SEI STOCKHOLM ENVIRONMENT INSTITUTE

Stockholm Environment Institute, Project Report 2017-02

Using the Clean Development Mechanism for nationally determined contributions and international aviation

Assessment of impacts on global GHG emissions

Lambert Schneider and Stephanie La Hoz Theuer

Using the Clean Development Mechanism for nationally determined contributions and international aviation

Assessment of impacts on global GHG emissions

Lambert Schneider[a] and Stephanie La Hoz Theuer[b]

Study prepared for the Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria and the Office of Environment of Liechtenstein

a Associate to Stockholm Environment Institute U.S.
b Independent researcher

Stockholm Environment Institute
Linnégatan 87D, Box 24218
104 51 Stockholm
Sweden
Tel: +46 8 30 80 44
Web: www.sei-international.org

Director of Communications: Robert Watt
Editor: Emily Yehle

Cover Photo: © Labradoodleb /Flickr

SEI STOCKHOLM ENVIRONMENT INSTITUTE

MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

AMT FÜR UMWELT
FÜRSTENTUM LIECHTENSTEIN

CONTENTS

ACRONYMS

BUR	Biennial Update Report
CDM	Clean development mechanism
CER	Certified emission reduction
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPA	Component project activity
DOE	Designated operational entity
ERU	Emission reduction unit
ETS	Emissions trading system
GHG	Greenhouse gas
ICAO	International Civil Aviation Organization
IET	International Emissions Trading
ITL	International Transaction Log
JI	Joint Implementation
JCM	Joint Crediting Mechanism
LDCs	Least developed countries
NDCs	Nationally determined contributions
PAF	Pilot Auction Facility for Methane and Climate Change Mitigation
PoA	Programme of activities
RBF	Results-based finance
SIDS	Small Island Developing States
tCO_2e	Tonnes of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change

ABSTRACT

Countries are currently considering using certified emission reductions (CERs) issued under the Clean Development Mechanism to achieve targets under the Paris Agreement and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) recently adopted by the International Civil Aviation Organization. Using CERs could lower compliance costs, support stranded projects and ensure sufficient supply for the implementation of CORSIA. This study, however, finds that purchase programmes or policies that recognize *all* types of CERs for use after 2020 are unlikely to trigger significant emission reductions beyond those that would have occurred in the absence of the programme or policy. To ensure that further emission reductions are triggered and respective economic incentives are provided to project developers and host countries, it is recommended that policy-makers (a) prioritize or limit eligibility to CERs from projects that are newly developed in response to the programme or policy and have a high likelihood of additionality, and/or projects that have already been implemented and are at risk of discontinuing greenhouse gas abatement; and (b) ensure robust accounting, in particular by addressing the risk of double claiming with 2020 targets and appropriately accounting for the vintage of CERs and the time frame of mitigation targets.

ACKNOWLEDGMENTS

We thank Sven Braden, Derik Broekhoff, Martin Cames, Thomas Day, Angela Friedrich, Aki Kachi, Michael Lazarus, Heike Summer, and Carsten Warnecke for review comments and inputs to this report, and Emily Yehle for careful editing. We thank NewClimate Institute for the cooperation on the model and the use of data on the implementation and operation status of CDM projects. This report has been commissioned by the Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria, and the Office of Environment of Liechtenstein.

SUMMARY

The Clean Development Mechanism (CDM) is the world's largest greenhouse gas (GHG) crediting mechanism, with 1.8 billion certified emission reductions (CERs) issued from about 8,000 registered CDM activities. The Paris Agreement established, through Article 6, provisions that enable countries to use international carbon market mechanisms to achieve mitigation targets pledged in their nationally determined contributions (NDCs). In the ongoing negotiations on Article 6, several Parties and stakeholders have proposed arrangements to transition the CDM to the Paris Agreement.

There are several ways the CDM could be incorporated under the Paris Agreement. First, CDM rules and governance arrangements could be adapted to the new mechanisms operating under Article 6. Second, CDM projects could be transitioned to mechanisms under Article 6, thereby allowing them to generate units for emission reductions achieved after 2020. And third, CERs issued for emission reductions up to 2020 could be used towards achieving international mitigation targets after 2020, including NDCs under the Paris Agreement and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) recently adopted by the International Civil Aviation Organization (ICAO).

This last option has been tied to several objectives. Using CERs towards post-2020 targets could, for example, lower the costs of meeting targets, prevent the loss of existing mitigation efforts, ensure continuity in the use of crediting schemes, and preserve investor trust and confidence (Greiner, Howard, Chagas, and Hunzai, 2017; Michaelowa et al., 2015). These are important objectives, but less attention has been devoted to what this option would mean for the environment.

This study focuses specifically on those environmental implications, systematically analyzing how the use of CERs for post-2020 mitigation targets would impact global GHG emissions. It provides recommendations to policy-makers on how to use CERs in a manner that ensures environmental integrity, drawing upon a bottom-up model to quantitatively assess the implications under different scenarios. In this study, environmental integrity is considered safeguarded if the use of CERs towards achieving targets under NDCs or CORSIA does not result in higher global GHG emissions than if the targets were achieved without CERs or other unit transfers.

Supply and demand for CERs

This analysis is informed by a detailed estimate of the CER supply potential from 2013 to 2020. It draws on a bottom-up model – co-developed with NewClimate Institute – that reflects recent research on the status and operation of CDM project activities, as well as CDM regulatory requirements that could limit the ability of projects to issue CERs (Schneider, Day, La Hoz Theuer, and Warnecke, 2017; Warnecke et al., 2017; Warnecke, Day, and Klein, 2015).

The supply potential from the 8,000 **registered projects and programmes of activities (PoAs)** is estimated to be about **4.7 billion CERs** from 2013 to 2020. The supply from non-registered projects in the pipeline – i.e. projects that initiated steps to seek CDM status, but have not (yet) been registered – is more uncertain, as it is not known how many projects have been implemented, are operating, and are able to comply with all CDM requirements. About 4,000 projects are under various steps of the validation process and about 8,000 non-registered projects have secured the possibility to register under the CDM through official notifications to the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). It is estimated that all **12,000 non-registered projects and PoAs in the pipeline** could generate an added **1.0 billion CERs** in emission reductions from 2013 to 2020.

Together, the **total CER supply potential** from registered and non-registered projects in the pipeline amounts to about **5.7 billion CERs**. This is not an estimate of the likely CER issuance under the current market conditions, but rather an estimate of the CER supply *potential*, assuming that project owners would have sufficient incentives to proceed to issuance.

The demand for CERs from 2013 to 2020 is estimated to be about 660 million. Consequently, about 5.0 billion CERs – from both registered and non-registered projects – could be left over for use after 2020. This is significantly larger than the potential demand from CORSIA, which is estimated to amount to about 2.7 billion in the period 2020 to 2035. The potential demand from countries that intend to use CERs towards achieving NDCs is not yet known.

What factors are critical for the GHG emissions impact?

Several factors influence how international market mechanisms impact global GHG emissions, including robust accounting, the quality of transferred units, the ambition and scope of any international mitigation targets of the transferring country, and possible incentives or disincentives for further mitigation action (Schneider, Füssler, et al., 2017). This study identifies four factors that are particularly critical in the specific context of using CERs after 2020:

1. For new projects, the **additionality** of the projects;

2. For already implemented projects, their **vulnerability to (or risk of) discontinuing GHG abatement**;

3. The risk of **double claiming** with 2020 targets (which include both pledges and Nationally Appropriate Mitigation Actions put forward in response to COP15 in Copenhagen and COP16 in Cancun); and

4. How the **vintage of CERs** is accounted for in relation to the time frame of mitigation targets.

These four factors are further discussed below. Other aspects – such as the risk of double issuance, double use, over-crediting, or disincentives for further mitigation action – would not have a significant impact when using CERs to achieve mitigation targets after 2020.

Additionality and vulnerability to discontinuing GHG abatement

Under crediting mechanisms, the quality of credits is in principle ensured if the mitigation action is: (a) additional – that is, it would not occur in the absence of the incentives from the crediting mechanism; and (b) the emission reductions are not overestimated. Additionality is assessed when a new project is developed and the decision is made on whether to proceed with the investment. The consideration of additionality is thus relevant when **new** projects are developed in response to a carbon market price and respective demand.

The direct emissions impact from using CERs beyond 2020 is more complex. The CDM market is currently characterized by a strong imbalance between supply and demand, resulting in low CER prices. In recent years, the supply of CERs has outstripped the demand, leading CER prices to plummet to less than 0.50 euros from well above 10 euros before 2011 (ICE, 2017). If in such a market situation projects have **already been implemented** – and hence investment costs are sunk – a key consideration for the global GHG emissions impact is whether the projects would continue to reduce GHG emissions even without CER revenues, or whether they are **vulnerable to (or at risk of)** discontinuing GHG abatement.

For some project types, such as hydropower or wind power projects, ongoing revenues from electricity sales typically exceed ongoing operational expenditures. Once implemented, these projects have strong economic incentives to continue GHG abatement, with or without CER revenues, because continued GHG abatement generates more income than discontinuing GHG abatement.

Other projects have ongoing operational costs but insufficient financial benefits beyond CER revenues. For example, the abatement of N_2O from nitric acid production requires the regular replacement of catalysts but does not save costs or generate income other than CER revenues. These projects have a high risk of discontinuing GHG abatement, because continuing GHG abatement is only economically attractive if they have ongoing financial support.

A project that is vulnerable to discontinuing GHG abatement is by definition additional. However, it is important to note that if a project is not vulnerable, it can still be additional. Rather, the lack of vulnerability recognizes that, from today's perspective of sunk investment costs, the project's ongoing revenues or cost savings – other than CER revenues – exceed its ongoing operational expenditures for the GHG abatement. Projects also might continue GHG abatement because policies promote or require continuation or because discontinuation is technically not viable.

This implies that in the current market situation, the impact of new demand for CERs on global GHG emissions differs between already implemented and new projects. For new projects, the additionality and the quantification of emission reductions determine the GHG emissions impact, whereas for already implemented projects the risk that projects discontinue GHG abatement and the quantification of emission reductions matter. A new programme or policy – such as CORSIA – that creates new demand for CERs would only trigger emissions reductions to the extent that:

1. The implementation of new GHG abatement projects that are additional is triggered through the programme or policy, and their emission reductions are not over-estimated; or

2. Already implemented projects that are at risk of discontinuing GHG abatement are spurred to continue GHG abatement, and their emission reductions are not over-estimated.

This situation would only change if the current imbalance between supply and demand ceases, i.e. if the overall demand from new programmes and policies exceeded the potential CER supply from already implemented and operating projects.

Drawing on previous research, the study finds that the risk of over-estimating emission reductions is limited (Cames et al., 2016). However, the likelihood that a project is additional or at risk of discontinuing GHG abatement depends on the project type and, to some extent, project-specific circumstances. Figure 1 shows the CER supply potential from registered projects, differentiated by the vulnerability of project types to discontinue GHG abatement, as assessed in recent research (Schneider, Day, et al., 2017; Warnecke et al., 2017; Warnecke, Day, and Klein, 2015).

About 3.8 billion CERs, or 82% of the total CER supply potential from registered projects, stem from project types that typically have a low vulnerability to

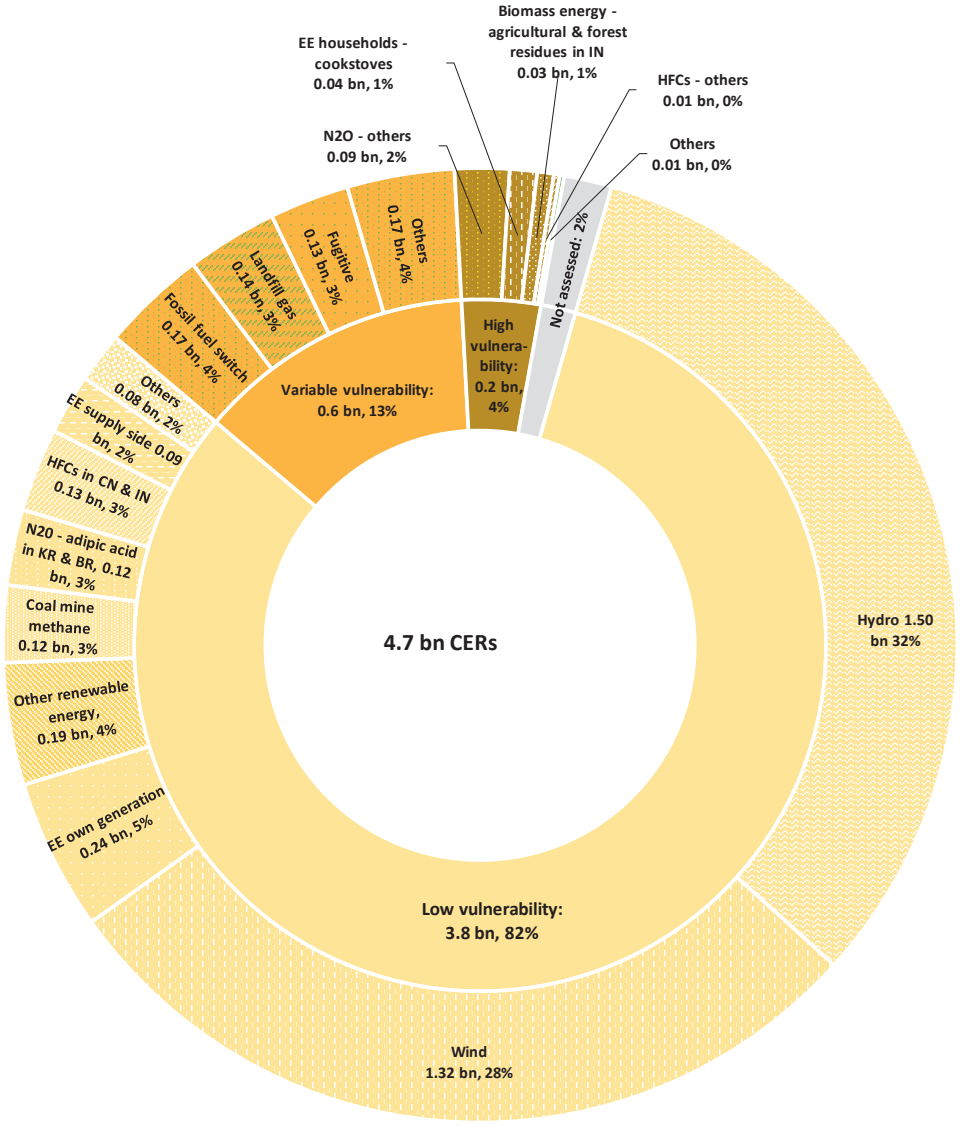

Figure 1: CER supply potential from registered projects for the period 2013 to 2020, differentiated by the vulnerability of project types to discontinue GHG abatement

Source: Adapted from Schneider, Day, et al. (2017)

discontinuing GHG abatement. While many of these projects currently do not issue CERs, most could resume CER issuance if they had enough incentives to do so. For another 13%, the vulnerability is typically variable, depending on the specific circumstances of the project.

Only about 170 million CERs, or 4% of the CER supply potential, are from project types that typically have a high vulnerability to discontinuing GHG abatement. The CER supply potential from vulnerable projects is relatively low because (a) many vulnerable projects have already discontinued GHG abatement or monitoring and can either not resume abatement or are temporarily not eligible for issuing CERs, (b) some methodologies for vulnerable project types use rather conservative approaches to quantify emission reductions, and (c) some countries have introduced domestic policies that ensure continued GHG abatement.

Double claiming

Double claiming is one form of double counting. It occurs if the same emission reductions are counted twice towards fulfilling mitigation targets: once by the country or entity where the reductions occur, through reporting of its emissions in its GHG inventory, and again by the country or entity using CERs. Double claiming could thereby lead to an increase in global GHG emissions.

The risk of double claiming is material for two reasons:

1. A large share of the CER supply potential is from countries with 2020 targets. About 77% of the CERs would originate from emission sources covered by a 2020 target, and only 18% would originate either from countries without a target or from sectors or GHGs not covered by a target (Figure 2).

2. Although the decision adopting the Paris Agreement and decisions under UNFCCC emphasize the need to avoid double counting in the context of international transfers in the period up to 2020, this principle has never been effectively integrated into an accounting framework. Developing countries submitting Biennial Update Reports (BURs) "shall" provide "information on international market mechanisms", but this is to be done for information which Parties "consider suitable and relevant for reporting". An evaluation of the most recent BURs of key CDM host countries found that none reported on or accounted for emission reductions from CERs claimed by other countries.

The risk of double claiming applies not only to using CERs after 2020, but also to using CERs under the Kyoto Protocol, and to using units from other GHG offsetting programmes. Double claiming with 2020 targets does not always increase global GHG emissions; the impact depends on whether host countries overachieve their 2020 targets. If a host country overachieves its 2020 target by an amount greater than the emission reductions issued and transferred under the CDM, then global GHG emissions would not increase, double claiming notwithstanding. This is because in this case the host country does not effectively make use of the reductions to achieve its 2020 target.

While the risk of double claiming is material, the political context of 2020 targets is an important consideration. Developing countries put forward mitigation targets for the first time – despite their lower capacity, capability, and historical responsibility for climate change. Some developing countries have argued that they submitted their targets assuming international support from developed countries – including through the use of mechanisms – and should therefore be able to use the emission reductions from CERs to achieve their targets. Moreover, countries approved CDM projects before communicating 2020 targets and were possibly unaware of any double claiming consequences. Lastly, 2020 targets do not have the same legal status as NDC targets or commitments under the Kyoto Protocol. For these reasons, countries could have different expectations with respect to avoiding double claiming in the context of 2020 targets.

However, one could also argue that the political context is different if CERs issued for emission reductions up to 2020 are used *after* 2020, towards NDCs or CORSIA. Both the Paris Agreement and the CORSIA resolution require the avoidance of double counting, and the decision adopting the Paris Agreement emphasizes the need to avoid double counting also with regard to pre-2020 mitigation action. If double claiming is addressed for units issued under the Paris Agreement – but not for CERs – that could potentially distort the carbon market. Avoiding double claiming with 2020 targets may thus be important for ensuring environmental integrity in the post-2020 period.

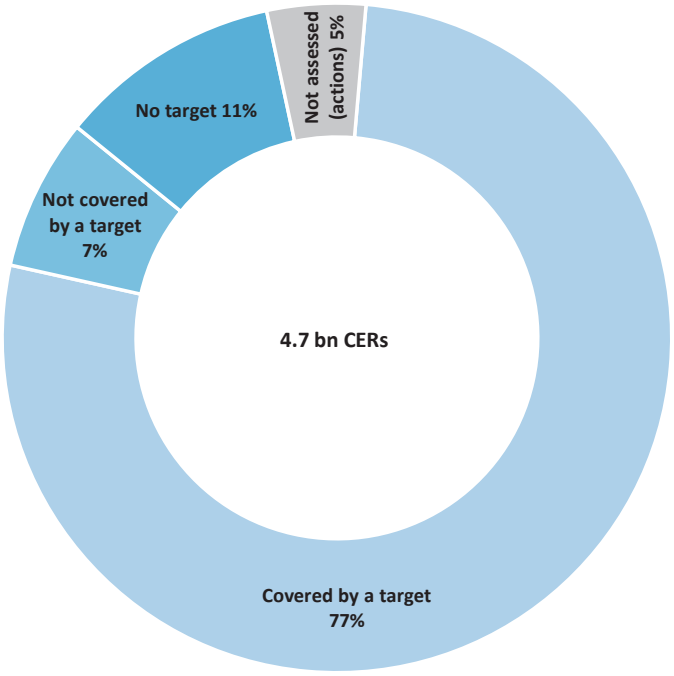

Figure 2: CER supply potential from registered projects in the period 2013 to 2020, differentiated by the coverage of 2020 targets

Accounting for the vintage of CERs and the time frame of mitigation targets

Appropriately accounting for the vintage of CERs and the time frame of mitigation targets is an important and complex issue for ensuring robust accounting. In theory, using CERs from emission reductions up to 2020 towards achieving post-2020 mitigation targets only affects the timing of emission reductions but not the cumulative GHG emissions levels: emissions are reduced by an entity or a country at an earlier point in time, which enables the same or another entity or country to emit more at a later stage. In practice, however, using CERs towards achieving future targets could also increase the cumulative emissions paths of the countries involved. The risk of this depends on the specific context.

Accounting rules for the Paris Agreement have not yet been determined, and it is unclear how the rules will account for the vintage of mitigation outcomes and the time frame of mitigation targets. Figure 3 illustrates the potential implications for two hypothetical countries that both have a single-year NDC target of stabilizing their emissions in 2030 at their 2010 level. In this example, Country A implements a CDM project with a technical lifetime of eight years – from 2013 to 2020 – and transfers the associated CERs to Country B, which uses them to achieve its target in 2030. The CDM project lowers the GHG emissions in Country A (dark green area), leading to lower actual emissions (black line) than would occur without the CDM project (red line). Country B uses the CERs from Country A to achieve its single-year emissions target in 2030 (light green area).

In Figure 3, Country B offsets the 2030 emissions above its target with the emission reductions from CERs created in Country A from 2013 to 2020. But the ability to use all CERs in a single year enables Country B to pursue a higher emissions path in the period up to 2030. This could thereby significantly increase the aggregated cumulative GHG emissions from both countries (by the grey area).

This environmental integrity risk decreases if CERs were instead used towards achieving multi-year emissions targets or trajectories (e.g. from 2021 to 2030). In this case, the emission reductions from CERs would be spread over more years, mitigating possible implications on pre-2020 emissions pathways.

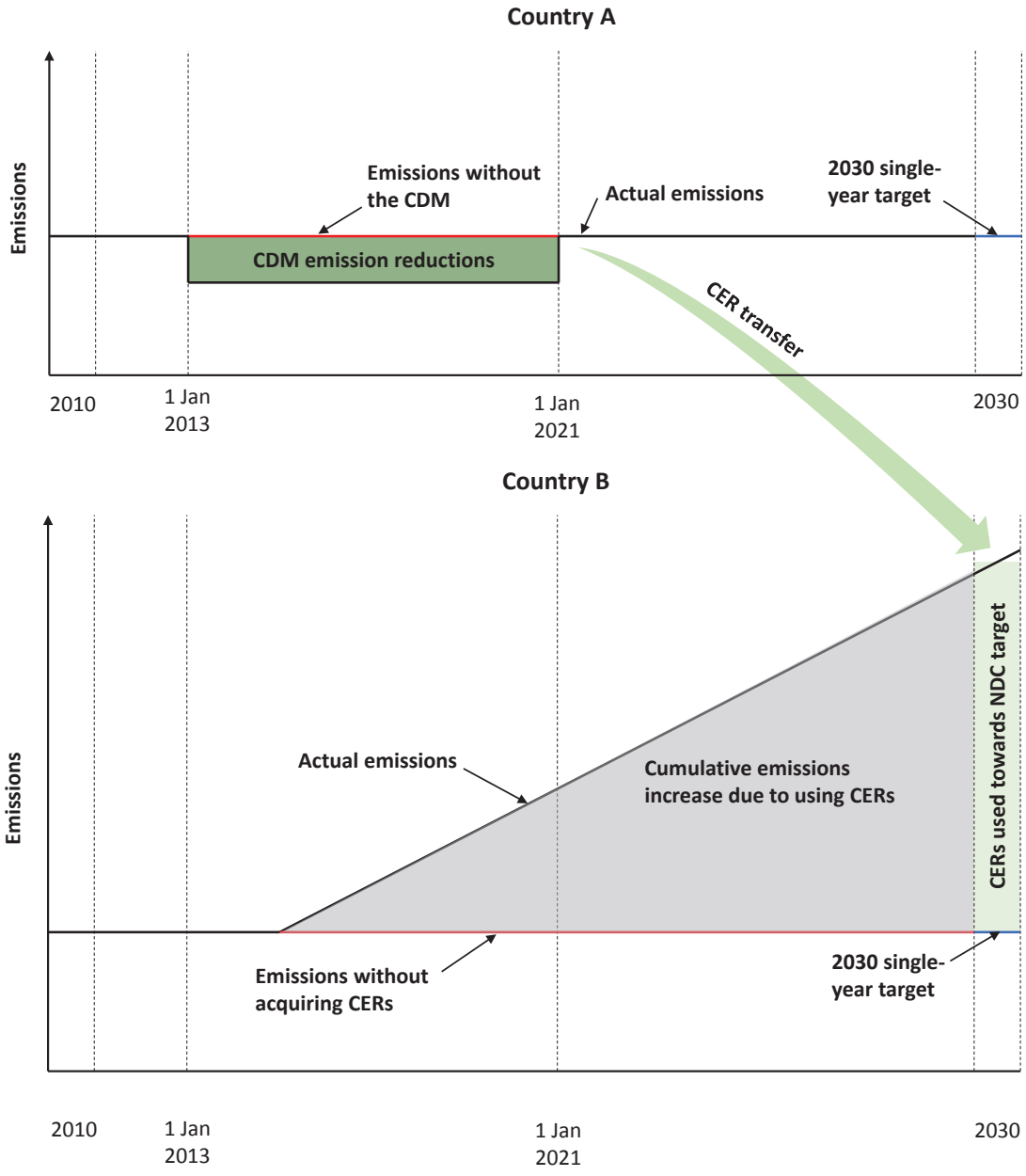

Figure 3: Implications of using CERs towards a single-year target in 2030

Implications of using all types of CERs

A key question for policy-makers is how to address the risks for environmental integrity discussed above. Here we first assess the implications of using all types of CERs and then discuss possible restrictions to address critical environmental integrity risks.

