy technologies (e.g. wind, solar PV, geothermal)", our analysis has not identified any wind or geothermal PoAs using the small-scale positive list or the microscale guidelines.

of these project types, despite their small unit size, particularly because of the role of other support programmes in promoting these technologies and possible over-crediting for cook stoves, for example. On the other hand, the extensive literature on household energy access technologies and carbon markets also points to numerous well documented barriers, and the high unit transaction costs associated with small unit size technologies (e.g. Gatti & Bryan 2013; IFC 2012; Warnecke et al. 2015, 2013). In addition, the analysis from the UNFCCC Secretariat mentioned earlier also shows that the average unit size of PoAs using the small-scale and microscale positive lists is, in fact, far below even the microscale unit size of 1% of the SSC threshold (Table 3-4).

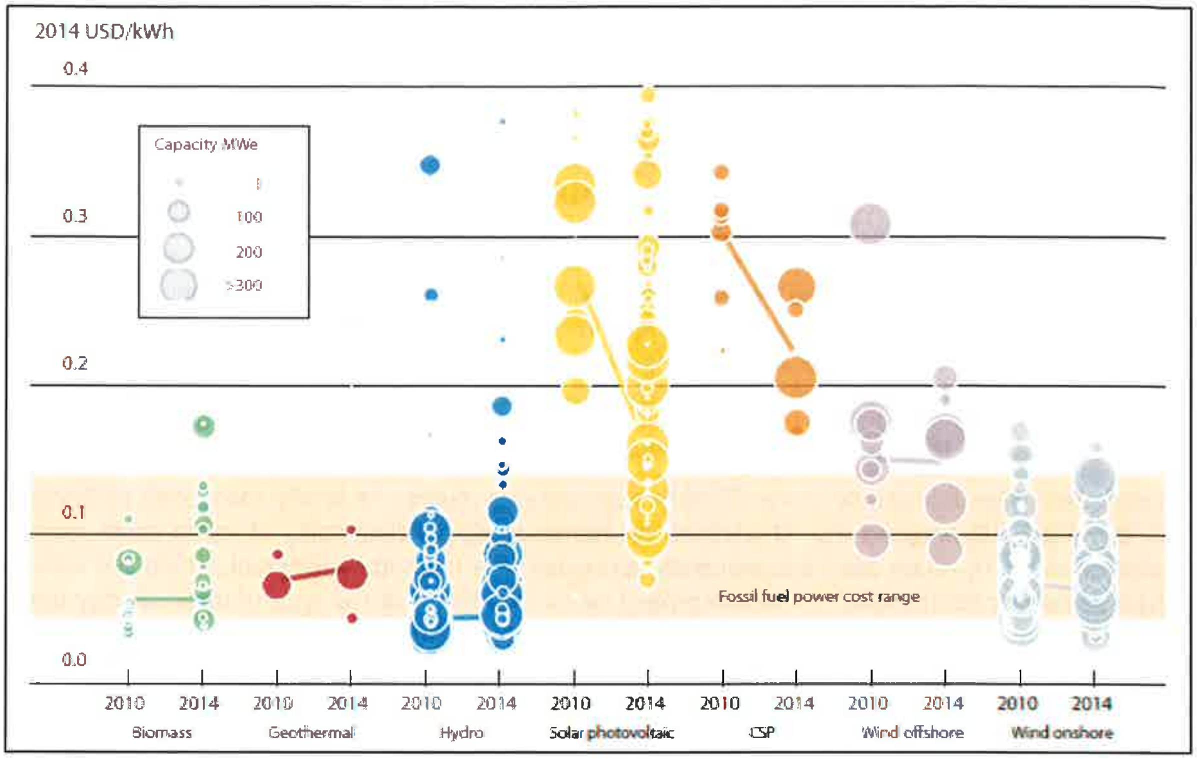
Table 3-4: Size of individual units in microscale and small-scale PoAs using positive lists

Unit size as % of SSC threshold	Type I (kW)	Type II (MWh)	Type III (tCO2)
1%	150	600	600
PoAs applying microscale criteria			
Average – 0.022%	3.3	13.3	13.2
Std deviation – 0.054%	8.1	32.4	32.4
PoAs applying small-scale criteria			
Average – 0.23%	34	136	137
Std deviation – 0.34%	51	204	204

Sources: Concept note: Thresholds for microscale activities under programmes of activities (CDM-EB85-AA-A09)

For renewable power technologies, even if the total capacity of a PoA was over 15 MW, the unit size could not be larger than 5 MW for most technologies (15 MW for solar PV or solar thermal) to qualify for automatic additionality. Given the economies of scale in renewable energy power generation (Prysma 2012), small unit sizes would be expected to have higher capital costs, and would therefore be more likely to face investment barriers than larger scale plants. Project-level analysis by the International Renewable Energy Agency (IRENA) also suggests that smaller renewable energy plants not only have higher costs (i.e. because the smaller dots, representing smaller scale projects, are generally higher up in the figure), but that for solar PV and solar thermal these costs are still considerably higher than for fossils fuels (Figure 3-9). Analysis by EPRI has also shown that solar power at the several MW scale is considerably more expensive than conventional alternatives (EPRI 2012). This suggests that a solar PV (grid connected or off-grid) programme of any total size would not be economically viable if the units were below the small-scale thresholds. However, the challenge with solar technologies is that they are so expensive that carbon revenue is unlikely to close the financial viability gap, so they may be more driven by national policies than carbon markets (Section 3.7).

Figure 3-9: Levelized cost of electricity from renewable technologies, 2010 and 2014



Notes: Size of the diameter of the circle represents the size of the project. The centre of each circle is the value for the cost of each project on the Y axis. The LCOE of a given technology is the ratio of lifetime costs to lifetime electricity generation, both of which are discounted back to a common year using a discount rate that reflects the average cost of capital.

Sources: IRENA (2015)

On the basis of the unit size analysis shown in Table 3-4, the Secretariat prepared a concept note with recommendations to the EB using on unit size, and not total project or CPA size, as the basis for determining microscale additionality (CDM-EB85-AA-A09). The EB agreed to begin to implement an approach of using only a unit size threshold to determine if the size of the project qualifies for microscale (EB85 report, paragraph 42). The other requirements for microscale (e.g. location in an LDC or SUZ, if the unit size is greater than 1% of the SSC threshold) would remain unchanged. This means that the CPAs comprised of technologies that were below the unit size threshold would not be limited in their total size. For example, a CFL PoA in an LDC could have a CPA with 100,000 MWh savings and still apply the microscale additionality guidelines.

3.6.2. Summary of findings

While the PoA rules do allow programmes with a total size greater than the small-scale and microscale thresholds to utilise the automatic additionality provisions for these scales of projects, there is no evidence that this increases the risk of non-additional projects on its own (i.e. the share of projects that could be non-additional). In other words, the PoA rules do not fundamentally change the additionality risks for a given category of project technologies. The PoA process could, of course, increase the overall *scale* of the risk because they were designed to facilitate the large scale dissemination of small, distributed technologies. For example, there are 40 registered 'improved stove' project activities with expected CERs of 1 million tCO_2 per year, but there are 46 registered 'improved stove' PoAs that already have expected CERs of 8.1 million tCO_2 per year.

3.6.3. Recommendations for reform of CDM rules

Reform of the CDM rules related to additionality for particular project types and positive lists will address any concerns about additionality of PoAs.

3.7. Positive lists

The concept of 'positive lists' means that specific project types are considered automatically additional. Positive lists are one option to reduce transaction costs and increase the certainty of the CDM system from the perspective of project developers. Similar to standardized baselines, creating a positive list requires an upfront evaluation of technologies and their economic and regulatory environment, independent of the assessment of a particular CDM project proposal, to establish certain objective criteria that, if met, will result in a high likelihood of additionality. Once a positive list is established, a specific CDM project only needs to show that the pre-defined criteria are met, and does not have to apply other tools to justify additionality.

3.7.1. Positive lists in the CDM and impact on CER supply

Positive lists were introduced in the CDM through various routes. As briefly mentioned in Section 3.6, the CDM EB adopted the "Guidelines for demonstrating additionality of micro-scale project activities" in 2010, which were subsequently converted to a methodological tool, which first established automatic additionality for certain project types regardless of the type of methodology used (i.e. small-scale or large scale). Table 3-5 shows the technologies covered under version 7 of that tool, and the criteria they must meet in order to be deemed automatically additional. In addition to total project size (or, in the case of PoAs, the size of an individual CPA), the technologies must meet a further criterion such as location, unit size and/or consumer group.

Table 3-5: Projects considered automatically additional under the tool "Demonstration of additionality of microscale project activities"

1	**Based on country (LDCs, SIDSs)** • Renewable energy up to 5 MW • Energy efficiency up to 20 GWh savings per year • Other small-scale CDM projects (Type III) up to 20 ktCO_2 emissions reductions per year
2	**Based on unit size and consumer (households, communities, SMEs) (i.e. any country)** • Renewable energy of any size as long as unit size is less than 1500 kW • Energy efficiency of any size as long as unit savings are less than 600 MWh per year • Other small-scale CDM projects (Type III) of any size as long as unit savings are less than 600 tCO_2 per year
3	**Based on host country designation of special underdeveloped zone (SUZ)** • Renewable energy up to 5 MW • Energy efficiency up to 20 GWh savings per year • Other small-scale CDM projects (Type III) up to 20 ktCO2 emissions reductions per year
4	**Based on designation of a technology by the host country** • Grid connected renewable energy specified by DNA, up to 5 MW, which comprises less than 3% of total grid connected capacity
5	**Based on other technical criteria** • Off-grid renewable energy up to 5 MW supplying households/communities (less than 12 hours grid availability per 24 hours is also considered 'off-grid')

Notes: LDCs = Least Developed Countries, SIDSs = Small Island Developing States, SME = Small and micro enterprises, DNA = Designated National Authority.

Sources: Tool for "Demonstration of additionality for microscale activities"

In 2011, the "Guidelines on the demonstration of additionality of small scale project activities", which later were similarly converted to a methodological tool, also included for the first time a list of technologies that would be considered automatically additional for any project meeting the small-scale CDM thresholds. This initially only included a list of grid and off-grid renewable energy technologies (i.e. the first two blocks in Table 3-6), but was expanded in 2012 to include small isolated units serving communities and renewable energy-based rural electrification.

Table 3-6: Technologies considered automatically additional under the tool "Demonstration of additionality of small-scale project activities"

6	**Renewable energy (up to 15 MW, grid or off-grid, all end users)** • Solar PV and solar-thermal electricity generation • Offshore wind • Marine technologies (e.g. wave and tidal) • Building integrated wind turbines or household roof top wind turbines (unit size =< 100 kW)
7	**Renewable energy (up to 15 MW, off-grid only)** • Micro/pico-hydro (unit size =< 100 kW) • Micro/pico-wind turbine (unit size =< 100 kW) • PV-wind hybrid (unit size =< 100 kW) • Geothermal (unit size =< 200 kW) • Biomass gasification/biogas (unit size =<100 kW)
8	**Distributed technologies for households/communities/SMEs (off-grid only)** • Aggregate size up to SSC threshold (15 MW, 60 GWh or 60 ktCO_2 emission reductions) with unit size =< 5 per cent of SSC thresholds (i.e. =< 750 kW, =< 3 GWh/y or 3 ktCO_2e/y)
9	**Rural electrification using renewable energy** • In countries with rural electrification rates less than 20%

Notes: Numbers in left hand column continue from previous table.
Sources: Tool for "Demonstration of additionality of small-scale activities" (version 10.0)

In addition to these tools, which apply across many methodologies, some individual methodologies have provided for automatic additionality for certain project types, often related to regulations. The most widely used is ACM0002 "Grid-connected electricity generation from renewable sources" (version 16.0), which was revised in November 2014 to include a two-part positive list for grid connected technologies. The first part is a list of technologies that are considered automatically additional: solar PV, solar thermal, offshore wind, marine wave and marine tidal (i.e. the technologies included in the first part of the small-scale CDM additionality tool, except at larger scale). The second part says that any technology with less than 2% of the total grid-connected capacity or less than 50 MW total capacity in the country is considered automatically additional. Since the revision of ACM0002, ten new project activities have requested and completed registration (no new PoAs have been registered). Of these, only one project has applied the new positive list provisions – a 141 MW solar PV facility in Chile. This is the largest solar facility to be granted automatic additionality.

