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Towards net zero: making baselines for international carbon markets dynamic by applying 'ambition coefficients'

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ABSTRACT

This paper discusses options to increase mitigation ambition in crediting mechanisms that serve the Paris Agreement (PA), such as the Article 6.4 mechanism. Under the Clean Development Mechanism and other crediting mechanisms, baselines have been specified in the form of greenhouse gas (GHG) intensity factors and linked to business-as-usual developments. This means that with increasing production of goods and services through carbon market activities, absolute emissions may increase or fall only slowly. At a global level, such an approach widens the 'emissions gap'. To enable continued use of emissions intensity baselines in crediting mechanisms while being in line with the PA's goal to pursue efforts to limit temperature rise to 1.5°C, we propose to apply an 'ambition coefficient' to emissions intensities of technologies when establishing the baseline. This coefficient would decrease to reflect increasing ambition over time, and reach zero when a country needs to reach net zero emissions. Due to the principle of common but differentiated responsibilities and respective capabilities, the coefficient would fall more quickly for developed than for developing countries. The latter would be able to generate emission reduction credits well beyond 2050, while for the former, crediting would stop around 2035 or before. An ambition coefficient approach would generate certainty for carbon market investors and preserve trust in international carbon markets that operate in line with the agreed, long-term ambition of the international climate regime.

Key policy insights:

- An ambition coefficient can help to align carbon market activities with net zero GHG emission pathways at country level, and ensure that carbon markets will not lead to a lock-in of emissions in participating countries.
- The ambition coefficient approach can serve as a 'bridging proposal' for the operationalization of PA carbon markets. It may resolve negotiation gridlock between those who want to increase stringency in carbon market instruments and those who think mitigation ambition should be generated through more stringent NDCs, facilitated by cost savings and increased financial resources generated by international carbon markets.
- The use of an ambition coefficient can enable the alignment of existing methodologies with necessary ambition levels to implement the PA, while also keeping transaction costs low.

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1. Introduction

Baseline setting is a critical element of international carbon markets, as the stringency of the baseline determines the volume of emission credits an activity can produce. So far baselines have mainly been set at business-as-usual (BAU) levels determined by historical emissions intensities of the production of goods and services. These levels remained unchanged over the period over which emission credits accrue. This has led to intense criticisms of international carbon markets based on the observation that the overall production of goods and services increases over time, and thus absolute emissions continue to increase even for activities that generate emission credits and thus are deemed to reduce emissions. The recent decision on rules for international carbon markets under Article 6 of the Paris Agreement (PA) includes stringent principles for baseline setting, including their alignment with the PA's long-term goal of limiting global temperature rise to 'well below' 2°C and pursuing efforts towards 1.5°C. This means that baselines need to become dynamic, that is, for their parameters to become more stringent over time. The operationalization of the baseline principles is currently underway.

This paper seeks to contribute to this operationalization by making a concrete proposal – the use of an 'ambition coefficient' declining over time – to make baselines consistent with emissions paths leading towards net zero emissions in the second half of the century. In section 2 we describe the tasks of carbon markets under the PA, followed by a section on how dynamic baseline elements were applied in the past. Section 4 discusses how dynamic baseline setting could be brought in under the Article 6 rules. In section 5 we introduce the ambition-coefficient approach and provide two case studies in which we illustrate its application. Section 6 assesses options to determine the underlying pathways towards which the ambition coefficient is employed. Subsequently, we discuss our results and highlight further research needs before concluding.

2. The role of carbon markets in the Paris Agreement

Under the PA, all countries take up commitments, but define their own national mitigation targets as well as related metrics and coverage in their Nationally Determined Contribution (NDC). NDCs are to be 'ratcheted up' at least every five years. Article 6 of the PA enables Parties to engage in international cooperation to increase overall mitigation and ambition of NDCs over time (see also Howard et al., 2017), while facilitating achievement of NDCs through reducing costs for buyers as well as generating financial resources for sellers of internationally transferred mitigation outcomes (ITMOs). It offers two avenues for such international carbon market cooperation. Firstly, under Article 6.2, Parties can engage in bi – or multi-laterally designed cap-and-trade or baseline-and-credit mechanisms at the activity, sectoral or policy scale and create government authorized ITMOs for compliance or voluntary carbon markets (UNFCCC, 2021b). Secondly, Article 6.4 establishes an international crediting mechanism, replacing the Kyoto Protocol's (KP) Clean Development Mechanism (CDM). The host country has the choice to authorise Article 6.4 emission reduction credits (A6.4ERs) to become ITMOs. Only then, these credits can be used towards other Parties' NDCs or other international mitigation purposes, such as the Carbon Offsetting and Reduction Scheme in International Aviation (CORSIA).

The key challenge of the PA is to reconcile its bottom-up nature with the ambition of its long-term, global goal of limiting global warming to 'well below' 2°C, aiming at 1.5°C. Current projections stipulate that the emissions gap between NDCs and 1.5–2°C compatible emissions paths in 2030 has increased over the last 10 years (UNEP, 2021). Global BAU emissions are projected to rise, mostly driven by strong economic growth and associated increased consumption levels in many developing countries. But global emissions must decrease drastically to reach the PA goal. Before and during the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2021, many countries declared net zero emissions targets for years between 2035 and 2070. The International Energy Agency (IEA) (Birol, 2021) estimates that global warming could be limited to 1.8°C if all the pledges were fully implemented. To achieve this, all countries need to pursue decarbonization pathways at an extraordinary pace. In this context, how can international carbon markets become enablers of the transformation and support countries moving towards net zero emission pathways?

