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Carbon Leakage Risks in the Post-Paris World

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Carbon Leakage Risks in the Post-Paris World

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Summary

With the adoption of the Paris Agreement, the climate policy world has changed insofar as that all countries that are parties to the Paris Agreement have set themselves climate targets in a bottom-up process – the so-called Nationally Determined Contributions (NDCs). This marks a change from the Kyoto regime, where only the industrialised countries (listed in the Annex I) had fixed emission targets, but where the vast majority of countries had essentially no obligations regarding their emissions.

Since there is no common agreed format or structure, the NDCs differ widely in terms of the type of target they set, the ambition that these targets embody, whether or not targets are conditional on other factors, such as financial assistance, their timeframe, the sectoral coverage and the detail on envisaged policy measures. But – despite their diversity, with few exceptions the NDCs represent a clear commitment towards limiting and reducing greenhouse gas emissions. By doing so, they set a medium- to long-term framework which can help companies and investors to form their expectations about future climate policy. As each country individually formulated its NDC in line with its national circumstances, priorities and preferences, one could expect that there is a higher chance that national governments will actually follow up and make good on the commitments expressed in the NDCs.

For the large majority of countries, and the overwhelming majority of global GDP, the existence of the NDCs means that carbon leakage now comes with a consequence for the leakage recipient country. For the recipient, leakage is no longer just a welcome boost that stimulates foreign investment in the domestic economy and increases demand for domestic products. Instead, carbon leakage now also comes at a cost to the recipient country in the form of associated emissions. Thus, there will be a trade-off to make between the benefits of carbon leakage (for recipient countries) and its downsides – as the additional emissions make it harder for a country to achieve its own NDC targets, and will necessitate additional mitigation action.

Under the Kyoto protocol, there was a concern that carbon leakage would lead to a net increase in emissions. This concern is justified for carbon leakage from Annex-I-countries – who all had binding emission reduction targets (so-called QELROs, i.e. quantified emission limitation and reduction objectives from a historic base year) – to non-Annex-I-countries that effectively had no constraint on their emissions, so that receiving leaked emissions had no consequence or penalty for them. However, with the transition from the Kyoto system to the Paris world, whether or not carbon leakage leads to a net increase in emissions will depend on the actual constellation of targets in the alleged "source country" and the "recipient country," respectively. Assuming that the leakage source country has a QELRO, the following constellations are possible:

- If the leakage recipient country also has a **binding and stringent QELRO** (be it expressed as an absolute emission target, or as a reduction below a fixed baseline, but, importantly, with no "buffer" for potential received leakage), the leaked industrial activity and associated emissions will be in direct conflict with the domestic target – hence every ton of emission increases from leaked activities will need to be compensated through domestic action in other sectors. Emission leakage will not result in additional emissions.
- If the leakage recipient country has a **non-stringent QELRO** (e.g. with an absolute emissions target so lax that it does not impose an effective constraint on emissions), leakage will result in a *de facto* (though not *de jure*) net increase in emissions.
- If the leakage recipient country has an **intensity-based target**, the situation is more complex – but since the leaked activities include particularly emission-intensive processes, whereas the intensity target is typically formulated for the economy as a whole, the carbon

leakage will tend to move the recipient country away from its target, and thus require intensified mitigation efforts in other sectors, thereby compensating part of the emission increase from leaked activities.

- A similar situation may arise if the leakage recipient country has a target to reduce emissions below **BAU**, but updates the BAU in light of stronger-than-expected economic growth – possibly augmented by leakage. In this case, leakage would result in additional net emissions – but the additional leeway from the BAU update should be less than the leaked emissions.
- If the leakage recipient country has **sector-specific, technology-specific or even installation-specific targets**, there could be a potential conflict to the extent these targets cover the leakage-recipient sector; yet this appears to be a relatively rare constellation.
- Finally, if the NDC does not include specific targets, or only unrelated ones – such as resilience, adaptation or the expansion of renewable energies – the leakage would have no further consequences, and leaked emissions would indeed constitute net additional emissions.

Thus, in most cases the leakage recipient country will face some kind of trade-off: leaked emissions will require some amount of compensation through increased domestic efforts by the leakage recipient country. Compared to the situation under the Kyoto Protocol, receiving leaked emissions is no longer "free" for many non-Annex-I-countries: it requires increased mitigation ambition in other sectors, or an increased risk of missing the pledged target.

Other than the trade-off faced by the regulator, the mere existence of NDCs also has an important signalling function for private plant operators and investors. In this context, it is necessary to distinguish between operational and investment leakage. Day-to-day production decisions on the basis of existing production capacities (operational leakage) are generally taken with a limited time horizon. They will therefore only factor in the costs of current climate policies, irrespective of the targets, or whether current policies are compatible with them. Thus, NDCs and their targets by themselves will have little influence on operational leakage – what matters is the actual policy on the ground. Investment leakage, however, involves decisions with a longer time horizon. It will therefore also factor in expectations of future policies, which will be derived from (or informed by) the long-term targets embodied in the NDCs. Even if there should be a discrepancy between targets and current policies, investors would not be well advised to ignore this discrepancy.

Zusammenfassung

Mit der Verabschiedung des Pariser Abkommens hat sich die Welt der Klimapolitik insofern verändert, als sich alle Länder in einem Bottom-up-Prozess eigene Klimaziele gesetzt haben. Dies stellt eine fundamentale Änderung gegenüber dem vorherigen Kyoto-Regime dar, bei dem nur die Industrieländer (die sogenannten Annex-I-Staaten) feste Emissionsziele hatten, bei dem aber die überwiegende Mehrheit der Länder keine konkreten Verpflichtungen hatte, ihre Emissionen zu begrenzen oder gar zu verringern.

Für die national bestimmten Beiträge (NDCs) der Vertragsstaaten des Pariser Abkommens gibt es nach wie vor kein gemeinsam vereinbartes Format oder eine gemeinsame Struktur. Daher unterscheiden sich die NDCs stark hinsichtlich der Art des darin festgelegten Ziels, des Ambitionsniveaus, das diese Ziele verkörpern, der Konditionierung der Ziele von anderen Faktoren, wie z.B. finanzieller Unterstützung, ihrem Zeitrahmen, der sektoralen Abdeckung und dem Detailgrad der geplanten Maßnahmen zur Erreichung der Ziele. Aber ungeachtet ihrer vielfältigen Formen stellen die NDCs mit wenigen Ausnahmen ein klares Bekenntnis zur Begrenzung und Reduzierung der Treibhausgasemissionen dar. Damit setzen sie mittel- bis langfristige Rahmenbedingungen, die Unternehmen und Investoren helfen können, sich Erwartungen an die zukünftige Klimapolitik zu bilden und ihre Entscheidungen daran auszurichten. Da jedes Land sein NDC individuell nach seinen nationalen Gegebenheiten, Prioritäten und Präferenzen formuliert hat, könnte die Wahrscheinlichkeit höher ausfallen, dass die nationalen Regierungen die in den NDCs eingegangenen Verpflichtungen auch tatsächlich weiterverfolgen und einhalten werden.