The study finds that purchase programmes or policies that recognize all types of CERs for use after 2020 are unlikely to trigger significant emission reductions beyond those that would have occurred in the absence of the programme or policy. This is largely owed to two reasons. First, under current CDM market conditions, new demand for CERs would mostly be served by projects that have already been implemented and would continue GHG abatement even without CER revenues. While purchasing CERs from projects that continue GHG abatement would financially support them (e.g. by helping investors recoup costs or increase profits), it would not impact their GHG abatement. Second, robust accounting for the transfer of CERs is not ensured under the current international framework. The use of CERs after 2020 could lead to double claiming or lead to higher emissions pathways in pre-target years, in particular if used towards single-year targets.

While this study focuses on the environmental implications, it is important to note that recognizing all types of CERs would not only fail to trigger significant further emission reductions but could also have adverse economic implications for project developers and host countries. CER prices would likely remain low, and thus might not generate sufficient incentives to develop new projects or continue GHG abatement in vulnerable projects. Moreover, a considerable part of the funding dedicated to purchasing CERs might be used to cover transaction costs, and only a small part might remain with the project owners. For these reasons, recognizing all types of CERs may not maintain investor trust and confidence or spur new investments.

Policy-makers may thus carefully consider whether and how they use CERs after 2020. To promote new or continued mitigation action, they could consider prioritizing or limiting the eligibility of CERs. Most programmes or policies deliberating the purchase or recognition of CERs use some type of eligibility criteria. For example, the assembly resolution adopting the CORSIA refers to an "eligible vintage and timeframe" of units and the World Bank's Pilot Auction Facility focuses on project types that are at risk of discontinuing GHG abatement.

Restrictions could be implemented to achieve one or more policy objectives, such as incentivizing the implementation of new and additional GHG abatement projects, supporting already implemented projects at risk of discontinuing GHG abatement, avoiding double claiming with 2020 targets, and promoting projects from specific host countries.

Restrictions to promote new and additional projects and to support vulnerable ones

Restrictions on project features could be used to prioritize or limit the eligibility of CERs to new projects that have a high likelihood of additionality and to already implemented projects that are at risk of discontinuing GHG abatement. This would require a method to (a) differentiate "new" from "already implemented" projects; (b) identify which new projects have a high likelihood of being additional; and (c) identify which already implemented projects are likely be to at risk of discontinuing GHG abatement.

Vintage restrictions based on documented project development milestones could be used to differentiate new from already implemented projects. Several milestones could be considered:

- The **registration date** – the date on which a project is formally accepted under the CDM – is inadequate to differentiate new from already implemented projects, due to the large number of non-registered projects in the pipeline. Many of these projects were likely implemented before 2013, but could still register under the CDM if they had the economic incentive to do so. These projects are estimated to be able to issue about 1 billion CERs in the period up to 2020.

- The **start date of the crediting period** – the date from which emission reductions can be issued as CERs – is also inadequate, because it is not necessarily related to when the emission reductions begin. Moreover, CDM rules allow projects to change the date after registration, and projects could thus change the date in order to become eligible under a CER purchase programme or policy.

- The **start date of the project** – the date on which the investment decision to proceed with implementation is made – is best suited to differentiate new from already implemented projects. It enables policy-makers to effectively ensure that only projects implemented *after* the adoption of a CER purchase programme or policy are eligible. Another advantage is that this date cannot be changed or influenced by project participants once the investment decision has been made. Under the current market conditions, however, few new projects are being developed. The CER supply potential from recent projects in the pipeline is therefore limited, and new projects would have to be developed in response to such a vintage restriction.

To identify new projects that have a **high likelihood of additionality**, policy-makers could establish a list of eligible project types. This poses several challenges, however, because additionality assessments are uncertain and depend on predictions of future developments, such as future energy prices. Project-specific circumstances also can play an important role. Existing analyses of the likelihood of additionality of different project types, and project categories considered automatically as additional under the CDM, could inform the prioritization of project types.

To identify projects that are **vulnerable to discontinuing GHG abatement**, policy-makers could also establish a list of eligible project types, based on the typical cost and revenue structure of the project type. Alternately, they could establish a methodo-

logical tool and a dedicated process to assess project vulnerability, under which individual projects would have to demonstrate that they would discontinue GHG abatement without continued CER revenues. Both options may require further research, building on previous assessments of project vulnerability. Project types that are typically highly vulnerable have a supply potential of about 170 million CERs, while project types with a typically variable vulnerability have a supply potential of another 600 million CERs.

Restrictions to address double claiming with 2020 targets

To mitigate the risks arising from double claiming with 2020 targets, two approaches could be pursued:

1. **Prioritizing or limiting eligibility to CERs issued for emission reductions that are not covered by 2020 targets.** This would apply to:

    - CERs from host countries without any 2020 target (corresponding to a supply potential from registered projects of about 500 million for the period 2013 to 2020); and

    - CERs from host countries with a 2020 target but for which the emission reductions are not covered by the target (corresponding to a supply potential from registered projects of about 340 million for the period 2013 to 2020).

2. **Prioritizing or limiting eligibility to CERs from host countries that commit to avoiding double counting.** Host countries could, for example, account for CERs by applying "corresponding adjustments" to their GHG emissions reported under the UNFCCC. Once an accounting framework has been agreed to under the Paris Agreement, host countries might also apply this framework mutatis mutandis to the context of 2020 targets.

Both approaches could in principle address the risk of double claiming and are not mutually exclusive. Approach 1 would be relatively simple to implement, but could penalize countries that put forward 2020 targets and provide an advantage to countries that were not ready to do so. Approach 2 would enable all countries to benefit from the opportunity of selling CERs for use after 2020, but could be politically challenging. Past efforts to gain agreement on common accounting principles under the UNFCCC have failed. Applying the accounting rules agreed under the Paris Agreement to the pre-2020 period would ensure that a consistent accounting framework is used for both emission reductions from CDM projects in the period up to 2020 and any international transfers after 2020. It would also help ensure that all carbon market units used under the Paris Agreement towards achieving NDC targets comply with the same requirements. A further, practical challenge of Approach 2 is applying corresponding adjustments in light of the diversity of 2020 targets, including their expression as single-year targets for 2020.

Restrictions to promote projects in specific host countries

Policy-makers could also limit the eligibility of CERs to specific host countries or regions, notably Least Developed Countries (LDCs) and Small Island Developing States (SIDS). Limiting CER eligibility to LDCs and SIDS could promote emission reductions in those countries and possibly improve regional distribution of CDM projects, potentially facilitating a more balanced regional distribution in the period after 2020 if the projects were transitioned and continued under Article 6. The CER supply potential of registered projects hosted in LDCs and SIDS lies at around 150 million CERs, corresponding to about 3% of the potential from all countries.

Combinations of restrictions

Policy-makers could also pursue combinations of the restrictions discussed above. Figure 4 shows the implications for the CER supply potential if different types of restrictions are combined. About 300 million CERs are from projects with a variable or high vulnerability and for which the emission reductions are not covered by 2020 targets. If eligibility would in addition be limited to LDCs or SIDS, only about 40 million CERs would be eligible, corresponding to about 1% of the overall CER supply potential.

Recommendations

Countries are currently considering using CERs to achieve targets under CORSIA and the Paris Agreement. Using CERs could lower compliance costs, support stranded projects and ensure sufficient supply for the implementation of CORSIA. This study, however, finds that CER purchase programmes or poli-

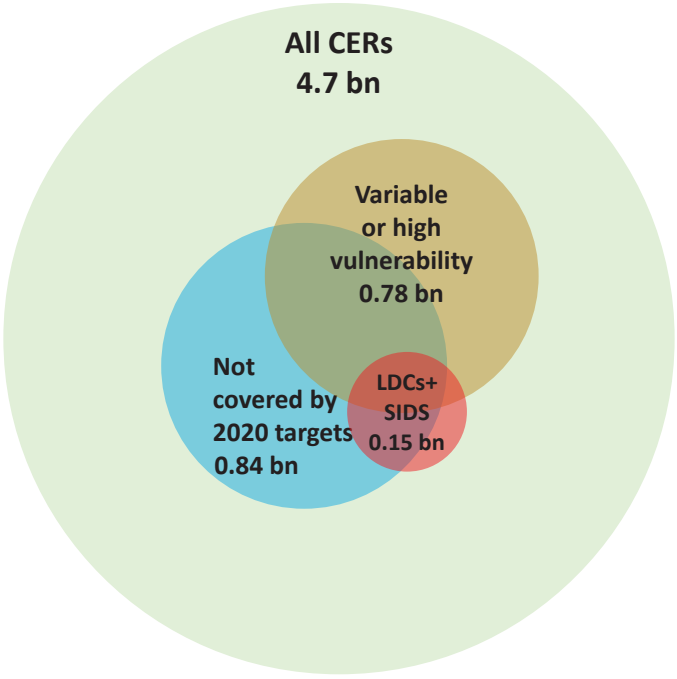

Figure 4: Implications of combinations of restrictions on the CER supply potential from registered projects in the period 2013 to 2020

cies that recognize *all* types of CERs for use after 2020 are unlikely to trigger significant emission reductions beyond those that would have occurred in the absence of the programme or policy. Recognizing all types of CERs could also lead to low CER prices and may not maintain or restore investor trust and spur new investments.

To ensure that further emission reductions are triggered and respective economic incentives are provided to project developers and host countries, it is recommended that policy-makers:

1. Prioritize or limit eligibility to CERs from:

   - Projects that are newly developed in response to the programme or policy and have a high likelihood of additionality, e.g. by restricting eligibility to projects with a start date on or after the adoption or implementation of the CER purchase programme or policy, and by prioritizing project types that are more likely to be additional; and
   - Already implemented projects that are at risk of discontinuing GHG abatement, e.g. by limiting CER eligibility of already implemented projects to a list of project types that are typically at risk of discontinuing GHG abatement.

2. Ensure robust accounting, in particular:

   - Address the risk of double claiming with 2020 targets, e.g. by requiring that CDM host countries apply corresponding adjustments for CERs used after 2020; and
   - Appropriately account for the vintage of CERs and the time frame of mitigation targets, e.g. by using CERs in the context of multi-year emissions targets or trajectories.

1 INTRODUCTION

The Clean Development Mechanism (CDM) has been an important international carbon market mechanism for many years. It is the world's largest greenhouse gas (GHG) crediting mechanism, with 1.8 billion certified emission reductions (CERs) issued from about 8,000 registered project activities and programmes of activities (PoAs). Yet demand for CERs has dwindled considerably in recent years – largely due to the global economic crisis, a stronger focus on domestic mitigation action, and the limited participation of Annex I countries under the Kyoto Protocol and the ambition level of their targets. Due to these developments, the supply of CERs has outstripped the demand, leading CER prices to plummet to less than 0.50 euros from well above 10 euros before 2011 (ICE, 2017).

The adoption of the Paris Agreement further changes the context under which the CDM operates. The Paris Agreement established, through Article 6, provisions that enable countries to use international carbon market mechanisms to achieve mitigation targets pledged in their nationally determined contributions (NDCs). Article 6.2 is commonly understood to allow Parties to transfer mitigation outcomes across borders – be it through international linking of emission trading schemes, international crediting mechanisms, or direct bilateral transfers – and to account those outcomes towards their NDCs. Article 6.4 of the Paris Agreement establishes a new crediting mechanism under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. The provisions of Article 6.4 strongly resemble those of the CDM, and many Parties propose that the new mechanism should replace or incorporate the CDM, although the purpose and scope of Article 6.4 may be broader. Moreover, the Kyoto Protocol will not have a third commitment period, and Parties could decide to end the Kyoto Protocol – including its institutional arrangements – once the books of its second commitment period have been closed. This would imply that CERs will not be issued for emission reductions occurring after 2020.

Parties are currently considering whether and how elements of the CDM should transition to the framework of the Paris Agreement, including (Greiner et al., 2017):

1. **Rules and governance arrangements** – such as baseline and monitoring methodologies, procedures for project registration and CERs issuance, and the CDM accreditation system – that could be (partially) adapted to the new mechanisms operating under Article 6.

2. **Projects** that could be transitioned to mechanisms under Article 6, thereby allowing them to generate units for emission reductions achieved after 2020. This could be subject to specific requirements.

3. **CERs** issued for emission reductions in the period up to 2020 that could be used towards achieving international mitigation targets after 2020. This could also be subject to specific requirements.

This study explores the last aspect: using CERs from emission reductions up to 2020 towards achieving international mitigation targets after 2020. Using CERs towards post-2020 targets could, for example, lower the costs of meeting targets, prevent the loss of existing mitigation efforts, ensure continuity in the use of crediting schemes, and preserve investor trust and confidence (Greiner et al., 2017; Michaelowa et al., 2015). These are important objectives, but less attention has been devoted to what this option would mean for the environment.

This study focuses specifically on those environmental implications. The study aims to comprehensively assess the global GHG emissions impact of using CERs to achieve international mitigation targets after 2020. It systematically analyzes what aspects and variables impact global GHG emissions, providing recommendations to policy-makers on how environmental integrity could be ensured. Towards this end, the study uses a bottom-up model that determines the potential CER supply and assesses the GHG emissions implications from using CERs under a range of scenarios, including the type of CERs used.

The use of CERs after 2020 has been proposed and is mainly being considered for two purposes, which are specifically explored in this study:

- Under the Paris Agreement, more than 190 countries have submitted NDCs which specify their proposed mitigation targets or actions after 2020. In negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), some Parties have proposed that CERs from emission reductions up to 2020 be recognized towards meeting NDC targets under the Paris Agreement; however, no agreement has been achieved on this matter so far.

- At its 39th assembly in October 2016, the International Civil Aviation Organization (ICAO) adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The scheme allows using emissions units generated from mechanisms established under the UNFCCC and the Paris Agreement, provided that "they align with future decisions, including on avoiding double counting". Whether and which CERs from emission reductions up to 2020 will be eligible under the scheme is currently being negotiated.

The study is structured as follows. It first provides a brief overview of key issues for transitioning the CDM to the Paris Agreement (section 2). It then assesses how many CERs could be issued for the period up to 2020 (section 3), and compares the potential CER supply with the demand that could arise before and after 2020 (section 4). Section 5 investigates and discusses which factors affect the global GHG emissions impact of using CERs to achieve post-2020 mitigation targets. Section 6 discusses the GHG emissions implications of using CERs, considering a range of scenarios for the types of CERs to be used and the conditions under which CERs may be used. This analysis informs conclusions and recommendations on whether and how policy-makers could ensure environmental integrity if pursing the recognition of CERs after 2020 (section 7).

This study employs specific terminology and makes several assumptions. It focuses on CERs issued for the Kyoto Protocol's second commitment period, i.e. CERs that generate emission reductions in the period 2013 to 2020. Although the CDM still allows issuing CERs for the first commitment period from 2008 to 2012, Annex I countries can no longer use such units and this study does not consider that they will be used after 2020. When referring to "CERs", the study therefore refers to CERs issued for the second commitment period. The term "environmental integrity" is used in the Paris Agreement and the UNFCCC, but it has not yet been defined. This study assumes that "environmental integrity" is safeguarded if the use of CERs towards achieving targets under NDCs or CORSIA does not result in higher global GHG emissions than if the targets were achieved without CERs or other unit transfers. When analyzing the GHG emissions impact, this study assumes that international mitigation targets – comprising commitments under the Kyoto Protocol, 2020 targets in the context of the Cancun Agreements, NDC targets, and targets under ICAO – will be achieved.

2 TRANSITIONING THE CDM TO THE PARIS AGREEMENT

The Paris Agreement does not contain provisions for the transition of the Kyoto Protocol mechanisms and their components into the post 2020 period, although this was part of the negotiations. In the ongoing negotiations on Article 6, several Parties have proposed arrangements to transition the CDM to the Paris Agreement. Calls for transitional provisions by some Parties[1] and stakeholders are rooted in the desire to:

- Maintain private sector trust and confidence by recognizing past investments and incentivizing continued engagement with international markets;
- Prevent the loss of ongoing mitigation activities;
- Enhance pre- and post-2020 ambition by spurring new investments in mitigation actions;
- Build on the experience gained and lessons learned from the CDM; and
- Ensure an orderly transition across regimes and quickly serve new demand, among others.

Transitional arrangements, including the use of CERs towards achieving mitigation targets after 2020, are also explored in the literature (Greiner et al., 2017; Michaelowa et al., 2015; Schneider and Ahonen, 2015).

In their discussions about transitioning towards Paris mechanisms, most Parties have focused on the CDM, while a small number of Parties has called for transitional provisions of Joint Implementation (JI) and International Emissions Trading (IET). The proposals on the CDM are also more concrete than on JI and IET. The overview here is limited to the CDM.

The proposals by Parties for transitioning the CDM relate to three areas: using CDM rules and governance arrangements under the Article 6.4 mechanism, continuing CDM projects under Articles 6.2 or 6.4, and using emission reductions achieved through CDM projects in the period up to 2020 towards achieving NDCs after 2020. While this study focuses on the latter question, the following sections provide a brief overview of key issues for all three aspects.

1 See Party submissions under UNFCCC (2017d)

2.1 Rules and governance arrangements

The Article 6.4 mechanism has several similarities with the CDM. Both mechanisms are crediting schemes, are under centralized governance, and require emission reductions to be additional. Some countries see the CDM as the basis for the Article 6.4 mechanism, or even propose to incorporate the CDM modalities and procedures into the rules, modalities and procedures for the Article 6.4 mechanism. Yet key differences in both design and context also exist. Importantly, the Article 6.4 mechanisms is applicable to all Parties and crediting takes place in the context of the NDC targets of host countries, while CDM activities can only be hosted in countries with no targets under the Kyoto Protocol.[2] Moreover, the CDM is applicable to individual projects and to programmes, which could be narrower than the scope of the Article 6.4 mechanism. Some Parties, for example, have called for the Article 6.4 mechanism to enable the crediting of sectors and policies; others have proposed allowing other international mechanisms to generate emission reductions under the Article 6.4 mechanism. Another important difference is that the Article 6.4 mechanism aims to deliver an "overall mitigation in global emissions", which is not contemplated by the CDM.

Understanding the commonalities and differences between the CDM and the Article 6.4 mechanism is important for assessing which CDM rules and governance arrangements might be applicable – and which would have to be adapted – to the Article 6.4 mechanism. Key areas include, among others:

- **Institutional arrangements**: Some Parties propose that institutional arrangements under the CDM – such as the Executive Board and its panels, designated national authorities (DNAs), and the CDM accreditation system – be the basis for the governance arrangements of the Article 6.4 mechanism. Other Parties propose to depart from the CDM, including establishing different rules for the composition and responsibilities of the body supervising the mechanism. This also reflects the possibly broader scope of the mechanism.

2 For a detailed analysis of the commonalities and differences across Kyoto and Paris mechanisms refer to Schneider, Broekhoff, Cames, Healy, et al. (2016)

- **Standards for quantifying emission reductions**: A key feature of the CDM is that it enables crediting only in countries that do not have mitigation targets under the Kyoto Protocol. Standards for the establishment of crediting baselines and for the demonstration of additionality may have to be adapted to the new context of the Paris Agreement, in which host countries have mitigation targets. This could include considering how domestic mitigation policies and progressively more ambitious NDC targets impact additionality, baselines, and the length of crediting periods. New standards may also have to be developed for the quantification of emission reductions from actions at the level of sectors or policies. Different methodological and accounting approaches could also be needed for emission reductions within and outside the scope of NDC targets.

- **Sustainable development provisions**: One of the purposes of the CDM and the Article 6.4 mechanism is to assist or support Parties in achieving sustainable development. Under the CDM, host countries are responsible for determining whether a project or programme contributes to achieving sustainable development. The CDM Executive Board adopted a tool that project developers can use to voluntarily report on sustainable development benefits. Some Parties would like to pursue a similar approach under the Article 6.4 mechanism, while others propose enhanced provisions that build, for example, on the 2030 Agenda for Sustainable Development.

- **CDM registry and ITL:** Some of the Kyoto Protocol unit-tracking infrastructure, such as the CDM registry and the International Transaction Log (ITL), could serve as a basis for relevant infrastructure under the Paris Agreement. Definitions on metrics and accounting rules under the Paris Agreement could have implications on what is tracked, and how.

2.2 Projects

Transitioning CDM projects into the Paris Agreement involves their migration to the Article 6.4 mechanism, or to other crediting schemes under Article 6.2 – thereby allowing the activities to continue issuing credits under the Paris Agreement after 2020 (Greiner et al., 2017). Arrangements for the transition of projects could depend on the extent to which rules and governance provisions under the Article 6.4 mechanism differ from the CDM. Some countries suggest that CDM activities be subject to filters and to re-assessments, with some Parties proposing to focus on projects that are at risk of discontinuing abatement in the absence of carbon market revenues. Other Parties indicate that all CDM activities could be grandfathered into the Paris context.

If CDM projects are transitioned to the Paris Agreement, the Agreement's provisions for avoiding double counting apply. If emission reductions from transitioned CDM projects were used by other countries to achieve their NDC targets, this could affect the ability of host countries to meet their own NDC targets. Parties could therefore consider that host countries must approve the transition of projects to the Paris Agreement.

2.3 Emission reductions

Some Parties have proposed that emission reductions achieved through CDM projects in the period up to 2020 be eligible towards achieving NDC targets after 2020. Using CERs for post-2020 targets could be subject to restrictions that consider, among other things, the type of projects or the vintage of reductions.

Emission reductions achieved through CDM projects in the period up to 2020 could be used in two different ways towards achieving NDC targets in the post-2020 period: (a) CERs issued for emission reductions up to 2020 could be directly used towards achieving NDC targets after 2020, or (b) CDM projects could first be transitioned to Article 6 of the Paris Agreement and then be eligible to issue credits for emission reductions in the period up to 2020 (Greiner et al., 2017). This report focuses on approach (a); however, the findings largely also hold if approach (b) were pursued.

3 WHAT IS THE POTENTIAL CER SUPPLY?

This section estimates the CER supply potential for the period 2013 to 2020, using a bottom-up model developed in cooperation with NewClimate Institute (Schneider, Day, et al., 2017) and further amended as part of this research project.

CERs could be generated from projects that are at different stages of development, including:

- **Registered projects**;
- **Non-registered projects in the pipeline**, i.e. projects that initiated steps to seek CDM status, but have not (yet) been registered;
- **New projects**, i.e. projects that have not yet taken any steps to seek CDM status and that could be developed in response to new demand.

This study focuses on the CER supply potential from registered projects. The CER supply potential from non-registered projects in the pipeline is also estimated, but the estimates are more uncertain, as less information is available on the implementation status of these projects and as it is unclear how many of these projects would be able to meet all CDM requirements. The CER supply potential from new projects is even more uncertain and not estimated here. Among the mitigation activities currently being implemented in non-Annex I countries, many may potentially qualify as CDM projects. However, the CDM limits the possibility to retroactively register a CDM project. New projects must notify the UNFCCC secretariat and the DNA of the host country of their intent to seek CDM status within 180 days of when the project owners commit expenditures for the main equipment or facility. The registration of new projects is thus limited to projects where the investment decision has not yet been made or where it has been made recently and the UNFCCC secretariat and the DNA have been notified.

The CER supply potential has been estimated by several other studies (Bailis, Broekhoff, and Lee, 2016; Cames, 2015; IGES, 2017; Schneider, Day, et al., 2017; UNFCCC, 2017b; Warnecke, Day, and Tewari, 2015; World Bank, Ecofys, and Vivid Economics, 2016). This analysis draws upon and further amends the bottom-up model co-developed with NewClimate Institute (Schneider, Day, et al., 2017). The model differs from previous studies in three ways. First, it combines official information on CDM projects provided by UNFCCC (2017b), with the latest available research on the implementation and operation status of projects from specific sectors. This includes a survey by NewClimate Institute to determine whether projects have been implemented, continue GHG abatement, and continuously monitor emission reductions (Warnecke, Day, and Klein, 2015), as well as detailed estimates of the CER supply potential for industrial gas projects (Schneider and Cames, 2014). Second, this study considers in detail the regulatory requirements of the CDM that could facilitate or limit the ability of project owners to issue CERs. And third, the analysis employs the bottom-up model to assess, for each project, key features that affect environmental integrity – such as whether double counting of emission reductions could occur or whether the project is at risk of discontinuing GHG abatement in the absence of CER revenues.

The analysis does not aim to estimate the likely *actual* CER issuance under the current conditions, which depends on CER demand and prices; rather, it aims to estimate the CER supply *potential*, assuming that project owners would have sufficient incentives to proceed to issuance. The sections below describe the methodology used to estimate the CER supply (section 3.1) and present the results (section 3.2).

3.1 Methodology to estimate the CER supply potential

3.1.1 Registered projects

To estimate the CER supply potential for registered projects and PoAs, this study draws upon the bottom-up model co-developed with NewClimate Institute. This section provides a summary of the methodology employed; a detailed description of the methodology can be found in (2017).

The model assesses for each project *how many* CERs can be issued *for which time period*. The analysis employs the most recent, available information to evaluate for each individual project the technical status and the impact of relevant CDM requirements, including major revisions of key regulatory documents adopted by the CDM Executive Board in February 2017. Four key aspects affect the amount of CERs and the period for which they can be issued from registered projects:

1. The **technical implementation and operation status** of projects, including the likelihood that the project was implemented and continues GHG abatement;

2. The **crediting periods and emission reduction calculations**, including whether steps to renew crediting periods were taken on time, and whether the use of more recent versions of the applicable methodologies significantly impacts the potential CER volume in the future;

3. The **availability of data to monitor emission reductions**, including whether the project is likely to continue CDM monitoring, and whether data is likely to be available even if full CDM monitoring systems are no longer in place; and

4. The **project performance**, including whether the project belongs to a project type that typically underperforms or overperforms as compared to ex-ante emission reduction estimates prepared in project design documents.