3. Baseline setting in historical carbon markets and consequences for Article 6 rules

Most historic carbon markets relied on so-called 'baseline-and-credit systems' which calculate credit volumes as the difference between emissions under a counterfactual, the so-called baseline, and emissions after the implementation of a greenhouse gas (GHG) mitigation activity. Methodologies for baseline definition differ by concrete activity (projects or programmes) and mitigation policy (see Wooders et al., 2016 for a discussion of the latter). Generally, a stringent baseline leads to a low amount of, or zero, emissions credits being allocated to a mitigation activity while a lenient one will allocate a lot of credits.[1] There is ample historic experience with baseline-and-credit systems through the KP's 'flexible mechanisms', namely the CDM and Joint Implementation (JI), which respectively generated 2 billion emission credits in developing countries without formal mitigation targets and 0.8 billion emission credits in developed countries subject to a KP target.

Article 6 cooperation is comparable to JI under which all participating countries had emission targets. The experience with JI highlights the importance of international oversight to ensure consistency and rigour, as under 'track 1', where countries could choose their own baseline methodologies, the lack of oversight led to widely differing approaches, where the stringency of methodologies was seen as insufficient by researchers (Korppoo & Gassan-Zade, 2014; Shishlov & Cochran, 2015). To avoid this, the Article 6.4 Supervisory Body (A6.4SB) will take up the task of approving baseline methodologies in a role comparable to the CDM Executive Board under the CDM. Baseline methodologies can be developed by the A6.4SB itself, but also activity developers, host country authorities or other entities.

Vast technical experience has been gained over the last 15 years of the CDM during the development of over 250 baseline methodologies for a wide range of mitigation technologies. For the majority of these methodologies, baselines are determined by an estimate of BAU emissions pathways where the BAU baseline is defined in terms of the emissions intensity per unit of production of a good or service, and not in terms of absolute emissions. Therefore, absolute emissions of the activity can still increase if the production of the goods and services increases and the rate of production increase exceeds the rate of GHG intensity reduction. The CDM has achieved a downward trend in emission intensities, particularly in the case of industrial gas activities, but has not been able to prevent absolute emissions increases in host countries. To be fair, it did not have this aim, as its purpose was to achieve emission reductions from BAU, given that developing countries did not have emissions targets under the KP.

The CDM and JI were heavily criticised by some environmental NGOs and researchers for various reasons (Michaelowa et al., 2019b; Shishlov & Bellassen, 2012). From 2011 onwards, this led to a reduction of demand for CDM emission credits, with the EU first limiting the use of such credits in its emissions trading scheme (ETS) and other countries following suit. This was compounded by the lack of regulatory clarity regarding the future of the KP and the very slow ratification of targets for a second commitment period of the KP (Doha Amendment). Prices for emission credits collapsed by 2013, and many observers saw no role for international carbon markets in the new international regime (Michaelowa et al., 2019b). Moreover, international carbon markets may lead to a 'carbon lock-in' the countries acquiring emission credits and work against net zero targets (see discussion of how to ensure environmental integrity of the systems by Schneider & La Hoz Theuer, 2019). So, it came as a surprise to many that the PA again included two approaches for international market-based cooperation.

With the adoption of the PA and its Article 6, the conflicts were far from over. Differing views on the role of carbon market instruments meant that rules could only be agreed at the 26th Conference of the Parties in November 2021 in Glasgow (ECBI, 2022). At a technical level, the scepticism regarding the consistency of baseline-and-credit systems with the PA architecture led to the decision that baselines for both Article 6.2 and 6.4 would be set below BAU, i.e. more stringent than BAU[2], and in line with the long-term goal of the PA. Through this, market mechanisms would contribute to the transformational change needed to shift emissions to pathways that are in line with the net zero targets countries have been taking up (Michaelowa et al., 2021b; ECBI, 2022). Moreover, in that context, 'lock-in' of carbon intensive technologies is to be considered when determining the additionality of activities under Article 6.4 (UNFCCC, 2021a).

If one would now continue to apply intensity-based baseline methodologies, absolute emissions would increase or only decrease slowly if production increases at a higher rate than intensity declines. Figure 1