Für die große Mehrheit der Länder und den überwiegenden Teil des globalen BIP bedeutet die Existenz der NDCs, dass die Verlagerung von CO_2-Emissionen (das sogenannte *Carbon* Leakage) nun eine Konsequenz für das Empfängerland hat. Für den Empfänger ist solches Leakage nicht mehr nur ein willkommener Impuls, der ausländische Investitionen in die Binnenwirtschaft stimuliert und die Nachfrage nach heimischen Produkten erhöht. Stattdessen geht die Verlagerung von CO_2-Emissionennun auch zu Lasten des Empfängerlandes. So entsteht ein trade-off zwischen den Vorteilen der CO_2-Verlagerung (für die Empfängerländer) und ihren Nachteilen: da die zusätzlichen Emissionen es dem Empfängerland erschweren, seine eigenen NDC-Ziele zu erreichen, und so zusätzliche Minderungsanstrengungen erforderlich machen.

Im Rahmen des Kyoto-Protokolls bestand die Sorge, dass Carbon Leakage zu einem Nettoanstieg der Emissionen führen könnte. Diese Besorgnis ist gerechtfertigt für den Fall der Verlagerung von CO_2 aus Annex-I-Ländern in Nicht-Annex-I-Länder: Während die Annex I-Länder allesamt verbindliche Reduktionsziele hatten (sogenannte QELROs, d.h. quantifizierte Emissionsobergrenzen und Reduktionsziele), lag in Nicht-Annex-I-Ländern praktisch keine Begrenzung ihrer Emissionen vor. Somit hatte der Anstieg ihrer Emissionen durch Carbon Leakage für sie keine weiteren Folgen und erforderte folglich keine Reaktion. Mit dem Übergang vom Kyoto-System in die Welt des Pariser Abkommens hängt es jedoch von der tatsächlichen Konstellation der Ziele im "Herkunftsland" und im "Empfängerland" des Carbon Leakage ab, ob diese zu einem Nettoanstieg der Emissionen führt. Unter der Annahme, dass das Herkunftsland ein QELRO hat, sind die folgenden Konstellationen möglich:

- Wenn das Empfängerland auch über ein verbindliches und strenges QELRO verfügt (sei es als absolutes Emissionsziel oder als Reduktion unter eine festgelegte Basislinie), stehen die verlagerte industrielle Produktion und die damit verbundenen Emissionen in direktem Konflikt mit dem inländischen Klimaziel – daher muss jede Tonne Emissionssteigerung durch Carbon Leakage durch inländische Maßnahmen in anderen Sektoren ausgeglichen werden. Carbon Leakage führt daher nicht zu zusätzlichen Emissionen.

- Wenn das Empfängerland ein schwaches QELRO hat (z.B. mit einem absoluten Emissionsziel, das aber so hoch angesetzt ist, dass es die Emissionen nicht wirksam deckelt), führt Carbon Leakage de facto (wenn auch nicht de jure) zu einem Nettoanstieg der Emissionen.
- Wenn das Empfängerland ein intensitätsbasiertes Ziel hat, ist die Situation komplexer - aber da die verlagerten Aktivitäten besonders emissionsintensive Prozesse betreffen, während das Intensitätsziel typischerweise für die Gesamtwirtschaft formuliert ist, wird Carbon Leakage, die Zielerreichung im Empfängerland tendenziell unterlaufen und somit verstärkte Minderungsmaßnahmen in anderen Sektoren erforderlich machen, wodurch ein Teil der Emissionssteigerung durch Carbon Leakage wieder kompensiert wird.
- Eine ähnliche Situation kann eintreten, wenn das Empfängerland ein Ziel hat, die Emissionen unter die BAU zu senken, die BAU aber im Hinblick auf ein unerwartet starkes Wirtschaftswachstum aktualisiert – womöglich mit bedingt durch den „Wachstumsimpuls“ Carbon Leakage. In diesem Fall würde Carbon Leakage zu zusätzlichen Nettoemissionen führen - der zusätzliche Spielraum durch das BAU-Update sollte jedoch geringer sein als die verlagerten Emissionen.
- Wenn das Empfängerland sektorspezifische, technologiespezifische oder sogar installationsspezifische Ziele hat, könnte es zu einem potenziellen Konflikt kommen, sofern diese Ziele den Leakage-Sektor abdecken; dies stellt jedoch eine eher seltene Konstellation dar.
- Wenn das NDC keine oder nur thematisch nicht relevante Ziele enthält – wie Erhöhung der Resilienz, Anpassung an den Klimawandel oder den Ausbau erneuerbarer Energien – hätte die Carbon Leakage keine weiteren Folgen, und die verlagerten Emissionen würden tatsächlich per saldo zusätzliche Emissionen darstellen.

In den meisten Fällen wird das Empfängerland von Carbon Leakage daher mit einem trade-off konfrontiert sein: Verlagerte Emissionen erfordern zumindest teilweise einen Ausgleich durch verstärkte klimapolitische Anstrengungen des Empfängerlandes. Im Vergleich zur Situation zu Zeiten des Kyoto-Protokolls sind die geleakten Emissionen – und die damit verbundenen wirtschaftlichen Aktivitäten – für viele Drittländer nicht mehr "kostenlos": sie erfordern erhöhte Minderungsambitionen in anderen Sektoren oder aber ein erhöhtes Risiko, das gesetzte Ziel zu verfehlen.

Abgesehen von dieser Abwägung, mit der sich die politische Führung konfrontiert sieht, hat die bloße Existenz von NDCs auch eine wichtige Signalfunktion für private Anlagenbetreiber und Investoren. Dabei muss zwischen operativem und Investitionsleakage unterschieden werden. Laufende Produktionsentscheidungen auf Basis der vorhandenen Produktionskapazitäten (*Operational Leakage*) werden in der Regel mit begrenztem Zeithorizont getroffen. Sie werden daher nur die Kosten der aktuellen Klimapolitik berücksichtigen, unabhängig von den Zielen oder der Frage, ob das aktuelle klimapolitische Instrumentarium mit den Zielen vereinbar ist. Daher werden NDCs und die darin formulierten Ziele allein wenig Einfluss auf das operative Leakage haben – entscheidend dafür sind die tatsächlichen politischen Maßnahmen, ihre Ausgestaltung und ihr Ambitionsniveau. Dies stellt sich etwas anders dar für Investitionsleakage. Investitionen sind Entscheidungen mit einem längeren Zeithorizont und müssen damit auch Erwartungen an die künftige Politik berücksichtigen. Diese sollten sich aus den in den NDCs verankerten langfristigen Zielen ableiten lassen, oder ihnen entsprechen. Selbst wenn es eine Diskrepanz zwischen den erklärten Zielen und der aktuellen Ausgestaltung der Politik geben sollte, wären Investoren gut beraten, ihre Entscheidungen nicht nur auf der aktuellen Politik zu basieren, sondern auch zukünftige Anpassungen einzuplanen.

