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Projecting Emissions Baselines for National Climate Policy: Options for Guidance to Improve Transparency

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ABSTRACT

Greenhouse gas (GHG) emissions baselines are reference emissions levels. This paper focuses on projected forward-looking baselines that can be used both to inform national climate policy and to set goals that are defined relative to a business-as-usual (BaU) scenario. As some developing countries have defined national mitigation goals for 2020 in this way, the underlying assumptions and methodologies used in setting these emissions baselines are relevant for assessing the magnitude of both the country's expected total emissions reductions and the global aggregate emissions mitigation effort.

Currently, there is limited international guidance available on setting national GHG baselines. The resulting variance and lack of transparency makes it difficult to understand emissions pledges defined as relative to BaU, and difficult to compare emissions scenarios across countries. Moving towards international guidance on setting baselines could improve transparency, clarity and comparability, while still allowing countries to maintain diversity in approaches. This paper discusses good practice and presents options for how guidance might be developed for key elements of baseline setting.

The options are presented as "tiers" that move from less detailed to more detailed guidance. The first tier describes guidance that would leave maximum flexibility for individual countries, whilst encouraging transparency. The second tier offers more detailed guidance for countries with greater domestic resources and capabilities. Countries could adhere to the tiers according to their capabilities, although they would be encouraged to follow the more detailed approach. The proposed tiers represent different levels of detail, rather than accuracy or data quality. More detailed guidance does not necessarily lead to "better" baselines, though it may help to improve understanding of different baselines.

JEL Classification: Q54, Q58, Q47
Keywords: Climate change; UNFCCC; emissions baselines; emissions projections

RÉSUMÉ

Le présent document porte sur les projections des niveaux de référence des émissions de gaz à effet de serre (GES), qui peuvent être utilisées à la fois pour éclairer l'élaboration des politiques climatiques nationales et pour fixer des objectifs par rapport à un scénario au fil de l'eau ou scénario de référence. Étant donné que certains pays en développement ont défini de cette façon leurs objectifs nationaux de réduction des émissions à l'horizon 2020, les hypothèses retenues et les méthodologies employées pour déterminer ces niveaux de référence sont importantes pour évaluer l'ampleur des réductions d'émissions ambitionnées par ces pays et celle de l'effort global mondial d'abaissement des émissions de GES.

À l'heure actuelle, il existe peu d'orientations internationales pour la définition des niveaux de référence des émissions nationales de GES. Les disparités et le manque de transparence qui en résultent font qu'il est difficile de comprendre les engagements en matière d'émissions qui sont définis par rapport à un scénario de référence, ainsi que de comparer les scénarios d'émission entre pays. La mise au point d'orientations internationales pour l'établissement des niveaux de référence pourrait améliorer la transparence, la clarté et la comparabilité, sans obliger les pays à renoncer à la diversité de leurs approches. Ce document examine les bonnes pratiques et présente des options pour l'élaboration d'orientations concernant les éléments clés de la définition des niveaux de référence.

Ces solutions envisageables sont présentées sous formes de "couches", qui correspondent à des orientations plus ou moins détaillées. Ainsi, la première couche permettrait aux pays de conserver une marge de manœuvre maximale tout en favorisant la transparence. La deuxième comporte des indications plus détaillées à l'intention des pays dotés de ressources et de capacités plus importantes. Les pays pourraient adhérer à l'une ou l'autre en fonction de leurs capacités, même s'ils seraient encouragés à opter pour la deuxième. La différence entre les deux couches concerne le niveau de détail plutôt que la précision ou la qualité des données. Des orientations plus détaillées ne garantissent pas l'obtention de "meilleurs" niveaux de référence, mais elles peuvent aider à mieux comprendre les différences entre ces niveaux.

Classification JEL: Q54, Q58, Q47
Mots-clés: Changement climatique; CCNUCC ; niveaux de référence des émissions; projections d'émissions

FOREWORD

This document was prepared by the OECD and IEA Secretariats in 2012 in response to a request from the Climate Change Expert Group (CCXG) on the United Nations Framework Convention on Climate Change (UNFCCC). The CCXG oversees development of analytical papers for the purpose of providing useful and timely input to the climate change negotiations. These papers may also be useful to national policy-makers and other decision-makers. Authors work with the CCXG to develop these papers in a collaborative effort. However, the papers do not necessarily represent the views of the OECD or the IEA, nor are they intended to prejudge the views of countries participating in the CCXG. Rather, they are Secretariat information papers intended to inform Member countries, as well as the UNFCCC audience.

Members of the CCXG are Annex I and OECD countries. The Annex I Parties or countries referred to in this document are those listed in Annex I of the UNFCCC (as amended by the Conference of the Parties in 1997 and 2010): Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland, and the United States of America. As OECD member countries, Korea, Mexico, Chile, and Israel are also members of the CCXG. Where this document refers to "countries" or "governments", it is also intended to include "regional economic organisations", if appropriate.

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Summary

Greenhouse gas (GHG) emissions baselines are reference emissions levels. They can have different uses at the national level, including to inform domestic climate change policy and strategic planning as well as to provide emissions information internationally. Whilst different types of baseline are possible, this paper focuses on forward-looking baselines used to inform climate policy and to determine progress towards meeting goals against a business-as-usual (BaU) or projected baseline. As some developing countries have now defined national mitigation goals relative to a future projected business-as-usual (BaU) level of emissions, the underlying assumptions and methodologies used in setting these emissions baselines have direct relevance for assessing both the country's and the aggregate global emissions mitigation effort. A better understanding of these baselines is therefore now of increased importance to the international community. Baselines at a sector or project level can also be used to calculate emissions reduction credits, but crediting is not a focus of this paper.

Currently, there is limited international guidance available on setting national GHG baselines. Variance in the transparency of baseline approaches and assumptions used by different countries is therefore significant. This lack of transparency makes it difficult to understand emissions pledges and actions defined as relative to BaU, and difficult to compare emissions scenarios across countries.

Moving towards international guidance on setting baselines could improve their transparency, clarity and comparability, while still allowing countries to maintain a diversity in approaches. This paper discusses good practice and presents options for how guidance might be developed for each of the following elements in setting a national emissions baseline:

- Start year and timeframe for emissions projections;
- Scope of emissions sources covered;
- Assumptions related to key drivers for emissions projections;
- Treatment of domestic climate policy measures;
- Modelling framework and/or projection methodology used;
- Uncertainty and sensitivity analysis;
- Consultation and/or review; and
- Updating the baseline.

For each element, two options are presented, which can be considered as “tiers” that move from less detailed to more detailed guidance. The first tier describes guidance that would leave maximum flexibility for individual countries, whilst encouraging transparency. The second tier offers more detailed guidance for countries with greater domestic resources and capabilities, aiming at increased consistency and ease of understanding of different countries’ baseline projections. Countries could adhere to the tiers according to their capabilities, although they would be encouraged to follow the more detailed approach. While this tiering concept loosely resembles that used for GHG inventories in the IPCC inventory guidelines, the proposed baseline guidance tiers represent different levels of detail, rather than accuracy or data quality. More detailed guidance does not necessarily lead to “better” baselines, though it may help to improve understanding of different baselines.