Another important methodology with automatic additionality provisions includes ACM0001 "Consolidated baseline and monitoring methodology for landfill gas project activities" (version 15.0), which was revised in late 2013 to consider the following technologies automatically additional if, prior to the project activity, landfill gas was only vented and/or flared:

- electricity generation in one or several power plants with a total nameplate capacity that equals or is below 10 MW;
- heat generation for internal or external consumption;
- flaring (assuming no flaring prior to the project).

AM0113 "Distribution of compact fluorescent lamps (CFL) and light-emitting diode (LED) lamps to households" (version 01.0) provides for automatic additionality for any project distributing self-ballasted LED lamps to households. Projects distributing CFLs are only considered automatically additional if they are in a country with "no or only limited lighting efficiency regulations" reported by the UNEP en.lighten initiative's Efficient Lighting Policy Status Map. AM0086 "Distribution of zero energy water purification systems for safe drinking water" (version 04.0) considers projects automatically additional if less than 60 percent of the population has access to improved drinking water sources or if the project proponents can demonstrate that more than half of the improved drinking water delivered does not actually meet the appropriate health standards. AMS-III.D "Methane recovery in animal manure management systems" (version 19.0) considers projects automatically additional when there is no regulation that requires the collection and destruction of methane from livestock manure. In addition to these, AM0001 "Decomposition of fluoroform (HFC-23) waste streams" (version 6.0), the first approved large-scale methodology, essentially uses a positive list approach based on regulation, because any project that does not face a regulatory requirement to abate HFC-23 emissions is considered additional. The same is true for ACM0019 "N_2O abatement from nitric acid production" (version 02.0).

While the positive lists presented above have not been used widely by CDM project activities (e.g. only 121 registered projects), PoAs have utilised the lists in the small-scale and microscale additionality tools (Table 3-2), with a third of CPAs in registered PoAs using these additionality approaches. Whether this growing group of PoAs presents concerns for the additionality depends on the strength of the justification for the original positive lists and for how long this justification is likely to be valid (i.e. how often the lists should be updated).

The criteria used to select the positive lists as well as the validity of these lists are presented in an information note prepared by the Small-scale Working Group in November 2014 called "Criteria for graduation and expansion of positive list of technologies under the small-scale CDM" (CDM-SSCWG46-A23). Table 3-7 summarises all of the positive list approaches, and shows the range of criteria used. The individual methodologies often refer to regulations to determine automatic additionality, or current penetration rates. The small-scale and microscale additionality tools use a mix of end-users, location, cost of service and penetration rates, depending on the specific technology group. This also highlights the similarity between positive lists discussed here and standardized baselines (Section 3.8), which also define a list of automatically additional technologies based on penetration rates and comparative costs.

Table 3-7: Criteria used for determining positive lists

		End-user	Regulation	Location	LCOS	Penetration	Capital cost
1	Microscale based on country (LDCs, SIDSs)						
	Renewable energy < 5 MW; Energy efficiency < 20 GWh; Other up to 20 $ktCO_2$			x			
2	Microscale based on unit size and consumer (households, communities, SMEs) (i.e. any country)						
	Renewable energy < 5 MW and unit size <1500 kW; Energy efficiency < 20 GWh and unit savings < 600 MWh; Other < 20 $ktCO_2$ with unit savings < 600 tCO_2	x					x
3	Microscale based on host country designation of special underdeveloped zone (SUZ)						
	Renewable energy < 5 MW; Energy efficiency < 20 GWh; Other < 20 $ktCO_2$			x			
4	Microscale based on designation of a technology by the host country						
	Grid connected renewable energy specified by DNA, up to 5 MW, < 3% of capacity					x	
5	Microscale based on other technical criteria						
	Off-grid renewables < 5 MW supplying households	x					
6	Small-scale renewable energy (up to 15 MW, grid or off-grid, all end users)						
	Solar PV and solar-thermal electricity generation; off-shore wind; marine (e.g. wave and tidal); building integrated wind turbines or household p wind =< 100 kW				x		
7	Small-scale renewable energy (up to 15 MW, off grid only)						
	Micro/pico-hydro (unit <= 100 kW); micro/pico-wind (unit <= 100 kW); PV-wind hybrid (unit <= 100 kW); geothermal (unit <= 200 kW); biomass gasification/biogas (unit <= 100 kW)						x
8	Small-scale off-grid distributed technologies for communities						
	Unit size =< 5 per cent of SSC thresholds	x					
9	Rural electrification using renewable energy						
	In countries with rural electrification rates less than 20%						
10	AM0086 water purification						
	<60% access to improved drinking water and <50% use of point-of-use zero energy water purification					x	
11	AM0113 energy efficient lighting						
	CFLs in countries with no or limited regulatory support All self-ballasted LED lamps		x			x	
12	ACM1 landfill gas utilisation						
	LFG for electricity or heat where vented or flared, or flaring where previously vented					x	x
13	AMS III.D methane and manure management						
	Biogas for power < 5 MW where no regulation requires collections and destruction of methane		x				
14	AMS III.C electric and hybrid vehicles						
	Market share of electric/hybrid vehicles < 5%					x	

Notes: LCOS = Levelized cost of service, LDCs = Least Developed Countries, SIDSs = Small Island Developing States, SMEs = Small and micro enterprises, DNA = Designated National Authority.

Sources: UNFCCC documents as cited in text

In terms of the duration of validity of the positive lists, the small-scale and microscale additionality tools did not originally include a time limit, although many of the methodologies specify a three-year duration of validity. The EB (EB81, paragraph 72) accepted a Small-Scale Working Group recommendation in late 2014 to set a three-year limit on validity for the small-scale CDM positive lists. In addition, the EB agreed on thresholds for 'levelized cost of service', 'penetration rate', and 'capital cost#, as shown in Table 3-8. Note that these new rules only apply to the positive lists under the tool for "Demonstration of additionality of small-scale project activities", and not to microscale activities or any other positive lists.

Table 3-8: Graduation criteria for technologies under the tool for "Demonstration of additionality of small-scale project activities"

	End-user	LCOS	Penetration	Capital cost
Grid connected renewable electricity generation				
All renewable energy technologies in the current positive list		>= 50% higher than all fossil fuels	Global average penetration <3%	
Off-grid renewable electricity generation				
All off-grid renewable technologies in the current positive list				>= 3 times the cost of all fossil fuels
Distributed technologies for households/communities/SMEs				
All distributed technologies eligible under Type I/II/III and providing services of households/communities/SMEs	Assess appropriateness of user groups		Global average penetration rate < 3%	>= 3 times cost of all plausible baseline technologies

Sources: Information note 'Criteria for graduation and expansion of positive list of technologies under the small-scale CDM' (CDM-SSCWG46-A23)

3.7.2. Assessment of current positive lists

The positive lists developed under the CDM to date are based on specific criteria such as penetration rate, costs, regulatory environment, and location. While these lists have not been used widely for automatic additionality among CDM project activities, their use among PoAs is widespread and growing. Some of the positive lists are now reviewed regularly, and have a clear basis for determining whether a technology should still be included in the lists. **This review of validity should also be extended to other project types, in particular those covered by the microscale additionality tool or approaches used in relevant methodologies (e.g. ACM0002).**

An important challenge with the current positive lists, however, is that the basis upon which they are established varies widely, without a clear rationale for the choice or level of the indicator (e.g. why penetration might be used for some technologies but levelized cost of service for others). **A consistent approach to determining technology eligibility is needed** to ensure that existing and new positive lists do not pose risks of non-additionality. The criteria and indicators used should have clear justification for how they influence project implementation. For example, while low market penetration or high capital costs could be strong indicators of prohibitive barriers for some technologies, it is not clear how the concept of 'special underdeveloped zones' (SUZ), which may be defined differently by each DNA according to UNFCCC guidelines, is a reliable indicator of barriers.

As part of the justification of project types and technology choices, **positive lists must address the impact of national policies and measures to support low emissions technologies** (so-called, E- policies). As discussed in Section 3.9 and many of the sections within Chapter 4, national policies may be the primary driving factor for the implementation of certain technologies, rather than their underlying economics, market position or location. In fact, one of the criticisms of allowing renewable technologies to be considered automatically additional is that their costs are so high that carbon revenue alone cannot possibly make them financially viable, and so other incentives and policies are the real determining factor (Lazarus et al. 2012; Spalding-Fecher et al. 2012). This is even truer with smaller scale technologies. For example, in a study in Southern Africa, the levelized cost of roof-top solar PV was 20% more expensive than utility scale solar PV, while small hydropower was 70% more expensive than large scale (Miketa & Merven 2013). For positive lists to avoid the possibility of 'false positives' driven by national policies, some objective measure of renewable energy support may be needed as part of the evaluation process. An example of this would be the REN21 renewable energy global overview and interactive map,[37] which provides a comprehensive technology-specific database of the policies in place to support renewables. A positive list that included renewables could therefore be qualified by restricting its applicability to countries that did not have any support policies in place for that technology. Having support policies in place does *not*, on its own, mean that those technologies would not be additional, but only that there is a greater risk of this and so applying a positive list approach in that country would not be appropriate. Projects in those countries could still use the other tools available for demonstrating additionality for small- and large-scale projects – they would only not have access to automatic additionality based on the positive list. As an example, the positive list in the tool for "Demonstration of additionality of small-scale project activities" includes all solar PV and solar thermal technologies in all CDM-eligible countries. According to the REN21 policy database, however, the following countries have support policies[38] in place for solar PV: Algeria, Argentina, Brazil, Cape Verde, China, Côte d'Ivoire, Ecuador, Egypt, Gambia, Ghana, India, Jordan, Lebanon, Malaysia, Mauritius, Nepal, Nigeria, Republic of Korea, Senegal, Thailand, Uruguay, Uzbekistan, and Venezuela. For these countries, therefore, it might be more appropriate to require an analysis of barriers to solar PV rather than considering them automatically additional. This approach could be refined based on additional research into publicly available and up-to-date databases of renewable energy policies.

Finally, to maintain environmental integrity of the CDM overall, **positive lists should be accompanied by negative lists**. This is because the introduction of a positive list without any negative list could, by definition, only lower environmental integrity compared to the traditional approaches. Projects that do not fall within the positive list can still apply the traditional approaches. So, the positive list will lead to more 'false negatives' passing the test, but will not rule out any projects that are not additional. Overall, environmental integrity is thus lowered (albeit with the positive element of reducing transaction costs). An exception to this could be the few methodologies that deem projects as ineligible if they reach a market penetration threshold above a certain level, because they, in essence, include both a positive and negative list.

[37] The interactive map is shown at: http://www.ren21.net/status-of-renewables/ren21-interactive-map/ . The full database of policies is available at http://www.ren21.net/wp-content/uploads/2015/09/Downloadable-Consolidatedv1.2.1.xlsx.