The model draws upon four main data sources:

- The UNFCCC database of CDM projects (UNFCCC, 2017c), which includes relevant data from individual projects;

- A comprehensive survey conducted by NewClimate Institute on the status of CDM projects (Warnecke, Day, and Klein, 2015);

- An assessment of the risk of different project types to discontinue GHG abatement (Warnecke et al., 2017); and

- Detailed project-specific estimates of the emission reduction volume of industrial gas projects developed by Schneider and Cames (2014).

3.1.2 Non-registered projects in the pipeline

The CER supply potential from non-registered projects in the pipeline is more uncertain than for registered projects. This has two reasons. First, less is known about the implementation and operation status of these projects; survey data or information on the actual issuance of CERs is only available for registered projects. Second, it is unclear how many of the non-registered projects would be able to comply with all CDM requirements, and thus be able to successfully register a project and issue CERs. This second aspect is particularly uncertain.

Table 1 provides an overview of the number of non-registered projects in various stages of development. Five main stages of project development are identified:

1. **Notification of prior consideration**: About 8,000 projects have notified the UNFCCC secretariat of their intent to seek CDM status but have not started validation by a designated operational entity (DOE).[3] This "notification of prior consideration" is an important prerequisite for registering a project for which the decision to proceed with its implementation was taken before the start of validation. It aims to ensure that project owners have considered the CDM when making the decision to proceed with the implementation. Notifications must be submitted within 180 days of the date when the decision to proceed with the implementation was made. If the notification is received in time, it secures the possibility to register as a CDM project. Otherwise, an activity is not eligible under the CDM.[4] As of 12 April 2017, 12,541 notifications of prior consideration had been received by the UNFCCC secretariat. Of these, only about 4,500 have initiated validation (additional projects have initiated validation, but did not need to file a notification). Hence, there are about 8,000 projects that submitted a notification of prior consideration – and thereby secured their ability to register with the CDM in the future – but never initiated validation. These projects could proceed to validation and be registered at any time, provided that all CDM requirements are met and that they have economic incentives to do so. For these projects, only the project title, the date of notifying the UNFCCC secretariat and the host country are known.

2. **Projects undergoing validation**: 606 projects are reported to be under validation. CDM rules do not establish a deadline for validation to be concluded; projects can finalize validation, including through a different DOE, and achieve registration at any time, provided that all CDM requirements are met.

3. **Validation terminated:** 2,888 projects are reported to have terminated their validation contracts. The termination of validation could

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

4 Projects with a project start date before 2 August 2008 do not have to submit such a notification, but have to demonstrate that the CDM was seriously considered in the decision to implement the project, providing relevant evidence that "continuing and real actions were taken to secure the CDM status". It is unlikely that many not-yet-registered projects would be able to provide this evidence to date. We conservatively assume here that no projects with a start date before 2 August 2008 will be registered under the CDM in the future.

Table 1: Overview of non-registered projects in the pipeline

Project status	Description	Number of projects
Notification of prior consideration	These projects have not yet started validation but have informed the UNFCCC secretariat of their intent to seek CDM status.	≈ 8,000
Undergoing validation	These projects have started but not yet finalized validation.	606
Validation terminated	These projects have started and terminated validation. The termination of validation could come after a positive or a negative validation opinion, or occur without finalization of validation.	2,888
Undergoing registration	These projects have finalized validation and already submitted information to request registration. Some of these projects may be under review by the CDM Executive Board.	185
Rejected or withdrawn	These projects have requested registration but have been either rejected by the CDM Executive Board or voluntarily withdrawn by the project participants.	345
Total		**≈ 12,024**

Source: Information from UNFCCC, IGES as of 12 April 2017. Note: Some projects have also re-started a second or third validation; these projects are counted only once here. "Undergoing registration" includes projects which have the UNFCCC status "pending publication", "requesting registration", "review requested", or "under review".

come after a positive or a negative validation opinion, or the contract could be terminated without finalizing the validation process. CDM rules allow these projects to re-start validation, including through a different DOE, and be registered at any time, provided that all CDM requirements are met.

4. **Undergoing registration:** 185 projects successfully concluded validation and are in the process of being registered under the CDM. For a large share of these projects, the registration fee is pending for several years, presumably due to a lack of financial interest from project owners to register their project under the CDM. These projects could continue the registration process once the fee is received.

5. **Rejected or withdrawn:** 345 projects requested their registration but were subsequently either rejected by the CDM Executive Board or voluntarily withdrawn by the project participants. These projects could in principle submit a new request for registration at any time, provided that all CDM requirements are met.

To estimate the CER supply potential, this study employs the database published by the UNFCCC secretariat (UNFCCC, 2017c) on the amount of emission reductions estimated in project design documents, adjusted for the issuance success rate, as described for registered projects above. For the 8,000 non-registered projects that only submitted a notification of prior consideration, information on the project size is not known. It is assumed that they have the same average emission reduction volume as the 8,000 registered projects, which is about 130,000 tCO_2e per year. This study furthermore considers that the situation of non-registered projects in the pipeline differs from registered projects in several aspects:

- **Conformity with CDM validation requirements:** Projects in all five stages in Table 1 could in principle still seek CDM status provided that all CDM requirements are met. However, it is uncertain how many of these projects would actually be able to meet all CDM requirements. The ability of projects to meet CDM requirements is likely to differ between the five stages of project development:

  - Projects that have submitted only a notification of prior consideration have not yet undergone validation. Some of them may not be able to meet all CDM requirements. Among all projects that have ever entered into validation, 70% were successfully registered, 66% of which within three years. If projects were not registered in the past, this could be due to CDM requirements but also for other reasons, such as loss of interest due to the CDM market situation, non-availability of a letter of approval from the host country, or non-

implementation of the proposed project. This study assumes that half of the projects with a notification of prior consideration could meet all CDM requirements.

- The ability to meet CDM requirements for projects undergoing validation and projects with the validation terminated is uncertain. A validation contract may be pending or may have been terminated for different reasons, such as loss of interest due to the CDM market situation, non-conformities with CDM requirements which cannot be addressed by the project owners, non-availability of a letter of approval from the host country, or non-implementation of the proposed project. Projects often linger in the pipeline, and information on the reasons for termination or pendency of validations is limited. An observation of trends over time indicates that some projects may not have proceeded to registration due to the current market situation: about a third of projects entering validation in the period up to 2010 – when CER prices were still at significantly higher levels – have failed to reach registration to date, whereas this rate increases to about half of projects in the period 2013 to 2015 when CER prices had collapsed. This change in trend could indicate that some projects were not further developed due to the market situation. In that case, they might still be able to comply with all CDM requirements and register the project if there are economic incentives to do so. Based on these indications, it is assumed that 25% of the projects under validation or with a validation contract terminated would be able to meet all CDM requirements.

- Projects that are undergoing registration have a high chance of meeting CDM requirements; more than 95% of the projects that have requested registration in the past have been registered, leaving less than 5% that were rejected or withdrawn. This study therefore assumes that 95% of these projects are able to meet all CDM requirements.

- Projects that have been rejected or withdrawn are unlikely to be able to meet all CDM requirements. It is assumed here conservatively that none of these projects would be able to meet all CDM requirements and be registered.

- **Implementation and operation status:** The implementation and operation status of non-registered projects in the pipeline is uncertain. However, according to the available information, it is likely that many of the non-registered projects in the pipeline have already been implemented, although some may not have continued GHG abatement. In the absence of further information, this study assumes that the status of implementation and operation of non-registered projects in the pipeline – including the possibility to initiate or resume abatement if new incentives emerge – is the same as observed through relevant surveys for registered projects. This assumption could be optimistic, but its impact on the results may be tempered by other conservative assumptions.

- **Period for which CERs can be issued:** Non-registered projects in the pipeline can only issue CERs for emission reductions occurring after their registration; CDM rules require that the start date of the first crediting period be on or after the date of registration. This limits their ability to issue CERs in the period up to 2020. Given that a price signal to proceed to registration does not yet exist and that resuming or finalizing validation may require time, this study assumes that projects could be registered and generate CERs as of 1 January 2019.

- **Availability of monitoring data and requirements for renewal of crediting periods:** In contrast to registered projects that may wish to retroactively issue CERs for emission reductions in the past, the availability of monitoring data and requirements for renewal of the crediting period are less relevant for non-registered projects in the pipeline. This is because monitoring only starts in the future, once the project has been registered, which allows the project participants sufficient advance time to prepare for the collection of relevant data. Similarly, the crediting period only starts on or after registration and a renewal of the crediting is not due in the period up to 2020.

In conclusion, the available information suggests that many non-registered projects in the pipeline are likely to have been implemented. However, it seems also likely that some projects may face difficulties in meeting all CDM requirements. Moreover, CERs can only be generated for emission reductions that occur after successful registration of the project. Overall, these factors limit the amount of CERs that may be supplied from non-registered projects in the pipeline.

3.2 CER supply potential

3.2.1 Registered projects

The CER supply potential from registered projects for the period 2013 to 2020 is estimated to be about 4.7 billion CERs, as shown in Table 2 (Schneider, Day, et al., 2017). This amount significantly exceeds current levels of CER issuance: a total of 1.8 billion CERs have been issued to date, of which 337 million were for the Kyoto Protocol's second commitment period. The stark difference between the CER supply potential and the volume of issued CERs is largely due to low CER prices since late 2012.

Figure 5 shows the CER supply potential differentiated by project type, using the UNEP DTU project classification (UNEP DTU, 2017). The vast majority of CER supply originates from renewable energy projects. About 60% of the CER supply potential is from hydropower and wind power projects. Industrial gas projects contribute only with 8% to the overall supply for the period 2013 to 2020, whereas they dominated the project portfolio in the first commitment period.

Around 82% of total potential CER supply originates from the Asia and Pacific region, dominated by China, which is responsible for 60% of the total. Around 140 million CERs (3% of the potential volume) stem from least developed countries (LDCs). Only around 160 million are estimated to originate from PoAs; however, this estimate considers only component project activities (CPAs) registered as of April 2017, so the actual volume could be higher.

3.2.2 Non-registered projects in the CDM pipeline

The CER supply potential of non-registered projects in the pipeline is estimated to amount to about 1 billion CERs. It is thus significantly smaller than the potential from registered projects, mainly because of the short period up to 2020 in which these projects could still generate CERs. The distribution of CERs by project type and region is similar to that of registered CDM projects. As highlighted earlier, this potential is more uncertain than the potential for registered projects.

Table 2: CER supply potential from registered projects for the period 2013 to 2020

CER supply potential	Million CERs	%
Total CER supply potential	4,650	100%
of which already issued CERs	340	7%
Project types		
Renewable energy	3,160	68%
Industrial gases	370	8%
Energy efficiency	450	10%
Fossil fuels	410	9%
Others	260	6%
Regions		
Asia and Pacific	3,830	82%
Latin America and the Caribbean	540	12%
Africa	240	5%
Economies in transition	40	1%
LDCs (across all regions)	140	3%
Programmes of activities (PoAs)*	160	3%
Projects registered after 31 December 2012	280	6%

Source: Adapted from Schneider, Day, et al. (2017)
Note: Numbers may not add up due to rounding.
* Includes only component project activities included as of 12 April 2017.

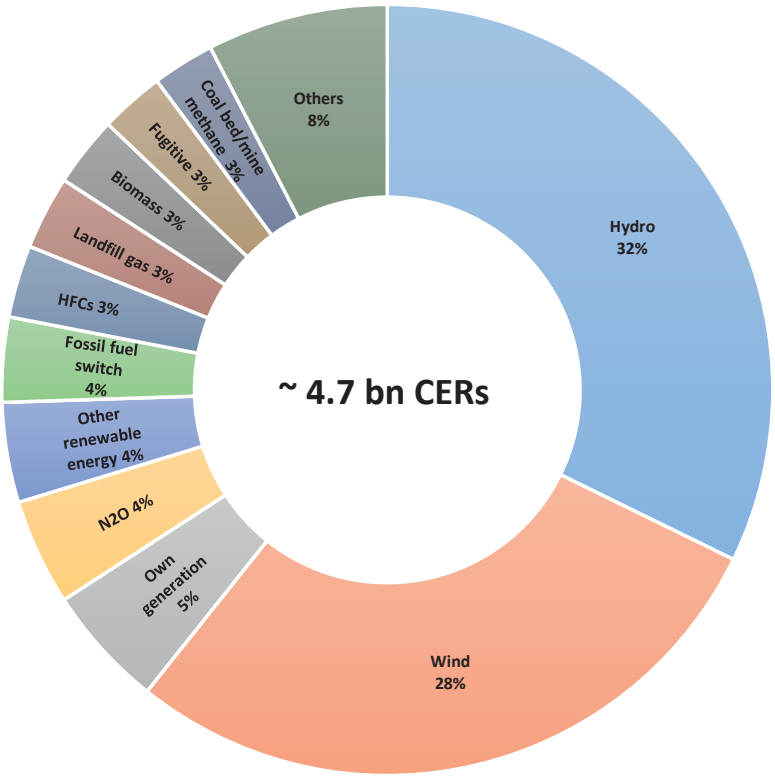

Figure 5: CER supply potential from registered projects for the period 2013 to 2020, differentiated by project type

Source: Adapted from Schneider, Day, et al. (2017)

4 WHAT IS THE POTENTIAL DEMAND FOR CERS?

This section explores the potential demand for CERs after 2020. It first provides an overview of the potential sources of demand for CERs including for the period up to 2020 and after 2020 (section 4.1). It then estimates the demand for CERs until 2020, in order to assess how much of the CER supply potential could be available for use after 2020 (section 4.2). Finally, this section explores the potential post-2020 demand for CERs from the two main potential sources: CORSIA (section 4.3) and NDCs (section 4.4).

4.1 Overview of potential sources of demand for CERs up to and after 2020

Demand for CERs, both in the period up to 2020 and after 2020, could arise from several different sources:

1. **Kyoto Protocol:** Most countries with a commitment inscribed in Annex B use CERs towards achievement of targets under the second commitment period of the Kyoto Protocol. Demand arises from the recognition of CERs in emissions trading systems (ETSs), in particular the EU ETS, and from government purchase programmes.

2. **2020 targets communicated in the context of the Cancun Agreements:** In response to COP15 in Copenhagen and COP16 in Cancun, developed and developing countries put forward voluntary pledges and Nationally Appropriate Mitigation Actions (hereinafter referred to collectively as "2020 targets"). These targets were "taken note of" by COP16 in the context of the Cancun Agreements (decision 1/CP.16).[5] Some countries might use the CDM to achieve these targets, either by purchasing CERs from projects hosted in other countries or by recognizing CERs from domestic projects as a means of compliance in domestic mitigation policies.

3. **Results-based climate finance:** Development cooperation agencies sometimes purchase CERs to effectively disburse results-based climate finance.

4. **Voluntary market:** Several initiatives aim to increase demand for voluntary offsetting of GHG emissions, including the United Nations online platform for voluntary cancellation of CERs.[6]

5. **CORSIA:** The CORSIA aims to offset a portion of the emissions from the international aviation sector with offsets. Units generated by mechanisms established under the UNFCCC and the Paris Agreement can be eligible for use in CORSIA, under conditions that still have to be determined.

6. **NDCs:** Around 86 countries state in their NDCs the intention of using markets towards the achievement of their contributions; of these, 13 intend to acquire international units (Obergassel and Gornik, 2015).

4.2 CER demand up to 2020

The overall demand for CERs from the second commitment period is estimated to amount to about 660 million units until 2020. This amount is much smaller than the total CER supply potential of 5.7 billion CERs from registered and non-registered projects in the pipeline (4.7 and 1 billion CERs, respectively). Consequently, about 5 billion CERs could potentially be used after 2020. Table 3 provides an overview of the different sources of potential demand, as further discussed in the sections that follow.

4.2.1 Kyoto Protocol compliance

In 2012, Parties adopted the Doha Amendment to the Kyoto Protocol. It determined that the second commitment period of the Kyoto Protocol covers the period 2013 to 2020. Although the Doha Amendment has not yet entered into force, countries with commitments inscribed in Annex B (Annex B countries) are planning to comply with their targets, including through the use of CERs. Annex B countries use the CDM in two ways to achieve their commitments: by recognizing CERs as a compliance tool in ETSs and through government purchase programmes.

The EU ETS is an important source of demand, with about 88 million CERs from the second commitment period expected to be used in the period 2013 to 2020. The ETS allows all entities to use about 1.532 billion CERs or emission reduction units issued under JI

5 For developed country Parties, see decision 1/CP.16, paragraph 36, as well as documents FCCC/SB/2011/INF.1 and FCCC/SBSTA/2014/INF.6.
For developing country Parties, see decision 1/CP.16, paragraph 49, as well as documents FCCC/AWGLCA/2011/INF.1 and FCCC/SBI/2013/INF.12/Rev.2.

6 https://offset.climateneutralnow.org

Table 3: Estimated demand for CERs in the period 2013 to 2020

Demand source	Total expected demand 2013-2020 (million CERs)
Kyoto Protocol compliance - from ETSs - from government purchase programmes	≈ 430 ≈ 90 ≈ 340
2020 targets	≈ 150
Results-based financing	≈ 60
Voluntary cancellation	≈ 20
Total	**≈ 660**

(ERUs) from 2008 to 2020; 94% of this overall budget – 1.445 billion units – has already been used with units from the first commitment period, leaving a balance of 88 million for units that can be used from the second commitment period (European Commission, 2015; European Environment Agency, 2016). Units from the first commitment period can no longer be used, and it is questionable whether ERUs will be issued for the second commitment period; it is therefore assumed that this remaining budget will be used only with CERs from the second commitment period.

The Swiss ETS also allows for the use of international units. For the period 2013 to 2020, it allows industries that took part in the pilot phase to use CERs and ERUs to offset 11% of five times the average emissions allowances allocated in 2008-2012 (ICAP, 2017d). Taking into account the rules for new entrants, the potential demand from the Swiss ETS is estimated at about 3 to 4 million CERs and ERUs in the 2013-2020 period. It is assumed that CERs will make up 50% of this amount.

Furthermore, several countries established government programmes to purchase CERs from the second commitment period. For example, the Norwegian Carbon Credit Procurement Program aims to purchase 60 million CERs for use by the government of Norway in the period 2013-2020 (Norway, 2017), and the Swedish Energy Agency is expected to purchase up to 40 million CERs during the same period (Swedish Energy Agency, 2015). According to the UNFCCC secretariat (UNFCCC, 2017a), Bloomberg New Energy Finance estimates that government demand for CERs from the second commitment period from EU member states and Norway will total around 340 million CERs in the period from 2013 to 2020.

4.2.2 2020 targets in the context of the Cancun Agreements

In response to COP15 in Copenhagen and COP16 in Cancun, developed and developing countries put forward voluntary pledges and nationally appropriate mitigation actions for the year 2020. These targets were "taken note of" by COP16 in the context of the Cancun Agreements (decision 1/CP.16). The targets of developed countries that participate in the Kyoto Protocol's second commitment period were later translated into quantified emission limitation and reduction objectives for the period 2013 to 2020 and included in Annex B under the Doha Amendment (see section 4.2.1), while the targets of other countries remain under the Convention.

CERs could be used in two ways to achieve 2020 targets: countries could purchase CERs from projects hosted in other countries or could recognize CERs from domestic projects as a means of compliance in domestic mitigation policies. Here it is conservatively assumed that governments will not use CERs from projects located in other countries to achieve their 2020 targets. Some demand for CERs, however, could arise from mitigation policies that recognize CERs from *domestic* CDM projects; some developing countries have either established or are in the process of establishing such schemes:

- The Korean ETS, implemented in 2015, allows an entity to use offsets for up to 10% of its compliance obligation – including CERs from domestic projects implemented after April 2010 (ICAP, 2017c). The UNFCCC (2017a) estimates the maximum potential demand by the scheme to be around 330 million CERs until 2020. The volumes traded to date (ICAP,

2017a), however, suggest that the real demand for CERs is likely to lie significantly below this maximum level. Moreover, the CER supply potential from registered CDM projects is lower than the demand. Here it is assumed that the Korean demand for CERs from 2013 to 2020 is constrained by the supply potential of registered Korean projects of about 130 million CERs.

- Earlier in 2017 the government of Colombia established a carbon tax that allows taxpayers to use domestic offsets to comply with their tax obligation. The regulation allows for the use of domestic offsets generated by the CDM and by other mechanisms from 2010 onwards. International offsets are allowed for use only in 2017 and only for mechanisms other than the CDM (Colombia, 2017). The scheme is estimated to cover taxpayers emitting around 50 $MtCO_2e$ per year (Thomson Reuters, 2017), creating a maximum demand of about 200 million offsets between 2017 and 2020. As in the case of Korea, the use of CERs could be constrained by the supply potential of registered projects, which is estimated at about 30 million CERs until 2020. The scheme may, however, spur the development of new (or not-yet-registered) projects.

- The government of Mexico established in 2014 a carbon tax that foresees the use of CERs from domestic projects as a compliance instrument. The necessary legislation to implement this provision, however, has not been enacted thus far (ICAP, 2017b). Given the uncertainty of whether CERs will be ultimately eligible to meet the carbon tax, this study assumes no demand for CERs from the scheme until 2020.

- The Chinese pilot ETSs make use of China Certified Emission Reductions, which could stem from CDM projects in specific circumstances. It is also expected that China Certified Emission Reductions will be used under the nation-wide Chinese ETS, which is currently under development (Swartz, 2016). According to Thomson Reuters (2016), no demand for CERs from current CDM projects is expected under the pilot schemes. Along the same vein, this study assumes no demand for CERs in the context of the nation-wide Chinese ETS.

- The government of South Africa has for a few years been working on a carbon tax that could include the use of CERs from domestic projects (World Bank and Ecofys, 2017). Due to delays in implementation, this study assumes that no demand will arise from South Africa until 2020.

4.2.3 Results-based finance

The CDM has been considered as a possible instrument for monitoring, reporting and verifying emission reductions, thus facilitating the disbursement of results-based finance (RBF) for climate change mitigation. Development cooperation agencies have begun purchasing CERs for climate finance provision through a number of initiatives. The World Bank's Pilot Auction Facility for Methane and Climate Change Mitigation (PAF)[7] established a pay-for-performance mechanism which uses auctions to allocate public funds to projects that are vulnerable to discontinuing GHG abatement. The World Bank's Carbon Initiative for Development[8] provides CER-based performance payments to support projects that use clean and efficient technologies in low-income countries. The UNFCCC (2016) estimates a demand of around 55 million CERs until 2020 from existing RBF initiatives. New programmes, such as the Nitric Acid Climate Action Group[9] launched by the German government, could increase that volume. It is estimated that about 60 million CERs could be used by RBF initiatives until 2020.

4.2.4 Voluntary cancellation

Demand in the voluntary market is driven by the private sector, mainly for purposes of social corporate responsibility. According to Ecosystem Marketplace (2016), total demand from the voluntary market between 2011 and 2015 varied between 68 and 103 $MtCO_2e$ per year; the demand in the period was lowest in 2013, and volumes have been raising around 10% per year since, to 84 $MtCO_2e$ in 2015. The market share of the CDM in the voluntary market has typically been small: between 2011 and 2015, the share of CERs in total transactions rose from 0.3% to around 1.9%. An exception is 2013, where the volume of CERs traded reached 7%, as uncertainties over the role of the CDM in the future climate regime led CDM project developers to offload their CERs in the voluntary market. Assuming that demand for units from the voluntary market will continue growing by 10% per year, and assuming a market share of the CDM of 2%, the total demand is estimated to be about 20 million CERs in the 2013-2020 period.

7 https://www.pilotauctionfacility.org

8 https://www.ci-dev.org/

9 http://www.bmub.bund.de/en/topics/climate-energy/climate/international-climate-policy/nitric-acid-climate-action-group/

4.3 Use of CERs under CORSIA

Under the UNFCCC, emissions from international aviation and maritime transport are usually reported by countries as memo items, but not included in their total national GHG emissions. The Paris Agreement does not explicitly refer to emissions from international aviation and maritime transport. Since these emissions are clearly anthropogenic, they are implicitly included in the scope of Article 4.1 of the Paris Agreement. However, drawing upon the approach in the IPCC Guidelines for reporting of GHG inventories, most countries did not include these emissions in the scope of their NDCs (Schneider, Broekhoff, Cames, Füssler, and La Hoz Theuer, 2016).

ICAO Member States have agreed on a global aspirational goal of carbon-neutral growth, meaning that after 2020 the CO_2 emissions impact should be kept to the emissions level of 2020. The aspirational goal also includes the aim of reducing carbon emissions from international aviation by 50% by 2050 compared to 2005 levels (ICAO, 2010). These goals are to be achieved through a basket of measures, notably fuel efficiency, biofuel use, and market-based measures.

In 2016, the 39th session of the ICAO Assembly adopted resolution A39-3 (ICAO, 2016a), establishing the Carbon Offsetting and Reduction Scheme for International Aviation. The scheme contributes to achieving carbon-neutral growth by requiring carbon offsets for emissions above 2020 levels. The scheme starts in 2021 and will be implemented in three phases: a pilot phase from 2021 to 2023, the first phase from 2024 to 2026, and the second phase from 2027 to 2035. The pilot and the first phase apply to countries that volunteer to take part. The second phase is mandatory for all countries that have a significant market share of international aviation activity, exempting Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries. As of 19 April 2017, 66 countries, representing more than 85% of international aviation activity, declared their intention to voluntarily participate in CORSIA from the outset.[10]

Rules for the eligibility of units under CORSIA, such as criteria on project types, eligible mechanisms, or the vintage of emission reductions, are yet to be determined. Paragraph 21 of Resolution A39-3 specifies that "emissions units generated from mechanisms established under the UNFCCC and the Paris Agreement are eligible for use in CORSIA, provided that they align with decisions by the Council, with the technical contribution of the Committee on Aviation Environmental Protection, including on avoiding double counting and on eligible vintage and timeframe".