1 Introduction

In the context of the Paris Agreement negotiations participating nations have submitted their contributions to international climate policy, the Nationally Determined Contributions (NDCs).1

From a leakage perspective, an important aspect of NDCs as laid out in Article 4.3 of the Paris Agreement is that they must be revised periodically in five-year intervals, and that the level of ambition embodied in the NDCs may only go up in these revisions. That general trend contributes to "levelling the playing field" across emitting sectors the world over, but discrepancies remain given the variance in specificity with which leakage-relevant sectors are addressed in NDCs. The following discussion presents some insights on the types of NDCs that exist, and the way they address emissions from specific sectors.

Technical note: Some countries, including Brazil and Canada, have revised their submissions – we analyse the most recent versions when referring to examples from individual NDCs. Also, the status of the NDCs of the USA and Turkey remains inconclusive2 – we nevertheless include them in this analysis.

[1] Even before the Paris Agreement entered into force on 4 November, 2016, parties began submitting to the UNFCCC their *intended* Nationally Determined Contributions (INDCs). After entry into force, these documents are known as NDCs – but most major parties had already submitted an INDC back in 2015. Although these are logged in the UNFCCC's NDC registry as having been submitted in 2016 or later, the original INDC constitutes the country's official pledge of policies and measures for many large countries with significant industry including China, India, and the United States. Thus, the terms "INDC" and "NDC" are largely interchangeable when discussed in the context of countries' stated climate policies and measures compared here.

[2] The US Department of State officially informed the United Nations it will withdraw from the Paris Climate Agreement in a document issued on 4 August, 2017. However, the US has not recalled its NDC and cannot submit a formal withdrawal until 4 November, 2019 and the withdrawal cannot take effect until 4 November, 2020. Turkey submitted its INDC in 2015 but has not ratified the Paris Agreement, meaning it is not a Party whose submission can be considered an NDC.

2 Overview: varieties of NDCs and their relation to domestic climate policy

Since there is no common format or outline for NDCs, they vary widely in their scope, structure, specificity and ambition. For instance, not all commitments can be characterised as "targets" – some countries just list policies and measures without any correlating emission reduction goals. Recent studies have categorised the contents of NDCs along various dimensions to reveal how many countries share certain aspects, and what portion of global emissions those countries account for. The 2016 UBA/DEHSt report "Categorisation of INDCs in the light of Art. 6 of the Paris Agreement" constitutes such an analysis, breaking down NDCs by e.g. which GHGs they cover, which IPCC guidelines and global warming potentials they use, whether they specify the party will participate in international carbon markets, and what types of targets (if any) they include.[3] Similar categorisations are available via the Netherlands Environmental Assessment Agency's *PBL Climate Pledge NDC tool*[4] and the German Development Institute's online "NDC Explorer."[5] The latter includes interactive online features that auto-generate relevant graphics, such as comparative charts.

These tools give some information at the aggregate level. For instance, the NDC Explorer allows users to search which types of policies and measures are explicitly mentioned in NDCs by comparing "mitigation focus areas" such as transportation, land use, or waste.[6] This breakdown by focus area reveals an emphasis on energy efficiency and especially renewable energy, particularly among larger developing countries.

Table 1: Which policies and measures do NDCs mention?

Mentioned as 'focus area' for mitigation efforts within NDC	Number of parties (out of 169 officially submitted NDCs)	Examples
Energy efficiency	48	Brazil, Canada, India
Renewable energy	74	Brazil, Canada, India, South Africa, South Korea
Carbon capture and storage	3	Canada, Norway, Saudi Arabia

Source: ‚NDC Explorer' Deutsches Institut für Entwicklungspolitik Klimalog (online tool available at https://klimalog.die-gdi.de/ndc/#NDCExplorer/) Table content data accessed February 2018

Further typologies provide an interesting overview of some NDC elements and features. According to findings by the Öko-Institut for instance, a vast majority of parties chose a target year (by which they pledge to have reached a certain level of GHG emissions) in 2030 or beyond.

[3] Graichen et al. (2016), 15.

[4] Available online only at http://themasites.pbl.nl/climate-ndc-policies-tool/. Accessed 8 November 2018

[5] See https://klimalog.die-gdi.de/ndc/#NDCExplorer/

[6] A comparison of actual NDCs texts with respect to specific policies, however, reveals that even characterising a measure as having been "explicitly mentioned" and certainly listing it as a "focus area" is quite subjective, as structure and emphasis of each NDC varies so widely. The NDC Explorer results should therefore be taken only as an indicative metric.

Table 2: Long-term nature of mitigation targets in NDCs

Target range	Number of parties (total: 191 NDCs in May 2017)
Before 2025	1
By 2025	13
By 2030	**154 (= 85%)**
After 2030	**8**
Several target years	12
Not indicated	3

Source: Herold, Siemens, Herrmann (October 2017)

Another finding revealed by aggregating aspects of NDCs is the apparent enthusiasm for market mechanisms among parties: according to the database underlying the UBA/DEHSt report of 2016, "80 countries, covering about 25 % of global GHG emissions, express some type of support to international market mechanisms in their (I)NDCs." Indeed, a more recent report of the Environmental Defense Fund (EDF) and the International Emission Trading Association (IETA) cites 90 countries.[7] However, the vast majority of NDC texts do not specify whether the country actually intends to make use of market mechanisms. In fact, according to the above source 17 countries, representing a larger share of global emissions (32 percent), explicitly declare that they do *not* intend to participate in international market mechanisms. Further, using international market mechanisms does not necessarily correlate with implementing domestic carbon pricing – many developing countries that hosted CDM projects under the Kyoto Protocol thereby participated in a market mechanism and would continue to do so going forward, but do not intend to enact a carbon tax or cap-and-trade programme.

Given that this project's overall analysis does not cover all parties to the UNFCCC, but rather key countries relevant to leakage risk from an EU perspective the most relevant categorisations are ones that contextualise particularly the NDC's *mitigation targets* - as opposed to whether and on what basis emissions from land use change are calculated, or to what extent adaptation is part of the NDC. The NDCs of major trading partners to the EU generally contain what can be characterised as targets, though expressed in different ways. These ways in turn imply varying degrees of *ambition*, though contrary to popular assumption the target type does not necessarily correlate with its level of stringency. Further, NDCs' *relationship to domestic climate policy* varies by country due to e.g. their specificity and the parties' political circumstances. The following sections illustrate these differences in target type, ambition, and relationship to domestic policy based on the literature and examples from relevant NDCs.