[38] Support policies may include, for example, feed-in tariffs, electric utility quota obligation, capital subsidies, tax credits, and net metering, but exclude renewable energy targets not accompanied by other incentives.

3.8. Standardized baselines

Project developers have repeatedly complained about the expensive and time-consuming process for formally registering a project under the CDM. The setting of the baseline for the greenhouse gas emission reductions associated with a project has required project developers to apply project specific methodologies in order to calculate baseline emission levels. The project developers take on significant costs before the approval of their project when collecting the data necessary to set the baseline and demonstrate additionality. In some cases the risks associated with these upfront costs may be too high for developers of smaller projects in poorer countries (Spalding-Fecher & Michaelowa 2013) – impacting the regional distribution of projects under the CDM. Apart from high transaction costs, the project-specific determination of baselines and assessment of additionality has been criticised in the past for being subjective (Schneider 2009). Due to the information asymmetry between project developers and DOEs subjective assumptions may be difficult to verify, which could result in non-additional projects or over-crediting, which both undermine the environmental integrity of the CDM.

The Cancun Agreements in 2010 provided for the use of *standardized baselines* in the CDM to address these limitations with the aim *"to reduce transaction costs, enhance transparency, objectivity and predictability, facilitate access to the clean development mechanism, particularly with regard to under-represented project types and regions, and scale up the abatement of greenhouse gas emissions, while ensuring environmental integrity"* (UNFCCC 2011c). In contrast to the project-by-project approach to setting baselines and demonstrating additionality, standardized baselines are established for a project type or sector in one or several CDM host countries. Standardized baselines can address any or all of three areas for standardization: demonstrating additionality, determining the baseline scenario or determining baseline emissions. In the latter case, standardization can include emission factors or individual parameters needed to calculate emission reductions.

Standardized baselines require host country approval and are submitted through the DNA of the host Party. They can cover one or several Parties. Once approved, project developers can use a standardized baseline when submitting a project for registration. In 2014, the EB further decided that it is up to the host Parties to decide whether projects must use an approved standardized baseline or whether they may alternatively use a project-specific approach, but noted that the EB could reject standardized baselines if this poses a risk to environmental integrity (CDM-EB78, para 24). In practice, all approved standardized baselines have so far been voluntary, except for a multi-country grid emission factor in the Southern African region.

The CDM allows standardized baselines to be derived either from suitable methodologies, from tools such as the *'Tool to calculate the emission factor for an electricity system'*[39] or from a generic framework that is applicable to all project types and sectors such as the *'Guidelines for the establishment of sector specific standardized baselines'*[40] adopted by the EB in 2011. Further regulatory documents include a procedure for submission of standardized baselines, a standard on the coverage and vintage of data, and guidelines for quality assurance and quality control.

The *'Guidelines for the establishment of sector specific standardized baselines'* combine elements of market penetration, performance benchmarks, investment and barrier analysis. Under this framework, the standardized baseline results in a positive list of fuels, feedstocks and/or technologies for a given sector. The least emission-intensive fuel/feedstock/technology needed to produce

39 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf.

40 https://cdm.unfccc.int/filestorage/4/I/Y/4IY1RB7DMKLWPGF59XC3UE6JNH8Q2A/eb62_repan08.pdf?t=N2d8bnRoeHN3fDDSYyp3xU9Kx6IMk5Ho1yFw.

a certain percentage of the sector's output (i.e. defined by the CDM EB)[41] is selected as the baseline fuel/feedstock/technology. All fuels/feedstocks/technologies that are associated with lower emission intensities than the baseline technology are candidates for inclusion in a positive list of fuels/feedstocks/technologies that are automatically deemed additional. The DNA of the host country also needs to demonstrate for each of the candidates for the positive list that they are either less economically attractive than the non-candidates or face barriers to entry (Schneider et al. 2012). The baseline technology is also used to determine the baseline against which emission reductions are calculated (Hermwille et al. 2013).

Table 3-9: Approaches for deriving grid emission factors

DNAs could use either the standardized baseline guidelines or the grid emission factor tool to determine the grid emission factor and submit the value as a standardized baseline. The weaknesses of this opportunity to choose between two alternative approaches are explained below:

1) **Pick and choose issue:** The two approaches will provide two different values for the grid emission factor. Thus, the DNA could pick and choose between two completely different methodological approaches for determining the grid emission factor. Countries for which the guidelines result in higher values will use that approach, whereas countries for which the tool results in higher values will use that approach. Overall, having two parallel approaches could undermine the environmental integrity compared to the current situation in which only one approach is available.
2) **Vintage of data issue:** The standardized baseline guidelines consider all plants, whether they were recently constructed or decades ago. This could result in a situation in which coal power is determined as the baseline fuel, even if no coal power plant has been constructed or been under construction for a decade. In contrast, the grid emission factor tool aims to consider recent developments by observing which plant types were recently added to the system or are under construction or which plants actually operate at the margin.
3) ***'One size fits all'* issue:** The grid emission factor tool uses a methodologically approach that considers the particularities of the electricity system, considering different possible effects of displacing grid electricity (marginal plants not being dispatched/the construction of other power plants avoided or delayed). In contrast, the guidelines do not consider the characteristics of the sector and make generalised assumptions, which have little meaning in the power sector. The guidelines therefore result in less accurate grid emission factors than the grid emission factor tool.

Sources: Own compilation

The environmental impact of standardized baselines will be affected by how stringently the standardized baseline is set for a given project type. The stringency of standardized baselines needs to safeguard the environmental integrity of the CDM whilst also striking the right balance between accuracy and transactions costs in order to ensure that there is an incentive for developing new CDM projects.

The implications of standardized baselines on environmental integrity will also vary depending upon the sector that they are applied to, as the approach relies considerably upon the assumption that the penetration of a fuel/feedstock/technology is negatively correlated with its cost and/or with barriers that impede their deployment (Hermwille et al. 2013). For certain sectors there will undoubtedly be a strong correlation, i.e. energy efficient lighting and efficient electrical appliances.

41 In its guidance, the EB has defined a preliminary additionality/crediting threshold of 80 % in priority sectors and 90% in other sectors.

However for other sectors, i.e. with multiple products or with strongly varying circumstances among installations, the correlation will be weaker or absent and alternative approaches for setting baselines and demonstrating additionality may be more suitable (Hermwille et al. 2013). Applying the current framework to sectors for which such a correlation is lacking could broaden the positive lists for technologies that are unlikely to be additional. In the power sector, for example, the guidelines do not reflect the particular features of an electricity system. The Methodologies Panel recommended that the EB limits the applicability of the SB standard to sectors other than the power sector (MP65, paragraph 38 and 39). In response, the EB requested the Methodologies Panel to assess the applicability of the proposed framework to different project types (EB81, paragraph 41). However, as of January 2016, the current guidelines are still applicable to all sectors. In 2015, a standardized baseline was finalized for consideration by the EB, which includes grid emission factors for different islands of Cape Verde and applies for some islands the "*Guidelines for the establishment of sector specific standardized baseline*" and for others the grid emission factor tool. The issues arising from the application of the guidelines to the power sector are highlighted in Table 3-9.

The following issues may pose further environmental risks through the implementation of standardized baselines in the future:

- **Mandatory versus voluntary use of standardized baselines:** The current CDM EB framework does not make the use of standardized baselines mandatory (CDM-EB74, para 24). It is the discretion of the DNA to decide whether project participants can select between project-specific or standardized baselines. In this regard, the DNA can make their use voluntary or mandatory. This may have two consequences:

  - Standardized baselines open an alternative route towards positive lists (Section 3.7), while keeping the approach of demonstrating additionality through the current means. By definition, this can only increase the number of false positives. Hence, the likelihood for additionality is lower, compared to a situation in which there would be no standardized baselines.

  - The voluntary use of standardized baselines could lead to project developers picking and choosing between baseline emission factors which could result in over-crediting (Table 3-9, bullet point 1). Indeed, Spalding-Fecher & Michaelowa (2013) argue that the CMP should make standardized baselines mandatory.

  The degree of these risks depends on how conservative the standardized baselines are set. The more conservatively that they are set, the lower the risk is. An example of how picking and choosing between project-specific and standardized baselines can undermine environmental integrity is the approved standardized baseline ASB0018 for cook stove projects in Burundi. The approved standardized baseline provides default values for the amount of non-renewable biomass consumed in the baseline (1.5 tonnes per person and year for households in urban areas and 1.1 tonnes per person and year for households in rural areas). However, at the same time, a PoA (9634) is registered in Burundi with project-specific baseline values based on data from a more recent survey. The project-specific baseline is more ambitious (1.21 tonnes per person and year for households in urban areas and 0.83 tonnes per person and year for households in rural areas). Had the standardized baseline been approved prior to the registration of the project, the project could have opted for the less ambitious standardized baseline. At the same time, projects with higher project-specific baseline values could opt for their project-specific baseline and not use the standardized baseline.

- **Quality assurance and quality control (QA/QC) of standardized baselines:** Version 04.0 of the procedure *'Development, revision, clarification and update of standardized baselines'*

(CDM-EB84-A10) sets out how a project developer can submit a proposal for a standardized baseline to the CDM EB following first the approval of the relevant DNA. It is necessary for the project developer to provide a list of documents when submitting a standardized baseline proposal, which includes the Form F-CDM-PSB, supporting documents and an Assessment Report of QA/QC. The CDM EB clarified only in 2015 that DOEs not only need to verify whether the required documents were submitted and that the data were collected according to guidelines for quality assurance and quality control but that they also need to check that the standardized baseline has been calculated in accordance with the relevant standards (CDM-EB85-A10). However, this decision still needs to be adequately reflected in the latest version of the *'CDM validation and verification standard'* (CDM-EB82-A14). Moreover, stakeholders expressed concerns that if the requirements for QA/QC are too stringent, it may prevent the approval of standardized baselines from LDCs (Hermwille et al. 2013). Therefore, the QA/QC Assessment Report is currently not compulsory for countries with 10 or fewer registered CDM projects as of 31 December 2010 for the first 3 submissions (CDM-EB84-A10, Para. 18), even though countries can request financial support from the UNFCCC for the development of Assessment Reports. These exemptions from applying the QA/QC guidelines could undermine the environmental integrity of the CDM.

- **Development of country-specific thresholds:** CMP9 requested the EB *"to prioritise the development of top-down thresholds for baseline and additionality for the underrepresented countries in CDM'"* (CDM-EB82-AA-A10, Para. 3). Many stakeholders regard the currently approved default thresholds for additionality and baseline as *'unattractive'* and *'not suitable'* for specific national/regional/sectoral circumstances (CDM-EB82-AA-A10). However, the adoption of country-specific thresholds could be a difficult process as such thresholds are a policy choice rather than a methodological choice. It is uncertain whether or not the development of country-specific thresholds would undermine the environmental integrity of the CDM. However, it would likely result in the incomparability of emission reductions from different standardized baselines within the same project type or technology.

- **Exclusion or inclusion of CDM facilities in the peer group to determine standardized baselines:** The development of certain standardized baselines relies upon the performance and actual output from the facilities of a sector of the host country. Some of these facilities may already have registered CDM projects (i.e. referred to as CDM facilities) that would have improved performance due to the incentives provided by the CDM. Given that it is difficult to determine the performance and outputs of these facilities in the absence of the CDM, it is necessary to take a decision on whether to include CDM facilities in the calculation of a standardized baseline or not. Exclusion of CDM facilities could undermine the environmental integrity of the CDM (CDM-EB78-AA-A05). As a default all CDM projects need to be included in the respective cohort unless the DNA can demonstrate that the cost of fuels/feedstocks/technologies exceed those of certain comparable projects (CDM-EB79, para 41).