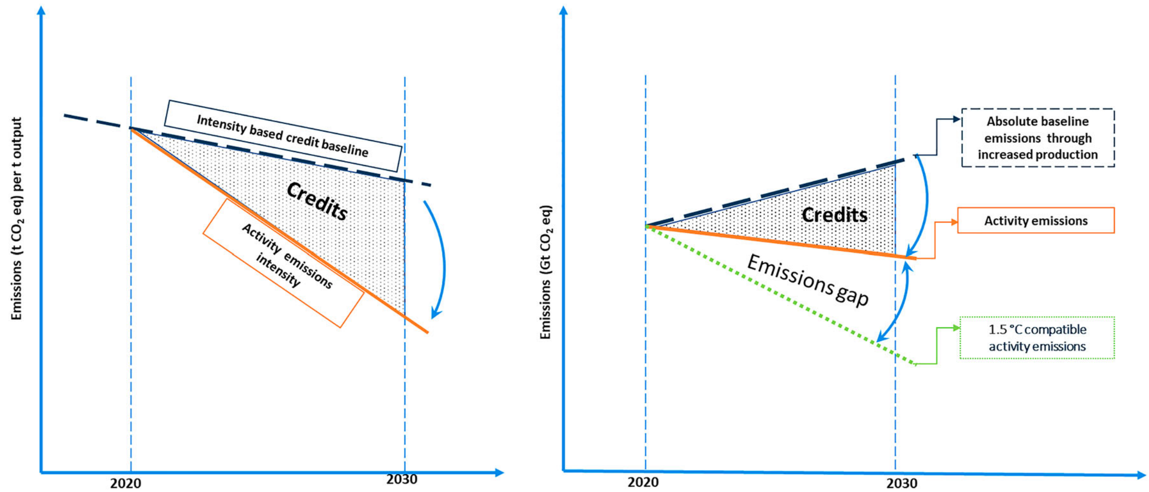

Figure 1. Intensity baseline decline while absolute emissions increase on an activity level. Source: authors.

shows the links between intensity-based assessments (left-hand side) and changes in absolute emissions (right-hand side) for an activity involving rapid production growth. In this case, even a sharp reduction in emissions intensity would neither be consistent with a 1.5°C compatible emissions pathway, nor the Article 6.2 guidance which requires Parties to ensure there is 'no net increase in emissions of participating Parties within and between NDC implementation periods' (UNFCCC, 2021b, annex, paragraph 17).

Given that developing new methodologies from scratch would require significant time and resources for setting up alternative approaches[3], at COP26, Parties agreed to allow for the transition of CDM activities into the Article 6.4 mechanism, subject to host country approval. They could still apply their CDM methodologies; new Article 6.4 methodologies would only be required from 2025 onwards (UNFCCC, 2021a).

4. Dynamic baseline setting under Article 6

There are two different approaches to the conceptualization of 'dynamics' in the context of baselines. The first one defines key parameters that are exogenous to the activity, e.g. overall level of economic activity or energy prices, and estimates them ex-ante. Credits are only issued for ex-post calculations of these parameters based on actual and validated data (Michaelowa et al., 2019a). As a consequence, such dynamic baselines adjust automatically to changing GHG emissions trajectories and reflect what has happened and not solely projections.

Under the second approach, baseline emissions intensity decreases over time through the application of a fixed dynamic transition parameter. The baseline emission intensity of the host country would gradually and in a predetermined way move downwards from a BAU trajectory towards a GHG emission level determined by norms or policy. This 'end point' can be set at different levels including at a level determined by the 'best available technology' (BAT) (Hermwille, 2020), at the economy-wide or sectoral level necessary to achieve the NDC, or at a level consistent with a net zero pathway in line with the long-term goal of the PA.

Both approaches will reduce the attractiveness of international carbon markets for activity developers, as they will reduce emission credit volumes compared to the traditional emissions intensity baselines. The first one generates a higher uncertainty for the activity developer compared to the second one, as the number of emissions credits remains unclear for the first approach until verification, whereas it is predetermined for the second approach. A governmental actor might favour the first approach, as it ensures that generated mitigation outcomes are real in the context of development of key parameters of the national economy. The second approach, though, might be more easily aligned with national policies and strategies and offer greater predictability hence improving the bankability of individual projects.

Already in the past, some dynamic elements were used for baseline determination. The CDM rules stipulated in the 2001 Marrakech Accords provide as one of three options to define a best 20% benchmark 'of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances' (UNFCCC, 2005, annex to decision 3/CMP.1, paragraph 48). Yet, this does not include a forward-looking component. Moreover, for some industrial gas projects, the applicable baseline emissions factors per unit of production have been reduced significantly over time. Driven by the persistent criticism of international NGOs and academia, they eventually became much stricter than actual values achieved in the past, to eliminate incentives to increase production to earn more credits (Schneider, 2011). In other methodologies, a dynamic outcome was achieved as conservative default factors replaced actually measured values in CDM methodologies. The main reason for this shift was a significant reduction of transaction costs for activity developers. For example, the initial version of methodology AM 0046 for energy efficient lighting had very cumbersome monitoring requirements regarding the utilization pattern of lighting and thus was not used widely. Subsequent versions applied default utilization hours that were lower than those found through measurement, and usage of the methodology picked up. This experience showed that activity developers are willing to accept a reduction in credit volumes against a reduction in transaction costs (Michaelowa et al., 2009).

The COP26 decisions on the Article 6.4 mechanism (UNFCCC, 2021a, 2021b) provide key principles for methodologies as described above which can lead to a dynamic character of baselines. Specifically, the preferable approaches under Article 6.4 are BAT assessments and performance benchmarks where the baseline is set 'at least at the average emission level of the best performing comparable activities providing similar outputs and services within a defined scope' (UNFCCC, 2021a, annex, paragraph 36aii). Füssler et al. (2019b) discuss how such benchmarks could be designed where baselines can still be based on projected or historical emissions but need to be adjusted downwards.