2.1 Mitigation targets found in NDCs

NDC typologies, including the ones mentioned above, generally break down mitigation targets into categories based on years considering base years ("from 1990 levels") and/or target years ("by the year 2030"). At a more fundamental level, however, it is necessary to define the

[7] EDF and IETA (2016).

measurement metric to which those years apply, e.g. an annual volume of emissions in a given year or a ratio of emissions to some other factor (such as GDP) or an emissions volume differential relative to a future scenario. One particularly specific set of definitions in this regard is the one contained in the World Resources Institute's November 2017 working paper on Enhancing ambition of NDCs,[8] which provides examples of the nuanced differences among NDC constructs. Drawing on that paper's distinctions, Table 3 defines mitigation targets only, to facilitate comparing them.

Table 3: Typology of mitigation commitments in NDCs

Target type	Definition	Examples
Absolute emission reduction relative to historical base year	Commits to reaching emissions levels a certain percentage below those of a given base year	Brazil, Canada, EU, Japan, New Zealand, Russia, USA
Fixed-level emission target	Commits to achieving a specified level of emissions in a certain year or timeframe	Argentina, Costa Rica
Intensity target relative to base year	Commits to reducing emission per unit of another factor (usually output as measured in GDP) by a certain amount relative to a base year	Chile, China, India[9]
Emission reduction relative to a "business-as-usual" (BAU) projection	Commits to reducing emissions by a certain amount relative to a reference case trajectory through a given year – usually one that assumes no mitigation actions	Indonesia, Mexico, Nigeria, South Korea
Intended emission trajectory	Commits to achieving a certain emission trajectory over a given (longer-term) timeframe, such as multiple years. This type includes "peaking" targets in which emissions are highest in a specified year and decline thereafter	South Africa

Source: Own representation based on Fransen et al. (2017)

The target type defined in the first row is most familiar to Europeans, given the historical precedent of Annex I countries expressing reduction commitments as quantified emission limitation reduction objectives ("QELROs") from a historic base year.[10] The EU's goal of cutting GHG emissions 40 percent below their 1990 levels by 2030, for example, is a QELRO measured from a base year, as are the commitments of other industrialised country UNFCCC parties including Japan (26 percent below 2013 levels by 2030) or New Zealand (30 percent reduction from 2005 levels by 2030).

[8] Fransen et al. (2017),

[9] Some NDCs, such as that of Brazil, include the estimated carbon intensity reduction their absolute target implies.

[10] Technically speaking, all countries listed in Annex I to the UN Framework Convention on Climate Change, i.e. the industrialised countries, should commit to an emission reduction target that is documented in Annex B to the Kyoto Protocol. In practice, some Annex-I-countries were not listed in Annex B in the first commitment period of the Kyoto Protocol: Turkey, Malta and Cyprus (originally Non-Annex-I country, but included upon their accession to the EU), and Kazakhstan and Belarus (not listed in Annex I at the time of adoption of the KP). In the 2nd KP commitment period, Malta, Cyprus, Belarus and Kazakhstan were included in Annex B, whereas Japan, Russia and New Zealand did not specify targets for this period in Annex B.

2.2 Level of ambition expressed in NDCs

With QELROs having been reserved for the parties with the largest responsibility to reduce emissions under the Kyoto Protocol, i.e. the Annex I countries (= industrialised countries), they are often assumed to embody more ambitious mitigation objectives than the other target types. However, it is possible to have a very lax QELRO that does not impose much constraint on emissions, just as it is possible to have a very tight intensity-based target that requires major investments and/or painful adjustments to achieve. Indeed, the relative ambition of targets is notoriously hard to determine, particularly when comparing those of countries with fast-growing economies and populations to the more stagnant ones of the industrialised parties. Even in and among rich nations, relative mitigation ambition can be deceiving.[11] For developing countries, characterising targets as more or less ambitious presents even greater challenges, given lack of reliable data on projected emissions and related factors including e.g. population and GDP.

Several analyses of targets contend that the most "problematic" of commitment types is a climate goal expressed as a deviation from business-as-usual (BAU). According to several characterisations, it is also the most prevalent type – depending on the study, 25-50 percent of NDCs express their climate goals this way.[12] It is also the type used by far the most among *developing* country parties – those whose NDCs can be considered to have mitigation "targets" at all. The problem is one of transparency: NDCs of this type often lack adequate explanation or documentation of baselines, scenarios, projections, etc, that went into the respective BAU forecast - in such cases, the concrete GHG emission target value implied by the BAU target remains uncertain. This in turn matters for the carbon leakage debate - for potential investors, it is often not so much the target itself as its *certainty* that is most important for location decisions.

However, a deeper look into the wording of NDCs reveals that many of the targets categorised as BAU are actually fixed level targets: they specify the exact expected emissions under the BAU scenario. The most pertinent example is South Korea: although its NDC states the country will "reduce its greenhouse gas emissions by 37% from the business-as-usual" level by the year 2030, it specifies that this BAU level is exactly 850.6 MtCO2eq, and even shows a table with BAU projections in 2020, 2025 and 2030. This easily translates to a fixed-level target of 535.8 MtCo2e in the year 2030 – compared to current emissions of roughly 700 Mt per year.[13] It turns out that many developing country BAU targets are laid out in this way, making them quite transparent in terms of accountability and relative comparability in a leakage risk assessment context.[14] Given

[11] The classic example in this regard is Europe's target of 20% below 1990 levels, which at face value looks more ambitious than California's target of merely reaching 1990 levels in the same year. In fact, however, California's population and economy will have *grown* significantly through 2020, whereas Europe's were projected to increase only modestly. In fact, California's population grew more than 30 percent between 1990 and 2017, whereas that of the EU grew about seven percent. California's target represented a 40 percent reduction from business-as-usual emission projections at the time, whereas achieving the EU target required much less drastic policy interventions – even more so since the financial and economic crisis and ensuing recessions delivered a good deal of the required emission reductions, albeit at high cost. The fact that the EU 20% target is less ambitious than it seems is also evidenced by the fact that the EU actually achieved this target six years ahead of time, in 2014, and is now set for an emission reduction of 28% by 2020. It should also be noted that the 20%-target, despite seeming to be ambitious, actually represented the lower end of the EU's mitigation ambition range: the EU pledges announced in the run-up to the Copenhagen UNFCCC climate conference in 2009 also involved an alternative 30% reduction goal in case that an international climate agreement with binding national mitigation pledges came into place.