- **Vintage of standardized baselines and static versus dynamic standardized baselines:** Standardized baselines are often constructed based on plants for which the investment decision was taken many years in the past. If a standardized baseline is static and not frequently updated, it can mean that additionality is established and baselines are determined based on a market situation that is ten or twenty years old (i.e. failing to take into account technological breakthroughs). This could result in significant crediting of BAU (Table 3-9, bullet point 2). The high-level CDM Policy Dialogue has therefore recommended that in order to drive technological change, the standardized baseline framework must ensure *"that the focus of incentives constantly shifts to the next generation of technologies"* (CDM Policy Dialogue 2012, p. 6). As a consequence, the current standardized baseline framework specified interim data vintages and update frequencies of 3 years respectively (CDM-EB77-A05). For example, sectors associated with slow dynamic developments in the past may allow for a relaxation in the frequency of updates without compromising the environmental integrity of the CDM.

- **Level of disaggregation:** The level of disaggregation is an important factor to consider in the development of a standardized baseline, which can enable a DNA with limited resources to prioritise which mitigation measures to incentivise within a sector. For example, Hermwille et al. (2013) refer to a case study of the rice mill sector in Cambodia where only a small number of large scale rice mills account for approximately 60% of the total output. Given that the remaining output is provided by thousands of small-scale rice mills with very varied use of technologies that are associated with different emission intensities, it was necessary to disaggregate the standardized baseline on the basis of plant size (i.e. focus standardisation on the large-scale mills). The importance of disaggregation of standardized baselines is further demonstrated in the power sector. If a standardized baseline is based upon the entire power sector of a country, it is likely that the use of renewables and possibly of the most efficient fossil fuel technologies would be encouraged. However, if the standardized baseline was disaggregated further to consider fossil fuel consumption only – different mitigation options such as fossil fuel switching would be encouraged instead (Hermwille et al. 2013). The appropriate level of disaggregation depends very much on the project type and the actual circumstances. With the current approach, DNAs can determine the level of disaggregation, though there is no EB guidance on how the appropriate level can be determined. In addition, such guidance would hardly be compatible with the 'one size fits all' approach pursued in the standardized baseline guidance.

In light of all of these challenges, the implementation of standardized baselines may not be suitable for all sectors, project types or countries. The development of a standardized baseline can achieve the objective of simplification in certain sectors associated with more homogenous products. However, standardized baselines will be more difficult to apply to sectors associated with a range of products and strongly varied circumstances amongst installations. Therefore, it should be carefully checked for which purposes, sectors, project types and baseline emission sources standardized baselines are appropriate. Applying one single approach to establish standardized baselines for different sectors, project types and locations, as currently pursued under the CDM, is likely to undermine the environmental integrity of the CDM. Standardized baselines should be developed from actual projects and reflect the particular circumstances of the sector, project type and location. Once approved within a country or region, standardized baselines need to be mandatory for all new CDM projects to prevent that more CERs are issued as if the standardized baseline was not established (Schneider et al. 2012).

To ensure that the concept of standardized baselines provides what it was established for, particularly *"to reduce transaction costs, ... while ensuring environmental integrity"* (UNFCCC 2011c), the EB should review the standardized baseline framework. This review should ensure that

- stringent QA/QC procedures are applied to all standardized baselines,
- all CDM facilities without any exemptions are included in the peer group for the standardized baseline,
- DNAs can build their decision on the appropriate disaggregation level on a clear guidance document which aims to determine the level of disaggregation in a way that covers the mitigation activity of the standardized baseline as accurately as possible and includes as few external factors ('noise') as possible;
- the practice of using the same methodological approach to establish standardized baselines for all the different sectors, project types and locations is replaced by the development

of project-specific standards derived from actual projects and reflect the particular circumstances of the sector, project type and location, and last but not least,

- standardized baselines are mandatory for new projects once they are approved for a country.

If these improvements were introduced, standardized baselines could be a valuable tool to improve the environmental integrity of the CDM while lowering transaction costs.

3.9. Consideration of policies and regulations

The consideration of policies and regulations in demonstrating additionality and establishing emissions baseline has been a controversial issue for project-based mechanisms as the CDM. Policies and regulations adopted by the host country can have a significant impact upon future emission pathways. For example, the introduction of air quality regulations for power plants impacts their CO_2 emissions while fossil fuel subsidies reduce the viability of less emission-intensive technologies (Schneider et al. 2014). When setting the baseline and demonstrating additionality there have been concerns raised about both perverse incentives for policy makers (i.e. host countries not implementing policies and measures that reduce emissions so that they can secure greater carbon revenues) and about environmental integrity, by either over-crediting of emission reductions (i.e. inflating the baseline by excluding polices and measures that reduce emissions) or non-additional projects (i.e. registering projects that are economically viable and do not face barriers by allowing the exclusion of subsidies in the investment analysis).

The modalities and procedures for the CDM require that *"a baseline shall be established taking into account relevant national and/or sectoral policies and circumstances, such as sectoral reform initiatives, local fuel availability, power sector expansion plans, and the economic situation in the project sector"* (decision 3/CMP.1, para 45(e)). However, in order to avoid the creation of perverse incentives for policy makers, the CDM EB adopted, at its 22nd meeting, the following rules with regard to the consideration of policies in setting baselines:

- **E+ policies:** to not consider polices adopted after 1997 which *"give comparative advantages to more emissions intensive technologies or fuels over less emissions intensive technologies or fuels"* in setting the baseline;

- **E- policies:** to not consider policies adopted after 2001 which *"'give comparative advantages to less emissions intensive technologies over more emissions intensive technologies"* in setting the baseline.[42]

These rules failed, however, to fully address perverse incentives for policy makers, as host countries would continue to have incentives to maintain existing E+ policies such as fossil fuel subsidies. Furthermore, although host countries will not be discouraged from implementing national policies and measures that reduce emissions (E- policies), the rules are likely to result in over-crediting of emission reductions.

Overall, in the case of E- policies it seems difficult to reconcile the two policy objectives: avoiding perverse incentives for policy makers and ensuring environmental integrity. If E- policies were excluded when demonstrating additionality or setting baselines, perverse incentives would be addressed but environmental integrity would be undermined, since projects that are financially viable could claim they are not, and emissions baselines would be inflated. If E- policies were included, environmental integrity would be ensured but perverse incentives not addressed.

[42] EB 22 report, Annex 3: Clarifications on the consideration of national and/or sectoral policies and circumstances in baseline Scenarios (Version 02), https://cdm.unfccc.int/EB/022/eb22_repan3.pdf.

In 2013, the EB reviewed its E- policy guidelines with a view to balancing these two conflicting policy objectives and *"agreed to pursue an approach by which, for the first seven years from the effective implementation date of the relevant E- policy, the benefit of that E- policy does not need to be considered by project participants in the additionality demonstration through investment analysis"* (CDM-EB73, para. 70). The approach would thus ignore new E- policies but for a limited time period. Initially allowing the exclusion of E- policies could be seen as addressing perverse incentives for policy makers, while ensuring environmental integrity in the longer term. It would also expand the approach of ignoring E- policies from baseline setting to demonstrating additionality. However, the EB has not yet been able to agree on a revision of its E+/- policy guidelines.

Based upon an econometric analysis, Lui (2014) raises questions about the decline of feed-in tariffs in China[43] that may imply a gaming to ensure wind projects are not economically attractive for the purpose of demonstrating additionality under the CDM. Schneider et al. (2014) argue that with regards to E- policies it is simply not feasible to achieve both a robust crediting baseline and avoid the creation of perverse incentives at the same time. Striking a balance between the two objectives is therefore required when setting the crediting baseline, which is likely to vary depending upon the sector, project type and type of policy.

Given the contrasting objectives, the decision on whether to include E- policies in the baseline or not and the determination of additionality of a project-based mitigation activity should depend upon the potential risk of either creating perverse incentives or over-crediting. Schneider et al. (2014) recommend that the following approach should be pursued when setting baselines and determining additionality:

- If the **risk of creating perverse incentives** is judged to be considerably larger than the risk of over-crediting, then E- policies should not be considered (for a certain period) in setting the baseline;
- If the **risk of over-crediting** is deemed to be considerably greater than the risk of creating perverse incentives, then E- policies should be considered in setting the baseline.

The extent to which the setting of baseline and determination of additionality for a project-based mitigation activity is more liable to either the risks of perverse incentives or over-crediting depends upon the wider co-benefits associated with a policy other than simply climate change mitigation. For example, the deployment of renewables is associated with multiple co-benefits such as employment opportunities, energy security and air quality improvements. Given the additional benefits associated with such E- policies, it is less likely that these policies would not be adopted as a consequence of changes to an international crediting mechanism. Schneider et al. (2014) and Spalding-Fecher (2013) therefore both argue that the risk of creating perverse incentives (i.e. delaying policies and regulations to secure more CER revenues) may be lower than the risks of setting a less robust baseline (i.e. by not including E- policies in the baseline) that leads to the over-crediting of emission reductions. Spalding-Fecher (2013) also points out that such co-benefits are likely to occur with electricity generation, energy efficiency and agriculture projects.

However, the risk of creating perverse incentives is likely to be greater from mitigation activities such as the capture of HFC-23, which reduce GHG emissions but do not lead to significant co-benefits. In such a case, preventing the creation of perverse incentives (i.e. host country delaying regulation on the capture of HFC-23) could be given priority over additionality and environmental integrity by not considering such E- policies when setting the baseline. Nevertheless, CERs resulting from such projects would be used to offset GHG emissions in other capped systems and, since

[43] Spalding-Fecher (2013) discusses the uncertainty within the CDM EB on how such a policy change should be classified under the E+/- policy guidance.

they are not truly additional, result in globally higher emissions. Therefore, it would be more appropriate to support such technologies by other means such as ODA or climate finance or by addressing these mitigation potentials as own contribution under the ADP negotiations.

From a more practical perspective, Spalding-Fecher (2013) emphasises the difficulty of accurately accounting for the effects of E- policies when setting either the baseline or demonstrating additionality. The level of difficulty depends upon the policy type. For example, the impact of direct financial incentives such as mandatory feed-in tariffs can be removed more easily from an emissions baseline than indirect sectoral incentives such as renewable energy portfolio standards or economy-wide policies such as domestic emissions trading schemes. Furthermore, defining the date of policy implementation and the effectiveness of enforcement may sometimes represent additional challenges (Spalding-Fecher 2013). If the guidance provided by the CDM EB – given the difficulty in isolating the impact of multiple (and sometimes conflicting) policies when setting emission baselines or demonstrating additionality – would only relate to direct financial incentives this could lead to the unequal treatment of host countries under the CDM based upon the types of policies implemented (Spalding-Fecher 2013). For example, it would be easier to determine the additionality of a renewable energy project in a host country with direct financial incentives such as feed-in tariffs compared to a host country that adopted a domestic emissions trading scheme. This practical problem could not only undermine the environmental integrity of the CDM but also mean that excluding E+ or E- policies may simply not be practical.

Taking into account the various challenges to strike the right balance between avoiding perverse incentives for policy makers and ensuring environmental integrity, Spalding-Fecher (2013) concludes that the risk of perverse incentives is not as high as previously assumed in many countries and sectors, while the risk of over-crediting is substantial. He therefore suggests that as a general rule all E- policies should be considered in both baseline-setting and additionality determination. Schneider et al. (2014) outline the following options in relation to E- policies:[44]

- No consideration of E- policies: No perverse incentives would be created if both existing and planned E- policies were not considered when setting the crediting baseline. In fact, host countries would be encouraged to introduce further E- policies to further reduce emissions below the baseline. However, the disadvantage of this option would be that the emission baseline would most likely be inflated above BAU.