In the following, we propose a simple approach for 'dynamic' baseline setting, complementing an emissions intensity baseline with a normative reference in order to operationalize one of the options for baseline setting approaches under the Article 6.4 mechanism, 'an approach based on existing or actual historical emissions, adjusted downwards (…)' (UNFCCC, 2021a, annex, paragraph 36,a,iii). This will allow the continued use of the existing body of methodologies, offering a solution to revise them and align them with the necessary ambition levels to achieve the PA objectives.

5. Introducing the ambition coefficient approach

5.1. Conceptual approach

For the calculation of emission reductions for activities and sectors, we propose the introduction of a dynamic baseline approach based on a pre-determined transition parameter: the 'ambition coefficient'. This coefficient will ensure that the mitigation mobilized is fully aligned with the host country's pathway towards net zero emissions.

The approach starts from the baseline approaches defining BAU which have been fine-tuned over the last 15 years under the CDM. For the 'downward adjustment', we propose to apply to the baseline emissions intensity a gradually decreasing multiplier, which over time reaches a 'normative reference' consistent with the long-term target of the PA, i.e. a net zero GHG emission situation at a specified time in the future. This point in time will determine the 'transition period' in which a given country can generate emission credits. We expect that its determination will be heavily contested. In this context, the application of the UNFCCC principle of common but differentiated responsibilities and respective capabilities (CBDR-RC) will be important. Just to give one example: for developing countries, the level of abatement costs that can be shouldered will be less than for developed ones, resulting in different transition periods.

Hermwille (2020) refers to the normative reference as an 'ought margin' which is defined as the normatively desirable endpoint of the emissions trajectory, i.e. zero GHG emissions if we follow the long-term objective of the PA. The baseline is calculated as a weighted average of the BAU (the situation) and the 'ought margin' (the ambition), with the weights shifting over time from 100% BAU and 0% 'ought margin' to 0% BAU and 100% 'ought margin' (see Figure 2). In contrast to what we propose in this paper, Hermwille (2020) does not use

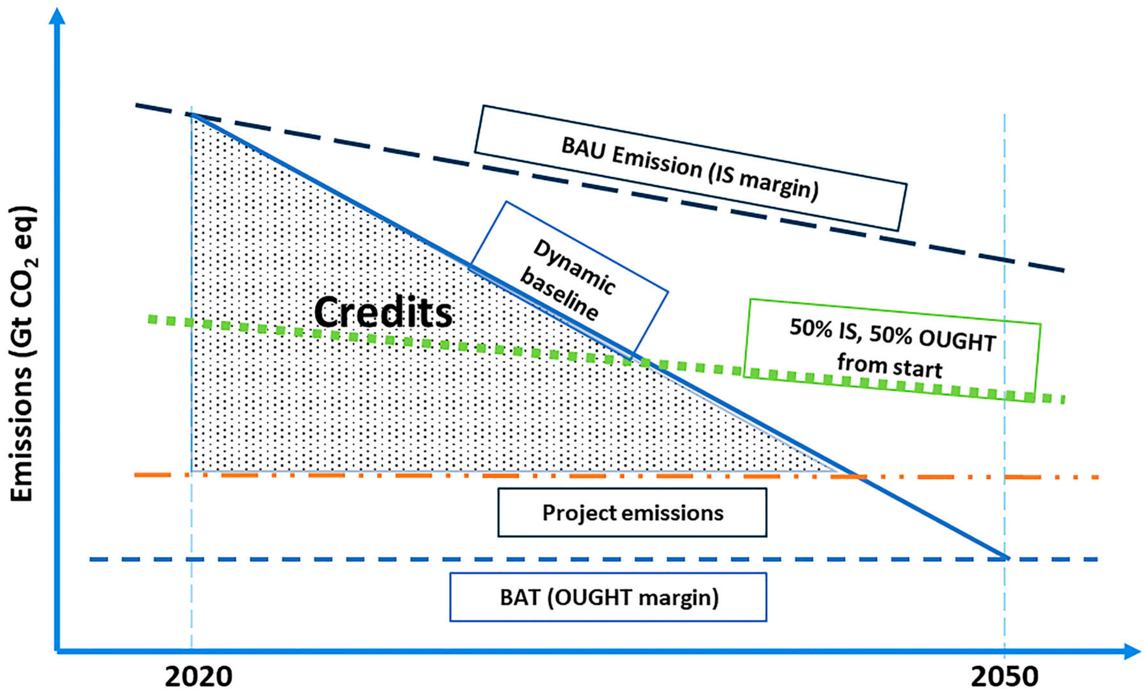

Figure 2. Transition from a BAU to an 'ought margin' defined by BAT through a dynamic baseline. Source: Hermwille (2020), p. 12.

the country's zero-emissions target but considers BAT as the 'ought margin'. In this case, the dynamic baseline allows for credit generation until approximately 2045. Afterwards the project emissions exceed the crediting baseline (see Figure 2).