The offset demand from CORSIA has been estimated in several studies (Bailis et al., 2016; Cames, Graichen, Siemons, and Cook, 2015; ICAO, 2016b). Most studies were prepared before the adoption of CORSIA and do not reflect the final design and coverage of the scheme as agreed by ICAO. This study employs estimates by van Velzen and Cames (2016), which are based on a detailed model that estimates aircraft engine emissions and reflects the final design and coverage of the scheme. Van Velzen and Cames (2016) estimate the total demand for offsets to be about 2.71 $GtCO_2$ in the period 2021 to 2035. Of that, about 120 $MtCO_2$ comes from the pilot phase (2021–2023), about 270 $MtCO_2$ comes from the first phase (2024–2026), and about 2.32 $GtCO_2$ comes from the second phase (2027–2035). The total amount is also in line with estimates by Lee and Owen (2016) and by the UNFCCC secretariat (UNFCCC, 2017a), which also reflect the actual design and coverage of the scheme.

4.4 Use of CERs towards NDCs

As of 6 June 2017, 142 Parties had submitted NDCs under the Paris Agreement.[11] NDCs vary considerably, including with regard to the types of targets, their sectoral coverage, and intended use of carbon markets (Graichen, Cames, and Schneider, 2016). The available assessments of NDCs indicate that the ambition of mitigation targets also varies strongly: while some countries are estimated to reduce emissions below their likely emissions path with current policies in place, other countries are estimated to have NDCs that are significantly less stringent than emissions projections based on current policies (CAT, 2016b; Rogelj et al., 2016; Schneider, Füssler, et al., 2017).

CERs from emission reductions up to 2020 could be used in different ways towards achieving NDC targets after 2020. They could be used domestically towards achieving an NDC target or internationally transferred and used by another country to achieve its NDC. Rules for such transfers are not foreseen in the Paris Agreement, but have been proposed by some Parties.

10 http://www.icao.int/environmental-protection/Pages/market-based-measures.aspx

11 http://www4.unfccc.int/ndcregistry/Pages/All.aspx

The demand from a possible use of CERs towards NDCs is uncertain. Most countries focus on national policy measures for achieving their NDCs. Although several countries indicate an interest in selling units internationally, only a few demonstrate interest in purchasing them (Obergassel and Gornik, 2015). This indicates that the use of international units (and of CERs) in the 2021-2030 period could be low. This represents, however, the current situation and should be regarded with some caution: when submitting their NDCs, it was still unclear to Parties whether carbon market provisions would be included in the Paris Agreement. Once the provisions of Article 6 are operationalized, more countries may make use of them – irrespective of what is currently stated in their NDCs.

The use of domestic CERs by the host country would require the host country to acquire the CERs, as these are under the ownership and control of project owners. Limited international demand could create favourable economic circumstances for countries to acquire domestic units at low cost. It is unclear, however, to what extent host countries would be interested in acquiring such units.

In conclusion, the use of CERs towards NDCs is highly uncertain, as it depends crucially not only on evolving economic circumstances and on rules to be enacted under the Paris Agreement, but also on domestic policies that are not yet developed.

5 WHICH FACTORS AFFECT THE GLOBAL GHG EMISSIONS IMPACT OF USING CERS AFTER 2020?

The GHG emissions impact of using CERs towards achieving international mitigation targets after 2020 is complex. Understanding which factors affect global GHG emissions under which circumstances is critical for ensuring environmental integrity. Drawing on a framework for assessing the GHG emissions impact from international transfers of carbon market units (Schneider, Füssler, et al., 2017), this section assesses four main factors which could affect the global GHG emissions impact from using CERs:

1. The **quality of CERs** can *directly* affect global GHG emissions. This study understands that a CER has quality if it corresponds to an emission reduction of at least 1 tCO_2e in the host country, compared to the situation in the absence of incentives from the CDM, the CER purchase programme or a policy recognizing CERs. We thus consider here the *direct* emissions impact from the CDM project, independently of other factors.

2. **Robust accounting** of the transfer and use of CERs is a key prerequisite for ensuring environmental integrity. If the transfer and use of CERs is not accounted for robustly, e.g. if emission reductions are double counted, global GHG emissions could increase.

3. The **ambition and scope of a mitigation target of the host country** could affect the global GHG emissions impact in *indirect* ways. If double counting of emission reductions is avoided, a transfer of units that lack quality could hinder the ability of the host country to achieve its mitigation and require it to compensate for such transfers.

4. The possibility to transfer CERs could provide **incentives or disincentives for further mitigation action**. International market mechanisms, such as the CDM, could lower the cost of mitigation, and thereby enable countries that acquire units to adopt more ambitious mitigation targets. Yet participation in international market mechanisms could also create disincentives for countries that sell units to set mitigation targets ambitiously. The possibility to participate in international market mechanisms could thus affect global GHG emissions *indirectly*.

These four factors are assessed below.

5.1 Quality of CERs

Three aspects can impact the quality of CERs, depending on the circumstances:

1. The additionality of the project;
2. The quantification of emission reductions; and
3. The vulnerability of projects to discontinue GHG abatement in the absence of CER revenues.

The quality of CERs is in principle ensured if the project is **additional** – that is, it would not occur in the absence of the incentives from the crediting mechanism – and the emission reductions are **not overestimated**. Additionality is assessed at project inception, when the decision is taken whether to proceed with the investment. Additionality is thus relevant when new projects are developed in response to a carbon market price and respective demand.

The direct emissions impact from using CERs beyond 2020 is more complex. The CDM market is currently characterized by a strong imbalance between supply and demand, resulting in low CER prices. If in such a market situation projects have **already been implemented** – and hence investment costs are sunk – a key consideration for the global GHG emissions impact is whether the projects would continue to reduce GHG emissions even without CER revenues, or whether they are **vulnerable to (or at risk of)** discontinuing GHG abatement.

For some project types, such as hydropower or wind power projects, ongoing revenues from electricity sales typically exceed ongoing operational expenditures. Once implemented, these projects have strong economic incentives to continue GHG abatement, with or without CER revenues, because continued GHG abatement generates more income than discontinuing GHG abatement. Projects also might continue GHG abatement because policies promote or require continuation or because discontinuation is technically not viable. These projects have a **low risk of discontinuing GHG abatement** in the absence of CER revenues.

Other projects have ongoing operational costs but insufficient financial benefits beyond CER revenues. For example, the abatement of N_2O from nitric acid pro-

duction requires the regular replacement of catalysts but does not save costs or generate income other than CER revenues. These projects have a **high risk of discontinuing GHG abatement**, because continuing GHG abatement is only economically attractive if they have ongoing financial support. Non-financial barriers may also play an important role, e.g. where the stakeholders that receive the benefits are different from those that bear the costs, such as in the case of cook stove projects.

For some project types, the risk of discontinuing GHG abatement is **variable**. For these project types, the vulnerability depends more strongly on local and project-specific conditions.

A project that is vulnerable to discontinuing GHG abatement is by definition additional. However, it is important to note that if a project is not vulnerable, it can still be additional. Rather, the lack of vulnerability recognizes that, from today's perspective of sunk investment costs, the project's ongoing revenues or cost savings – other than CER revenues – exceed its ongoing operational expenditures for the GHG abatement. Laws and regulations could also require continuing GHG abatement, or it may not be technically feasible to discontinue GHG abatement.

This implies that in the current market situation, the impact of new demand for CERs on global GHG emissions differs between already implemented and new projects. For new projects, the additionality and the quantification of emission reductions determine the GHG emissions impact, whereas for already implemented projects the risk that projects discontinue GHG abatement and the quantification of emission reductions matter. A new programme or policy – such as CORSIA – that creates new demand for CERs would only trigger emissions reductions to the extent that (Schneider, Day, et al., 2017):

1. The implementation of new GHG abatement projects that are additional is triggered through the programme or policy, and their emission reductions are not over-estimated; or

2. Already implemented projects that are at risk of discontinuing GHG abatement are spurred to continue GHG abatement, and their emission reductions are not over-estimated.

This situation would only change if the current imbalance between supply and demand ceases, i.e. if the overall demand from new programmes and policies exceeded the potential CER supply from already implemented and operating projects.

5.1.1 Additionality

Additionality is a key consideration for new CDM projects that are implemented in response to a new programme or policy recognizing CERs.

The additionality of CDM projects has been assessed in various studies (Dechezlepetre et al., 2014; Erickson, Lazarus, and Spalding-Fecher, 2014; Haya and Parekh, 2011; He and Morse, 2013; Lütken, 2012; Michaelowa and Purohit, 2007; Purdon, 2014; Schneider, 2009; Spalding-Fecher et al., 2012), with a recent study providing a comprehensive and up-to-date analysis (Cames et al., 2016). The likelihood of additionality is often found to differ considerably between project types, and is often deemed more questionable for projects where CER revenues have a small financial impact. Major challenges in the assessment of additionality are the information asymmetry between project developers and regulators, as well as the uncertainty of assumptions on future developments.

In a detailed assessment of the CDM rules and their application to CDM project types, alongside economic and sectoral analysis, Cames et al. (2016) conclude that most energy-related project types, including hydro, wind and waste heat recovery, are unlikely to be additional. Biomass and some household energy efficiency projects, including cook stoves, are found to have medium likelihood of additionality. Industrial gas projects (HFCs, adipic acid, nitric acid) and methane projects (landfill gas, coal mine methane) are found to have high likelihood of additionality. To ensure that further emission reductions are triggered by a policy or programme recognizing CERs, policymakers could prioritize or limit eligibility to project types that are commonly deemed to have a higher likelihood of additionality.

5.1.2 Vulnerability of discontinuing abatement

The vulnerability of CDM projects to discontinue GHG abatement in the absence of CER revenues is a key consideration for a programme or policy that recognizes CERs from already implemented projects. The risk that CDM projects discontinue GHG abatement has been assessed in several studies and is deemed to be low for most projects (Schneider and Cames, 2014; Schneider, Day, et al., 2017; Warnecke et al., 2017).

Table 4 shows that about 82% of the CER supply potential from registered projects – corresponding to 3.8 billion CERs – stem from project types that typically have a low vulnerability to (or low risk of) discontinuing GHG abatement. While many of these projects currently do not issue CERs, most could resume CER issuance if they had enough in-

Table 4: CER supply potential from registered projects for the period 2013 to 2020, differentiated by project vulnerability to discontinue GHG abatement

Vulnerability of projects to discontinue GHG abatement	Million CERs	%
Low	3,800	82%
Variable	600	13%
High	170	4%
Not assessed	80	2%
Total CER supply potential	**4,650**	**100%**

Note: Numbers may not add up due to rounding. Source: Schneider, Day, et al. (2017)

centives to do so. For another 13%, the vulnerability is typically variable, depending on the specific circumstances of the project. Only about 170 million CERs, or 4% of the CER supply potential, are from project types that typically have a high vulnerability to (or high risk of) discontinuing GHG abatement (Schneider, Day, et al., 2017).

The CER supply potential from vulnerable projects is not only low because of the lower market share of these project types in the CDM, but also for three other reasons (Schneider, Day, et al., 2017):

1. Many of the vulnerable projects have already discontinued GHG abatement or monitoring and can either not resume abatement or are temporarily not eligible for issuing CERs. This is also a consequence of the collapse in CER prices in the last few years.

2. For some of the vulnerable project types, such as HFC-23 and nitric acid projects, the methodologies to calculate emission reductions have been revised, introducing more conservative approaches that allow only part of the emission reductions to be issued as CERs.

3. Some countries have introduced domestic policies that incentivize or require continued GHG abatement of certain project types. For example, many countries support the use of efficient lighting (Warnecke et al., 2017), and China and India introduced policies to abate HFC-23 emissions (UNEP, 2017).

Figure 6 shows the CER supply potential from registered projects, differentiated by the vulnerability of project types to discontinue GHG abatement. The figure illustrates that the vast majority of the CER supply potential is from projects that typically have a low risk of discontinuing GHG abatement:

- Renewable energy projects – particularly wind and hydro projects – constitute the largest share (68%) of the CER potential of registered projects, and 96% of these projects, with a supply potential of 3.02 billion CERs, are estimated to have a low vulnerability. Biomass projects are deemed to have a variable vulnerability, but make up a lower share of the overall CER supply potential.

- Industrial gas projects make up 8% of the CER supply potential from registered projects. Their vulnerability varies between countries, with 35% of the CER supply potential from this project type being from projects that typically have a high vulnerability. HFC-23 projects in China and India are considered to have a low vulnerability.

- Energy efficiency projects account for 10% of the CER supply potential of registered projects. Most of them are considered to have a low vulnerability, with the exception of cook stove projects, which are considered to have a high vulnerability but account for less than 1% of the CER supply potential.

- The vulnerability of fossil fuel projects varies. The vulnerability of projects related to fossil fuel switch and fugitive emission projects varies according to country context, while coal bed/mine methane projects are estimated to have low vulnerability.

- Other projects include mainly landfill gas and methane avoidance projects and account for 6% of the overall CER supply potential. Their vulnerability varies according to local conditions.

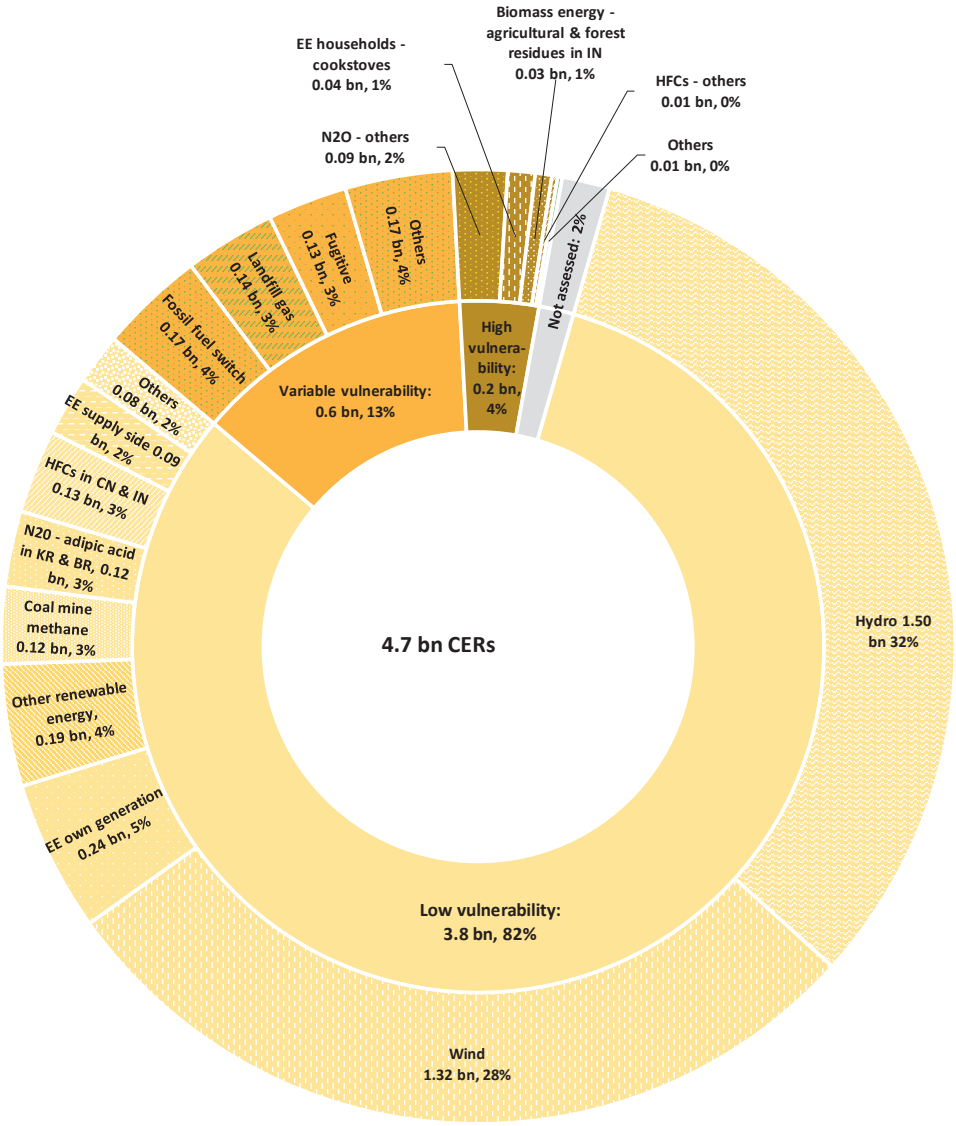

Figure 6: CER supply potential from registered projects for the period 2013 to 2020, differentiated by the vulnerability of project types to discontinue GHG abatement

Source: Adapted from Schneider, Day, et al. (2017)

Their share of the supply potential is also low because many of the registered projects were either never implemented or ceased GHG abatement.

5.1.3 Quantification of emission reductions

The quantification of emission reductions affects the GHG emissions impact for both new and already implemented projects.

Ensuring that emission reductions are not overestimated involves several considerations, including that the emission reductions be real, measurable and attributable to the credited activity; that indirect emission effects be appropriately considered; and that the duration of crediting does not exceed the period in which emission reductions occur. Another challenge inherent to the concept of crediting is that it subsidizes mitigation action rather than making the polluter pay: this can lead to a systematic overestimation of emission reductions, even if projects are fully additional and the direct GHG emissions impact of a project is quantified appropriately (Calvin et al., 2015).

Cames et al. (2016) evaluate the quantification of emission reductions under the CDM for major CDM project types. Overall, their findings suggest that there is little risk of over-estimating emission reductions. As shown in Figure 7, 66% of the CER supply poten-

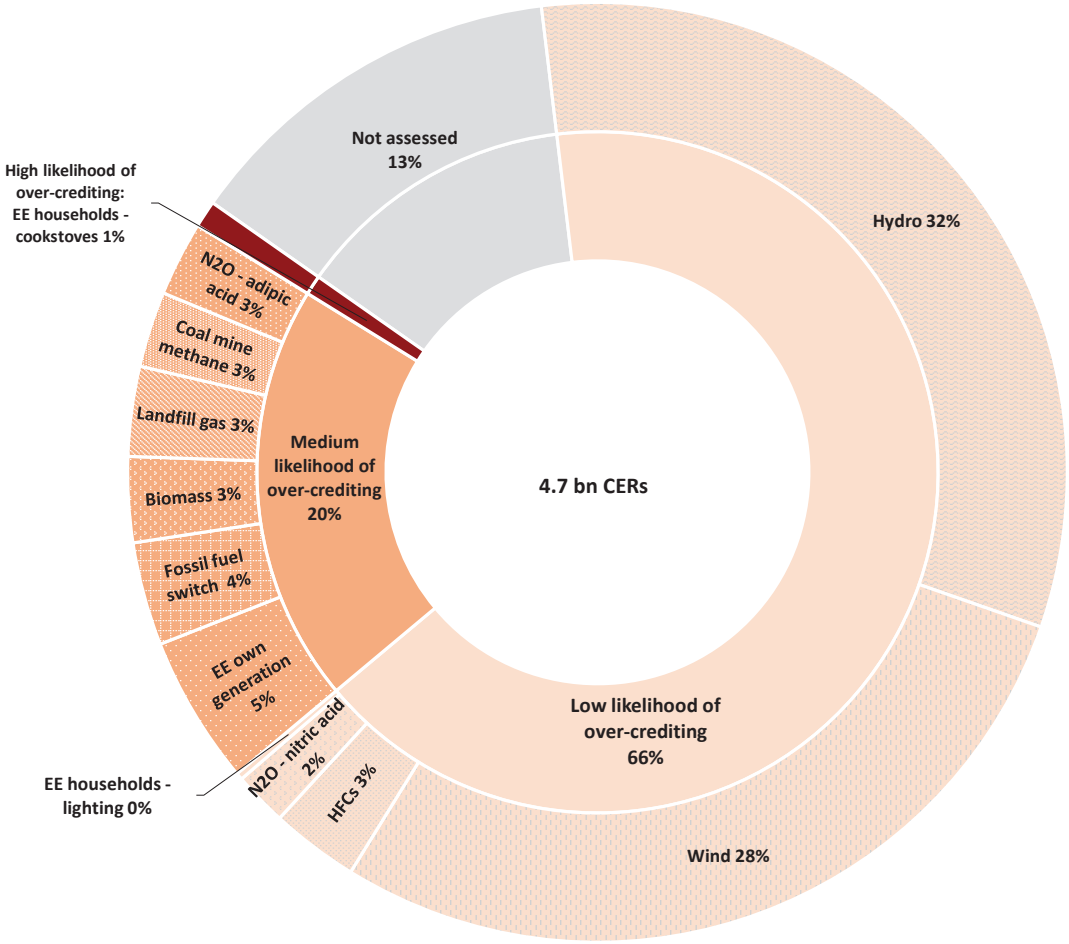

Figure 7: CER supply potential from registered projects for the period 2013 to 2020, differentiated by the likelihood of over-estimating emission reductions for different project types

Source: Adapted from Cames et al. (2016)

tial from registered projects stems from project types unlikely to be over-credited – including wind, hydro, HFC-23 and adipic acid projects. For some of these project types, emission reductions are estimated conservatively, likely leading to an under-estimation of the actual emission reductions. Schneider and Cames (2014) estimate that the emission reductions from all registered HFC-23 and adipic acid projects over the period 2013 to 2020 would be about 1.8 times higher than the amount of CERs that can be issued.

Twenty percent of the CER supply potential stems from project types that have a medium likelihood of over-crediting. Drawing on a detailed assessment of the emission reduction calculations from cook stove projects (Bailis, Drigo, Ghilardi, and Masera, 2015), Cames et al. (2016) conclude that cook stoves are the only project type subject to over-crediting under the CDM. However, these projects make up only 1% of the CER supply potential from registered projects and the CDM Executive Board recently agreed to revise the relevant methodologies to address issues with the quantification of emission reductions.[12]

In conclusion, there could be some over-crediting under the CDM but also potential for under-crediting. Overall, the quantification of emission reductions under the CDM does not seem to present a major threat to the GHG emissions impact for the post-2020 use of CERs.

12 Meeting report of the 90th meeting of the CDM Executive Board, paragraph 58.

5.2 Robust accounting

Robustly accounting for the transfer and use of units towards achieving international mitigation targets requires several issues to be addressed (Schneider, Broekhoff, Cames, Füssler, et al., 2016), including:

- Defining mitigation targets as quantifiable indicators and tracking progress towards mitigation targets;
- Tracking unit transfers, e.g. through registries;
- Avoiding double counting of emission reductions;
- Addressing different metrics, such as non-GHG targets or different global warming potentials;
- Accounting for the vintage of emission reductions from units and mitigation targets, such as for single-year targets;
- Addressing any non-permanence.

Accounting rules to avoid double claiming would only be effective if countries intend to achieve their mitigation targets. For example, if a transferring country does not intend to achieve its target, the country could "over-sell" units, without engaging in emission reductions to still achieve its mitigation target. In this study, it is assumed that countries achieve their mitigation targets.

This section first provides an overview of how CERs could be used to achieve various international mitigation targets (section 5.2.1). It then explores two key issues for robust accounting of CERs: the avoidance of double counting (section 5.2.2) and accounting for the vintage of CERs and the time frame of mitigation targets (section 5.2.3).

5.2.1 In which ways could CERs be used to achieve international mitigation targets?

CERs could be used in several ways to achieve international mitigation targets. Two dimensions are important for robust accounting: first, CERs can be used either domestically or transferred internationally, and second, they can be used either in the period in which the emission reductions occurred or in a future period. These two dimensions imply four possible ways of using emission reductions from the CDM to achieve international mitigation targets:

1. **Domestic use:** In this case, the CDM host country uses the emission reductions to achieve its international mitigation target. The reductions occur in the same period to which the mitigation target is applicable. For example, South Korea recognizes CERs from domestic projects in its ETS, which contributes to achieving its 2020 target.
2. **International transfer:** In this case, the emission reductions occur in the CDM host country but are used by another country (or under ICAO) towards achieving an international mitigation target. The reductions occur in the same period to which the mitigation target is applicable. This includes, for example, the use of CERs by Annex B countries within the same commitment period under the Kyoto Protocol.
3. **Domestic inter-temporal transfer:** In this case, emission reductions are achieved in one period and used by the CDM host country to achieve an international mitigation target for a future period. For example, a CDM host country might use CERs issued for the second commitment period to achieve its NDC target.
4. **International inter-temporal transfer:** In this case, the emission reductions occur in the CDM host country in one period and are used by another country (or under ICAO) in a future period to achieve an international mitigation target. Examples are using CERs issued for the second commitment period under ICAO or a country that is not the host country using CERs to achieve its NDC target. These cases are also further investigated below.

These four cases have different implications for accounting. In the first case, the CERs do not need to be added to the emissions budget of the country, or subtracted from its reported emissions. This is because the emission reductions associated with the CERs are usually automatically reflected in the GHG inventory of the country; in other words, the country already accounts for the reductions by reporting lower GHG emission levels.[13] In the other three cases, the country (or the airline) would have to add the CERs to its emissions budget, or subtract them from its reported emissions, in order to use the emission reductions to achieve its international mitigation target.

13 Emission reductions from mitigation actions are usually automatically reflected in GHG inventories (Schneider, Broekhoff, Cames, Füssler, et al., 2016). In some instances, however, GHG inventories could be incomplete or more advanced inventory methods (IPCC Tier 2 or 3) are needed for mitigation actions to be reflected in GHG inventories. This issue has also been referred to as "visibility" of emission reductions in GHG inventories (Prag et al., 2013). Whether mitigation actions are reflected in the GHG inventory of the transferring country can impact the global GHG emissions outcome from international transfers (Kollmuss et al., 2015).