A draft of this paper was presented at the CCXG Global Forum on 26 September 2012. Participants discussed the various purposes of baselines, and how to distinguish between guidance for the baseline-setting process and guidance for baseline reporting to the international community. Participants also discussed the role of existing good practice in shaping potential guidance. In general, participants favoured considering the options for guidance as a tiered approach, rather than as parallel options. This paper presents these two tiers as a first step in considering how international guidance might be developed, focusing on good practice already being demonstrated in both developed and developing countries.

1. Introduction

National greenhouse gas (GHG) emissions baselines are reference emissions levels used to inform strategic planning on climate change, emissions mitigation goal setting and climate policy design. A range of different types of baseline are possible, from using emissions from a single historical year as a fixed baseline, to forward-looking baselines based on projections of likely future emissions trajectories. The focus of this paper is on the latter type of baseline. While often viewed as a purely technical component of climate change planning, baselines play an increasingly important role in the political side of climate change policy decision-making. As some developing countries have defined mitigation actions in relation to projected BaU scenarios, the baselines used are now relevant to estimating the effect of planned national mitigation actions. In addition, deviations from baseline can be used to assess stringencies of policies targeting emissions mitigation (see Box 1). It is important for both policymakers and technical experts developing the baselines to recognise the influence of key assumptions in setting baselines, which can impact national climate change policies and goals, and ultimately the national (and therefore global) GHG emissions trajectory.

Guidance for setting national baselines could improve the transparency and ease of understanding of baselines and low-emission development strategies in different countries, and provide clarity of progress towards implementation of countries' mitigation goals and actions. Such guidance could provide a "how to" guide for baseline development, and could ultimately be used for developing guidance for how governments communicate their baseline projections internationally.

At present, no standard guidelines for national emissions baselines exist, either for the baseline development process or for the reporting and communication of emissions projections. Across all countries, a variety of methods is currently employed to set national baselines fitting with national circumstances. However, there are also varying levels of transparency in the methods and underlying assumptions used. These factors combine to result in a lack of clarity across baselines and related climate mitigation goals and actions. Countries could maintain this diversity of approaches and still benefit from guidance on specific elements to improve the technical aspects of baselines, as well as transparency.

The aim of this paper is to propose options for guidance on setting national GHG emissions baselines to improve transparency and clarity on how baselines are calculated, and to influence how these baselines are ultimately reported. While the process of consensus-building in baseline development is important, process elements are not covered explicitly in the proposed options. These options for possible guidance are intended to bring together good practice already demonstrated in different countries, building on both the Danish Energy Agency/UNEP Risø/OECD initiative in sharing baselines experiences,[1] and on the Mitigation Action Plans & Scenarios (MAPS) collaborative project on long-term transition planning scenarios.[2]

Options for guidance presented in this paper could apply to either developed or developing countries, recognising that capacity and data availability will vary according to country circumstances. In most cases, projected national baselines are built up using specific assumptions and definitions for each significant emitting sector, and issues surrounding the choice of these assumptions are briefly discussed in this paper. For countries with an emissions profile concentrated in one or two sectors, baselines covering only those sectors may also be an appropriate tool for national planning. Baselines at the sector or sub-sector level can

[1] As discussed at CCXG Global Forums held in September 2012, March 2012 and September 2011 (see www.oecd.org/env/cc/ccxg).

[2] See www.mapsprogramme.org.

also be used for the purpose of issuing carbon credits under a baseline-and-credit mechanism, but this application is beyond the scope of this paper.[3]

The paper is organised as follows: the remainder of Section 1 defines baselines, describes key influences, and reviews what guidance is available today. Section 2 briefly outlines the key elements of national baselines and provides some preliminary examples of good practice. Section 3 proposes tiered options for moving forward on guidance for each baseline element, and Section 4 draws conclusions and highlights outstanding issues.

Box 1: Why are GHG emissions baselines important?

For all countries, baselines can guide climate change policies and actions, and are important for national strategic planning. They are also useful for informing the debate on levels of emissions mitigation ambition and the global GHG emissions trajectory. Baselines using emissions projections have recently taken on a greater importance to the international community as some national mitigation goals have been defined in terms of a reduction from a future reference level of emissions. Eight non-Annex I countries (representing approximately 18% of current non-Annex I GHG emissions)[4] have defined mitigation actions in the international climate change negotiations in terms of a reduction from a future business-as-usual level of emissions (UNFCCC, 2011b). The international community thus has a strong interest in understanding the assumptions behind the national emissions projection baselines used to define business-as-usual (BaU) scenarios, against which actions and levels of ambition will be assessed.

Under existing UNFCCC agreements, Annex I countries are required to include projections of emissions baselines in their national communications to the UNFCCC, in order to inform the international community of their expected emissions trajectories. Whilst there is no mandatory reporting of non-Annex I projections or baselines to the international community, some countries have provided them (e.g. South Africa in their second national communication to UNFCCC, 2011).

There is a considerable variance in the methods used to construct national emissions baselines and projections, as countries and institutions use different approaches and assumptions. For example, baselines for Mexico developed by several institutions using different modelling platforms showed a variance of over 60% in emissions projections for 2020, and over 80% in 2030, although some of this variance is explained by differences in scope, such as which GHGs are modelled (Clapp *et al.*, 2009). While countries will have differing national circumstances that drive their approaches, the current lack of transparency on different assumptions or approaches makes it difficult to understand emissions pledges and actions defined as relative to BaU, and difficult to compare emissions scenarios across countries.

1.1 What is an emissions baseline?

The term "baseline" conveys different meanings depending on the context. As noted in Prag and Clapp (2011), the definition and application of emissions baselines remains unclear after over a decade of experience in the UNFCCC. Box 2 provides some clarity on the terminology as used in this paper, and elaborates on some of the uses of baselines.

[3] See Prag and Briner (2012) for a recent discussion of crediting baselines and their interaction with national policies.

[4] Brazil, Chile, Indonesia, Israel, Mexico, Singapore, South Korea, and South Africa.

Box 2: What is an emissions baseline?

An emissions **baseline** indicates a reference emissions level that could be used to establish a goal and/or to measure changes in GHG emissions over time. This reference level could be based on a fixed emissions level (e.g. historical emissions for a particular year), on a simple historical trend, or can be an estimated projection of how emissions may evolve in future. This paper focuses on the latter type of projected baseline. A national baseline intends to illustrate economy-wide GHG emissions for a country (for some countries, focusing on one or two sectors or GHGs may cover the majority of national emissions). Baselines can inform strategic planning on climate change, emissions mitigation goal setting, and climate policy design.