- Consideration of existing E- policies, exclusion of future E- policies: A more balanced approach could involve the introduction of a cut-off date for excluding future E- policies from being considered in the setting of the crediting baseline. However the setting of a cut-off date is problematic. For example, if the cut-off point is set too early it may inflate the crediting baseline by considering E- policies that have already been adopted. Nevertheless, the option provides a positive incentive for host countries to adopt new E- policies (after the cut-off point) to reduce emissions.

- Consideration of existing and future E- policies: A robust crediting baseline would be established if both existing and future E- policies were considered (either ex-ante or ex-post), however this would most likely create disincentives to introduce E- policies as their introduction could lower the potential for credits. In addition, this option would provide greater uncertainty for investors as to when a crediting baseline would be updated.

In order to prevent the over-crediting of emission reductions, it would be a sensible approach to include current E- policies in the crediting baseline. However, accounting for future E- policies is

[44] These options are outlined in the context of a sector based crediting mechanism though they also apply to the CDM.

more problematic and warrants further research to ensure that a reasonable balance is achieved between limiting the over-crediting of emission reductions and preventing the creation of perverse incentives. Schneider et al. (2014) and Spalding-Fecher (2013) conclude that the balance should be more in favour of limiting over-crediting in the CDM or future mechanisms as they judge this risk to be greater to undermining environment integrity than from the creation of perverse incentives. Therefore, as a general rule Schneider et al. (2014) recommend that adopted policies and regulations reducing GHG emissions should be included when setting crediting baselines and policies that increase GHG emissions should be discouraged by their exclusion from the crediting baseline where possible.

3.10. Suppressed demand

One of the challenges of applying GHG accounting approaches in poor communities is that the current consumption of many household services (e.g. heating and cooking energy, lighting and potable water) may not reflect the real demand for those services. This could be a result of lack of infrastructure, lack of natural resources or poverty, particularly the high costs of these services relative to household incomes. The situation of 'suppressed demand' creates a problem for setting baselines, because the CDM rules say that the baseline scenario selected for a project should provide the same level of service and quality as the project scenario (Gavaldão et al. 2012; Michaelowa et al. 2014; Spalding-Fecher 2015; Winkler & Thorne 2002). This is clearly not the case if the project scenario provides a much higher service level, owing to low historical consumption. At the same time, the CDM rules state that "the baseline may include a scenario in which future anthropogenic emissions by sources are projected to rise above current levels, due to the specific circumstances of the host Party" (UNFCCC 2006a para. 46). This section analyzes how the concept of suppressed demand has been implemented in CDM methodologies and what the potential impacts on CER issuance as a result of the revised and new methodologies. For a more detailed conceptual explanation of suppressed demand, as well as background on previous EB decisions and guidance, see Chapter 9 of Spalding-Fecher et al. (2012).

3.10.1. Treatment of suppressed demand in approved methodologies

Table 3-10 below shows the methodologies in which suppressed demand has been explicitly considered, in three different categories. The first group is from a work plan agreed by the EB at their 67th meeting, when the EB requested that the Secretariat and relevant support panels explore how to incorporate suppressed demand. The second group is methodology revisions for which the proponent of the revision motivated the change based on the Suppressed Demand guidance. The final group is new methodologies that were developed after the approvals of the Suppressed Demand guidance and incorporated those ideas, as documented in the UNFCCC Methodology Guidebook. Of the original 10 methodologies in the EB work plan, 5 were revised or replaced, while an additional 8 methodologies fall into the second and third categories.

Note that a group of methodologies not listed here, but that implicitly recognise suppressed demand, are those addressing new large-scale power generation or industrial development. New renewable energy, natural gas or high-efficiency coal power plants are not required to show that they actually replace an existing power plant. Given that most developing countries have shortages in power supply, building a new natural-gas-fired power plant, for example, could potentially increase emissions compared to current levels. However, the accepted principle on baseline development across the CDM is that the baseline is not necessarily the same as historical emissions, but should reflect the most likely development scenario for the sector. Even in countries with chronic power shortages, it would be difficult to argue that there would be *no* capacity increases under the baseline scenario. This means that, even in these cases, CDM projects – if properly justified –

would potentially displace another alternative new plant. The determination of the alternative plant is then the subject of the methodology's baseline scenario analysis.

Table 3-10: Methodologies explicitly addressing suppressed demand or part of EB work plan on suppressed demand

Meth No.	Meth Name	Re-vised?	When	Pipeline[1)]	
				Pro-jects	PoAs
From EB67 work plan List of Methodologies					
AM0025	Alternative waste treatment processes	ACM22	EB69	127	5
AM0046	Distribution of efficient light bulbs to households	No		2	0
AM0086	Installation of zero energy water purifier for safe drinking water application	No	EB70	1	0
AM0094	Distribution of biomass based stove and/or heater for house-hold or institution	No	EB70	0	0
ACM0014	Treatment of wastewater	Yes	EB77	47	1
ACM0016	Mass Rapid Transit Projects	No		16	1
AMS I.A	Electricity generation by the user	Yes	EB69	50	17
AMS I.E	Switch from non-renewable biomass for thermal applications by the user	Not nec-essary	EB70	24	58
AMS II.E	Energy efficiency and fuel switching measures for buildings	No		44	5
AMS III.AR	Substituting fossil fuel based lighting with LED/CFL lighting systems	Yes	EB68	4	14
Additional revisions referring to Suppressed Demand					
AM0091	Energy efficiency technologies and fuel switching in new and existing buildings	Yes	EB77	0	0
AMS II.G	Energy efficiency measures in thermal applications of non-renewable biomass	Yes	EB70	45	62
AMS III.F	Avoidance of methane emissions through composting	Yes	EB67	103	20
New methodologies where EB noted Suppressed Demand					
ACM0022	Alternative waste treatment processes	New	EB69	10	0
AMS II.R	Energy efficiency space heating measures for residential buildings	New	EB73	0	0
AMS I.L	Electrification of rural communities using renewable energy	New	EB66	0	1
AMS III.BB	Electrification of communities through grid extension or new mini-grids	New	EB67	0	0
AMS III.AV	Low greenhouse gas emitting safe drinking water production systems	New	EB60/62	0	10
Total with revisions or new related to suppressed demand				**473**	**194**
Total pipeline				**11,990**	**446[2)]**

Notes: [1)] Pipeline is as of 1 January 2014. [2)] PoA DD's submitted, which may include multiple methodologies and include 23 PoAs replaced by new versions. Total number of methodology citations in all PoAs submitted is 874.

Sources: Authors' own compilation

While the proportion of project activities influenced by these methodologies is very small, a significant share of PoAs are utilising the revised or new methodologies. In terms of the quantitative impact of the revisions to methodologies to incorporate suppressed demand; however, this may only relate to projects or PoAs entering the pipeline after the revision. While project participants are allowed to update the version of the methodology that they use prior to the renewal of the crediting period, this should not make the emission reduction calculations less conservative. Given that the suppressed demand revisions could increase the baseline significantly, it is not entirely clear whether the EB would approve this revision for existing projects prior to the renewable of the crediting period (when the latest version of the methodology must be used). Because AM00025 was replaced by ACM0022 in order to address suppressed demand, none of the projects or PoAs under AM0025 (which was not used after October 2012) would be able to utilise the new suppressed demand approach embodied in ACM0022. Table 3-11 below shows the number of PoAs and Projects in the pipeline both before and after the revisions.

Table 3-11: CDM pipeline affected by suppressed demand methodologies

Meth No.	Meth Name	Total pipeline		New pipeline since revision	
		Projects	PoAs	Projects	PoAs
Revised methodologies					
ACM0014	Treatment of wastewater	47	1	0	0
AMS I.A	Electricity generation by the user	50	17	0	13
AMS III.AR	Substituting fossil fuel based lighting with LED/CFL lighting systems	4	14	3	1
AM0091	Energy efficiency technologies and fuel switching in new and existing buildings	0	0	0	0
AMS II.G	Energy efficiency measures in thermal applications of non-renewable biomass	45	62	2	18
AMS III.F	Avoidance of methane emissions through composting	103	20	7	8
New methodologies that incorporate suppressed demand					
AMS I.E	Switch from non-renewable biomass for thermal applications by the user	24	58	24	58
ACM0022	Alternative waste treatment processes	10	0	10	0
AMS II.R	Energy efficiency space heating measures for residential buildings	0	0	0	0
AMS I.L	Electrification of rural communities using renewable energy	0	1	0	1
AMS III.BB	Electrification of communities through grid extension or construction of new mini-grids	0	0	0	0
AMS III.AV	Low greenhouse gas emitting safe drinking water production systems	0	10	0	10
Total		**283**	**183**	**46**	**109**

Sources: Authors' own compilation

How the suppressed demand concepts and guidance are implemented varies significantly by methodology. With the exception of AMS III.AR, all of the methodologies use the project activity level as the baseline activity level. Only AMS III.AR defines a quantitative Minimum Service Level that is used to calculate baseline emissions. AMS I.L and AMS III.BB define an MSL, but it is only used to adjust the emissions factor for the baseline, rather than to directly calculate baseline activity levels or emissions. For AMS III.F and ACM0022, the minimum service level is qualitatively defined as having a solid waste disposal site (i.e. rather than considering the quantity of waste processed per household). What the methodologies all do, however, is to define a baseline technology that may have higher emissions than the actual current technology. For example, households may currently only use candles and kerosene hurricane lamps, and therefore have very low lighting services, but the methodologies use a kerosene pressure lamps for the baseline technology, because this can deliver the MSL for lighting services.

For the revised methodologies, the resulting baselines emissions could be substantially higher per household (Annex 8.2, Table 8-1). For example, under ACM0014, baseline methane emissions may still be considered even if the wastewater is currently not treated or stored in a way that would necessarily produce emissions (e.g. lagoons with depth less than 1 m). ACM0022 and AMS III.F have emissions factors that could be double the current practices, while for AMS I.L and AMS

III.BB, the emission factor for very small users (e.g. 50 kWh/yr) is almost 7 times the emissions factor originally used in AMS I.A for these projects.

3.10.2. Impact on CER supply

If current energy service demand is suppressed by lack of income, relatively high energy prices and/or lack of physical access, how quickly might this change without the CDM project? In other words, how long might it take for the current emissions to reach the suppressed baseline emissions? This depends on many factors, including income growth in the host communities and changes in access. Data from the World Bank's World Development Indicators (World Bank 2014), for example, shows that, at a highly aggregated level, per capita incomes in most developing regions have, indeed, increased substantially, but this is slower in low income countries. Electricity consumption per capita, however, has not shown such consistent growth in Africa, largely due to population growth outstripping energy supply growth and electrification programmes (World Bank 2014). This data cannot necessarily be applied to specific sub-regions or project areas, but does show that significant increases in energy consumption are possible in a relatively short time frame. In terms of electrification rates, these have increased relatively rapidly for key countries, rising from 25% or 30% to 60% to 80% in as little as 10 or as many as 30 years (Bazilian et al. 2011). Clearly, the level at which the minimum service level is set will also influence the risk of over-crediting, with lower service levels being more likely to reflect potential consumption in the shorter term without the CDM.

Even if the households were not to reach the minimum service levels in the near term and the emissions factors used in these methodologies is substantially higher than in traditional methodologies, the overall impact on CER generation is likely to be very small. The total CERs projected to 2020 for the methodologies in Table 3-11 after the revisions to those methodologies is approximately 17 million. Even if all of the CERs for those methodologies are considered (i.e. before and after revision), at approximately 112 million, this is still less than 1% of the entire CDM pipeline, and so does not represent a significant impact on emissions.