[12] The NDC Explorer's breakdown cites over 50% of NDCs as being of the BAU type, whereas an October 2017 study by Oeko Institut (Herold et al., 2017) posits that around 47% constitute this type – the WRI study (Fransen et al., 2017) concludes that about 25% of commitments assessed in 2016 can be considered a baseline scenario target.

[13] UNFCCC, 'Emissions Summary for Republic of Korea.',

[14] Argentina's target, though categorised as "relative to BAU" in the NDC Explorer (DIE) and the DEHSt 2016 discussion paper, is actually a fixed level target *derived from* a BAU projection. Ghana's target lays out conditional and unconditional reductions from BAU emissions levels in 2030 (15% and 45% below that level, respectively) but then states the exact BAU emissions in 2030 (74 Mt) which makes those targets fixed. In none of these cases does the text of the NDC state that the country reserves the right to recalculate the BAU or use a different projection from which to measure the promised percentages.

that NDCs must be updated as stipulated in the Paris Agreement, it is entirely possible that parties will use different BAUs for future calculations. However, given that the Paris Agreement stipulates that those updates must also increase the NDC's ambition, this requirement could make it difficult for a state to argue for a revamped BAU scenario that implies a net increase in emissions. Few NDCs (e.g. Saudi Arabia) explicitly state that the country reserves the right to update the baseline scenarios upon which its mitigation contribution is based.

Thus, to assess what level of ambition the NDC embodies, NDCs built around a *transparent* BAU scenario are less problematic than those using the intensity metric. In the latter, the "goal" is based on a factor numerically independent of emissions (in China's case, GDP) that will not be known until the target year. To make a BAU target transparent, a party must merely include a clearly defined emissions forecast. The GDP figure underlying an intensity pledge, however, is by definition unknown until the target year: to date, no party that has an intensity target uses a fixed or current GDP projection for the GDP portion of the calculation. Nations taking on a GHG intensity pledge do so precisely *because* they prefer the flexibility to adjust their mitigation contribution to uncertain future growth.[15] This presents a far greater challenge for comparing relative ambition of climate policies in terms of leakage risk assessment.

2.3 NDCs and domestic climate policy

NDCs vary not only in the way they express the goal or target the party is proposing to be held accountable for,[16] but also in their *likelihood of being achieved* (or even pursued) given the difference of governance types among parties. While China's target, formulated in terms of emissions per GDP in a future year, is not ideal in terms of transparency, its likelihood of being achieved is arguably higher than others given its government structure and its previous record of target achievement. What China promises at the international level can be fulfilled even if drastic measures have to be taken – an example is Beijing shutting down almost all industry during the 2012 Olympics to achieve clear air conditions.

Indeed, China's NDC notes the degree to which the country has accomplished goals previously set at the international level and puts these in perspective with its current pledges:

Table 4: China's climate targets over time

	In 2009, goals for 2020	Accomplished by 2014	Goals for 2030, as set in NDC (2016)
Decrease CO_2 emissions per unit of GDP from 2005 level	40-45%	33.8%	60-65%
Increase share of non-fossil fuels in primary energy consumption, compared to 2005	15%	11.2%	"around 20%"

[15] Jacoby, Chen, Flannery (2017).

[16] Hood and Soo (2017. Note that the different terms (goal or target) do not imply any substantive difference – different NDCs use different terminology, some NDCs also use both terms interchangeably.

	In 2009, goals for 2020	Accomplished by 2014	Goals for 2030, as set in NDC (2016)
Increase forested area from 2005 level, increase forest stock volume	40 million hectares, 1.3 billion cubic meters	21.6 million hectares, 2.2 billion cubic meters	4.5 billion cubic meters

Source: Chinese (I)NDC submitted in 2015, own compilation into table format

How relevant the NDC is to the leakage discussion depends largely on the *emission profile* of the country in question. In cases like China, industries will clearly have to contribute to achieve the NDC goals, whereas GHG standards in metals manufacturing or chemical production may be less relevant in nations whose total emissions are dominated by land use change, transport or waste. Unfortunately, countries with significant industrial sector contribution to emissions do not necessarily have correspondingly detailed discussion of or specific policies directed at this sector in their NDCs. In fact, largely the opposite is true: countries with relatively little heavy industry can focus on specific standards for the few facilities they *do* have, whereas those with a significant industrial sector refrain from making specific sectoral commitments they could be held accountable for. While Namibia's NDC mentions specific emissions standards at its (only) cement plant, the NDC of the Russian Federation mentions no subtargets, no specific actions in any industrial sectors, and no policies or measures. China could be said to fall somewhere in the middle here: with at least some specificity in terms of targets, goals, and policies to achieve them,[17] analysts at least have a basis from which to assess the degree certain EU industries or products may be "leakage prone" vis-à-vis their Chinese counterparts.

2.3.1 How decisive is the NDC for national policy formulation?

NDCs represent essentially the opposite of their predecessors, the Kyoto targets, which were largely "top-down" goals guiding national policy formulation – NDCs are by definition "bottom up," embodying what their respective party believes it can "bring to the table" in terms of emissions reduction. Rather than being decisive for policy formulation, they are instead a result of (or embodiment of) national policy formulation and thus reflect the extent to which the respective country prioritises climate action.

This is evident in several NDC texts of relevant countries. India's target "to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level" is not cited as decisive for policy formulation in the industrial sector specifically, as measures in industrial manufacturing are not mentioned – however, energy efficiency is cited as a strong priority (India operates a trading scheme involving units of efficiency improvement[18]), meaning industries are affected to the extent that efficiency plays a role in their projected growth.

Brazil's NDC is similarly "bottom up" in that it specifies which national laws are currently in place to help achieve the espoused 37 percent reduction below 2005 levels in 2025.[19] The role of

[17] China's NDC codifies many targets, particularly in the energy sector, in quantifiable terms – this increases accountability and also analysts' ability to project energy sector developments over time with a view to their impact on leakage. For instance, the NDC pledges to "lower coal consumption of electricity generation of newly built coal fired power plants to around 300 grams coal equivalent per kilowatt hour" and to have natural gas account for">10% of primary energy consumption by 2020."

[18] The Perform, Achieve and Trade (PAT) scheme, see explanation at India's Ministry of Power https://beeindia.gov.in/content/pat-3

[19] "All policies, measures and actions to implement Brazil's INDC are carried out under the National Policy on Climate Change (Law 12, 187/2009), the Law on the Protection of Native Forests (Law 12, 651/2012, "Forest Code"), the Law on the National System of Conservation Units (Law 9, 985/2000), related legislation, instruments and planning processes." Excerpt from page 1 of English

the NDC is rather to internationally codify that mitigation measures are being taken in the country, not necessarily to set the bar for such measures and guide future policymaking. Unlike many developing countries, Brazil points out that implementation of its commitments "is not contingent upon international support" (Brazil's INDC, page 3).