A baseline can be used to define a **mitigation goal or target**, either through a goal that explicitly refers to a reduction from a baseline, or by implicitly informing how goals are set. Emissions baselines are a tool that can inform strategic planning such as low-emission development strategies or LEDS (see Clapp *et al*., 2010) and provide input to the design of climate change policy and actions.

A baseline could be the same as a **business-as-usual (BaU)** trajectory, but in some circumstances may also be set at an emissions level distinct from the expected development of emissions under BaU. For evaluation of specific policies, countries may use a projected baseline to represent a counterfactual that does not include the impact of policies that would otherwise be considered in BaU.

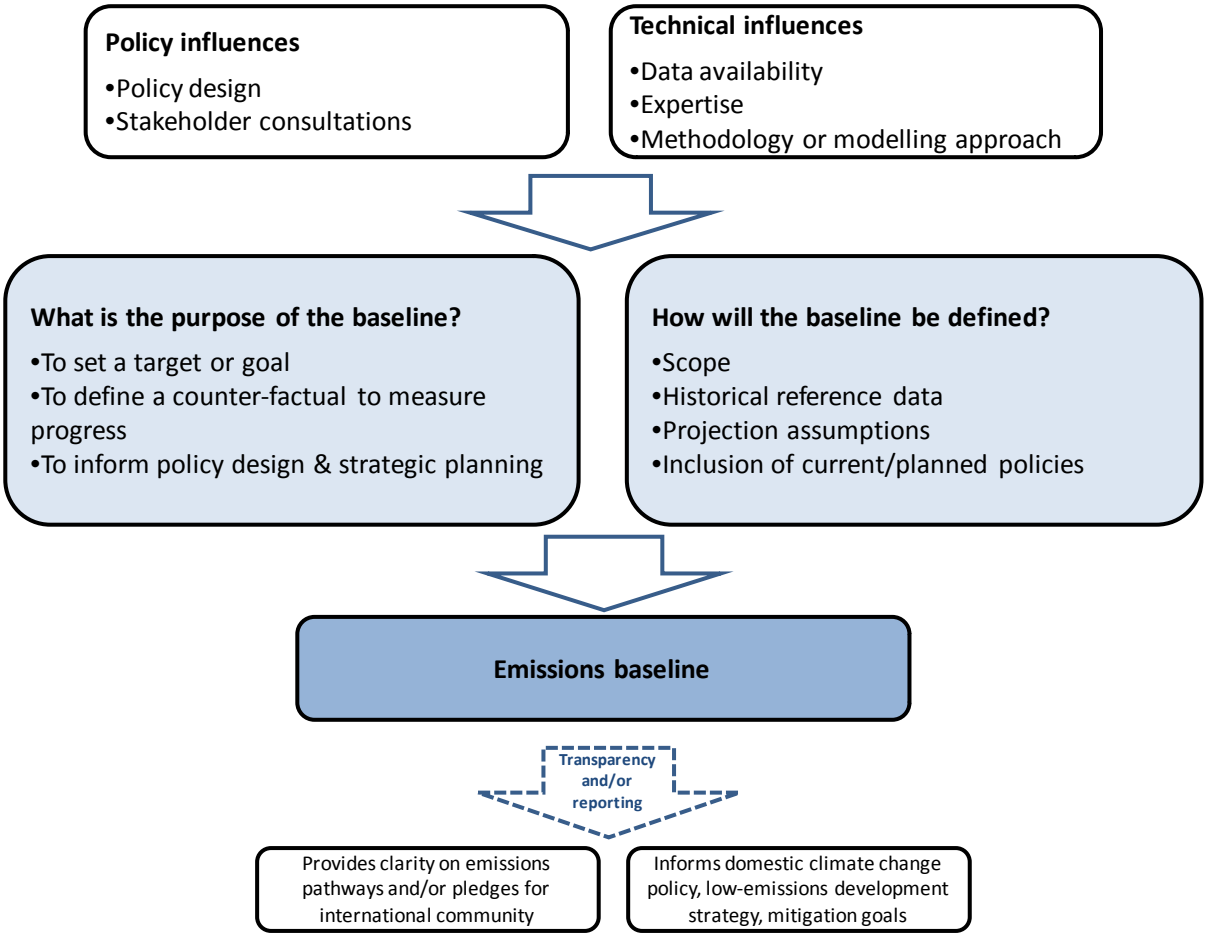
Baselines distinct from BaU may also be used for issuing carbon credits. For example, in Clean Development Mechanism (CDM) projects, the baseline may be at or slightly below BaU, whereas for an environmentally ambitious sectoral crediting mechanism, the baseline could be defined as a crediting threshold at a level significantly below BaU to incorporate a level of environmental ambition (Prag and Briner, 2012). However, baselines for crediting purposes are not covered in this paper.

Source: Adapted from Prag and Clapp, 2011

The process of setting baselines using projections is subject to a large number of inputs, which combine both technical approaches and assumptions as well as aspects subject to political influences. Defining the purpose and determining the assumptions and methods used will impact the resulting emissions baseline. This process can be influenced by policy design considerations and stakeholder consultations, as well as by technical capabilities and availability of data. Figure 1 illustrates these influences and decision points in setting a baseline.

The key elements in defining a baseline (e.g. scope, assumptions, and what policies to include) are discussed further in Section 2. Assumptions underlying each element can influence the credibility of the baseline, thus transparency on the methods, assumptions and approaches is an important factor when considering what form guidance may take.

Figure 1: Influences and decisions in setting a baseline



Source: Adapted from Prag and Clapp, 2011

1.2 What guidance is available today?

No standard international guidance for setting national GHG emissions baselines exists.[5] There is some general guidance on the reporting of emissions projections to be included in Annex I National Communications (UNFCCC, 1999), but no specific guidance for setting national baselines for either developed or developing countries. The lack of guidance is related to the inherent uncertainty in future emissions projections, as well as to the diversity of different countries' national circumstances. In addition, before countries defined mitigation goals in relation to BaU, there was less attention paid to baseline projections as future projections were mostly done by developed countries and/or for domestic information purposes and did not directly affect the overall magnitude of the expected global mitigation effort.

Several initiatives now exist outside of the UNFCCC process aiming to share good practice in baseline setting and low emission scenario development. These include the Mitigation Action Plans & Scenarios (MAPS) collaboration on designing scenarios, and the Danish Energy Agency (DEA)/UNEP Risø/OECD initiative focused specifically on baselines (see Box 3). Also, UNEP's "Multi-criteria analysis for climate change" (MCA4Climate) initiative has developed guidance for emissions baseline modelling choices (Stanton and Ackerman, 2011).