The main reason to suggest an alternative to a BAT-oriented approach is that it may not be sufficient to reach the long-term goal of the PA and may only work for some sectors (for a detailed discussion, see Michaelowa et al., 2021a). Instead, we propose that the 'ambition coefficient' starts at 1 and reaches zero when a country needs to reach net zero emissions.[4] This also allows to specify the transition period. At the global level, GHG emissions will need to be at net zero in 2050 to limit global warming to 1.5°C with high probability

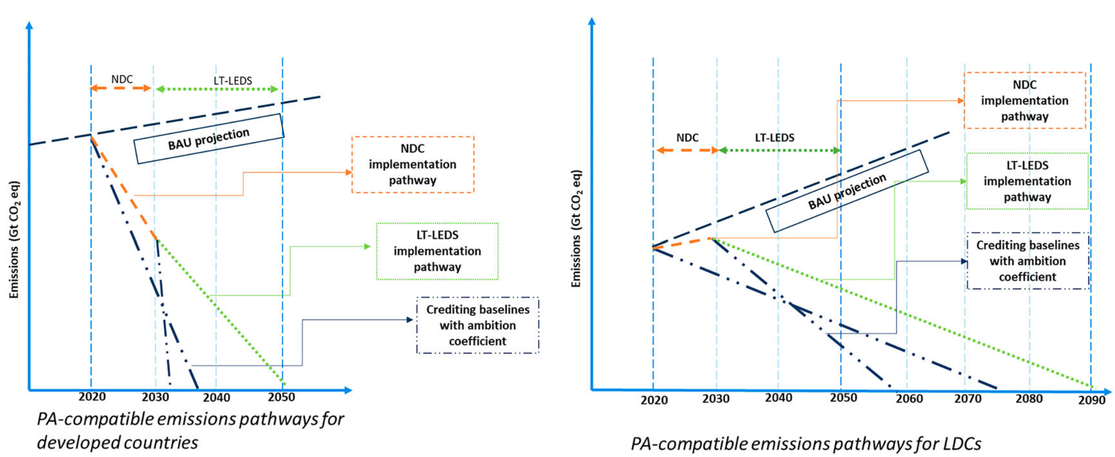

Figure 3. Different net zero pathways consistent with CBDR-RC. Note: LT-LEDS: Long-term low emissions development strategy. Source: authors.

(IPCC, 2022). Correspondingly, a global ambition coefficient would start at 1 in the starting year (2020) and decrease in a linear manner until it reaches zero in 2050. After that, only GHG removal[5] activities would generate emission credits.

Given the CBDR-RC principle, the time when countries will no longer be able to export emission reductions to international carbon markets will be earlier for developed countries than developing ones (see Figure 3 for stylised examples of emissions paths with accelerated action starting in 2020/2030). This is also in line with the concept of 'suppressed demand' for goods and services in developing countries that is explicitly recognized in Article 6.4. Suppressed demand is a recognition of the fact that, as development occurs in these countries, demand for goods and services and therefore also emissions rise. Therefore, developing countries, and least developed countries (LDCs) in particular, should have more 'carbon space' in the coming decades compared to a developed country, which in our example would already have to achieve net zero emissions before 2040.

5.2. Case 1: adjusting grid emission factors

The conceptual application of the ambition coefficient is shown in Figure 4 for two countries, a developed one and a developing one, here exemplified by South Korea and Rwanda. The proposed approach would take the BAU emissions intensity, as calculated in CDM baseline methodologies, and multiply it by the ambition coefficient which declines over time.

To illustrate the functioning of the ambition coefficient concept in detail, we now explore two cases for different sectors. First, we undertake the calculation of baseline emissions for projects producing renewable electricity for the grid[6] and for saving electricity in South Korea, and Rwanda, respectively. We assume that the projects start in 2021, as ITMOs are generated through mitigation activities from 2021 onwards (UNFCCC, 2021a, 2021b). We assume that the activities have a crediting period of five years, renewable twice (so a maximum of 15 years) as per the rules of the Article 6.4 mechanism (UNFCCC, 2021a), reaching the year 2035. As a first step we take the average grid emissions factor calculated as per the baseline methodology applicable under the CDM, using the 'Tool to calculate the emission factor for an electricity system', from the database published by the Institute of Global Environmental Strategies (2021): 626 g CO_2/kWh for South Korea and 654 g CO_2/kWh for Rwanda.

As second step, we apply a country-specific ambition coefficient for each emission reduction vintage year. Here we apply our own assumptions to determine the ambition coefficients; we discuss in the next section how international agreement on the ambition coefficients could be found. For South Korea as an OECD member, responsibility is high as acknowledged by the government when declaring a net zero target for 2050. We thus set 2040 as the year in which the ambition coefficient reaches zero. For Rwanda as an LDC, responsibility is low and therefore 2070 is set as the date when the ambition coefficient attains zero.