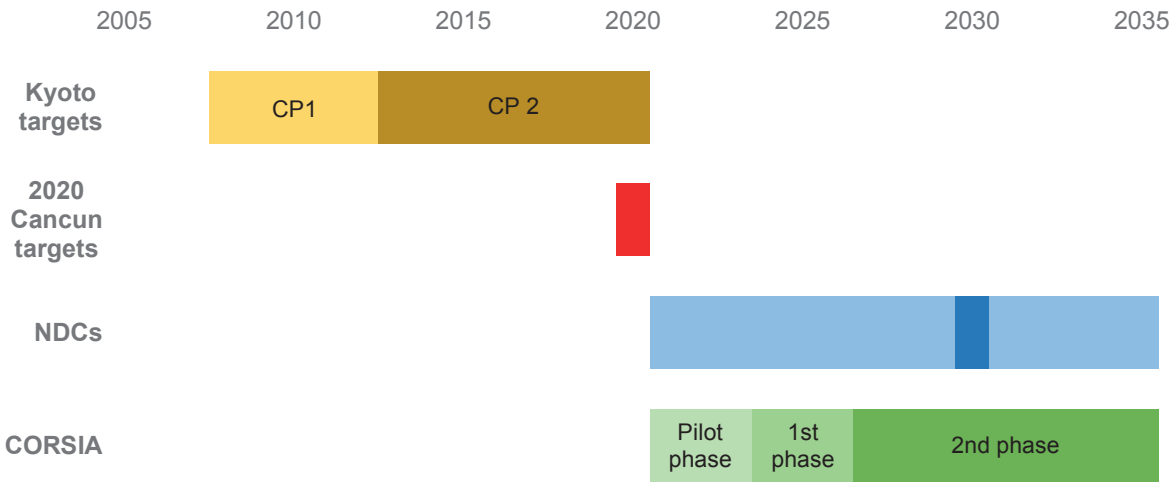

Figure 8: Applicable time periods of international mitigation targets

Figure 8 illustrates the applicable time frames of international mitigation targets which could potentially be achieved by using CERs. The Kyoto Protocol commitment periods and the phases under CORSIA are multi-year periods. The 2020 targets communicated in the context of the Cancun Agreements were pledged with the intent of achieving emission reductions in the period up to 2020, but they only include a target level for the year 2020. Similarly, many NDCs only indicate single target years, mainly for 2030.

This study investigates the global GHG emissions impact of using CERs towards achieving post-2020 mitigation targets. It therefore focuses on robust accounting of inter-temporal transfers, including domestic and international transfers. The analysis does not assess the global GHG emissions implications of using CERs for purposes other than achieving international mitigation targets, such as voluntary offsetting by companies or a tool to deliver results-based finance.

5.2.2 Double counting

Avoiding double counting of emission reductions is an important principle under all international regimes involving international mitigation targets.

The **Kyoto Protocol** establishes an accounting regime that effectively avoids double counting of emission reductions within that regime. Mitigation targets are economy-wide, cover a common set of GHGs, and are expressed as absolute continuous multi-year GHG emission budgets, using the same global warming potential values. International transfers are accounted for by adding or subtracting units from emission budgets.

The **Cancun Agreements** do not provide for an accounting framework for 2020 targets communicated in the context of the agreements. In subsequent negotiations on carbon markets, Parties agreed that "various approaches, including opportunities for using markets … must meet standards that … avoid double counting of effort".[14] Decision 1/CP.21, adopting the Paris Agreement, also refers to avoiding double counting in the context of action prior to 2020, urging "host and purchasing Parties to report transparently on internationally transferred mitigation outcomes, including outcomes used to meet international pledges, and emission units issued under the Kyoto Protocol with a view to promoting environmental integrity and avoiding double counting".

The **Paris Agreement** requires countries to avoid double counting in the context of accounting for NDC targets (Article 4.13), international transfers (Article 6 and paragraph 36 of decision 1/CP.21), and the transparency framework (paragraph 92 of decision 1/CP.21), see Table 5.

The **CORSIA** under ICAO also establishes a principle to avoid double counting. The scheme allows using emissions units generated from mechanisms established under the UNFCCC and the Paris Agreement, provided that "they align with future decisions, including on avoiding double counting".

While all four regimes aim to avoid double counting of emission reductions from international trans-

14 Decision 2/CP.17, paragraph 79.

Table 5: Provisions to avoid double counting in the Paris Agreement

Issue	Applicable provisions
Accounting for NDCs (Article 4)	Article 4.13: Parties shall avoid double counting in accounting for their NDCs.
International transfers (Article 6)	Article 6.2: Parties engaging in international transfers of mitigation outcomes shall apply robust accounting to ensure, inter alia, the avoidance of double counting. Paragraph 36 of decision 1/CP.21: The guidance under Article 6.2 should "ensure that double counting is avoided on the basis of a corresponding adjustment by Parties for both anthropogenic emissions by sources and removals by sinks covered by their NDCs". Article 6.5: Emission reductions resulting from the Article 6.4 mechanism shall not be used to demonstrate achievement of the host Party's NDC if used by another Party to demonstrate achievement of its NDC.
Transparency framework (Article 13)	Paragraph 92: The modalities, procedures and guidelines for Article 13.13 should take into account the need to ensure that double counting is avoided.
Enhanced action prior to 2020 (decision 1/CP.21)	Paragraph 106: Parties are encouraged to promote the voluntary cancellation by Party and non-Party stakeholders, without double counting, of units issued under the Kyoto Protocol, including certified emission reductions that are valid for the second commitment period. Paragraph 107: Host and purchasing Parties are urged to report transparently on internationally transferred mitigation outcomes, including outcomes used to meet international pledges, and emission units issued under the Kyoto Protocol with a view to promoting environmental integrity and avoiding double counting.

Source: Schneider, Broekhoff, Cames, Füssler, et al. (2016)

fers, their levels of operationalization differ. Rules to effectively avoid double counting only exist under the Kyoto Protocol. The Convention and its Cancun Agreements do not have provisions to effectively avoid double counting. Provisions to avoid double counting under the Paris Agreement and CORSIA are currently being negotiated.

A critical challenge is avoiding double counting when emission reductions are transferred across these regimes. This holds for units generated under both the Kyoto Protocol and the Paris Agreement:

- The Kyoto Protocol only avoids double counting of emission reductions within its boundaries and does not have provisions to account for unit transfers to other frameworks, such as to CORSIA or NDCs under the Paris Agreement. It also has no provisions to avoid double counting with 2020 targets communicated in the context of the Cancun Agreements.

- Article 6.2 of the Paris Agreement refers to mitigation outcomes that are used by Parties to achieve NDCs. The Paris Agreement does not include explicit provisions on how to avoid double counting with other regimes, such as with CERs issued under the Kyoto Protocol or the use of international units under CORSIA. However, Article 4.13 of the Paris Agreement requires countries to ensure the avoidance of double counting in the context of accounting for their NDCs. This provision could be interpreted as requiring countries to ensure that they do not count towards their NDCs emission reductions that they have also transferred to other regimes, such as to CORSIA. Accounting rules under Article 4.13 could thus address potential double counting between NDCs and CORSIA (Schneider, Broekhoff, Cames, Füssler, et al., 2016).

In conclusion, avoiding double counting when transferring units across international regimes is an important challenge that should be addressed through appropriate accounting rules. The sections that follow assess how double counting can occur and how it can be addressed when using CERs towards achieving NDCs or implementing CORSIA. Three types of double counting are considered: double issuance, double claiming, and double use.

5.2.2.1 Double issuance

Double issuance occurs if more than one unit is issued for the same emissions or emission reductions and used to achieve international mitigation targets. Double issuance can involve one or multiple mechanisms and one or multiple entities. A particular challenge is that double issuance can occur in indirect ways, notably

if mechanisms issue units for indirect emissions that occur upstream or downstream of the entities receiving the units. Crediting mechanisms often award credits to those entities that undertake the mitigation actions, while the actual emission reductions occur elsewhere (Schneider, Kollmuss, and Lazarus, 2015).

Double issuance can be avoided through a range of approaches, such as requiring project owners to sign an attestation that they do not seek credits for the same emission reductions under other crediting mechanisms, or requiring verifiers or host countries to check that no double issuance occurs (Schneider et al., 2015). The CDM has established provisions to avoid double issuance of CERs from the same or other CDM projects. For example, baseline and monitoring methodologies ensure that only the producer or the consumer of a good or service can claim CERs for the emission reductions.

However, the CDM does not have any provisions to avoid double issuance with other GHG offsetting programmes or mechanisms, including government programmes such as Japan's Joint Crediting Mechanism (JCM) or the Chinese certified emission reductions, as well as non-governmental programmes such as the Verified Carbon Standard. The CDM was set up and operates based on the assumption that it is the only mechanism that issues units for emission reductions in non-Annex I countries and that can be used towards fulfilling international mitigation targets. While the CDM operates within the framework of the Kyoto Protocol, the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol has requested that the CDM Executive Board consider the use of the CDM for other purposes.

Practically, the CDM's lack of provisions to avoid double issuance with other programmes is unlikely to have a material impact. So far, all major GHG offsetting programmes and mechanisms have some provisions in place to avoid double issuance with the CDM. That implicitly avoids double issuance between these programmes or mechanisms and the CDM, even if the CDM has no provisions itself.

One caveat is important to note. While the CDM has relatively detailed procedures to avoid double issuance within the CDM – including for specific project types and indirect forms of double issuance – the robustness of provisions under other mechanisms varies. Many other mechanisms largely focus on avoiding double registration. However, they may not consider to the same extent indirect forms of double issuance, such as when emission reductions are claimed by other entities from emissions occurring upstream or downstream of the project (Schneider et al., 2015).

5.2.2.2 Double claiming

Double claiming occurs if the same emission reductions are counted twice towards fulfilling mitigation targets: once by the country or entity where the reductions occur, through reporting of its emissions in its GHG inventory; and again by the country or entity using the CERs. Double claiming could thereby lead to an increase in global GHG emissions.

Generally, double claiming can be addressed through the establishment of an accounting balance where additions and subtractions are made for the amount of units internationally transferred. These adjustments can be made either to emission budgets or to reported emissions, leading to the same outcome (Schneider, Broekhoff, Cames, Füssler, et al., 2016).

The Kyoto Protocol requires countries to implement additions and subtractions to their assigned emissions budget for the relevant commitment period. Countries report annually on additions and subtractions in a standardized format. A final accounting balance is prepared after the end of each commitment period and documented in a compilation and accounting database maintained by the UNFCCC secretariat. These rules effectively prevent double claiming between countries with commitments inscribed in Annex B.

However, the Kyoto Protocol does not have rules in place to avoid double claiming with mitigation targets communicated under the UNFCCC or the Paris Agreement. A risk for double claiming arises for CERs issued for the second commitment period, which overlaps with the time frame of 2020 targets communicated in the context of the Cancun Agreements. The emission reductions achieved through the CDM could be claimed twice: once by the CDM host country, through reporting lower emission levels in its GHG inventory and thereby meeting its 2020 target, and once by the country acquiring the CERs to comply with its own mitigation target.

The risk of such double claiming is material, for two reasons:

1. **A large share of the CER supply potential is from countries with 2020 targets:** Figure 9 shows that about 77% of the CERs would originate from emission sources covered by a 2020 target, and only 18% would originate either from countries without a target or from sectors or GHGs not covered by a target. About 5% of the CER supply

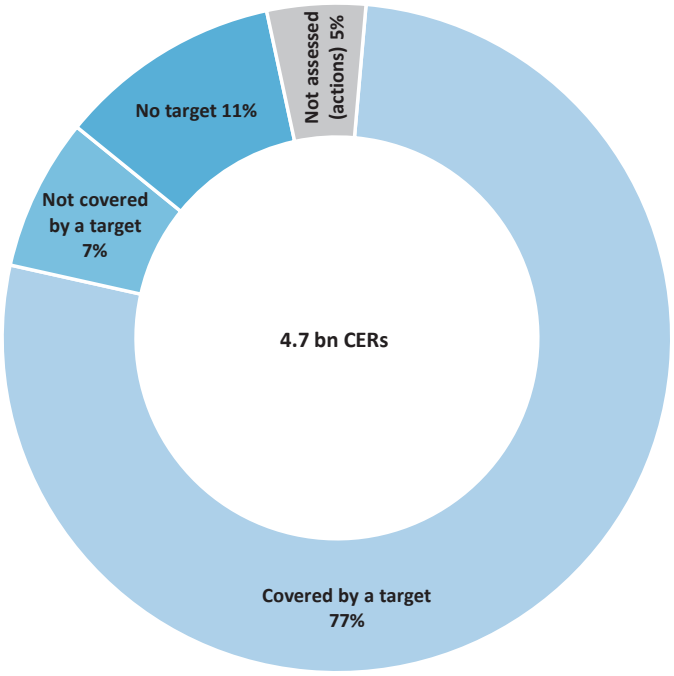

Figure 9: CER supply potential from registered projects in the period 2013 to 2020, differentiated by the coverage of 2020 targets

potential would originate from countries that communicated only actions; whether CDM projects overlap with these actions has not been assessed. Thus, there is a risk of double claiming for the vast majority of the CERs from registered projects.

2. **Lack of international accounting rules for international transfers up to 2020:** Although the decision 1/CP.21 adopting the Paris Agreement and decisions under UNFCCC emphasize the need to avoid double counting in the context of international transfers in the period up to 2020, this principle has never been effectively integrated into an accounting framework. The current framework for reporting and reviewing GHG emissions under the UNFCCC does not provide for accounting rules to avoid double claiming. The framework requires developed countries to report on international transfers, whereas developing country Parties submitting Biennial Update Reports (BURs) "shall" provide "information on international market mechanisms", but only for information that Parties "consider suitable and relevant for reporting" (UNFCCC, 2014). An analysis of the most recent Biennial Update Reports from CDM host countries responsible for about 80% of the total CER supply potential – China, India, Brazil, Korea, Mexico, and Vietnam – suggests that none of these countries have so far reported on or accounted for emission reductions from CERs claimed by other countries. Similarly, buyer countries do not seem to engage with CDM host countries to identify means of avoiding double claiming of emission reductions from CDM projects.

Thus, under the current situation, the large majority of emission reductions from CERs issued for the second commitment period are likely to be double counted. Importantly, this holds true for any use of the CERs towards meeting international mitigation targets, including the use towards meeting commitments of Annex B Parties under the Kyoto Protocol, towards 2020 targets, towards NDC targets, and towards CORSIA.

It is also important to note that double claiming in the period up to 2020 could also occur for other GHG offsetting programmes or mechanisms that are used towards international mitigation targets. For example, Japan intends to use the JCM towards achieving its 2020 target, but the bilateral memoranda of understanding between Japan and the host countries do not include provisions to address double claiming.[15] In the absence of a bilateral agreement on accounting for the emission reductions, it is

15 https://www.jcm.go.jp

unclear whether JCM host countries will report and account for the internationally transferred emission reductions correspondingly.

Double claiming with 2020 targets does not always increase global GHG emissions; the impact depends on whether host countries overachieve their 2020 targets:

- **Achievement of the 2020 target even without the CDM:** If a host country overachieves its 2020 target by an amount greater than the emission reductions issued and transferred under the CDM, then the country would also be able to achieve its target if it were to apply corresponding adjustments to avoid double claiming. The host country does not effectively make use of the reductions to achieve its 2020 target. Not applying corresponding adjustments would therefore not have implications for GHG emissions. This remains true, however, only if the over-achievement is not used for any other purposes, such as being carried-over and accounted towards future mitigation targets.

- **Achievement of the mitigation target due to the CDM:** If the host country achieves its mitigation target, but would not do so without the emission reductions from the CDM, double claiming could increase global GHG emissions. In this case, the host country needs the emission reductions from the CDM to achieve its mitigation target. If it would avoid double counting (e.g. by applying corresponding adjustments), it would have to pursue other mitigation action in order to still achieve its mitigation target.

It is yet unclear whether all countries will achieve their 2020 targets. According to the emission projections by Climate Action Tracker (CAT, 2016b), some countries are well on track and likely to over-achieve their targets– including without the emission reductions from CDM projects – while others may not achieve their targets without the emission reductions from the CDM.

While the risk of double claiming is material, the political context of 2020 targets is an important consideration. Developing countries put forward mitigation targets for the first time – despite their lower capacity and capability, and their lower historical responsibility for climate change. Some developing countries have argued that they submitted their targets assuming international support from developed countries – including through the use of mechanisms – and should therefore be able to use the emission reductions from CERs to achieve their targets (Schneider et al., 2015). Moreover, countries approved CDM projects before communicating 2020 targets and were possibly unaware of any double claiming consequences. It is also possible that countries would have put forward less ambitious 2020 targets if it were clear that double counting must be avoided. Lastly, 2020 targets do not have the same legal status as NDC targets or commitments under the Kyoto Protocol. For these reasons, countries could have different expectations with respect to avoiding double claiming in the context of 2020 targets.

However, one could also argue that the political context is different if CERs issued for emission reductions up to 2020 are used *after* 2020, towards NDCs or CORSIA. Both the Paris Agreement and the CORSIA resolution require the avoidance of double counting, and the decision 1/CP.21 adopting the Paris Agreement emphasizes the need to avoid double counting also with regard to pre-2020 mitigation action. If double claiming is addressed for units issued under the Paris Agreement – but not for CERs – that could potentially distort the carbon market, providing a comparative advantage to CERs. Avoiding double claiming with 2020 targets may thus be important for ensuring environmental integrity in the post-2020 period.

5.2.2.3 Double use

Double use refers to the situation where the same issued unit is used twice to achieve an international mitigation target, either twice by the same country or once each by two different countries. Double use may occur, for example, if a unit is duplicated in registries, or if one country uses the same unit in two different years to attain mitigation targets.

Double use is unlikely to occur under the CDM because registry systems under the Kyoto Protocol prevent the same unit from being accounted twice. To use CERs outside the scope of the Kyoto Protocol, countries could require cancellation in the CDM registry as a means to surrender CERs. For example, South Korea requires that CERs be cancelled in the CDM registry in order to convert them into Korea Offset Credits for use in its ETSs. The CDM registry ensures that one CER can only be cancelled once and allows the purpose of the cancellation to be specified.

5.2.3 Accounting for the vintage of CERs and the time frame of mitigation targets

Appropriately accounting for the vintage of CERs and the time frame of mitigation targets is an important and complex issue for ensuring robust accounting. Not appropriately accounting for the vintage of emission reductions can, in some instances, lead to higher cumula-

tive global GHG emissions, even if the transferred units have quality (Kreibich and Obergassel, 2016; Lazarus, Kollmuss, and Schneider, 2014; Prag, Hood, and Barata, 2013). Using CERs from emission reductions up to 2020 towards achieving mitigation targets after 2020 involves such risks (Schneider and Ahonen, 2015).

Purchasing CERs from emission reductions up to 2020 could be pursued with the aim of incentivizing further pre-2020 mitigation action. Enhancing prompt mitigation action is a key objective in international climate negotiations, including in the decision 1/CP.21 adopting the Paris Agreement. Prompt mitigation action could reduce the cumulative warming impact from CO_2 emissions, avoid lock-in of emissions-intensive capital stock, enhance technology development and innovation, and thus facilitate the adoption of deeper targets in the future. The GHG emissions impact depends strongly on whether and how CERs are used to achieve future mitigation targets (Schneider and Ahonen, 2015).

In theory, using CERs from emission reductions up to 2020 towards achieving future mitigation targets only affects the timing of emission reductions but not the cumulative GHG emissions levels: emissions are reduced by an entity or a country at an earlier point in time, which enables the same or another entity or country to emit more at a later stage. In this regard, implementing CDM projects in the period up to 2020 and using the CERs after 2020 could be a zero sum game to the atmosphere – assuming that purchasing one CER triggers emission reductions of one tCO_2e – with the potential benefits of reducing emissions earlier.

In practice, however, the effects depend on how CERs are accounted for when achieving post-2020 targets. If not appropriately accounted for, using CERs could significantly affect the cumulative emissions of countries and ultimately lead to a result that is contrary to the objectives pursued, with a delayed mitigation action and a higher potential for the lock-in of carbon-intensive technologies. Under which circumstances there is such a risk depends on the specific context. This is further explored below.

5.2.3.1 Using CERs towards single-year targets

Accounting rules for the Paris Agreement have not yet been determined, and it is unclear how the rules will account for the vintage of mitigation outcomes and the time frame of mitigation targets. Figure 10 illustrates the potential implications for two hypothetical countries that both have a single-year NDC target of stabilizing their emissions in 2030 at their 2010 level. In the absence of international carbon market mechanisms, the countries could achieve their single-year targets with different emissions paths; in the period 2011 to 2029, the emissions could be higher or lower than their 2010 and 2030 level. Here it is assumed for simplicity that both countries would, without international transfers, keep their emissions at a constant level throughout the period from 2010 to 2030. It is also assumed that both countries do not have 2020 targets.

In this example, Country A implements a CDM project with a technical lifetime of eight years – from 2013 to 2020 – and transfers the associated CERs to Country B, which uses them to achieve its target in 2030. For illustrative purposes, the emissions impact of the CDM project is shown to be relatively large. The CDM project lowers the GHG emissions in Country A (dark green area), leading to lower actual emissions (black line) than would occur without the CDM project (red line). Country B uses the CERs from Country A to achieve its single-year emissions target in 2030 (light green area), by adding the CERs to its emissions budget (or subtracting them from its reported emissions). This allows Country B to have higher GHG emissions in 2030, compared to the situation in the absence of international transfers.

In Figure 10, Country B offsets the 2030 emissions above its target with the emission reductions from CERs created in Country A from 2013 to 2020. But the ability to use all CERs in a single year enables Country B to pursue a higher emissions path in the period up to 2030. This could thereby significantly increase the aggregated cumulative GHG emissions from both countries (by the grey area). Here it is assumed that Country B starts deviating on a higher emissions path in 2015 when it communicates its NDC and decides to use international units to achieve its NDC. The extent to which aggregated cumulative GHG emissions increase depends on when and how Country B pursues a higher GHG emissions path due to the use of international units.

5.2.3.2 Using CERs towards multi-year targets

In the example above, the environmental integrity risk becomes clearly visible because emission reductions achieved over a period of eight years are used in a single year towards achieving the NDC target. However, the same risk – although to a much lesser degree – persists with multi-year emissions targets, as illustrated in Figure 11. The figure shows the implications for the same CDM project and the same two countries, except that both countries have

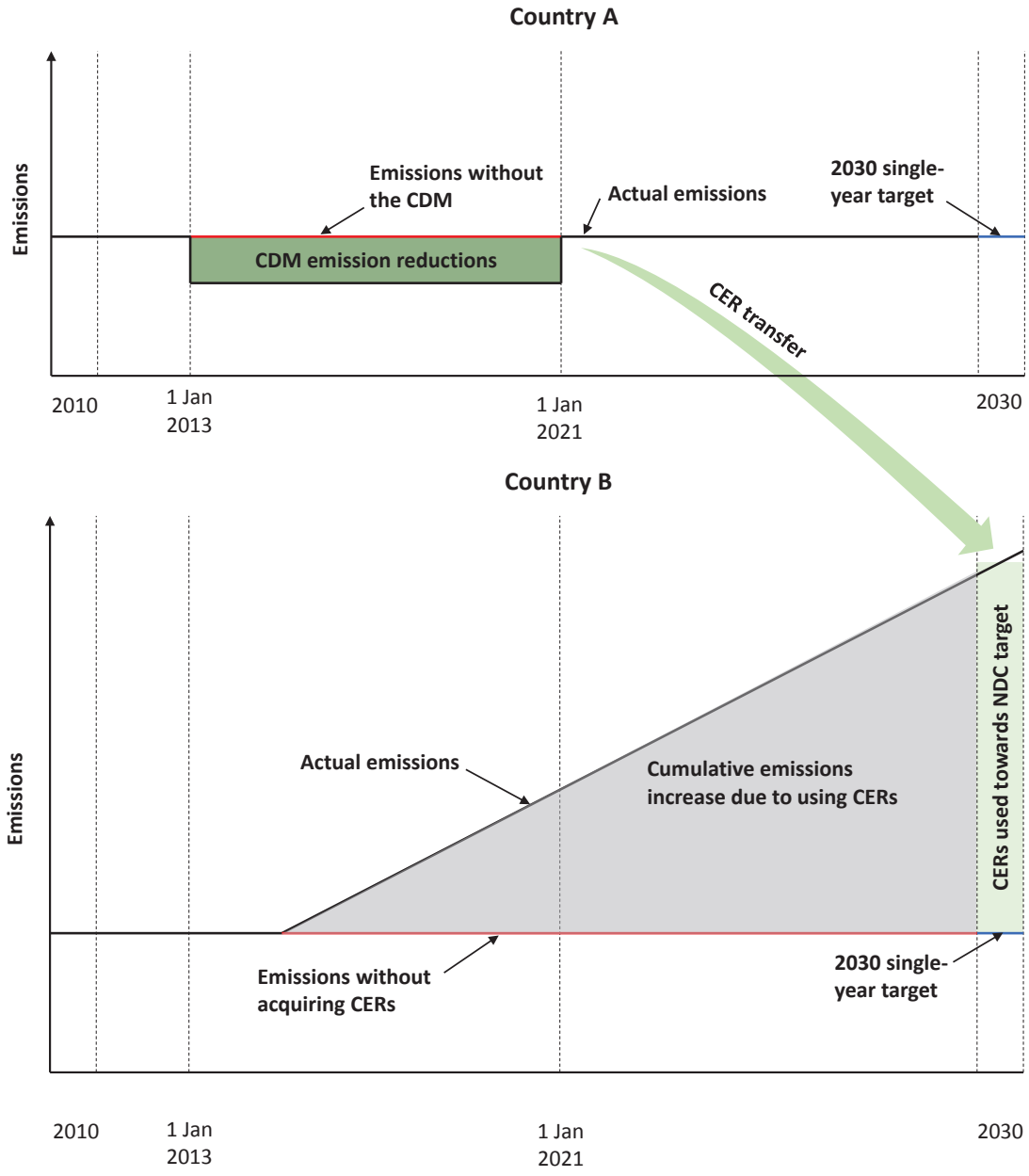

Figure 10: Implications of using CERs towards a single-year target in 2030

a multi-year NDC target of stabilizing their 2010 emissions in the period 2021 to 2030. As in the example of single-year targets, Country A transfers CERs to Country B, which uses them to achieve its NDC target. But in this example, the emission reductions achieved by the CDM project from 2013 to 2020 are now spread over the 10-year NDC target (2021 to 2030). Obviously, the ability of Country B to engage in a higher cumulative emissions path is more limited than in the case of a 2030 single-year target. The implications are mitigated not only because the CERs are spread over 10 years, but also because the period until the first target year (2021) is shorter. However, the cumulative aggregated GHG emissions would still be higher than if the countries achieved their targets domestically (shown by the grey area), depending on when and how Country B pursues a high GHG emissions path due to the transfer.