[5] Methodologies do exist for setting crediting baselines for specific projects in the Clean Development Mechanism and other carbon crediting protocols. However, baselines used to create tradable assets, whether for individual projects or more broadly, bring different challenges, e.g. data monitoring, leakage, demonstrating additionality. Baselines for crediting mechanisms are thus not considered in this paper.

Box 3: Sharing good practice through the MAPS and DEA/UNEP/OECD initiatives

Two initiatives in particular provide a forum for sharing best practice in setting baselines and designing scenarios that reflect expected future developments:

- The **Mitigation Action Plans & Scenarios (MAPS) collaboration**[6] is an enabling programme to share information and best practices on low-carbon transition planning and scenario development. The MAPS programme grew out of South Africa's experience developing national Long Term Mitigation Scenarios (LTMS, 2007), and is an initiative of the University of Cape Town's Energy Research Centre (ERC), in partnership with SouthSouthNorth (SSN). The programme currently focuses on Latin America, where it supports collaboration between active government-mandated projects in Brazil, Colombia, Chile and Peru, with Argentina under investigation. The programme works with these country governments and technical practitioners in the partner countries to establish an inclusive process for designing emissions scenarios, including baseline or reference scenarios as well as economic data and mitigation options data, and to share knowledge on technical aspects of scenario development. While some countries, e.g. Argentina, are at the beginning of the process of establishing a mandate for working on scenarios, other countries, e.g. Chile, are building up their technical expertise on modelling approaches.
- The **Danish Energy Agency (DEA)/UNEP Risø/OECD initiative** also aims to share current practices being used in setting national emissions baselines across a range of developing countries. Governments and research groups from countries involved in this initiative (Brazil, China, Ethiopia, India, Indonesia, Kenya, Mexico, South Africa, Thailand and Vietnam) are sharing common challenges and solutions, including on data, assumptions and sensitivities, methodology, transparency and review. A collaborative publication, involving contributions from experts in all countries involved, is planned for the end of 2012. This publication will highlight existing experience through chapter contributions from country experts and aims to initiate discussions on lessons learned and good practice.

Beyond these targeted initiatives, there are several other activities that examine best practices in mitigation efforts more broadly. For example, the WRI GHG Protocol Mitigation Accounting Initiative[7] is a research group that was initiated in 2012, with technical working groups focused on guidance for mitigation goals and actions, including discussion of baselines. In addition, the WRI Measurement and Performance Tracking (MAPT)[8] initiative aims to build and support capacity in developing countries for measuring emissions and performance, with support from Germany's International Climate Initiative. Other international activities or institutions that have projects relevant to baselines include the Green Growth Best Practice Initiative, the International Partnership on Mitigation and MRV, and the LEDS Global Partnership. There are also bilateral initiatives to build capacity for GHG inventories and modelling, e.g. the US EPA National GHG Inventory Capacity Building programme.[9]

2. Considering good practice in key elements of baselines

To initiate the development of a national baseline, a government mandate can be important to kick-start the process. For example, the MAPS programme is currently working with several governments including Argentina to help establish such a mandate (see Box 3). Cross-ministry co-ordination is also an important

6 www.mapsprogramme.org

7 http://www.ghgprotocol.org/feature/wri-launches-ghg-protocol-mitigation-accounting-initiative

8 http://www.wri.org/project/low-carbon-development/measurement-and-performance-tracking

9 http://www.epa.gov/climatechange/EPAactivities/internationalpartnerships/capacity-building.html

part of the process, as different assumptions and approaches can be favoured by different ministries. In the case of Israel, an international consultant (McKinsey) was commissioned in an effort to gain the attention of high levels of government (Clapp *et al.*, 2010). Stakeholder involvement of industry, academia and NGOs can help solidify support for approaches to different aspects of a baseline. As part of the MAPS programme, Chile is organising stakeholder meetings within their Scenario Building Team, which includes more than 50 representatives from public, private, academic and NGO sectors. In addition, Chile is organising sectoral stakeholder meetings for technical experts across eight key sectors.

In parallel to an inclusive cross-ministry and external stakeholder process, individual technical elements of setting a baseline require careful consideration. This section briefly summarises some of the main issues involved with key elements of developing emissions baselines at the national level. Each element involves analysing technical information and making assumptions about how future emissions may evolve.

Emissions inventory

An emissions inventory gives a snapshot of the emissions sources (and sinks) at a particular moment in time. Emissions inventories and past emissions trends can provide a concrete starting point or validation for projecting future emissions trajectories, although projections can also be estimated without being tied to a detailed inventory for a particular year. It can, however, be technically challenging to reconcile inventories with pre-existing modelling frameworks, as they may incorporate different sectoral definitions and may vary in their coverage of a country's total emissions. Establishing a time series of historic GHG emissions can help inform a smooth transition to emissions projections in the future, and to inform national climate change strategies, such as has been carried out in Chile.

In general, developing an emissions inventory requires both activity data – for example, level of output or input for a particular economic sector – and emissions factors, to convert activity data into total emissions. The quality of both activity data and emissions factors is important to the accuracy of an inventory and for the subsequent construction of a baseline projection. Setting up measurement systems and processes in order to gather activity data is a particular challenge in developing countries.[10] Similarly, detailed emissions factors are important for developing an emissions inventory, but default factors can be used for initial baseline calculations.

Inventories are already subject to specific guidelines (for both developed and developing countries). Detailed guidelines for the compilation and reporting of inventories have been drawn up by IPCC at the request of the UNFCCC Secretariat (IPCC 1996, 2006).[11] Mandatory inventory reporting for Annex I countries stipulates the use of IPCC Guidelines, but allows for use of country-specific methods if considered more accurate and compatible with IPCC Guidelines, provided that countries document their methods (UNFCCC, 2006). For example, whilst the IPCC has developed an extensive database of generic emissions factors, country-specific factors are likely to be more accurate in many cases. Many developing countries have also chosen to produce emissions inventories according to these guidelines, with specific emissions factors in some cases.

[10] Some countries have also implemented national GHG reporting programmes, which seek to collect emissions data from emitting sources. This data can then be used to help inform the more aggregate and comprehensive national GHG inventory data (Kauffmann *et al*., 2012).

[11] Note that the IPCC also published Good Practice Guidance documents on uncertainty management (2000) and LULUCF (2003).

Projection start year and timeframe

In general, countries choose to start their projections either on a single specific year of GHG emissions inventory data, or a series of years over which trends can be analysed.[12] If a projection is based on a single start year, the choice of year can have a significant impact on future projections, depending on economic circumstances and natural factors particular to the year chosen. Such factors include: short-term trends in GDP growth; factors affecting the energy system (such as fuel prices and supply interruptions); natural variations (such as weather variations, where a mild winter may lead to lower emissions, and fluctuations in rainfall, which can reduce the level of hydro-electric production and therefore increase fossil emissions); and weather and forest fires that may affect sequestration in the LULUCF sector.