Applying these values to calculate the ambition coefficient, it reaches 75% in 2025, 50% in 2030 and 25% in 2035 for the case of South Korea, while it reaches 90% in 2025, 80% in 2030 and 70% in 2035 for Rwanda. The resulting baseline emission factors and ambition coefficients are shown in Table 1. The outcome would be that

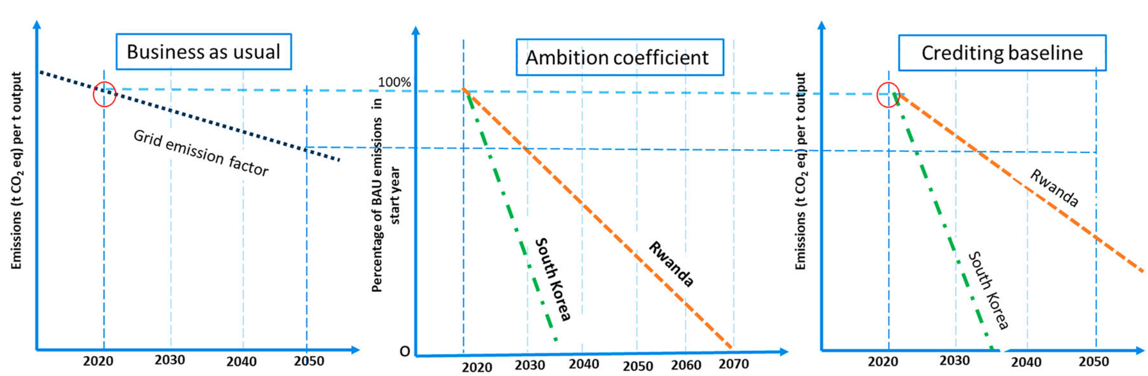

Figure 4. Application of the ambition coefficient to the BAU to derive a dynamic crediting baseline in a case study. Source: authors.

Table 1. Declining baseline emissions factors (g CO_2/kWh) for grid electricity-related activities and ambition coefficients (%) in South Korea and Rwanda: 2020–2035.

Country	2020	2025	2030	2035
Rwanda	654 (100%)	589 (90%)	523 (80%)	458 (70%)
South Korea	626 (100%)	470 (75%)	313 (50%)	157 (25%)

Source: authors, 2020 baseline emission factors from IGES (2021).

an activity in Rwanda would generate significantly more credits compared to South Korea for a similar type of project from the late 2020s onward.

Note that we choose South Korea because it has historically been an OECD country without an emission target under the KP. Developed countries may also collaborate under Article 6, but their transition period would be very short under our proposal. Hence, we expect that they might primarily rely on removal technologies for which the ambition coefficient approach is not designed (see below). For example, the Government of Sweden even specified a removal target of 10.7 Mt CO_2e from 2045 onwards in a recent report (Statens Öffentliga Utredningar, 2020, p. 85). Even in a net zero world, some emissions will remain necessary but they will require appropriate compensation using removals (Obergassel et al., 2021). Furthermore, in an intermediate period, where the PA requires global net zero emissions while developing countries still generate emissions, developed countries need to achieve an equivalent volume of removals (see e.g. WBGU, 2021, p. 7).

5.3. Case 2: adjusting emission baselines for waste sector activities

The second case looks at the waste sector. Activities can include landfill gas flaring reduction, composting or reduction of methane generated from wastewater treatment. We take two actual, recent CDM projects in South Korea ('LFG power plant in Changwon', UNFCCC registration number 10501) and Ethiopia ('GHG emissions reduction through Modjo Common Effluent Treatment Plant', UNFCCC registration number 10265). Again, projects would start in 2021, with the crediting period lasting until 2035. The first step is calculation of the baseline methane emissions according to the CDM tool 'Emissions from solid waste disposal sites' for the South Korean case and the large-scale methodology AM0080 'Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants' for the Ethiopian project. Baseline emissions for the South Korean project fall over time, while those of the Ethiopian project are constant.

The second step is the calculation of the ambition coefficients for the two countries; they develop as described in the first case study, given that Ethiopia like Rwanda belongs to the group of LDCs. The results are shown in Table 2 below. The combined reduction of baseline emissions as well as the ambition coefficient for the South Korean case leads to a reduction of the annual credit volume to about 10% of the initial volume,

Table 2. Baseline and project emissions and credit volume differences between CDM and ambition coefficient approach (t CO_2) for waste-related activities in South Korea and Ethiopia.

Emissions	2020	2025	2030	2035
LFG power plant in Changwon, South Korea				
Baseline under CDM	15,560	11,707	8808	6627
Declining accountable share of BAU emissions as per ambition coefficient	100%	75%	50%	25%
Baseline including ambition coefficient	15,560	8780	4404	1657
Project emissions	–	–	–	–
Credit volume per CDM approach	15,560	11,707	8808	6627
Credit volume per ambition coefficient approach	15,560	8780	4404	1657
Difference in credit volume between CDM and ambition coefficient approach	*0%*	*−25%*	*−50%*	*−75%*
GHG emissions reduction through Modjo Common Effluent Treatment Plant, Ethiopia				
Baseline under CDM	151,230	151,230	151,230	151,230
Declining accountable share of BAU emissions as per ambition coefficient	100%	90%	80%	70%
Baseline including ambition coefficient	151,230	136,107	120,984	105,861
Project emissions	8627	8627	8627	8627
Credit volume per CDM approach	142,603	142,603	142,603	142,603
Credit volume per ambition coefficient approach	142,603	127,480	112,357	97,234
Difference in credit volume between CDM and ambition coefficient approach	*0%*	*−11%*	*−21%*	*−32%*

Note: Project emissions are zero for the LFG power plant in Changwon, South Korea.

whereas for the Ethiopian case, the activity implemented as such has continued GHG emissions so that the percentage reduction in credits is slightly larger than the decline of the ambition coefficient.