In conclusion, the environmental integrity risk decreases if CERs are used towards achieving multi-year emissions targets or trajectories, but the aggregated cumulative emissions could still be higher than they would be if the mitigation targets were achieved domestically.

5.2.3.3 Domestic use of CERs

CERs from emission reductions up to 2020 could also be used by the host country to achieve its NDC target after 2020. If a country uses domestic CERs from the period 2013 to 2020 to achieve its post-2020 mitigation targets, it could also engage in a higher cumulative GHG emissions path in pre-target years. The environmental integrity risk is therefore similar to that for international transfers.

5.2.3.4 Implications for the use of CERs after 2020

The environmental integrity risks described above arise because pre-target emissions pathways change when countries use CERs from emission reductions up to 2020 towards achieving NDC targets after 2020. In the two-country example, the transfer of CERs enables Country B to increase cumulative emissions more than Country A reduces them, leading to a higher emissions level from both countries together. In other words: emissions deviate in both countries when targets are not achieved domestically, but the degree of deviation differs between the two countries involved.

The figures above are based on several assumptions. In practice, the GHG emissions impact can differ if some of these assumptions are changed. Key considerations include:

- **Quality of CERs:** In the figures above, it is assumed that using one CER towards achieving post-2020 mitigation targets triggers an emission reduction of one tonne of CO_2e. This aspect is discussed in section 5.1.

- **Pre-target emissions path:** The figures assume that countries achieve their emission targets through linear emissions pathways. The aggregated cumulative GHG emissions impact depends on the extent to which the country using the CERs engages in a higher GHG emissions path in pre-target years.

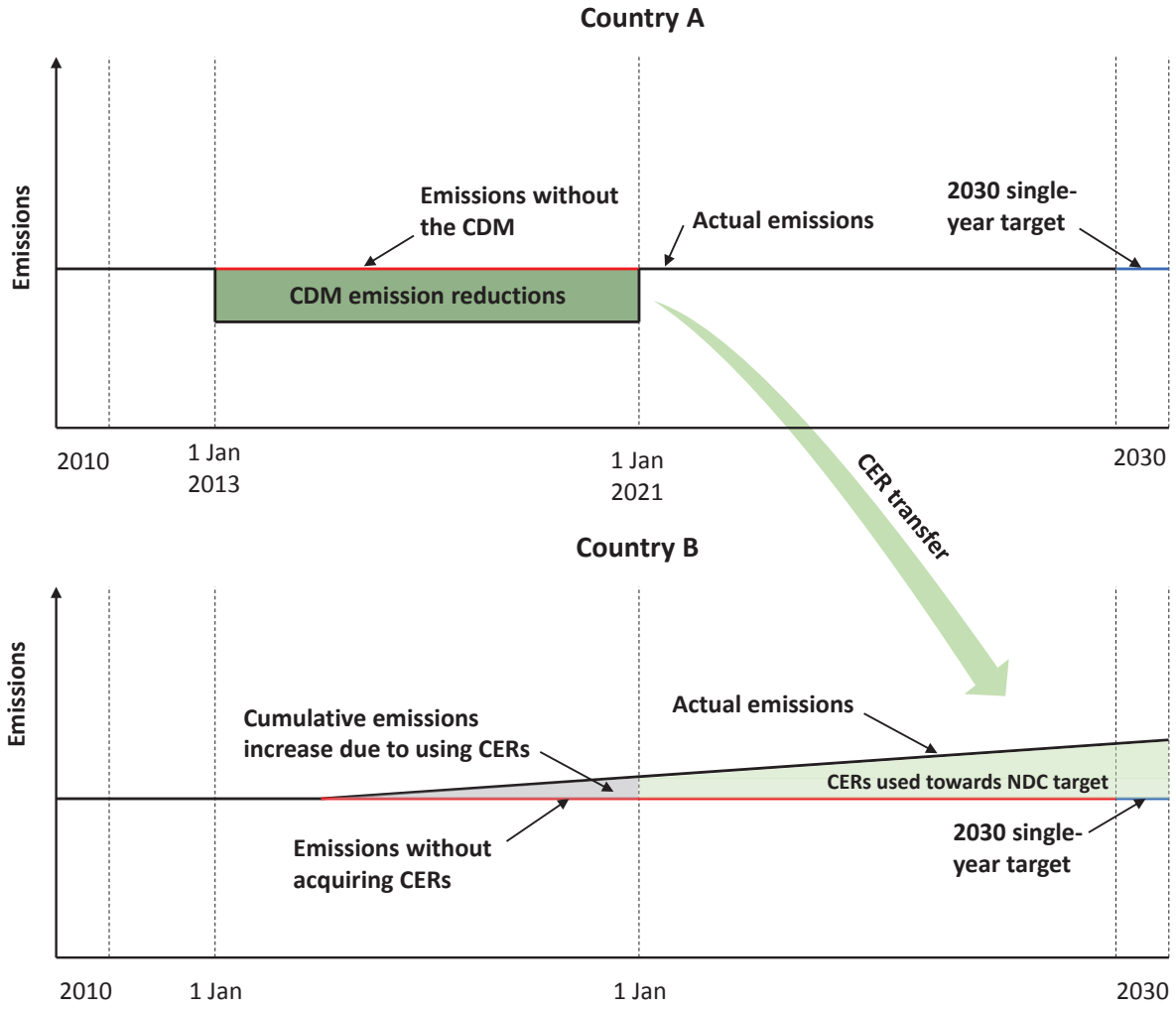

Figure 11: Implications of using CERs towards a multi-year target for the period 2021 to 2030

If Country B kept its emissions constant throughout 2020 (in the case of the multi-year target) or 2029 (in the case of the single year target) – and increased its emissions only in the target period or year – then cumulative aggregated GHG emissions from both countries would not be higher than they would be if the countries would achieve their targets domestically. This is, however, an unrealistic scenario. It is unlikely that countries would keep their emissions at low levels in pre-target years and only increase them in (single) target years. Although emission paths are usually not fully linear, it is reasonable to assume that countries achieve their targets through similar emissions pathways.

- **International mitigation targets in the period up to 2020:** In the figures above, it is also assumed that the countries do not have international mitigation targets in the period up to 2020. If the country using the CERs has an international mitigation target in that period (e.g. a target under the Kyoto Protocol), the outcome may change, depending on the ambition of the target and whether over-achievement of that target could be carried over into the Paris Agreement. If a country has an ambitious target, then using CERs after 2020 may not impact the emissions path in the period up to 2020; the country may, with or without the use of CERs, have to take action to achieve its target. If the target is less stringent than the likely business-as-usual (BAU) emissions and if the country cannot carry over its "hot air" into the Paris Agreement, then the use of CERs after 2020 could impact the emissions pathway of the country in the period up to 2020.

- **Double claiming with 2020 targets:** About 77% of the CER supply potential from registered projects comes from emission reductions that are covered by 2020 targets (see section 5.2.2.2). In this case, the emission reductions from CERs could be double-counted: once by the host country towards achieving its 2020 target, and once by the country using the CERs towards achieving its NDC target. For an inter-temporal transfer of CERs within the country – i.e. using domestic CERs to achieve an NDC target – the risk for higher cumulative emissions could be mitigated if countries with 2020 targets accounted for the carry-over of CERs to the Paris Agreement. They could do so by adding the CERs that have been carried over to their reported GHG emissions in the period up to 2020. This would require the host country to over-achieve its 2020 target in order to use the emission reductions towards achieving its NDC target, similar to provisions for carry-over of units under the Kyoto Protocol. However, in practice, CDM host countries currently do not account for the use of CERs in the context of 2020 targets (see section 5.2.2.2). Hence, this scenario is not yet relevant, but could be considered in an accounting framework that addresses the use of CERs under the Paris Agreement. Moreover, this approach would only address the underlying concern if 2020 targets are ambitious and thus require the country to reduce its emissions; if the target is less stringent than the countries' likely BAU emissions path, the need to account for the transfer of CERs may not have any bearing on the country's emissions path in the period up to 2020.

These considerations suggest that the exact impact on cumulative emissions pathways is rather complex and depends on the specific context. However, some general conclusions can be drawn.

First, the environmental integrity risk is very high if CERs are used towards single-year emission targets, whereas the risk is more limited if they are used towards multi-year targets or trajectories starting in 2021. In the latter case, the emission reductions from CERs are spread over more years, mitigating the implications on pre-2020 emissions pathways. Moreover, the time remaining until 2021 is shorter, which reduces the likelihood that the use of CERs after 2020 significantly affects emissions pathways up to 2020. For these reasons, the risk of higher cumulative emissions in pre-target years is also rather limited when using CERs under CORSIA, which provides for a multi-year emissions goal and already starts in 2021.

Second, the risk of higher cumulative emissions paths in pre-target years is lower if the country using the CERs already has an ambitious mitigation target in the period up to 2020. In this case, it is less likely that the use of CERs after 2020 would impact its emissions pathway in that period.

And third, where host countries intend to use domestic CERs towards achieving their NDC targets, addressing double claiming with 2020 targets could mitigate the risks of higher cumulative emissions.

5.3 Ambition and scope of the mitigation target of the host country

The ambition and scope of the mitigation target of the host country could affect the global GHG emissions outcome in *indirect* ways. If a host country has an ambitious economy-wide mitigation target and if double counting of emission reductions is avoided,

the quality of the transferred units does not affect the global GHG emissions outcome. This is because if the host country transfers units that lack quality to another country, it would have to compensate for the transfer – though domestic abatement or the purchase of international units – in order to still achieve its mitigation target. The host country thus has an incentive to ensure that transferred units have quality, since a lack of unit quality would hinder its ability to achieve its mitigation target. By contrast, if the host country does not have a mitigation target, if the reductions are not covered by its target, or if the target level is less stringent than its likely BAU emissions, then the quality of units directly impacts global GHG emissions. In this case, the host country would not have a direct incentive to ensure the quality of the transferred units, since a lack of unit quality would not hinder its ability to achieve its mitigation target (Kollmuss, Schneider, and Zhezherin, 2015; Schneider, Füssler, et al., 2017).

These considerations presume that double counting of emission reductions is avoided. In the context of the CDM, double counting with 2020 targets is currently not addressed: an accounting framework is not in place, and so far, host countries do not voluntarily account for emission reductions used by other countries through the CDM (see section 5.2.2.2). This also implies that host countries do not compensate for CERs that lack quality in order to achieve their 2020 targets. Under these circumstances, the ambition and scope of 2020 targets of CDM host countries have no impact on global GHG emissions.

5.4 Incentives and disincentives for further mitigation action

The possibility to engage in international carbon market mechanisms could provide incentives or disincentives for further mitigation action. Using CERs from emission reductions in the period up to 2020 towards achieving international mitigation targets after 2020 could lower the costs of complying with international mitigation targets, which could potentially enable countries or ICAO to adopt more ambitious mitigation targets. International rules on carbon markets were not in place when the first NDCs were formulated, but it might be possible, for example, that some countries planned to use CERs to achieve their NDCs and that this influenced the ambition of their NDC targets.

If new CDM projects were implemented due to the possibility of using CERs after 2020, another benefit could be earlier mitigation action. That could facilitate the transition towards a low carbon economy, and ultimately enable the adoption of more ambitious mitigation targets in the future.

Yet participation in international market mechanisms can also create disincentives to set mitigation targets ambitiously. Countries might set mitigation targets at unambitious levels, or define their scope narrowly, in order to accrue more benefits from transferring units internationally (Carbone et al. 2009). However, this particular risk is not relevant for the context of the CDM, since the ability to sell CERs from reductions in the period up to 2020 does not create a disincentive for host countries to set future NDC targets less ambitiously.

5.5 Which factors are critical for using CERs after 2020?

The systematic assessment of factors that affect the global GHG emissions impact of using CERs after 2020 identified four factors that are critical:

1. For new projects, the **additionality** of the projects;

2. For already implemented projects, their **vulnerability to (or risk of) discontinuing GHG abatement**;

3. The risk of **double claiming** with 2020 targets; and

4. How the **vintage of CERs** is accounted for in relation to the time frame of mitigation targets.

The assessment found that other aspects – such as the risk of double issuance, double use, over-crediting, or disincentives for further mitigation action – would not have a significant impact when using CERs to achieve mitigation targets after 2020.

A key question for policy-makers is how these risks for environmental integrity could be addressed. In the next section, we assess the implications of different scenarios for using CERs, including restrictions to address critical environmental integrity risks.

6 SCENARIOS AND IMPLICATIONS FOR USING CERS AFTER 2020

This section discusses several scenarios for the use of CERs after 2020 and explores their implications for global GHG emissions. Most programmes or policies deliberating the purchase or recognition of CERs consider some type of eligibility criteria or prioritize some type of CERs. For example, the ICAO assembly resolution adopting the CORSIA refers to an "eligible vintage and timeframe" of units. Many purchase programmes or policies prioritize specific project types, vintages of emission reductions, or regions. For example, the Norwegian government purchase programme and the World Bank's PAF focus on project types that are at risk of discontinuing GHG abatement without CER revenues. Furthermore, some policies in developing countries, such as Colombia or South Korea, focus on domestic projects with specific vintages.

Eligibility criteria or prioritization could be implemented to achieve one or more policy objectives, such as avoiding double claiming with 2020 targets, incentivizing the implementation of new and additional GHG abatement projects, supporting already implemented projects that are at risk of discontinuing GHG abatement, and promoting projects from specific host countries.

This study focuses on those aspects that are critical for environmental integrity. To ensure environmental integrity, policy makers could prioritize or limit eligibility of CERs to projects that are newly developed in response to a CER purchase programme or policy and that have a high likelihood of additionality, and/or to already implemented projects that are likely at risk of discontinuing GHG abatement. This would require a method to (a) differentiate "new" from "already implemented" projects; (b) identify which new projects have a high likelihood of being additional; and (c) identify which already implemented projects are likely to be at risk of discontinuing GHG abatement. Some of the analysed scenarios and options aim to pursue this approach; others have been proposed or are being discussed under the Paris Agreement and CORSIA.

Generally, prioritization or eligibility criteria for the use of CERs could relate to several aspects, including:

- **Project features**, with priority given to projects with defined features that are more likely to achieve specific policy objectives. That could include limiting eligibility to project types for which there is a higher level of assurance that they deliver real, measurable, and additional emission reductions, or to project types that have a higher risk of discontinuing GHG abatement;
- **Double counting risk**, with priority given to CERs for which double counting is avoided;
- **Regions or countries**, with priority given to CERs from specific host countries, such as LDCs or SIDS.

Policy-makers could also establish limits on the amount of CERs that can be used after 2020 or introduce discount or exchange rates. These options are not explored further in this study.

This chapter first discusses the implications if CERs from *all* projects are eligible for use after 2020 (section 6.1). It then identifies possible restrictions on the use of CERs and discusses their implications (sections 6.2 to 6.6). Finally, it discusses the implications for the specific context of a few countries from different regions (section 6.7).

6.1 Full use of CERs after 2020

Policy-makers could consider recognizing CERs from all projects, without any restrictions, including from already implemented and from new projects. If all CERs were eligible for use after 2020, it is unlikely that the CER purchase programme or policy would trigger significant further emission reductions beyond those that would have occurred in the absence of the programme or policy. This is largely owed to two reasons.

First, under current CDM market conditions, it is plausible that new demand for CERs would mostly be served by projects that have already been registered and implemented, that would continue GHG abatement even without CER revenues, and that have the necessary monitoring data to issue CERs. These projects are likely to have lower marginal costs for issuing CERs than new projects or projects at risk of discontinuing GHG abatement; their investment costs are sunk and the continuation of GHG abatement is economically viable, with or without CER revenues. Therefore, their marginal costs of issuing CERs corresponds to the CDM transaction costs for preparing monitoring reports, verifying emission reductions, and issuing CERs. Indeed, the current CER price approximately represents the transaction costs

of issuing CERs for a broad range of projects with simple requirements for monitoring and quantification of emission reductions.

By contrast, new projects and registered projects that are at risk of discontinuing GHG abatement have higher costs of generating CERs, as they not only have to cover CDM transaction costs but also must finance the GHG abatement costs through CER revenues. As long as the overall demand for CERs does not exceed the potential supply from already implemented and non-vulnerable projects, it is likely that these projects will outcompete new or vulnerable projects.

Our quantitative analysis shows that the potential CER supply from already implemented and non-vulnerable projects is considerable. About 3.8 billion CERs, corresponding to 82% of the CER supply from all registered projects, could be issued from project types that typically have a low risk of discontinuing GHG abatement (see Figure 6 in section 5.1.2). An estimated 3.3 billion CERs, or 70% of the total supply potential, come from active crediting periods of projects that have been implemented, that are continuing GHG abatement, and that are able to monitor emission reductions. Many of these projects have relatively low costs for monitoring and verifying emission reductions, particularly hydropower and wind power projects, which together account for 2.8 billion CERs. Overall, the potential CER supply from these projects exceeds the currently expected future demand for CERs, including from CORSIA.

Second, robust accounting for the transfer of CERs is not ensured under the current international framework. A key risk is double claiming with 2020 targets. Our quantitative analysis indicates that for about 3.6 billion

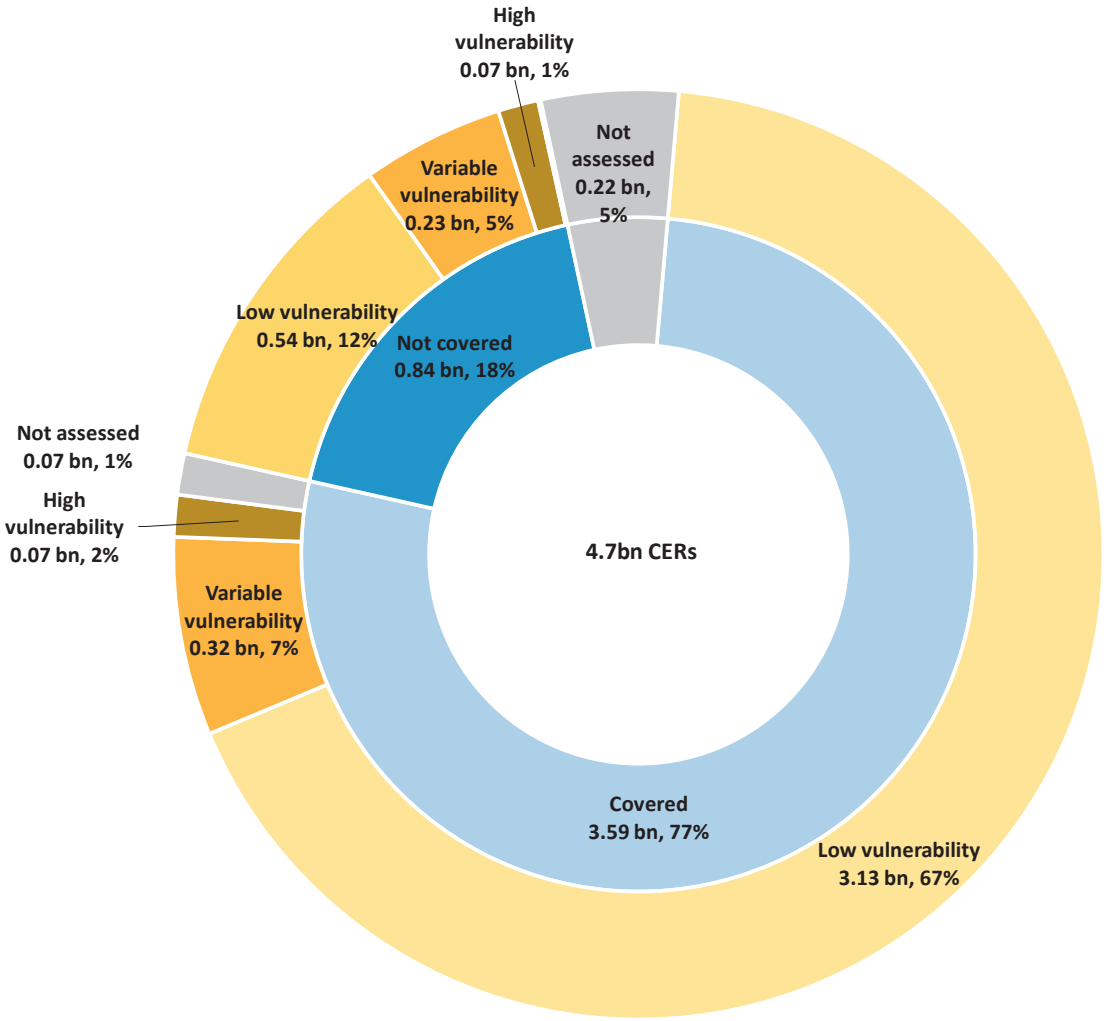

Figure 12: CER supply potential from registered projects for the period 2013 to 2020, differentiated by the coverage of 2020 targets and by the vulnerability of project types to discontinue GHG abatement

CERs, corresponding to about 77% of the CER supply potential, there is a risk of double claiming. Of these, about 3.1 billion CERs, corresponding to about 67% of the CER supply potential, are from projects that have a low risk of discontinuing GHG abatement (see Figure 12). Only about 1% of the CER supply potential is from emission reductions that are not covered by 2020 targets and that have a high risk of discontinuing GHG abatement. Another 5% of the supply potential is not covered by 2020 targets and is from project types that typically have a variable vulnerability, depending on the specific circumstances of the project. Another risk is that the use of CERs after 2020 could lead to higher emissions pathways in pre-target years, in particular if used towards single-year targets.

While this study focuses on environmental implications, it is important to note that recognizing all types of CERs would not only fail to trigger significant further emission reductions but also have adverse economic implications for project developers and host countries. CER prices would likely remain low, and thus might not generate sufficient incentives to develop new projects or continue GHG abatement in vulnerable projects. Moreover, if CER prices remain low, a considerable part of the funding dedicated to purchasing CERs might be used to cover transaction costs – including for the verification of emission reductions and issuing CERs – and only a small part might remain with the project owners. For these reasons, recognizing all types of CERs may not maintain investor trust and confidence or spur new investments.

To promote new or continued mitigation action, policy-makers could prioritize some types of CERs or consider restrictions on what type of CERs are eligible under a CER purchase programme or policy. Options for such restrictions and their implications are assessed in the sections that follow.

6.2 Vintage restrictions

6.2.1 Overview of options

Vintage restrictions involve establishing time-related limits for the eligibility of CERs towards achieving NDCs or implementing CORSIA. Policy-makers could pursue two objectives with vintage restrictions:

1. **Promoting new mitigation action:** Vintage restrictions could be used to differentiate new from already implemented projects. This would allow the promotion of new mitigation action that is implemented in response to the purchase programme or policy that recognizes CERs.
2. **Generally limiting the use of CERs beyond 2020:** Limits reduce the number of CERs that are eligible for use beyond 2020 and thus implicitly also limit any possible negative impacts on aggregated GHG emissions.

Vintage restrictions could relate to the timing of project implementation or the timing of the emission reductions:

1. **Timing of project implementation:** CERs from a project are eligible if the project passed a project development milestone at a defined point in time. The CDM has several documented project implementation milestones, in particular:

   • Start date of the project
   • Start date of validation
   • Date of requesting registration
   • Registration date
   • Start date of the crediting period

2. **Timing of emission reductions, verification and issuance:** CERs from a project are eligible if the emission reductions, verification activities or issuance of CERs occurred after a defined point in time. The CDM has three main documented milestones for these activities:

   • Start and end date of each monitoring report and associated issuance
   • Date of verification of emission reductions
   • Date of issuance of CERs

If the main purpose of vintage restrictions is promoting new or recently developed projects, then vintage restrictions should apply to the timing of project implementation, and not to the timing of emission reductions, verification and issuance. If the main purpose is to limit the number of CERs used beyond 2020, then policy-makers could pursue either one or both of the restriction types.

Policy-makers could consider a range of dates for restricting the use of CERs. The implications of the following possible options are assessed:

- The start of the second commitment period of the Kyoto Protocol: 1 January 2013
- The year following the adoption of the Paris Agreement: 1 January 2016
- The year following the adoption of CORSIA: 1 January 2017

- The year following of the expected finalization of the rules, modalities and procedures for the Article 6.4 mechanism: 1 January 2019

6.2.2 Restrictions on the timing of project implementation

To assess the implications and suitability of restrictions on the use of CERs based on the timing of project implementation, this section assesses the CDM rules governing the project development milestones and quantifies the CER supply potential under different restrictions (see Table 6). Two considerations are important: first, when a milestone is passed in the project development process; and second, whether the dates of these milestones can be changed by project participants with the intention of becoming eligible under a certain purchase programme or policy that recognizes CERs.