These issues surrounding choice of start year can be particularly contentious where a single base year is used to set an emissions target (such as in the Kyoto Protocol). However, it can usually be addressed by a well-designed modelling exercise to produce robust emissions projections not dependent on a particular base year.[13] There is currently no agreed standard base year for mitigation pledges and actions for 2020 as submitted to the UNFCCC under the Copenhagen Accord and the Cancún agreements, and no guidance on the use of inventory data when making emissions projections.

Countries may also present baseline projections over different timeframes to provide input to different policy and planning considerations. Thus, the guidelines for reporting of emissions projections in Annex I countries in national communications indicate that countries should report projections to 2020, showing 5-year intervals of data, e.g. 2005, 2010, and 2015 (UNFCCC, 1999). Unsurprisingly, the end date of projections included in Annex I country 5th National Communication therefore varies (e.g. 2010, 2020). It could be informative to the international community to have information on national baselines over similar timeframes, and it may be logical for guidance to suggest co-ordination between the timeframes of projections and the pledges or targets put forward by countries.

Scope

National emissions baselines cannot always account for every last tonne of GHG emissions within a national boundary, as the availability of data required and the costs involved for extending the scope are likely to exceed the benefits once the most significant emissions sources are included. For example, Guyana focused on the forestry sector as their most important economic and emitting sector in their Low Carbon Development Strategy (Guyana LCDS, 2010) and associated baseline. The scope of a baseline involves decisions on which GHGs to include in the projection – e.g. CO_2 only, or the basket of Kyoto Protocol GHGs, or other sets of GHGs – and which emitting sectors or sources to include. National emissions can be divided up in a number of ways, for example by economic sector, or according to emissions sources themselves, as is recommended in the IPCC Guidelines for Emissions Inventories (1996).[14] The distribution of emissions across sectors or sources varies significantly between countries. Some countries therefore take decisions to focus on the more significant sectors in terms of proportion of total emissions, in order that the baseline setting exercise be both credible and cost-effective.

Annex I countries report national level emissions projections to the UNFCCC, and some of these also include sector level projections. However these sector level projections use different sectoral definitions and aggregations, and are inconsistent in their coverage (Ellis *et al.*, 2010). In general, differences in

[12] The start year is sometimes known as the base year, but this term is not used here to avoid confusion with base years used as fixed baselines e.g. to set targets in the Kyoto Protocol.

[13] Modelling or projection methodologies can be designed to take into account some annual fluctuations in emissions to provide continuity across years.

[14] Emissions can also be allocated on a consumption (instead of production) basis, but as the UNFCCC process has focused on national production-based emissions, this is the approach followed here.

sectoral definitions across models and projection methods make it difficult to compare baselines (Clapp *et al*., 2009). Greater alignment or transparency of sector definitions would allow for more robust comparisons across baselines and models. However, the diversity of existing models and definitions used for constructing baselines means that a complete harmonisation is unlikely to be a realistic objective.

Assumptions related to key drivers for emissions projections

All projections are based on assumptions about the future evolution of the key drivers of emissions.[15] These drivers can vary significantly by country, and analysing the trends involved can help improve the credibility of a baseline. Important steps in constructing a baseline therefore include identifying the drivers for the most significant sectors, and deriving assumptions on how those drivers will vary over the timeframe of the baseline. In many cases, key drivers include changes in overall economic output – GDP growth, itself an aggregate of sectoral value added – energy prices, and changes in population. Secondary drivers can include non-linear changes in the rate of adoption of new low emissions technology, and resulting substantial changes in the energy system.

If countries do not have local sources for input data, they may rely on data sets produced by international organisations for some data aspects, e.g. UN data sets for population and IEA data for regional or international energy use (Clapp *et al*., 2009).[16] However, for GDP projections, countries tend to incorporate a variety of sources for their assumptions and often rely on their own domestic projections. An important issue for producing international guidance for emissions baselines is how to compare assumptions made based on country-specific datasets concerning the key drivers.

While domestic data may be more accurate, international data can serve both as a comparison to national estimates, and to provide an international view on key drivers. For example country- or regional-level data and other information compiled by international organisations can indicate how national, regional and/or global GDP may evolve, which can be important for national projections in heavily trade-exposed countries. A possible solution is to recommend that, for some key assumptions such as those that have a significant impact on total GHG emissions, national datasets are compared to internationally-available data in order to assess uncertainty and be transparent about where and why there are differences. See Box 4 for further information on new reference scenarios under development in the international modelling community that could be applied to national circumstances. Whilst these scenarios are designed over a long timeframe out to 2100, they provide internationally-recognisable storylines that may help to improve coherence between countries' emissions baselines over the time frame relevant to UNFCCC negotiations, i.e. 2020-2030 (and, to a lesser extent, to 2050).

[15] IPCC Guidelines refer to *key categories* which are prioritised in an emissions inventory due to their estimated significant influence on the total GHG emissions (IPCC, 2006).

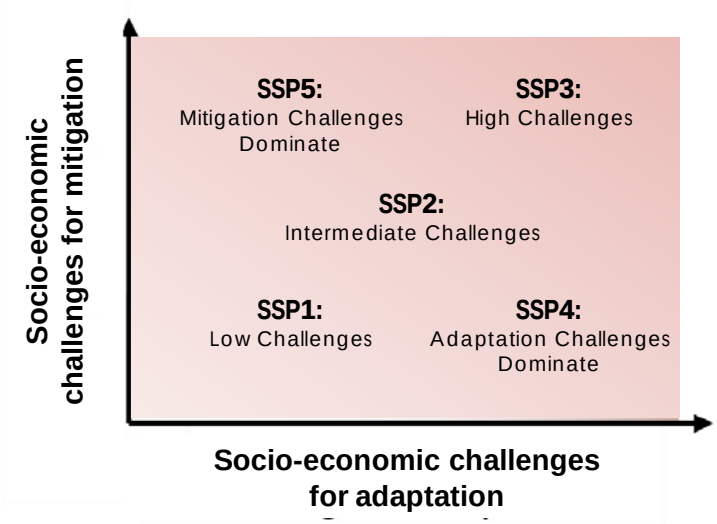
[16] Note however that country-level energy data held by the IEA is usually provided by national governments, so is not necessarily additional to what those governments themselves compile in their national datasets.

Box 4: A new generation of long-term reference scenarios

The IPCC has asked the international research community to collectively develop new reference scenarios for the integrated analysis of future climate change for the IPCC 5th Assessment Report. The new scenarios are being designed by a diverse group of modellers and researchers, followed by a broad stakeholder review process including governments, NGOs and others to ensure broad international acceptance (IPCC, 2008).