Given its de facto "fixed" target, South Korea somewhat presents an exception to the bottom up relationship between NDCs and domestic policymaking. In theory, the exact target of 535.8 Mt CO_2e in the year 2030 gives policymakers a concrete number upon which to calibrate their mitigation policies. In Korea, those primarily include the emission trading system (KETS), which began in 2015 and covers over 600 companies and more than half of the country's emissions, as well as renewable energy quotas in the power sector and g/km average emission standards for vehicles targeting the transport sector. It is possible for the target set in the NDC to drive ambition of Korean domestic mitigation efforts, rather than the other way around. The main legal statute through which this would be done is the country's long-term overarching law under which most climate policies (like the KETS) are implemented, usually translated as Korea's "Framework Act on Low Carbon and Green Growth."

The degree to which Paris Agreement signatories feel bound to their NDCs, and thus adhere to their commitments, is the subject of legal and political discussion that is relevant to this research but beyond the scope of its analysis. It should be noted that the actual obligations for a party to the Paris Agreement are in fact limited aside from reporting. Article 4.2 requires that each party "shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions." Countries must set themselves some kind of target related to the overall goals of the agreement, and take the measures that they consider appropriate in light of these targets. It is not required that the measures be sufficient or adequate to ensure that the target is achieved.

Regarding the level of ambition that NDCs should embody, Article 3 generally requires that parties' efforts are "ambitious", and Article 4.3 stipulates that successive NDCs "will represent a progression beyond the Party's [previous NDC] and … reflect [each Party's] highest possible ambition." This is generally understood to imply that each successive NDC has to be more ambitious than the previous one. There are, however, some caveats: First, it is not clear what change would constitute a "progression": a more ambitious target would certainly be a progression, but what about a target that covers a larger part of the economy, or a more specific target that supersedes a generic one? Second, what is the "highest possible ambition" of a Party at the time of preparing its revised NDC? Depending on the countries' economic and political circumstances, which Article 4.3 also takes into account, there could be situations where countries deem that their highest possible ambition is lower than it was in the past, e.g. in the aftermath of a severe economic crisis, armed conflict or a severe international trade dispute.[20]

Beyond the question of targets and their achievement lies the question of NDCs' legal force. International agreements in the style of the Paris Agreement (and the Kyoto Protocol before it) involve no economically punitive sanctions for non-compliance, but rather merely procedural "punishments." However, lack of sanctions does not mean that violations do not have consequences. The experience of the US announcement to withdraw from the Paris Agreement,

version of Brazil's NDC, available online at http://www4.unfccc.int/ndcregistry/PublishedDocuments/Brazil%20First/BRAZIL%20iNDC%20english%20FINAL.pdf

[20] Unfortunately, the "Paris Rulebook" adopted in December 2018 at the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement in Katowice does not add much more clarity on these issues. Annex 1 of Decision FCCC/PA/CMA/2018/3/Add.1 is intended to provide more clarity on the structure of the Nationally Determined Contributions. It specifies that countries ought to describe why they consider their NDC as fair and ambitious in the light of their respective national circumstances, but does not provide criteria for doing so; neither does it touch on the question what would represent a progression.

and Canada's 2011 decision not to comply with the Kyoto Protocol, both have demonstrated that there is at least a political cost to walking away from an international commitment. In the aftermath of the respective decisions, both countries' governments faced repudiation from the international community for these actions, diminishing their reputation and their standing in international negotiations and thereby their soft power. Whether this loss of influence and reputation also translates into a political cost domestically will depend on the political priorities of the voter base.

2.3.2 Will domestic climate policies match the ambition expressed in the NDC?

Since they were developed "bottom up," the NDCs are more likely than their Kyoto target predecessors to reflect their party's mitigation ambition. For investment decisions in industry, however, the certainty of regulation is often more important than the actual level of regulation, and situations where domestic policies are not well-aligned with the declared target are a source of uncertainty. For this reason, starting from a set of policies aligned with an *un*ambitious target could be an easier starting point to raise ambition of target and policies over time, than a situation where current policies are *un*aligned with an already ambitious target.

Any alignment of domestic policy with NDC ambition, however, is only possible to the extent political (and in some cases geographic or climatic) realities allow. China's NDC, for example, includes extensive and rather numerically detailed commitments to reforestation (see Table 4 that would imply policies (such as government-funded tree planting initiatives) calibrated to achieve the promised rate of forest cover increase. But no matter how well such policies align with the ambition stated in the NDC, they may easily fail to do so given unforeseen drought or other climatic conditions that render forestry efforts less effective. This in turn can affect the ambition of measures in other sectors, possibly including the industrial sector, which would have to "pick up the slack" if reforestation efforts contribute less than planned to China's CO2-to-GDP ratio toward 2030.

Brazil could encounter similar problems given the extent to which its overall emissions come from deforestation: policies that affect its overall emissions most in terms of sheer volume are those regulating land use, where there have been negative changes in recent years.[21] More than China's, Brazil's NDC also exemplifies the political/legal side of policy ambition only matching the targets to the extent reality allows. Laws under which the NDC is being implemented can change, altering the degree to which mitigation measures they facilitate actually line up with the NDC's ambitions. In Brazil, this is exemplified by the March 2018 Supreme Court ruling upholding the new (2012) version of the country's Forest Code – many of the articles of that code were challenged by environmental groups and had the court ruled in their favour, the law would have resulted in more ambitious mitigation outcomes going forward.[22] Brazil's INDC notes that its (absolute) target corresponds to an estimated greenhouse gas *intensity* reduction (CO_2 per GDP) of 75 percent in 2030, in relation to 2005.

Canada presents one of the best examples of domestic policy alignment with its NDC, but also serves as a reminder that domestic implementation is completely contingent upon (party) political realities. The country's current Liberal government laid out a long-term policy package called the Pan-Canadian Framework on Clean Growth and Climate Change, a major component of which is a mandatory nationwide carbon price starting in 2019 at C$10/tonne and rising to $50/tonne by 2022. The country's NDC, submitted by the current government, specifically refers

[21] See Climate Action Tracker, 'Brazil', n.d., https://climateactiontracker.org/countries/brazil/.

[22] Brandford and Torres (2018).

to this carbon price[23] – thereby enshrining a policy that had yet to be implemented into an international commitment. However, the federal requirement allows Canadian provinces flexibility in how they impose carbon pricing, with forced adherence to a federal "backstop" policy for those provinces whose plans are deemed insufficient. Several provinces are challenging the constitutionality of the federal backstop in court. To what extent Canada's actual domestic climate policies will match the ambition of its NDC thus remains uncertain.