3.10.3. Additionality concerns

In summary, while the introduction of the concept of suppressed demand in CDM methodologies is expanding, and will have important development impacts, it is unlikely to have a major impact on the overall additionality of CDM projects. In many project areas, it is likely that the communities could reach the Minimum Service Levels during the course of the CDM project life, although this is uncertain and will depend on local circumstances. Creating an open and transparent process of setting minimum service levels, with expert input as well as input from other stakeholders, could also help to balance the risks of over-crediting with the potential increased development benefits. In addition, the application of suppressed demand principles in methodologies could be restricted to certain country groups (e.g. LDCs, under-represented countries), in which development needs are highest and the potential for over-crediting it the smallest. Even if the suppressed demand does lead to some over-crediting, the overall impact is very small, particularly if restricted geographically. More importantly, the increased contribution to sustainable development provides a strong justification for this approach to project types that address poverty and development issues.

4. Assessment of specific CDM project types

The relevant literature highlights that the likelihood of CERs representing real, measurable and additional emission reductions varies considerably among project types. Some project types do not generate revenues other than CERs. These projects have a high likelihood of being additional. Other project types are heavily promoted and/or subsidized by governments, generate significant other revenues, or their economic feasibility is hardly impacted by CER revenues. For these projects, additionality is more questionable.

Other aspects affecting the quality of CERs also vary among project types. Perverse incentives are particularly relevant for projects that generate large CER revenues compared to the cost structure of their main business (e.g. HFC-23 projects). Baselines are particularly challenging to determine in dynamic sectors with high rates of learning and innovation and penetration of new technologies over relatively short periods of time. The length of crediting is critical for project types which are implemented earlier due to the CDM incentives.

For these reasons, this chapter evaluates the ability to deliver real, measurable and additional emissions reductions for specific CDM project types. In the following, we select important project types in Section 4.1 and assess these project types in the subsequent sections.

4.1. Project types selected for evaluation

We select the project types for evaluation mostly based on their potential CER volume in the period of 2013 to 2020 according to the current CDM project portfolio. Focusing on the period of 2013 to 2020 and on the largest CDM project types in terms of potential CER volume allows the best estimation of the quality of the overall CDM project portfolio for future new demand for CERs. Moreover, the project types with the largest market share are most critical for the overall quality of the CDM.

The specific project types selected for evaluation are provided in Table 4-1. The table also shows that these project types cover a potential CER volume of 4.8 billion CERs, which corresponds to 85% of the overall CER supply potential for the period of 2013 to 2020 (Section 2.3). This ensures a large representativeness.

Table 4-1: Project types selected for evaluation

Project type	Potential CER supply 2013 to 2020 [million]	Focus areas analyzed
Wind power	1,397	Additionality, baselines
Hydropower	1,669	Additionality, baselines
Biomass power	162	Additionality, baselines, leakage
HFC-23	375	Perverse incentive, baselines
Adipic acid	257	Perverse incentives (leakage)
Nitric acid	175	Perverse incentives, baselines
Landfill gas	163	Additionality, baselines, perverse incentives
Coal mine methane	170	Additionality, baselines
Waste heat recovery	222	Additionality, baselines
Fossil fuel switch	232	Additionality, baselines
Efficient cook stoves	2.3	Additionality, baselines
Efficient lighting	3.8	Additionality
Total of all selected project types	**4,829**	
Total of all projects in the CDM portfolio	**5,671**	

Source: Authors' own compilation and calculations

4.2. HFC-23 abatement from HCFC-22 production

4.2.1. Overview

Hydrofluorocarbon-23 (HFC-23) is a waste gas from the production of hydrochlorofluorocarbon-22 (HCFC-22), which is a GHG and an ozone-depleting substance (ODS) regulated under the Montreal Protocol on Substances that Deplete the Ozone Layer. HCFCs were introduced as an alternative to the highly ozone-depleting chloro-fluorocarbons (CFCs) because of their lower ozone-depleting potential. HCFC-22 is mainly used for two purposes: as a refrigerant in refrigeration and air-conditioning appliances and as a feedstock in the production of polytetrafluoroethylene (PTFE). The production for the refrigeration and air-conditioning industry is regulated under the Montreal Protocol, whereas the production for feedstock purposes is not.

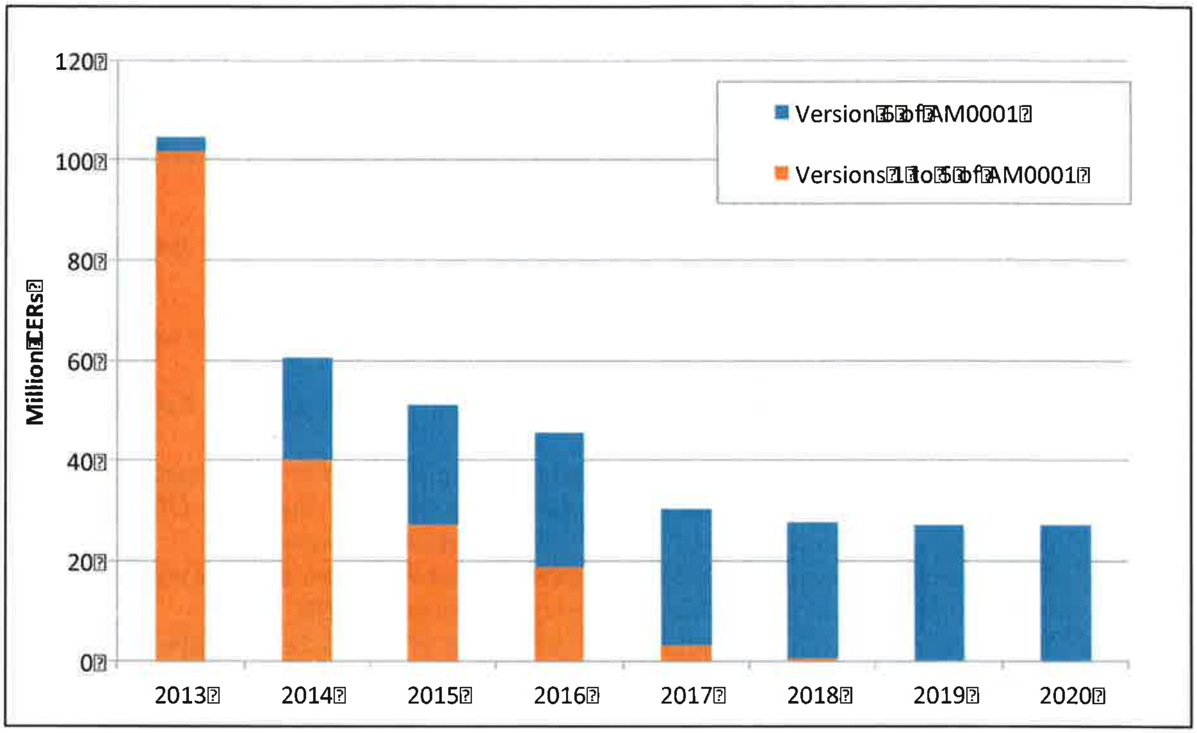
HFC-23 is a potent greenhouse gas; its global warming potential (GWP) is estimated at 14,800 for the second commitment period of the Kyoto Protocol. Emissions of HFC-23 from HCFC-22 production can be abated in two ways: a) by reducing the rate of waste gas generation (by-product rate) through process optimization and b) by capturing and destroying HFC-23 through installation and operation of high temperature incinerators. In the absence of regulations, incentives, or voluntary commitments by the industry, HFC-23 is usually vented to the atmosphere (Schneider & Cames 2014).

4.2.2. Potential CER volume

Under the CDM, 19 HFC-23 projects have been registered. Eleven projects are located in China, five in India; South Korea, Argentina and Mexico each host one project. All projects apply the baseline and monitoring methodology AM0001. In the first commitment period of the Kyoto Protocol, the abatement of HFC-23 has been the project type with the largest CER issuance: 516 million HFC-

23 CERs or 36% were issued of a total of 1.4 billion CERs by the end of 2013. The potential CER supply for the period of 2013 to 2020 is estimated using a bottom-up model based on a detailed evaluation of the information in PDDs and monitoring reports from all 19 projects (Schneider & Cames 2014). In estimating the potential CER supply we differentiate between CERs from the application of versions 1 to 5 and version 6 of the applicable baseline and monitoring methodology AM0001 due to the significant differences between these methodology versions. The potential CER supply for the period of 2013 to 2020 is illustrated in Figure 4-1; it amounts to approx. 375 million CERs for the entire period, with 191 million from the application of version 1 to 5 and 184 million from the application of version 6 of the methodology AM0001.

Figure 4-1: CER supply potential of HFC-23 projects



Sources: Authors own compilation

4.2.3. Additionality

All versions of the applicable baseline and monitoring methodology AM0001 consider HFC-23 projects to be automatically additional, as long as no regulations to abate HFC-23 are in place in the host country. This rule seems appropriate. Prior to the CDM, none of the plants in developing countries had equipment to destruct destroy HFC-23; HFC-23 generated in the production process was vented to the atmosphere. The same holds for plants that are not eligible for crediting under the CDM because they started commercial operation after 31 December 2001. Plant operators do not have economic incentives to install HFC-23 destruction equipment, as the installation and operation does not reduce costs or generate any significant revenues other than from CERs.[45] Based on these considerations, we assess that this project type is very likely to be additional.

[45] Schneider & Cames (2014) report that plant operators could sell HF which is a by-product from flue gas treatment. However, these revenues are likely lower than the costs for HFC-23 destruction.

4.2.4. Baseline emissions

HFC-23 generation from HCFC-22 production depends on two factors: the amount of HCFC-22 production and the ratio between HFC-23 generation and HCFC-22 production, which is often referred to as 'waste generation rate'. The applicable methodology AM0001 determines baseline emissions of HFC-23 based on these two factors, by multiplying the baseline HCFC-22 production with the baseline waste generation rate.[46] How these two parameters are calculated, has evolved over time.

The approaches changed over time with a view to addressing perverse incentives which are a particular concern for the crediting of HFC-23, due to the low technical abatement costs[47] and significant profits which can accrue from CER revenues and could exceed the costs of HCFC-22 production (Schneider 2011, UNFCCC 2011b, TEAP 2005). Significant perverse incentives were observed in two JI projects in which plant operators increased the waste generation rate to unprecedented levels once methodological safeguards were abandoned (Schneider & Kollmuss 2015). Perverse incentives can arise from the CDM in the following ways:

- HCFC-22 plants could operate at a higher waste generation rate than they would in the absence of the CER revenues, leading to over-crediting;
- The amount of HCFC-22 produced at CDM plants could be higher than in the absence of the CER revenues. This could lead to over-crediting if
  - HCFC-22 production is displaced at non-CDM plants that have a lower waste generation rate than the baseline rate used at the CDM plants;
  - HCFC-22 production is displaced at plants located in Annex I countries that already are required to abate HFC-23 emissions;
  - HCFC-22 is not produced for use in applications but is vented to the atmosphere;
  - The use of HCFC-22 becomes economically more attractive due to the CDM and is increasingly used compared to other less GHG-intensive alternatives;
  - The base year emissions (2009-2010) under the accelerated phase-out under the 2007 amendment to the Montreal Protocol are higher due to the CDM;
  - The implementation of the accelerated phase-out of HCFC-22 is delayed due to the CDM.
- The HCFC-22 plants could operate longer than they would in the absence of CDM revenues. This could lead to over-crediting under the same circumstances as a higher HCFC-22 production at the plants.

Robustness and conservativeness of the methodology has significantly increased over time. Perverse incentives constitute a major challenge in versions 1 to 5, whereas the conservative approach in version 6 largely avoids and compensates for perverse incentives.