This new scenario framework includes a set of Shared Socioeconomic Pathways (SSPs), which describe socioeconomic projections at the national level for almost all countries in the world and the associated GHG emissions for 2010-2100. The SSPs combine qualitative information in general storylines (mostly at the regional level) with quantitative information on emissions and the main socioeconomic drivers, including population and per capita income.[17] While narratives and emissions focus on the regional level, the quantitative information on population and per capita income is available at country level. The scenarios reflect different views on international developments up to 2100 and are meant as baselines in the sense that they do not contain estimated impacts of climate change, nor new climate policies. The SSP storylines revolve around the dual challenges of mitigation and adaptation, and can be categorised according to the five storylines as plotted in the following diagram (for further information and descriptions of the storylines see O'Neill *et al.*, 2012):

Schematic representation of the SSPs



Source: O'Neill *et al.* (2012)

The reference socioeconomic projections can be used in several ways:

- When making new baseline scenarios, modellers can choose an SSP and use the quantitative data available, together with some qualitative information that is given in the SSP storyline.[18] Modellers can then make different projections for different SSPs.
- SSPs could also be used to categorise baselines that are produced using domestic or alternative data sources. Projection elements in common with the SSP storylines (either assumptions e.g. on energy efficiency, or outcomes e.g. on emissions) can be identified, thus mapping baselines to an SSP in the matrix provided in the diagram above.

A combination of these two approaches is also possible, e.g. where domestic population projections are combined with income projections from the most closely related SSP.

Source: Adapted from Chateau *et al.* (forthcoming 2013)

[17] The full descriptions of the SSPs and detailed projections at the country level will be published early in 2013; a draft version of population and income projections is already available on https://secure.iiasa.ac.at/web-apps/ene/SspDb/ Note that Chateau *et al.* (forthcoming 2013) provide detailed descriptions of the income projections for all SSPs for more than 175 countries in the world.

[18] Quantitative information could include total primary energy use and agricultural yield increases (if available at the country level), while the storyline provides context to guide own choices of assumptions.

Treatment of domestic climate policy measures

Many policy measures affect GHG emissions, both mitigation-specific policies such as cap-and-trade and general policies not necessarily related to climate change, such as fuel taxes or subsidies, and industrial or infrastructure development policies. It is therefore very difficult – and probably not sensible – to completely isolate emissions trends from the impact of existing and expected future policy developments. Most baseline scenarios include expected impacts of policies not directly related to climate change, even if these have an impact on emissions trajectories. Nevertheless, a key role of baselines guidance could be to help understand which policies (climate-specific or otherwise) are or are not included in a particular baseline, in order to understand how different baselines may relate to one another.

Existing UNFCCC guidelines for emissions projections in Annex I countries to be included in national communications broadly distinguish between projections (i) without measures, (ii) with only existing measures and (iii) with existing plus additional future measures (UNFCCC, 1999). However, the guidelines do not provide any examples of which types of policies could be included according to these definitions, leaving the current labelling of scenarios open to much interpretation. There is no requirement for countries to present all three types of projections. Furthermore it is difficult to retrospectively assess past emissions projections – for example, assessing in 2012 how accurate 1999 projections were with and without measures – because it is challenging to isolate the impacts of specific policy measures.

Whether and how to include particular policy measures within baseline scenarios (as opposed to considering such measures as deliberate mitigation actions that would not occur under BaU) can be controversial. This is because the same policy measures are sometimes considered as distinct mitigation efforts, particularly if the measures are dependent on international financing. These efforts might then be included in a mitigation policy scenario rather than a baseline scenario. For example, South Africa's LTMS project did not include the effects of any climate policies in their "growth without constraints" scenario, although some effects of existing policy measures were included in the "current development plans" scenario (LTMS, 2007). Other non-climate policies that can impact GHG emissions are sometimes included in country baselines.

A baseline which assumes no new climate action beyond a specific point in time could be the clearest way to treat climate policies for all countries. However even this can be difficult, as there is often a time lag between agreeing to a policy and actually implementing it, during which time the expected effects of the policy may change due to compromises made during the legislative process or other factors. One way to distinguish between policy measures is between those that have already been voted or approved into legislation, and those that are not yet legally formalised, even if they appear likely. For example, South Africa's "current development plans" scenario included the effects of existing energy efficiency and renewable measures in their current phases up to 2013 and 2015, but assumed no further effects after this time (LTMS, 2007). A different example is the treatment of production tax credits for renewables in baselines for the USA. If the current tax credit schedule is due to expire by the end of a particular year, official projections assume that it does so, even if observers would say that another similar measure is likely to replace it. Chile demonstrated a practical solution in choosing 2007 as their baseline projection start year, considering that the country's national inventory runs from 1984 to 2006 and that 2007 is the year in which Chile began to implement early actions that have resulted in GHG emissions reductions.

Modelling framework or projection methodology

Projections can be done through simple extrapolation using historical emissions trends and inventory data, or by more complex modelling, either at the national economy level or built up sector-by-sector. The choice of projection method or model can have a significant impact on baselines and resulting mitigation potential (see Clapp *et al*., 2009 and Hoogwijk *et al*., 2009 for further detail).

Extrapolation can be done relatively easily using a spreadsheet model to make assumptions on some key variables and emissions drivers to assess the impact on emissions. If the trends in GDP and population are

smooth and stable, the extrapolation may not deviate much from those derived using more advanced modelling techniques. However, if there are elements in the projections from key drivers that deviate from past trends, then a more elaborate method is preferable.

More complex modelling frameworks can generally be divided into top-down and bottom-up approaches:[19]

- **Bottom-up models** are designed to answer questions about how specific technologies or programmes can mitigate emissions. They generally offer a more detailed picture of specific emissions sources, and thus require detailed data sets. They ignore the larger economic context (e.g. macroeconomic feedbacks) and usually do not account for indirect effects of other non-climate policies on emissions. Bottom-up models are better suited for a detailed description of the impact of specific policy instruments (e.g. fuel economy standards), but cannot guarantee the overall economic coherence of their projections.

- **Top-down models** are designed to answer questions about how mitigation constraints impact the broader economy. They focus on interlinkages in economic processes rather than technological detail, and thus require an understanding of complex interactions between actors in an economy. While these models contribute to a better understanding of the broader economic impacts, they do not provide a great degree of technological and sectoral detail.

Different (or multiple) modelling approaches may be of interest and available to different countries, depending on the level of detail they want to achieve, the time horizon for the baseline (long horizons make extrapolation approaches less reliable) and national circumstances. Also relevant are the policy questions they would ultimately like to answer by making the projection – for example whether to assess the outcome of a specific policy intervention, or to set a reference trajectory for setting a goal for overall national emissions.

Given this range of reasons why modelling approaches may vary, a key challenge when considering international guidance on setting baselines is how to allow for a diversity of nationally-specific approaches. This flexibility needs to be balanced with sufficient clarity and transparency in the baseline process to ensure that the differences between them can be understood by the international community. Guidance could be provided as to which model types are more suitable for different purposes.