To summarize the effect of the ambition coefficient, emission reduction activities for the international carbon market in developed countries would be phased out between 2030 and 2040 onwards (leaving afterwards only the option to credit removals) while developing countries could sell emission reduction credits until well into the 2nd half of the century.

6. Operationalizing pathways for ambition coefficients

Which parameters should be applied to calculate the ambition coefficients in different country contexts? It could be expected that different approaches would be developed for developed and developing countries, along with LDCs and Small Island Developing States, whose special circumstances are acknowledged. Nevertheless, a more nuanced approach to determine an appropriate emission pathway for developing countries with different capabilities and responsibilities will be required to ensure 'fairness'.

Obviously, NDCs and long-term low emissions development strategies (LT-LEDS) could be a starting point, but it needs to be acknowledged that their ambition is often not commensurate to the country status nor with the overall objectives of the PA, as shown by the Climate Action Tracker (2021). We therefore suggest building on exercises that have tried to calculate fair emissions pathways e.g. Holz et al. (2018), van den Berg et al. (2020), Fujimori et al. (2021), Robiou du Pont et al. (2017) or Rajamani et al. (2021). This is in line with the latest decisions by Parties at COP26 on the 'Glasgow Climate Pact' to recognize the importance of best available science for effective policy making (UNFCCC, 2021c).

Appropriate indicators for such calculations should take into account both the country's capacity and its responsibility for the current level of emissions. Such indicators could thus include:

- Gross national income (GNI)/capita
- Cumulated historical emissions
- Mitigation potential
- Geographic criteria

Instead of taking results directly from research exercises, a multi-equation model could be developed to fit coefficients to the relevant indicators matching the global emissions path consistent with the ambition. Such exercises could be undertaken in multi-institution modelling studies, like the studies testing integrated assessment models in the context of IPCC Assessment Reports. In this context, it may be worth considering not only aggregate national pathways, but also sector-specific pathways. For example, an energy sector ambition coefficient may be steeper than for other sectors like agriculture or energy-intensive industries whose emissions are more difficult and costly to mitigate. Sectoral net zero pathways may therefore be helpful to complement national pathways if disaggregated at an appropriate level of geographic granularity. However, the discussion of sectoral pathways and ambition coefficient derived from them is beyond the scope of this conceptual paper.

In the rare event that a LT-LEDS would be more ambitious than the algorithm, the LT-LEDS would have to constitute the benchmark in a PA-governed carbon market, so as not to jeopardise or undermine the country's objective, a key principle for Article 6 cooperation.

We would like to note that this approach does not require agreement under the UNFCCC on a 'fair' distribution of the burden of mitigation action as a whole, which may never be achieved (see also the discussion of 'politically convenient ambiguity' in Kinley et al., 2020, p. 7). Our proposal solely relates to the mitigation outcomes that are eligible in international carbon markets for 'offsetting' and as a mean to substitute own mitigation action. Participation in international carbon markets is voluntary and limited to activities that are in line with the Article 6 principle to increase mitigation ambition, support the PA goals and respect CBDR-RC. Furthermore, a larger share of the mitigation remains in the host countries thereby facilitating them to raise ambition in their NDCs and protecting the PA from perverse incentives for governments to keep mitigation action low to increase revenues from carbon markets.[7] Nevertheless, getting agreement on ambition coefficients will be contentious, especially with regard to differentiation of countries.

Governing and administering the ambition coefficients can in principle be undertaken by UNFCCC entities like the A6.4SB and its support structure. There is relevant experience in this regard, as regional collaboration centres established under the UNFCCC Secretariat already support developing country governments in calculating standardized baselines for widely applied activity types, replacing the need for activity-specific baselines or baseline-parameters and driving down transaction costs. Before the Article 6.4 infrastructure is in place, it is possible that Article 6.2 'buyer clubs' could emerge, like the supporters of the San José Principles (Government of Costa Rica, 2020) who could apply ambition coefficients jointly for their purchases (on the different types of 'clubs' in the international climate policy regime, see Falkner et al., 2022). Sweden, for instance, already intends to apply more stringent baseline methodologies for their Article 6 pilots pursued in bilateral cooperation (Michaelowa et al., 2020).

7. Discussion and further research questions

A key benefit of the ambition coefficient approach compared to baseline methodologies linked to NDC targets is that there is no potential for gaming by the host country, i.e. to adopt less stringent targets to maximize carbon credit revenue, as the ambition coefficient remains the same. Over time, the stringent baseline for international carbon markets means that more and more mitigation from activities remains in the host country. The ambition coefficient concept is thus an incentive that is compatible with a continuous ambition increase. At the same time, the ambition coefficient baseline does not interfere with the NDC and thus respects each country's sovereignty. While already in the past under the CDM the definition of baseline scenarios has been seen as unfair by some countries, e.g. countries that have historically had a hydropower-dominated electricity system and were unable to harness carbon finance for investments in renewable energy, the approaches approved by the CDM regulators were generally accepted.