For CERs issued to projects under versions 1 to 5, the amount of over-crediting is uncertain, since it hinges strongly on assumptions on HCFC-22 production levels, HFC-23 waste generation rates and the indirect effects noted above. Munnings et al. (2016) suggest that under-crediting due to conservative baselines may have more than compensated for the potential over-crediting from perverse incentives that these baselines were intended to curb. However, Munnings et al. (2016) make several assumptions that seem rather implausible. For example, they assume that in the absence of the CDM, some plants would have produced more HCFC-22 than they did under the CDM. As a result, we do not find their arguments persuasive.

[46] Versions 1 to 5 of methodology AM0001 do not explicitly calculate baseline emissions but directly calculate the emission reductions.
[47] Schneider & Cames (2014), Appendix, provide an overview of technical abatement costs for HFC-23 destruction.

Under version 6, on the other hand, net under-crediting (or net emissions benefit) is very likely since the methodology uses an ambitious default value of 1.0% for the baseline waste generation rate and caps the amount of HCFC-22 production that is eligible for crediting in a more conservative manner (Erickson et al. 2014). However, as of 1 January 2016, no credits have been issued under version 6.

4.2.5. Other issues

Continued low CER prices could jeopardize continued abatement activities at CDM HFC-23 project sites, an unfortunate outcome given the very inexpensive abatement opportunities they provide. At the same time, the failure of the CDM market to ensure continued abatement creates the opportunity for other policies that could yield even greater net emission benefits, especially if no credits are generated that could be also used to increase emissions elsewhere. For example, China recently launched a results-based finance programme that supports HFC-23 abatement in CDM and non-CDM plants (NDRC 2015). This programme helps support HFC-23 abatement across the sector in China. However, continued abatement in other CDM-eligible countries is less certain.

There are also other means to ensure these important abatement opportunities are not lost. Emissions of HFC-23 from HCFC-22 production can be regulated through the Montreal Protocol and for new facilities that have not yet installed GHG abatement, the Protocol's Multilateral Fund (MLF) for GHG abatement can provide financial support (Schneider & Cames 2014).

Note also that continued crediting under the CDM could also create perverse incentives for policy makers not to pursue alternative policies such as these, which address emissions without yielding CERs.

4.2.6. Summary of findings

Past changes to methodologies have now improved the integrity of these projects. If they are operated they are likely to yield more emissions reductions than CERs – i.e. a net mitigation benefit. However, continued low CER prices jeopardize their continued operation in some countries.

Additionality	• Likely to be additional
Over-crediting	• Risk of perverse incentives largely addressed in most recent methodology (version 6). • Version 6 could lead to under-crediting (net mitigation benefit)
Other issues	• Low CER prices jeopardizes continued operation • Emissions could be addressed through Montreal Protocol • Perverse incentives to avoid domestic regulation

4.2.7. Recommendations for reform of CDM rules

The necessary changes in AM0001 have been implemented in recent years. No changes in CDM rules are needed.

4.3. Adipic acid

4.3.1. Overview

Adipic acid is an organic chemical that is used as a building block in a range of different products, most importantly polyamide, often referred to as 'nylon'. Other applications include the production of polyurethanes and plasticizers. Adipic acid is a globally traded commodity, with more than one-third of the production traded internationally. Nitrous oxide (N_2O) is an unwanted by-product of adipic acid production. The formation of N_2O cannot be avoided; it is the result of using nitric acid to oxidize cyclohexanone and/or cyclohexanol. Generally, the amount of N_2O generated varies very little over time and among plants.

N_2O in the waste gas stream can be abated in different ways: by catalytic destruction, by thermal decomposition, by using the N_2O for nitric acid production, or by recycling the N_2O as feedstock for adipic acid production (Schneider, L. et al. 2010). These methods typically reach an abatement level of about 90% (IPCC 2006, p. 3.30, Ecofys et al. 2009, p. 44). However, plants implemented under CDM and JI achieved significantly higher abatement levels of approx. 99% in the case of CDM and 92% to 99% in the case of JI, apparently through the strong economic incentives from the CDM and JI (Schneider, L. et al. 2010).

4.3.2. Potential CER volume

Under the CDM, four projects were registered. Two projects are located in China, one is in Brazil and one in South Korea. All four CDM plants had no abatement installed before project implementation and applied either thermal or catalytic abatement. The four implemented CDM plants cover only a part of the adipic acid production in developing countries because the applicable CDM methodology AM0021 is limited to plants that started commercial operation before 2005. Since then, five new plants are known to have started commercial operation in China; none of them abates N_2O emissions (Schneider & Cames 2014). Based on a bottom-up model used by Schneider & Cames (2014), the four CDM projects could generate about 257 million CERs in the period of 2013 to 2020.

4.3.3. Additionality

The applicable methodology AM0021 combines the approaches included in the different approaches to demonstrate additionality. Version 1 establishes three criteria for additionality demonstration: no regulations should require N_2O abatement, the project should not be common practice and it should not be economically viable. Versions 2 and 3 refer to the additionality tool and hence the investment analysis is not mandatory for additionality demonstration, as compared to version 1. Nevertheless, all four registered projects conduct an investment analysis and determine the net present value (NPV). Versions 2 and 3 also require reassessment of additionality during the crediting period if new NO_X regulations were introduced.

N_2O abatement from adipic acid production can be regarded as highly likely to be additional, for several reasons. Firstly, none of the non-Annex I countries in which adipic acid is produced have regulations in place to abate N_2O. Secondly, for thermal or catalytic destruction of N_2O, plant operators have no economic incentives to abate N_2O emissions. The abatement generates steam as a by-product; however, the cost savings or revenues are lower than the investment and operation and maintenance costs. Based on a review of PDDs and literature information, the technical abatement costs are estimated at €0.3/t CO_2e, with a range from €0.1/t CO_2e to €1.2/t CO_2e (Schneider & Cames 2014).

Thirdly, the abatement of N_2O from adipic acid production is not common practice in non-Annex I countries. In Western industrialized countries, N_2O has been abated voluntarily since the 1990s. In non-Annex I countries, only one plant in Singapore had abatement technology installed prior to the CDM (Schneider, L. et al. 2010). None of the plants commissioned after 2004, which are not eligible for crediting under the CDM, installed N_2O abatement technology.

4.3.4. Baseline emissions

Baseline emissions of N_2O are determined by multiplying the amount of adipic acid production eligible for crediting with a baseline emission factor. The methodology further estimates baseline emissions from steam generated during the catalytic or thermal destruction of N_2O. Baseline emissions from steam generation are very small compared to baseline emissions of N_2O.

The baseline emission factor is determined as the lower value between the actual rate of N_2O formation and a default value of 270 kg N_2O / t adipic acid, which corresponds to the lower end of the uncertainty range of the IPCC default value of 300 kg / t adipic acid (IPCC 2006). This approach is used in all three methodology versions and intends to exclude the possibility of manipulating the production process to increase the rate of N_2O formation. Versions 2 and 3 require the actual N_2O formation rate to be determined in two ways: 1) based on the consumption of nitric acid and the ratio of N_2O to N_2 in the off-gas, and 2) based on direct measurements of N_2O in the off-gas adjusted by a 5% discount factor to account for measurement uncertainty. As a conservative approach, the lower resulting value of the two ways is used to determine the baseline emission factor. Overall, the methodology ensures that the baseline emission factor is determined in a conservative manner. The rate of N_2O formation typically observed is higher than the default value of 270 kg / t adipic acid, which could potentially lead to under-crediting of few percentage points.

The amount of adipic acid production that is eligible for crediting is capped in all three methodology versions with a view to avoiding incentives to expand the production as a result of the CDM. Version 2 and 3 establish the cap as the highest annual production in the three years prior to the implementation of the project activity. Version 1 does not provide a procedure to determine a cap but specifies that the methodology is "only applicable for installed capacity (measured in tons of adipic acid per year) that exists by the end of the year 2004". There has been controversy about how this requirement is to be interpreted. Following a request for clarification (AM_CLA_0148), the Methodologies Panel recommended using production data from three historical years, similar to Versions 2 and 3. However, the CDM EB concluded that the panels' clarification "provides too extensive interpretation to an older version of methodology" and clarified instead that the cap should be determined as the "validated maximum daily production of adipic acid multiplied by 365 days multiplied by the operational rate".[48] This was further interpreted in a way that allowed plants to seek credits beyond their annual design capacity specified in PDDs. All four CDM projects were registered with Version 1 of the methodology. Two projects (0099 and 0116) recently renewed their crediting period, applying Version 3 of the methodology, which lead to caps that that are 14.8% and 13.9% lower than the caps applicable in their first crediting period.

While the methodology intended to avoid production shifts through caps on the amount of production that is eligible for crediting, data on adipic acid production, plant utilisation and international trade patterns suggest that carbon leakage, i.e. a shift of production from non-CDM plants to CDM plants, occurred during the economic downturn in 2008 and 2009 (Schneider, L. et al. 2010). Such production shifts do not only lead to distortions in the adipic acid market but can also lead to over-crediting if N_2O is abated in the non-CDM plants. Schneider, L. et al. (2010) estimate that carbon leakage leads to over-crediting of approx. 6.3 $MtCO_2e$ or about 17% of the CERs from adipic acid projects issued in 2008 and approx. 7.2 $MtCO_2e$ or about 21% of the CERs from adipic acid projects in 2009. These effects could thus outweigh the conservative determination of the baseline emission factor.

The lenient interpretation of historical production capacity in version 1 of the methodology considerably contributed to the carbon leakage. However, the more conservative approach for the establishment of the cap on adipic acid production in versions 2 and 3 of the methodology addresses this issue only partially. In a global economic recession, adipic acid production could fall well below historical rates of plant utilisation. Depending on the CER prices, CDM plants operators would then have significant competitive advantage over non-CDM plants, which could lead to similar produc-

[48] Report of the 48th meeting of the EB, paragraph 24.

tion shifts as observed in 2008 and 2009. As for HCFC-22 production, the underlying issue is that carbon market revenues can have a strong impact on adipic acid production costs. Carbon leakage is unlikely to occur at current market prices for CERs, but could become an issue again if CER prices increased.

4.3.5. Other issues

No other issues were identified.

4.3.6. Summary of findings

Adipic acid projects have a very high likelihood of additionality. The baseline emission factor is determined in a conservative manner that could lead to a few percentage points of under-crediting. The methodology does not include sufficient provisions to address carbon leakage. This could lead to significant over-crediting in times of higher CERs prices and when the adipic acid production capacity significantly exceeds demand.

Additionality	• Likely to be additional
Over-crediting	• Most recent methodology could lead to slight under-crediting • Leakage could lead to significant over-crediting in times of higher CER prices
Other issues	• None

4.3.7. Recommendations for reform of CDM rules

Based on the considerations above, we recommend revising the applicable CDM methodology as follows:

- The provisions for additionality demonstration could be simplified, as this project type can be considered to be very likely additional. We recommend considering this project type as automatically additional, as long as no regulations require N_2O abatement.

- The potential for carbon leakage should be addressed. We recommend introducing a standardized ambitious emission benchmark to determine baseline emissions. Carbon leakage would be avoided most effectively if a consistent emissions benchmark is used for all plants around the world, including plants under ETSs, and if it is set at or below the abatement level typically achieved in the industry. A standardized global emission benchmark for all adipic acid plants, regardless of policy approach or specific emission trading mechanism, could provide a level playing field for the adipic acid industry and eliminate potential economic distortions. Adipic acid production is particularly amenable to a standardized global benchmark because it is a highly globalized industry, and all plants are very similar in structure and technology (Schneider, L. et al. 2010). We recommend a level at or below 30 kg/t adipic acid, which reflects the abatement level achieved by the large majority of producers world-wide.