Uncertainty and sensitivity analysis

All projections are descriptions of the future and so unlikely to be completely accurate. Rather, projections aim to provide an estimated path of how emissions are likely to evolve given certain conditions. As emissions trajectories are generally very sensitive to key drivers, assessing baselines against a number of possible scenarios will help to ensure that the baselines are robust. These scenarios can reflect different views on expected future developments (e.g. different 'storylines', see Box 4) or for instance involve sudden changes or shocks in drivers – such as a (sharp) decrease in GDP growth – or be based on projected impacts of deliberate mitigation policies that result in reduced emissions intensity.

The presentation of multiple scenarios can provide information on sensitivity to key drivers and on varied approaches to the inclusion or otherwise of policy measures, as described above. The resulting portfolio of scenarios allows for better understanding of likely emissions trajectories and can therefore help to build international confidence if one scenario is then chosen as the baseline for an overall mitigation goal or action. Furthermore, an initial presentation of multiple scenarios based on different assumptions can allow for a transparent means to switch to a different baseline in future, for example if GDP growth deviates

[19] Although more complex top-down models that have ample technological detail can best be characterised as hybrid.

from its expected path, without redoing the entire modelling exercise. Sensitivity analysis can also help guide future updates to baselines.

Consultation and/or review of baseline scenarios

Under the Cancun Agreements, developed country mitigation targets are subject to International Assessment and Review (IAR) and mitigation actions (and effects thereof) put forward by developing countries, described in Biennial Update Reports, will undergo International Consultations and Analysis (ICA) (UNFCCC, 2011a).[20] Although IAR does not specifically focus on baselines, the existing process for in-depth review of national communications includes a brief review of emissions projections. Developed country targets have generally been expressed as fixed percentage reductions from a historical emissions level in a base year (e.g. 1990 or 2005), and so emissions projections do not affect the total reduction in emissions that would be achieved by meeting the target (though such projections can help in evaluating the effort and policies required to meet the target). ICA currently does not include specific provisions for assessing baseline projections, even though some developing countries' mitigation objectives are dependent on the initial calculation of a BaU baseline scenario.

Guidance for setting baselines could stipulate a minimum level of third party analysis or review of methodologies and assumptions in order to build confidence in the robustness of countries' baseline scenarios. This could be achieved through improved understanding of how countries' baselines relate to one another, including clarity on technical, procedural, and political aspects, such as how impacts of policy measures are estimated (Ellis *et al*., 2011). A further step could be to establish international accreditation requirements for the competency of third-party reviewers.

Consultations or review of baselines could involve a technical peer review by experts, or a more formal approach launched under the UNFCCC. One such example is the Annex I national communications, in which countries are subject to an in-depth technical review process.

Updating baseline projections

As economic and other conditions change over time, the assumptions originally used to construct baseline scenarios may become less adequate, and this may affect the ongoing relevance and credibility of a baseline projection. It is difficult to assess at what point such assumptions become no longer valid, or when the deviation becomes important enough to warrant selection of a different scenario from the original sensitivity analysis or a fuller reconstruction of the baseline – either through re-running a model with altered assumptions or through more substantial redesign of the projection approach. This is particularly important when the baseline is being used to measure national mitigation pledges or actions, and is also relevant for sectoral or other baselines being used to measure credited emissions reductions. Therefore some international guidance on updating national baselines could improve clarity for the international community. However more frequent updating might depend on the availability of a country's resources to do so.

Updating baselines might also be instigated following changes in government, even if there are no particular technical or economic reasons to update the baseline at that time. Transparent involvement of stakeholders, including across government ministries, could increase the domestic credibility and longevity of a baseline. In addition there is an underlying issue of how to deal with economic cycles – on the one hand updates should use recent data, but on the other hand baselines should not become too dependent on the effects of the current economic cycle, particularly if baselines are projected over a long timeframe. Furthermore, not all parameters would necessarily need to be updated at the same time.

[20] Technically, IAR will be carried out on Biennial Reports (developed countries) and ICA on Biennial Update Reports (developing countries), but these reports will contain information on mitigation targets and goals.

A stipulation that baselines should be recalculated on a fixed time schedule may be insufficient if before the stipulated time significant exogenous changes occur that could impact near-term projections, e.g. a prolonged recession. A solution therefore may be that baselines be updated if measured data on any key driver deviates by more than a certain percentage from the value assumed for the construction of the baseline scenario – for example, if GDP growth deviates significantly from that assumed in the original projection. Such a trigger value could be included in guidance for baseline setting. A challenge to this approach is that there is often a time lag over when such deviations appear formally in official data. Therefore the availability of sensitivity analyses around the chosen baseline would be particularly useful to show how changes in key drivers would affect emissions, and therefore when a new baseline ought to be considered based on updated parameters for these key drivers.

3. Tiered options for guidance

Across the elements described in the previous section, greater transparency and clarity could enhance understanding on country actions and plans, and on aggregate GHG emission trajectories. Developing guidance for establishing national emissions baselines would be one way of moving forward in this direction, noting that there is a distinction between stipulating how baselines should be calculated, and how they should be communicated and reported. Options for possible guidance in setting national baselines could be steered by the following objectives:

- Increased transparency on how emissions baselines are constructed;
- Greater clarity on mitigation targets, actions and progress towards them; and
- Improved understanding of how baselines and underlying assumptions differ across countries.

Guidance could take a variety of approaches, from a more flexible to a more detailed approach. For each of the key technical elements for baseline setting discussed above in section 2, options for how guidance could be established are presented in Table 1. Two options are presented for each element, with Option 1 offering more flexibility (e.g. for countries with limited resources) and Option 2 offering more detailed guidance.

Considering the different circumstances of countries, as is often stressed in the international negotiation process, guidance would need to be flexible enough to ensure that it is appropriate for national circumstances. Developing countries may have less capacity in terms of data availability and expertise in setting baselines. This might affect whether and how these options would be applicable to different countries. To address these differing circumstances and resources, the guideline options can be viewed as tiered, i.e. Option 1 is the more flexible tier, and Option 2 is the more detailed tier which offers greater transparency, though not necessarily greater quality of baselines. Countries should be encouraged to follow the Option 2 guidance when possible, as this would provide the greatest degree of transparency and clarity to the international community.