Through ambition coefficients calculated for each country or country group, a tedious case-by-case revision of CDM methodologies with justification for chosen parameters can be avoided, as generic guidance (e.g. through a methodological 'tool') could be developed and approved by the A6.4SB on how to apply the ambition coefficient in the context of the existing CDM methodologies.

Political feasibility may at first glance look very difficult to achieve, given that host country governments may see the regulatory definition of the ambition coefficient as taking away credit sales potential 'with the stroke of a pen'. Similarly, carbon market actors and investors may see this proposal as creating barriers to the upscaling of carbon markets and a deterrent for the mobilization of private finance, as it reduces credit volumes. Yet, the system ensures that at least some trade can still happen, and furthermore, current trade in emission reduction credits might be at least partially replaced by trade in removal credits (Obergassel et al., 2021).

Like in the case of the default parameters for energy efficiency methodologies under the CDM, investors may support use of an ambition coefficient as it provides a stringent but transparent system of dynamic baselines with zero transaction costs for project developers. This provides a much better basis for mid-term business and investment planning than a complex monitoring of policy instruments and other factors influencing baseline emissions in which ad hoc changes would be needed to bring carbon markets in line with global mitigation targets. To provide even more investment certainty, the ambition coefficient valid for the relevant crediting period of the activity should be fixed ex ante until the end of the current NDC cycle (5 years). The ambition coefficient should then be updated with every new NDC cycle in the light of the results of the most recent global stocktake. By doing so, one could take into account whether countries are actually in line with the net zero pathways.

As indicated above, the ambition coefficient is not directly applicable to removal activities as typically these do not feature an intensity baseline (or this baseline is zero). Still, we believe that the underlying principle of including a normative reference point could also be applied for removal activities. Yet, elaborating this would require future research.

8. Conclusions

Given the repeated criticism of the role of international carbon markets in mobilising the necessary amount of mitigation, and the wide emissions and ambition gap that must be closed to reach the PA goals, a stringent and credible approach to baseline setting for baseline-and-credit systems is required. An approach applying an ambition coefficient to a BAU baseline would allow to keep the accumulated knowledge of the CDM with regard to activity-type specific baseline setting while ensuring that baselines are in line with the ambitious long-term, global goal of the PA. Baseline emission factors would become zero once a country reaches the point in time where its emissions need to be zero in a fair global burden sharing approach, acknowledging there are different ways to determine the 'fair' share. With such an approach, developing countries would still be able to generate emissions reductions credits for many decades, while developed countries would need to finance emission reductions through other means, in line with their responsibility and capacity. The approach outlined here incentivizes ambition levels to be increased over time. While an extension of the ambition coefficient to cover emission removals is beyond the scope of this paper, we deem that the key concepts of the transition period and the normative reference of what is a fair contribution to the PA targets remain relevant there.

The proposed system would be transparent and long-term oriented so that it could generate new trust in carbon markets and encourage new investments to reach the long-term goals of the PA in an efficient way and compatible with a fair distribution of burden. Buyer countries would finance a share of the needed emission reductions in developing countries, whereas developed countries would have to finance similar activities by domestic means. Application of the ambition coefficient approach could be decisive to generate trust that international carbon markets are fully aligned with the long-term ambition of the PA.

Notes

1. It should be noted that whether credits are allocated at all depends on the additionality determination of a mitigation activity. If an activity is not additional, it should not generate any credits even if the eligible baseline methodology would lead to a positive allocation of credits. Additionality determination is particularly relevant in the context of the bottom-up determination of NDCs and the risk of hot air (Michaelowa et al., 2019a), but not discussed further in the context of this paper.
2. Note that stringent baselines do not directly lead to overall mitigation of global emissions, as host countries will 'keep' the not-credited emission reduction for their NDCs (Füssler et al., 2019a). Options to operationalize the overall mitigation of global emissions will not be discussed in the context of this article.
3. Development of a CDM methodology typically costs USD 0.1-0.2 million. The accumulated body of methodologies thus has a value of USD 25–50 million.
4. Or even a certain level of net negative emissions to compensate for poor countries that cannot be expected to reach net zero by the time the PA target of net zero globally is to be reached.
5. Removal includes biological approaches such as afforestation and reforestation, but also technological approaches like direct air capture of CO_2. For an overview of these technologies see Honegger et al. (2021). To date, the biological approaches have been used to a limited extent in the CDM, but widely in voluntary carbon markets. Due to their high costs, technical approaches have not yet featured in carbon markets, but can be expected to gain relevance in the future as other options will become more expensive.
6. Some observers argue that mature forms of renewable energy such as wind and solar should no longer be eligible under Article 6 as they would no longer be additional. In our view, this reasoning is flawed. 20 years ago, non-hydro renewables were not additional anywhere. 10 years ago, they were not additional only at the best sites. Now, they are not additional in sites with average resource availability. Over time, the "additionality frontier" will move towards sites with lower resource availability. Renewable energy in locations with limited resources (low windspeed, variable river flow, low sunshine duration) will remain additional for the foreseeable future.
7. Further measures that relate to securing the ambition of the host or selling country include requiring ambitious NDCs or LEDS before engaging in cooperation, requiring the inclusion of emissions targeted by an Article 6 activity in future NDC measures, or restricting crediting periods (Füssler et al., 2019a).

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