- If a standardized ambitious emissions benchmark is introduced, the methodology could be further simplified as measurements and calculations of the rate of N_2O formation would not be necessary.

4.4. Nitric acid

4.4.1. Overview

Nitric acid is mainly used for the production of synthetic fertilizers and explosives. In the industrial production of nitric acid, ammonia (NH_3) is oxidized over precious metal gauzes (primary catalyst) to produce nitrogen monoxide (NO), which then reacts with oxygen and water to form nitric acid. N_2O is an unwanted by-product generated at the primary catalyst. The better a primary catalyst functions, the lower the N_2O emissions. Nitric acid is produced during production campaigns of typically 3-12 months (Kollmuss & Lazarus 2010).

N_2O emissions from nitric acid production can be abated in three ways (Schneider & Cames 2014):

- **Primary abatement** prevents the formation of N_2O at the primary catalyst. According to gauze suppliers, improved gauzes could potentially lead to a 30-40% reduction of N_2O formation (Ecofys et al. 2009).
- **Secondary abatement** removes N_2O through the installation of a secondary N_2O destruction catalyst in the oxidation reactor. The abatement efficiency of the secondary catalyst is often estimated as ranging from 80% to 90%. However, in practice it varies in CDM plants from about 50% to more than 90%. Registered CDM projects achieved an average abatement efficiency of 70% (Kollmuss & Lazarus 2010, Debor et al. 2010).
- **Tertiary abatement** removes N_2O from the tail gas through either thermal or catalytic decomposition. Tertiary abatement can reduce N_2O emissions by more than 90% but involves larger investment and operating costs and more demanding technical requirements than secondary abatement. Registered CDM projects achieved an average abatement efficiency of 86% (Kollmuss & Lazarus 2010, Debor et al. 2010).

Four methodologies have been approved for N_2O abatement from nitric acid production:

- **AM0028** is applicable to tertiary abatement in plants that started commercial operation before 2006. 19 projects used the methodology. In 2013, the methodology was limited to caprolactam production in 2013, and replaced by amending the methodology ACM0019.
- **AM0034** is applicable to secondary abatement in plants that started commercial operation before 2006. 56 projects used the methodology. In 2013, the methodology was withdrawn and replaced by amending the methodology ACM0019.
- **AM0051** is also applicable to secondary abatement in plants that started commercial operation before 2006. The methodology was never used and was withdrawn in 2013. It is therefore not considered in detail in this study.
- **ACM0019** is applicable to both secondary and tertiary abatement and both existing and new plants. 26 projects used the methodology. Since 2013, this is the only valid methodology for nitric acid projects.

Table 4-2 provides an overview of the main features of and differences between the methodologies.

Table 4-2: Overview of methodologies for nitric acid projects

	AM0028	AM0034	AM0051	ACM0019
Projects	19	56	None	26
Technology	Tertiary	Secondary		Secondary and tertiary
Validity	Limited to caprolactam in 2013	Withdrawn in 2013		Valid
Applicability	Plants that started operation before 2006			Existing and new plants
Additionality demonstration	Additionality tool			Automatically additional
Baseline emission factor	Ex-post measurements	Ex-ante measurement campaign	Ex-post measurements	Emission benchmark
Cap on baseline production	Design capacity			No cap
Re-assessment of baseline scenario or additionality	In case of new NO_X regulations			Not applicable

Sources: Authors own compilation

4.4.2. Potential CER volume

Under the CDM, 97 projects were registered and another four projects were submitted for validation as of January 2014. China is the most important host country with 44 projects. Other important countries are India (5 projects), Uzbekistan (6 projects), South Africa (5 projects), and Brazil, Egypt, Israel and South Korea which host each four projects. Among the 97 registered CDM projects, only 51 have issued CERs as of January 2014. In the current market situation, it is likely that most of the remaining 47 projects have not been implemented. Based on a bottom-up model developed by Schneider & Cames (2014), the 101 published CDM projects could generate approx. 175 million CERs in the period of 2013 to 2020. Potential new projects that have not yet been developed or published are estimated to have a potential of approx. 31 million CERs over the same period.

4.4.3. Additionality

Up to 2011, all three approved methodologies (AM0028, AM0034, AM0051) used the additionality tool to demonstrate additionality. In 2011, ACM0019 was adopted, which deems projects to be automatically additional and employs a dynamic emission benchmark to determine baseline emissions.

N_2O abatement from nitric acid production can be regarded as highly likely to be additional, for similar reasons as for HFC-23 abatement from HCFC-22 production and N_2O abatement from adipic acid production. Non-Annex I countries usually do not have regulations which address N_2O emissions from nitric acid production. Prior to the CDM, secondary or tertiary abatement is not known to have been used in non-Annex I countries and N_2O is usually released to the atmosphere. While plant operators have economic incentives to take primary abatement measures to reduce the rate of N_2O formation, they do not save any costs or generate any revenues – other than carbon market revenues – from the installation of secondary or tertiary abatement. Based on a review from PDDs and literature information, the average technical abatement costs are estimated at €0.9/t CO_2e for secondary abatement and at €3.2/t CO_2e for tertiary abatement (Schneider & Cames 2014). For these reasons, in our assessment, the approach in ACM0019 of assuming this project type automatically additional seems reasonable.

4.4.4. Baseline emissions

Baseline emissions are determined by multiplying the amount of nitric acid production with a baseline emission factor. The methodologies AM0028, AM0034 and AM0051 limit the amount of nitric acid production eligible for claiming emission reductions to the design capacity of the plant in 2005; ACM0019 has no such cap. The baseline emissions factor is determined in three different ways in CDM methodologies: through measurement campaigns conducted prior to the installation of the abatement technology (AM0034), through measurements during the crediting period (AM0028 and AM0051), and by using an emissions benchmark (ACM0019).

All three methodologies using measurements (AM0028, AM0034 and AM0051) aim to provide safeguards to avoid perverse incentives to artificially increase the rate of N_2O formation in order to increase CDM revenues (UNFCCC 2012b; UNFCCC 2013; Schneider & Cames 2014). In AM0028, the baseline emission factor is capped to the level of previous monitoring periods if project participants do not use a primary catalyst that is common practice in the region or has been used in the nitric acid plant during the last three years and if they cannot justify the use of a different catalyst. In addition, key operating conditions of the plants cannot be changed during project implementation. In AM0034, the methodology requires a new baseline measurement campaign to be conducted if the chemical composition of the primary catalyst is changed after project implementation. While these provisions aimed to avoid perverse incentives to increase the N_2O formation due to the CDM, they provide economic disincentives to plant operators to use primary catalysts that reduce the formation of N_2O, as this would lower their CER revenues and could involve additional costs for conducting a new baseline campaign (UNFCCC 2012b; UNFCCC 2013; Schneider & Cames 2014). However, advanced primary catalysts that increase the NO yield and lower the generation of the by-product N_2O are emerging in the industry. They have become widespread in Europe, are gaining market shares in other parts of the world, and have been used in a number of CDM projects prior to their start (UNFCCC 2012b). It is thus possible that some CDM projects applying the AM0034 or AM0028 methodology would, in the absence of the CDM incentives, employ more advanced primary catalysts, in particular over the time frame of three crediting periods, leading to over-crediting (UNFCCC 2012b).

The Methodologies Panel further identified that some plants using the AM0034 methodology had established baseline emission factors which are significantly above the uncertainty range of the IPCC default values and which would result in considerable economic losses for the plant operators (UNFCCC 2012b). The highest reported value from a baseline measurement campaign is 37.0 kg N_2O / t nitric acid, while the highest IPCC default value is 9.0 kg N_2O/t nitric acid, with an uncertainty range of ±40% (IPCC 2006). Such high emission factors indicate that these plants are operated at a high specific ammonia consumption. Plant operators could intentionally reduce the production efficiency during the baseline campaign in order to achieve a higher CDM baseline emission factor (UNFCCC 2012b). Moreover, while inefficient plant operation can be observed in Non-Annex I countries, it seems questionable whether the observed levels of nitrogen loss would continue over the course of three crediting periods. On the other hand, it is important to take into account that the IPCC default emission factors were estimated at times when much less information was available on N_2O formation from nitric acid plants. In particular, continuous measurements over the length of a production campaign, with increasing N_2O emissions towards the end of the campaign, were not available. The values and their assigned uncertainty should therefore not be overweighed.

To address these two issues, the CDM EB withdrew the AM0034 and AM0051 methodologies and limited the applicability of the AM0028 methodology to caprolactam plants in 2013. At the same time, the EB revised the methodology ACM0019, distinguishing the approach between plants that used AM0028 or AM0034 in their first crediting period and other (mostly newer) plants. For AM0028 and AM0034 plants up to their design capacity, the methodology uses the lower value between the historical baseline emissions during the first crediting period under AM0028 and AM0034 and a default value set at the upper end of the uncertainty range of the IPCC default value and declining by 0.2 kg N_2O/t nitric acid per year to reflect technological innovation in primary catalysts that may reduce emissions over time. This approach caps the baseline emissions particularly for those plants that have established baseline emission factors above the IPCC uncertainty range. It also reduces the maximum amount of baseline emissions that can be claimed over time to account for technological innovations in primary catalysts. For production above the design capacity and other (mostly newer) plants, the methodology uses a more ambitious emissions benchmark set at 3.7 kg N_2O/t nitric acid in 2013 and declining by 0.2 kg N_2O/t nitric acid per year, up to a level of 2.5 kg N_2O/t nitric acid in 2020 which is maintained in subsequent years.

The new approach has several advantages but also some shortcomings:

- Importantly, using default emission benchmarks – whatever the real baseline emissions from a specific plant are – fully avoids perverse incentives for plant operators not to use advanced primary catalysts that reduce the formation of N_2O. Plant operators have incentives to innovate, as this lowers their project emissions and increases the number of CERs issued;
- Using default emission benchmarks further fully avoids the risk that plant operators could intentionally increase the rate of N_2O formation during a baseline campaign in order to maximize CER revenues;
- Using default emission benchmarks can lead to over-crediting in plants that actually have lower N_2O formation rates and to under-crediting in plants that actually have higher N_2O formation rates. Both under- and over-crediting is likely to occur since the N_2O formation rate observed in CDM projects varies by a factor of 10 from 3.5 to 37.0 kg N_2O/t nitric acid, with an average value of 8.6 kg N_2O/t nitric acid (UNFCCC 2012b). Significant over- and under-crediting can have several unintended consequences (Schneider et al. 2014). Plants with a high N_2O formation rate may not be able to reduce their project emissions significantly below the emissions benchmark and may thus not be implemented – although their implementation would be possible with a project-specific baseline. Such 'lost opportunities' could increase the global cost of GHG abatement.

The overall impact on environmental integrity depends on the methodology and plant type (Table 4-3). For newer plants, the emission benchmark declining from 3.7 to 2.5 kg N_2O / t nitric acid is rather conservative and will likely lead to under-crediting for most – if not all – plants. For plants that used AM0028 or AM0034 in the first crediting period, the declining project-specific benchmark in ACM0019 is a reasonable baseline on average over all projects in our assessment; projects with higher baseline emission rates than the IPCC range will receive less CERs, while some over-crediting could occur for projects that adopt more advanced catalysts at a faster rate than the decrease of 0.2 kg N_2O / t nitric acid per year foreseen in the methodology. The use of AM0028 and AM0034 could lead to over-crediting in some instances, due to the issues identified above. Considering all plant types and methodology versions together, it seems likely that the approaches for