The **start date of the project** is the date on which project participants commit to making expenditures for the main equipment or service, such as when the contract for the purchase of a new wind turbine is signed.[16] For PoAs it is the date when the entity managing the programme officially notifies the UNFCCC secretariat of its intention to seek CDM status. It thus reflects the date when the investment decision is made to proceed with the project or when a PoA is being planned. If policy-makers wish to use vintage restrictions to promote new activities implemented in response to the policy or programme, this date may be best suited: it establishes a clear link to the investment decision to proceed with the project, which is not necessarily the case for other CDM milestones. This enables policy-makers to effectively ensure that only projects implemented *after* the adoption of a CER purchase programme or policy are eligible. Another advantage is that this date cannot be changed or influenced by project participants once the investment decision has been made. Under the current market conditions, however, few new projects are being developed. The CER supply potential from recent projects in the pipeline is therefore limited, and new projects would have to be developed in response to such a vintage restriction (see Table 6).

Another option is using dates that relate to the **administrative process of seeking CDM status**: the **start of validation** (the date when the project design document is published for global stakeholder consultation), the **date of requesting registration** (the date when the designated operational entity submits all project documentation for approval to the UNFCCC secretariat) and the **registration date** (the date on which a project is formally accepted under the CDM). The start date of validation is the earliest among the three steps, followed by the date of requesting registration and the date of registration.

Importantly, the timing of these administrative steps is not necessarily related to the timing of the implementation of the mitigation action. The CDM allows registering a project that was implemented in the past, subject to two conditions. First, the start date of the project must be on or after 1 January 2000. Second, either the start of validation must be before the start date of the project or projects must have submitted a "notification of prior consideration" (see section 3.1.2). In total, about 97% of the approximately 12,000 non-registered projects in the pipeline have either submitted a notification of prior consideration or have started validation before the start date of the project. If the date of registration or the date of requesting registration were used as vintage restrictions, then these projects would be eligible, even though most of these were implemented before 2013, as shown by the distribution of the start date of projects in Figure 13. These projects are estimated to be able to issue about 1 billion CERs in the period up to 2020, even if the vintage restriction were set at a future date (Table 6). If the start date of validation were used as vintage restriction, the implications could be similar, because projects could re-start a new validation process to comply with the vintage restriction, while at the same time using the original validation process to comply with the CDM requirement on "prior consideration".

The **start date of the crediting period** is either on or after the date of registration, but cannot be earlier, except for projects for which a request for registration was submitted by 31 December 2005 or for afforestation and reforestation project activities. This date is therefore also inadequate to differentiate new from already implemented projects, because it does not necessarily relate to when the

16 "For a CDM project activity (non-A/R) or CPA (non-AIR), the date on which project participants commit to making expenditures for the construction or modification of the main equipment of facility (e.g. a wind turbine), or for the provision or modification of a service (e.g. distribution of energy-efficient light bulbs, change of transport management system), for the CDM project activity or CPA. Where a contract is signed for such expenditures (e.g. for procurement of a wind turbine), it is the date on which the contract is signed. In other cases, it is the date on which such expenditures are incurred. If the CDM project activity or CPA involves more than one of such contracts or incurred expenditures, it is the first of the respective dates. Activities incurring minor pre-project expenses (e.g. feasibility studies, preliminary surveys) are not considered in the determination of the start date." (CDM glossary, version 09.0.)

Table 6: CER supply potential for the period 2013 to 2020 under different vintage restrictions on the timing of project implementation (million CERs)

Vintage restriction		From registered projects	From non-registered projects in the pipeline	Total
Start date of the project	1 Jan 2013	120	140	260
	1 Jan 2016	0	30	30
	1 Jan 2017	0	0	10
	1 Jan 2019	0	0	0
Registration date	1 Jan 2013	280	1,000	1,280
	1 Jan 2016	20	1,000	1,030
	1 Jan 2017	0	1,000	1,000
	1 Jan 2019	0	1,000	1,000
Start date of the crediting period	1 Jan 2013	1,320	1,000	2,330
	1 Jan 2016	80	1,000	1,080
	1 Jan 2017	10	1,000	1,020
	1 Jan 2019	0	1,000	1,000

Note: Numbers may not add up due to rounding.

emission reductions begin. Moreover, CDM rules allow projects to change the date after the project is registered, as long as they have not yet started issuing CERs. Projects could thus change the start date of the crediting period in order to become eligible under a CER purchase programme or policy. Table 6 shows that the CER supply potential is the highest if this date is used as vintage restriction. These estimates do not take into account that some registered projects could change the start date of the crediting period, which could further enlarge the amount of CERs eligible under this option.

In conclusion, the start date of the project is the only option that effectively differentiates new from already implemented CDM projects. All other options would grant eligibility to projects that were implemented before the cut-off date of the vintage restriction but could still register under the CDM if they had the economic incentive to do so. The start date of the project is therefore recommended if the aim is to promote new mitigation action.

6.2.3 Restrictions on the timing of emission reductions, verification and issuance

Vintage restrictions could also apply to milestones that take place after project implementation and registration. These mainly include milestones related to the generation of emission reductions and issuance of CERs. Importantly, these options only limit the volume of CERs eligible; they do not address any of the environmental integrity risks of using CERs towards NDCs or CORSIA, but rather contain the overall implications by limiting the overall use of CERs.

Vintage restrictions on the **timing of emission reductions** could in principle be implemented but may require significant administrative efforts to identify when the emission reductions occurred for each CER. This is because serial numbers of CERs identify the commitment period, but not the calendar year or precise period in which the emission reductions occur. Project participants can choose the duration of monitoring periods arbitrarily, and monitoring reports often include emission reductions from more than one calendar year. If a monitoring report covered periods before and after the vintage restriction, then either all the CERs issued for that monitoring report would not be eligible, or the emission reductions would have to be allocated to each period in order to determine the fraction of eligible CERs. This second approach is applied to monitoring periods spanning over both commitment periods of the Kyoto Protocol: the volume of CERs pertaining to the first commitment period (i.e. until 31st December 2012) is separated from the volume pertaining to the second commitment period (i.e. from 1 January 2013). Further complications arise for PoAs, where CERs for the same

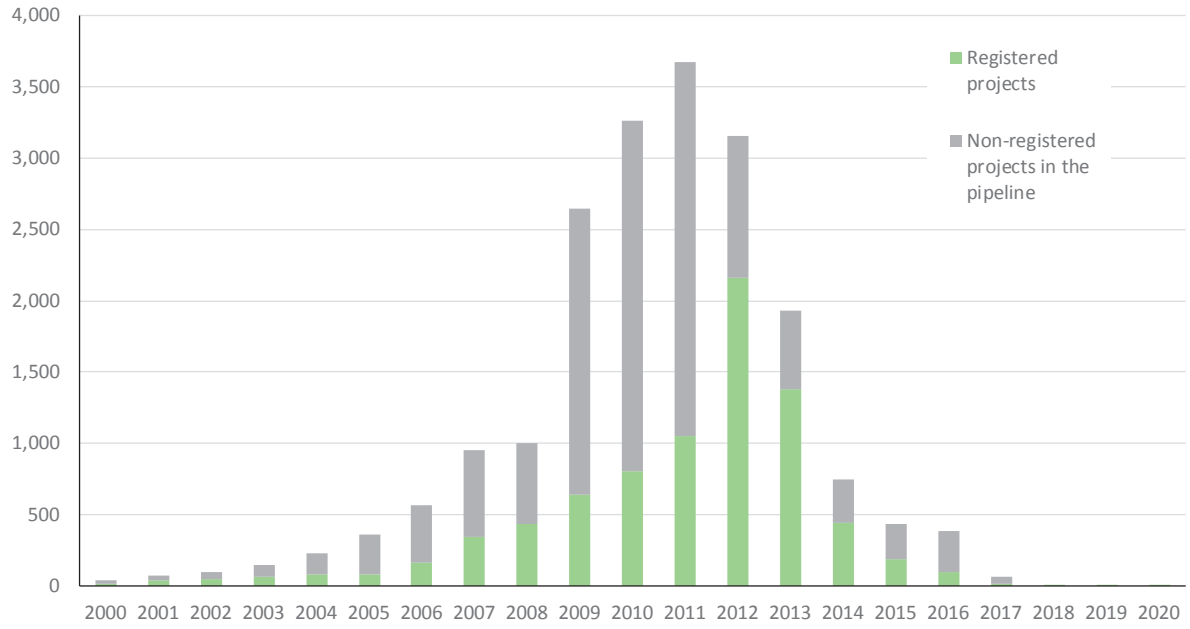

Figure 13: Start date of registered and non-registered projects in the pipeline

monitoring period can be issued in several batches, with each batch including some of the activities included under the PoA.

Table 7 illustrates the CER supply potential from registered projects and non-registered projects in the pipeline under different restrictions on the timing of emission reductions. The table shows that the volume is very large – ranging from about 2.3 to 5.7 billion CERs – even if the cut-off date would be set on 1 January 2019.

The **timing of verification or issuance** relate to administrative processes which, under CDM rules, can take place at any time after the emission reductions took place. These dates are thus not meaningful options to restrict CER eligibility, as project participants could adjust the timing of verification or issuance in response to such restrictions.

In conclusion, vintage restrictions on the timing of emission reductions are not well-suited because they do not address any of the underlying environmental integrity risks associated with using CERs after 2020 and because they are complex to administer. It is therefore not recommended to pursue this type of vintage restriction, except in the context of supporting projects that are at risk of discontinuing GHG abatement. The PAF, for example, targets future emission reductions from vulnerable projects, which ensures that further emission reductions are triggered as a result of the programme.

Table 7: CER supply potential for the period 2013 to 2020 under different restrictions on the timing of emission reductions (billion CERs)

Vintage restriction		From registered projects	From non-registered projects in the pipeline	Total
Timing of emission reductions	1 Jan 2013	4.65	1.00	5.66
	1 Jan 2016	2.92	1.00	3.93
	1 Jan 2017	2.35	1.00	3.35
	1 Jan 2019	1.29	1.00	2.29

6.3 Restrictions on project features

Restrictions on project features could be used to prioritize or limit the eligibility of CERs to projects that comply with defined features, with the view to achieving specific policy objectives. Criteria could include:

- **Additionality:** project types that have a high likelihood of additionality;
- **Vulnerability to discontinuing GHG abatement:** project types that are at risk of discontinuing GHG abatement;
- **Emission reduction quantification:** project types that have a high likelihood of delivering real and measurable emission reductions;
- **Sustainable development co-benefits:** project types providing larger sustainable development co-benefits;
- **Transformational impact:** project types that strongly contribute to the transition towards a low carbon economy;
- **Programmes of activities:** component project activities registered under a PoA;
- **Methodological aspects:** project types that use standardized baselines.

This section briefly explores how criteria could be implemented in relation to additionality and project vulnerability.

6.3.1 Additionality

The additionality of projects is relevant for new projects that are implemented in response to a purchase programme or policy recognizing CERs. The likelihood of additionality is commonly considered to vary between project types (see section 5.1.1). To promote projects that have a high likelihood of additionality, policy-makers could establish a list of project types that are deemed to have a high likelihood of additionality. This poses, however, several challenges, because additionality assessments are uncertain and depend on predictions of future developments, such as future energy prices. Project-specific circumstances also can play an important role. Existing analyses of the likelihood of additionality of different project types, and project categories considered automatically as additional under the CDM, could inform the prioritization of project types.

6.3.2 Vulnerability

The vulnerability of projects is relevant for already implemented projects that are supported by a purchase programme or policy recognizing CERs. To ensure that a programme or policy triggers further emission reductions, policy-makers could restrict the eligibility of already implemented projects to those that are at risk of discontinuing GHG abatement in the absence of continued CER revenues. As highlighted in section 5.1.2 above, it is important to note that limiting eligibility to vulnerable projects does not contest their additionality.

The risk that projects discontinue GHG abatement depends on the project type, but also on the country context and the specific situation of individual projects (Warnecke et al., 2017). This poses challenges for assessing whether a project is vulnerable. To address this challenge, two approaches could be pursued:

1. **Project type assessment:** Policy-makers could establish a list of project types that are typically vulnerable to discontinuing GHG abatement, without considering the specific circumstances of the host country and individual projects. Information to assess vulnerability would be largely based on the typical cost and revenue structure of the project type and may not adequately reflect the circumstances and policies of the host country.

2. **Individual project assessment:** Policy-makers could establish a process under which individual projects would have to demonstrate that they would discontinue GHG abatement without continued CER revenues. A methodological tool to assess project vulnerability could be developed, building on existing tools under the CDM. For example, scenarios for continuation and discontinuation could be identified in a first step, and ongoing revenues, costs and barriers could be evaluated to identify the most plausible continuation or discontinuation scenario in subsequent steps (Warnecke et al., 2017).

Both approaches may require further research, building on previous assessments of project vulnerability (Schneider and Cames, 2014; Schneider, Day, et al., 2017; Warnecke et al., 2017; Warnecke, Day, and Klein, 2015). Ultimately, the degree of vulnerability of a project is a judgment similar to – though less uncertain than – the assessment of additionality. Policy-makers could require varying degrees of certainty that a project is at risk of discontinuing GHG abatement. A possible disadvantage of considering the specific circumstances of the host country could be that host countries might have perverse incentives not to introduce policies that ensure continued abatement, in

order to benefit from the support provided by the CER purchase programme or policy.

Project types that are typically highly vulnerable have a supply potential of about 170 million CERs, while project types with a typically variable vulnerability have a supply potential of another 600 million CERs (see section 5.1.2).

6.4 Restrictions to address double counting risks

Among the three forms of double counting – double issuance, double claiming and double use – double claiming with 2020 targets poses the largest risk for environmental integrity. About 77% of the CER supply potential from all registered projects stems from emission reductions that fall within the scope of these targets. However, CDM host countries currently do not report or account for these emission reductions, which could lead to double claiming of emission reductions between the CDM host country and the acquiring country (see section 5.2.2.2).

To mitigate the risks arising from double claiming with 2020 targets, two approaches could be pursued:

1. **Prioritizing or limiting eligibility to CERs issued for emission reductions that are not covered by 2020 targets.** This would apply to:

    - CERs from host countries without any 2020 target (corresponding to a supply potential from registered projects of about 500 million for the period 2013 to 2020); and

    - CERs from host countries with a 2020 target but for which the emission reductions are not covered by the target (corresponding to a supply potential from registered projects of about 340 million for the period 2013 to 2020).

2. **Prioritizing or limiting eligibility to CERs from host countries that commit to avoiding double counting.** This would require host countries to account for the use of CERs in the period up to 2020. Host countries could, for example, account for CERs by applying "corresponding adjustments", as envisaged under the Paris Agreement, to their GHG emissions reported under the UNFCCC. Once an accounting framework has been agreed to under the Paris Agreement, host countries might also apply this framework mutatis mutandis to the context of 2020 targets.

Both approaches could in principle address the risk of double claiming and are not mutually exclusive. Approach 1 would be relatively simple to implement, but could penalize countries that put forward 2020 targets and provide an advantage to countries that were not ready to do so. Approach 2 would enable all countries to benefit from the opportunity of selling CERs for use after 2020, but could be politically challenging. Past efforts to gain agreement on common accounting principles under the UNFCCC have failed. Applying the accounting rules agreed under the Paris Agreement to the pre-2020 period would ensure that a consistent accounting framework is used for both emission reductions from CDM projects in the period up to 2020 and any international transfers after 2020. It would also help ensure that all carbon market units used under the Paris Agreement towards achieving NDC targets comply with the same requirements.

An important prerequisite for Approach 2 is that mitigation targets are transparent, quantified, and expressed in GHG metrics. A practical challenge in applying corresponding adjustments is the diversity of 2020 targets, including their expression as single-year targets for 2020. The impact of Approach 2 thus depends on the robustness of the accounting framework used to avoid double claiming.

6.5 Restrictions on countries or regions

Policy-makers could prioritize or limit eligibility of CERs to specific host countries or regions. Restrictions could be established, among others, on the basis of relevant UN classifications – notably LDCs and SIDS. An example is the EU ETS, in which eligibility of projects registered after 31 December 2012 was restricted to projects hosted in LDCs (European Commission, 2017). Other options are possible but not further explored here, such as the World Bank's classification into low, lower-middle, upper-middle and high income countries (World Bank, 2017), or a focus on countries that are "underrepresented" in the CDM.

Prioritizing or limiting eligibility to LDCs and SIDS would not necessarily promote environmental integrity. But it could be implemented with the aim of improving the regional distribution of CDM projects, potentially facilitating a more balanced regional distribution in the period after 2020 if the projects were transitioned and continued under Article 6.

The CER supply potential of registered projects hosted in LDCs and SIDS lies at around 150 million CERs, corresponding to about 3% of the potential from all countries.

6.6 Combinations of restrictions

Policy-makers could also pursue combinations of the restrictions discussed above. Figure 14 and Table 8 show the implications for the CER supply potential if different types of restrictions are combined. Of the total CER supply potential of 4.7 billion from all registered projects, about 780 million are from project types that typically have a variable or high vulnerability, about 840 million are from projects that are not covered by 2020 targets, and about 150 million are from projects located in LDCs or SIDS.

Combinations of these restrictions further reduce the CER supply. Of the 840 million CERs that are not covered by 2020 targets, about 300 million CERs are from projects that typically have a high or variable vulnerability.

Of these 300 million, about 70 million are from project types that typically have a high vulnerability. These stem mainly from N_2O, cookstove and biomass energy projects: 30 million are from nitric acid projects located mainly in Asia; about 20 million are from cookstove projects located mainly in Africa; and about 10 million are from biomass energy projects located mainly in Asia. About 15 million of these 70 million CERs – all from cookstove projects – would stem from LDCs or SIDS.

The remaining 230 million CERs are from project types with a variable vulnerability. These stem mainly from projects related to fugitive emissions (100 million), biomass energy (50 million), landfills (50 million), and methane avoidance (20 million). About 25 million of these 230 million CERs would stem from LDCs or SIDS.

The share of projects that are at risk of discontinuing GHG abatement is considerably larger in LDCs and SIDS than for all CDM countries. About 25% of the CER supply potential from LDCs and SIDS is from project types that typically have a high vulnerability; most are from PoAs located in Africa that distribute energy efficient household appliance projects, such as cooking stoves. Another 21% are from project types that typically have a variable vulnerability. The remaining 54% stems from project types that type have a low vulnerability, including mainly renewable energy and methane avoidance projects.

Prioritizing projects in LDCs and SIDS could have a better GHG emissions impact as compared to the overall pipeline, since only a small portion of the po-

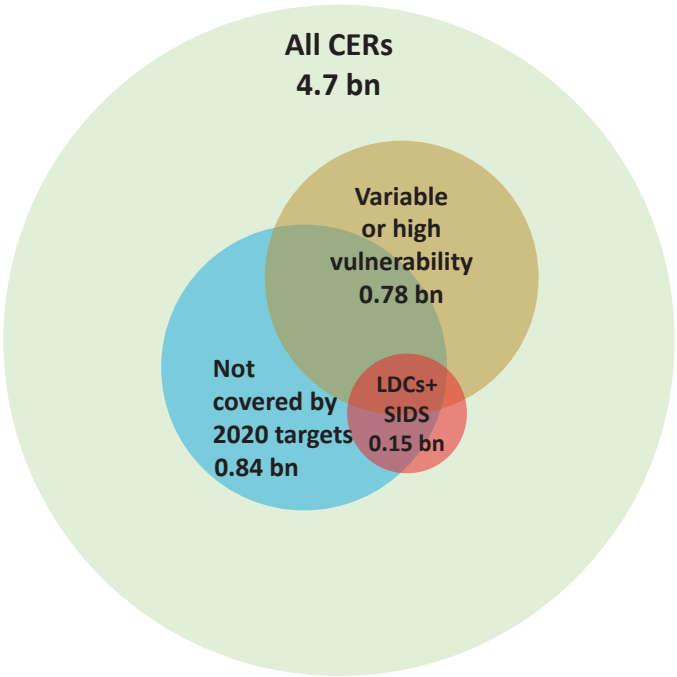

Figure 14: Implications of combinations of restrictions on the CER supply potential from registered projects in the period 2013 to 2020

Table 8: CER supply potential from registered projects for the period 2013 to 2020, differentiated by coverage by 2020 targets, project vulnerability and host countries (million CERs)

	All countries	LDCs and SIDSs
Not covered by 2020 targets	**840**	**90**
High vulnerability	70	20
Variable vulnerability	230	30
Low vulnerability	540	40
Vulnerability not assessed	0	0
Covered by 2020 targets	**3,590**	**30**
High vulnerability	70	0
Variable vulnerability	320	0
Low vulnerability	3,130	20
Vulnerability not assessed	70	0
Coverage not assessed	**220**	**40**
High vulnerability	40	20
Variable vulnerability	50	0
Low vulnerability	130	10
Vulnerability not assessed	0	0
Total	**4,650**	**150**

Note: Numbers may not add up due to rounding.

tential is subject to double claiming, and a higher proportion of projects is at risk of discontinuing abatement. Nevertheless, the share of projects deemed to have a high vulnerability is less than half of the supply potential.

6.7 Implications in the context of specific countries

Several countries have adopted policies or are considering policies to either purchase CERs from other countries or to use CERs from domestic projects. Others may wish to use the CDM to achieve their emission targets by selling CERs internationally. Here we explore for a few countries the potential implications if CERs were used after 2020, in the light of the findings of this study.

Norway intends to use of CERs to achieve its target in the second commitment period of the Kyoto Protocol. Norway has put forward an NDC target of reducing its GHG emissions by 40% below 1990 by 2030; the target is to be developed into an emissions budget covering the 2021 to 2030 period. According to estimates by Climate Action Tracker in 2016 (CAT, 2016a), Norway's NDC target in 2030 is about 20 million tCO_2e more stringent than its projected emissions with current policies. Norway intends to make use of international offsets if there is no agreement for collective delivery of the NDC with the EU (Norway, 2016). Norway also states in its NDC that it supports the opportunity to continue using units accruing from the CDM and JI in the Paris Agreement.

Norway's current CER purchasing programmes focus on acquiring CERs from projects vulnerable to discontinuing abatement due to low CER prices (Norway, 2017). If Norway were to make use of CERs towards achieving its NDC, and if it were to continue focusing on purchasing CERs from vulnerable projects, then the global GHG emissions impact of using such CERs would depend mainly on whether the CERs acquired are double claimed (section 5.2.2.2).

South Korea introduced an ETS which became operational in 2015 and allows for the use of offsets from "external reduction activities implemented by non-ETS entities". Offsets are eligible if the activities were implemented after 14 April 2010 and if they meet certain international standards – including the CDM (ICAP, 2017c). The use of offsets is limited to 10% of each entity's compliance obligation, totalling a maximum poten-

Table 9: CER supply potential from registered South Korean projects for the period 2013 to 2020

South Korea	Million CERs
All registered projects	130
Low vulnerability	80
Variable vulnerability	20
High vulnerability	20
Vulnerability not assessed	0

Note: Numbers may not add up due to rounding.

tial demand of 330 million tonnes by 2020 (see section 4.2.2). In phase three of the scheme (2021-2025), half of this limit can be fulfilled with international offsets (ICAP, 2017c). It is not clear whether eligibility rules for offsets will change for phase three (ICAP, 2017c).

South Korea has an economy-wide mitigation target for 2020; estimates by Climate Action Tracker (CAT, 2017b) indicate that current policies could be insufficient to achieve the target, with a gap of around 150 million tCO_2e in 2020. Climate Action Tracker (CAT, 2017b) also estimates that South Korea's NDC target in 2030 is about 200 million tCO_2e more stringent than its projected emissions with current policies. South Korea might thus use international transfers to achieve its NDC target.

The CER supply potential of registered South Korean projects for the period 2013 to 2020 lies at about 130 million CERs. Table 9 illustrates that most South Korean CDM projects (about 80 million) typically have a low vulnerability to discontinuing abatement, whereas some 20 million stem from project types that typically have high vulnerability. Projects with a high vulnerability are four N_2O projects and one HFC-23 project. Projects with a variable vulnerability include mainly SF_6 and landfill gas power projects.

In the case of South Korea, double claiming of emission reductions is a material risk, for three reasons: South Korea has an economy-wide 2020 target and all emission reductions from CDM projects are covered by the target; an analysis of the latest South Korean BUR[17] indicates that South Korea does not report on or account for emission reductions from CERs claimed by other countries; and South Korea is not forecasted to overachieve its 2020 target.

If South Korea continues to allow using CERs from emission reductions up to 2020 in its ETS after 2020, an important consideration for the global GHG emissions impact is whether South Korea would account for these CERs when accounting for its NDC target, either by adding them to an emissions budget corresponding to the NDC target or by subtracting them from its reported emissions. In that case, environmental integrity could be undermined and the cumulative GHG emissions from South Korea could be higher than its international targets. By contrast, if CERs are only used as a domestic compliance instrument in its ETS, but not accounted for internationally, only the emissions impact from South Korea's ETS may be undermined. To still achieve its NDC target, South Korea would have to compensate for the lower mitigation outcome from its ETS by reducing emissions in sectors not covered by the ETS or purchasing international units. In this case, global GHG emissions would not be affected.

Brazil, in its March 2017 submission to the UNFCCC argued for the "continuation of registered CDM project activities issuance under the [Article 6.4 mechanism]" and for the "eligibility of existing CDM CERs towards Article 6 of the Paris Agreement" (Brazil, 2017). Brazil argues that such provisions "could address demand issues and provide for a new price signal for CERs, which would, in turn, spur new project activities". Brazil thus proposes that CERs from emission reductions in the period up to 2020 be used towards achieving NDC targets after 2020. It is yet unclear whether Brazil intends to sell CERs from Brazilian projects to other countries or use them domestically to achieve its NDC target.