Table 1: Tiered options for guidance

a) Projection start year and timeframe

Option 1	Countries indicate and explain choice of their projection start year(s) for projections. Countries report projections over similar time frames, e.g. to 2020 in 5-year intervals.
Option 2	Countries use an internationally-agreed projection start year(s) on which to base projections. Countries report projections over similar time frames, e.g. to 2020 in 5-year intervals.

b) Scope

Option 1	Public reporting of which sectors and GHGs are included, and how sectoral scope of baselines maps to other sectoral definitions, e.g. IPCC Guidelines and the scope of any NAMA initiatives put forward by the country if relevant.
Option 2	Standardised sectoral definitions are used that are map to sectoral definitions in other recognised processes e.g. IPCC Inventory Guidelines. Countries analyse or model all important sectors or key categories (e.g., comprising x% of estimated total national emissions), including LULUCF if relevant. Reporting of which sectors and GHGs are included.

c) Assumptions related to key drivers for emissions projections

Option 1	Countries retain flexibility on data and choice of assumptions, but default international sources of data for key drivers[21] could be listed on UNFCCC website for countries that do not have local sources for input data, e.g.: • Global/regional GDP trends: Word Bank indicators, IMF World Economic Outlook • Population trends: UN high/low/medium projections • Energy trends: IEA • GHG emissions: OECD, IEA for CO_2 from energy, EPA non-CO_2 GHG projections, FAO forest cover • Future storylines and assumptions: SSPs Countries demonstrate relationship between inventory and projections.
Option 2	Countries use own projections or alternative data sources, and report on how the projections compare with international data sources such as those under option 1 (also see uncertainty element below). Countries demonstrate relationship between inventory and projections. Also demonstrate that national baselines are coherent with baselines put forward for other purposes within the country, such as for crediting programs or other financing of NAMAs, but also economic projections for other purposes.

[21] The key drivers of emissions are GDP, population, and energy consumption and emissions intensity of energy use, as per the Kaya identity (IPCC, 2000).

d) Treatment of domestic climate policy measures

Option 1	Public reporting, labelling and justification of policy treatment following one common scenario definition, e.g. as adapted from UNFCCC (1999): • "No new measures": no climate action is undertaken in addition to those measures already in the legislative process beyond a specified point in time. Countries indicate the year beyond which no new policies are assumed to be implemented, and whether impacts of existing policies are assumed "frozen" after that point in time, or whether penetration trends are extrapolated. Additional scenarios may also be developed and compared to the "no new measures" baseline. Assumptions and methodologies used for estimating the impact of policies (both climate-specific and climate-relevant policies such as infrastructure plans) are documented and made publicly available.
Option 2	Public reporting, labelling and justification of policy treatment according to common scenario definitions, e.g. as adapted from UNFCCC (1999): • "No new measures": no climate action is undertaken additional to those measures already in the legislative process beyond a specific point in time. Countries indicate the year beyond which it is assumed that no new policies will be implemented, and whether policy impacts are assumed "frozen" after that point in time, or whether penetration trends are extrapolated • "With new measures": all implemented and planned climate-specific actions are included. Countries indicate which measures are included and the methodology used to estimate their impacts. Assumptions and methodologies used for estimating the impact of policies (both climate-specific and climate-relevant policies such as infrastructure policies) are documented and made publicly available.

e) Modelling framework or projection methodology

Option 1	Identification and detailed description of models and/or projection methods, e.g. projections based on extrapolation of historical inventory or model-based projections (top-down, bottom-up, hybrid). Guidance could be provided for which types of models are most appropriate for different purposes.
Option 2	Countries that have developed baselines using multiple methods indicate which models and methods have been used with a detailed description and explanation of the choice of particular top-down or bottom-up modelling techniques. Comparison of results using different methods is encouraged.

f) Uncertainty and sensitivity analysis

Option 1	Countries describe key drivers that are likely to show uncertainty, e.g. GDP growth.
Option 2	Sensitivity analysis on key socioeconomic variables, e.g. GDP growth to produce a range of scenarios. If multiple approaches have been used, demonstrate relationship between different baseline approaches, e.g. projections based on historical inventory, bottom-up facility reporting, or model-based projections.

g) Consultation and/or review

Option 1	Optional technical review of baselines with results made publicly available.
Option 2	UNFCCC or third party technical review of baselines, including categorisation of baselines according to recognised storylines (e.g. SSPs, see Box 4) to facilitate comparison across countries. [This review process could form part of a future process through which baselines could be recognised under UNFCCC as eligible for defining pledges and actions relative to BaU conditions.]

h) Updating

Option 1	Update baselines when unexpected changes in key drivers occur (e.g. when GDP growth is more than x% different to what was projected due to an unexpected shock).
Option 2	Update baselines on a regular basis e.g. every 4 years (which could align with national communications and biennial update report cycles). Updates could also be made more frequently, e.g. when unexpected changes occur in key drivers (i.e. beyond the expected economic cycle).

4. Concluding remarks and next steps

The options for guidance for setting national emissions baselines presented in this paper could offer improved transparency and clarity over the current situation of limited international guidance. The options for each element can be considered in a tiered approach. Of the two options presented for each element in the previous section, Option 1 offers more flexibility for countries with lower data availability or resources, while Option 2 offers more detailed guidance for countries that are able to provide more information. These tiered options represent a flexible approach for varying national circumstances, and should not be viewed as tiers of differing quality. Countries should be encouraged to follow the more detailed tier guidance whenever resources allow, as this option would provide greater transparency to the international community.

Across the elements presented here (start year and timeframe, scope, key drivers, policy treatment, modelling or projection methodology, uncertainty analysis, consultation and/or review, and updating), some general conclusions can be drawn that would help to improve transparency and lead to greater consistency. To help provide a nationally-credible foundation for the process of setting baselines, a clear mandate from government and involvement of stakeholders are important first steps. As elements of baselines are considered according to the purposes they will serve (e.g. for policy analysis or goal setting), transparency in assumptions and methodologies could improve comprehension of baselines and progress towards goals for the international community. Comparisons of key assumptions and national datasets to internationally available sources could help address uncertainty and improve consistency across baselines.

A draft of this paper was discussed at the CCXG Global Forum on 26-27 September 2012, which attracted nearly 200 expert participants including representatives from 46 national governments, of which 15 were non-OECD countries. At the Forum there was general consensus that technical work on improving national projections was welcome, and that some form of guidance reflecting good practice for policy development would be useful for countries in the process of setting a baseline. Participants also agreed that it is important to clarify the purpose of baselines up front so as to distinguish which baselines are most relevant to the international community, e.g. baselines primarily intended for domestic policy design purposes may still attract international interest in relation to global emissions trajectories and mitigation efforts. Guidance for the baseline-setting process could then be designed building on the preliminary options presented in this paper.

Further scoping would be needed on the reporting process for baselines. While guidance on what is reported to the international community could provide greater clarity on global emissions trajectories, there is as yet no convergence in the UNFCCC framework on whether reporting guidance for emission baselines is necessary and on whether such guidance should be formalised and used to recognise baselines for defining pledges and to assess progress towards implementing pledges under the UNFCCC.

This paper proposes initial options for tiered guidance to improve transparency and clarity on national GHG emissions baselines. However several issues remain unresolved, such as how baselines might be reported to the international community. The tiered options for guidance could be further refined in future based on more detailed analysis of existing good practice, including lessons learned from Annex I experience in setting national baselines and reporting projections in national communications to the UNFCCC.

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