2.3.3 How specific are NDCs about leakage-relevant sectors?

Most NDCs set an economy wide target, but few break it down into sectors (or even mention individual sectors) and even fewer reveal how specifically leakage-prone sectors may be affected. Among the major emitters, China stands out in this regard as its NDC outlines how mitigation measures are "delegated" in terms of government authority over implementation, with the country's 12th five-year-plan containing various "sectoral work plans." The most relevant of these for leakage is the Action Plan for Addressing Climate Change by the Industrial Sector (2012–20). It attributes responsibilities for e.g. industrial energy efficiency regulation, industrial process emissions reduction, low-carbon technology development and application, as well as production and consumption of low-carbon industrial products. Relevant mitigation actions are thus neatly packaged under one authority, potentially making them easier to quantify for comparison to their European counterparts. The same is done in other sectors: China's Ministry of Transport is in charge of initiating energy saving projects in road, marine, and air transport.[24]

Like China, Brazil's NDC breaks down at least some measures by sector – mostly in the area of land use. For the energy sector, the NDC mentions the country "intends to adopt further measures" including expanding use of non-hydro renewable energy to 28-33 percent of the total energy mix by 2030. It mentions several subtargets, such as expanding use of non-fossil energy sources domestically to at least 23 percent by 2030 and achieving 10 percent energy efficiency gains by that year. These apply specifically to the power supply and power generation, however – not the industrial sector. The latter is mentioned only vaguely with reference to promotion of new clean tech standards and general energy efficiency, without percentage targets, timeline, or naming of specific industrial sectors.

Some countries' NDCs contain references to mitigation measures in industrial sectors as part of their target-setting. Indonesia's, for instance, is of the BAU type and contains no targets for specific subsectors, much less individual industries. However, its Annex lists the assumptions used for projecting BAU emissions the target is based on, broken down into a scenario of unconditional reductions from that BAU and conditional reductions subject to external funding (the latter being more ambitious). These scenarios in turn include assumptions about specific industrial sectors, such as changes in the clinker to cement ratio across the Indonesian cement industry and CO2 recovery/scrap utilisation in the steel industry. By way of BAU projections, therefore, Indonesia has listed the estimated effect of imposing climate mitigation measures on key leakage-relevant industries.

[23] UNFCCC, 'Canada's 2017 Nationally Determined Contribution Submission to the United Nations Framework Convention on Climate Change.' Available online at https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=CAN. Accessed 8 November 2018

[24] Ranping Song et al., 'ASSESSING IMPLEMENTATION OF CHINA'S CLIMATE POLICIES IN THE 12TH 5-YEAR PERIOD', n.d., 48.

3 NDCs and the Carbon Leakage Risk

The variety of NDCs leads to very different possible investment constellations at home and abroad – with consequences for the carbon leakage risk. To better understand how the existence of NDCs changes the terms of the carbon leakage debate, it is necessary to distinguish between different *aspects of carbon leakage*.

3.1 Carbon leakage and the effectiveness of non-harmonised climate policies

One strand of the carbon leakage debate views carbon leakage predominantly as a problem that undermines the overall effectiveness of non-harmonised climate policies.[25] In this view, leakage is a problem because emission reductions achieved in one jurisdiction are (partly) offset by emission increases in another – the net mitigation effect is lower. Even worse, if emission-intensive activities leak from a country with a binding emission target (e.g. a QELRO) to one with no constraint (or a constraint that intentionally includes a "buffer"), a net emission increase could occur, as other installations in the leakage source country pick up the slack and increase their emissions (in case of a national limit: until this limit is reached). Meanwhile, the leakage recipient country has no incentive to tackle the leaked emissions.

This consideration was particularly relevant under the Kyoto protocol, under which one group of countries (the Annex-I-countries) had binding QELROs, whereas the other group (non-Annex-I-countries) effectively had no constraint on their emissions, so that receiving leaked emissions had no consequence or penalty. In this context, carbon leakage from an Annex-I-country to a non-Annex-I-country would risk increasing net emissions. However, with the transition from the Kyoto system to the Paris world leakage depends on the actual constellation of targets in the alleged "source country" and the "recipient country," respectively. Assuming that the leakage source country has a QELRO, the following constellations are possible:

- If the leakage recipient country also has a **binding QELRO** (be it expressed as an absolute emission target, or as a reduction below a fixed baseline, but, importantly, with no "buffer" for potential received leakage), the leaked industrial activity and associated emissions will be in direct conflict with the domestic target – hence every ton of emission increases from leaked activities will need to be compensated through domestic action in other sectors. Emission leakage will not result in additional emissions.
- If the leakage recipient country has a **non-stringent QELRO** (e.g. with an absolute emissions target so lax that it does not impose an effective constraint on emissions), leakage will result in a *de facto* (though not *de jure*) net increase in emissions. It remains unclear to what extent leakage recipient countries may have integrated expected leakage into their targets when setting them, i.e. left a "buffer" for emissions growth from leaked emissions when calculating realistic emissions trajectories.
- If the leakage recipient country has an **intensity-based target**, the situation is more complex – since the leaked activity will increase both emissions and economic activity / GDP in the recipient country, both the nominator and the denominator are affected. But since the leaked activities include particularly emission-intensive processes, whereas the intensity target is formulated for the economy as a whole, the carbon leakage will tend to move the recipient country away from its target. To remain on track towards target achievement, the recipient country will need to intensify mitigation efforts in other sectors, thereby compensating part of the emission increase from leaked activities.

[25] Allwood et al. (2014).

- A similar situation may arise if the leakage recipient country has a target to reduce emissions below **BAU**, but updates the BAU in light of stronger-than-expected economic growth – which could be partly induced by leakage. In this case, leakage would result in additional net emissions – but since the leaked activities have a much higher emission intensity than the overall economy, the additional leeway from the BAU update should be less than the leaked emissions.[26]
- If the leakage recipient country has **sector-specific, technology-specific or even installation-specific targets**, there could be a potential conflict to the extent these targets cover the leakage-recipient sector; yet this appears to be a relatively rare constellation.
- Finally, if the NDC does not include specific targets, or only unrelated ones – such as resilience, adaptation or the expansion of renewable energies – the leakage would have no further consequences, and leaked emissions would indeed constitute net additional emissions.

Thus, in most cases the leakage recipient country will face some kind of trade-off: leaked emissions will require some amount of compensation through increased domestic efforts by the leakage recipient country. Compared to the situation under the Kyoto Protocol, receiving leaked emissions is no longer "free" for many non-Annex-I-countries: it requires increased mitigation ambition in other sectors, or an increased risk of missing the pledged target.

3.2 Carbon leakage and the competitiveness of domestic industries

The politically most salient strand of the leakage debate centres around competitiveness of domestic industries (more specifically, domestic production locations). Carbon leakage is seen as problematic since climate policies increase the production costs of domestic industries relative to competitors who do not face comparable emissions constraints. This situation is regarded as fundamentally unfair: countries with more ambitious climate policies (who thus contribute to the global public good of a stable global climate) are penalised in that they "loose" production facilities (and the employment and tax revenue those facilities' owners provide) to other countries that have less ambitious environmental policies.