Brazil has a 2020 target which, according to estimates by Climate Action Tracker (CAT, 2017a), it is on track to *over-achieve* by around 250 million tCO_2e in 2020. Also according to estimates by Climate Action Tracker (CAT, 2017a), Brazil's NDC target in 2025 is about 10 million tCO2e less stringent than its projected emissions with current policies. Based on these projections, Brazil would not need to use

17 http://unfccc.int/resource/docs/natc/rkorbur1.pdf

Table 10: CER supply potential from registered Brazilian projects for the period 2013 to 2020

Brazil	Million CERs
All registered projects	230
Low vulnerability	170
Variable vulnerability	50
High vulnerability	10
Vulnerability not assessed	0

Note: Numbers may not add up due to rounding.

any CERs from emission reductions up to 2020 to achieve its NDC target.

The CER supply potential of registered Brazilian projects for the period 2013 to 2020 is about 230 million CERs. Most of the potential (170 million) stems from project types that typically have a low vulnerability. About 50 million are from project types that typically have variable vulnerability, mainly landfill gas projects. Only 10 million are from project types that typically have a high vulnerability, mainly from manure management and nitric acid projects (see Table 10).

Many of the Brazilian projects are implemented and likely to continue GHG abatement; they are also likely to have a low cost for issuing CERs. If Brazil intends to "spur new project activities" and to "provide for a new price signal for CERs", as communicated in its submission to the UNFCCC, a domestic CER purchase programme would have to ensure that new projects are being developed. A programme could do this by introducing respective vintage restrictions, or by ensuring that the demand significantly exceeds the supply from registered projects.

Double claiming of CERs vis-à-vis the 2020 target, however, may be less of a concern in the case of Brazil. This is because the expected over-achievement of its 2020 target is much larger than the emission reductions from the CDM. However, using CERs towards achieving its NDC target could lead to higher cumulative emissions (see section 5.2.3).

Kenya has a 2030 NDC target that is conditional on international support, and its NDC "does not rule out" the use of international market-based mechanisms. The country did not put forward a 2020 target.

The CER supply potential from registered Kenyan projects in the period 2013 to 2020 is about 21 million CERs (see Table 11); most of this volume stems from large renewable energy (geothermal and wind) projects that typically have low vulnerability to discontinuing GHG abatement. One million CERs could stem from project types that typically have high vulnerability, notably cook stove projects. Some 2 million CERs stems from projects deemed to have variable vulnerability, notably reforestation and domestic manure projects.

Kenya's absence of a 2020 target means that there is no risk of double claiming with 2020 targets when using CERs in the post-2020 period. The environmental impact of using CERs from Kenyan projects thus mainly depends on the vulnerability of projects to discontinuing GHG abatement.

Table 11: CER supply potential from registered Kenyan projects for the period 2013 to 2020

Kenya	Million CERs
All registered projects	21
Low vulnerability	17
High vulnerability	1
Variable vulnerability	2
Vulnerability not assessed	0

7 CONCLUSIONS AND RECOMMENDATIONS

Countries are currently considering using CERs issued for emission reductions up to 2020 to achieve targets after 2020 under the Paris Agreement and CORSIA. Using CERs could lower compliance costs, support stranded projects and ensure sufficient supply for the implementation of CORSIA. This study, however, finds that purchase programmes or policies that recognize *all* types of CERs for use after 2020 are unlikely to trigger significant emission reductions beyond those that would have occurred in the absence of the programme or policy.

This is largely due to two reasons. First, under current CDM market conditions – which are characterized by a strong imbalance between supply and demand – new demand for CERs would mostly be served by projects that have already been implemented and would continue GHG abatement even without CER revenues. While purchasing CERs from projects that continue GHG abatement would financially support them (e.g. by helping investors recoup costs or increase profits), it would not impact their GHG abatement. Second, robust accounting for the transfer of CERs is not ensured under the current international framework. The use of CERs after 2020 could lead to double claiming or lead to higher emissions pathways in pre-target years, in particular if used towards single-year targets.

While this study focuses on the environmental implications, it is important to note that purchasing or recognizing all types of CERs would not only fail to trigger significant further emission reductions but could also have adverse economic implications for project developers and host countries. CER prices would likely remain low, and thus might not generate sufficient incentives to develop new projects or continue GHG abatement in vulnerable projects. Moreover, if CER prices remain low, a considerable part of the funding dedicated to purchasing CERs might be used to cover transaction costs, and only a smaller part might remain with the project owners. For these reasons, recognizing all types of CERs may not maintain investor trust and confidence or spur new investments.

Policy-makers may thus carefully consider whether and how they use CERs after 2020. To ensure that further emission reductions are triggered and respective economic incentives are provided to project developers and host countries, it is recommended that they:

1. **Prioritize or limit eligibility to CERs from:**
   - Projects that are newly developed in response to the programme or policy and have a high likelihood of additionality, and/or
   - Already implemented projects that are at risk of discontinuing GHG abatement;
2. **Ensure robust accounting, in particular:**
   - Address the risk of double claiming with 2020 targets; and
   - Appropriately account for the vintage of CERs and the time frame of mitigation targets.

7.1 Prioritizing or limiting eligibility to specific projects

To prioritize or limit eligibility to new projects that have a high likelihood of additionality and to already implemented projects that are at risk of discontinuing GHG abatement, a method is required to (a) differentiate "new" from "already implemented" projects; (b) identify which new projects have a high likelihood of being additional; and (c) identify which already implemented projects are likely to be at risk of discontinuing GHG abatement.

To differentiate new from already implemented projects, various documented project development milestones could be used. Based on our analysis, the start date of the project – when the investment decision to proceed with the implementation of the project is made – is the most suitable milestone. Other options – such as the registration date or the start of the crediting period – would qualify projects as new that may have already been implemented in the past.

To identify new projects that have a high likelihood of additionality, policy-makers could establish a list of eligible project types. Though this poses several challenges, the prioritization of project types could be informed by existing analyses of the likelihood of additionality of different project types, and by project categories considered automatically as additional under the CDM.

To identify projects that are vulnerable to discontinuing GHG abatement, policy-makers could also establish a list of eligible project types, based on the typical

cost and revenue structure of the project type. Alternately, they could establish a methodological tool and a dedicated process to assess project vulnerability, under which individual projects would have to demonstrate that they would discontinue GHG abatement without continued CER revenues. Both options may require further research, building on previous assessments of project vulnerability.

7.2 Ensuring robust accounting

To avoid double claiming, either the use of CERs could be limited to emission reductions not covered by 2020 targets or host countries with 2020 targets could account for the issuance and transfer of CERs. Establishing such an accounting framework could be politically difficult, due to the political context of the 2020 targets. One option might be applying the accounting framework currently being negotiated under the Paris Agreement to the context of 2020 targets. While the implications of double claiming are limited in the context of the use of CERs up to 2020, there could be wider implications if CERs are used after 2020 towards NDCs and CORSIA. Addressing double claiming in this case would help ensure that a common accounting framework and the same principles apply to all carbon market units used after 2020, avoiding a market distortion between units with different vintages. It would also respond to the requirement under CORSIA to avoid double counting, as well as decision 1/CP.21 adopting the Paris Agreement, which urges countries to avoid double counting with regard to emission units issued under the Kyoto Protocol.

To appropriately account for the use of CERs in relation to the time frame of mitigation targets, countries could use CERs from emission reductions up to 2020 only towards multi-year emission targets or trajectories starting in 2021. This mitigates the risk for higher cumulative GHG emissions in pre-target years because the CERs are spread over several years and because the period until the first target year is relatively short.

8 REFERENCES

Bailis, R., Broekhoff, D. and Lee, C. M. (2016). *Supply and sustainability of carbon offsets and alternative fuels for international aviation*. *Stockholm Environment Institute, Working Paper 2016-03*. Stockholm Environment Institute (SEI). https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-03-ICAO-aviation-offsets-biofuels.pdf

Bailis, R., Drigo, R., Ghilardi, A. and Masera, O. (2015). The carbon footprint of traditional woodfuels. *Nature Climate Change*, *5*(3), 266–272. https://doi.org/10.1038/nclimate2491

Brazil (2017). *Views of Brazil on the Process Related to the Rules, Modalities and Procedures for the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement*. http://www4.unfccc.int/Submissions/Lists/OSPSubmissionUpload/525_318_131354420270499165-BRAZIL - Article 6.4. SBSTA46 May 2017. FINAL.pdf

Calvin, K., Rose, S., Wise, M., McJeon, H., Clarke, L. and Edmonds, J. (2015). Global climate, energy, and economic implications of international energy offsets programs. *Climatic Change*, *133*(4), 583–596.

Cames, M. (2015). *Availability of offsets for a global market-based mechanism for international aviation*. Öko-Institut. https://www.oeko.de/oekodoc/2394/2015-552-en.pdf

Cames, M., Graichen, J., Siemons, A. and Cook, V. (2015). *Emission Reduction Targets for International Aviation and Shipping. Study for the ENVI Committee, European Union*. http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf

Cames, M., Harthan, R., Füssler, J., Lazarus, M., Lee, C., Erickson, P. and Spalding-Fecher, R. (2016). *How additional is the clean development mechanism? Analysis of the application of current tools and proposed alternatives*. https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

CAT (2016a). Norway NDC rating. http://climateactiontracker.org/countries/norway.html

CAT (2016b). Tracking (I)NDCs: Assessment of mitigation contributions to the Paris Agreement. http://climateactiontracker.org/countries.html

CAT (2017a). Brazil NDC rating. http://climateactiontracker.org/countries/brazil.html

CAT (2017b). South Korea NDC rating. http://climateactiontracker.org/countries/southkorea.html

Colombia (2017). *Decreto 926 (1 Junio 2017)*. http://es.presidencia.gov.co/normativa/normativa/DECRETO 926 DEL 01 DE JUNIO DE 2017.pdf

Dechezlepetre, A., Calel, R., Colmer, J., Gennaioli, C., Glachant, M., and Schröeder, A. (2014). *Assessing the Additionality of the Clean Development Mechanism: Quasi Experimental Evidence from India*.

Ecosystem Marketplace (2016). *Raising Ambition: State of the Voluntary Carbon Markets 2016*. Forest Trends' Ecosystem Marketplace.

Erickson, P., Lazarus, M. and Spalding-Fecher, R. (2014). Net climate change mitigation of the Clean Development Mechanism. *Energy Policy*, *72*, 146–154. https://doi.org/10.1016/j.enpol.2014.04.038

European Commission (2015). Updated information on Exchange and International Credit Use in the EU ETS. https://ec.europa.eu/clima/news/articles/news_2015050402_en

European Commission (2017). Use of international credits. https://ec.europa.eu/clima/policies/ets/credits_en

European Environment Agency (2016). *Trends and Projections in the EU ETS in 2016: The EU Emissions Trading System in Numbers*. European Environment Agency, Luxembourg. https://doi.org/10.2800/472636

Graichen, J., Cames, M. and Schneider, L. (2016). *Categorization of INDCs in the light of Art. 6 of the Paris Agreement*. German Environment Agency, Berlin.. https://www.dehst.de/SharedDocs/downloads/EN/project-mechanisms/Categorization_of_INDCs_Paris_agreement_discussion_paper.pdf;jsessionid=

BFBA59FBBE7934C1FBD81AF1ABD7C9D6.1_cid284?__blob=publicationFile&v=2

Greiner, S., Howard, A., Chagas, T., and Hunzai, T. (2017). *CDM Transition to Article 6 of the Paris Agreement*. http://www.climatefocus.com/publications/cdm-transition-article-6-paris-agreement-options-report

Haya, B. and Parekh, P. (2011). *Hydropower in the CDM: Examining additionality and criteria for sustainability*. *Berkeley Energy and Resources Group Working Paper*. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2120862

He, G. and Morse, R. (2013). Addressing carbon Offsetters' Paradox: Lessons from Chinese wind CDM. *Energy Policy*, *63*, 1051–1055. https://www.researchgate.net/publication/257068805_Addressing_carbon_Offsetters_Paradox_Lessons_from_Chinese_wind_CDM

ICAO (2010). *Resolution A37-19: Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change*. International Civil Aviation Organization (ICAO). https://www.icao.int/environmental-protection/37thAssembly//wp025_en.pdf

ICAO (2016a). *Assembly Resolutions in Force (as of 6 October 2016). Doc 10075*. International Civil Aviation Organization (ICAO). http://www.icao.int/Meetings/a39/Documents/Resolutions/10075_en.pdf

ICAO (2016b). *Role of Carbon Markets in the Global MBM Scheme. Presentation delivered at the 2016 Global Aviation Dialogues*. International Civil Aviation Organization (ICAO). http://www.icao.int/Meetings/GLADs-2016/Documents/20160316_Role of Carbon Markets in ICAO global MBM.pdf

ICAP (2017a). *Emissions Trading Worldwide: Status Report 2017*. International Climate Action Partnership (ICAP). https://icapcarbonaction.com/en/?option=com_attach&task=download&id=447

ICAP (2017b). *Fact sheet: Mexico*. International Carbon Action Partnership (ICAP). https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=59

ICAP (2017c). *Korea Emissions Trading Scheme*. International Climate Action Partnership (ICAP). https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=47

ICAP (2017d). *Swiss ETS*. International Climate Action Partnership (ICAP). https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=64

ICE (2017). Emissions CER Index. https://www.theice.com/marketdata/reports/icefutureseurope/ECXCERIndex.shtml

IGES (2017). *IGES CDM Project Data Analysis & Forecasting CER supply*. https://pub.iges.or.jp/pub/iges-cdm-project-data-analysis-forecasting-cer

Kollmuss, A., Schneider, L., and Zhezherin, V. (2015). *Has Joint Implementation reduced GHG emissions? Lessons learned for the design of carbon market mechanisms. SEI working paper 2015-07*. Stockholm Environment Institute (SEI). http://www.sei-international.org/publications?pid=2803

Kreibich, N., and Obergassel, W. (2016). *Carbon Markets After Paris: How to Account for the Transfer of Mitigation Results?* (JIKO Policy Paper No. 01/2016). Wuppertal Institute. http://www.carbon-mechanisms.de/fileadmin/media/dokumente/publikationen/PP_2016_01_Accounting_bf.pdf

Lazarus, M., Kollmuss, A. and Schneider, L. (2014). *Single-year mitigation targets: Uncharted territory for emissions trading and unit transfers* (Working Paper No. 2014–1). Stockholm Environment Institute. https://www.sei-international.org/publications?pid=2487

Lee, D. S. and Owen, B. (2016). Environmental integrity of the ICAO offsetting scheme and the aviation part of the ETS under various scenarios. Presentation delivered at COP-22, Marrakesh.

Lütken, S. E. (2012). Penny wise, Pound foolish? Is the original intention of cost efficient emissions reduction through the CDM being fulfilled? http://orbit.dtu.dk/files/52915815/Pennywise_Poundfoolish_URC_WP1.pdf

Michaelowa, A., Greiner, S., Hoch, S., LE Saché, F., Brescia, D., Galt, H., Mayr, S. and Diagne, E.-H. M. (2015). *The Paris Agreement: The future relevance of UNFCCC-backed carbon markets for Africa*. *ClimDev-Africa Policy Brief*. http://www.climatefocus.com/publications/paris-agreement-future-relevance-unfcc-backed-carbon-markets-africa

Michaelowa, A., and Purohit, P. (2007). *Additionality determination of Indian CDM projects*. http://climatestrategies.org/wp-content/uploads/2007/02/additionality-cdm-india-cs-version9-07.pdf

Norway (2016). *Norway first NDC*. http://www4.unfccc.int/Submissions/INDC/Published Documents/Norway/1/Norway INDC 26MAR2015.pdf

Norway (2017). Norwegian Carbon Credit Procurement Program. https://www.regjeringen.no/en/topics/climate-and-environment/climate/innsiktsartikler-klima/norwegian-carbon-credit-procurement-program/id2415405/

Obergassel, W., and Gornik, M. (2015). Update on the Role of Market Mechanisms in Intended Nationally Determined Contributions. *JIKO Policy Brief*, (04/2015). http://www.carbon-mechanisms.de/en/2015/update-on-role-of-market-mechanisms-in-intended-nationally-determined-contributions/

Prag, A., Hood, C., and Barata, P. M. (2013). *Made to Measure: Options for Emissions Accounting under the UNFCCC*. Paris. http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/ENV/EPOC/IEA/SLT%282013%291&docLanguage=En

Purdon, M. (2014). *Ex-post Evaluation of the Additionality of a Clean Development Mechanism Cogeneration Project in Uganda: the significance of changes in project financing and background economic conditions* (No. 152). Grantham Research Institute on Climate Change and the Environment Working Paper. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/04/Working-Paper-152-Purdon-2014.pdf

Rogelj, J., Schaeffer, M., Friedlingstein, P., Gillett, N. P., van Vuuren, D. P., Riahi, K., Allen, M. and Knutti, R. (2016). Differences between carbon budget estimates unravelled. *Nature Climate Change*, *6*(3), 245–252. doi:10.1038/nclimate2868

Schneider, L. (2009). Assessing the additionality of CDM projects: practical experiences and lessons learned. *Climate Policy*, *9*(3), 242–254. https://doi.org/10.3763/cpol.2008.0533

Schneider, L., and Ahonen, H.-M. (2015). *Crediting early action: options, opportunities and risks*. https://www.energimyndigheten.se/contentassets/f3fd4d21d25a4aed8946ae5a33e9917f/crediting-early-action-final-report-schneider-ahonen.pdf

Schneider, L., Broekhoff, D., Cames, M., Füssler, J., and La Hoz Theuer, S. (2016). *Robust Accounting of International Transfers under Article 6 of the Paris Agreement - Preliminary Findings*. German Emissions Trading Authority, Berlin. http://sei-us.org/publications/id/595

Schneider, L., Broekhoff, D., Cames, M., Healy, S., Füssler, J., and La Hoz Theuer, S. (2016). *Market Mechanisms in the Paris Agreement - Differences and Commonalities with Kyoto Mechanisms*. German Emissions Trading Authority, Berlin. http://sei-us.org/Publications_PDF/DEHSt-2016-Market-mechanisms-Paris-Agreement-Kyoto-Protocol.pdf

Schneider, L., and Cames, M. (2014). *Options for continuing GHG abatement from CDM and JI industrial gas projects*. Öko-Institut. https://www.oeko.de/oekodoc/2030/2014-614-en.pdf

Schneider, L., Day, T., La Hoz Theuer, S. and Warnecke, C. (2017). *Discussion paper: CDM supply potential up to 2020*. NewClimate Institute. https://www.dehst.de/SharedDocs/downloads/EN/project-mechanisms/CDM-Supply-Potential-up-to-2020.pdf?__blob=publicationFile&v=2

Schneider, L., Füssler, J., La Hoz Theuer, S., Kohli, A., Graichen, J., Healy, S. and Broekhoff, D. (2017). *Environmental Integrity under Article 6 of the Paris Agreement*. https://www.dehst.de/SharedDocs/Downloads/EN/JI-CDM/Discussion-Paper_Environmental_integrity.pdf?__blob=publicationFile

Schneider, L., Kollmuss, A. and Lazarus, M. (2015). Addressing the risk of double counting emission reductions under the UNFCCC. *Climatic Change*, 473–486. https://doi.org/10.1007/s10584-015-1398-y

Spalding-Fecher, R., Narayan Achanta, A., Erickson, P., Haites, E., Lazarus, M., Pahuja, N., Pandey, N., Seres, S. and Tewari, R. (2012). *Assessing the impact of the clean development mechanism.* CDM Policy Dialogue. http://www.cdmpolicydialogue.org/research/1030_impact.pdf

Swartz, J. (2016). *China's National Emissions Trading System: Implications for Carbon Markets and Trade*. International Centre for Trade and Sustainable Development (ICTSD). http://www.ictsd.org/themes/climate-and-energy/research/china's-national-emissions-trading-system-implications-for-carbon

Swedish Energy Agency (2015). Swedish Programme for International Climate Change Mitigation. http://www.energimyndigheten.se/en/cooperation/international-climate-cooperation/flexible-mechanisms---cdm-ji--et/the-swedish-cdm-and-ji-programme/

Thomson Reuters (2016). *Carbon Market Monitor - Review of global carbon markets in 2015 and outlook for 2016 - 18*. http://climateobserver.org/wp-content/uploads/2016/01/Carbon-Market-Review-2016.pdf

Thomson Reuters (2017). *Will Colombian fuel tax uphold domestic carbon projects ?*

UNEP (2017). *Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol. Seventy-ninth meeting. Bangkok, 3–7 July 2017. Key aspects related to HFC-23 by-product control technologies (decision 78/5). Doc. number UNEP/OzL.Pro/ExCom/79/4*. http://www.multilateralfund.org/79/English/1/7948.pdf

UNEP DTU (2017). *CDM/JI Pipeline Analysis and Database*. http://www.cdmpipeline.org/

UNFCCC (2014). *Handbook on Measurement, Reporting and Verification for Developing Country Parties*. United Nations Climate Change Secretariat. http://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf

UNFCCC (2016). *Options for using the clean development mechanism as a tool for other uses. Concept note*. https://cdm.unfccc.int/filestorage/2/M/1/2M1EZ9RTQCY58NX6AIO73SWBKFUVPJ/eb88_propan01.pdf?t=cmV8b3ZncHFofDDGr5_VD3MPcfU6zoNgZFqJ

UNFCCC (2017a). *Carbon market and policy developments. Presentation delivered by the UNFCCC secretariat to the 95th meeting of the Executive Board of the Clean Development Mechanism. July 2017*. http://cdm.unfccc.int/Meetings/MeetingInfo/DB/WI3AR50OPCF8STQ/view

UNFCCC (2017b). CDM Insights. http://cdm.unfccc.int/Statistics/Public/CDMinsights/index.html

UNFCCC (2017c). *Database for PAs and PoAs*. http://cdm.unfccc.int/Statistics/Public/files/Database for PAs and PoAs.xlsx

UNFCCC (2017d). Submission Portal - SBSTA. http://www4.unfccc.int/submissions/SitePages/sessions.aspx?showOnlyCurrentCalls=1&populateData=1&expectedsubmissionfrom=Parties&focalBodies=SBSTA

van Velzen, A. and Cames, M. (2016). *Forecasted offset demand under CORSIA. Unpublished model run of AERO-MS for BMUB/DEHSt.*

Warnecke, C., Day, T. and Klein, N. (2015). *Analysing the status quo of CDM projects: Status and prospects*. http://newclimate.org/2015/05/16/analysing-the-status-quo-of-cdm-projects/

Warnecke, C., Day, T., Schneider, L., Cames, M., Healy, S., Harthan, R., Tewari, R. and Höhne, N. (2017). *Vulnerability of CDM projects for Discontinuation of Mitigation Activities: Assessment of Project Vulnerability and Options to Support Continued Mitigation*. https://www.dehst.de/SharedDocs/downloads/EN/project-mechanisms/vulnerability-of-CDM.pdf?__blob=publicationFile&v=3

Warnecke, C., Day, T. and Tewari, R. (2015). *Impacts of the Clean Development Mechanism*. http://newclimate.org/2015/11/30/impacts-of-the-clean-development-mechanism/

World Bank (2017). World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

World Bank andEcofys (2017). *Carbon Pricing Watch 2017*. https://openknowledge.worldbank.org/bitstream/handle/10986/26565/9781464811296.pdf

World Bank, Ecofys and Vivid Economics (2016). *State and Trends of Carbon Pricing 2016*. https://doi.org/10.1596/978-1-4648-1001-5

SEI - Headquarters
Stockholm
Sweden
Tel: +46 8 30 80 44
Executive Director: Johan L. Kuylenstierna
info@sei-international.org

Visitors and packages:
Linnégatan 87D
115 23 Stockholm, Sweden
Letters:
Box 24218
104 51 Stockholm, Sweden

SEI - Africa
World Agroforestry Centre
United Nations Avenue, Gigiri
P.O. Box 30677
Nairobi 00100
Kenya
Tel: +254 20 722 4886
Centre Director: Stacey Noel
info-Africa@sei-international.org

SEI - Asia
15th Floor
Witthyakit Building
254 Chulalongkorn University
Chulalongkorn Soi 64
Phyathai Road, Pathumwan
Bangkok 10330
Thailand
Tel: +(66) 2 251 4415
Centre Director: Niall O'Connor
info-Asia@sei-international.org

SEI - Oxford
Florence House
29 Grove Street
Summertown
Oxford, OX2 7JT
UK
Tel: +44 1865 42 6316
Centre Director: Ruth Butterfield
info-Oxford@sei-international.org

SEI - Stockholm
Linnégatan 87D, 115 23 Stockholm
(See HQ, above, for mailing address)
Sweden
Tel: +46 8 30 80 44
Centre Director: Louise Karlberg
info-Stockholm@sei-international.org

SEI - Tallinn
Lai str 34
10133 Tallinn
Estonia
Tel: +372 627 6100
Centre Director: Lauri Tammiste
info-Tallinn@sei-international.org

SEI - U.S.
Main Office
11 Curtis Avenue
Somerville, MA 02144
USA
Tel: +1 617 627 3786

Davis Office
400 F Street
Davis, CA 95616
USA
Tel: +1 530 753 3035

Seattle Office
1402 Third Avenue, Suite 900
Seattle, WA 98101
USA
Tel: +1 206 547 4000

Centre Director: Michael Lazarus
info-US@sei-international.org

SEI - York
University of York
Heslington
York, YO10 5DD
UK
Tel: +44 1904 32 2897
Centre Director: Lisa Emberson
info-York@sei-international.org

Stockholm Environment Institute

SEI is an independent international research institute that has been engaged in environment and development issues at local, national, regional and global policy levels for more than 25 years. SEI supports decision-making for sustainable development by bridging science and policy.

sei-international.org

Twitter: @SEIresearch, @SEIclimate