To weigh in on how NDCs influence this debate, the main question is what actually determines the carbon leakage risk – is it the ***targets*** that countries set themselves, the ***strategies*** they adopt to achieve these targets, or the ***policies*** that are actually implemented? To answer this, it is useful to distinguish between operational and investment leakage.

- **Operational leakage** (or production leakage) occurs where differences in the stringency of climate regulation leads to the shift of production volumes and market shares *within existing production capacities*, as the producer in the less regulated country can produce more cheaply. This type of leakage is driven by the **actual policies**, and the effective carbon constraint that they impose on producers. A country's long-term climate targets do not matter for this day-to-day decision, neither does a mismatch between targets and policies. However, in some countries policies can change swiftly and significantly. Thus, if carbon leakage widens the gap between climate targets and actual emissions, and if countries stay true to their commitment, leakage itself could necessitate increased ambition in domestic policies.

[26] This holds in the most straightforward case that a BAU update simply reflects higher-than-expected GDP growth, with no changes in the emission intensity of the economy.

- **Investment leakage** happens when, compared to a baseline with equally stringent climate policies at home and abroad, companies invest more in facilities in regions that have less ambitious mitigation policies, and less in facilities located in carbon-constrained regions. Thus, compared to the baseline, investment leakage leads toward higher production capacities in the less ambitious countries, and lower capacities in the more ambitious ones. Since investment decisions involve a longer timeframe than operational decisions, they would arguably consider both current policies and expected future policies (and hence strategies and targets). Given that most NDCs set a long time horizon extending to 2030 and beyond, they also create greater certainty for investors. This is also true if (ambitious) targets are not matched by actual (lax) policies: only a very risk-friendly investor would choose to ignore this mismatch, and base her decisions only on current policies. For most investors, unless they have reason to doubt the commitment of current and future governments to their targets, a mismatch would signal that more ambitious policies are to be expected. Also, due to the dynamic foreseen in the Paris Agreement (ratcheting up of NDC ambition, Article 4.3), investors are well-advised to consider that targets, and as a result measures, will become increasingly stringent over time.[27] Moreover, where there is a discrepancy between targets and current measures, the mere fact that this discrepancy exists may undermine investor confidence – based on the argument made earlier (see section 2.3.2) that investors loathe regulatory uncertainty more than regulation itself. In this context, it should be noted that discrepancies between targets, strategies and policies are by no means only to be found in the leakage recipient country – they are found aplenty in countries that consider themselves at risk for leakage. Thus, keeping the ambition level of domestic climate policies while setting ambitious targets does not instil confidence of would-be investors either.

3.3 The bigger picture: NDCs as a signal to businesses, investors and finance

Beyond their direct effect, an important function of the Paris Agreement and the NDCs has also been to set the long-term directions for global economic development and, together with the Sustainable Development Goals, to establish a new *leitbild* of sustainable and inclusive prosperity. This is also reflected in the fact that while the Paris Agreement is an intergovernmental treaty, it is only the most tangible result of a much broader process that involves not only governments but also a broad range of stakeholders, including businesses. In this way, the NDCs also provide the reference framework in which private businesses and sectoral associations develop their strategies.[28]

Thus, there will also be countries to "leak to" in the bottom-up world of the Paris Agreement: those with weak NDCs, those that do not feel bound to their NDCs, or those whose policies simply do not match the ambition their NDCs embody. Yet the question is whether there will always be investors ready to seize this opportunity (probably yes), and whether it will be in their own long-term interest to do so (perhaps not). At the very least, companies that are seen to exploit weak climate regulation could face an increasing reputational risk, in the same way as companies' image suffers if they are seen as exploiting weak labour, health or safety standards in poorer countries.

[27] Indeed, Bauer et al. (2018) make the point that capital markets will anticipate stricter regulation, and find evidence of investors disinvesting from coal-fired power generations in anticipation of a future carbon price, up to a decade before the price signal is effectively established.

[28] See, for instance Philipp Gerbert et al. (2018).

4 Conclusions

With the Paris Agreement, the climate policy world has changed insofar as that all countries have set themselves climate targets in a bottom-up process. This marks a change from the Kyoto regime, where only the industrialised countries (listed in the Annex I) had fixed emission targets, but where the vast majority of countries had essentially no obligations regarding their emissions.[29]

Since there is no common agreed format or structure, the NDCs differ widely in terms of the type of target they set, the ambition that these targets embody, whether or not targets are conditional on other factors, such as financial assistance, their timeframe, the sectoral coverage and the detail on envisaged policy measures. But – despite their diversity, with few exceptions the NDCs represent a clear commitment towards limiting and reducing greenhouse gas emissions.[30] By doing so, they set a medium- to long-term framework which can help companies and investors to form their expectations about future climate policy. As each country individually formulated its NDC in line with its national circumstances, priorities and preferences, one could expect that there is a higher chance that national governments will actually follow up and make good on the commitments expressed in the NDCs.

For the large majority of countries, and the overwhelming majority of global GDP, the existence of the NDCs means that carbon leakage now comes with a consequence for the leakage recipient country. For the recipient, leakage is no longer just a welcome boost that stimulates foreign investment in the domestic economy and increases demand for domestic products. Instead, carbon leakage now also comes at a cost to the recipient country in the form of associated emissions, making it harder to achieve its own NDC targets, and will necessitate additional mitigation action.

But the existence of NDCs can also affect the incentives that private plant operators and investors face. In this context, it is necessary to distinguish between operational and investment leakage. Day-to-day production decisions on the basis of existing production capacities (operational leakage) are made with a limited time horizon, and will thus only factor in the costs of current climate policies, irrespective of the targets, or whether current policies are compatible with them. Thus, NDCs and their targets by themselves will have little influence on operational leakage – what matters is the actual policy on the ground. Investment leakage, however, involves decisions with a longer time horizon. It will therefore also factor in expectations of future policies, which will be derived from (or informed by) the long-term targets embodied in the NDCs. Even if there should be a discrepancy between targets and current policies, investors would not be well advised to ignore this discrepancy.

[29] Article 10 of the Kyoto Protocol introduced an obligation that *all* parties (subject to several qualifiers) should formulate, implement and publish national programmes of measures to mitigate climate change; yet beyond this obligation – which had limited effect in practice – the non-Annex-I countries were essentially free to emit as much as they would choose.

[30] The exception being that not all countries chose to formulate emission targets in their NDCs; some (in particular least developed countries, as well as some Gulf countries) opted to include a list of projects and activities for mitigation and adaptation in their NDC, without setting any emission targets.

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